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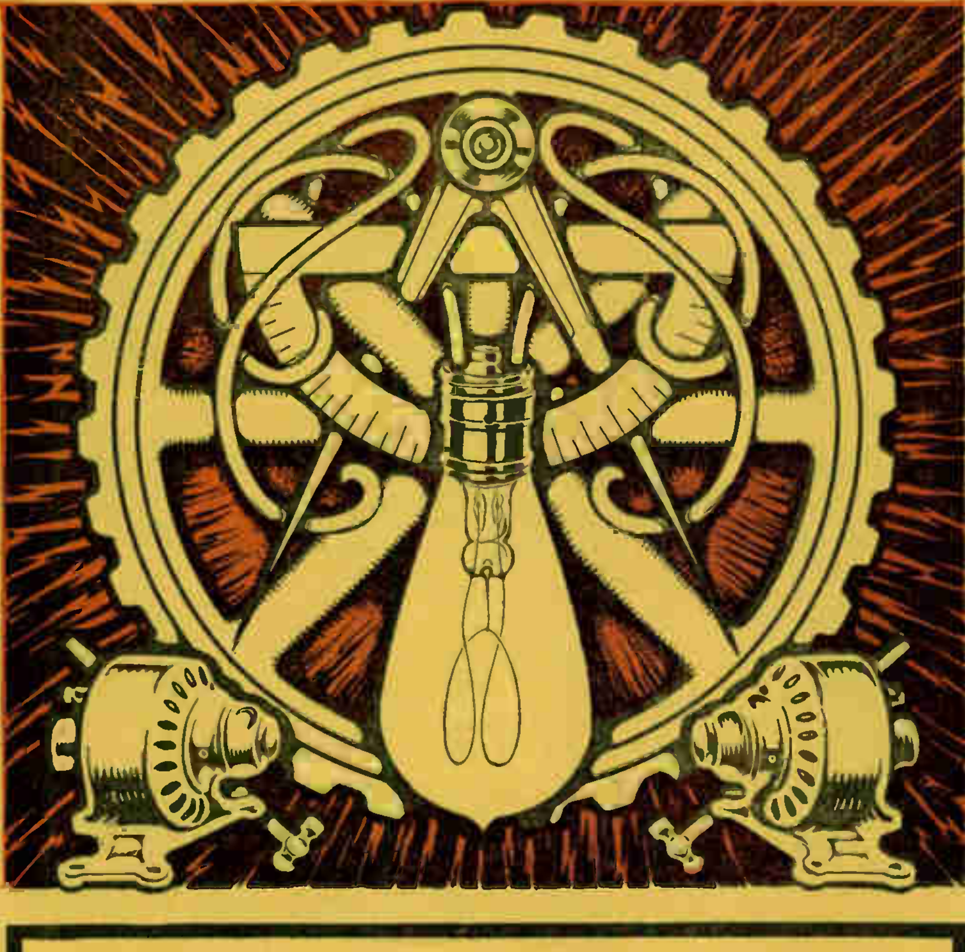
ELECTRICIAN & MECHANIC



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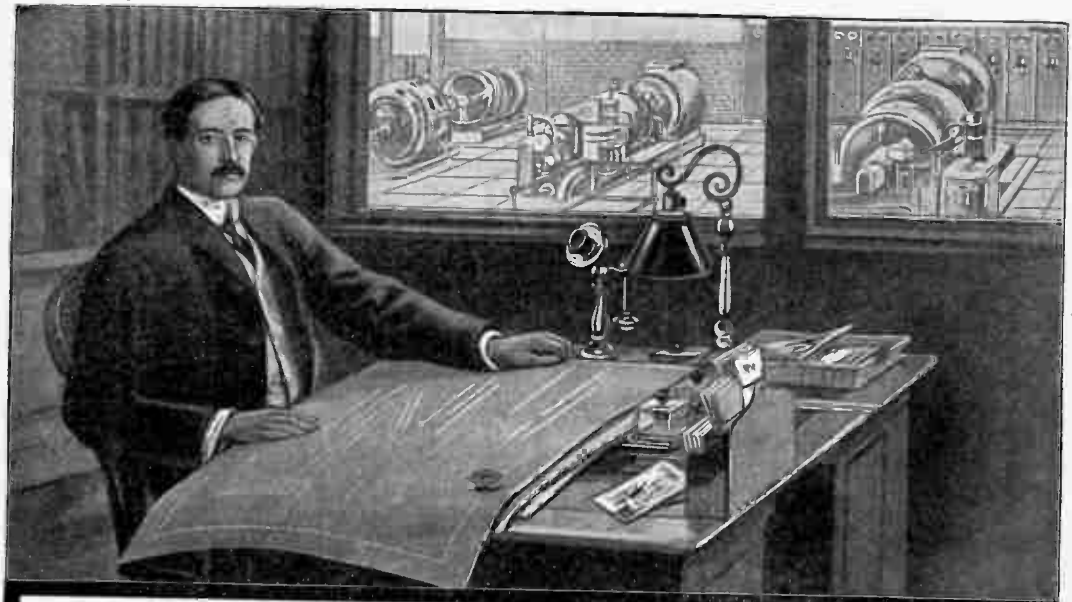

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ELECTRICIAN & MECHANIC

VOLUME XXIII DECEMBER, 1911 NUMBER 6

THE ELEMENTS OF MAGNETISM IN ELECTRICAL MACHINERY

WM. G. MEROWITZ

Men, engaged in the electrical trades are all more or less familiar with the phenomena of electromagnetism, but it is to the men in charge of electrical equipment and to electrical machine designers that this subject should be of first importance in the mastery of electrical engineering fundamentals.

The realization of all electrical power that we of the present day have at our hands is due entirely to that mysterious force—magnetism, the phenomenon of which is as unknown to us as the mystery of that invisible agent—electricity. For practical use we must reduce these quantities to definitions in previously familiar terms. Such definitions are only possible to comprehension when fundamental facts are clearly understood.

We know that without magnetism there would be no voltage induced in the armature windings of a generator, no torque produced in a motor or no transformation of electrical power in a transformer. Long ago Faraday discovered that when a piece of wire was moved across a magnetic field a voltage was induced in that wire by its cutting the magnetic lines of force, or conversely, if the magnetic field was moved across the wire the same effect would result. That is, when wire cuts 100,000,000 lines of force in every second of its motion an electrical pressure of one volt is set up. If the wire was bent into a closed circuit a current would flow; the strength of the current depending upon the resistance of the circuit. Faraday then followed up this discovery by finding that when a current flowing in a wire is changing in strength, it may induce a secondary current in another closed circuit near it. This principle is the sole means of producing electrical energy, for upon it are based the modern dynamo machines for generating electrical energy mechanically, as well as induction coils, transformers, and other appliances.

The generation of this energy is obtained by what we term electromagnetism. It is an established fact that if we wind a current carrying wire around a piece of iron as a core magnetic flux will be produced in the iron, which may either remain or disappear when the circuit is broken, depending upon whether the iron is hard or soft. Hence, to repeat Faraday's discovery and obtain a voltage in a generator, we have provided electromagnets to insure a strong flux in our generators and have arranged the wires that will cut this flux at right angles to the direction of the magnetic lines emerging from the electromagnets or field poles. The number of lines of force which are cut in a second by a wire moving in a magnetic field depends upon four items: (1) Upon the number of lines of force in each square centimeter; (2) length of wire which is in the field of field area; (3) upon speed with which wire moves, and (4) upon the angle with which the wire moves across the field.

Iron and steel are the only materials suitable for the construction of magnetic circuits. However, the following metals are magnetic substances: nickel, cobalt, manganese and chromium; but they possess magnetic properties in a very inferior degree compared with iron and its alloys. The relative ease with which magnetism may be produced in a body is called its *permeability*. The permeability of a magnetic substance at any stage of magnetization is a ratio between (1) the intensity of the magnetic force acting upon the substance and (2) the resulting magnetic density in the substance. That is, the quotient obtained by dividing (2) by (1) will be the permeability of the substance, and it varies with, (*a*) the flux density, (*b*) chemical composition of the iron and (*c*) the heat treatment which it may receive. In electrical machinery the magnetic circuit usually contains one or more air gaps. As air offers the greatest resistance to the passage of magnetic flux, the permeability of air is the lowest of all magnetic conducting substances. The resistance which opposes the passage of magnetic flux is

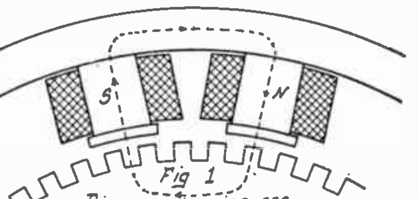


Diagram showing one magnetic circuit in a multipolar machine.

called *reluctance*. The reluctance of a magnetic circuit depends upon (1) the length of the circuit, (2) the cross-sectional area of the path and (3) the permeability of the substances which constitute the circuit.

The calculation of a magnetic circuit is a more complicated problem than that of an electric circuit, but the operation is much simplified by treating the magnetic circuit in the same manner as an electric one and applying the principle of Ohm's law. It must be understood that it is only the principle of Ohm's law which is applied, and not any of the actual electrical quantities. The magnetomotive force is that which tends to drive the lines of force along the magnetic circuit against a resistance. This resistance we have called reluctance to distinguish it from electrical resistance. The quantity of magnetism which is driven along the magnetic path can be found from the relation,

$$F = \frac{MMF}{R}$$

where F is quantity of magnetic flux, MMF is magnetic pressure, and R is reluctance. This equation is seen to resemble the familiar Ohm's law relation.

$$C = \frac{EMF}{R}$$

where C is the quantity of current, EMF is electrical pressure and R is resistance.

Whenever the lines of force are rapidly changed in the field poles of a machine, we encounter an effect which is called *hysteresis*. The iron or steel in the core becomes heated, which necessitates a certain amount of energy wasted. The energy expended by hysteresis is furnished by the force which causes the change in the magnetism; and in the case of an electromagnet where the magnetism is reversed, by the magnetizing current being reversed as in a transformer, the energy is supplied by the magnetizing current. The same effect is produced when the armature iron is rotated in the constant magnetic field of a d.c. machine; this case differs from the transformer magnet only in the fact that the magnetic flux remains at rest and the iron core is made to rotate. In this case, since the core is rotated from the armature shaft, the energy lost in hysteresis is furnished by the force, which drives the shaft. The loss of energy due to hysteresis depends upon: (1) the hardness and quality of the magnetic substance in which the magnetic changes take place; (2) upon the volume of metal in which the reversal takes place; (3) upon the number of complete reversals of magnetism per second, and (4) upon the maximum density of the flux in the metal.

In all electrical machinery, all the lines of magnetic flux produced by the magnetomotive force cannot be confined along one path; a certain proportion in every magnetic circuit will stray from the main circuit and take shorter cuts. This tendency is called magnetic *leakage* and as much as from 15 to 20 per cent of the field flux is lost in this way. The nature of magnetic leakage may be better understood by remembering that air is really a magnetic conductor, although its reluctance is much greater than that of iron or other magnetic substances. Consequently, when the reluctance of the main circuit becomes large at any point, some of the lines find an easier and shorter path for themselves through the air. Leakage is also caused by proximity of iron or steel masses, such as bearings and their pedestals, hence they should be placed as far away from the pole pieces as is convenient, or if they are necessarily close the castings should be of non-magnetic material. With a high degree of flux density in the armature, leakage is increased, as the flux will find other paths, when the armature iron holds practically all the flux that it can hold, or, as we say, when the iron is *saturated* with flux. Some loss in magnetizing force due to leakage is unavoidable, but even a comparatively large leakage represents but a small percent of the output of the machine, so that the loss in this regard is not excessive.

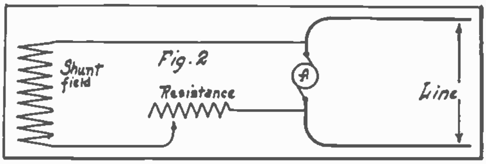
When a current is flowing in a conductor located in a magnetic field a reaction exists between the current and the field, so that a force must be applied to the conductor in order to move it through the field. This reaction is divided into two components; one of these acts in a direction at right angles to the field in which the armature revolves and so distorts it; while the other acts in a direction opposite to the field, and therefore reduces its strength. This effect is known as *armature reaction*, and the field windings of machines must be augmented with additional ampere-turns to counteract this effect and maintain the desired magnetic field strength. Another addition of field ampere-turns is also made to compensate for the leakage of flux mentioned previously. Results of magnetic excitation calculations are always expressed in ampere-turns, which is merely the product of amperes flowing in a coil of wire and the number of turns in that coil. Therefore, an increase of ampere-turns does not necessarily mean more wire; the amperes of exciting current may be increased, keeping the number of turns constant. It is the *product* of the two quantities that supply the magnetic flux, to give the desired voltage in a generator or drive a motor at a desired speed.

The current sent into the field windings of generators must flow continuously for continuous operation of the machine, and this field excitation may be produced in five possible ways:

(1) By using permanent magnets,
(2) By taking current from an outside source,
(3) By using a shunt winding,
(4) By using a series winding,
(5) By using a compound winding.

Whether the current flowing around the field poles is taken from the armature (self-exciting), or whether current is used from an outside source (separately excited), the object is to provide a magnetic flux which will enter the armature of the machine and flow around the magnetic path, as shown in Fig. 1.

Permanent magnets are used only for the fields of very small machines, such as magnetos for spark generation in gas engines, or for ringing bells.

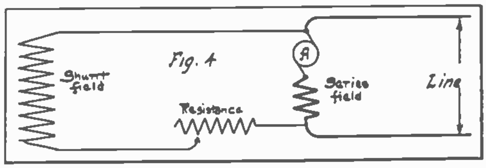


Current taken from an outside source, such as from another small d.c. generator or storage battery, is used to excite the fields of practically all alternators, as the alternating current produced by the armature, cannot be used to produce the desired flux, which must be induced by a continuous current. In the shunt winding, the field terminals are connected directly to the brushes of the machine, through a regulating field resistance (regulator), as shown in Fig. 2. When the shunt machine is started from rest there is a slight amount of magnetism in the field poles, and the rotation of the armature conductors in this residual field produces a small voltage, which sends a current through the field circuit and creates more flux, which in turn produces a greater voltage. This "building up" process continues until the rate of increase of flux is reduced with increase of field current which is due to saturation of the iron.

The series winding has the connections shown in Fig. 3. It is seen that this field wire which is in series with the armature must be large enough to carry the entire armature or load current. The magnetic flux in this field is thus proportional to the current in the outside circuit.

In a shunt machine the voltage at full load is always less than that at no-load. This is due to: (1) loss of e.m.f. in the resistance of the armature and brushes; (2) reduced field flux, on account of this reduced terminal e.m.f., and (3) to armature reaction, which weakens the field when current flows through the armature winding, and further reduces the terminal e.m.f. On the other hand, in series machines, the e m.f. usually rises with the load, as the same current flows through the field as does through the armature, and the magnetic flux is thereby increased with increased loads up to the limit of saturation of the field cores. Now by combining the shunt and series excitation on the field winding of a machine it is possible to maintain the same terminal e.m.f. at full load as at no-load. Such a winding is called a compound field winding, and is shown diagrammatically in Fig. 4. By correctly proportioning the series winding in this combination, the terminal e.m.f. at full load may be greater than that at no-load.

It is seen then that magnetism is the important essential to the generation of electrical power or the operation of electrical machinery. Whether the magnetic flux is induced by a direct current,



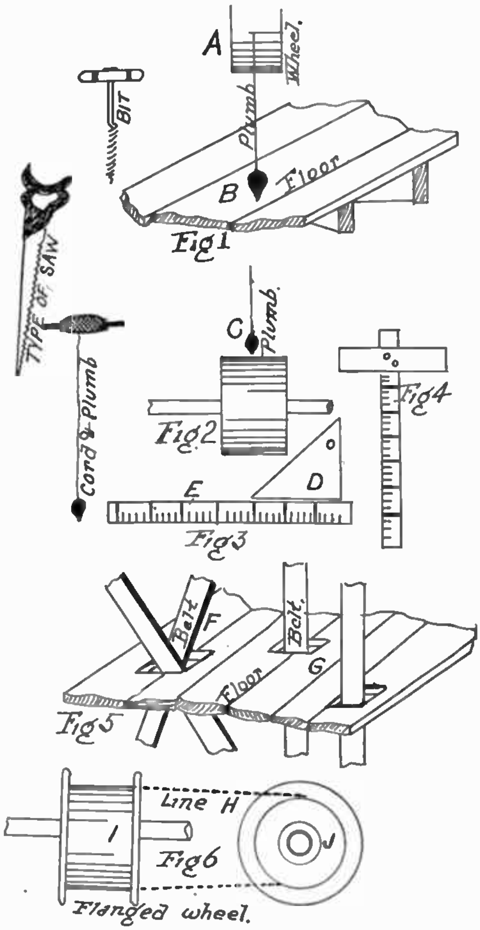
as in d.c. machines and the fields of alternators, or by alternating current, as in the cores of transformers and a.c. motors, the fundamental principle involved is that an electrical conductor must cut lines of magnetic flux, or be cut by that flux, either to generate power or to do mechanical work.

CUTTING HOLES THROUGH FLOORS FOR BELTS

GEORGE RICE

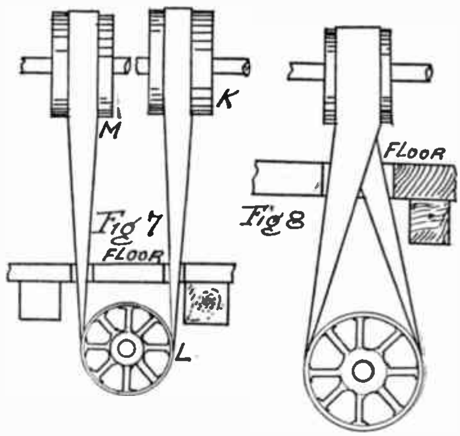
There is a little problem of cutting holes through floors in mills for belts which is a frequent source of annoyance to mill men. Let us see how it is done. We will take it for granted that a hole is needed through the mill floor to make a passage-way for the running belt driven by the shaft of an upper room, and connected with a shaft for a lower room. It becomes necessary to get some form of slot through which the leather or canvas belt may run. Now then, I have seen workmen go at this thing with a hatchet or axe and chop and shatter until some style of opening is made. The result is that a very rough, crude slot is produced. Then again some workmen will strive to get a very smooth slot, and succeed in doing so, but that slot will be entirely unsuitable for the service required. Sometimes the slant of the slot with the angle of the floor and the running belt is not right. Often the slot is too small in proportions and the belt edges rub against it and are worn and ripped. Then the slot is oftentimes too large and too roomy for guiding the belt, and increased to a size which permits articles to fall through the floor to the apartment below. It is the desire of the mill man to get a perfect slot in the floor, of the correct angle for the inclined belt and shaped to harmonize with the conditions.

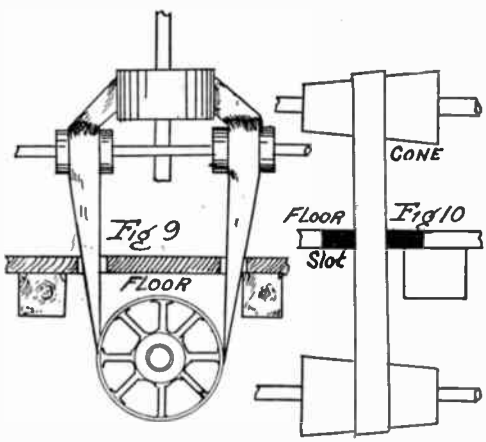
Let us first see what tools are needed. One ought to have a bit-stock with some bits. With the ⅝ bit the hole is put through the floor at the corners designated by the pencil or chalk lines. Then with the common type of key-hole saw, one may saw out the section and make the desired slot for the passage of the belt. The plumb line may be used as in Fig. 1. Get the center of the driver or overhead wheel and set the line on it as at *a*. The center will be at *b* on the floor. If the belt is a straight one, there will not be much trouble in cutting the slots through the floor to correspond with the center plumb line, as at *c*. But if the wheels make a quarter or a half turn, or if the belt runs on cones, or if flanged wheels are employed, some special construction of the slot will be required. The angles



will have to be marked off properly. This can be done with the ruling stick *e*, Fig. 3, and the triangle *d*. The stick is a simple hardwood one, and can be utilized with the common rule of designating angles. If the belt crosses in effecting the quarter turn, as at *f*, Fig. 5, the worker will require these marking devices and also the T-square shown in Fig. 4. The center may be located with the plumb bob and line and then with the drawing instruments the lines for cutting out the block may be defined. When the belt passes straight through the floor as at *g*, the work is simplified a great deal. But with the requirements of the half turn or the quarter turn, the hole must be made correctly, otherwise the belt will chafe on the hard edges of the flooring. Using the center point of the marked section, work outward, describing the needed oblong-shaped slot, inclined so as to harmonize with the turn of the belting.

This can be done readily with the drawing instruments shown, providing the workman gets the right start. One can readily imagine the cross of the belting in the center between the two pulleys, and the slot may be shaped to correspond with the turn thus made. In Fig. 7 is exhibited the form of driving system often used when it is necessary to drive two lines of shafting in opposite directions on an upper floor, through the ceiling. The driver is at *l* and the driven wheels are designated *m* and *k*. It is not a hard matter to define the cutting lines on the floor for the shaping of the slots for this purpose. The workman may get his centers with the plumb and line and gauge these centers to harmonize with the wheel rim below. Then he marks off the sizes and forms of the slots to accommodate the running belt. An allowance of something more than ½ in. play on either side should be made for an ordinary belt. If the belt





has some special duty to perform, such as the driving of a machine which calls for extra exertion at times, thereby causing the belt to flay and sway, a margin of an inch or more will be necessary.

In Fig. 8 is shown a type of crossing of a belt at the floor line which results from the turning of the angles of the shafts carrying the wheels. The half turn thus effected requires the modeling of an oblong hole, the same to be expanded a little at the driving edge of the cross. Here we get a center again with the plumb, and mark off the shape of the hole with the pencil or chalk and cut out the wood flooring accordingly. Now and then we get a combination of the nature exhibited in Fig. 9. Here there is an upright shaft to deal with. The belt is made to take a turn around the wheel on the upright shaft and then run down to the wheel below the floor at another angle over the two guide pulleys, as shown. In order to cut the holes through the floor for an installation of this character, we locate the centers for the holes from the two pulleys on the guide shaft. Place these pulleys in line of operation, just as they will run when in service, and then strike the center line through the floor boards to the center of the rim of the wheel on each side below. The common center thus obtained in the woodwork will furnish the object from which to define the angles of the slots. The lines are marked off in the usual manner, and then comes the boring and cutting.

Occasionally there will be a cone system for our attention. This means that quite a prominent slot will have to be made. The slot should be of ample length to allow the belt to move readily back and forth on the line of the cones. Fig. 10 explains the situation. In the varying of the speed of the machinery by means of moving the belt back and forth on these cones, plenty of slot room is needed. The workman strikes his center for cutting as before, and proceeds as in the former cases, except that when he cuts the length of the slot, he will have to add on sufficient space to permit the belt to have plenty of room.

FILES AND THE ART OF FILING

F. W. BENTLEY, JR.

Ever since man in his most primitive condition began to construct things requiring a mechanical operation, files and filing have played an important part in the advancement of his skill in the manipulation of tools. Even though the file of our ancestor of the stone age was only a flat rough stone, nevertheless in its use he was on the high road to the use and manufacture of one of the most essential and important tools used by the mechanic today.

History is interesting, and but few mechanics have any idea of the file's antiquity. Proof that files of a metallic nature were in use at a very early date is gained from the Bible. The first book of Samuel, XIII, 21, mentions the use of files for sharpening the coulters, goads, and mattocks, proving that the art of filing had passed from the flat rough stone of the earlier period, to the use of a metallic implement later on, thus maintaining itself a suitable instrument for working the material of the earlier mechanic, whether such material was of wood, stone or iron.

In the metal trades there is perhaps no more difficult a task than that of expertly filing. The cutting tools of the shaper and planer are stationary and solid. The work is held to the bed which is moved unswervingly in the parallel ways. On the other hand, the use of the file is manual, and consequently requires much patience in practice with it to execute good work.

Fig. 1 Side view of file, exaggerated to show plan of convexity.

A good test in the art of filing is to secure a true flat surface upon a piece of narrow work, a piece, for instance, about one-eighth of the stroke of the file. To those not familiar with the construction of the file it would perhaps seem necessary that the file should possess a perfectly flat and true cutting surface, and be moved in a perfectly straight line across the work. Assuming that such might be the case, the pressure applied by the operator at both ends of the file in moving it would produce a slight concavity to its cutting face, and cause a rounding surface on the piece of work under the file.

In order to eliminate this, the file is given a light convexity to its cutting faces, shown by Fig. 1. This affords a smaller cutting area and enables the operator more easily to strike the spot where a cut is necessary. In truing up many kinds of work possessing a plate or table-like surface, the absence of convexity in the file would render it of little use, as it would then be hard to touch the higher spots indicated by the straight-edge or face-plate.

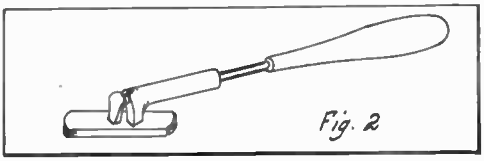


Fig. 2

Too little attention is often given the file handle. Many times it is forcibly driven half-way up the tang, doubling the chances of splitting the turned wooden piece. Where the tang hole is too small, the tang should be heated, carefully, so as not to draw the temper of the file, and the body of the tang burned snugly up into the handle.

The variety of work on which the file is used necessitates a great many shapes and sizes, and with a great many different cutting faces. In many operations connected with work on the lathe, a long file is useless because of its length.

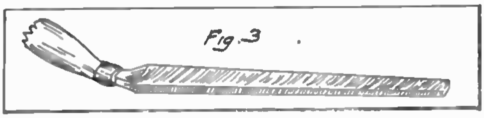


Fig. 3

A stub file with a suitable holder is often used. These pieces or stubs of file are of great variety with regard to their cutting faces. An idea of their construction and utility on lathe work can be gained from Fig. 2.

To file and spot large table-like surfaces the tang is frequently bent up as in Fig. 3. The tang is also sometimes held by the handle arrangement shown in Fig. 4. These methods, although well enough to some extent, do not give the workman the opportunity to use the file as well as the arrangement shown in Fig. 5. The full benefit of the convex provision in the file can be secured and eliminate much of the work done by the scraper.

There are a great many ideas among workmen as to the height the vise jaws should be from the floor. This is because, no doubt, of the varied work which different users of the file are accustomed to perform.

The best height for general work is gained by bringing the jaws of the vise to a level with the elbows of the workman. This height will be found on an average to be from 40 to 45 in. This altitude enables the use of a full free swing of the arms from the elbow. If the work is of a small or delicate character and requires simply a movement of the hand or arm, the jaws can be a little higher, in order that the workman can stand more erectly, and be better enabled more closely to scrutinize the work in the vise. If the work is of a heavy nature the jaws should be somewhat lower than the elbow height, to permit the weight and momentum of the body to be thrown upon the file,

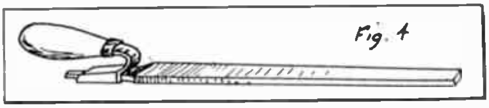


Fig. 4

causing it to bite deeper and be more easily pushed over the work. At this point it might be well to consider the mode of grasping the file while performing work of a heavy nature. As such work necessitates the use of a heavy file which must be held firmly by both hands, it can best be held in such a way that the end of the handle fits into and brings up against the fleshy part of the palm below the joint of the small finger, the thumb lying along the top of the handle in the direction of its length; the finger ends upwards. The point of the file is grasped by the first two fingers and thumb, the hand to bring the thumb, as the ball presses on top of the file, in

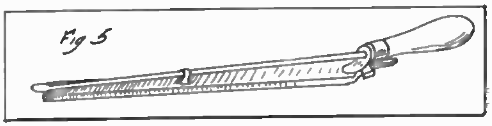


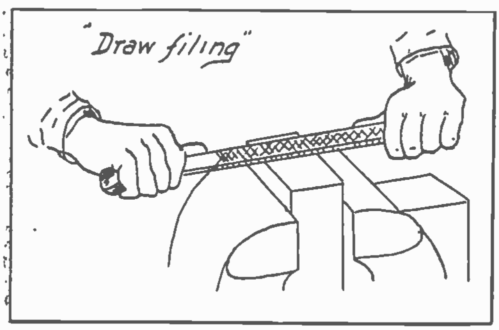
Fig. 5

line with the handle, when the heavy strokes are required.

With the lighter strokes less pressure is required on the file, the thumb and fingers can change directions until the thumb lies at right angles or nearly so with the length of the file, the position easily changing more or less with the pressure required on the file.

While filing the natural tendency of the hands and arms is to carry the file in circular lines, as the joints of the limbs act as centers of motion. This movement of a convex file would appear to give a concavity to the piece of work, but the tendency, more especially on narrow work, is quite the reverse, as the work acts as a fulcrum over which the file gains a rocking motion, giving the work a convexity, except when the file is in the hands of a skilled operator. The point then is to cause the file to deviate only enough from the line of straight motion so as to feel that each inch of the stroke is brought into exact contact with the desired portion of the work. This ability when acquired will prevent "grooving," and give the true and even surface.

For the good of the file and the work also, the pressure should be relieved on the backward stroke of the file. An examination of the teeth will show that the file can cut only on the forward or advancing strokes, and that pressure applied on the backward stroke is indeed damaging to the file.



Draw-filing is the operation of using the file much in the manner of a spoke-shave. Files of ordinary make do not cut except when used with a forward stroke, and the same file cannot be used to best advantage in draw-filing unless care is taken that the teeth present themselves during a forward movement of the file at a sufficient angle to cut instead of to scratch the work. When properly done work can be finished finer in this manner, and the scratches more closely congregated than by an ordinary use of the file.

When properly used and taken care of the life of a file is by no means a short one. When no longer serviceable on one class of work it can be efficiently used on another. In the case of a file used for finishing larger surfaces of cast iron, its next best service is on smaller work of the same metal. As it has been somewhat worn by cutting larger areas of cast iron its teeth will not tear or rip the more narrow work of the same material.

The file best suited for general work will not serve as well on softer metals as those having teeth especially set for those metals.

Files when sent out from the factory are coated with oil to prevent their rusting during shipment. In some cases the oil will not interfere with the immediate use of the file, as oil can be advantageously used while filing metals of a hard fibrous nature. Upon finer work in steel or wrought iron the use of oil will prevent the disagreeable scratch or drag of the file.

Where the oil interferes with the cutting qualities of the file, it is easily removed by filling the teeth with chalk, which readily absorbs the oil, and cleaning out everything with the wire file-brush.

One of the most destructive customs is that of loosely throwing files, fine and coarse, small and large, into a drawer filled with cold chisels, hammers, sets, etc., and then throwing other heavy tools on top of them. The teeth of the files thus come into forcible contact with metals harder than themselves, and they are soon useless for work of any kind.

One day an Irishman was asked to come to work an hour earlier than usual. This he promised to do. Next morning he was an hour late. "Shure, sor," he explained, "I should have been no good if Oi'd come, as I was fast asleep at the toime."—*American Boy.*

ELECTRIC LIGHTING FOR CYCLES AND MOTOR-CYCLES

HAROLD H. U. CROSS

There are three systems of installing electric light upon cycles, *viz.*, accumulator systems, battery (primary) systems, and, lastly, generator systems, each possessing points of merit. Most lamps on the market will require no alteration beyond a change of bulb to suit any one of the current-producers; and, indeed, many lamps will run equally well off both batteries and generators, which is a very desirable precaution against a possible breakdown; as, if a small pocket-lamp battery were carried in addition to a generator, it could be switched in circuit with the same lamp on emergency.

The first costs of electric lamps vary from about $1.00 to $5.00, according to the pattern and style of finish; thus, for those who want a searchlight to project a beam from 5 to 600 ft., the cost would be the latter figure; while those whose requirements would be amply met by a moderate light, such as is given by a good oil lamp, the cost would approximate to the former figure. Electric lamps have a decided advantage over oil and gas lamps, in that their light is perfectly white, and also, owing to its high degree of concentration, a comparatively low candle-powered bulb will give excellent results, if used in a lamp that adequately focuses and dispenses the light.

DRY-BATTERY SETS

There are two sorts of batteries in common use, one termed "ordinary" and the other, which is infinitely better, called "double life;" the exact constructional difference between these two kinds

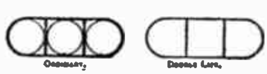


Fig. 1

will be rendered clear by the diagrams in Fig. 1, which show the two arrangements of the cells contained inside the black cardboard case, indicated by the outside lines in each instance. It will be observed that the cells in the "double life" battery are specially made to fit the whole of the case, and so employ the maximum active material, which consequently increases their life very considerably. There is one other cell of special interest, that is, a battery which is shipped "dry" and which will not deteriorate in stock, or become exhausted by accidental short-circuit of its terminals or connectors, as it is quite inactive until excited by filling with water. The base of the battery, comprising the usual three cells, is fitted with removable rubber corks, covering three holes communicating directly with the interior. To use the cell requires only the addition of water (distilled or otherwise); they are then essentially the same as the usual

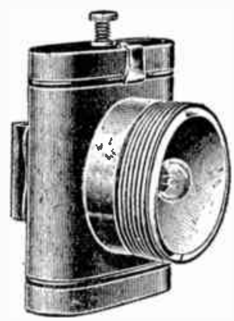


Fig. 2

genus; but the writer is inclined to favor the ordinary type, as he has found the voltage a little uncertain in these small sizes; but in the larger ones the voltage is distinctly higher than in the ordinary species. Also, when run down, they can be more easily recuperated by the application of salammoniac solution. The cost of the "ordinary type" battery is about 20 cents, while the superior type mentioned is about double that amount, so also the "export" type. The voltage of each battery, comprising three cells joined in series (*i.e.*, zinc of one cell connected to the carbon of the next, and so on), is 4.5 volts, and the capacity on a .3 ampere discharge is sometimes as high as two ampere-hours, although, owing to the nature of these cells, which scale but a few ounces, the exact amount of energy obtainable is very uncertain, principally owing to the complex actions and reactions which take place inside them. Some makers guarantee the above capacity. Basing our calculations upon the two ampere-hour assumption, the cost of current works out at approximately

1½ cents per run of one hour's duration, which, all things considered, is not exorbitant. Fig. 2 shows the kind of cycle-lamp in which these small dry batteries are used. It is a thoroughly serviceable article, although most people prefer the battery to be separate from the lamp; also, their small capacity is a decided drawback. It is possible to increase the capacity of such a set by using a battery of two cells instead of three, which will allow of another ampere-hour (at the same rate of discharge) being obtained from it. A special lamp fitted with an opal glass reflector compensates for the decrease in voltage. Fig. 3 gives a fair idea of the special high-efficiency tungsten lamp required.

Fig. 3

The voltage of the lamps for a three-cell and two-cell battery should be 4.5 and 2.5 respectively; although, in the former case, if the conducting wire is thin flexible, it will add to the general efficiency of the system to use a 3.5 volt lamp. The cost of all these small lamps is about 30 cents each; but one must be very careful to purchase lamps whose current-consumption is .3 of an ampere, otherwise the installation will not give satisfaction, as with cells of the size in question it would not be possible to obtain a heavier discharge than this for any length of time. No wiring will be needed with the above set, as the connections are automatic, as is the case with all pocket flash-lamps. Most readers will, of course, prefer to use a battery separate from the lamp, as previously stated. Such a set as is shown in Fig. 4 is a typical example of a good solid lamp suitable for rough treatment, such as it would get on a motorcycle. The switch is shown at the back of the lamp, and the case is attached to the rear of the top tube of cycle. The best battery to carry is one of those that are used with house-lanterns, and the like. Measuring 3 in. high, 3⅞ in. long, 1⅜ in. wide, such a battery would provide enough current for a half-hour's run each day for over two months; owing to the increase in active material; also, an enormous gain in the direction of efficiency. All lamps made to fit small Edison screw bulbs will do for the above dry-battery system; so, also, will they

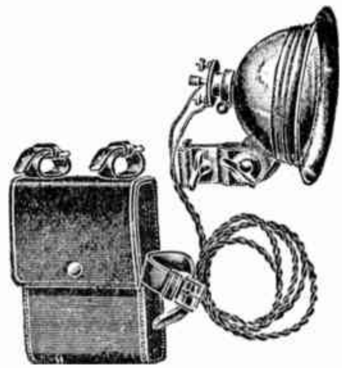


Fig. 4

answer for the ensuing applications of electricity to cycle lighting, with the exception of a special high candle power lamp which needs a small candelabra bayonette cap-holder. It is a wise plan to carry a small pocket refill as a spare.

It is not a difficult matter to construct a very crude but serviceable cycle-lamp, such as indicated by Fig. 5. It merely comprises a lamp-holder, as depicted by Fig. 6, arranged in a convenient-sized wooden box, with a hinged lid kept in position by the little fastener, as shown in Fig. 5, or retained by screws or tacks. To attach it to the lamp-bracket, a strip of thick rubber, such as is used for mats (or, in default, a piece of shoe leather), is fastened on to the back by means of screws bearing upon thin washers (to prevent the heads from cutting the material), so that the lamp-bracket is a tight fit when pushed into position. The angle of the lamp may be altered by placing a wooden wedge between the bracket and the strip. A metal socket would be, if anything, a little more workmanlike in appearance; but the rubber or leather takes up the vibration and remains silent. The lens in front can be obtained from any cycle-dealer, and is

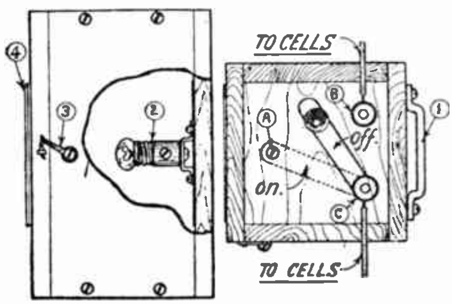


Fig. 5

designated as a "double convex." The necessary hole to take the lens is executed with a fret-saw. The front of an old oil or gas lamp can be readily fitted into its up-to-date electric competitor, owing to the metal rim that accompanies it being extremely easy to push into its position. If a glass lens alone is obtainable, it must be secured in its place with clips and putty. Behind the lamp is fixed a circular piece of bright sheet tinned iron, to act as a reflector, and the lamp can then be finished off with a paint or black enamel to taste. The method of connection is as follows: a short length of insulated wire is taken from one of the screws fixed on to the lamp-holder to one of the terminals (marked *B*), and a second wire is run from the other connection screw on lamp-holder to the brass wood screw marked *A*, which can be placed into contact with the terminal *C* at will by means of the movable brass arm. The battery is joined to *B* and *C*, and when the switch-arm is over *A*, the lamp will receive the necessary current. The lamp globe utilized is the special high-efficiency one (see Fig. 3) of 2.5 volts pressure, or 3.5—4.5 volts in the case of the three-cell battery. In conclusion of this section, the writer desires to mention the fact that the illuminating power of all these low-voltage lamps is owing to the intense whiteness of the light, and therefore the amount of light given by day is scarcely discernible; hence judgment should be reserved until nightfall. The dry-battery system, particularly the smaller equipments, are the most expensive of all methods, but form reliable stand-bys.

ACCUMULATOR SYSTEMS

The greatest drawback in connection with cycle-lighting accumulators is their uncertainty of action after a week or so of inactivity. With a dry battery it is quite feasible to use it for half an hour, then leave it in disuse for a month or more without much fear of the energy dissipating; but not so with the small accumulator battery. This must not be expected to yield a satisfactory output long after charging has ceased. In the very earliest pocket cells, pitch was used, which naturally proved very unsatisfactory, owing to its hygroscopic nature, and the resultant electrical leakage.

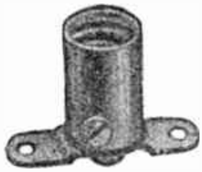


Fig. 6

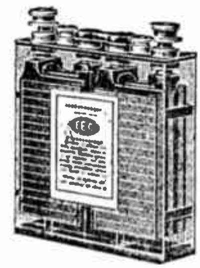


Fig. 7

Cells of a later date appear to be sealed with black wax, which, though a great improvement, is much in the rear of a celluloid case. Fig. 7 shows a typical celluloid accumulator made for our special purpose. It is about as near perfection as is possible in the light of the present knowledge. The plates measure 3 in. long by 1$^{11}/_{16}$ in. wide, and the complete accumulator contains four negatives and two positives, arranged three plates per cell, of which there are two cells joined in series in the usual way. When discharged at one ampere, this battery will last five hours continuously; therefore it is admirably suited for lighting a 4-volt, 4-c.p. metal filament lamp, which it will do for five hours with the most efficient makes of bulbs. It can be employed in conjunction with the high c.p. lamp described later, as, owing to the rigid construction of the negatives, it will stand a discharge of two amperes without injury to the plates. The first cost of such a cell is $1.50, which, when contrasted with a dry battery, is high; but it must be borne in mind that its upkeep is very low, as most garages and electricians "charge up" such a battery for 10 cents, which sum provides the necessary illuminating power for a lamp for over 15 hours continuously, and even when used in the customary manner, the cost of light would not reach one cent per hour.

There is one point in connection with the smallest-sized accumulators (such as are used in pocket flash-lamps and in the cycle lamp shown in Fig. 2 previously), which is of first importance, *viz.*, the voltage of these must not exceed two, as the employment of more than one cell is fatal to success, as it is not possible to stop the electric leakage between the cells, which reaches a very high value in the cells under consideration. It will be self-evident that there can be no "between cell" leakage in a 2-volt accumulator; hence the only wastage path is from plate to plate, via the sealing-in compound or celluloid lid, as the case may be, and this leakage is again retarded by the decrease in electro-motive force, as it is reasonable to suppose the conductivity of the parasite circuit is the same, as the external case is the same size with both voltages; therefore, we see that, by Ohm's law, the waste of current must be decreased by one-half. A further point of interest, which is quite consistent with the dry-battery lore previously set forth, is the doubling of capacity, which results in halving the pressure—*e.g.*, a "dry" accumulator, such as used for the above class of apparatus, will light a very high-efficiency lamp six hours at a stretch, when its two-minute cells are joined in series. When connected up in parallel it will last for twelve hours on a 2-volt lamp. It is hoped that no one will be misled into thinking that the *light* is equal in both cases, for, of course, this is not so; but there are ways of compensating to which allusion has already been made. There are other minor advantages that the 2-volt has over the 4-volt accumulator of this small type, of which, perhaps, the increased capacity for acid is not the least important. The method of charging these accumulators calls for a brief notice. In the first place, all, or nearly all, of the very small cells are what is known as the "dry" type, which are about as much "dry" as their well-known primary competitor. They use the ordinary sulphuric acid diluted to a specific gravity of about 1.20, absorbed by means of "glass wool," a material of the nature of "spun" glass. This absorbed electrolyte works exceedingly well in these miniature cells; but the writer is inclined to favor the jelly acid for their larger prototypes, if one *must* use non-spillable acid. A useful formula for jelly acid is as follows: acid sulphuric, 1.250 s.g., to be mixed with a dilute solution of sodium silicate; 1.180 s.g., in the proportion of three of acid to one of the silicate solution. When first made the solution is colorless, and it should be poured into the accumulator as it begins to thicken; after 24 hours it will set to a jelly, having a bluish tinge.

The charging rate of the cells must not exceed ½ ampere in the smallest size, and ¾ ampere for the large size, as illustrated (Fig. 7). The cell can be charged in series with a lamp off the house supply, if such exist, providing the current is "direct," or they can be charged off a modified form of Georges Leclanché's time-honored production, known under the name of the sack type cell. Various firms have even improved this, and called their respective appliances by names suggestive of their use. Two of such cells, when joined in series, will charge 2-volt pocket-lamp-sized accumulators in six hours, and four will charge the similar 4-volt battery in about four hours. Connection can be made direct from the cells to the accumulator, no resistance being needed; but care must be taken to attach the wire from the zinc electrode to the negative terminal of the accumulator, and not *vice versa*. If an ammeter reading decimals of an ampere is at hand, it will be well to include it in circuit during the charging operations, as if, by any chance, the current flowing exceeds .5 of an ampere, the cell may polarize and fail to "charge." Should it not be convenient to use a meter, test the battery from time to time with a lamp, taking care to previously disconnect the accumulator. At the conclusion of the charge the battery can be put away as used, and will keep in perfect order until further required. Before charging is commenced it is necessary to note that the accumulator has its full complement of acid, and, in the case of the dry type, add a little with the aid of a fountain-pen filler before proceeding to charge, in any case.

A few notes as to the method of fixing the accumulator to the cycle may assist. A stout leather satchel or case is the best and neatest device for the conveyance of the storage battery. It should be fixed to the rear of the machine, as suggested previously, taking great precaution to minimize the vibration by securing it with stout straps. The inside of the case and lid should be well rubbed with vaseline or soft candle fat, in order to render it acid-proof and to keep it supple. Of course, this does not apply to cases that have an additional acid-proof lining. In connection with the dry-battery set, it would be quite satisfactory to use a canvas case for the transport of the cells.

A HOME-MADE STORAGE-CELL

Those who wish to *make* a small storage cell, such as is used in connection with the special 2-volt lamp, the following details may assist. In the first place procure two negative plates measuring 4 x 2 in. x 5/32 in., and one positive plate of the same dimensions; also one piece of corrugated celluloid, size 4 x 4 in., of medium thickness, and two small terminals for connection purposes. The cost of these materials should not exceed 50 cents, allowing for the necessary cigar-wood and wax. The corrugated celluloid is to be cut down the middle, which will produce two pieces the size of our plates; next, mount the positive plate between the two negatives, and place the separators between them, so that the positive plate is insulated from the negatives on either side of it. A rough measurement should now be taken of the over-all sizes, so that the containing case may be prepared. With the plates in question, a cigar-wood box should be constructed, whose internal measurements are 5 in. high, 2¼ in. wide, and 1⅛ in. in thickness. The pieces of wood having been cut to size, they must be treated with melted paraffin-wax as follows: Take an old pie-dish, of such a size that the wood pieces will lie comfortably therein, and melt up a few ounces of paraffin-wax (commercial quality). When quite liquid, immerse the wood, and give each piece a thorough soaking in the melted wax. After the above treatment, the box should be constructed in the ordinary manner, and a further quantity of wax must be run in at all corners, seams, and the like crevices previous to its final pasting with semi-liquid wax to the thickness of about ⅛ in. When set, the lining can be gone over with a warm piece of metal, to render its surface reasonably smooth. Two pieces of wood must be fitted in the bottom coating of wax for the plates to rest on, as, if the plates were allowed to lie direct on the wax at the base of the case, no provision would be made for falling paste, etc., which in time would accumulate to such an extent that the cell's action would be seriously hampered. If the wooden rests are warmed slightly, they can be pushed into the wax coating; or a better plan would be to affix them before the wax has set, during the lining process. The plates can now be introduced into the case, and fixed in position by means of small paraffin-waxed pieces of wood. A cover-piece of waxed wood must now be prepared, with two holes for the lugs of the plates to pass through, also a third one for the introduction of the acid. The terminals should be fixed to the lugs, as shown in Fig. 8, *A*. In the event of the lugs being too short, further pieces of sheet lead should be connected to them, which can be readily accomplished by means of a soldering-iron, taking the precaution to well clean the lug and the additional connector before attempting to join them. This joint should be protected from the action of the acid by coating it with cycle enamel; the outside

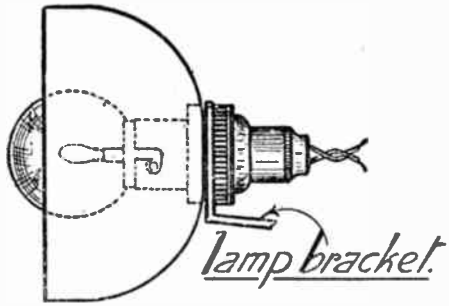


Fig. 8, B

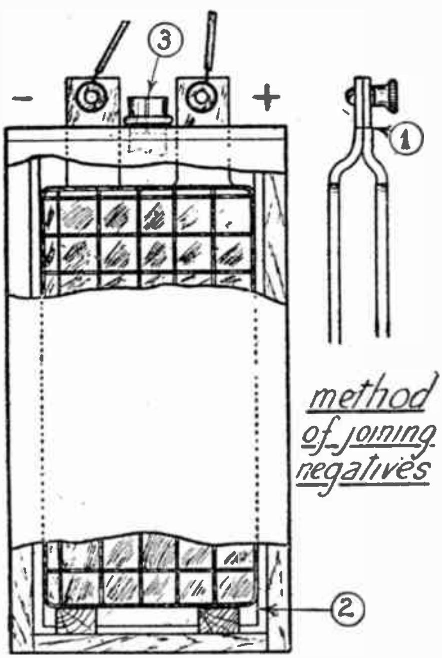


Fig. 8, A

of the case should also be finished in the same manner. To render the cell acid tight, it is not a bad plan to pack the inside with woven glass, or to run in black wax, taking care to put a skewer or pencil into the acid-hole* before doing so, in order to secure a free passage through the wax. (Note the skewer should be removed as the wax is setting; also it is as well to put the acid into the cells before pouring in the sealing compound, as, if by any chance the compound finds its way past the wooden lid, owing to bad fitting, the cooling effect of the acid will prevent its further progress.) If it is desired to construct a 4-volt battery, make up two of the above and glue them together, taking care to connect the positive terminal of one to the negative terminal of the other cell, thus leaving a positive and negative connection free for the attachment of lamp cable.

HIGH CANDLE-POWERED LAMPS

Many readers will doubtless wish to use lights of the maximum power possible with so small an accumulator as can be conveniently carried on the cycle. The accumulator illustrated in Fig. 7 will run a lamp giving 8 c.p. for two hours continuously without injurious results, for reasons already mentioned. The lamp indicated by Fig. 8, *B*, essentially consists of an ordinary lamp-holder, fitted with a parabolic reflector 2¾ in. in diameter and 1½ in. deep (which can be purchased at most electrical shops for about 25 cents), together with an 8 c.p. 4-volt pipeless tungsten lamp, whose filament is so arranged to give the maximum effect with the above type of reflector. The cost of the lamp bulb is 60 cents. The complete lamp is fixed on to the cycle-lamp bracket, as shown in figure, and connected up in the usual way. A switch can be placed at the back of the lamp where most convenient, or it can be fitted to the accumulator case if preferred. The illumination obtained with this lamp is very high, as compared with the impromptu lamp described previously. For runs about town, where a powerful light is of no advantage, the special converter now on the market effects considerable saving. The device consists of an adapter that fits a small bayonet cap-holder, and contains a small Edison screw-socket, which accommodates all the usual low-current consumption lamps. The cost of the device is but little more than an ordinary holder.

MAGNETO SYSTEMS

Magneto electric lighting, though not by any means new, since the time of Michael Faraday, has only quite recently been adapted to the cycle and motorcycle, as before the metallic filament lamp was evolved on a commercial scale, any effort to displace batteries, both primary and secondary, was futile, owing to the peculiar nature of the carbon filament. With the metallic lamp, the regulating effect of the filament is in the desired direction, and as the generator speeds up, the filament's resistance rises† very approximately in proportion; also the weight of the apparatus for producing the current is a matter of very small moment, now that efficiency of the lamps is so high—in fact, the complete outfit does not weigh 2 lbs.

In general principles, the lighting magneto is precisely similar to the well-known ignition magneto, and consists of a coil of insulated wire wound on an iron cylinder, rotating between the poles of a permanent horse-shoe magnet, electric connection being established to the rotating portion by means of having connected one end of the wire on the cylinder directly to the iron, and the other extremity is attached to a little metal ring (technically known as a slip-ring) mounted on a piece of non-conducting material. This ring is arranged to touch a small copper gauze brush which is secreted in the insulated terminal. To use the current, all that it is necessary to do is to connect one wire from the lamp to the metal frame, which is in electric connection with one end of the wire on the cylinder, and the other wire to the insulated terminal. The photograph, Fig. 9, shows the device in working position. It will be noticed that the machine is driven from the front rim by the aid of the small rubber pulley on the right-hand side of the magneto (it is possible to drive from

* When in use the acid-hole should be closed with a cork treated with paraffin wax; the neck of a 2 oz. glass bottle forms a very serviceable bush to mount the cork. In any case, leave a pinhole through the cork for any gas to escape by.

†With the old type carbon lamp precisely the reverse takes place, as the electrical resistance of carbon is *lower* hot than when cold.

Fig. 9

the back wheel, but the front is in many ways preferable). This pulley needs to bear lightly on the rim, to get a satisfactory drive. The switch, upon which the operator has his fingers at the top of the picture, is attached to the handle-bar and is connected to the magneto by a spring connector so arranged that a slight twist of a small knob releases the tension on the spring and allows the magneto to disengage from the rim and assume the position of that in Fig. 10. The lamp is connected by means of the flexible cable, as shown, and the current controlled at will by means of an electric switch on the straight portion of the lamp. The switch can be seen projecting a little above the lamp-stem. The necessary wires and fittings do not in any way interfere with existing arrangements. The letter *A* indicates the position of the spring that controls the magneto drive. It will be obvious that the rider can manipulate the switch-gear without dismounting. The letter *B* points to the position of the auxiliary spring and supporting bracket. This bracket is sprung so that any inequalities of rim or road are automatically allowed for. The running costs of such a set are very small, as the only wearing part is the rubber pulley, which costs but a few cents to replace, and has a reasonable length of life. The type of cylce rim shown in the photographs is not the best possible for good results, as the somewhat shallow shape causes the pulley to wear unevenly; but the modern cycle rims, which have, as a rule, broad portions unencumbered by spokes, are admirably adapted for the purposes of electric lighting. The power required to drive the machine is inappreciable, as there are no field-windings to excite, and hence the total output never exceeds a few watts—generally 4 volts .3 ampere, which amounts to 1.2 watts only; and when we consider that 1 h.p. will produce many hundreds of watts, it can be assumed that the rider will not drop from physical exhaustion owing to the extra power he must exert. Owing to the fact that the magnetic field is constant, and that the air-gap is large, the extra current produced by increasing the speed is very small, after a certain critical speed is attained, which speed is arranged to suit the "walking pace." A slight increase on the speed brings the light up to its maximum, and the armature reaction and increase in filament resistance prevent but a fractional increase, although the speed of the cycle may be as high as 30 miles per hour.

Fig. 10

The electric switch on the lamp is very useful if a 4-volt battery be carried as a spare, or to run the light when cycle is at rest; otherwise the mechanical switch is all that is required to turn "on or off" the light. The disadvantages of the magneto systems are: (1) Failure of Light when Machine is Stopped; (2) The Possibility of Mechanical Break-down.—The first point needs no further comment than to state that the practice of carrying even a pocket-lamp refill will amend matters. The latter point covers a much larger range of possibilities, and a selection of a few of these that the author met with while testing his equipment may prove interesting. On one of the first test runs the light was at times a little unsteady, owing to the tension of the *A* spring being incorrect. This was brought about by the fact that no definite length can be assigned by the manufacturers, as the distance from the forks to the top of the handle-bar, which forms the one important measurement, varies with practically each cycle; hence the makers supply ample wire to meet the exigencies of the abnormal case. Experience alone will correct this fault. On another occasion the light flickered considerably, and upon inspection the cause was traceable to a bad connection at the insulated binding-screw. During a very fierce storm which occurred a while ago, the light was most unsteady, owing to the reduction of friction of the highly-enamelled surface of the rim causing the pulley to slip. One of the most troublesome faults experienced was due to a partially-insulated earth or frame connection consequent upon the large amount of oil retained in the bearings, which caused the earthed end of the armature wire considerable difficulty in fulfilling its function. To remedy the above, should it be inconvenient to extract the greater part of the oil, requires only the addition of a piece of thin wire, one end of which is to be attached to the uninsulated terminal, and the other extremity just twisted once round the shaft between the pulley and the bearing brass. To avoid such a fault, do not add more than a spot or two of thin oil. It is always advisable to carry the following spares if on a long journey: A small screw-driver, a few inches of thin copper wire, a spare rubber ring for pulley, and a 4-volt .3 ampere tungsten lamp, not omitting a small pocket-lamp refill. The above requisites will easily go into the saddle-bag.—*English Mechanic.*

DRILLING ATTACHMENT FOR A MILLERS FALLS BREAST DRILL

W. GOSLING

The sketch shows a simple attachment for a Millers Falls breast drill, which will enable the drill to be used for a screw feed. This attachment has proved very handy for small model engine work, especially for drilling the stud holes in cylinders, where it is necessary that the hole be drilled quite true and square, and the cylinder is of a long stroke. Another point is that the machine is peculiarly adapted for model boiler work, for drilling holes in the end flanges, and shells. This sort of work generally calls for an awkward rig-up on the average bench drill.

To describe the attachment: The breast drill is one of the $1.50 sort, and drills up to 3/16 in. The parts required are a piece of bright steel 1 in. diameter, 20 in. long, threaded 1 in. for about 4½ in. up; a cast-iron table (half plan in Fig. 2) to form the base, feed-screw, arm for same, and bracket to which the drill is bolted.

The table is of cast-iron, with a spigot, as shown in Fig. 1, for the reception of the drill post. The back part of the table has three ¼ in. holes drilled for bolts to fasten the machine to the bench. A washer is fitted on the under side of the bench to take *all* three holes.

The washer is made of ⅛ in. plate, 1½ in. wide by 3½ in. long. The other ¼ in. holes shown in sketch are drilled in positions calculated to be of most use for fastening work down to the table. The table is, of course, symmetrical, so that I have only shown it in half plan.

The bracket which takes the drill next claims our attention. This is made of

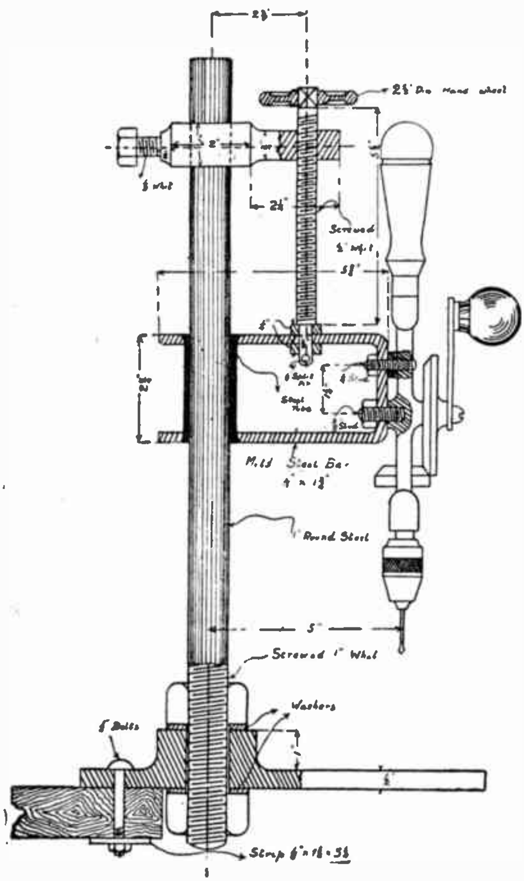


Fig. 1

flat steel bar, and forged to shape shown, care being taken that a good inner radius be left on the corners, as, if brought up too square, there is every possibility of a fracture occurring. The 1¼ in. holes are drilled exactly opposite each other, and each hole is slightly countersunk. The next thing is to obtain a piece of tube about 3 in. long, 1 in. bore. In my case I got mine from an old metal shop for a modest sum. The tube was about 3⁄32 in. thick. I had to cut it to suit length. I annealed it well, by leaving it in the fire all night. It should then be fitted in place, as shown, and the ends belled out, to fill up the countersinks with the ball of a small hammer. This will have the effect of thoroughly fixing the tube, and at the same time strengthening the bracket. The tube might also be expanded by a suitable sized draft pin (oiled first), but this is not absolutely necessary. With regard to fixing the drill to the bracket: If the drill be examined, there will be found to be a steadying handle screwed into the drill frame casting, and a little further up (1¼ in.) a ¼ in. stud also screwed into the casting. Both should be removed, and the lower hole taking the handle should be tapped up ⅜ in., while the upper hole should be tapped up ¼ in. Suitable steel studs should be fitted. The bracket may now be drilled to accommodate these studs, the holes being put in line midway between the width of the bracket and allowing sufficient clearance on the inside, so that the nuts may be turned around. A washer will be required for the ¼ in. stud, to go between the casting and the bracket.

The top arm is forged from a piece of mild steel. The plan is not shown in the sketch, but the part sliding up and down the post is circular, 2 in. diameter, running off rectangular, ¾ in. deep by 1 in. wide. The hole for the feed screw is drilled 2⅜ in. from the center of the post. This hole should be drilled first, and the arm dropped down on top of the bracket, and the hole marked off for the end of the feed screw to fit in. This is, of course, also midway between the width of the bracket.

The feed screw is a piece of ½ in. mild steel, squared on one end for a small hand wheel, and turned down ⅜ in. on the bottom to fit the hole in the bracket. It might be made much shorter than I have shown in the sketch, say about 3 in.

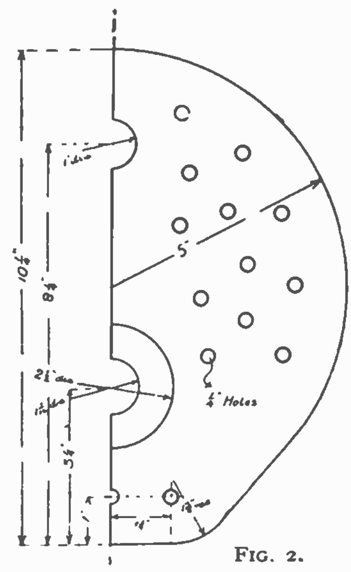


Fig. 2.

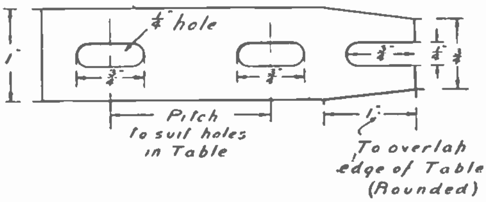


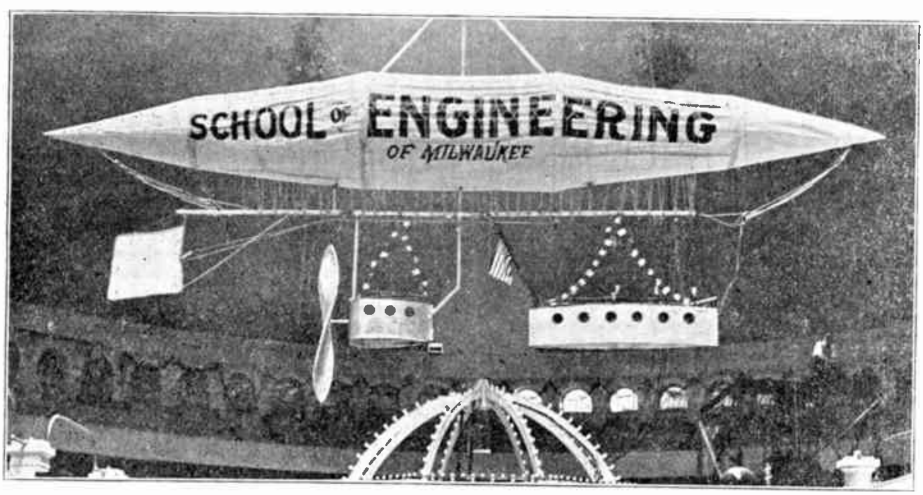
Fig. 3

long. Washers are placed on top and underneath where the screw fits into the bracket, and the whole held in place by a 1/8 in. split pin. When using the drill the arm should be placed as near the bracket as possible. The method of fixing the post to the table will be easily understood by the sketch.

Regarding the rig-up for boiler drilling: I obtained a piece of 3/16 in. steel plate, put 1/4 in. elongated holes, as shown in sketch (Fig. 3), and then arranged the drill by slewing the upper arm and bracket, so that the drill point came about 3/4 in. over the edge of the table. I then fixed the plate, and adjusted it so that the drill point came central with the slot in the end of the plate. This end with slot is rounded to take the shape of the shell, and then all is plain sailing for boiler drilling. The elongated holes might be put in to suit the holes in table or special holes put in the table for this purpose.

I think this completes the description, and the cost will be found to be not greatly in excess of the shop-made article, besides being twice as rigid and more adaptable. All dimensions are inserted, and with the exception of the boiler-drilling attachment, the sketches are pretty true to scale (half full-size).—*Model Engineer.*

AIRSHIP CONTROLLED BY WIRELESS



The halftone illustrates a rather novel application of the principles of radio-telegraphy in the form of an airship controlled by wireless which is the product of the students of the School of Engineering of Milwaukee, Wis.

A wireless transmitting station is used to produce the electromagnetic waves which actuate a coherer and relay at the little receiving station on board the airship. By means of an ingenious clock-work arrangement, each signal from the transmitting station will, in turn, sound a whistle, ring a bell, set the propeller in motion and turn on the lights. When the ship is under way, the flag at the flagstaff will be unfurled, and the cannon will be electrically discharged, after which the operations may be repeated at will.

"It's good to have money and the things that money can buy; but it's good, too, to check up once in a while and make sure you haven't lost the things that money can't buy."—*George Horace Lorimer.*

WIRELESS TELEGRAPHY

In this department will be published original, practical articles pertaining to Wireless Telegraphy and Wireless Telephony

THE QUENCHED SPARK SYSTEM

EUGENE PETERSON

The "quenched spark" or "shock excitation" method of producing high-frequency oscillations is one of the most efficient systems known at the present time, and it is surprising that it is not in general use by amateurs, showing, as it does, many points of superiority over the old spark-gap method.

A few of the important advantages are, in brief, that it is noiseless in operation, at least twice as efficient as the ordinary gap, produces a high-pitched, penetrating note; slightly damped waves are produced, which can be sharply tuned.

Of the several methods for producing high-frequency oscillations, the two that I shall describe (the Telefunken and the Von Lepel systems) are very efficient, easy to make, and fit the conditions of the amateur much better than the others.

The operation of the quenched gap depends upon certain principles discovered by Wien in 1906. While experimenting with two closely coupled oscillation circuits containing a short spark gap, he discovered that the oscillations in the condenser circuit were strongly damped, and that the second closed circuit was then thrown into strong vibration, according to its natural frequency and damping.

Many theories have been advanced

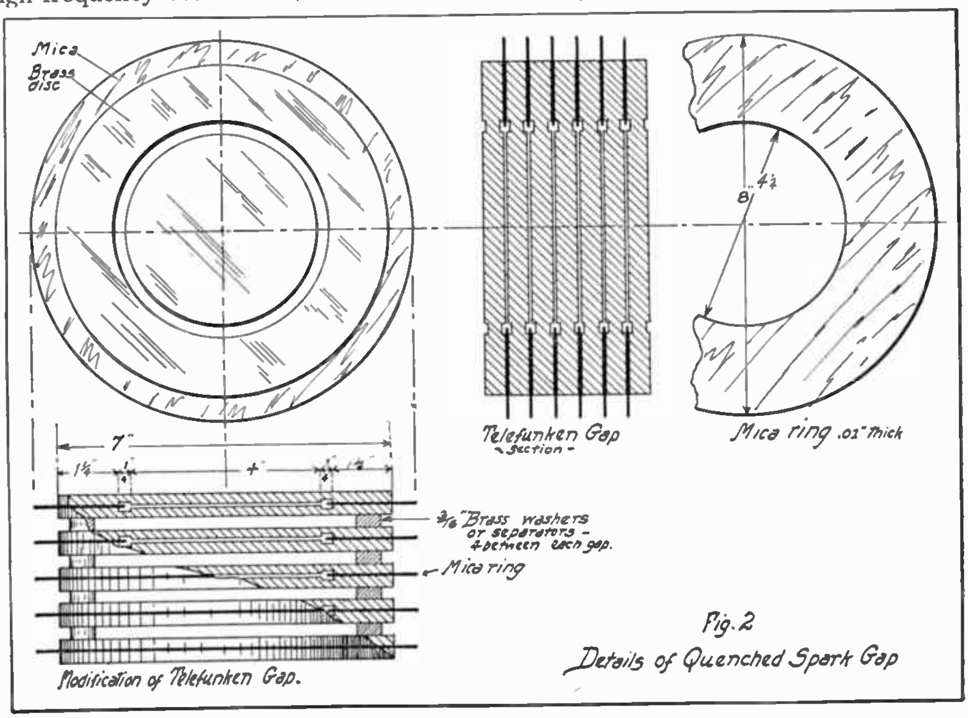


Fig. 2
Details of Quenched Spark Gap

which attempt to account for the large damping of a very short spark gap; and one of these, the most generally accepted, states that after the spark has passed, the flat electrodes conduct the heat very rapidly from the spark and thus quench the oscillations after a few swings. Another, widely different than the one given above, is known as the "Compression Theory," and was advanced by Galletti. He claimed that, due to the great heat generated by the spark, the gas enclosed between the two electrodes expands and is compressed, thus raising the dielectric strength of the enclosed gas and quenching the spark.

The first commercial application of Wien's principles was made by Baron Von Lepel, in Germany. His gap, called the "Von Lepel Generator," consisted of two thick water-cooled copper discs, separated by a sheet of paper shunted by capacity and inductance, and fed from the 500-volt direct current mains,

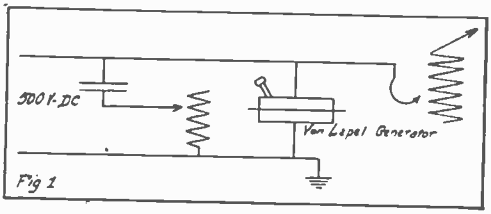


Fig 1

as shown in Fig. 1. Choke coils were inserted to prevent the high frequency oscillations from surging back through the direct current mains. In operation, an arc is formed, which gradually burns away the paper and produces high-frequency alternating current. The products of the combustion of the paper are gases rich in hydrocarbons, which greatly increase its efficiency.

An efficient method of adapting this gap to high-tension alternating currents consists in connecting up a number of these gaps in series. The number of discs to be used depends upon the voltage of the transformer, but I have found 200 to 250 volts per pair of plates to give excellent results. This gap may be constructed as follows:

From 1/16 in. aluminum or brass (preferably the former) cut out the required number of discs about 6 in. in diameter. The paper used must be dry, unruled, closely woven, and free from all defects, cut in squares 7 in. on a side with a 1 in. hole in the center. The hole is cut in the center of the paper to start the spark jumping from the center outwards, as otherwise the spark would jump at the edge of the discs and admit air, greatly interfering with the proper working of the gap. The gap is assembled by placing two sheets of paper between each disc, and the whole gap clamped tightly.

The efficiency of the above gap has been estimated at from 50 per cent (Eckles & Makower) to 89 per cent (Galletti). However, Eckles & Makower used 500 volts direct current, while Galletti used 34,000 volts direct current, obtained from a high voltage transmission line in France. There was quite a discussion as to the accuracy of Galletti's calculations, but I believe he has fully substantiated them. In his experiments, a hot-wire ammeter in the aerial circuit indicated as much as 100 amperes.

The Von Lepel gap has the disadvantages of requiring attention and frequent renewals of paper. To eliminate this, a groove is cut into each disc about 1 in. from the edge, as this prevents the paper from burning up to the edge and admitting air.

The Telefunken Company has produced a gap which makes use of the advantages of the Von Lepel gap, at the same time requiring no attention. This consists of a number of gaps in series constructed with grooved metal discs separated by mica rings. In practice, the discs are made of copper, silver, or phosphor bronze. The exact dimensions, together with the details of construction, are fully shown in the drawing, Fig. 2. It will be noticed that the inside diameter of the mica ring, when properly placed, coincides with the exact center of the groove. The groove is cut in the disc to prevent the spark from jumping near the mica, as it is a well-known fact that mica becomes conducting when heated. A small fan is used to dissipate the great heat generated by the spark.

Inasmuch as the expense of phosphor bronze or cast copper discs would make it prohibitive to the average amateur, I have devised a gap which is much cheaper than the usual Telefunken gap, eliminating the fan while operating at practically the same efficiency. The discs are turned from 1/8 or 1/4 in. brass and grooved in a lathe. Unlike the other gap, however, the brass is grooved on one side only, thus allowing a thinner disc to be used. The mica rings used are identically the same as those used in the Telefunken gap. In assembling the gap, the discs are so placed that the grooved sides face each other. Separators are placed between each pair of discs to provide a 3/16 in. space between each pair of discs for the air to circulate and cool the gap. As a large surface is exposed, it is comparatively easy to cool the gap. It is connected up as shown in Fig. 3.

I have purposely omitted giving a detailed description of the gaps, as the details of construction can be seen at a glance from the drawings.

Another form of Von Lepel gap uses two enormous water-cooled discs in series on the high-tension alternating current, separated by a sheet of paper. In operation, the frequency produced is

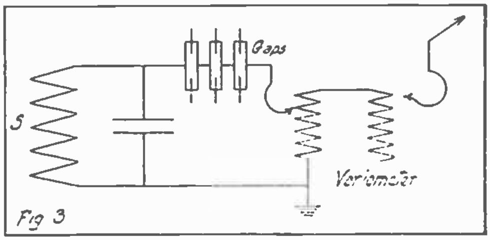


Fig 3

so high as to be beyond the limits of audibility, and, consequently, a ticker must be used in the detector circuit. This gap is used only in case of interference by forced oscillations or other strong disturbances.

In conclusion, I wish to state that if the directions for making the quenched gaps are closely and intelligently followed, results can be obtained which would be impossible with any other system; in fact, an increase in range of 50 per cent to 100 per cent is not unusual.

SPARK IRREGULARITY: ITS CAUSES, EFFECT AND PREVENTION

A. L. PATSTONE

Much irregularity of spark is often noticed from a wireless station while transmitting, especially from one using a stationary spark gap. One cause of this may be an uneven alternating current entering the transformer; this is caused by an unsteadily running generator. Another, and in most cases the real cause, may be found in the spark gap itself. This is always the result of poor insulation and construction.

The following extract from the Navy Wireless Manual will give an excellent idea of the conditions necessary to be fulfilled.

"135. The function of the spark gap in an oscillatory circuit is to allow the condenser to charge to the required potential, and then to break down and permit the condenser charge to surge back and forth until its energy is dissipated. The ideal spark gap would be one which would insulate perfectly while the condenser was charging and conduct perfectly while it was discharging, and the nearer these conditions can be fulfilled the more efficiently will the spark gap perform its duty. Either one of these conditions can be fulfilled alone, but the combination is somewhat difficult to obtain.

"The resistance of the spark gap when the discharge is passing depends upon two factors; it increases rapidly with the spark length, and decreases rapidly with the oscillatory current, amounting with a ½ in. gap to several hundred ohms when a fraction of an ampere passes, and a small fraction of an ohm when 50 or 60 amperes are flowing. With the spark length about ½ in., the resistance with the same oscillatory current flowing may be taken as roughly proportional to the spark length. But in a condenser circuit the amount of electricity stored up in the condenser, and hence the amount of oscillatory current, increases with the spark length, thus we have two conditions working against each other as regards the influence of the spark length on the spark resistance; but we can increase the amount of current flowing without increasing the spark length by increasing the size of the condenser, and the most efficient form of circuit for a given power is that in which a moderate spark length and large condensers are used."

"Condenser capacity required to give full power for ½ in. spark gap and one spark per half cycle is given in the following table:

Kw.	60 Cycles	120 Cycles	460 Cycles
1	0.019 m.f.	0.009 m.f.	0.002 m.f.
2½	0.047 m.f.	0.023 m.f.	0.006 m.f.
5	0.093 m.f.	0.047 m.f.	0.012 m.f.
10	0.185 m.f.	0.093 m.f.	0.024 m.f.
15	0.278 m.f.	0.139 m.f.	0.036 m.f.
35	0.648 m.f.	0.324 m.f.	0.085 m.f.

1 standard jar condenser=0.002 m.f."

Much more work will be accomplished by using a smooth, steady spark, not necessarily of high frequency, than a ragged one. This, because, with the spark in this condition it is at its most efficient point, and, too, it is much more pleasant for an operator to read.

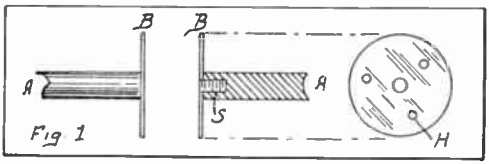


Fig 1

Muffling the spark without adding a blower is common at the majority of stations. Although this reduces the noise considerably it should be avoided, unless a blower is attached, as it is a great injury to the station's efficiency. After a station has been transmitting only a very few minutes the muffler becomes full of metallic vapor, and this forms a high-frequency alternating arc, that is, if the gap is set to break down at 30,000 volts, when the muffler becomes "choked" with this metallic vapor the spark passes at a considerably lower voltage.

The writer, who has had much experience with the stationary spark gaps, has given careful consideration to the three following features. First: perfect insulation, which too much care cannot be given. Second: sufficient surface. Third: a uniform spark distance, the most important of all.

It can be readily seen that with the majority of spark points, which have round and blunt points, their opposite centers are of a shorter distance apart than their opposite outside edges. This causes one frequency at the center of the gap and a lower frequency, more distance to travel, at the outside. All metals, if cut square to each other, will, within a short time, wear to a rounding surface, as the spark always has a tendency to jump at the edges—high-frequency current travels mostly on the surface of a conductor. This has been overcome by the use of thin sheet copper terminals drilled with small holes to allow the current to reach the center of the gap as well as the edges, and supported by much smaller rods.

The writer recommends the series gap, as it has been noticed that with the generator running unsteadily the spark does not become so irregular when this gap is used. The distance between all the plates should equal the distance at which the station works best when using only a two-terminal gap. This gap can

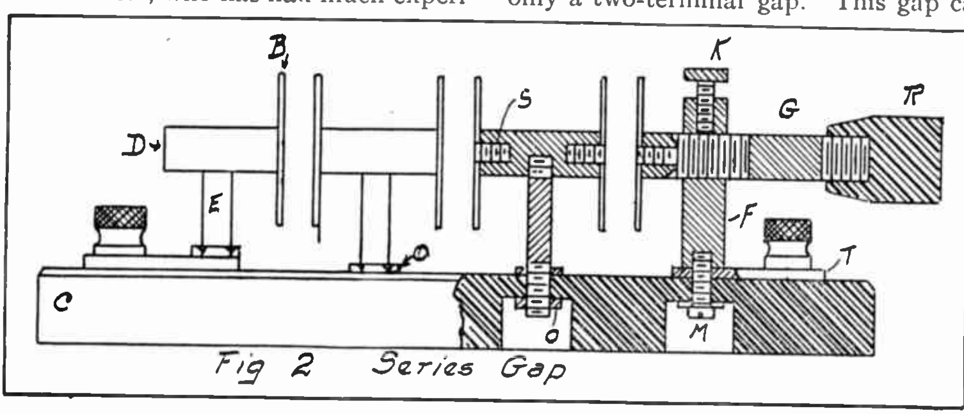


Fig 2 Series Gap

be made smaller by inserting a metal plug between one or more of the gaps.

The anchor gap has been greatly neglected by most stations, in that a lack of sufficient surface is provided. If the spark gap requires large surface why should not the anchor gap require as much, if not more? It will not be necessary to go into further details on account of the many different types of anchor gaps for straight and looped aerials. The copper disc plan can be easily added to the majority of these gaps, and when so used, with the smallest possible air gap and perfectly insulated, will give surprising and excellent results.

The diagrams will be found clearly to explain themselves.

THE REVOLVING SPARK GAP

B. FRANCIS DASHIELL

The revolving spark gap is used in wireless stations, where a very high-frequency spark is desired. Sometimes dynamos giving a great number of alternations are used to get this high-frequency spark from a transformer; but this is above the average wireless experimenter, and he must fall back on the series gap or the revolving spark gap, if he wants efficiency.

Everyone knows that a high-frequency spark is more desirable, inasmuch as it is more easily read at a great distance, and through interference, etc.

The writer will endeavor to explain in the following the construction of a simple and easily made rotary spark gap.

As shown in Fig. 2, *D* is a hard rubber disc with 12 electrodes about its edge. It rotates at a high speed between two other electrodes, and thus presents a large cooling surface.

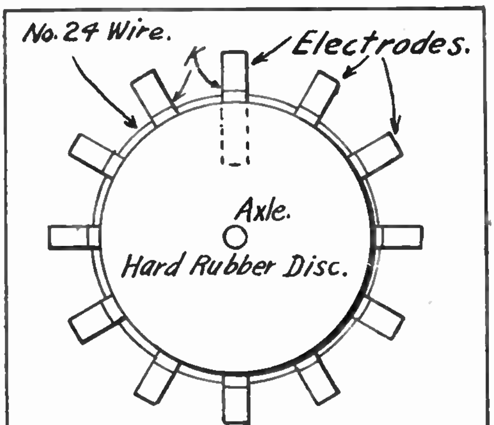


Figure 1.

Fig. 1 shows the rotating disc. It is cut from either hard rubber or fiber, and is 2 in. in diameter and ¼ in. thick.

Twelve holes are drilled around the edge. They are evenly spaced and should be ½ in. deep. A No. 30 drill is used.

The electrodes are each 1 in. long. Twelve of them are cut from a piece of No. 8 B. & S. gauge brass wire. They are held firmly in place by a drop of shellac in the holes, or preferably by threading and tapping the holes and wire, and the protruding ends should be filed smooth. All of the ends should be equidistant from the center of the disc.

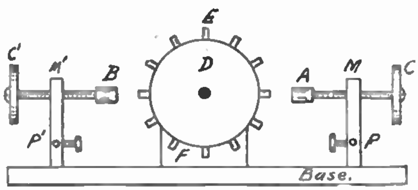


Figure 2.

A piece of No. 24 bare copper wire is twisted about each electrode, as shown in Fig. 1. *K* shows the one turn about the electrodes; this is to connect all of them together.

Any small battery motor will furnish ample power to rotate the disc, which is glued or shellacked firmly to the motor axle, as shown in Fig. 2.

F is the motor; *E* is one electrode, and *M*,*M'* are two pieces of ¼ in. square brass, each 2½ in. high. They are drilled and tapped to take two brass 8-32 screws, which carry the adjustable zinc electrodes, *B* and *A*. The distance between *M* and *M'* should be 7 in. The electrodes, *B* and *A*, are made from a wet battery zinc and are ¾ in. long.

Two fiber washers, *C* and *C'*, are shellacked under the screw heads, to serve as insulated knobs.

Binding posts, *P'* and *P*, are to receive the connection wires.

The base is made of fiber or hard rubber or well-seasoned hard wood, and is 9 x 5 x ½ in.

A contact may be fixed to the aerial switch to close the motor circuit when the switch is closed for sending.

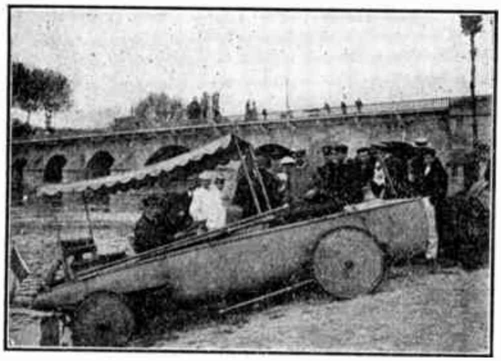
If the motor is run on 110 volts, the maker should take care to get good insulation between the motor and the electrodes in periphery of the revolving disc.

AN AMPHIBIOUS MOTOR

FELIX J. KOCH

A motor that can travel on land as well as in water was tested recently, on the Seine, in France, the trials proving entirely satisfactory.

To tourists who make use of this amphibious vehicle—canals, rivers and lakes will present no serious difficulties, as they can be crossed with ease and comfort whenever moderately gentle and smooth slopes, natural or artificial, can be found for entering and leaving the water. The hull of the boat is mounted, by means of springs, on axles and wheels. The axles pass through water-tight tubes, which traverse the hull, the motor being placed near the bow.



The power is transmitted to the rear or driving wheel by means of chains and pinions. In the water the vehicle is driven forward by a screw. Steering is effected by a wheel—as in ordinary motoring. The motor enters and leaves the water without any preparatory change, except in mechanical connections. When afloat its stability is perfect. It leaves the water and climbs the bank under the impulsion of its driving wheels if the ground is reasonably firm, and the grade less than 15 per cent.

To Read a Coin's Date

Lying on a table in front of a numismatist was an old copper coin. It had experienced hard usage.

"Can you read the date and the inscription?" inquired the collector.

The visitor inspected the specimen, but, although he had the aid of a magnifying glass, he confessed that the words and figures were illegible.

"Let me assist you," the collector remarked. Going to the kitchen range he thrust an ordinary coal shovel into the fire and permitted it to remain there until red hot. Withdrawing it, he dropped the coin on the utensil, and it speedily became as red-hot as the shovel itself. Immediately the date, 1794, showed brightly in glowing figures on the obverse side of the coin, and similar treatment revealed the words, "United States of America, one cent," on the reverse. This test, according to the numismatist, seldom fails with any coin, even when the inscriptions have been worn so perfectly smooth that they are invisible to the naked eye.—*New York Press.*

METER DEPARTMENT TROUBLES

J. A. S.

A considerable amount of technical description has been given in various periodicals and text-books referring to the various types of electrical metering apparatus, and the systems adopted for organizing and maintaining a meter department in connection with a central station supply of electrical energy. However, it is not perhaps quite so common to obtain records of the actual troubles, some of them of an elementary but none the less worrying character, which invade the mind of the meter man on supply systems, and it may therefore be of interest to electrical engineers to read one or two notes which do not profess to be more than extracts from the diary of a mains engineer whose duties included the supervision of meters and their auxiliary devices. For this reason the following statements of examples, met with in actual practice, may not be without interest, although they do not pretend to rank among the highly technical contributions to the literature on this subject.

One of the simplest and yet most difficult problems with which a mains engineer has to grapple, is the carelessness or stupidity of the less skilled assistants whom he may have to control. Contrary to the belief of some station engineers, if one may judge by the staff provided, the meter is in reality an intricate piece of mechanism which requires a certain amount of skill, both in its first erection and its subsequent maintenance. In other words, the "fool proof meter" has yet to be invented. For example, in one instance a bulk supply of electricity was being given to a small town from a power house supplying a widely extended combined lighting and tramway system through some miles of feeder cable which was of concentric type operated at a medium pressure. The energy so obtained was paid for on the basis of the meter readings, registered at the power house end of the cable, and these readings were checked by the records of the purchaser's meter at the receiving end of the cable. There was no other means of transmitting the energy from the power house of the sub-station devoted to the lighting of this small town. On the first night of running it was found that the meter readings could not be made to agree, and the allowance for cable loss and other disturbing factors was gone into with much care and elaboration by the engineer in charge of the supply, without arriving at a satisfactory solution. After much thought and mental friction had been wasted in this way, a further cause was sought and it was then found that the station meter was, owing to the carelessness on the part of a wire man, connected the wrong way round and was registering backwards. By some process of logic, however, it was the superintendent of the meter department who came in for the trouble.

Owing to the increasing use of polyphase alternating current systems for the transmission of power, it may be worth while drawing attention to trouble which has been experienced when, as is often done, two meters are installed across a pair of phases. It may be found that, owing to unequal loads upon the phases or inequality in the winding of the motors, the phases become unevenly balanced, and in many cases it has been noticed that under such conditions separate meters on each phase will not register correctly; that is to say, one meter will go forward at a rate approximating to the actual consumption of energy, while the other meter either stands still or actually reverses its motion. In such cases it is advisable to take out the two separate meters and install a two-phase meter which takes account of the energy passing in the two phases at each instant. Where, however, this is impossible, or not considered worth while, it may be helpful to adopt the practice of charging the consumer by referring to the readings of the meter which goes forward; that is to say, the estimation is made by doubling the consumption registered by the meter which goes forward, and taking no notice of the one which behaves erratically. This is, of course, only a rough and ready approximate method which cannot be used in important or continuous cases.

It may seem rather like juggling with

facts to make these approximations, but it should be remembered that after all a meter is perhaps inferior to the average conscience in regard to infallibility. So much depends not only upon the actual law of the meter, but also upon the way in which it is being treated prior to and during the period of operation and also to the class of work upon which it is to be operated. Some meters are frequently incapable of giving anything like a correct measurement of the power passed through them, if, for example, this power is applied in sudden jerks. As an instance of this may be taken the familiar fact that supply authorities' meters on elevator motor circuits in residential flats usually register very little, a common figure being about an average of 15 units per quarter. Now it is well known that such elevators are used to a very great extent and are called upon frequently to lift considerable weights. It is not unreasonable to suppose that even the best meter does not register the full consumption; under such circumstances it merely obtains an approximation, more or less accurate under ordinary conditions, to the mean load upon the circuit during a short interval of time. The closeness of approximation under, for example, elevator loads, where the maximum effort is on and off again within half a minute or so, depends largely upon the inertia of the moving parts of the meter, the state of its jewel bearings, and the efficiency of its counting mechanism. Due to a combination of these causes an electric meter can quite easily become a very inaccurate instrument.

Turning now to actual difficulties found in meters; these may roughly be divided into those inherent to the design, and others which are due to careless erection or bad position; and with regard to the latter fault, it should be pointed out that the excellence of a meter over its competitors is almost purely a matter of reference to the apparatus for which it is required; in just the same way that a chemical balance contrasted with a coal weighing machine is just the thing for a laboratory but would be absurd in a boiler house. It will be found, however, in reference to the former point that some meters have been constructed with a turning movement actually insufficient to actuate more than one dial of the connecting train. A certain type of alternating current meter frequently stops at the figures 9, 99, or 999. These meters have dials operated by means of a cyclometer mechanism on the counting train and at the readings above specified, either two, three or four dials have to be moved at the same time. The makers of these meters, in order to overcome this difficulty have in a later type added a movable counter weight to the dial. This weight is gradually raised with the revolution of the first dial, and when the 9 indication is reached it falls over from a dead center position and its accumulated energy when falling is sufficient to actuate the other dials of the train. In some cases, however, it has been found necessary by supply authorities to call in meters of the earlier type and to replace them with dials of the clock pattern.

Reference was made above to the fact that meters which were very good in one position were not necessarily the best which could be adopted in another, and that in choosing a meter a certain amount of regard had to be paid to the situation in which it was to be placed. In order to emphasize this point reference may be made to trouble which was experienced in connection with a private house meter installation. Some types of motor meters on alternating current supplies make a continuous and irritating humming noise while in some cases the gearing can be distinctly heard. This sort of thing is particularly annoying to consumers where the meter is installed in a comparatively quiet location; and, indeed, it may be found that in certain circumstances the presence of such sound has a distinctly injurious effect upon the business of the consumer. In such cases it is hardly to be wondered at that the owner of the installation objects strongly to the noise; and supply authorities have had to take down such meters, although they work with perfect accuracy, and substitute others of a different type which run noiselessly. Yet another instance of unsuitability of meters as regards location may be mentioned; some of the earlier types of instruments had, in order to secure coolness in working, a very light metal case, which was capable of easy distortion, although it presented a very efficient cooling surface. The result of this was that the slightest injury would put the meter cover out of shape and such distortion would render its dust-proof qualities negligible. In one such instance a meter which had been installed in a coal cellar, after several years' use was found to be running very slowly, and as was apparent after examination this was not at all surprising, as the rotating disc was found to be carrying a load of about half an ounce of coal dust which had penetrated into the works of the meter.

Special care should be taken when installing a meter in any situation where damp may be expected that the insulation properties of the meter should be such as to withstand the trying conditions to which it is subjected. In one case the main coil of the meter, owing to the dampness of the place in which it was situated, earthed on to the cover. This caused the coil to fuse through until ultimately it became entirely open-circuited, destroying the function of the meter altogether. Not only so, but this melting of the main coil in combination with an earth which occurred upon the other pole of the supply, produced a heavy current, blowing the main fuse of the installation. As the supply was an important one it became necessary to abandon the permanent repair until a more convenient time, and in order to restore supply, the leads to the meter were disconnected and joined across, power being given to the consumer on the basis of an estimate until a suitable time occurred for the restoration of meter arrangements.

It may be interesting, in conclusion, to refer briefly to the subject of slot or prepayment meters, which are now coming into vogue for the purpose of selling electricity to customers who, owing to short tenure on premises and other causes, prefer to pay for their electricity in small quantities, although usually at a dearer rate than if quarterly accounts were kept. When the proposition was first attempted the usual type of slot meter adopted was made available for the reception of coins of small value only. It was found, however, that in the winter time these became a nuisance, inasmuch as the money boxes attached to the meters were in most cases too small. In some instances the cash boxes would become quite full in less than a month, and it was impossible, without a large increase of staff for the supply authorities concerned, to empty the cash boxes at less than monthly intervals. The result was that as the cash boxes had no tops they became filled too quickly and the money overflowed into the interior of the meter, impeding the working. This was by no means infrequent and in one instance a considerable value in money flowed at once into the main body of the meter. The result of the influx of such a large amount of excellent conductors of electricity was that the coins between them managed to short-circuit a shunt connection with a series connection in the interior of the meter, and before sufficient time had elapsed to operate the main fuse of the installation, a considerable mess had been made of the interior of the meter and several of the coins were so much disfigured that they had to retire from further circulation. In order to overcome difficulties such as these it has within recent years been decided by several makers of prepayment meters to adopt a larger unit of money value, and the use of a coin of large value has not the same disadvantage, as although the weighing apparatus of the meter may be lighter, the cash box holds a considerably higher value of coin than formerly without inconvenience.

There will be no necessity to emphasize the fact that the above notes are somewhat discursive, inasmuch as it is hardly possible in a short article to systematize the total results of a varied experience with electricity supply meters. It is, however, hoped that these notes will serve as stray indications from which information may be drawn by engineers covering the same class of operation.

Danger in Celluloid Collars

The Paris police have issued edicts forbidding anybody to wear celluloid collars or cuffs behind the scenes of a Paris theatre. The reason for this peculiar order is the danger of fire. A few days ago a cabman who was lighting his pipe was badly burned and his cab was almost totally destroyed because a spark set fire to his collar.

Percival (politely): "Chicken croquette, please."

The Waiter (lustily): "Fowl ball!"

THE HOME CRAFTSMAN

RALPH F. WINDOES

SMALL ARTICLES OF FURNITURE

There are a number of small articles of furniture of which the amateur craftsman should undertake the construction before he tackles anything really elaborate. Among these may be placed foot-stools, tabourets, plant stands, small tables, plate racks, magazine racks, etc. They are very useful pieces, and are always found very acceptable as gifts at the holiday season. It is not necessary that he build all of those described and illustrated in this article, but only those which he most admires, or for which he will have the most use.

FOOT-STOOL

The following material will be needed for the construction of the foot-stool, all the lumber of which is given in finished sizes and should be planed and sanded at the mill to these sizes:

4 pcs. 1½ in. x 1½ in. x 8 in., oak
2 pcs. ⅞ in. x 3 in. x 11 in., oak
2 pcs. ⅞ in. x 3 in. x 7 in., oak
2 pcs. ½ in. x 2 in. x 7⅝ in., pine
1 pc. ½ in. x 7⅝ in. x 11⅝ in., pine
1 pc. 10 oz. canvas 9 in. x 13 in.
1 pc. leather 19 in. x 22 in.
Curled hair, dowel pins, tacks, nails and finish.

The first thing to do toward the construction of the stool is to shape the legs. Notice that the bottom of each leg tapers down to 1 in. square, starting at a distance of 3 in. from the bottom. This is accomplished easily with the planes. Next round the top of the legs just a little so as to give them a finished appearance.

The stringers should next be worked up. They run from 3 in. at the ends to 2½ in. at the middle.

The drawings show dowel joints, but these may be substituted by mortise and tenon if the builder so desires. In that case he must add 1½ in. to the length of each stringer given in the material list.

The two ½ in. strips are nailed to the end stringers from the inside and the other thin piece is fastened onto them. Over this is placed the curled hair, heaped up slightly in the center. The canvas is tacked tightly over the hair and onto the upper edges of the stringers.

The finish should next be applied to the piece, or it may be done before the hair and canvas are put into place. It should consist of filler, stain and wax, applied as has been already stated in this course.

Finally the leather should be tacked on by curving it under the stringers and fastening it from the inside.

TABOURET

For the tabouret we will need:

4 pcs. 1¾ in. x 1¾ in. x 19½ in., oak
8 pcs. ⅞ in. x 2 in. x 12½ in., oak
1 pc. ⅞ in. x 14 in. x 14 in., oak
8 flat head screws, No. 10, 1¼ in.
Glue, stain, filler and wax.

The bottom of the legs of the tabouret are shaped in a little, as shown, while the tops are rounded over as in the case of the foot-stool. The mortises are cut in the legs and the corresponding tenons made to fit them, after which these parts are glued up and clamped together. The top is fastened in place, with the screws put in diagonally through the stringers. The detail on the next plate shows how this is accomplished.

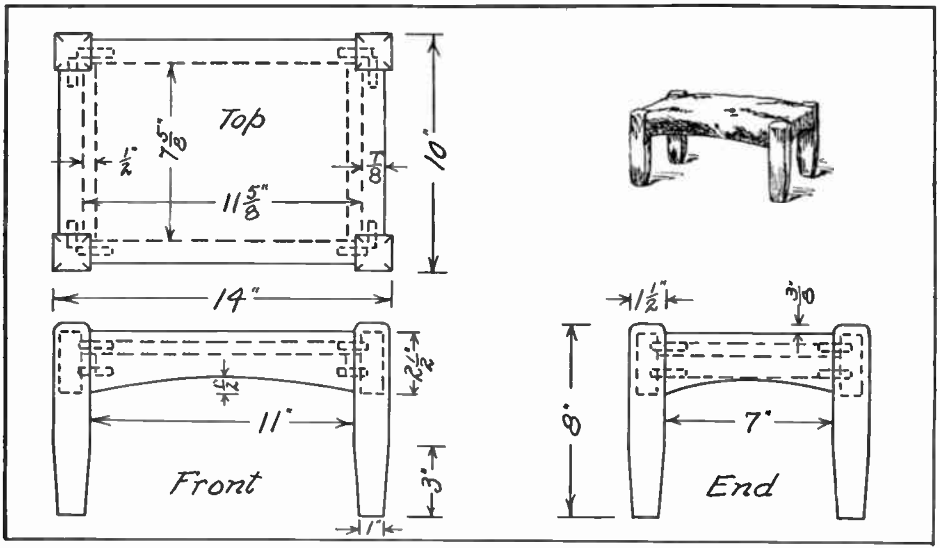
The finish of filler, stain and wax completes the piece.

DUTCH STOOL

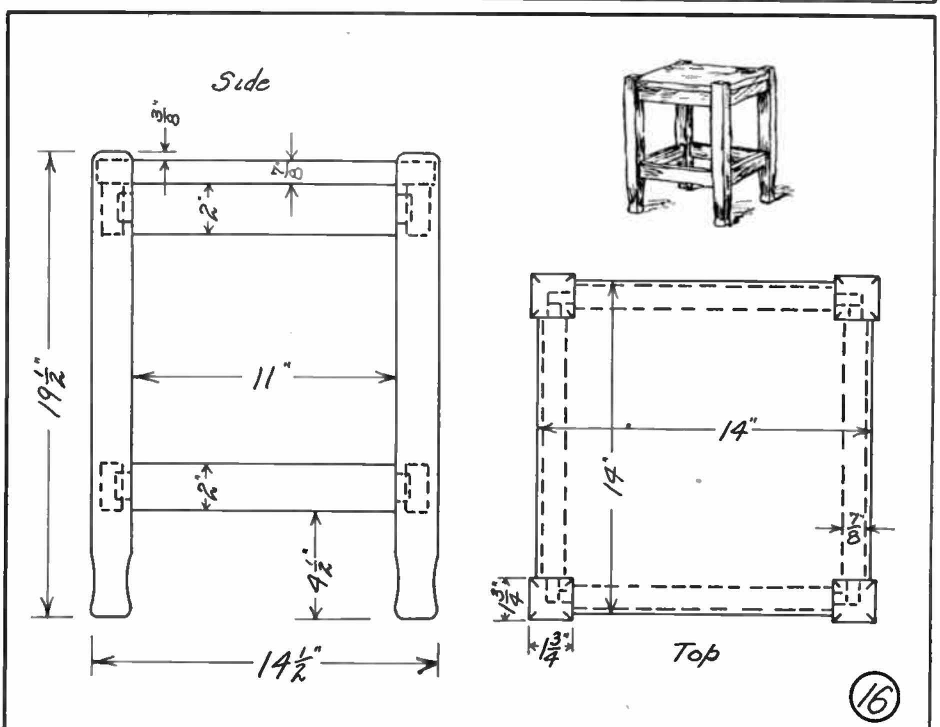
The stool here illustrated makes a very desirable piece of furniture, as it may be conveniently used for either a plant stand or a tabouret. The stock needed to complete it is as follows:

2 pcs. ⅞ in. x 16 in. x 17 in., oak
1 pc. ⅞ in. x 6 in. x 10¼ in., oak
1 pc. ⅞ in. x 16 in. x 16 in., oak

FOOT STOOL.



TABOURET.



RFW 1911

4 pcs. 7/8 in. x 1 in. x 7 in., oak
8 flat head screws, No. 10, 1¼ in.
Nails, glue, filler, stain and wax.

The sides should be worked into shape first. It lessens the work somewhat if the two are nailed together and worked up as a pair. In nailing, care must be taken to leave the heads out so that they may be easily withdrawn. It is a good plan to put the nails where the unsightly holes will not show when they are withdrawn.

The cross decoration in the sides is made with the half-lap joint. When the joints are finished lay them under the holes in the sides which are to receive them, and mark their exact length while in this position. Saw these exact and glue and nail them into place. The small nails are used and they are toe-nailed from the inside. Notice that this cross is not flush on the outside, but sets back about ¼ in.

The top and the shelf are screwed into place as shown in the detail. A hole is bored in one of the pieces diagonally, so that it comes through exactly in the center of the piece. Through this the screw is placed.

Complete the work by applying the finish.

(*To be continued*)

GETTING NEW TOOLS

Under a spreading blacksmith sign,
The village blacksmith sat;
He heard the chuf-chuf-chuf and said,
"Where is my business at?
The road is full of horseless things,
And bikes and such as that."

The smith was deeply in the dumps;
Ah! that was plain to see.
His wink-eye winked a knowing wink
Up at the chestnut tree;
And then he said, "These horseless things
Have put a horse on me."

And through his crisp and curly hair
His sinewy hand he ran,
Says he, "I'll get some different tools,
As well as any man
I'll mend a punctured rubber tire—
I'll charge whate'er I can."

He fixes up a charging plant
To work at sixty amps.
He charges automobile cells,
Keeps pumps and oil for lamps;
In fact, there's nothing he don't sell,
From sparking plugs to gamps.

Week in, week out, from morn till night,
His bellows blow no fires,
Instead it feeds a rubber tube,
That blows up rubber tires.
He has a tank of gasoline,
And cement, pipes and wires.

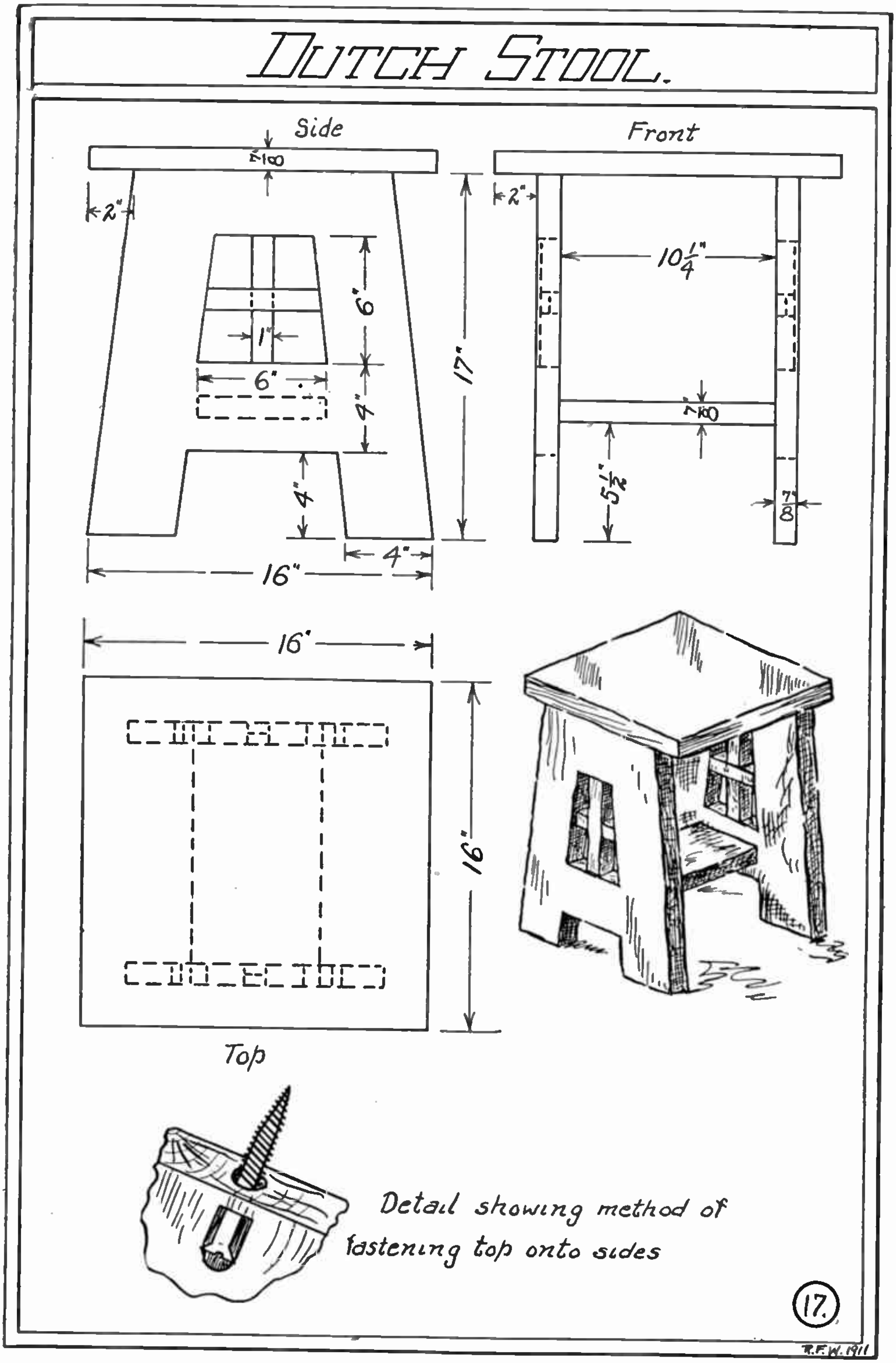
And children coming home from school
Rubber in at the open door;
They rubber at the rubber tube,
A-rubbering 'round the floor;
They rubber at the rubbersmith,
Who rubbers tires that tore.

He can't go, Sunday, to the church,
For that's his busy day.
Some city chauffeur's in the lurch,
And here is work—and pay.
The chauffeur buys some gasoline
And chuf-chufs on his way.

But never mind, his daughter's there,
Up in the choir stand;
And as she holds the hymn-book high,
Shows diamonds on each hand;
For daughter's buying jewelry
And Dad is buying land.

Repairing, pumping, mending,
Onward through life he goes;
Each morning sees some tire break,
Each evening sees it close.
Something mended, somebody done,
Puts money in his clothes.

Thanks, thanks to thee, my worthy friend,
On the lesson I'll meditate.
All must at times get different tools,
This world will never wait;
If we would live the strenuous life,
We must keep up to date.


DUTCH STOOL.
Side
Front
Top
2"
6"
1"
4"
17"
16"
10 1/4"
5 1/2"
7/8
Detail showing method of fastening top onto sides
17.
R.F.W. 1911

THREE-WIRE DISTRIBUTION

This system of electrical distribution was devised by Edison in 1882, and first put into practical use by the Edison Electrical Illuminating Co., of Boston, in February, 1886, from which time its use has been general in lighting plants using direct current, and in many power plants.

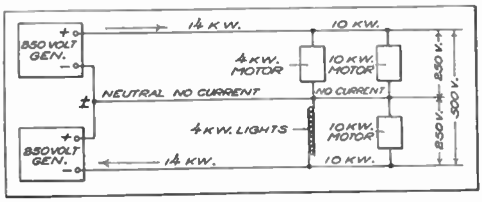


FIG. 1. IDEAL 3-WIRE DISTRIBUTION

From well-known laws governing electrical phenomena it is easily shown that the weight of copper required to carry a given power at a given per cent. loss varies inversely as the square of the electromotive force.

In other words, if the voltage is multiplied by 2, the weight of copper with the same line loss will be the first weight divided by the square of 2, or 4. In the same manner if the voltage is multiplied by 3, the copper weight is divided by the square of 3, or 9. From this may be seen the immense advantage of using high voltages where practicable.

A difficulty, however, at once presents itself from the fact that high voltages are dangerous, increasing the chances of injury to those coming in contact with live wires, besides increasing the fire risk where the wires are brought into wooden buildings. As a compromise between the two evils of a heavy outlay for copper wire on one hand and of danger to life and property on the other, the three-wire system was evolved.

In a few words the system consists simply in doubling the allowable voltage and placing the lamps or motors made for the allowable voltage in series of two.

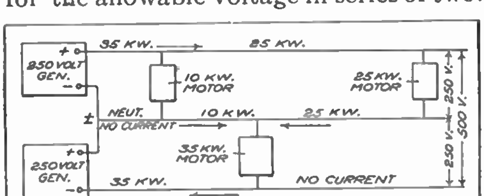


FIG. 2. COMMON CURRENT DISTRIBUTION IN 3-WIRE SYSTEM

The conditions are that the generating plant must produce two voltages, one voltage being one-half of the other and that a neutral or third wire be carried back to the generating station and connected at a point in the generating circuit giving one-half the maximum voltage.

The purposes of the neutral wire are two-fold: its first office being to convey current to the generator having the greatest load in an unbalanced system (see Figs. 3 and 4); and its second service is in carrying current from the terminals of the lights or motors on the positive side to those on the negative side, either in a balanced or unbalanced load.

Thus the neutral wire, while carrying no current back to the generators, may at some other points be carrying heavy currents and in opposite directions on different sections of the circuit as shown in Fig. 2.

In practice the conditions will rarely allow connections to be made as in Fig. 1, in which the neutral wire carries no current at any point while the load is balanced, or off.

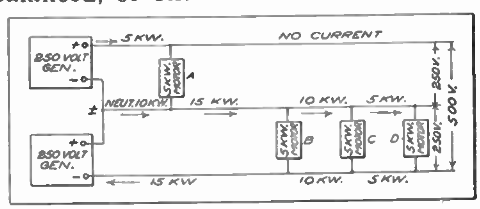


FIG. 3. UNBALANCED DISTRIBUTION ON 3-WIRE CIRCUIT

As neither the positive nor negative pole of the three-wire circuit is grounded, it is evident that the difference in potential or voltage between any wire and the ground cannot exceed one-half the maximum voltage.

This is an important condition in mine work, as it allows the use of 500-volt equipment with only 250 volts between the ground and any part of the circuit.

Where the neutral wire is placed almost entirely upon pole lines, as is customary in lighting circuits, it is customary to insulate it and to have it of the same size as the positive and negative wires, in which case the amount of copper required, as compared with a two-wire system of the same capacity, will be 3 to 8.

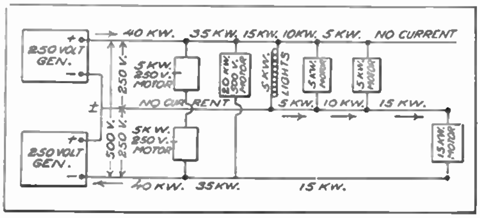


FIG. 4. BALANCED LOAD ON 3-WIRE CIRCUIT

In mine work the rails are generally utilized as the return branch of the circuit, and where the three-wire system is installed the rails form the neutral branch of the circuit. The fact that the rails are grounded while conveying current from one part of the circuit to another, as in Fig. 2, does not matter.

Referring to Fig. 3 it will be seen that the neutral wire between motors A and B is carrying the full current made by the generator. In practice the load is so distributed that this condition rarely occurs.

The motors may be so connected that the two sides will be balanced where the motor loads are proportionally the same, but in practice it is manifestly impossible to maintain this condition, and the excess load generally fluctuates to a certain degree from one side to the other.

In connection with the two-generator system, apparatus has been devised to shift automatically part of the load from the heavily loaded side to the idle side, but it has never come into general use, owing to the complicated nature of the mechanism and its liability to get out of order. The latest practice consists in the use of apparatus constructed to meet the conditions.

Three-wire generators have been designed and placed upon the market by several manufacturing companies, and they have been in successful operation for a number of years. These three-wire or double voltage generators differ from standard single voltage direct current generators only in that additional leads from the armature winding are connected to collector rings mounted on the armature shaft. The arrangement is exactly similar to that employed for the alternating current side of the armatures of rotary converters.

This connection may be either single, two or three-phase, but the two-phase is generally used, as experience has shown it to give the best regulation.

Across the two-phase collector (Fig. 5) a pair of balance coils, A B, are connected. These balance coils differ from transformers in that they have but a single winding upon a laminated core. The mid points of the balance coils are interconnected as shown in diagram and from this connection is led the neutral wire.

The voltage between the d.c. terminals of the 3-wire generator is 500 volts where 250 volts is required between the neutral and the other two wires.

Three-wire generators may be compound wound, and may be operated in multiple in the same manner that d.c. generators are operated.—*Practical Engineer.*

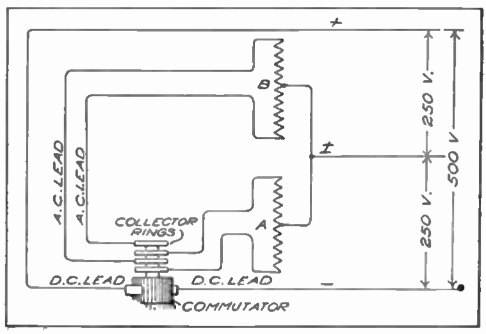


FIG. 5. METHOD OF CONNECTING BALANCE COILS

TABLE SHOWING RELATIVE SENSITIVENESS AND RELIABILITY OF DETECTORS

Compiled from Experiments and Observations

Detector	Sensitiveness	Reliability	How affected by Transmitter
Marconi Coherer	Very sensitive	Very bad	Gradually destroyed
Lodge-Muirhead Coherer	Very sensitive	Fairly good	Adjustment slightly impaired
Marconi Magnetic Detector	Insensitive	Perfect	Not at all
Fessenden Thermo Detector	Insensitive	Fairly good	Not at all
Electrolytic Detector (American)	Very sensitive	Fairly good	Gradually destroyed, but easily renewed
Electrolytic Detector (English)	Sensitive	Very good	Gradually destroyed
Carborundum Crystal	Sensitive	Very good	Very slightly destroyed. (Lasts for months)
Silicon Crystal	Very sensitive	Very bad	Adjustment quickly destroyed
Tellurium and Graphite	Very sensitive	Very bad	Adjustment quickly destroyed
Zincite and Copper Pyrites	Sensitive	Good	Adjustment gradually destroyed, but easily renewed
Zincite and Bornite	Sensitive	Good	Adjustment gradually destroyed, but easily renewed
Galena and Graphite	Fairly sensitive	Good	Adjustment gradually destroyed, but easily renewed

WOOD-INCISING

GEO. F. RHEAD

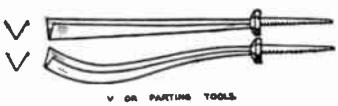


Fig. 1.

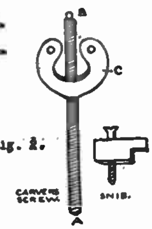


Fig. 2.

The art of wood-carving is one which for the purpose of the enrichment of wooden surfaces would be difficult to excel. It is, however, not within the power of everyone to carve, and it is to these that the process of wood-incising will appeal, for this art is very closely related to carving and yet does not necessitate the skill or expenditure for tools that the latter process does. It has also the advantage of being simple to acquire and is therefore an admirable one for the beginner in carving; we say simple, because there is really little to learn. Dexterity in the handling of the tools, of course, comes by practice, but beginners can by executing simple patterns produce really excellent effects, even at the start. The process resembles low-relief carving, the sinking of the background rendering the patterns in relief. It was employed largely in lieu of the former in the sixteenth and seventeenth centuries for enriching chests, furniture, and similar household articles, details of which are given on this page taken from old furniture in the South Kensington Museum, London, the designs in each case being incised and the ground cut away to give an appearance of relief.

The requisites for the work are few. They consist of a wood-carver's V-tool, two forms of which are shown in Fig. 1, a couple of cramps, or something that will serve a similar purpose to hold the work perfectly rigid during the incising;

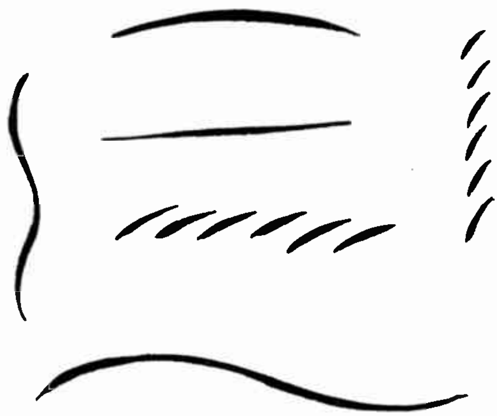


Fig. 3. Practice Strokes

a carver's screw, shown in Fig. 2, serves excellently, the manner of using it being to screw the end *A* into the back of the work, passing the other end through a hole drilled in the bench. The thumbscrew is then screwed up tightly, so as

Details of Incised Work from the South Kensington, London, Museum

Fig. 4. Correct Angle to Hold Tool.

to bring the panel well up against the bench. A useful little implement, three or four of which serve the same purpose, is the "snib," this is cut from a hard piece of wood and is screwed to the bench. (See Fig. 2.) Two repousse "matts" will be found useful for stamping backgrounds. These are shaped much like a large nail, and are made with a variety of patterns on the end, two of the most useful forms being the star and the circle. Quite a serviceable one may be made by neatly filing cross-lines upon the end of a large wire nail. The tools may therefore be procured at little cost, but we do not include saw and hammer and an oil-stone, as these will usually be found already in the house. The oil-stone is a necessity, for it is no use whatever to go to work with a blunt tool, as the fibers of the wood will split and cause a jagged line. A word as to woods; any material will serve for first efforts, so long as there are no knots on the surface; those woods that are close in grain are, however, the most suited for the work—such as holly and sycamore, while mahogany perhaps

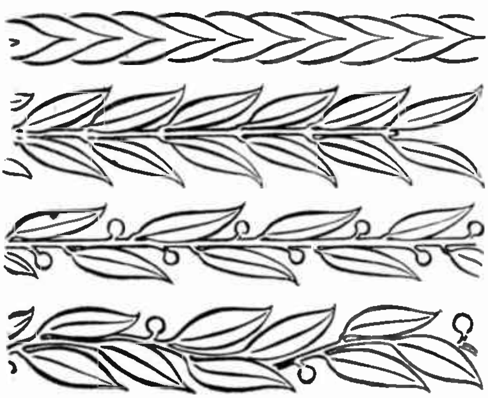


Fig. 5. Simple Borders for Incising

looks the best. In using mahogany, be sure to procure a good hard piece, for some kinds are too soft and fibrous for this sort of work.

The worker for a start should sand-paper up a board, clamp it to a table or bench and practise such strokes as illustrated in Fig. 3, so as to gain some proficiency in the handling of the tool, which is pushed forward with both hands (the correct angle being shown in Fig. 4), with deliberation and some force. A weak stroke, starting heavily and finishing off like a mere scratch, will look very poor indeed. Sharp corners will be found a difficulty at first and require care, the successful handling of the

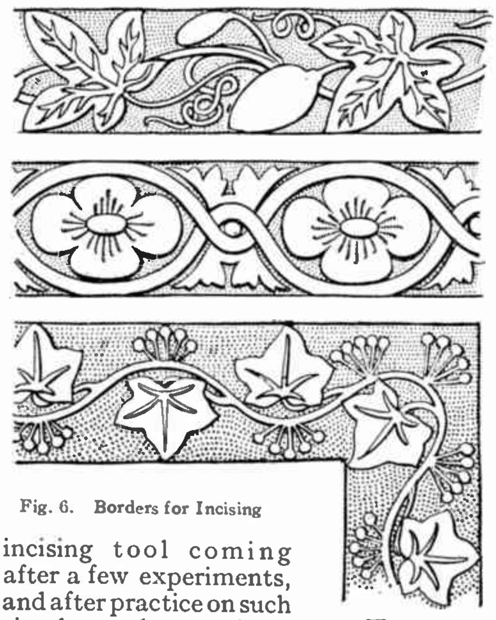


Fig. 6. Borders for Incising

incising tool coming after a few experiments, and after practice on such simple strokes as illustrated. After a small amount of proficiency has been acquired the worker can proceed with such simple patterns as the laurel borders illustrated (Fig. 5), which will offer few obstacles to successful accomplishment. They would be quite suited for the decoration of picture-frames or similar purposes. Further borders, but more advanced ones, are shown in illustrations (Fig. 6), and the backgrounds of these are stamped with a "matt" as previously mentioned.

Numerous small objects of the home would be admirably suited for decoration by this means, and of these a few examples are given. They comprise

Fig. 7. Brush Rack

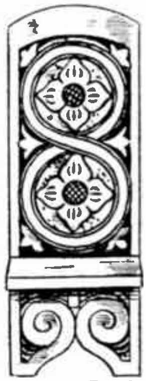


Fig. 8. Wall Bracket

racks for ornaments, books, pipes, brushes, hats, etc., boxes, coal-scuttles, stools, panels, picture-frames and numerous other objects; in fact, if one is ambitious enough to attempt larger things, the scope is almost unlimited. If one is not able to design, he can adapt from existing patterns, which can easily be done, even if he can sketch only a little. The pattern should be neatly drawn out full-size on paper and when the article has been cut to shape the design is transferred to the wood by laying it on the surface, inserting a piece of carbon paper between, and going over all the lines with a hard pencil. The pattern will then be ready for incising; cramp the work, and proceed to outline the forms, keeping well on the outside of the transfer lines and making the outlines of the main forms broader than the less important details. In the case of the brush-rack, illustrated in Fig. 7, for instance, the center will be

Fig. 9
Incised Ornamentation for Picture Frame

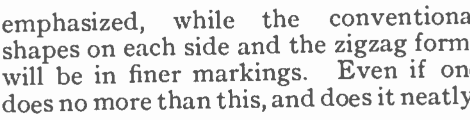


Fig. 10
Key or Coat-Rack Design

emphasized, while the conventional shapes on each side and the zigzag forms will be in finer markings. Even if one does no more than this, and does it neatly, the result will be an attractive piece of decoration. It is an improvement to stain the work, but the ground may be sunk and enriched with the "matts" for greater effect. These are held between the thumb and first finger of the left hand and tapped with a hammer held in the right, for it is possible to give a fair degree of relief to the forms by going over the ground in this manner. The "matts," as before mentioned, are procurable in numerous patterns so that the grounds may be varied. In Fig. 7 the background has been sunk where it is shown dark; in Fig. 8 it is sunk deeply on the outside of the interlacing circles, the inside of the circles being only slightly "matted." The ground of the border for the picture frame (Fig. 9) is well sunk to bring the pattern in relief. The key or coat-rack design (Fig. 10) has

Fig. 11. Fish Panel for Incising

such a little ground that it may be either left plain or matted, with slight difference in effect.

For more advanced workers bird or fish forms treated conventionally form interesting subjects. They require great care, however, in drawing, but otherwise they are little more difficult to execute than the preceding examples. The fish panel shown in Fig. 11 would look very charming if carefully incised and would form a piece of decoration of which one might be proud.

Waterproof Glue

Two good recipes are as follows:

To 0.5 pint best Scotch glue add 1 oz. bichromate of potash. The glue cannot be re-melted after cooling.

Melt and mix together 1 part beeswax and 2 parts rosin. Stir into this hot whiting rubbed fine until a stiff mixture is obtained. This is made into sticks and used like sealing wax.—*Practical Engineer.*

A MODEL BAMBOO BIPLANE

A bamboo biplane, made by H. H. Groves, a member of the Aero Models Association of England, is highly interesting, not only on account of its good flying capabilities, but also because of its excellent construction and workmanship. Considering the weight of the model its strength is very great, and it has stood numerous collisions with trees without damage.

The machine is the result of some eighteen months experimenting, and is one of several equally efficient models of various sizes and shapes. A record flight for this particular model is 330 yds., but the average straight flight is 200 yds. Quite recently the model has been fitted with wheels, and has repeatedly flown 190 yds. from the ground, rising by its own power.

One of Mr. Groves' models has recently won the first prize for the longest distance, in a competition organized by the South Eastern Branch of the Aero Models Association, and no doubt during the coming season they will figure prominently in competitions.

THE FRAMEWORK

This is almost entirely made of split bamboo, the long members being ⅛ in. square. It will be seen in the plan and side elevation, Figs. 2 and 3, that the framework is rather different from that usually seen in model biplane construction, but it is admirably adapted for bamboo. It will also be seen at Fig. 9 that the joints are made in a somewhat novel manner, by splitting the main members and fitting the pieces in, the joints being glued up and bound round with jute. This method of making a joint has a very neat appearance, as shown at Fig. 10, and it is very strong, and no doubt the best way of joining up bamboo.

The bracing is done by fine plated piano wire, but instead of using ordinary wire strainers, Mr. Groves uses steel wire just strong and stiff enough to hold the stay-wires, as shown at Fig. 10. A turn of the curved wire, with a pair of round nose pliers, is enough to pull the wire up quite tight, and it answers every purpose of wire-strainers at a great saving of weight.

THE MAIN PLANES

The main planes, 2 in. x 3 in., are made in the manner shown at Fig. 13, but a stronger method used for larger machines is shown at Fig. 12; here the ribs are let into the main spars, as shown at Fig. 14. The tips are upturned slightly, and the framework is covered with ordinary silk, glued and stretched on, and proofed with celluloid varnish, made by dissolving celluloid in amyl acetate.

The planes are 3½ in. apart, and joined by means of round uprights of bamboo. The top plane is screwed to the framework through the front spar, and is held quite rigid. Bracing wires are attached to the top ends, and are carried to the middle of the bottom plane in front only. Mr. Groves originally braced the main planes to a decided dihedral angle, but abandoned it for upturned tips, which have proved highly satisfactory.

THE ELEVATING PLANE

The elevating plane, 8¾ in. x 1¾ in., is built up similarly to the main planes, to the shape shown in the plan, Fig. 2. There are four ribs, a very slight camber and upturned tips, as in the main planes. The elevator is manipulated by means of a lever; it is attached by one screw to the rod, which carries the rudder shown in plan and at Fig. 7, and at the end of the rod a screw, as shown in section at Fig. 15, is fitted. By turning the screw the angle of incidence may be easily adjusted. It will be seen at Fig. 5, a front elevation of the end only, that the elevating plane is attached to the framework by a bracket; this is screwed to the spar; it is easily adjustable, and may be turned to any angle.

THE RUDDER

The rudder, 2 sq. in. in area, shown in position in the side elevation, and in detail at Fig. 7, is not adjustable, and really acts in maintaining a straight flight. It is made of piano wire, attached to a wooden spar, and is covered with proofed fabric.

THE PROPELLERS

The model is now fitted with two built-up wooden propellers of 8 in. diameter and a pitch of 1½ times the diameter.

They are not truly helical, but the blades are set back 1/8 in. at the hub, on the entering edge, as shown at Fig. 16. *A* shows the entering edges. Bent wood propellers of the same diameter and pitch, and the shape given at Fig. 17, were originally fitted. These were made of tulip wood veneer, glass-papered smooth, cut to shape, and varnished with shellac varnish. They were afterwards held over a flame until pliable, bent to shape and clamped in a frame and held under the tap. This method proved very satisfactory, but as increased efficiency may be had in a built-up propeller, the latter are now in use.

MOTIVE POWER

Twelve strands of 1/8 in. square rubber is used for each propeller, and with a soft soap lubricant, a total number of 500 turns is available. The rubber is placed round the projection shown at Fig. 11, and fitted over a triangular ended propeller shaft.

Lightning Explained by New Theory

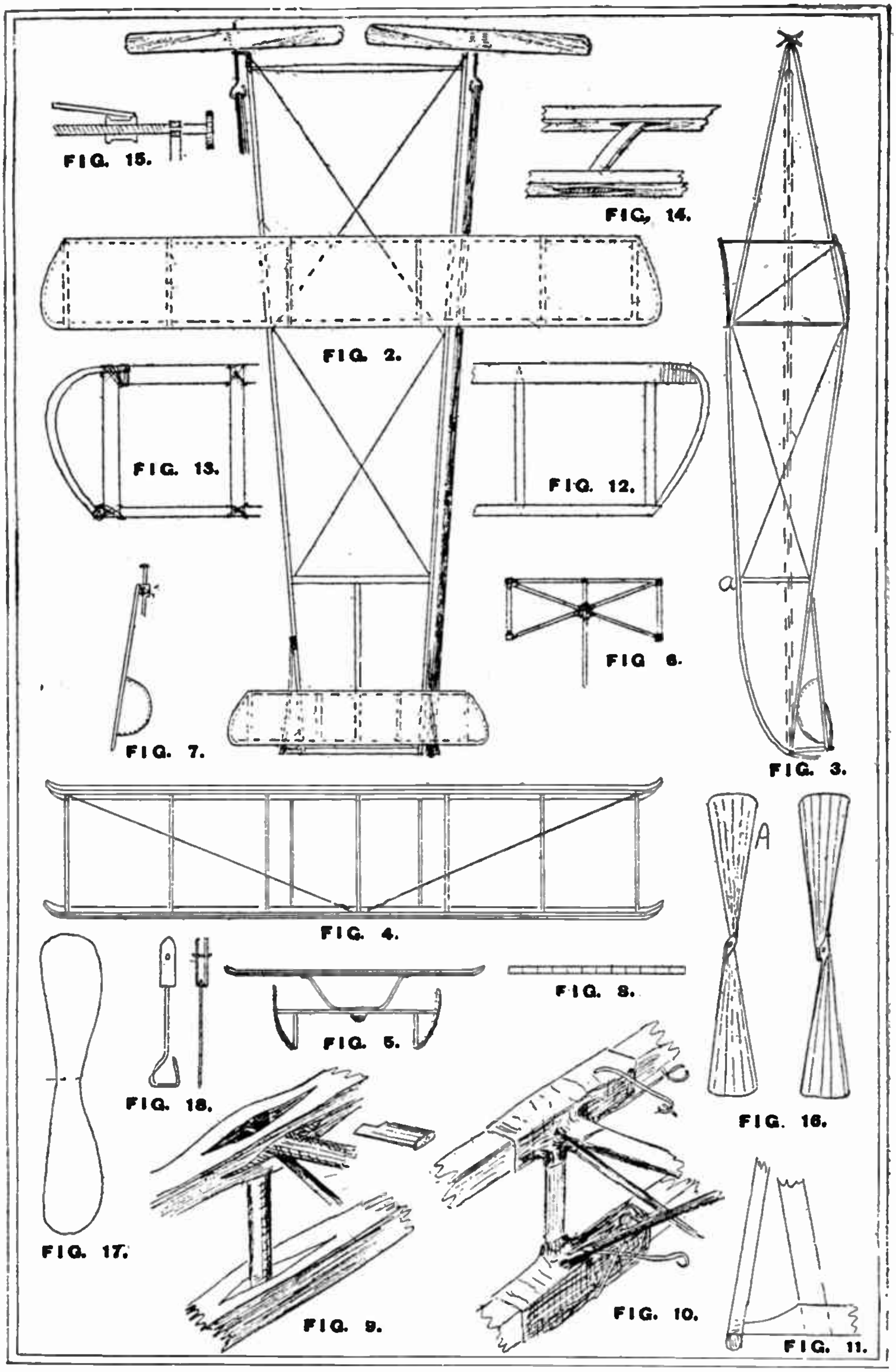
It is well known that lightning is an electrical phenomenon, and it has been popularly supposed that a lightning flash is caused by a momentary electrical breakdown of the air between a cloud and the earth or between two clouds, when the density of the electric charge in the cloud or clouds exceeds a certain amount. But, as Dr. Charles P. Steinmetz pointed out in a recent lecture, this would presume an electrical pressure of nearly a million volts for each foot that the lightning travelled, and he regarded it as inconceivable that any reasonable source of electricity could produce the immense energy implied by such a figure.

This new theory regards lightning not as a simple electric rupture, but as an equalization of internal strains and stresses. A mechanical illustration is afforded by the well-known "Rupert's drop," which is made by dropping molten glass into water. When the pear-shaped head of the drop is scratched or when its tail is broken off, the drop immediately bursts into a mass of fine powder. Similarly, a badly annealed plate of glass will crack in all directions when it is scratched or splintered in one place.

Thus, in the thundercloud, the electrical charge may be very unevenly distributed, owing probably to the different rates at which the individually-charged rain particles become massed together at various places When the electrical density becomes excessive in some one spot, a flash over a few inches or so in length is produced. This increases the density in the next spot, and so the discharge surges on, increasing as it travels, and results very quickly in a lightning flash, which may extend many miles. And all this may very well be started by an initial electrical pressure of only a few hundred volts.

An extension of this theory accounts for heat lightning. If the rain particles are not charged sufficiently to produce lightning in the manner already explained, a change in atmospheric conditions may cause the rain-drops to re-evaporate. Since gases do not carry electrical charges, each dwindling raindrop retains its original charge. But the charge, being spread over a diminishing surface, increases in density, until finally the tension becomes so great that a lightning discharge is propagated throughout the cloud mass which has now become so attenuated as to be practically invisible to the eye.

A simple method of arriving at the relative merits of different grades of tool steel, claimed to be satisfactory for ordinary commercial purposes, is pointed out by a contemporary as consisting of a steel disc about 24 in. in diameter and 2 or 3 in. thick, with a hole in the center about 3 in. in diameter. Then have one or two tools made from each sample of steel intended for purchase, and after cleaning the disc, set it in the lathe and try each tool on it, starting from the center, with a heavy cut and a fairly high speed. Then take the diameter of the disc at the point where the tool fails or becomes blunt, and divide the price per pound of that particular steel by that diameter. Thus, each tool will have a figure which will denote fairly accurately its commercial value. The depth of the cut must, in each test, be exactly the same and identical in every detail.



2. The plan. 3. The side elevation. 4. Front elevation of main planes. 5. Front elevation of elevating plane. 6. The shape of the framework at "a." 7. Rudder. 8. Scale of inches. 9. Method of splitting the bamboo. 10. Portion of the finished framework at "a." 11. Projection at the front to hold rubber. 12. Method of making the main planes. 13. Alternative method. 14. The ribs attached to spars. 15. Method of adjusting the elevator. 16. Built-up propellers. 17. Alternative bentwood propellers. 18. Rubber hook attached to the propeller.

SPEED CONTROL OF D.C. MOTOR

C. C. WHITTAKER, PH.B.

The electric motor owes its popularity to its adaptability to all forms of service. The flexibility of speed control offered by this machine makes it indispensable to many installations.

Consider first, the factors which control the speed of a motor. Given a motor which is operating. It possesses a field and a rotating armature. These

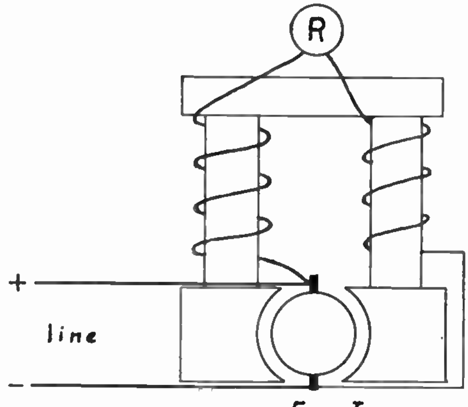


Fig. I

two elements, when the motor is in the condition assumed above, act precisely like a generator, and generate an e.m.f. which is a few volts less than the impressed e.m.f. It is the difference between these two e.m.f.'s which causes a current to flow in the armature. Thus, if a shunt or compound motor is started with no load, the speed will continue to increase until the difference between the counter and the impressed e.m.f. allows just enough current to flow in the armature to produce a torque or turning effort sufficient to overcome the brush friction, bearing friction, windage and iron loss. Now, it should be easy to see that if we could by any means lower the counter e.m.f., more current would flow in the armature, yielding a corresponding increase in torque which manifests itself by increased speed, provided the load remains constant.

One of the most universal methods of speed control of shunt or compound motors is a control effected by a resistance placed in the shunt field winding (Fig. 1). The shunt coil receives its energizing current from the line. If the resistance of this circuit be increased, less current will flow and the intensity of the field will be diminished, and consequently the counter e.m.f. Thus, we arrive at the following: By increasing the field flux, we diminish the speed; by diminishing the field, we increase the speed.

As an illustration of the above reasoning, assume a motor operating on a 110-volt circuit. The resistance of the armature to be .2 ohm, and the current flowing in the armature to be 10 amperes. Now, what e.m.f. is required to cause this flow? From Ohm's law, $I=\frac{E}{R}$ or $E=IR=10 \times .2=5$. We have, then, 5 volts as the difference between counter and impressed e.m.f. Now, suppose we decrease the field 10 per cent by cutting in resistance. That means that we decrease the counter e.m.f. 10 per cent because this varies directly with the intensity of the field. 10 per cent of 105 volts is 10.5. Subtracting this from 105 volts, we get 94.5 volts as our new counter e.m.f. The difference between this and the impressed voltage is 15.5, which causes a current of $C=\frac{15.5}{.2}=77.5$ amperes to flow. A total diminution of the field will cause the motor to "run away," provided the load is not sufficient to check it. In a large machine, such a

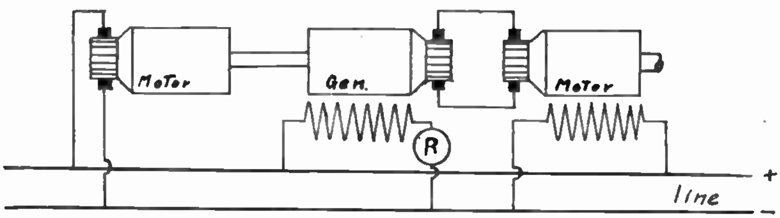


Fig. 2

high peripheral velocity would soon be reached that the machine would explode if the armature was not burned out before by the excessive current. For this reason, a series motor should never be started unless under load. The belting of a series motor to its load is very poor practice because of the liability of the belt to break when under load.

The practice of speed control by a resistance placed in series with the armature should never be used from an economical standpoint. In this case, the power used up in the resistance is often greater than that used by the motor. Aside from this disadvantage, a change of load will greatly effect the speed of the machine. Nevertheless, this system is sometimes used in an experimental way.

Another method in general use is the multiple voltage system. This consists of operating the machine on different voltages conveyed to the motors by separate wires. This system, used in connection with a shunt rheostat, furnishes a large range of speed control.

The field may be weakened by varying the air gap while the field current remains constant. Such a machine has hollow field cores provided with sliding poles whose positions are simultaneously changed by means of gears. By increasing the air gap, commutation is also improved.

The Ward-Leonard system, while expensive, offers the most perfect means of speed control. It is used largely on warships to operate gun turrets. This method requires the use of a separate motor and generator. The connections are as shown in Fig. 2. The motor *A* drives the generator. The field of the generator is connected across the mains and is controlled by a rheostat. By varying the generator field, any voltage from zero to full load voltage may be obtained and impressed upon motor *B*, thus varying its speed through a maximum range.

The Teaser system is advantageously used with motors operating machines having massive moving parts and requiring a large torque to overcome their initial inertia. An ordinary motor installation, in starting a machine of this kind, would draw an excessive amount

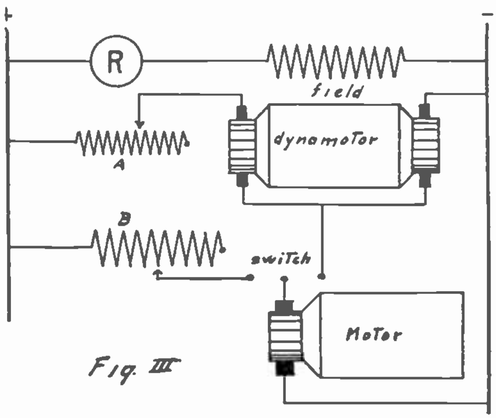


Fig. III

of current from the line. As is often the case, the motor may be run from lighting mains and a heavy drain of the current would mean a dimming of the lamps.

To obviate this difficulty, a dynamotor is used in conjunction with the driving motor. This consists of a single armature having two separate windings, each connected to a separate commutator. The same field furnishes flux for both windings.

In starting, the driving motor requires a heavy current supplied at low pressure. Accordingly, the windings of the dynamotor are such that the counter e.m.f. of the motor end shall be several times the induced e.m.f. of the generator end. With the connections as shown in Fig. 3, the voltage of the mains is cut down first, by the resistance at *A*, and second, by the character of the dynamotor's windings. The negative brush of the motor end is connected to the positive brush of the generator end of the dynamotor.

When the driving motor has reached the maximum speed obtainable from the dynamotor, it is switched over to the circuit completed by the resistance *B*. This resistance is now gradually cut out and the motor brought up to full load operation.

The regulation of the motor is accomplished through a controller.

He who sedulously attends, pointedly asks, calmly speaks, coolly answers, and ceases when he has no more to say, is in possession of some of the best requisites of man.—*Lavater*.

EXTRACTING A BROKEN TAP

E. ROBSON

A thing which tries the patience of an engineer is to break a tap in a hole. The problem now before us is, how can the remaining piece be removed? In some cases it can be got out by knocking it round with a hammer and chisel. Sometimes, however, the tap is wedged tight in the hole, and instead of working round when the above method is adopted the only result is a peculiarly shaped hole and a few chippings. Even yet there is hope, and the casting or piece of work need not be scrapped. We might soften the tap by allowing a Bunsen flame to play upon it or by putting the piece of work into the fire and then allow to cool after it has reached red heat. And now, with great care, we may drill the offending piece out. But as I have said, great care must be taken with the last-named method, so that an easy method will be welcomed by all engineers. It will be seen that Fig. 1 represents the section of a tap and the exterior dotted circle is the "tapping size." The inner circle is of such a diameter that it just clears the bottom of each plate on the outside.

Fig 1

Fig 2

Now, after this little explanation of Fig. 1, we will proceed. First obtain a piece of steel of good quality whose diameter is as near that of the circle *E*, Fig. 1, as possible, and about as long as the broken tap was. It should now be turned or filed to the diameter *E*. Now a hole should be bored in the center of one end of diameter *D*, Fig. 2, and about 2½ times *D* deep. Four slots should now be either filed or milled, whose width is a little greater than the length of the tooth, on the tap, *T*, Fig. 1, and about the same length as the hole. A square should now be filed on the other end, Fig. 2, to fit a key. And now, brother engineer, I think you can plainly see that by inserting the extractor into the hole the fangs will fit into the flutes, and by the aid of a key the tap may be extracted.

I have two more tools that might prove useful to some engineer. The first is for cleaning the thread in a nut after it has been hardened. A piece of 1/8 wire (iron or steel) is obtained and a 1/4 in. of one end bent at right angles. This piece is then filed to the shape of a tooth; the other end is then knocked into an old file handle, and the tool is complete. As will be seen, it saves the risk of spoiling a tap.

The second is of greater use to the plumber; by its aid nipples may be screwed into piping without injuring the thread on them. An old square or triangular file is now sought, and the end is ground to a taper. If the temper has not been destroyed the tool is ready for use. When you have the nipple as far as it will go, the "nipple driver" is put into the hole and given a knock with a hammer, and you may turn it in as fast as you like. For large sizes the middle of the file may be drawn out and a hole either drilled or punched. Now any handy bar may be used as a lever to screw the nipple in. This tool would be useful to a fitter to aid him in extracting a broken screw from a piece of work. By boring a hole in the remaining piece whose diameter is smaller than that of the screw, the nipple driver is now knocked in and the screw may be easily turned out.

The Broom at the Masthead

It was the famous Dutch Admiral Van Tromp who originated the custom of hoisting a broom at the masthead of his ship, showing his intention of sweeping the English fleet from the sea, in the seventeenth century. His signal was answered by the English admiral hoisting a horsewhip, to indicate that he meant to give the Dutch a good whipping. Nowadays vessels that make record trips hoist the broom, while a pennant is still oftentimes referred to by seafaring men as the horsewhip.—*The Marine Journal.*

MAKING A KNURLING TOOL

CHESTER L. LUCAS

To the mechanic with a lathe in his workshop, the field for "making things" is unlimited, provided he has a few of the necessary tools and a knowledge of how to use them—or the ability to learn. One of the most-to-be-desired tools, though not strictly essential for plain lathe work, is a knurling tool. This is needed to add the finishing touches to binding posts, adjusting screws, etc., and for making center punches, nail sets, and numerous other small tools and fittings. Knurling tools are expensive to buy, and ordinarily they are difficult to make, but by following the accompanying directions, anyone at all mechanically inclined should be able to make a good serviceable tool.

At Fig. 1 the knurling tool is shown complete. Fig. 2 shows the details and dimensions of the various parts. The dimensions given are for a tool to be used in a small lathe, but by increasing the proportions the design may be used in making a knurling tool for a larger lathe.

The shank should properly be made from a piece of tool steel, although in the absence of a suitable piece of tool steel, machine steel may be used and case-hardened. A good size of stock to use is 5/16 in. x 5/8 in., such as is used on small lathe tools, and, in fact, an old lathe tool should furnish a good piece of stock for the shank. From the illustration, it will be noticed that the stock is reduced from a point 7/8 in. from the head of the shank. This may be done by forging or shaping, but another way is to drill a row of closely spaced holes just outside of the outline of the shank, chip the waste edge off, and file to the line. In the absence of a planer this is the best method to follow, unless one has access to a milling machine. After the back end and body of the shank have been finished, drill and ream a 1/4 in. hole through the center of the piece, at a point slightly over 5/16 in. from the end. Now, with a 5/8 in. counterbore, having a 1/4 in. pilot, this hole should be counterbored to the depth of 1/16 in. on each side. If there is no counterbore of this description to be had, one is easily made by turning

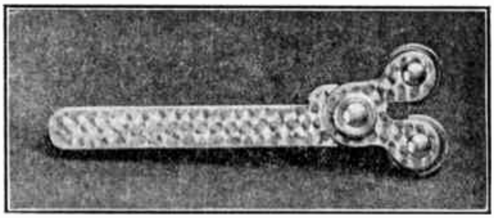


Fig. 1

a short piece of steel to 5/8 in. diameter, then reducing the end to 1/4 in. for a short distance and filing each side down to the pilot. This done, the two lips should be relieved and the counterbore hardened and drawn to a full straw color. After the shank has been counterbored, the end should be trimmed down to the counterbored part, the shank smoothed up with emery-cloth, and this part of the work is finished.

Next we must consider the side plates. These two plates are made from tool steel, 1/16 in. thick, and it is very essential that they be exactly alike, as regards locations of holes, etc. First saw out two pieces of the 1/16 in. sheet tool steel somewhere near to the size and shape required. After seeing that these pieces are smooth and flat, polish one side of one of the pieces, copper with a little blue vitriol and lay out the outline of the side plate and the three 1/4 in. holes. In laying out this plate, the easiest and best way is to describe a circle with a radius of 7/16 in., and on the circumference locate three points equidistantly spaced. With one of these points as a center, describe a 5/8 in. circle and from each of the other two points describe 1/2 in. circles. It is now an easy matter to connect the three circles with short arcs as shown. Rivet the two pieces of steel together with two small rivets placed in the waste edge of the stock. The three 1/4 in. holes may now be drilled and short pieces of 1/4 in. rod inserted to hold them together temporarily after the edges have been trimmed to the line. Around the outside edges of the two 1/2 in. circles the edges of one side of each plate should be rounded for the sake of finish. Both the shank and these two side plates should be hardened in oil and the temper drawn to a purple

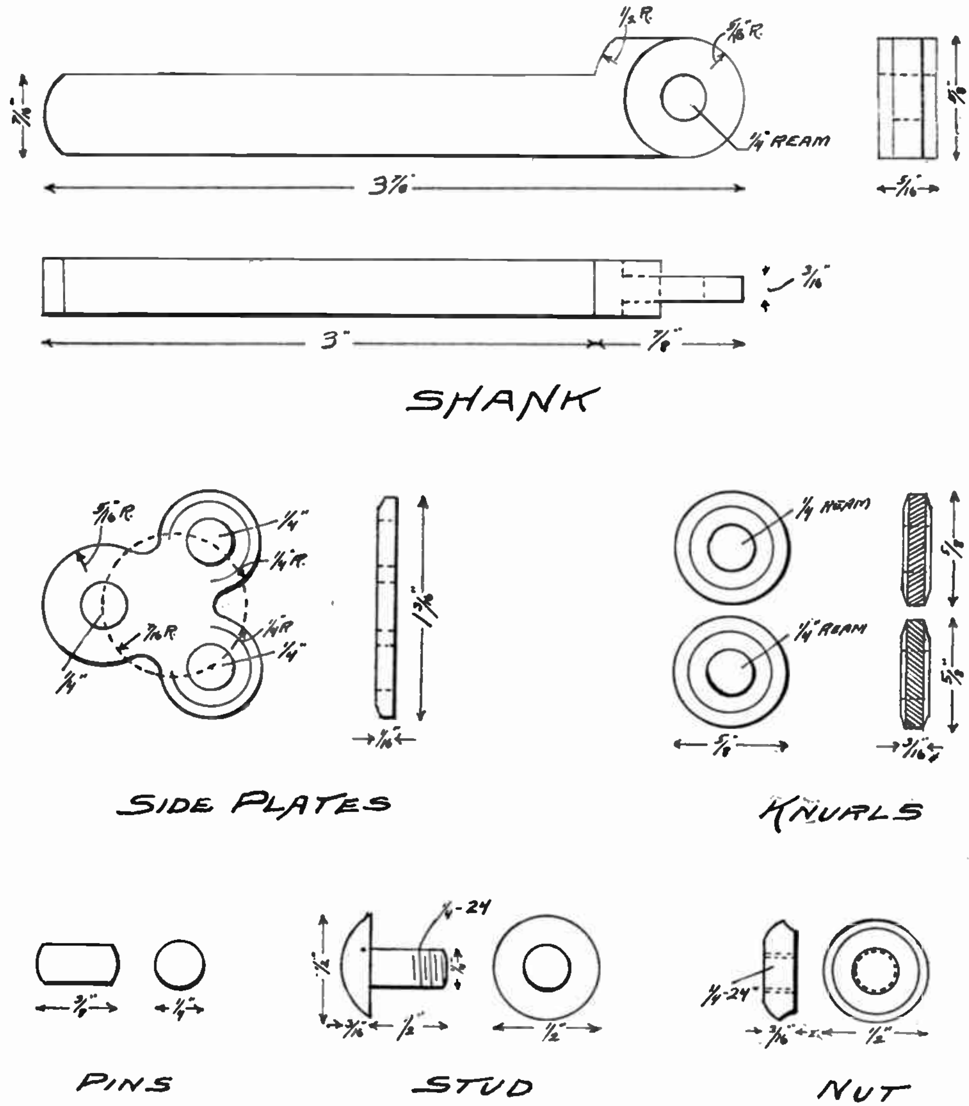


Fig. 2

color. In drilling the three holes in the side plates it will be well to run through a drill that is slightly smaller than the ¼ in. before using the full-sized drill, thus avoiding the tendency for the drill to run as well as to save reaming.

The knurls themselves may be purchased for about twenty-five cents each, but if another knurling tool can be borrowed for a few minutes it will be interesting work to make a pair from them. Drill and ream a ¼ in. hole through a short piece of tool steel. A piece 2 in. long is about right. Center this piece with a 60-degree countersink and turn it down to ⅝ in. diameter. Hold the knurling tool in the lathe tool post with one of the wheels against the work, and block it up so that the other roll is out of the way. Put the lathe on the slowest speed, use a little oil and slowly force the knurl to duplicate itself on the short piece of stock, bearing in mind that a knurled section twice the width of the knurling wheel is all that is needed. Roll the second knurl in the same manner and cut them from the piece, leaving stock enough on the sides to finish. Next place these semicompleted knurls on an arbor and turn up the sides to the dimensions in the sketch. Harden the knurls in salt water and barely start the temper color to a faint straw.

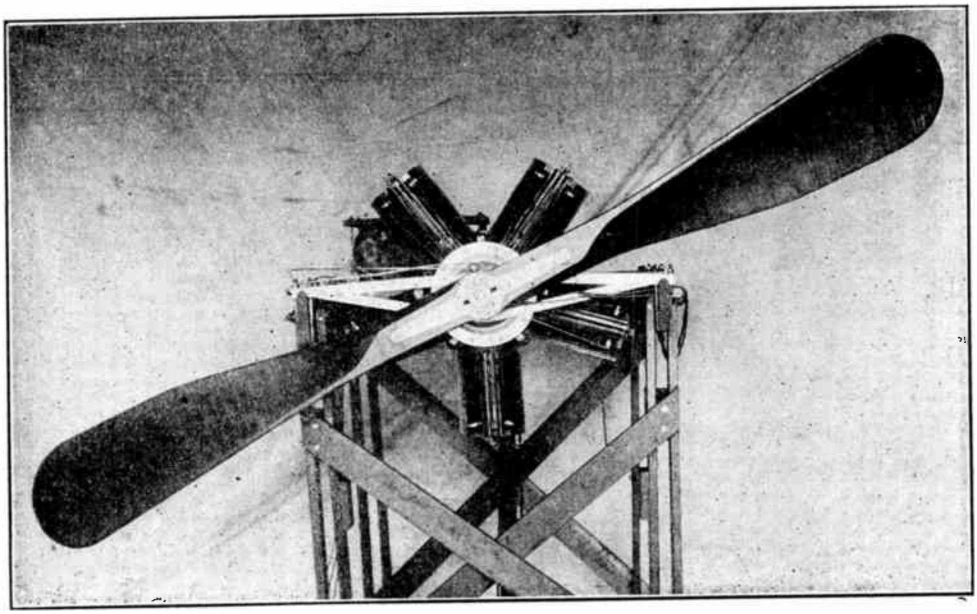
The two pins that the knurls turn upon need little explanation, nor do the central stud and nut present any difficulties. The two pins must be hardened and drawn to a dark straw. These pins should fit tightly in the side plates, but the knurls should run freely upon them. The central stud should be threaded with a fairly fine thread—¼–32 or ¼–24—and the edges of the nut knurled. This latter part may be done after the tool is completed. It is not necessary to harden the central stud. In assembling, the side plates should be mounted on the shank and held in place by the stud; then if the knurls are of the right thickness they should slip freely between the side plates, and after driving the pins into place the knurling tool is ready for use, without any further trouble.

DESCRIPTION OF THE NEW 72 H.P. AVIATION MOTOR

A western manufacturing company who, in 1898, built the first revolving cylinder motor that actually ran, and since 1903 have been building cars driven by a motor of this type, are now turning their attention seriously to the production of high-powered aviation motors, and have brought out a 72 h.p. motor, revolving vertically, as shown by photograph herewith. Since most of the laurels won by heavier-than-air flyers have gone to motors of the revolving cylinder type, this new motor, by the world's first builders of that type, is of especial interest.

In some respects this motor is very similar to the five-cylinder revolving motors used in their car, having the same number of cylinders, the same single-throw crank, the same positive oiler and the same crank case construction. In other respects, however, it is quite different, being designed from the ground up solely for aviation purposes, and revolving in a vertical plane, so that it may be directly connected to propeller shaft or have propeller mounted directly upon the motor for aeroplane work.

The most interesting improvement found on this motor, and no doubt the most important advance made in the construction of aviation motors since the introduction of the revolving cylinder



type, is the elimination of the carburetor and employment of injection with a means for absolutely regulating the amount of gasoline injected into each cylinder, and insuring that all cylinders will receive exactly the same mixture. This also makes it possible to do away with the inlet valve, and employ one valve for both inlet and exhaust, as only air is drawn in by the suction stroke of the piston, while the gasoline is sprayed within the cylinder, where it is mixed with the charge of air before compression. Having but one valve in the head of the cylinder, it can be made amply large to insure a full charge and a free exhaust.

In order to relieve the cam controlling the action of all five valves from the heavy load of opening a large valve against the high pressure at the time exhaust takes place, the cylinders are provided with auxiliary exhaust ports, which are uncovered by the piston on its downward stroke. No check valves are required over these auxiliary ports, as on the suction stroke, pure air and not a mixture of gas is drawn in, so what air is drawn in through the auxiliary ports on the suction stroke becomes a part of the explosive mixture in the cylinder, and being a constant quantity does not affect the operation of the motor.

The control of the motor is entirely taken care of by regulating the amount of gasoline used, and the only adjustment that might be construed as belonging to the carburetion system, is the valve, by means of which this control is accomplished. The motor is not sensitive to adjustment, and the speed may be regulated through quite a wide range by this simple means.

The lubrication system above mentioned consists of an oiling device covered by one of Mr. F. O. Farwell's patents. This oiler consists of a single rotary member, much resembling in form the cylinder of a revolver, with longitudinal chambers bored therein. Each of these chambers carries a plunger, which, as the cylinder revolves, is driven from end to end by two stationary cams, causing a small amount of oil to be drawn into each of the chambers at the bottom and ejected into a corresponding tube at the top.

This oiler supplies cylinder oil of an extra heavy grade to the various bearings and to the cylinders, doing away with the necessity for splash lubrication, which calls for the flooding of other revolving cylinder motors with a great quantity of oil, which gums up the valves and soots up the spark plugs.

There are two spark plugs in each cylinder of this motor, and two independent ignition systems are employed, so that either or both of the sets of plugs may be used, thus insuring against the accidental stoppage of the motor from a broken wire.

Something over ten years ago this company conducted a series of experiments to determine the action of the air in circulating about the cylinder of a revolving cylinder motor, and as a result, established beyond question the fact that longitudinal ribs are much more efficient than the circular type. The air coming in contact with the cylinder walls is thrown off radially, circulating lengthwise of the cylinders; so the only logical arrangement of cooling ribs is lengthwise of the cylinders. The placing of ribs in this way has the further advantage of strengthening the cylinder against tensile strain caused by the action of centrifugal force and the explosion.

This new motor operates satisfactorily on any grade of gasoline, using ordinary stove gasoline or naphtha with perfect success, but when these grades are employed it is desirable to have a small tank of higher grade gasoline to facilitate starting.

In designing this motor reliability has been considered above extreme light weight, as evidenced by the large bearings on the connecting rods, and crank shaft, and the fact that four rings are employed on the pistons where some builders of aviation motors are using only a single ring.

The materials employed are, of course, of the highest class, and vanadium chrome nickel steel is used wherever practicable.

Having a bore of 6 in. and stroke the same, this motor is rated at 72 h.p. by the A.L.A.M. formula (square the bore, multiply by the number of cylinders and divide by 2½), and on actual propeller tests, has delivered more power than this. It drives a 9 ft. 6 in. propeller of 6 ft. pitch at 900 to 1,000 revolutions per minute, developing a thrust of 440 to 460 lbs., which pull can be maintained indefinitely without overheating the motor.

Probably 72 h.p. is more than the average aviator requires at present, but as competition in this line becomes more keen and greater records must be set to interest government officials and other prospective purchasers of heavier-than-air machines, this additional power will be required; and as machines of greater stability and larger carrying capacity are built the high power will be found essential. Another point to be remembered is that while a motor of small power may be able to fly when properly tuned up, it is necessary to have a motor of larger power if one is to be sure of flying under all conditions and rising from the ground quickly where there is not room for a long run in starting.

Those who have seen this motor on the testing stand declare that it is the ideal motor for aviation purposes and will, no doubt, be the future power plant of many record-breaking machines.

How Stamps are Gummed

If there is one thing above another which has been brought down to a science it is the gumming of adhesive postage stamps. The precautions taken to secure a uniform coating of gum on the back of stamps approaches the marvelous.

When the stamps are gummed they are tested to establish if the coating varies on sheets one seven-thousandth of a pound. The stamps after being printed go to the gumming room. Pipes convey the gum in a heated and melted state to small vats, into which it is slowly dropped as needed. From these vats it is allowed to ooze slowly onto rollers.

The sheets of stamps pass under the rollers, receiving a thin coating of gum, and then drop onto a continuous belt. The belt carries them into vats which contain coils of steam pipe 50 ft. long. The slow passage of the freshly gummed stamp sheets through the vats dries them. When they reach the other end of the vats they are dry enough to be piled one upon another, tested, counted, and sent to be perforated.

The precautions taken to insure uniformity in the gumming are the most interesting part of the work. Each morning when the workmen report for the day duty they are given a series of blanks, which they must fill out during the day as their work progresses., A most careful account is kept of every ounce of gum given to the men and of every sheet of stamps which they handle. The system is an absolute check on the stamp sheets, but was designed to insure the use of the proper quantity of gum in proportion to the stamp sheets.

When the work starts in the morning each of the men is charged up with so many sheets of stamps and so many pounds of gum. He must spread that amount of gum over the given number of sheets. Exhaustive experiments and exact scientific calculation have determined the proportion of gum and paper.

Rigid and continuous inspection and the keeping of a running account with each operator in the gumming room makes it almost impossible to neglect any sheets or to dispose of the gum, except by spreading it with absolute uniformity over the sheets. The little vats which hang over the rollers contain delicate instruments, which show the temperature at which the gum is kept and its specific gravity.

Moisture in the atmosphere presents the greatest problem to the operators in the gumming room. The quantity of the gum varies with the seasons. To secure the desired results it is not only necessary for the employees to be carefully watched, but the actual atmospheric conditions in which they work are carefully regulated.—*American Boy.*

What About the Yesterdays?

A little relative once asked me: "What becomes of all the yesterdays?" I couldn't answer him intelligently, but sometimes I believe that they are being woven into a panoramic view to be unscrolled to man in some future existence, so that he may see the glorious opportunities he daily overlooked. If so, let's digest well the passing show of the todays.—W. A. MacKensie.

In answer to the question, "What are the five great races of mankind?" a Chinese student replied, "The 100 yards, the hurdles, the quarter-mile, the mile, and the three miles."—*Kansas City Star.*

A LABORATORY ELECTRIC FURNACE—Part II

Construction of a Step-Down Transformer

GEORGE F. HALLER

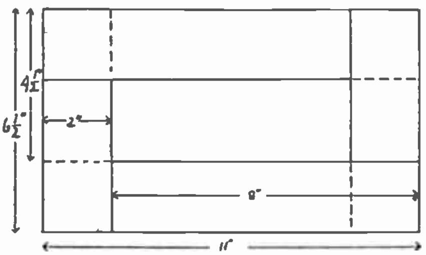


Fig. 5
Plan of Transformer Core

A transformer for use with the electric laboratory furnace described in a previous article, can be constructed by the amateur at a small expense. It is of the core type, designed for operation on 110 or 220-volt, 60-cycle alternating current. Its capacity for short runs, such as are encountered in operating the electric furnace, is approximately 2 kw. The secondary voltage can be varied from about 2½ volts to 35 volts by steps approximating 2½ volts each. This variation in voltage is necessary in using a furnace of this type, since the resistance of the carbon resistor mass falls rapidly as it is heated; hence, some means must be provided to limit the excess current which would flow, due to the lowered resistance. This is most easily provided for by taking a number of taps from the secondary winding. A variable resistance might have been used to limit the excessive current flow, but it would have been expensive in operation. It will be found in practice that steps of 2½ volts in the impressed voltage will be sufficient to regulate the current flowing through the furnace.

Both the primary and secondary windings are divided into two sections, one-half of each winding being placed on either leg of the core; this is done in a properly designed transformer to reduce the magnetic leakage to a minimum. The secondary is wound outside the primary on both legs. While this is not ordinarily good practice, it is done in the present instance to facilitate the bringing out of the secondary taps.

CORE

The core is built up of thin sheets of soft iron carefully insulated from each other by a thin coat of varnish or shellac. Suitable strips are cut from Russian stove-pipe iron, or if possible from silicon steel. It is sometimes possible to obtain strips of the best grade of transformer iron, carefully annealed and coated on one side, from the regular makers of transformers. They have strips left over at times from cutting their regular punchings, which may be suitable for use in this transformer.

The dimensions and assembly of the core are shown in Fig. 5. About 30 lbs. of 2 x 9 in. strips and 15 lbs. of 2 x 4½ in. strips will be required. Enough strips should be cut to make two piles of each size 3 in. high when compressed. If commercial stove-pipe iron is used, the strips should be wrapped in sheet asbestos, and bound up with heavy iron wire. The bundle should be placed in the furnace, or in the kitchen range, towards evening, so that the mass may become red hot and then cooled as the fire dies out. The asbestos covering keeps the iron clean and prevents the formation of scale. This process will thoroughly anneal the iron and greatly enhance its magnetic properties. If strips are obtained from a transformer manufacturer, or are cut from the cores of burnt-out lighting transformers, which can sometimes be obtained, this annealing process is not necessary. If the strips have not already been varnished, they should be painted on one side with some good insulating varnish, such as Armalac or M.I.C.

The longer sides are first built up with the alternating ends overlapping 2 in., as shown in Fig. 6. In order to facilitate this building up of the core, the method illustrated in the drawing should be adopted. Two blocks about 4½ in.

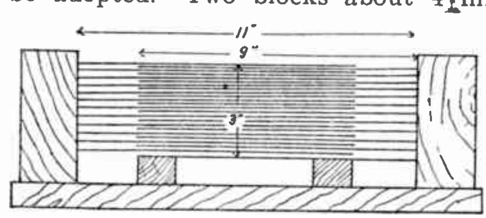


Fig. 6
Method of Assembling Core

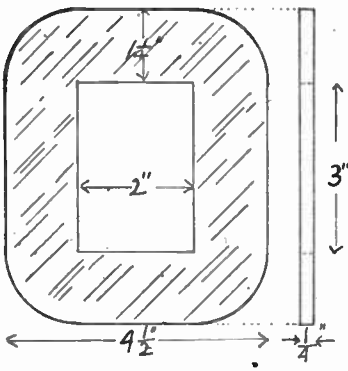


Fig. 7
Fiber Heads

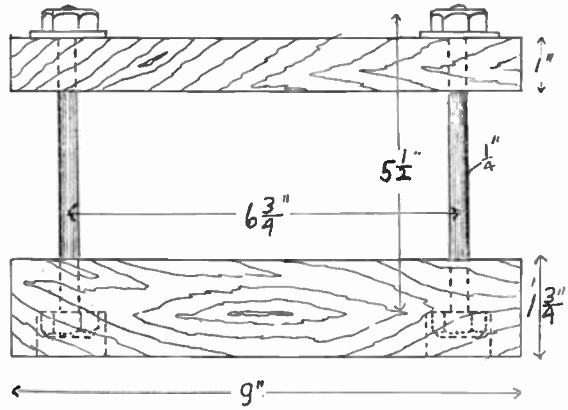


Fig. 9
Clamps for Core

high are nailed on a smooth board 11 in. apart. Two small pieces of wood are laid between these, so that the strips are raised above the board while the core is being built up. This facilitates the slipping of a clamp under the core and holding the latter securely while it is removed from between the two blocks. The 9 in. strips are laid alternately against each end block until a pile 3 in. high, when compressed, is built up. The strips should be tightly clamped and the bundle wrapped with two layers of friction tape. The remaining 9 in. strips should be built up into a second bundle similar to the first one, thus making the two long legs of the core.

WINDINGS

Four fiber heads are cut from a ¼ in. sheet to the dimensions shown in Fig. 7. Two of these heads are placed on each of the assembled legs, as shown in Fig. 8. They should be spaced just 6½ in. apart. Each section of the primary winding consists of three layers of No. 10 double cotton-covered magnet wire. Fifty-seven turns should be wound in each layer. It will require about 6½ lbs. for the complete primary. Drill a hole in the end of one of the heads and allow the wire to project several inches. Wrap the core with several layers of empire cloth, or in its absence use heavy paper. The wire is wound as evenly as possible, being careful that there are no bare spots in the insulation. It is very essential in winding A.C. apparatus that no turns are short-circuited. If a short exists, the turn then acts as a short-circuited secondary of a single turn transformer. A heavy current at once circulates the

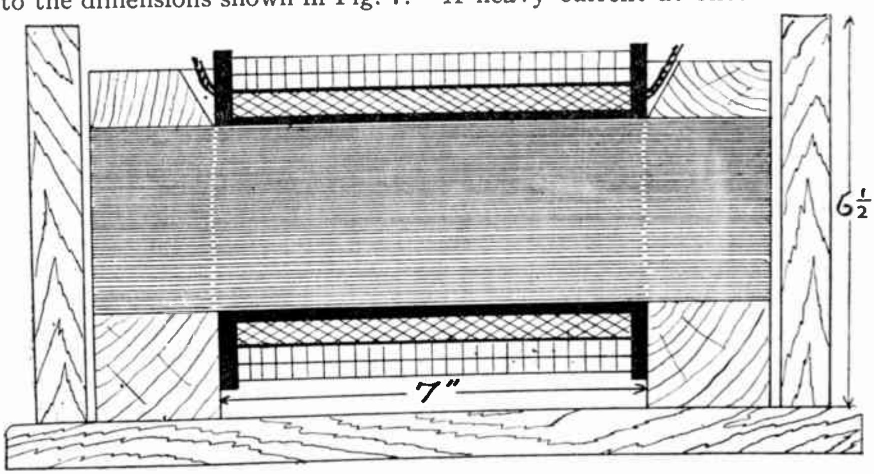


Fig. 8
Section of Completed Transformer

"shorted" turn, with the result that the wire is burnt in two, thereby opening the winding. In D.C. windings the short-circuiting of any small portion of the winding is not so serious, as the effect is only to render that portion of the winding ineffective.

When the primary winding is finished, the end of the wire should be brought through a hole drilled in the opposite head on the same side as the beginning of the winding. Wrap the winding with several layers of cloth held in place with shellac. A knot should be tied in the end of the winding so as to identify it when the transformer is assembled. The primary on the second leg is wound in the same manner as the first, being careful to wind in the same direction.

The secondary consists of two layers of No. 4 B. & S. d.c.c. magnet wire wound double. There are 28 single turns or 14 double turns to the layer. One-half of the total 56 turns should be wound in each section. 9 lbs., or 70 ft., of No. 4 wire should be procured. It should be divided into two equal lengths and wound on separate spools. The ends of the two wires are securely soldered together and wound side by side as if it were a single wire. One wire of No. 1 gauge could be used in place of the two No. 4 wires, but the difficulty in winding warrants the use of two conductors in parallel.

The same amount of wire is wound on each section, but the number of taps is different, there being but one tap on the first section, and four on the other section. The most convenient way to tap the winding is to bare about 1 in. of the insulation of both wires and bend a heavy piece of sheet brass or copper 2 in. long and ¾ in. wide around the two wires. Solder is run into the joint so as to make good electrical contact. The wire and strips are carefully insulated with two layers of paraffin tape, which can be made by dipping long strips of silk lisle in melted paraffin. This tape is very thin and can be made sufficiently adhesive by the heat from the fingers.

Taps are made from the 14th, 28th, 42d, 45th, 49th and 52d turns of the secondary winding. As there are 28 double turns on the first section, the tap of the 28th turn is made by bringing the end of the first section and the beginning of the second to the same switch

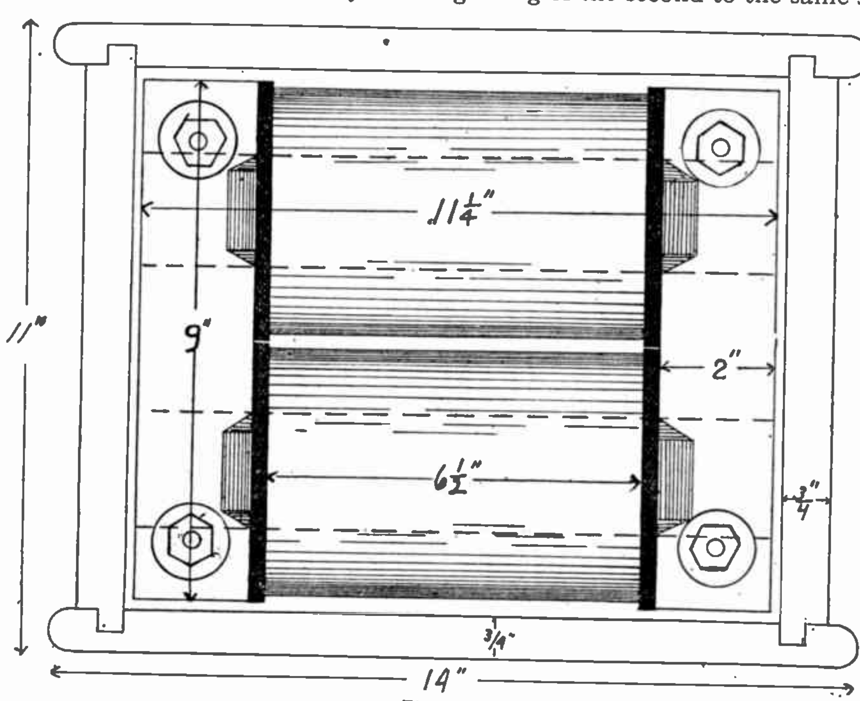


Fig. 10

Plan of Completed Transformer (cover removed) point. Be sure all the taps are brought out on the same side of the coils, so that connections can be made by soldering short pieces of No. 0 wire to the brass strips. The taps can be staggered to avoid shorts.

When the secondary winding is finished, the two legs are set so that the windings encircle the core in the same direction. The short end pieces are slipped into the spaces between the long strips, and the core is carefully squared up. Two clamps, shown in Fig. 9, are made to hold the core tightly together. They are placed across the end strips, as shown in Figs. 8 and 10. Notches should be cut in the upper pieces as shown, in order to make room for the terminals of the windings.

The transformer should be enclosed in a box which can be zinc-lined and filled with paraffin oil. The use of oil is advised in order to keep the transformer cool. The transformer can be operated without oil, but this will reduce its capacity somewhat.

The primary terminals are to be brought to four binding posts on the cover and connected as shown in Fig. 11. If this method of making connection is followed, it is only necessary in operating the transformer on 220 volts to bridge the middle post, thereby connecting the two sections of the transformer in series. When operating on 110 volts the outer posts are bridged with a piece of wire, thereby connecting the two sections of the transformer in parallel.

The secondary leads and taps are connected to the dial switches on the cover as shown. These switches have several advantages over the usual sliding arm type of switch. They are far simpler to construct, as all parts can be obtained in the open market. Procure two unmounted 100 ampere single pole switch knives, and eight unmounted clips. The knives should be secured on the ends of rods so that they can be mounted on the cover as shown, so that they may be rotated. The clips are set on the arc of a circle so as to make contact with the knife as the latter is rotated. A glance at the figure will make the construction clear. This method will be found to give far more satisfactory results than the usual sliding type as constructed by the average amateur.

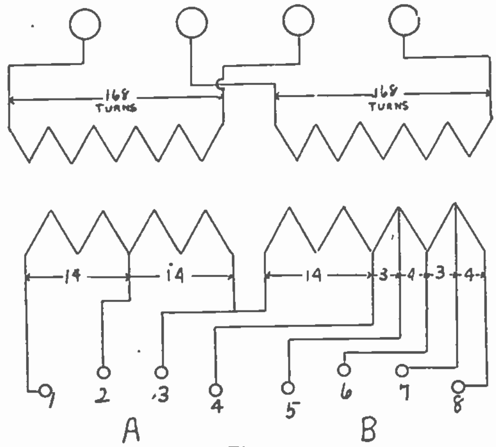


Fig. 11
Diagram of Transformer Connections

The switch *A* is connected as shown, so that each step cuts in or out 14 turns of the secondary winding; thus increasing or decreasing the secondary voltage about 9 volts. The points on the switch *B* are connected from the taps 45, 49, 52 and the end of the winding, which is turn 56, so that each step on this switch is practically 2½ volts.

Thus by the proper adjustment of the two switches it is possible to secure any voltage from 2½ to 35 volts by steps of 2½ volts. For example: With the switch arms at the points 1 and 8, as illustrated, the maximum voltage of 35 is obtained. By connecting to point 4 on switch *A* and point 8 on switch *B*, the voltage is practically 9 volts. Thus it is seen that moving the switch *B* to the left subtracts 2½ volts at each step, while moving the switch *A* to the left adds 9 volts to the secondary e.m.f. With the switches making connection with points 4 and 5 the lowest voltage of 2½ is obtained.

The primary of transformer should be connected to the line through a switch capable of carrying 25 amperes. Two 25-ampere fuses should be connected in the primary winding. The secondary winding should be fused for 100 amperes.

In connecting up the furnace, some form of ammeter or other current-indicating device should be included in the circuit. Without such a device the experimenter will be at a loss to know when to reduce the current passing through the furnace. An ammeter which will give current indications ap-

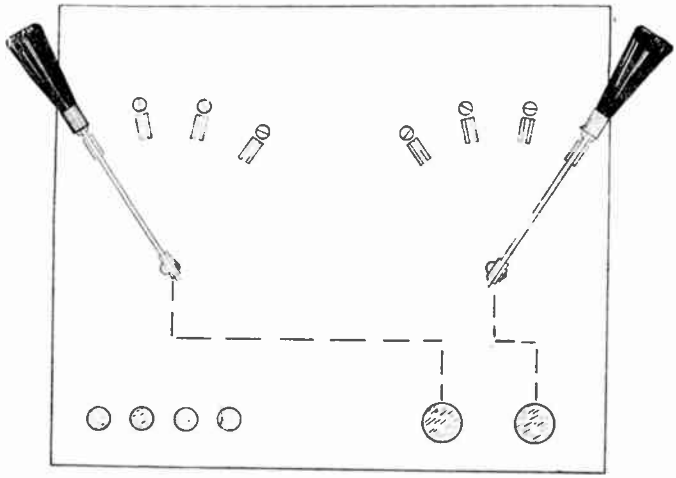


Fig. 12
Cover of Transformer, showing Arrangement of Switches

proximate enough for this work can be easily constructed on the magnetic vane principle. In using the furnace, whenever the current rises above 75 amperes, the voltage should be reduced 2½ volts by moving the switch over one step.

In starting the furnace for the first time the block under the crucible is set in the middle of the bottom. The crucible is set as concentrically as possible, and the space around it is lightly packed with the resistor material, until about half full. The insulating ring is laid on top of the carbon granules, and the furnace is filled to the upper distributing rings. The heat should be applied very slowly at first so that the moisture in the two linings can be thoroughly driven out. Start with a low voltage, increasing somewhat if necessary, so that the current does not exceed 10 to 15 amperes. Operate the furnace at this rate for several hours so that everything is thoroughly dried out.

In regular operation it will be found necessary to start on the maximum voltage of the transformer. As the current increases, due to the heating up of the carbon, the voltage is gradually cut down so that not more than 75 to 80 amperes flow. About 18 to 20 volts will generally be sufficient to maintain the temperature in ordinary reduction work.

BORING AND TURNING UP A HALF-BRASS

G. E. WILLIAMS

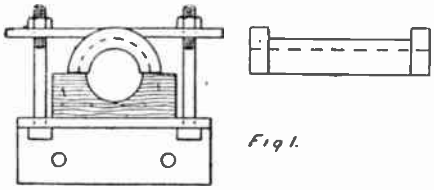


Fig. 1.

It is required to bore and turn a half-brass, as shown in the sketch below. Firstly, to bore the brass, procure a small block of hardwood, and make a semi-circular groove down it as shown, care being taken to see that the two faces (the one on the angle-plate, and the one on which the brass rests) are parallel, and also that the groove is slightly bigger than the finished bore of the brass. The brass is set up on an angle-plate (Fig. 1) ready to be fixed to the face-plate, and bored out to required dimensions. While it is still on angle-plate, face the flanges and round off the end of bore, if required, care being taken when facing the last flange to see that the first is parallel to the face-plate. Secondly, to turn the brass, procure a mandrel about one and one-half times the bore of brass, and turn down a portion to fit the brass, and slightly shorter in length than the overall length of same. Then end of mandrel is next screwed to take a standard nut and washer, as shown in Fig. 2. Place the brass in position, as shown in Fig. 3, and tighten on nut. Place the mandrel in between the centers, and with due care it will be found an easy matter to turn the brass to any dimensions you wish.

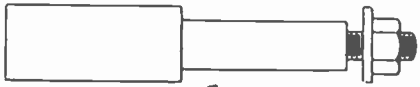


Fig 2

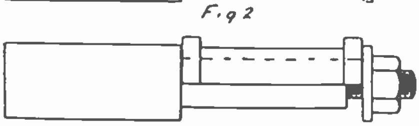


Fig. 3

MACHINE FOR TESTING THE THRUST OF SCREW PROPELLERS FOR MODEL AEROPLANES

C. T. POLLIT

The accompanying drawing is a side elevation of a machine which I have designed and constructed for the purpose of testing the thrust and efficiency of various sizes and shapes of screw propellers for model aeroplanes, driven by an elastic motor.

It is capable of taking propellers up to 1 ft. or more in diameter, a length of elastic up to 2 ft. and a thrust up to 5 oz.

It is some eighteen months or more since I commenced it, during which time it has been altered and added to a good many times, and although not yet perfect may be of interest and perhaps useful to some readers.

I am quite aware that a stationary machine for testing something which travels through the air when at work is not quite correct; but it will, at any rate, give comparative results.

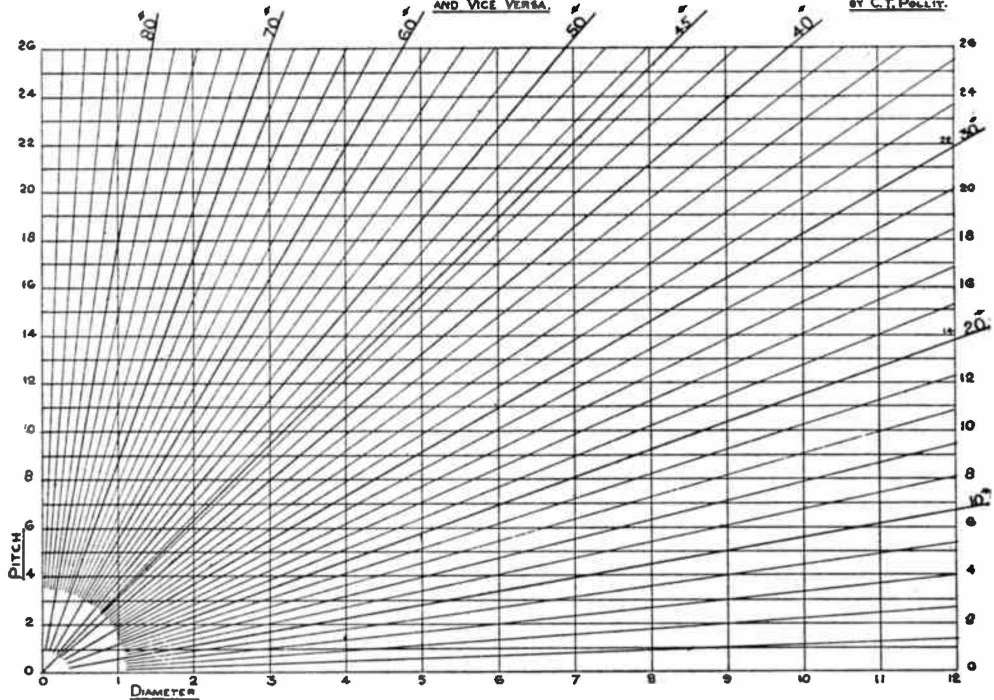
A better appliance would, no doubt, be what is called a whirling table, but this would require a much more expensive apparatus, and more room than I have at disposal, and might not be worth while. There are, I believe, already two or more large machines of this kind for testing full-sized propellers.

The construction of the machine will be easily understood from the drawing. The ⅜ in. square (ash) rod, 2 ft. 4 in. long, is fitted with a brass angle plate, screwed on to one end, for carrying one end of the propeller shaft, and a loose angle plate, secured with a sleeve, for carrying the other end. The other end of the rod is fitted with a sliding head, with hook, which can be adjusted for various lengths of elastic.

This rod is supported on two pairs of rocking levers, the rear ones being extended below the point of support to take a balance weight, which is approximately equal to the weight supported by the levers.

A connecting rod conveys the thrust of the screw to the lever, with spring attached to it near the bottom, the amount of thrust being indicated in

DIAGRAM FOR FINDING THE PITCH OF SCREW PROPELLERS FROM THE ANGLE AT THE TIP OF THE BLADES AND VICE VERSA. BY C. T. POLLIT.



ounces on the scale at the top. There is also a loose lever which remains where it has been pushed to, showing the maximum amount of thrust.

This was all I had at first. The winding-up gear, which was added later, and gives six revolutions to the propeller for one of the handle, not only saves time, but is also much less laborious than winding up with the finger. A revolution counter also indicates the number of turns which have been given to the elastic, and after winding up, the propeller is held by a loop of string, and the bracket, with winding-up gear attached, slipped off the end of the frame, so as to be out of the way. The time it took the elastic to unwind was taken by a watch held in the hand.

The self-registering arrangement was added still later. This shows not only the maximum thrust and the time it takes the elastic to unwind, but also how the thrust decreases during the unwinding of the elastic.

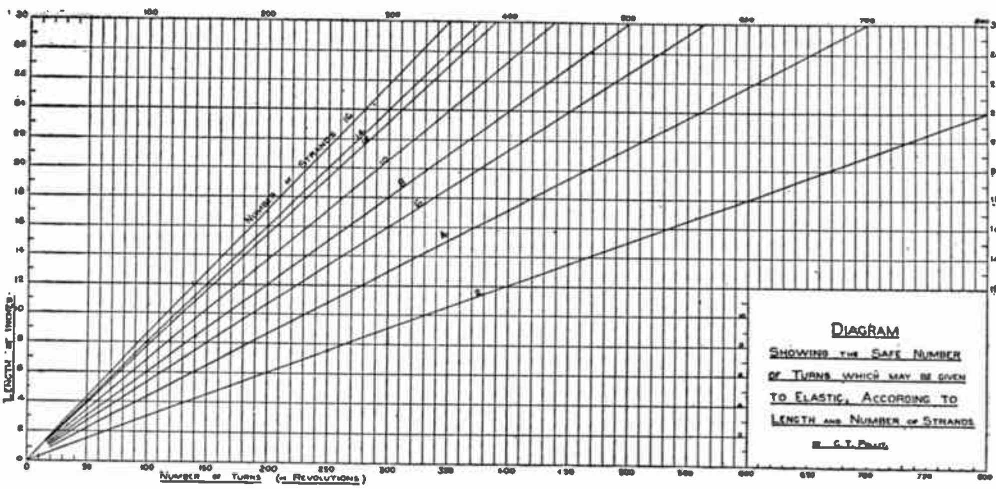
The self-registering apparatus consists of a drum (on which a paper is fixed), driven by a motor and governed by a revolving pendulum. The drum is made 2⅜ in. diameter, or 60 eighths of an inch in circumference, and is made to revolve once in a minute, so that ⅛ in. division is equal to one second of time; the paper on which the diagrams are recorded being ruled as per enclosed sample.

The motor is a clockwork one (out of a boat), set up on end, the spring being removed and a drum fixed so as to drive by a cord and weight. A slotted arm is fitted on to the spindle at the top, in which the revolving pendulum works, in order to give the correct motion to the drum. A second cord (with small weight attached, and wound round the drum the opposite way to the driver) serves to wind it up.

An arm carrying a pencil conveys the thrust of the screw from the index lever with spring attached to the paper on the drum. The pencil works in a slot formed by two parallel bars, so as to prevent side movement, and a small weight on the top gives the necessary pressure.

The machine is made chiefly of wood, with brass plates attached to the levers, working on small brass screws for bearings, and all is made to work easily.

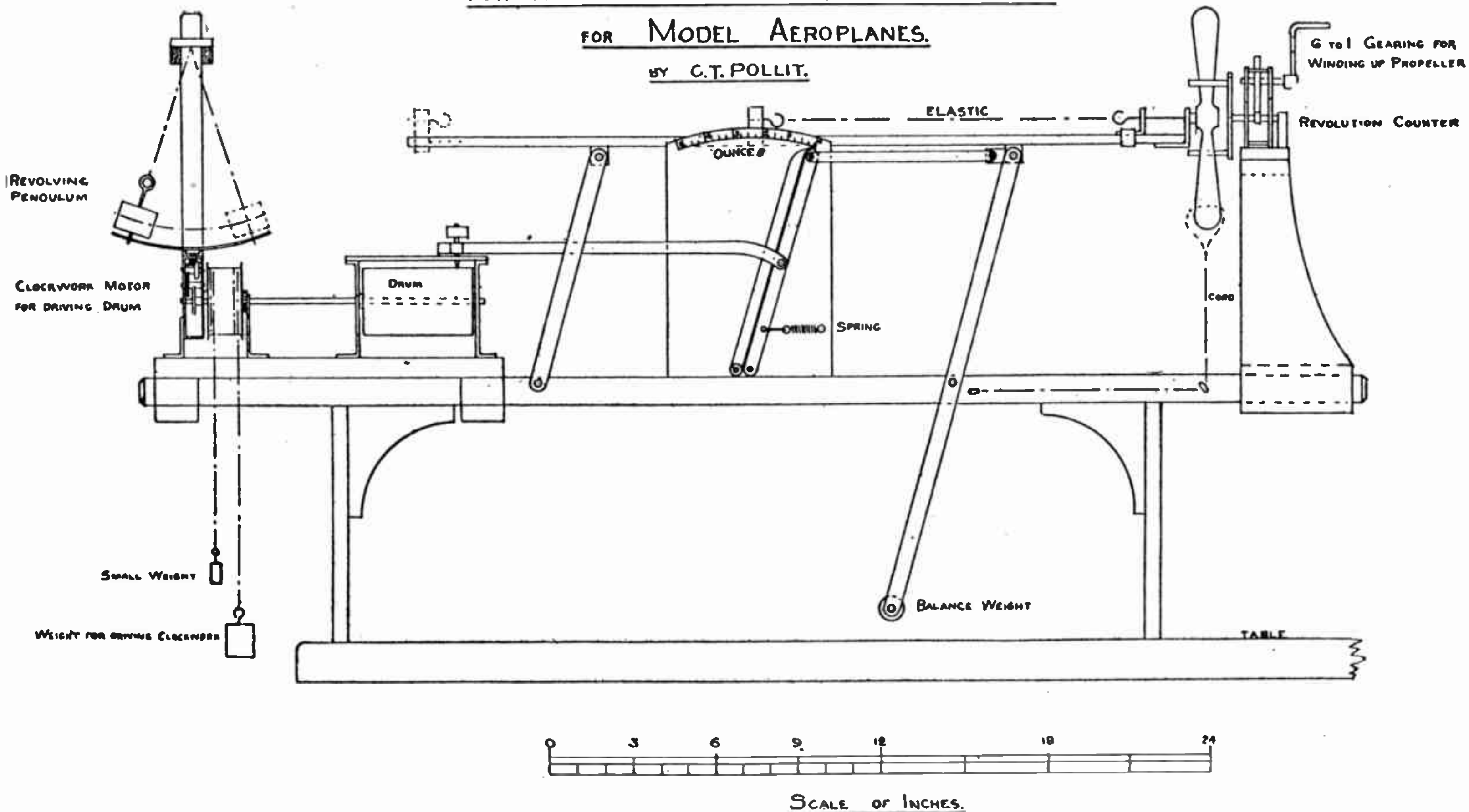
A test is made as follows: Having fixed a paper on the drum, and adjusted the pencil (which is movable along the arm) so that the point coincides with the zero line on the paper, wind up the propeller the desired number of turns, according to length and number of strands (say, 150 for 12 strands 1 ft. long), slip the cord over one of the blades, and remove the bracket with winding-up gear attached, so as to be out of the way. See that the loose arm is close up to the one with spring attached. Wind up and start the motor driving the drum by pulling gently at the driving weight. At a suitable moment release the propeller, and observe what takes place. Make a note of the thrust, as indicated by the loose lever, and compare it with that on the diagram.



MACHINE

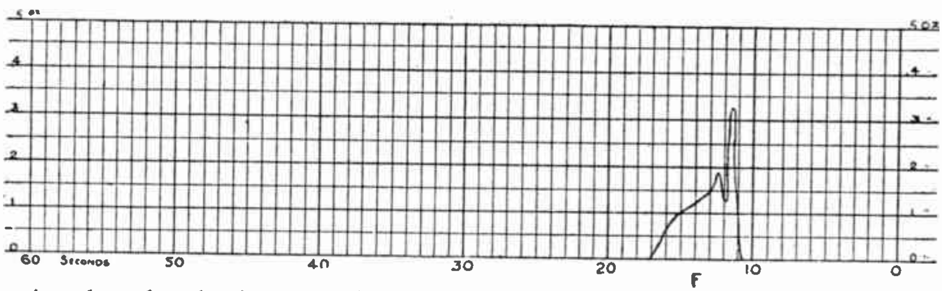
FOR TESTING THE THRUST OF SCREW PROPELLERS FOR MODEL AEROPLANES.

BY C. T. POLLIT.



Number the diagram, and put down particulars of each test on a sheet of paper, which can afterwards be transferred to the diagram. If desired, the

Mark	Diam.	Pitch	Elastic	No. of turns	Thrust	Time	Date	Remarks
Letter F	Inches 8	Inches 11	12 Strands 1/16" x 12" as above	150	Ounces 3¼	Seconds 6	15/3/11	Carved out of solid.



time it takes the elastic to unwind can be taken by a watch, and compared with that shown on the diagram.

The diagram below was taken from a propeller, of which the following are the particulars:

In order to find the pitch of a propeller, it is necessary to multiply the circumference of the circle described by the tip of the blades by the tangent of the angle formed at the tip with the plane of revolution. This is a somewhat tedious process, so I have constructed a diagram from which it can be more easily ascertained. The vertical lines represent the diameter, the horizontal lines the pitch, and the angles are shown for every two degrees. From the intersection of any two of these lines the third can be found.

Thus, diameter 8 in., angle 23½, gives 11 in. pitch. The angle at the tip of the blade must first be found.

I need scarcely say that if it was desired to test propellers having a greater thrust than 5 oz., it would only be necessary to substitute a stronger spring, graduate the index, and rule the paper to suit.

I may add that the graduating of the index was done by attaching one end of a cord to the rod carrying the propeller, and, after passing it over a pulley temporarily fixed off the end of the machine, applying weights to the other end, and marking the position of the pointer as each weight was applied.

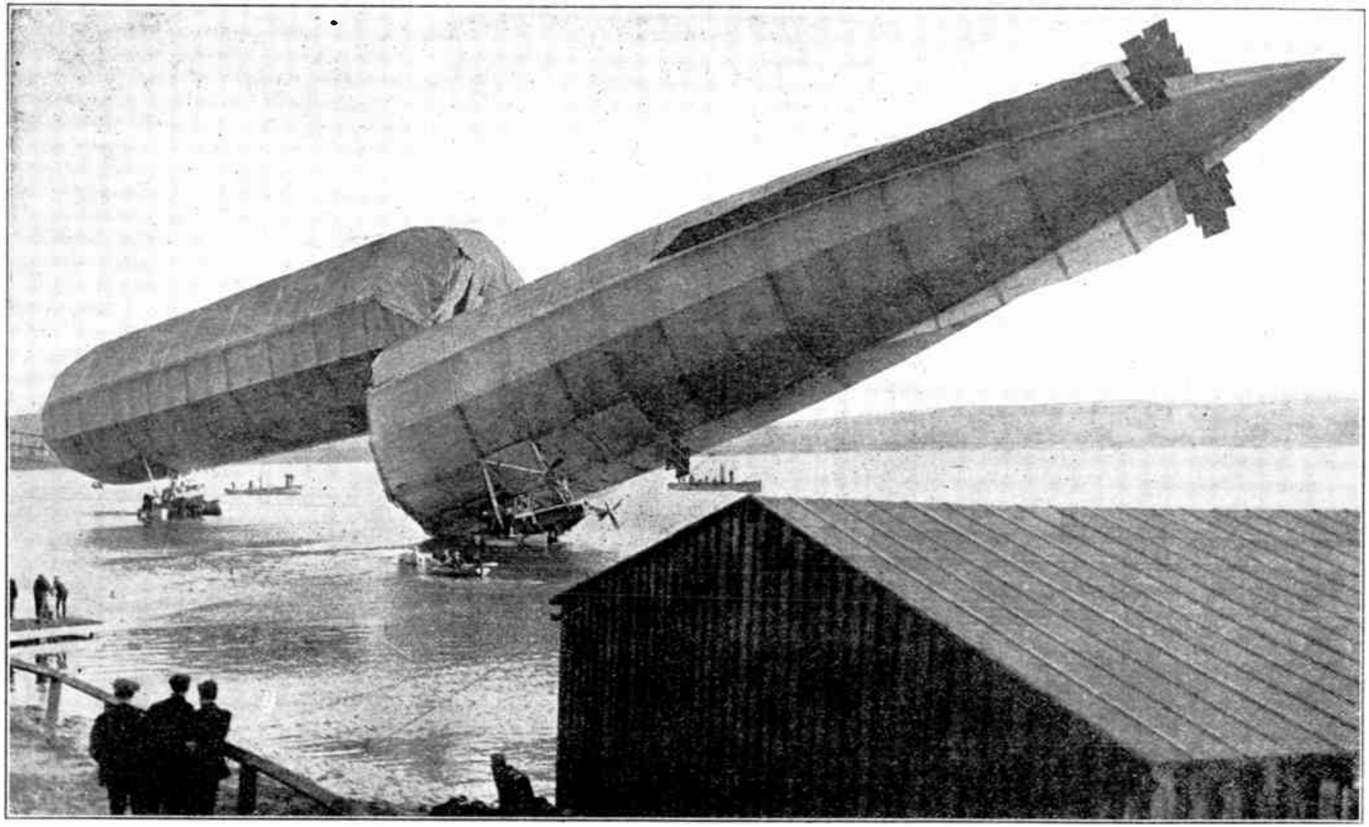
Details of the apparatus used in making the tests will be given in a subsequent issue.

Since sending in the results of the tests of elastic, I have constructed a diagram, from which the safe number of turns, which may be given to any length and number of strands, can be ascertained at a glance.—*Model Engineer and Electrician.*

A Curious Property of Water

Most people are vaguely aware that if water is allowed to drop upon a piece of heated metal it will only fizzle when the metal is comparatively cool. If very hot, the water runs off without making any noise, and this fact is utilized by laundresses to test the heat of their irons. An interesting experiment can be made by allowing drops of water to fall upon a plate of metal heated over a spirit lamp. At first, it will boil away with the usual noisy ebullition, but after a time each drop will be seen to take a spherical form and roll about the plate without the least hissing noise and without the production of any bubbles of steam. If the eye is now brought to a level with the plate it will be seen that the drops of water are not in contact with the metal. They roll about, in fact, as if the plate were greased. But if the lamp is removed and the plate permitted to cool, the water will suddenly begin to boil and quickly disappear.

The explanation is simple. When the plate is very hot the water evaporates so rapidly that a cushion of steam is interposed between the plate and the drop of liquid. This serves to protect the fluid from the heat of the plate, and keeps it at a short distance from the latter.



The Disaster of the British Naval Airship "May fly." The giant airship settling on the water after collapsing in the center. *Courtesy of "Aircraft."*

THE WONDERFUL TELEPHONE

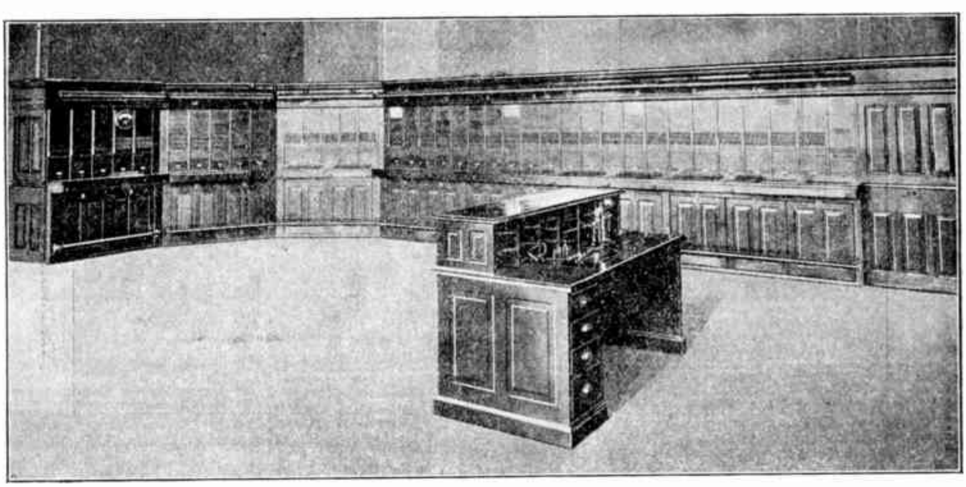
B. LLOYD DAVIES

There have been written many articles in the mechanical, electrical and other magazines, on mechanics, electricity and its uses, etc., but I have not as yet seen anything of interest on that marvel of marvels, the telephone, and for this reason I shall endeavor to give a slight description of the workings of this now indispensable instrument of commerce and business. It will be impossible to go into elaborate details, as space will not permit; therefore, I shall content myself with a brief description of what the telephone, its exchange, etc., is like, and hope it will be appreciated by all who peruse; and that to those who have no idea of what a study telephony is, this will prove somewhat of an eye-opener and bring closely home to them what a miracle Alexander Graham Bell accomplished when he discovered how human speech could be conveyed over great distances.

There have been many types and systems of telephones, telephone services, etc., since Bell's original conception, and I will therefore only attempt to speak of the modern system used today. In following the telephone from its birth to its present usefulness, one will notice that it has ever been the ambition of the great telephone companies to enlarge and facilitate the scope of telephone service, and in order to do this, and allow rapid connecting up from one telephone to another, it has taken a tremendous amount of money, labor and terrific mental energy. Also there is no doubt that more knowledge is required in telephone work than anything else in the electrical field, and to bring to perfection the vast telephone exchange systems of today against gigantic odds and public prejudice of the past, must have required heroic, determinated energy. The pioneers certainly deserve all kinds of "Nobel" prizes, and the praise of this world's teeming grateful millions.

In all telephone systems of the past the telephone subscriber was furnished with a small magneto generator, to call "central," and local batteries, wet or dry cells, for speech; but this was found to be an inefficient means of producing electrical energy, and very costly, as batteries had to be refilled, if wet, and charged, if dry cells. It was found that if a current for energizing subscriber's instruments was supplied over the line, wires from a set of batteries charged by a dynamo at the exchange, the cost would be nearly forty times cheaper and far more efficient.

In the central battery systems, to be now explained, the current, for supply-



Interior of a Modern Exchange

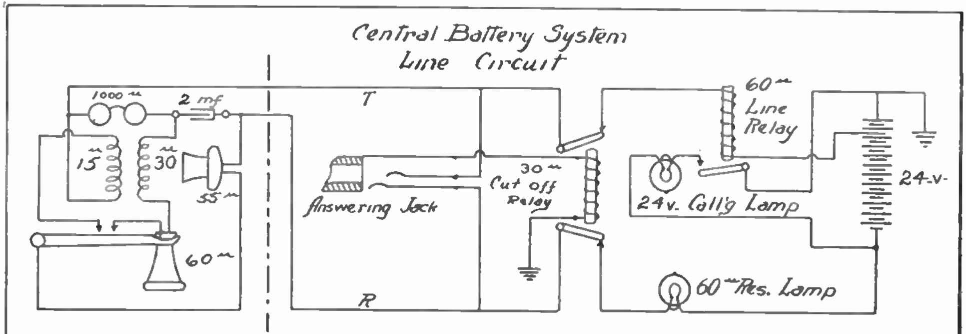


Figure 1

ing the transmitter at the subscriber's end, could also be used for calling and disconnecting purposes. One of the earliest central battery systems was designed for working on ground circuit lines: the battery was inserted in series with the cords in the exchange and the current flowed over the line through the subscriber's instrument to ground return.

The most important central battery system in use today is that of The Western Electric Co. As a starting point in the description it will be advisable to run through the general operating method: the subscriber removes his receiver from the switch-hook, and this closes the necessary circuit for the lighting of a lamp situated just above his local jack at the exchange, known as the "answering jack." At the same time a pilot lamp lights, this being a lamp of a larger size, of which there is one for each panel. This is for the purpose of supervision, and also to facilitate the reception of calls when the exchange is not busy. As soon as the answering jack plug is inserted into the answering jack, the calling lamp goes out automatically, the operator pushes over the "speaking key," or "cam," and tenders the enquiry "Number, please!" On learning the number required she plugs the corresponding jack on the multiple with the calling plug, pushes down the calling ringing button, thus notifying the called subscriber he is wanted. There are two lamps acting as supervisory signals, one for the answering plug and one for the calling plug. These lamps light when the subscribers hang up their receivers on the switch-hook. The operator is thus notified, and disconnects the lines, but not until both lamps light; the lamps being just in front of the plugs greatly accelerate operating.

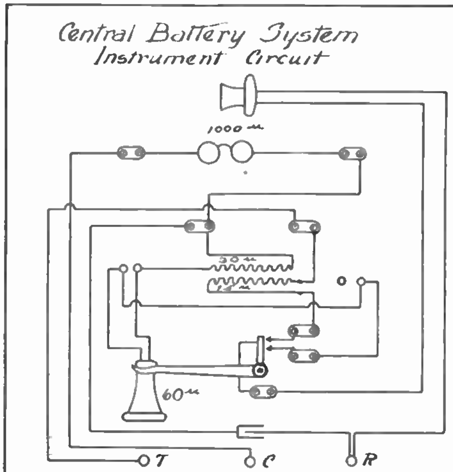


Figure 2

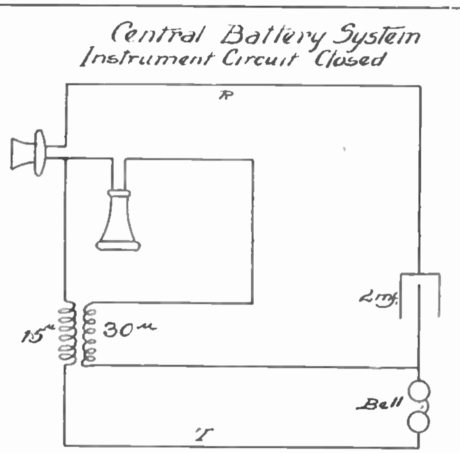


Figure 3

Fig. 4
Desk Set

Fig. 1 is a skeleton diagram of a central battery-line circuit. Fig. 2 shows the connections of the complete central battery instrument. Where there is only one instrument installed *T* and *C* are joined together and connected to one line and *R* to the other line. The circuit, when the receiver is on the hook, is from *R* through the 2 m.f.d. condenser and $1{,}000^{10}$ bell in series, back to *T*; there is no path for the battery current from the exchange, but the alternating ringing current passes readily through the condenser and rings the bell. When the receiver is removed from the switch-hook, the circuit is as shown on Fig. 3; then there is a circuit from the terminal *T* through the low resistance winding of the induction coil, which is of 17 ohms resistance, and thence through the transmitter, and thus back to *R*; there is consequently a low resistance circuit across the loop, through which the battery flows. Fluctuating currents can also induce in the high winding of 28 ohms, and then flow around the receiver of 60 ohms resistance and the condenser.

Fig. 4 shows a pedestal or desk instrument with signal case containing condenser, bells, induction coil, etc. Returning to Fig. 1, we note the answering-jack *S* (meaning sleeve or base of plug) connected through a cut-off relay to ground; the *T* or tip (meaning top of plug) to 60-ohm line relay, and two cells of battery (*i.e.*, 4 volts); and the *R* or ring (meaning center of plug) through 60-ohm resistance lamp to negative of battery. When the receiver is on the hook, the instrument circuit consists

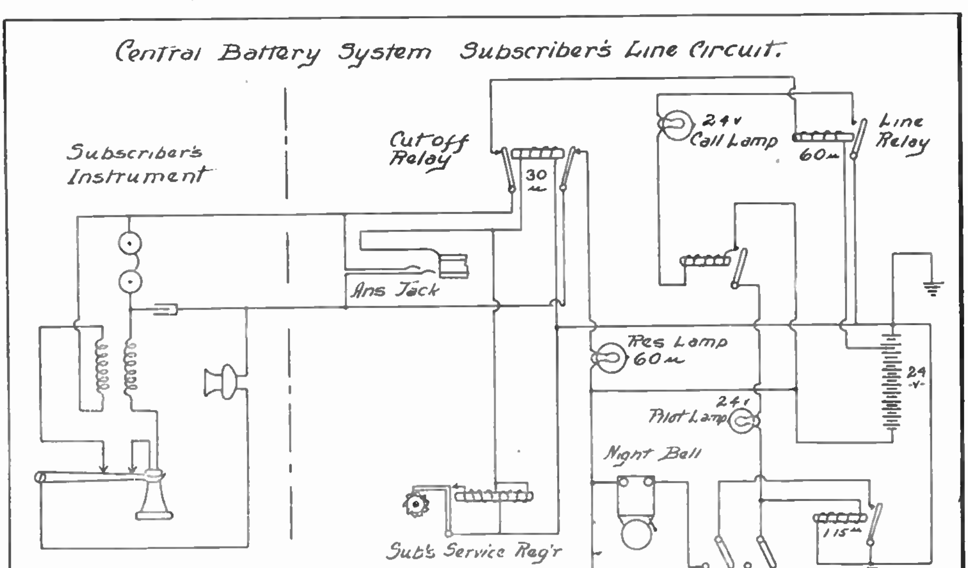
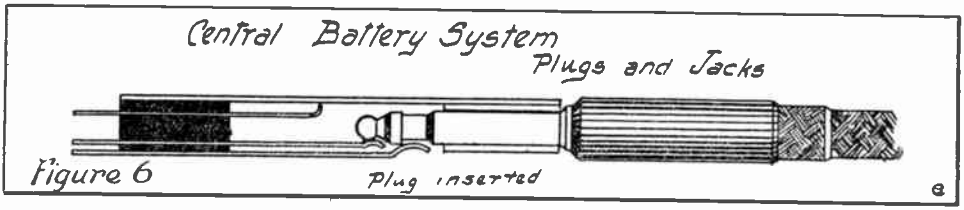


Figure 5



of a 1,000-ohm bell and a 2 m.f.d. condenser in series, so that there is no path for the nine cells around the line relay; but when the receiver is taken from the hook, the instrument circuit consists of the low resistance winding of the induction coil and transmitter in series across the loop; then the line relay is actuated and lights the calling lamp. On the insertion of the plug into the answering jack, the cut-off relay is energized, and the calling apparatus removed from the line circuit. The line relay is connected at a point with 4 volts potential above ground, in order that ground faults on the *T* line will be indicated by the actuation of the relay, and for a similar reason the resistance lamp in the *R* line is inserted; this also acts as a regulator of the current flow over the *R* line, preventing excessive discharges when the *R* lines are grounding. The line relay is not inserted in the negative side of the battery, as the circuit is arranged for the drawing of current over the *R* lines for extension working. The complete central battery line circuit with subscriber's registers (used for registering calls) is shown in Fig. 5. When the line relay is actuated the calling lamp is lit, and the low resistance pilot relay is actuated. This lights pilot lamp, and if the switch at the right-hand bottom corner of the circuit is open, actuates night bell relay, which works either the buzzer or night bell, according to the position of the left-hand switch. When the operator plugs into the answering jack the cut-off relay of 30 ohms resistance is actuated, but the 500-ohm register which is in parallel with the relay is not affected, as it is arranged to actuate with a larger current, as will be explained further on. The answering jacks are arranged in strips of 10, and the multiple jacks in strips of 20, both kinds being 8¼ in. long and ⅜ in. deep. The jack is specially designed in conjunction with the plug to prevent short-circuiting on the insertion of the plug into the jack. Fig. 6 shows the jacks and plugs. The calling-lamp jacks are numbered 0 to 9, and the answering jacks are provided with rectangular number plates, on which the subscriber's actual number is engraved, placed on the right-hand side of each jack. The multiple jacks are numbered 0 to 9 twice, and the initial number is marked on the style strip supporting the jacks. The line and cut-off relays are combined. The line relay is of the knife-edge pattern, and in some cases is fitted with a guard contact, consisting of a spiral of thin copper wire; this, however, is now discontinued, these relays being made up in strips of 10, and having a metal cover common to the strip. Fig. 7 shows the line relay rack in the center, with the vertical side of the intermediate distributing frame

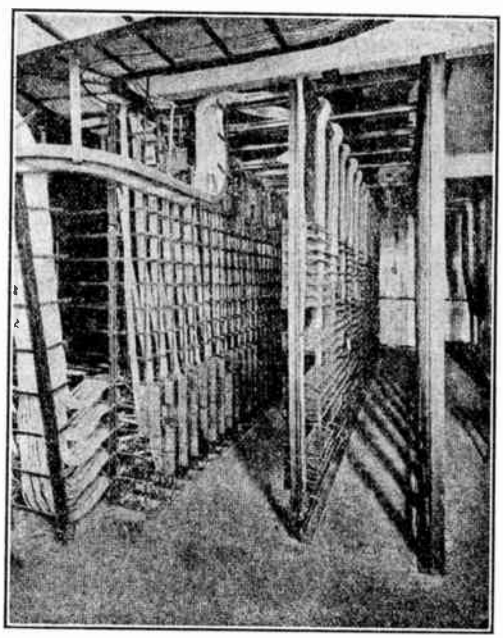
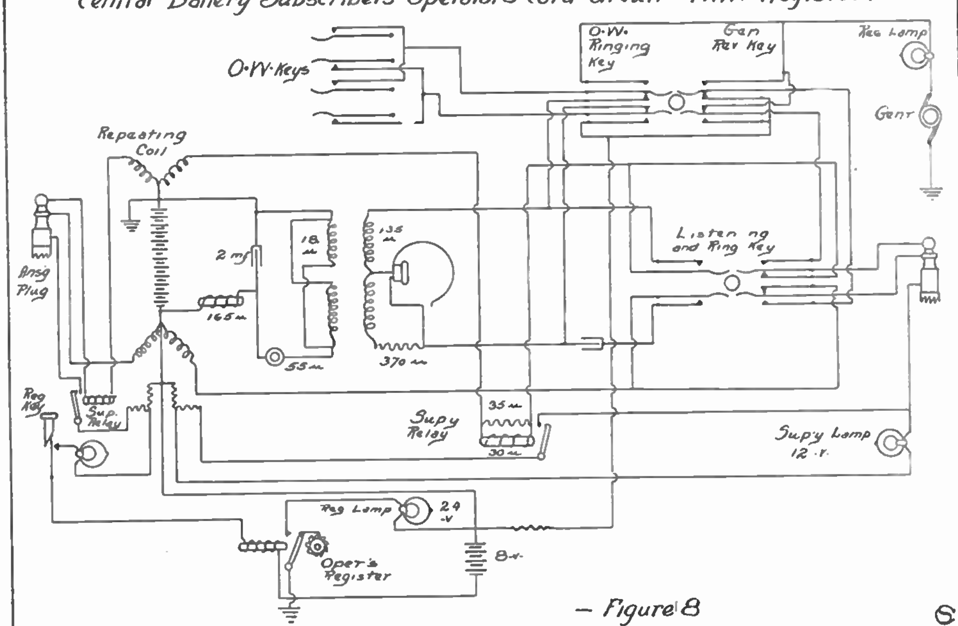


Fig. 7
Rear of Switchboard

on the left commonly known as V.I.D.F The multiple cables can be seen clearly on the extreme left. The line relay is generally adjusted to close with 1,000 ohms in series to release with 15,000 ohms, and not to stick after 24 volts have been applied direct. The cut-off relay is adjusted to be actuated by 24 volts applied through 243.5 ohms. Subscriber's service registers are mounted on an iron rack running parallel to the line relay rack. The registers are put in ordinary numerical order, and in addition carry a removable numbered cover with the subscriber's actual number on it. They are wired on one side of the line and on the other side are grounded. The line lamps are designed to work with varying voltages of from 19 to 20 volts, and have a candle power of about .35 c.p. at 24 volts. They take an average of .1 ampere. Pilot and night bell relays are 1.25 ohms resistance, and are wound to carry a heavy current. They are fitted with individual metal covers.

To connect one subscriber to another, it is of course necessary to have connecting cords to enable the operator to do so, and to these we will now turn our attention, Fig. 8. This is very complex, and will require some close study. The cord circuit is divided at the center by a repeating coil or translator, with 1.1 winding; this both divides the circuit for signaling purposes and affords a feeding-point for the battery. There are two supervisory lamps in connection with the answering and calling plugs, controlled by series relays. These two are shunted with non-inductive resistances in order to obviate loss of speaking current due to inductance. When the plugs are inserted in the answering jacks, the supervisories are lit through 83.5 ohms resistance coils and 30-ohm cut-off relays on the bushes of the jacks, which bring the P.D. across the lamp terminals to 12 volts. The supervisory relays control the lamps by reason of the 40-ohm shunt spools which, when shunted across, reduce the current in the lamps below that necessary to bring the filaments to a visible increase of temperature. The operator's instrument circuit (as explained further on) is arranged so that there is a minimum of side tone (*i.e.*, hearing yourself speak in your own transmitter). The transmitter is fed through a choking coil and primary of induction coil. The choking

Central Battery Subscribers Operator's Cord Circuit With Register.



— Figure 8

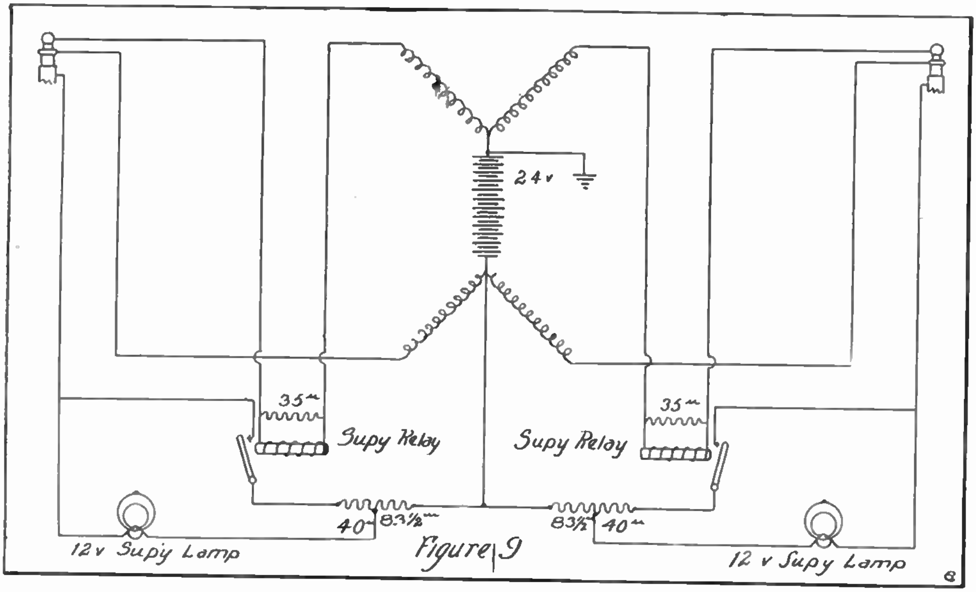


Figure 9

coil prevents disturbances from the battery or charging machines, and the condenser provides a path through primary for speaking fluctuations from transmitter. The register key connects an additional 4-cell battery on the third conductor of the answering plug. The high voltage, *i.e.*, 32 volts actuates the subscriber's service register in connection with the line circuit, and also the operator's register of both supervisories in order to ensure the call has been effective. The operator presses the register key in connection with all effective calls; in the case of ineffective calls the operator presses a special key in connection with an ineffective call register. This is not shown in the diagram. The advantages of this method of recording calls are considerable. Fig. 9 shows in a simplified form the cord circuit connections. There are several types of C.B. repeaters: the type at present is that known as No. 11 (see Fig. 10 for arrangement of windings). This type, when used in subscribers' cord circuits, is not magnetized during talk between two subscribers with equal resistance loops. This coil gives high efficiency speech, but is liable to cross talk with everything but a very short common lead.

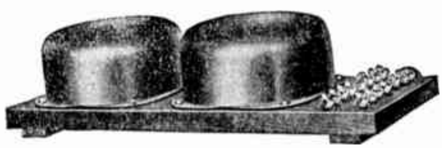


Fig. 11
Repeating Coil

The resistance of the four coils is 42 ohms each.

The No. 13 type of repeating coil has windings of 47, 60, 75 and 62 ohms, and in this case the core is magnetized during use. The transmission is not quite so good as with No. 11 type, but on the other hand the liability to cross talk

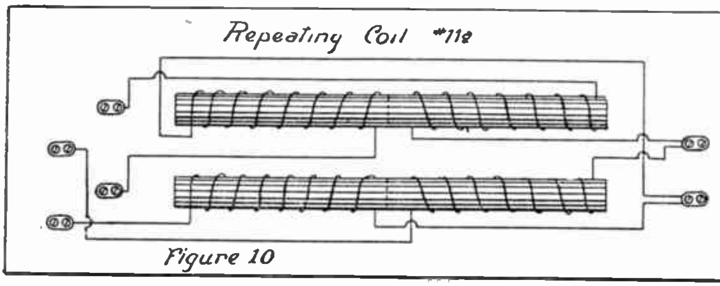


Figure 10

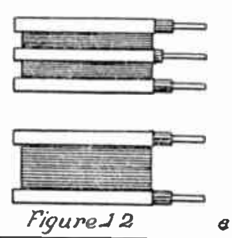


Figure 12

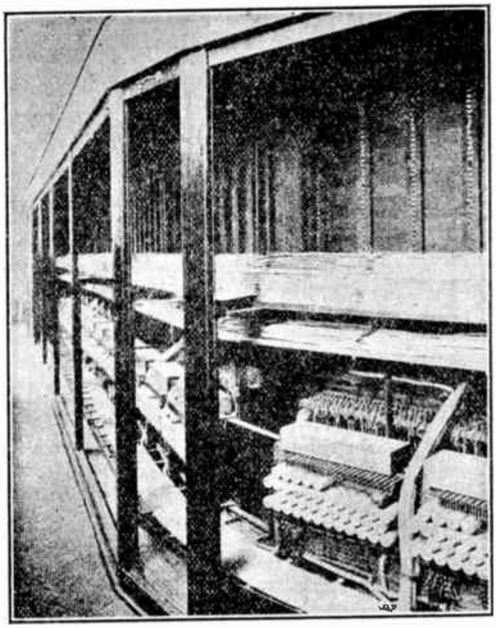


Fig. 13
Central Battery Switchboard

is very much reduced. The latest type of coil is known as the toroidal or ring pattern; two of these are mounted on one base (see Fig. 11), and take up the same room as the No. 11 type. The efficiency is greater than in the No. 11 type, and the electrical circuit is similar. The resistance of the coils is 22.5 ohms each. Supervisory relays are of the knife-edge pattern, the frame or carcasses being similar to those of the line relays. In the latest pattern the line coil is of 30 ohms resistance and the non-inductive shunt 70 ohms resistance; the latter is wound over the inductive coil. This pattern relay will work with 13 milli-amperes. An earlier pattern of relay has a 30-ohm magnet coil and a 35-ohm non-inductive shunt; this requires 19 milli-amperes to operate. The relays are mounted on plates fixed behind the switchboard, each relay having a brass or aluminum cover which prevents cross talk by magnetic induction from relay to relay. The supervisory lamps are 12-volt, and are placed in separate jacks, mounted on the key shelf of the switchboard. These lamps take .1 ampere, being of 120 ohms when hot. The 83.5 and 40 ohms resistance spools are combined on one spool. The spools are insulated by sheets of micanite, which is a mixture of mica and shellac subjected to great pressure. Fig. 12 shows a double spool, and also a single spool; these are mounted behind the switchboard on an iron base plate.

Looking back on Fig. 8 shows the operator's induction coil circuit. The coil has two primary windings, each of 18 ohms resistance, and a secondary consisting of two 135-ohm windings. This is so arranged as to avoid side tone. The induction coil is arranged on the Wheatstone Bridge principle (see Fig. 8). The receiver is in place of the galvanometer, and the nearer the calling subscriber's line impedance through the non-inductive resistance of 370 ohms, the less the action of the primary on the receiver. Fig. 13 shows a front view of a central battery switchboard (one section only); there are eight panels per section and the subscribers are generally multiplied every nine panels, but multiples on the subscriber's switchboard are being done away with, local trunks being used to get the multiple on the trunk board.

The old multiples are being replaced with a three-calling lamp system. To explain this system in detail would

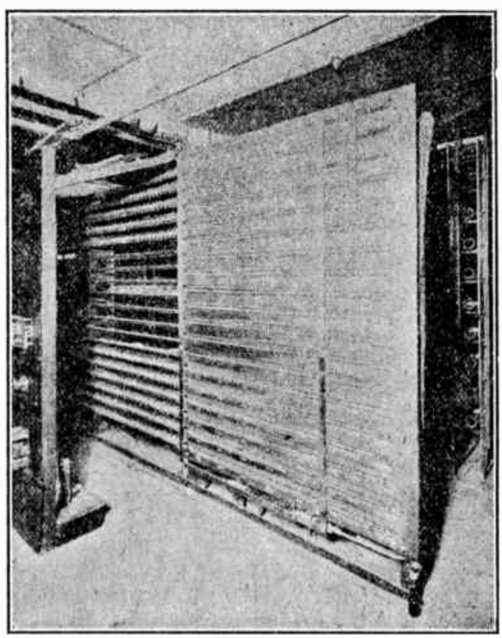


Fig. 14
Central Battery Switchboard

require another article to be written, and at present only a few exchanges are fitted with this new system. On the key shelf can be seen the 17 pairs of plugs at the back, and then a row of register keys, then 17 pairs of supervisory lamps, and to the right another register key for recording ineffective calls. In front again, there is the row of 17 keys and both on the left and right the order wire keys. Just behind the plugs in the multiple panels are four special lamps; the one on the left is the pilot lamp, then the instruction lamp, which is used in connection with a circuit so arranged that the exchange manager or monitors can call all the operators simultaneously if special operating information is required. Then comes an order wire lamp, which lights when certain order wire keys are pressed to notify the operator that the particular wire is outside the normal area, and lastly, a register key lamp, which lights when a register key is pressed. Fig. 14 shows the rear view of a subscriber's section, showing the supervisory relays resistance spools, and above these the cord fastener shelf with the outgoing trunk cables, and above this a shelf carrying the subscriber's multiple cables.

The local jack and repeater coil cables are run in an iron rack at the bottom of the section. In the later pattern roller shutters are used to enclose the back of the sections and also fire slides fitted just above cord fastener shelf, to protect the upper portion of switchboard from possible fusing of wiring, etc.

There are an untold number of details that could be described if space would permit, such as trunk telephone service, power work of an exchange, etc., which, with the editor's kindness, will be published later; but I sincerely trust this little article may open the eyes of some readers in wonder when they realize what a marvelous thing is the telephone and its exchanges.

ENGINEERING LABORATORY PRACTICE

Gauge Testing

P. LE ROY FLANSBURG

Among the more important boiler-room accessories are the steam and vacuum gauges. The essential part of these two gauges is the same, and consists of an elliptical tube of metal of approximately constant cross-section bent in a circular form. An interior view of such a gauge is shown in Fig. 1. One end of the tube is fixed and connects by means of a short piece of piping with the point at which the pressure is being measured, while the other end is securely sealed and can move freely. When steam pressure is admitted to the gauge, the tube tends to straighten out, and this motion is transferred through a lever, circular rack and pinion to the pointer which moves over the dial scale. The scale of the pressure gauge reads in pounds per square inch, while that of the vacuum gauge reads in inches of mercury. To increase the accuracy of pressure indication a small hair-spring is attached to the pinion. If the temperature of the tubing changes to any great extent the scale reading is affected, and for this

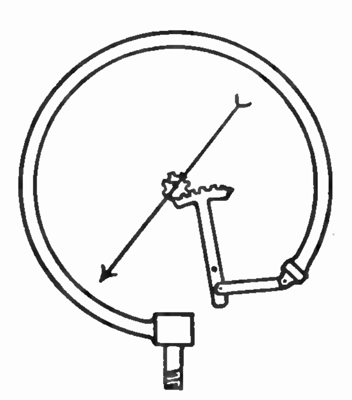


Fig. 1.

reason it is necessary to prevent the hot steam from entering the gauge. The common way of doing this is to interpose

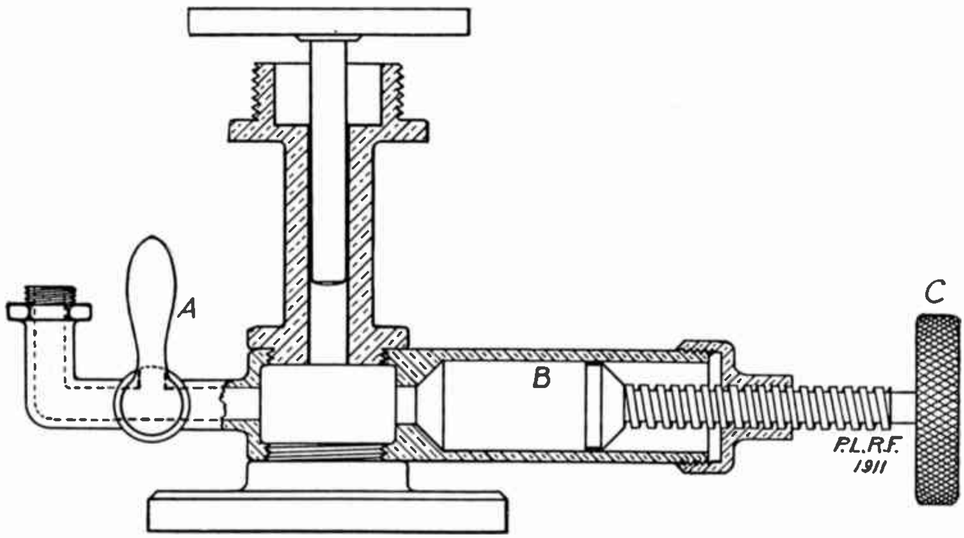


Fig. 2.

a U-shaped pipe or siphon filled with water between the gauge and the hot boiler steam.

TESTING PRESSURE GAUGES

A pressure gauge tester is shown in Fig. 2, and is an instrument for accurately testing and correcting pressure gauges

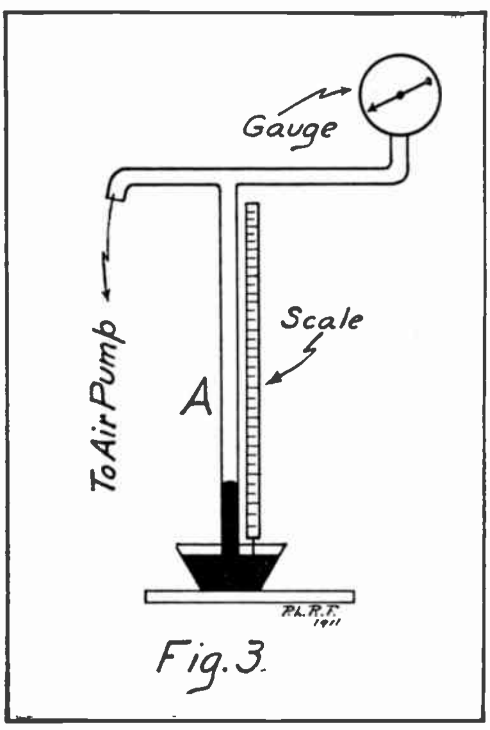


Fig. 3.

by means of weights. It is very accurate, and is much more convenient to use than a mercury column. The method of carrying on the test is as follows:

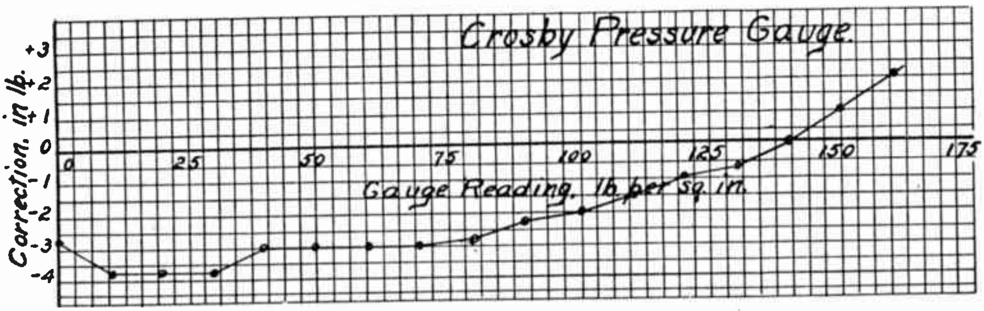
Place the tester upon some level surface, such as a table or bench, in order that the weight piston will be in a vertical position, for if this is not done the piston will not work smoothly in the upright cylinder. If there is friction between the cylinder and piston it will cause false readings of the pressure. When ready to start the test, close the three-way cock, *A*, on the gauge connection and screw the plunger into cylinder, *B*, as far as it will go. Remove the weight piston and pour oil into the vertical cylinder, gradually unscrewing the hand-wheel, *C*, until the instrument is completely filled. Screw the gauge (which is under test) to the upright pipe of the gauge tester, and open the three-way cock. Now insert the weight piston into the vertical cylinder, and the apparatus is ready for use.

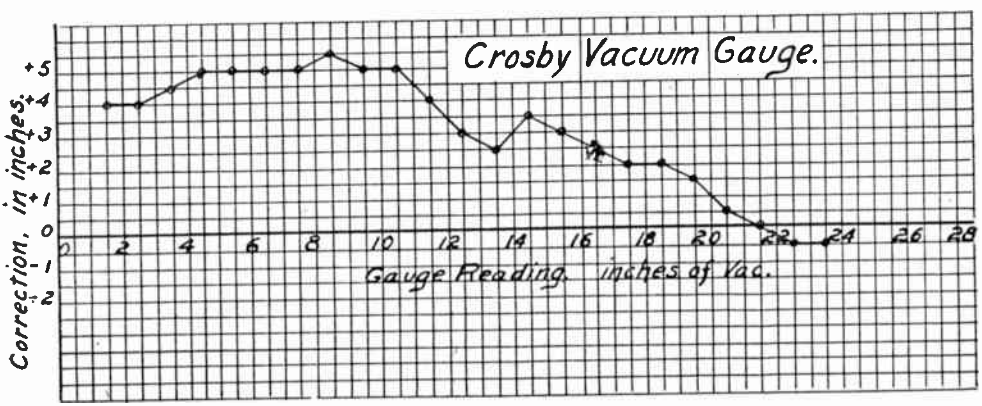
The oil transmits pressure equally in all directions, so that by applying known weights upon the weight tray and then noting the actual gauge reading, it is possible to find the correction which must be applied to the gauge reading at each of these points. The weights which are used have their correct weight stamped upon them and are furnished with the tester. As the weights are applied the weight piston is forced toward

Crosby Vacuum Gauge.					Crosby Pressure Gauge.				
Actual inches of Mercury	Gauge reading ascending.	Gauge reading descending.	Average.	Corr.	Actual pressure lb./sq. in.	Gauge reading ascending.	Gauge reading descending.	Average.	Corr.
1.5	1.1	1.1	1.10	+0.40	0	2.5	3.0	2.75	-2.75
2.5	2.1	2.1	2.10	+0.40	10	13.5	14.0	13.75	-3.75
3.5	3.0	3.1	3.05	+0.45	20	23.5	24.0	23.75	-3.75
4.5	4.0	4.0	4.00	+0.50	30	33.5	34.0	33.75	-3.75
5.5	5.0	5.0	5.00	+0.50	40	43.0	43.0	43.00	-3.00
6.5	6.0	6.0	6.00	+0.50	50	53.0	53.0	53.00	-3.00
7.5	7.0	7.0	7.00	+0.50	60	63.0	63.0	63.00	-3.00
8.5	7.9	8.0	7.95	+0.55	70	73.0	73.0	73.00	-3.00
9.5	9.0	9.0	9.00	+0.50	80	82.5	83.0	82.75	-2.75
10.5	10.0	10.0	10.00	+0.50	90	92.0	92.5	92.25	-2.25
11.5	11.1	11.1	11.10	+0.40	100	102.0	102.0	102.00	-2.00
12.5	12.2	12.2	12.20	+0.30	110	111.0	112.0	111.50	-1.50
13.5	13.3	13.2	13.25	+0.25	120	121.0	121.0	121.00	-1.00
14.5	14.2	14.1	14.15	+0.35	130	130.5	131.0	130.75	-0.75
15.5	15.2	15.2	15.20	+0.30	140	140.0	140.0	140.00	+0.00
16.5	16.4	16.3	16.35	+0.15	150	149.0	149.0	149.00	+1.00
17.5	17.2	17.4	17.30	+0.20	160	158.0	158.0	158.00	+2.00
18.5	18.3	18.3	18.30	+0.20					
19.5	19.4	19.3	19.35	+0.15					
20.5	20.5	20.4	20.45	+0.05					
21.5	21.5	21.5	21.50	+0.00					
22.5	22.5	22.4	22.45	+0.05					
23.5	23.6	23.5	23.55	-0.05					

the bottom of the vertical cylinder, and therefore the hand-wheel, *C*, should be screwed in more and more, thus forcing the weight piston up and preventing it from striking the bottom of the cylinder. To insure greater accuracy in the readings, the weight piston should be revolved slowly while the readings are being made. This is done in order to reduce to a minimum any friction that there might be between the piston and the cylinder.

(*Continued on page* 428)





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.

1686. **Rheostat for Small Motor.** A. H. P., Arlington Heights, Mass., writes that he is using a small battery motor for a rotary spark gap and that a water rheostat is used to afford resistance for the motor when used on the alternating current lighting circuit. He wishes to know how to make a German silver wire rheostat to displace the water type. (2) Where can fine iron wire suitable for use in construction of hot-wire ammeter be obtained? Ans.—(1) We do not advise the use of a rheostat of any description on an a.c. circuit, as a small transformer is so easily constructed and the low voltage current from it will not injure the little motor to so great an extent. Refer to the January, 1911, issue for description of a very useful and easily constructed step-down transformer. (2) We refer you to any of our advertisers who carry materials to be used in the construction of apparatus described in this magazine.

1687. **Model Railway Equipment.** O. B., Milwaukee, Wis., sends sketches of a 4-pole generator and a bipolar motor, and asks if the proposals are good for the purpose, and what windings will suffice for a 10-volt output? Ans.—We do not know whether you have the mechanical parts yet made, but if not, would propose several modifications, whereby greater output or better working conditions would be secured. A circular yoke for the exterior portion of the generator has a good appearance, but to have it circular within, does not give the best utilization of space for the field coils. If you have the shape there octagonal, you can get longer spools, or wind them to a greater depth. Also reduce the width of the pole pieces to 1⅛ in. in place of 1¼ in., but do not lessen the section in the cast iron yoke. You will then have room for winding to a depth of 1 in. and a length of 1⅛ in. Use No. 20 s.c.c. wire. For armature, you will get better regulation and less sparking if you use about twice as many slots. They can be ¼ in. wide by ½ in. deep, the more slender the better. A maximum of 24 can be used, but this will require the multiple winding, and the equipment with four brushes. If you will make but 23 slots, you can use a series winding, and have brushes at but two places on the commutator,—these being 90 degrees apart. About 12 wires per slot, if the series winding is used, or 24 if the parallel, in this latter case the wire being of one-half the size of the other. We can advise more fully if you wish. For the motor, you can use No. 20 on the armature and No. 18 on the series field, the terminals of the latter being arranged so as to allow the two coils to be put either in series or in parallel with each other, thus giving opportunity of securing various speeds.

1688. **Dynamo.** P. R. C., Milton, Wis., sends a sketch and general dimensions for a proposed 115-volt, 5-ampere, 2500-revolution dynamo, and asks if the design is good. If not, in what way should it be changed? Field magnet is of the "Manchester" consequent pole type, having the two wrought iron cores 4 in. long and 1¾ in. in diameter; upper and lower pole pieces are of cast iron, 9¼ x 3 in., with a 4 in. bore diameter. Armature core is 2⅛ in. long, 3⅞ in. in diameter, with 10 slots, each 5/16 x 5/16 in. Commutator has 10 segments. Ans.—This type of field magnet does not give so economical a use of material, or so symmetrical an appearance as if you had a ring armature. For the complete design and directions for making a machine of this sort, but with a smooth core ring armature, see Watson's "How to Make a One-Half Horse Power Dynamo." It has just the rating you desire. Ten slots and commutator segments are altogether too few for sparkless operation. The machine we recommend has 32. Taking your design, the armature would require about 700 turns of wire, or 70 per coil, each coil occupying half the space in a slot. To get in this number you would have to use so fine wire as to reduce the current capacity far below the desired 5 amperes. You could easily put 24 slots, deep but narrow, in a core of the diameter given, and thereby find room for the desired number of turns, wire being not smaller than No. 19. Have about 5 lbs. of No. 24 single-covered wire in each field coil.

1689. **Dynamo.** H. A., St. Paul, Minn., sends sketch and data for a small dynamo on which the machine work is done, and he wishes to know what winding will give the best results. Field magnet consists of a casting in the form of a ring, 5¾ in. inside diameter, ¾ in. thick, and 2⅞ in. wide. Two laminated pole pieces are fitted to the inner surface, leaving room for an armature 3 in. in diameter, and 2 in. in length. Core has 12 slots, ⅜ x ⅜ in. Air gap is 3/16 in. Ans.—Except for the air gap the design appears to be very good. For so small a machine the separation between armature and polar faces should not be over 1/32 in. Perhaps you made some error in the statement. If your measurement is correct, you will diminish the output of dynamo to one-half what it should be. You will find a winding that will give 6 to 10 volts, and a maximum of 10 amperes, will be practicable. Use No. 18 d.c.c. on armature, all you can get on, but filling the slots only half-way with any given coil, in the standard manner of a drum winding. For field use No. 21 s.c.c. wire, as much as you can get into the space. Coupling the two field coils, either in series or parallel, will give you double range of voltage and speed.

1690. **Dynamo.** H. C., Indianapolis, Ind., sends a sketch of dynamo he proposes to build, and asks our advice. Field magnet is upright, like the original Thomson-Houston motors, having wrought iron cores 6 in. long and 1½ in. in diameter. Pole pieces are 5 in. high, with a bore of 4¼ in. Magnet yoke is a wrought-iron block, 8¾ x 2½ x 1¼ in. Armature core is 4 in. in diameter, and 2½ in. in length, having 12 round slots, each ⅝ in. in diameter. What sizes of wire should be used to permit an output of 110 volts and 5 amperes? Ans.—First of all we shall have to criticize the design of the armature, it being too short to permit economical winding. Still, as you have it already made, use it, by all means. You can, however, correct the proportions of the field magnet. From your statement we were not sure whether the pole pieces only were to be of cast iron, or all the parts for the magnetic circuit. Parts other than poles should be of wrought iron, especially for such a misproportioned armature. Make the field cores 2 in. in diameter and 4½ in. long, and the yoke either wider or thicker, or both, so it will have a section fully equal to one of the cores. You will require about 70 turns per coil—using 12 coils—and you ought to be able to use No. 19 d.c.c. wire. It will be much better for 110 volts to have 24 segments in the commutator, and to accomplish the proper winding, bring out a loop after winding about 35 turns, then wind 35 more turns in the same slots, and bring out a second loop. The slot should then be half full.

1691. **Dynamo.** F. W. H., New Haven, Conn., sends a sketch of a small machine of the following design and dimensions: Field magnet of 1¼ x 2 in. wrought iron bar, bent in a U-shape. Space between limbs, 1¼ in., with a 3¹⁄₁₆ bore for armature. Field winding consists of No. 24 d.c.c. magnet wire, connected as a shunt. Armature has 12 round slots, and is wound with No. 20 d.c.c. wire. The question asked is, what should be the output in volts and amperes, when the speed is 2,000 to 2,200 revolutions per minute? Ans.—You omit an essential specification in not stating the diameter of the field spools. With this we could compute the probable amount of wire, its resistance, and the maximum voltage permissable. You would improve the machine if you fitted extensions to the polar extremities so that about three-fourths of armature was covered. Apparently you have it only one-half covered at present. Perhaps your machine will be unreliable for use as a generator, for the reason that an entirely wrought iron field magnet often retains an insufficient amount of "residual" magnetism. If you put on the proposed extensions, let them be of cast iron. About 4 amperes will be a safe limit for the current.

1692. **Motor Loads.** W. C. B., Dayton, O., asks if it is possible to calculate the actual horse-power used in motors, say in 2 h.p. and 10 h.p. 220-volt direct current machines. Ans.—Though the meaning is clear, we suppose you mean "current" and not horse-power consumption. You wish to know how to tell if a motor is overloaded. Most motors contain a statement of the normal current rating in the data given on the name plate. The only way to tell whether you are exceeding this amount is to put an ammeter in circuit. A convenient place to connect the ammeter leads in the place of one of the fuses. When starting the motor, have a short-circuit across the ammeter binding posts, else the initial rush of current may bend the pointer. With only 220 volts across the line, this precaution involves no personal danger. If the name plates contain no such statements, you can safely assume that the efficiency of the smaller motor is 80 per cent, and that of the larger, 85 per cent. With this assumption, the current at full loads should be about 9 amperes and 40 amperes, respectively.

1693. **Selenium: Telautograph.** D. R., Grant, Mich., wishes to know (1) where he can secure selenium. (2) Is there any machine made that will transmit the alphabet over an electric circuit, the same as a typewriter? (3) Would such an instrument have any commercial value? Ans.—(1) Selenium may be obtained through Merk & Company, New York City. (2) Such a machine is in daily use by the large telegraph companies at the present time. (3) Its commercial value is unquestionably great.

1694. **Cast Iron Brazing.** A. C., St. Louis, Mo., asks for a good compound that will reduce the graphitic carbon in cast iron so that it will braze. Ans.—There are many patented compounds on the market at the present time that appear to reduce the carbon in cast iron brazing, but which in reality do not do so. The chemical process is a somewhat complicated one and its full explanation is beyond the scope of these columns. We would suggest that you get in touch with Mr. F. A. Saylor, 2360 Auburn Ave., Cincinnati, Ohio, in regard to this subject. Mr. Saylor is the author of a number of very instructive articles on the subject of brazing and autogenous welding, and we feel sure he may have some suggestions to offer. We would also suggest that you look up Mr. Saylor's article on "Cast Iron Brazing," in our July, 1910, issue.

1695. **Induction Coil Difficulties.** F. W., New York City, writes us that he has just finished building a 4 in. spark coil, but is unable to obtain more than a 1 in. spark from same. Specifications are as follows: Core 12 in. long, 1¼ in. diameter, two layers No. 12 wire for primary, insulating tube is ⅛ in. thick rolled from very thin sheet fiber. Secondary No. 34 wire wound in 34 sections, each ³⁄₁₆ in. thick. Insulation between discs four pieces of waxed paper. All joints are soldered. Secondary sealed in paraffin but not vacuum impregnated. Interrupter is of the double spring independent type. He sends us a sample of one of the sections and asks our opinion on the construction in general. Ans.—A brief inspection of the sample section gives us the impression that the inside diameter of the annular ring of wire is too small for the insulating disc employed. In other words, we believe that there might be some danger of a spark passing over the inside edge of the insulating disc from one section to its neighbor. On every pair of sections there is a maximum difference of potential at this point. We would suggest that you remove a few of the inside turns of each section so that the diameter of the opening may be increased by ⅛ in. We also suggest that you use empire cloth in place of the fiber for insulation at all points. We believe that this insulation would be more effective than fiber or paper unless the latter were very carefully impregnated with wax. Beyond this we have no criticism to make in regard to the construction of the coil. Its failure to give more than 1 in. spark may be caused by any one of several things. If you are certain that no sections have been connected in opposition, and that your battery is fresh and powerful enough to operate the coil, we would suggest that you vary the condenser capacity around the interrupter contacts. The importance of the condenser is not fully realized by many amateur coil builders until their attention is called to this point. If you will refer to the series of articles on the "Construction of a 6 in. Coil," appearing in our February and March, 1911, numbers, you may find some useful hints therein.

1696. **A Laboratory Electric Furnace.** R. B. K., Birmingham, Ala., asks for details of the construction of a small electric furnace for a laboratory workshop to be operated from the 110-volt a.c. lighting circuit. He expresses his appreciation of the value of our magazine, and compliments us on the marked improvement during the past year. Ans.—In our November issue you will find a very practical article on this subject by Mr. George F. Haller, and in the present issue the second and concluding installment appears. We can do no better than refer you to these articles for the information you require.

1697. **Electrolytic Rectifier.** T. R., Chicago, Ill., writes that he has read the articles in the January and July numbers on "Electrolytic Rectifiers," and is much interested. He states that a similar rectifier is in use in his laboratory for charging storage cells and reports excellent results. He states further, that he has never found a satisfactory explanation of their action and asks us to give him our opinion. Ans.—The commonly accepted theory of the action of these rectifiers is that an impervious layer of oxide of aluminum is formed on the aluminum plate. This coating permits the current to pass in one direction only, that is, from the aluminum to the lead, and this acts as a check valve to the opposite side of the cycle. The object of using four cells and the method of connection shown in the articles you mention is to get the benefit of both sides of the cycle, thus considerably increasing the efficiency.

1698. **Electric Interrupter.** J. F. N., Seneca Falls, N.Y., writes that he is unable to obtain the glass rod and lead wire for making the electrolytic interrupter described in Mr. Stanleigh's article. He also adds: "Since it is better to have direct current, should there not be four rectifiers, and how large should the aluminum electrode be?" Ans.—The glass tube known as an "ignition tube" may be obtained from any large glass blower or dealer in physical supplies. If there are none in your vicinity, you might write to Houghton & Curtis, Waltham, Mass. It is not essential that lead wire be used as an electrode in the interrupter, as a narrow lead strip will serve equally as well as the wire inside the tube. Where it is desired to use the interrupter on an alternating current circuit, it is well to rectify the current into direct before it reaches the interrupter. In the January issue of *Electrician and Mechanic* you will find described a useful and practical form of rectifier, which is very well adapted to this purpose.

1699. **Wireless Transmission.** E. H. B., Des Moines, Ia., asks if a wireless message can be transmitted a distance of 300 miles using a large induction coil on a 110-volt direct current circuit with an electrolytic interrupter. Ans.—While such a thing would most assuredly be possible, still it is not practicable. Modern practice with the ordinary spark gap method requires an alternating current, which may be obtained from a motor generator or a rotary converter connected to the direct current mains. The efficiency would be far higher and the installation less costly in the long run if alternating current is used. The new and highly efficient "quenched spark" system sometimes employs a direct current of very high voltage, but such a current is rather difficult to obtain and equally good results appear to have been shown by apparatus of this type operated from ordinary alternating current transformers.

1700. **High-Frequency Transformers.** R. F., Jacksonville, Fla., writes as follows: Have been greatly interested in the series of articles on "Experimental High-Frequency Apparatus," by Stanley Curtis, and have constructed the Oudin resonator, condenser and ½ k.w. closed core transformer. The transformer and condenser work to perfection and they appear to give even better results than the author claims for them. In damp weather, however, I have met with difficulty in operating the resonator. Under such circumstances, when it is set in operation the secondary is covered with minute sparks which jump across the space between turns on the secondary cylinder. I do not think that this is as it should be as I can only draw a 6 in. spark from the ball on top of the resonator under these conditions, whereas on other days a 14 in. spark is readily obtained. Any suggestions you may offer will be greatly appreciated. Ans.—The difficulty undoubtedly lies in imperfect drying and treating of the cardboard cylinder, which would under ordinary circumstances absorb moisture from the atmosphere quite readily. The drying process should be continued for several days in moderate heat and the sealing-up treatment should be given immediately after the cylinder is removed from the drying room. It is at this point where careful work counts, as the difference of potential between adjacent turns may amount to more than 1,000 volts. We would suggest that you again refer to the paragraph on treating the cylinder, or if you are not in a position to give the tube such a treatment you may obtain a cylinder already dried and sealed from advertisers whose announcements appear in this magazine.

TRADE NOTES

We take pleasure in calling the attention of our readers to the fact that the Marconi Wireless Telegraph Company of America is now prepared to supply inexpensive apparatus to the experimenter. This firm have been an operating and manufacturing company for nine years in this country, but up to the present time have sold licensed apparatus for commercial and government use only. The new line of experimental apparatus has been produced in response to repeated demands for less expensive instruments by experimenters. The high standard of Marconi apparatus has been maintained in the new line. The catalog of this company lists some high-class wireless measuring instruments, some of which are made in this country, while others are imported. These are intended to appeal particularly to the schools and colleges. The company will be very glad to forward their catalog to those who are interested.

The Norman W. Henley Publishing Company, 132 Nassau Street, New York City, announce a novel innovation in the shape of isometric drawing paper. Isometric drawing has always been surrounded with technicalities and involved description until it seemed to be an art to be mastered only by arduous study and for this reason has never been very popular. The new ruled paper now makes it easy to complete such a drawing without any special knowledge of isometric projection. A drawing on this paper may be scaled in the three main directions, the axes of which are 120 degrees apart, one being vertical and the others 30 degrees from the horizontal. All horizontal lines are laid along the 30 degree line in either direction and a cube becomes a hexagon and the circles become ellipses. The value of this paper will be readily understood by the machine designer or draftsman.

We desire to call our readers' attention to the wood-carving tools made by Mack & Company, of Rochester, N.Y. These tools are of the Addis English pattern made by a workman who was a native of England, and who formerly made carving tools for Addis before he came over to this country. The steel used in these tools is of the best English grade, hardened and tempered by a secret process, which has undoubtedly had much to do with giving this line of tools an unequaled reputation.

BOOK REVIEWS

Wiring Houses for Electric Lighting, and *Low Voltage Electric Lighting with the Storage Battery*. By Norman H. Schneider. New York, Spon & Chamberlain, 1911. Price, 25 cents each.

These two notable additions to the Model Library of practical low-priced hand-books should fill a long-felt want in this particular field. Mr. Schneider has grouped his subject matter in clear and concise form, and he writes from the standpoint of one who knows his subject thoroughly. With the advent of the high efficiency tungsten lamp, isolated lighting plants have become exceedingly popular in such places where central station current is not available. These two little books cover the selection and installation of plants of various sizes to meet nearly all requirements, and give practical working instructions for house wiring according to modern standards.

Frank Armstrong's Vacation. By Mathew M. Colton. New York, Hurst & Co., 1911. Price, 60 cents.

The first of the new series of those alluring tales of adventure which are so dear to the young American boy. The quest of the young hero for hidden treasure is interestingly told, and Frank's adventures will, no doubt, be followed with many a thrill by the boys.

The Second Boys' Book of Model Aeroplanes. By Francis A. Collins. New York, The Century Company, 1911. Price, $1.20 net.

A fitting sequel to the author's earlier book, the "Boy's Book of Model Aeroplanes," which was reviewed in these columns a few months ago. What we said for the first book can cordially be repeated for the second. Mr. Collins' latest contribution brings up to date the science and sport of model aeroplane construction and flying, both in this country and abroad. The book is filled with many helpful working drawings and photographs, and contains detailed instructions for building some fifteen of the newest model aeroplanes. A special chapter of the book is devoted to parlor aviation, and full instructions are given for building small paper gliders reproducing the lines of famous models which will fly in an ordinary room. Another interesting feature is a chapter giving the rules for conducting model aeroplane contests as sanctioned by the West Side Y.M.C.A., New York, and the New York Model Aero Club.

Aerial Navigation. By Albert Francis Zahn, A.M., M.E., Ph.D. London and New York, D. Appleton & Company, 1911. Price, $3.00.

This book is a popular portrayal of the substantial progress of aeronautics from its earliest beginning to the present time. The reader is not burdened with accounts of experiments which constitute no advance in the art of aviation, and failures and tragedies are described for the lesson involved rather than for any curious interest investing them. A brief account of the medium the airships navigate follows the story of their evolution. Particular attention is given to the circumstances which affect the density and motion of the air. A number of interesting historical facts for the popular reader and the more important quantative data are placed in the appendix for the use of the technical or special student.

Power of the Hour. By Victor W. Page, M.E., Kansas City, Motor Car Publishing Company, 1911. Price, 50 cents.

A simple non-technical and comprehensive treatise of the art of aerial navigation containing many illustrations and charts and much valuable information to the student of aeronautics. In the text are a number of extremely practical hints on constructional details of aerial craft and many complete designs and specifications for the various types are included.

A Soldier of Valley Forge. By Robert Wilson Stephens and J. E. Theodore Roberts. Boston, L. C. Page & Co., 1911. Price, $1.50.

A posthumous work by the author of "An

Enemy to the King," "Philip Winwood," and many other brilliant historical romances. Prior to Mr. Stephens' death, the rough draft of this story was laid aside for other work, and later, without completing the novel, the plot was utilized for a play. With the play completed, Mr. Stephens again turned his attention to the novel, but death intervened before its completion. The difficult task of finishing the work has been handled with great care and skill by Mr. Roberts.

An incident of the Revolution is taken as a theme for the story, and the scene, as in the earlier novel, "The Continental Dragoon," is the "debatable ground" north of New York. The many admirers of Mr. Stephens' novels will find in this story all of the intense interest of plot and originality of development which form a characteristic of his works.

Rodney the Ranger. By John V. Lane. Boston, L. C. Page & Co., 1911. Price, $1.50.

The thrilling adventure of Rodney Allison, a native of Virginia way back in the days when the Old Dominion was an English colony, should command the attention of every true American lad. The little patriot, who, at the age of fifteen, played a man's part in the troublous times immediately preceding and during the American Revolution, showed those sterling qualities of courage, loyalty, manliness and endurance which enabled the gallant men of '76 to win that which we have today. This stirring tale of a boy's indomitable pluck should receive a royal welcome at the hands of young America.

CORRESPONDENCE

Electrician and Mechanic,
Boston, Mass.

Dear Sirs:—In looking over your October number, I was quite interested in the enameled wire controversy, and give below a few points gained from practical experience and actual working conditions.

Firstly: in virtue of the high inductive capacity inherent in enameled wire, it is unsuited to any apparatus where the current flowing therein whether alternating or pulsating is of a very high frequency or where the pulsations or half waves reach their maximum values instantaneously or nearly so. Hence tuning coils, either loose or close-coupled, or other coils or helices subject to the usual high-frequency wireless currents, should not be wound with enameled wire, if the highest efficiency is to be realized from them. The best coils for these purposes are wound with cotton-covered, silk-covered or bare wire, preferably the latter. My experience with induction coils having secondaries of enameled wire was that with small coils up to 3 or 4 in. spark and slow speed spring vibrators, the enameled wire did not develop any bad points; but with large X-ray coils and Wehnelt interrupters it was found necessary to abandon the idea of using enameled wire, and recourse was had to the old stand-by cotton.

A very peculiar effect resultant from utilizing enameled wire for the secondaries of closed core transformers for different purposes, such as ozone machines and X-ray generators, was observed and remedied during some experiments carried out for a large X-ray manufacturer.

No trouble was experienced with enameled wire for secondaries of the closed-core transformers as long as they were operated on 60 or 120 cycles 110 or 220 volt primary current, and not over 10,000 to 15,000 volts at secondary.

However, when the large (5 to 10 kw.) X-ray transformers, delivering 100,000 to 130,000 volts at the secondary, were tried with enameled wire secondary coils, the results were very unsatisfactory, in fact, bad, and the return was made to cotton-covered wire. These transformers were used also to charge Leyden jars, and the enameled wire windings gave poor results. The primary current was 60 or 120 cycles at 110 or 220 volts a.c.

Enameled wire is certainly very useful when it can be used, owing to the great saving in space required for insulation with a consequent great number of turns in a given space, but the best results obtained by the writer have been on direct current apparatus. I am,

Very respectfully yours,
H. WINFIELD SECOR.

Engineering Laboratory Practice

(*Continued from page* 423)

Never attempt to remove the weights or weight piston without first unscrewing the hand-wheel, *C*, as far as it will go.

TESTING VACUUM GAUGES

The connections for the testing of vacuum gauges are as shown in Fig. 3. The glass tube, *A*, should be of uniform cross-section, and one end of it dip into a cup of mercury. The other end is connected to an air pump and the air is gradually exhausted from the tube. As the air is withdrawn the mercury rises, and the height to which it rises is read upon the scale. The difference between the gauge reading and the scale reading is noted, and this difference is the correction which must be made to the gauge reading. After the corrections for a certain gauge have been found, it is customary to make a plot showing the relation between the correction and the gauge reading.

The results shown on the chart and by the curves were obtained from a test made on two gauges, one a pressure gauge and the other a vacuum gauge. In order to obtain more accurate results, the corrections were found both at increasing and decreasing pressures and similarly both for increasing and decreasing vacuum.

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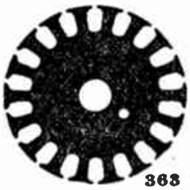

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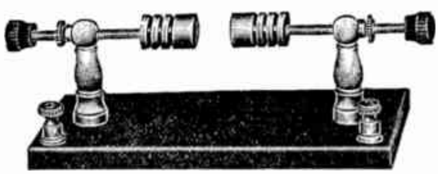

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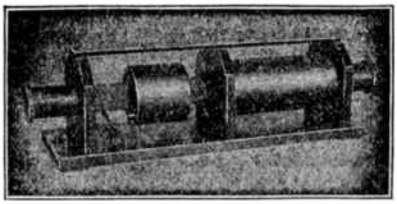

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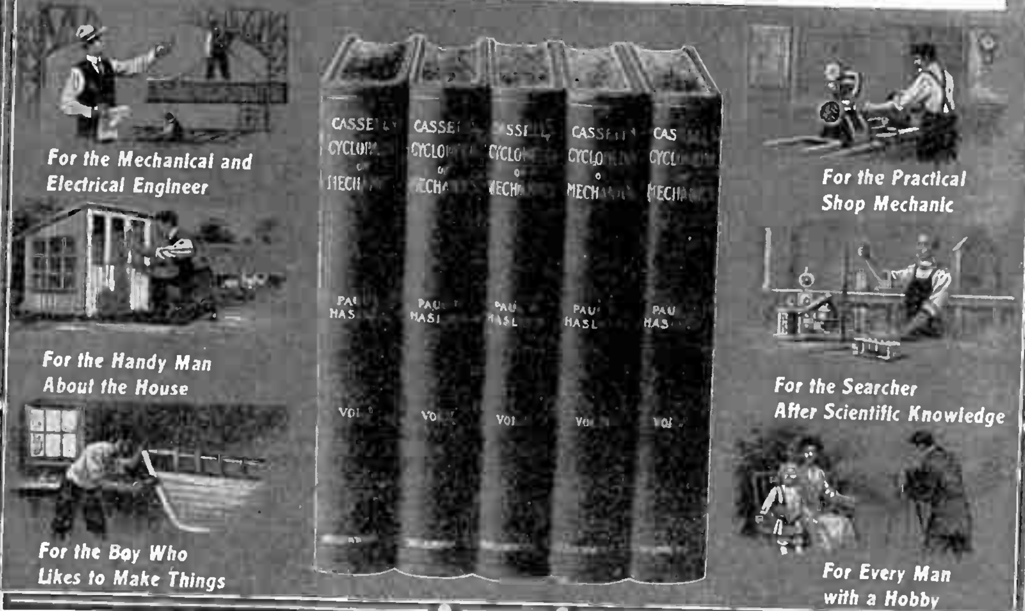

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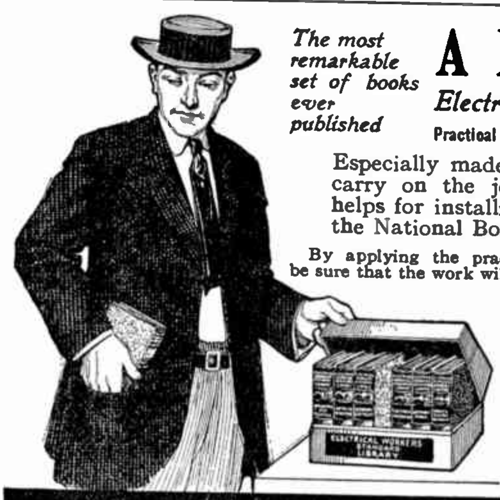

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