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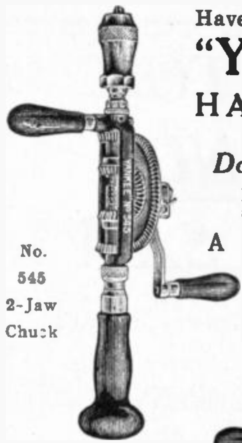

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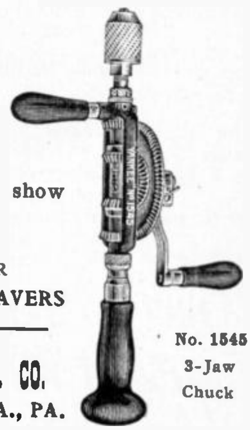

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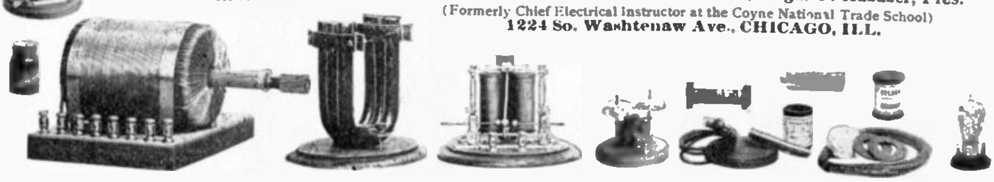

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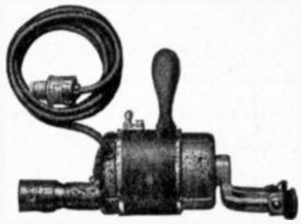

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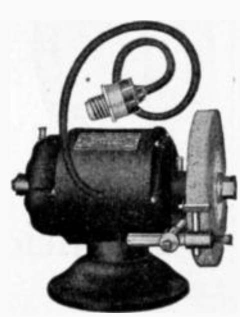

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Electrician and Mechanic

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SELENIUM CELLS

SAMUEL F. KERR

Selenium was discovered by Berzelius in 1817, but it was not until 1873 that Willoughby Smith announced the discovery that it possessed the peculiar property of changing its electrical resistance under the influence of light.

In its chemical and physical properties it closely resembles sulphur and tellurium. Its name originates from selen—the moon. The specific gravity of selenium is 4.3; its atomic weight, 79.5 and its symbol, *Se*.

In its vitreous state selenium is a very poor conductor of electricity; in fact, it is so poor that it may be called a dielectric, its resistance being almost forty thousand million times as great as that of copper.

By keeping it for some hours at a temperature just below its fusing point (about 200°F), and then cooling it slowly, it assumes a crystalline state. In this state the resistance is greatly reduced, and it also becomes sensitive to light, having a very high resistance in the dark, while when exposed to light the resistance falls considerably.

If a selenium cell connected in series with a battery and a galvanometer is placed in a darkened room and, if a ray of light is allowed to strike the surface of the cell, the resistance of the cell will fall according to the strength of the light, and allow the current from the battery to flow through the cell, thereby deflecting the needle of the galvanometer. When a telephone receiver is used instead of the galvanometer, a click will be heard when the light falls on the cell.

On account of this peculiar property selenium is very useful in connection with various electrical instruments. One of the first uses to which the selenium cell was put, was the Photophone invented by Professor Bell. A beam of light from the sun or some other source is reflected to a distant point by a thin mirror which is delicately balanced, and is capable of being vibrated by the voice. At the distant point is a selenium cell connected in series with a battery of a few dry cells and a telephone receiver. The beam of light is made to fall upon the selenium cell. When the thin mirror is vibrated by the voice, the beam falls with varying intensity upon the cell, thus changing

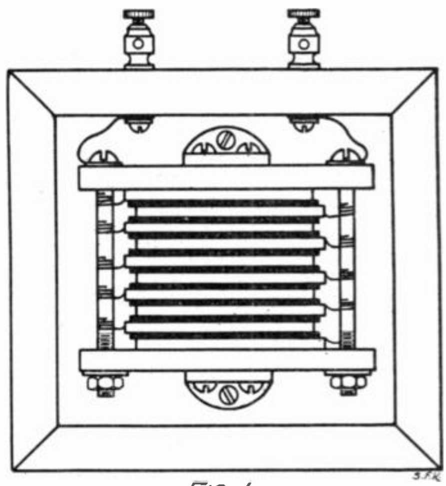


FIG. 1.

the conductivity accordingly, allowing more or less current to pass through the cell to the telephone receiver and reproducing the words or sounds made at the distant transmitter. This was the first wireless telephone. The distance over which speech can be transmitted by this method is, of course, limited, depending upon the distance to which the beam of light may be thrown.

This scheme is being used by Ruhmer in his wireless telephone, with several variations from the original plan. A powerful arc is used as the source of light, and with this, speech can be carried on over a distance of about four or five miles. The intensity of the beam of light is not varied mechanically as in the Bell system, but is varied electrically. This is done by utilizing the speaking arc, the intensity of the light being varied by the changes of the resistance in the telephone transmitter when being spoken into. Any obstacles in the way of the beam will, of course, interefere with its successful operation.

Other wonderful instruments for transmitting photographs, writing and all kinds of pictures by wire are made possible by the use of the selenium cell.

A type of cell used by Bell in his photophone, consisted of a number of brass discs stacked together, but insulated from each other by mica discs. The mica discs had a smaller diameter than the brass ones, so that the edge of the brass discs project slightly beyond the mica discs. The appearance of the pile is the same as that of a number of silver dollars stacked together with cardboard discs having a smaller diameter, placed between them.

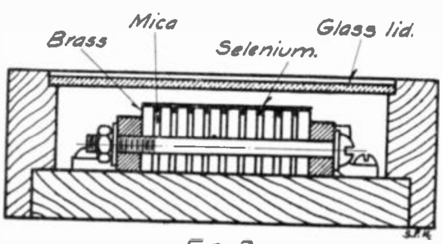


FIG. 2.

The discs are then fastened together by an insulated bolt running through the centre of the pile. It is then heated to the melting point of selenium. A stick of selenium is rubbed over the surface so that the molten selenium fills up the small spaces between the brass discs formed by the smaller mica discs.

Another type, used by Mercadier in his experiments, consisted of two long brass strips insulated from each other by a strip of parchment and wound in an oval or circular form. The block thus formed is heated and then selenium rubbed over the surface until a thin layer is deposited over the entire face.

A type of cell which has been found very sensitive by the writer is described below. Every selenium cell has the same principle of operation, the difference between the various inventors' cells being in the shape or construction, this being simply to adapt the cell to the best advantage to whatever use it is to be put. The cell described below is an adaption of the two just described, but is very much simpler for the average experimenter to construct, and is just as sensitive as the others.

Thirty-two pieces of brass strips 1/16 in. thick, 3/4 in. wide and 2 1/4 in. long are required. They are stacked together in the manner of the Bell cell. Between these strips of brass are strips of some insulating material, preferably mica. The mica strips are not quite as high as the brass, the small space thus left being to receive the molten selenium.

Fig. 1 shows the view looking down on the cell and illustrates the method of placing the insulating strips between the brass strips. In the drawing the heavy black lines represent the mica strips placed between the brass. The drawing of the strips is somewhat exaggerated, only ten strips being shown, but this is merely to illustrate it more clearly.

Two fibre strips are then placed, one on each end of the pile and bolted together as shown, so as to form a compact block. The fibre strips are 1/4 in. thick, 5/8 in. wide and 3 1/4 in. long.

The brass strips are connected up in multiple, *i.e.*, every second strip is connected together by soldering it to the bolt as shown. This is somewhat on the plan of a condenser, every other tin foil sheet being connected.

This divides the brass strips into two sets, insulated from each other by the mica strips. The face of the block is then polished very smoothly. Before going farther, it would be a good plan to test with telephone receivers to ascertain if the insulation is perfect. This is done by connecting the cell, a battery, and the telephone receiver in series; if no click is heard, the insulation is perfect.

The block is then heated in a sand bath until it has reached the temperature at which selenium melts. This can be ascertained by touching the heated block with a stick of selenium. The sand bath consists of a metal dish in which sand has been placed. Sand is poured all around the block, but its face should remain uncovered. The dish is then placed in an oven and as soon as the melting temperature has been reached, it is taken out and the polished surface rubbed all over with a stick of selenium until a thin film covers the entire surface; the thinner the film, the better. When this has been done, the dish is placed back in the oven and a temperature of about 220° F. is maintained for about an hour, after which it should be taken out and allowed to cool.

A neat case should now be made from ½ in. hard wood and the cell screwed down to the base of same by small brass angle pieces. Fig. 2 shows

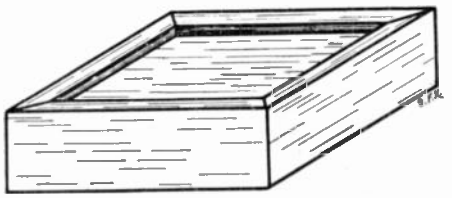


FIG. 3.

a sectional view of the completed cell. To protect the thin layer of selenium a glass lid should be put on the top of the case.

Fig. 3 shows the completed cell. The lid should be wiped frequently to allow the light to pass unobstructed through the glass.

Many interesting experiments can be performed with a selenium cell. With it the experimenter can mystify his friends by performing magical tricks. It would seem somewhat mystifying to them that by simply striking a match in a darkened room or turning on the lights a bell would suddenly start ringing and stop just as suddenly as soon as the light was extinguished. Or a motor could be started running, an electric lamp lit, a cannon fired or anything else that could be operated by the closing of an electrical circuit.

Fig. 4 is a diagram of the wiring. When a ray of light strikes the selenium cell, the resistance is lowered thereby allowing the current from the battery to flow through the relay magnets. The magnets then attract the armature, thus cutting in a local circuit. In this circuit is placed the motor, light or whatever is to be operated. When a cannon is to be fired a spark coil will, of course, have to be placed in the local circuit to produce the spark.

The cell can be put to a more useful purpose than the above, however. It can be used advantageously to take the place of the more expensive time switch to turn electric lights in show windows on as soon as it becomes dark and turn them off when it becomes light.

The scheme was worked out by the writer and is now under consideration

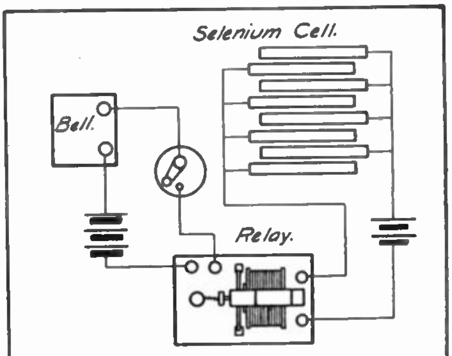


FIG. 4.

by several business men. It has several advantages (referred to later) over a time switch run by a clock. The selenium cell has not been used for this purpose before, as far as the writer knows, and a description of the instruments may prove interesting.

Fig. 5 is a diagram of the wiring. The switch is made somewhat on the order of a telegraph sounder. It consists mainly of an electromagnet in series with a battery connected in the local circuit of the relay. When no

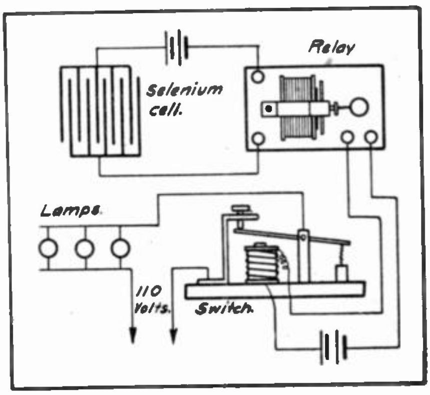


FIG. 5.

current is flowing through the magnet coil, the armature of the switch has a tendency to spring upward on one end, owing to the pull of a coiled spring on the other end, thus making contact with a screw above it.

By referring to the diagram, it becomes evident that it shows the apparatus as it is during the night, *i.e.*, the lights are burning. No current flows through the selenium cell, owing to it being in darkness, consequently the armature of the relay is not attracted. Under these conditions the local circuit is, of course, open and no current flows through the electromagnet of the switch. This allows the armature of the switch to make contact with the screw above it, thus completing the light circuit and lighting the electric lamps.

When the sun rises in the morning the resistance of the selenium cell decreases sufficiently to allow the current to flow through it and attract the relay armature, thus closing the local circuit and permitting current to flow through the switch electromagnet; the armature of the switch is attracted, thereby breaking the light circuit and cutting out the lamps.

It is evident that the selenium cell must be placed in such a location that the sun's rays will fall upon it and yet it will not be influenced by the light from the lamps or other source during the night.

The relay can be so adjusted that the current flowing through the selenium cell, during daylight, will be sufficiently strong to close the local circuit; but it must not be adjusted too sensitively or the resistance of the cell will decrease enough, on bright moonlight nights, to allow the relay to close the local circuit, thus cutting out the lamps. In other words, the light from the sun should operate the relay while the light from the moon should not.

Dry cells are not suitable to operate the relay and switch, as the current must be used all through the day to energize the electromagnets of both the relay and switch. Gravity cells are about the cheapest and best to use for this kind of work. Of course, no current will be used at night, giving the battery a chance to recuperate. The switch can be made so that when the armature is first attracted it will stay down and at the same time automatically cut out the battery current. In this case dry cells will be suitable.

One advantage of a time switch like this over a time clock is that it does not have to be wound up. Another is that when the seasons change, no adjustments need be made, *i.e.*, no matter whether it be summer or winter, the lamps will light as soon as it reaches a certain degree of darkness. With the time clock however, as the seasons change, the clock must be timed to turn the lights on or out accordingly, the same as an alarm on an alarm clock has to be set to ring at a certain time.

Still another advantage and probably the best is that if it should become dark or foggy during the day as it frequently does in the winter months, the lamps will light up and will be turned off as soon as it becomes light again.

Aeroplane accidents seem to multiply. They serve the useful purpose of indicating defects in the machines of the present day, and showing where improvement must be made. Dr. Lissauer of Germany ascended recently in his machine, and while under way a cylinder head blew off. Fortunately, he came down without injury. Otto Lindpaintner, the well-known Munich aviator, ascended with Countess Edeltrud von Bopp, and almost killed himself and his passenger, for a propeller struck a loose guy-wire and was splintered. Fortunately, Lindpaintner succeeded in descending before the propeller was entirely broken. Lindpaintner went up a little later with the injured propeller, but came down again in four minutes. His left wheel buried itself in soft ground and the machine, which was still in circular motion, was upset and wrecked. Lindpaintner emerged from the wreckage safe. He is also said to have caused the accident to Baroness de Laroche, as he passed over her and the air wash from his propeller may have caused her descent.

In the death of Prof. Cyrus Thomas the United States has lost one of its most eminent authorities on the history of the North American Indians. Professor Thomas was connected for many years with the Bureau of Ethnology of the Smithsonian Institution.

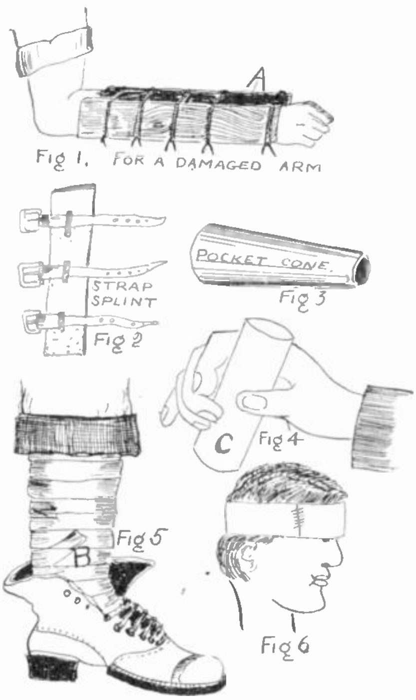
ACCIDENTS AROUND MACHINERY

GEORGE RICE

Often men get injured around machinery in places where it is not possible to have the services of a surgeon at once. Sometimes the injury is of such nature that almost any one with a few appliances may be able to relieve the suffering of the patient, and, at the same time, apply a first aid remedy that will be of assistance to the surgeon when finally he arrives. Fig. 1 shows how a broken arm can be bound up with a couple of pieces of plain boards and some cords or cloth bandages. In the event of a man breaking a limb of any kind, and a doctor cannot be obtained for some little while, the boards and bandages may be applied with good results. Perhaps the patient will have to be bundled into a conveyance and carried some miles to the nearest physician. If the broken bone is not supported in some way, the victim will suffer much unnecessary pain as well as subject the injured limb to needless jolts and motions. In case a man with a broken arm is put into a conveyance to be taken to a doctor, the man will seek to relieve the broken limb by winding a coat sleeve or a carriage robe or other article at hand around the limb. The two plain boards and string will answer all purposes. In some shops and mills there are outfits of ready-relief devices in readiness all the time. There are managers of industrial establishments that buy miniature surgeons, equipments for treating persons who may get tangled in a belt and injured in gearing or other ways. In other places no precautions are taken whatever. It does not cost much to carry a few ready-relief articles in stock. You can have the mechanic of the place turn out a number of devices to keep in readiness for service. Or, you can buy some of the required devices at dealers. A home-made arrangement for strapping about the broken limb of a person is shown in Fig. 2. There are three straps adjusted in the manner shown, and in case of application it is not necessary to search for cords or bandages to bind with. The straps will be used for securing the board in place.

A type of pocket cone made of leather or paper pulp, like that in Fig. 3, is carried in stock in the emergency box of many places. These cones are very useful for relieving a person who has suffered a broken limb. The device is intended merely as a support for an arm or leg until a surgeon arrives. The cone can be slipped over the broken limb very quickly and easily.

Fig. 4 at *c* shows a cylindrical piece of wood. In the event of a person injuring his fingers, and in case it becomes necessary to relieve one or more fingers by providing a support in the form of a grip, the cylinder is placed in the palm of the hand and the injured person can



secure support by gripping the same. Bandages may be wound outside and the fingers quite nicely supported until the doctor comes.

Fig. 5 is to illustrate the manner of winding a bandage of fabric about an injured leg, as at *B*. It is a good plan to have some of the bandage stock ready. It is best to buy the bandages all ready split and rolled in several widths. The drug stores handle these rolled bandages and sell them cheaply.

Bandages of narrow width should be

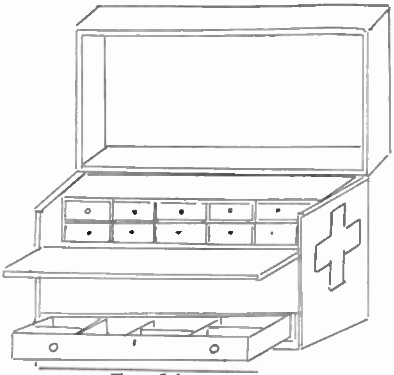


Fig 6A

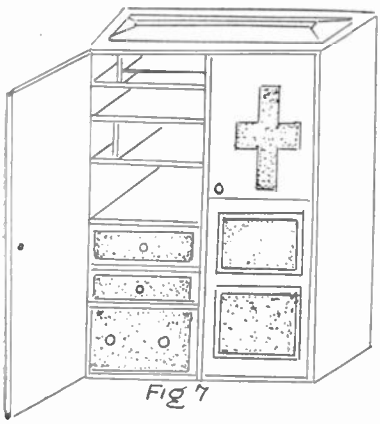


Fig 7

carried for cases of this nature. Also some wider bandage material for application to the forehead, as in Fig. 6, in the event of injury to the skull. In fact, an assortment of splints, bandages and a few ointments can be used to very great advantage in any plant where men are liable to get injured.

The writer has been employed in manufacturing establishments in which considerable suffering has been allayed and time and trouble saved because of the presence of an outfit with a few boards and medical contrivances. It is a good plan to have a regular set of drawers carrying an assortment of remedies, if the plant is situated remote from a drug store or the office of a doctor. I know that some owners of mechanical plants make it a point to buy complete kits from surgeon's supply stores, so as to have a reliable outfit. Fig. 6*A* is a drawing of one of the compartment chests used for carrying ready-relief contrivances and supplies for first aid to the injured in mills, shops, mines, electrical plants, etc.

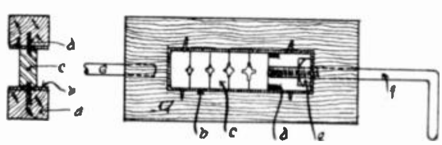
Fig. 7 is a cabinet arranged on a more elaborate style. These cabinets are usually made to order at the works of some supply house that makes a specialty of this line of furniture. However, the superintendent of the plant need not go into black walnut cabinets if he does not want to. The crude, home-made affair, with a few compartments and some of the most necessary supplies, will do.

AN EASILY MADE SCREW PLATE FOR SMALL DYES

JAMES P. LEWIS

A wooden screw plate for holding small, adjustable dies, can be made in the following manner:

A piece of oak or other hard wood (*a* in sketch) is selected, about 1 in. in thickness, 3 in. wide and 6 or 7 in. long. The size, of course, depending upon the size of die plates to be held. A rectangular hole is cut in the centre of this block, ⅛ in. wider than width of die-plates and somewhat longer than their combined lengths. A piece of sheet steel, just thick enough to slide easily in groove of die-plates, is sunk along the horizontal centre line of the sides of this hole, leaving each projecting the depth of groove in die-plates plus



1/16 in. This is shown at *a*. The whole inside of this hole is now lined with 1/16 in. sheet iron, *b*, and held in place with a few small flat head screws sunk flush with surface.

A hole is next bored in one end of block through which passes freely a rod *f* with one end threaded for a short distance to receive nut *e* and a couple of inches of other end bent at right angles.

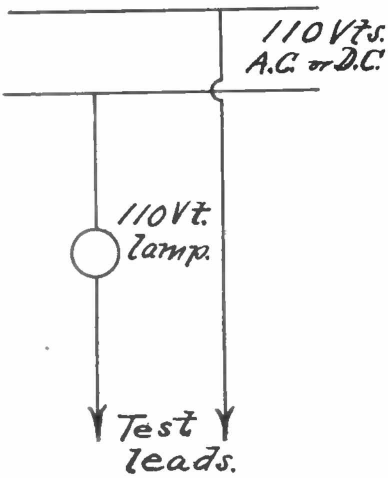
ELECTRICAL SHOP NOTES FOR AMATEURS.—Part II

Testing Methods

H. WINFIELD SECOR

A few words may not be amiss here on some of the common shop-testing methods. Tests for grounds, opens, etc., are generally made on all ordinary apparatus by applying one lead from a 110-volt circuit to the winding, and the other lead (with a 110-volt lamp in series), to the frame or other part of the instrument under test; see Fig. A.

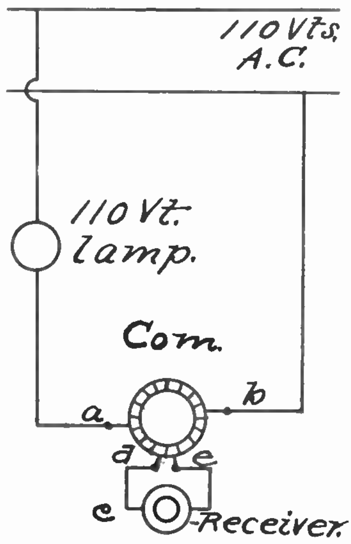
Several ways of testing out armatures will next be described: The scheme



A

shown in Fig. B is applicable where an a.c. circuit is at hand. The two leads *a* and *b* are tied on to the commutator of the armature in the same relative positions as those occupied by the brushes. An ordinary telephone receiver *c* is bridged across two neighboring bars as shown, making this test all way around the commutator. If a coil is all right or normal, a certain tone or hum will be heard in the receiver. If an open coil, a loud "crack" will result in the receiver. Short circuits in the coil will manifest themselves by a decreased value in the tone or hum in the receiver, this decreasing more as the short circuit nears the commutator, until, if it should be across two adjacent bars, the hum in the receiver will be nearly cut out. Shorts existing right on the back of the commutator where the leads are soldered to it will often be found quickly with this arrangement, permitting of getting right at the trouble and remedying it without unsoldering a dozen leads or so, and testing across bars in the ordinary way.

Another very good method of testing armatures is to connect the two test leads as shown in Fig. B, only the supply circuit being d.c. The lamp may be substituted by an adjustable lamp bank or rheostat, which will allow considerable current to flow through the armature winding. For the testing instrument, a voltmeter may be used, or often an old ammeter without its shunt is called into service, either one being bridged across two adjacent bars and the reading noted. The current is adjusted until sufficient deflection is obtained. A normal coil will give a certain reading. A deviation of several degrees below or above this point indicates trouble and it should be looked for before proceeding. A higher reading will indicate an open circuit or loose connection. A lower reading indicates a short circuit either in the coil or in the commutator. This is the

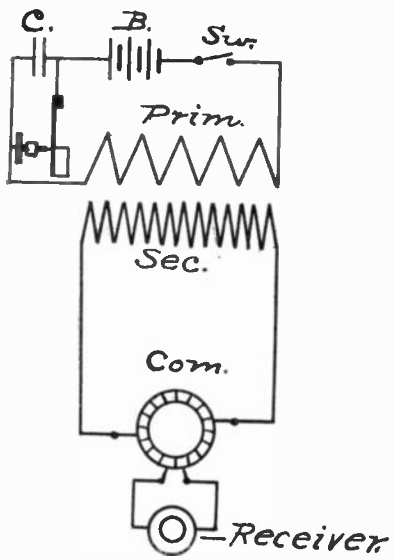


B

method generally used in testing manufactured machines, as it gives a definite and visual result, and is very accurate.

There is a portable testing instrument on the market which employs an induction coil (such as a medical coil) to supply current suitable for the test cited in Fig. B. The current is taken from the secondary coil and applied as in Fig. C; a telephone receiver *v* is used the same way as described above. It forms an efficient and useful testing set.

A very cheap, but satisfactory test set may be made out of an ordinary buzzer, operated on dry cells, as per diagram in Fig. D. The test leads are taken from both sides of the vibrator, *i.e.*, one from the armature and one from the contact screw. For testing



C

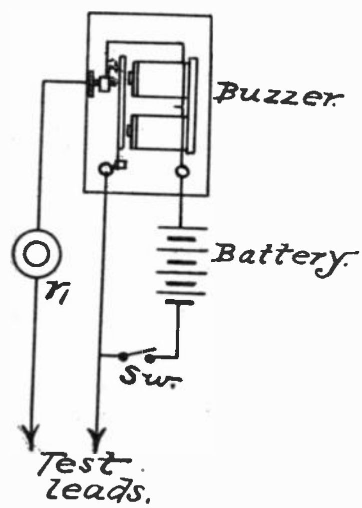
armatures the two leads are connected on to the commutator as described before, and the telephone receiver connected across adjacent bars, noting the buzz in same. For testing condensers, high resistance coils, etc., connect the receiver in series with one test lead as shown. This method will be found very efficacious in testing condensers, as a low hum will be heard when they are all right and a loud one when they are short-circuited.

It is often necessary to rewind electrical apparatus for a different voltage from that for which it was originally intended. The following few examples and rules may prove of value in calculating the size of wires involved in rewinding.

Taking a magnet coil wound with No. 22 B. & S. gauge magnet wire, which has been run on 110-volt d.c. for example: what must be the size wire to rewind it with for use on 220 volts d.c.? The ratio of the voltages is $\frac{220}{110}=2$;

Divide the area in circular mils (c.m.), of the old wire by this ratio "factor," and the resultant area obtained will be that of the new wire in c.m. This size can be taken from any B. & S. wire table or the diameter in mils $= \sqrt{\text{c.m.}}$;—

The area of No. 22 B. & S. wire is 642.4 c.m. and the result after dividing by 2=321.1 c.m. The nearest gauge number corresponding to this area is No. 25 B. & S. with an area of 320.4 c.m., hence the magnet coil should be rewound with the same weight,



D

about, of No. 25 B. & S. magnet wire. To be exact, twice as many turns will go on, which coupled with the halving of the cross-sectional area will increase the resistance 4 times. By using this method, employing the voltage ratio "factor," it is possible to calculate the size wire required, for rewinding for any voltage.

Rule 1.—For all voltage higher than the original voltage, to get the ratio "factor," divide the new voltage by the original voltage, and divide the c.m. area of the old wire by it to get the c.m. area of the new wire.

Rule 2.—For all voltage lower than the original voltage, divide the original voltage by the new voltage to get the ratio "factor," and multiply the original c.m. area by it to obtain the c.m. area of the new wire.

To illustrate the last rule, suppose it was required to rewind the above coil to operate on 55 volts d.c. Divide 110 by 55=2 for a ratio "factor." Now multiply the original area 642.4 c.m. by this factor 2, which gives 1284.8 c.m. as the area of the new wire, corresponding to No. 19 B. & S. gauge. For this winding only one half the number of feet of the original length will be put on. The original area is doubled and the resistance is only one quarter of that of the 110-volt winding.

It will be evident from the foregoing that for rewinding for voltages twice the original rating, a wire 3 gauge numbers smaller must be used and of twice the original length. Also, for voltages one half the original, a wire 3 gauge numbers larger will be required, with one half the original length. For rewinding for a voltage 4 times the original rating, use a wire 6 gauge numbers smaller than the original, etc., etc. For all odd voltages it will be found necessary to use the rules given above.

The End

AN ELECTRIC HEATER

F. ERSKINE HENEY

With the coming of early fall and the first cool days and nights, the problem arises what to do about starting up the furnace or the steam heating system. As sure as they are put in operation, the weather will change, so what is the use, for a while longer at least? So more than likely the whole family will submit to several shivering spells during the fall.

It is the intention of the writer to describe a simple home-made electric heater, almost as efficient as a factory-made one, which may be constructed by any ingenious person. The material necessary for the construction is not expensive and the work is very easy.

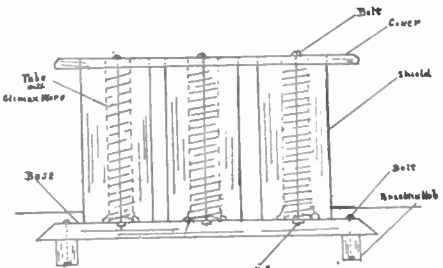


Fig I

Procure three porcelain tubes about 16 in. long and wind on each about 15 ft. of No. 26 climax resistance wire. Now make a base from stove-pipe iron bent into the shape of an inverted pan and bore three holes in the centre for the rods to pass through, which hold the heating units in place.

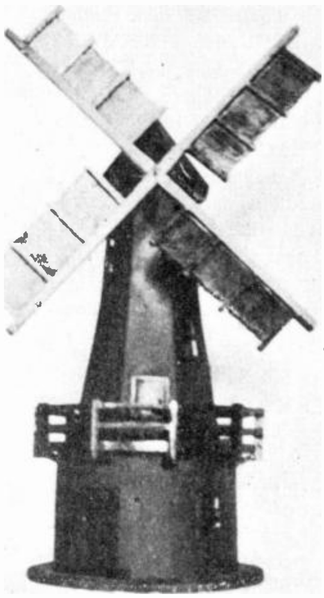
The shields can be made from stove-pipe iron also, rolled into a tube 3 in. in diameter and riveted.

The cover can be made from the same material as the base with holes in the top for the bolts. The legs are porcelain knobs held in place by small bolts passing through the base. A heater of this kind has given the writer very good results.

Simultaneously with the announcement that the Mersey Dock and Harbor Board has decided to construct a huge dock suitable for liners 1,000 ft. in length, comes the announcement from Liverpool that the Cunard Company is about to undertake the construction of at least one liner of 60,000 tons. The new vessel is therefore to be of the same tonnage as the White Star "Olympic" and "Titanic," but of much greater length and speed. Although the company has made no official announcement, it is admitted that a large vessel is in contemplation to take the place of the "Lucania," which was recently destroyed by fire.

A SMALL WORKING MODEL OF A DUTCH WINDMILL

STUART K. HARLOW



This small model of a Dutch windmill is the handiwork of Mr. George R. Betts, of Chicago, Ill. It was constructed of boards obtained from boxes given away at the grocery store.

The base is made from 1/4 in. material. It is 7 1/4 in. in diameter. At the same time we may also saw out a round board for the top of the lower story of the windmill, 7 1/8 in. in diameter and 1/4 in. thick.

The lower story is constructed of sections glued together and turned in a lathe to 6 in. in diameter. The sections are 3 1/2 in. long by 2 1/4 in. wide by 1/2 in. thick and eight are required. When the glue has dried and it has been turned to 6 in. in diameter mark out the openings for the windows and the front door. Cut out the openings by drilling a chain of holes close around the inside of the mark and with a sharp knife cut the openings smooth and to the dimensions of the outside of the windows and the door.

The lower front door, Fig. 6, next requires our attention. The door casing is made of four different pieces glued together. The threshold is 2 3/4 in. long by 5/16 in. wide by 1/2 in. thick. The two side pieces are 2 in. long by 5/32 in. wide by 1/2 in. thick; the top piece, 2 9/32 in. long by 5/32 in. wide by 1/2 in. thick. Apply glue to the different pieces and secure them in place with small brads. While the glue is drying, the door is made, 2 in. long by 1 29/32 in. wide by 5/16 in. thick. The inside edges of the door are drafted or beveled slightly, as shown in the drawing, so that the door closes easily and fits snugly. The common slide lock is placed on the outside of the door 3/4 in. above the threshold. The slide pin, 3/32 in. square and its handle 1/16 in. in diameter, is made of hickory; in fact, the whole lock may be made of hickory to advantage. Two 1/2 in. brads nailed through the door casing serves as hinges for the door. The edge AB of the door should be slightly rounded so as to allow the door to be opened. A piece of wood, 1/2 in. long by 3/32 in. thick, is placed on the inside of the door casing as a stop for the door.

Two windows for the lower story are made, 1 5/16 in. long by 1 1/16 in. wide by 3/8 in. thick, and each placed 2 in. distance from each side of the front door, as shown in Fig. 1. They are cut from a single piece of wood and the back chiseled to a depth of 1/2 the thickness and 1/16 in. larger than the window pane and a piece of glass fitted in, as in Fig. 5. We now glue the door and the windows in place and line the inside of the lower story with wall paper, so as to make it look inviting when one opens the door and peeps in. The top base is next secured in place with brads and glue.

Our next work is the construction of the tower. The tower is made of eight boards, measuring 8 1/16 in. long by 2 1/8 in wide at the bottom and tapering to 1 1/8 in. at the top by 1/4 in. in thickness. Three forms will be required, one for the top, one in the middle, and one for the bottom. The bottom one is a regular octagon (eight-sided), every side of which measures 1 15/16 in. The top one is a regular octagon, whose side measures 7/8 in. in length. The middle one is a regular octagon, whose side is 1 in. in length. They are made from 1/2 in. thick boards. The inside edges of the tower pieces are beveled and to a greater extent as the top of the tower is approached. When the sides are made to fit perfectly glue is applied.

String is now wrapped around the tower its full length very tightly, drawing it down to a close fit and giving the curve to the tower. When the glue has dried the string may be unwrapped, and the tower sandpapered to a smooth finish. The lower window in the tower is marked out 2 7/16 in. above the tower base. The two side windows are 5 in. above the tower base. The three windows are made to the dimensions as given in Fig. 5. The door in the tower is next marked off 3/8 in. above the tower base, cut out and fit in place. This door is made in the same way that the lower front door was made. The door knob consists of a double string passing through a hole in the door secured by a knot in the string at the back and a small hickory stick is tied as a knob in front. The tower is now secured to its base with brads and glue. Drill a hole clear through 1/2 in. from the top of the tower for the brass bearings for the windwheel shaft.

The bottom base board, 7 1/4 in. in diameter is next fastened to the lower part of the first story with glue.

The pointed top of the tower is made of eight triangular pieces 3 3/8 in. long by 1 1/2 in. wide at the base. The angle at the vertex on each piece is exactly 15°. The base of this top is a regular octagon, the length of its side being 1 3/8 in. When the pieces are made to fit they are glued together and left to dry. When dry it is sandpapered and glued to the top of the tower.

The fence around the lower part of the tower consists of ten posts 1 5/8 in. long by 1/4 in. wide by 3/16 in. thick. They are fastened with brads and glue at equal distant points around the circumference of the base of the tower. Short pieces for brackets are secured, as in Fig. 1. The double railing is constructed of the same stock.

The windwheel, Fig. 2, is made of 5/16 in. square material 6 in. in length. The opposite edge of each end of each arm for a distance of 4 9/16 in. is planed off to a width of 3/8 in. Beginning 5/16 in. from the end of each arm square holes are made 1 1/2 in. apart between centres for the tenoned ends of the blade posts to be glued in. The blade posts are 1 11/16 in. long by 1/4 in. wide by 1/8 in. thick, and are set in the arms at an angle of 45° with the horizontal. The blades on the wheel are thin veneer 1/16 in. or less in thickness. They are cut wavy and feathery at the outer edge by cutting nearly through with a sharp knife and bending each half back at right angles when they will break, leaving the desired rough edges. When all

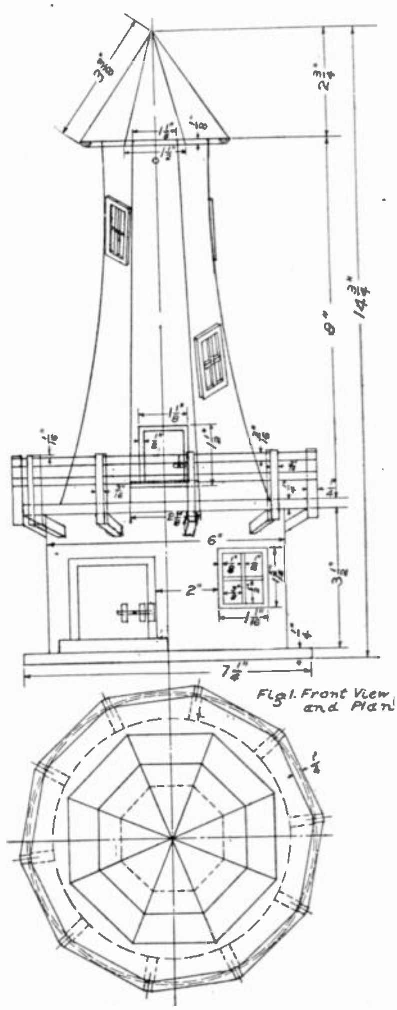


Fig. 1. Front View and Plan

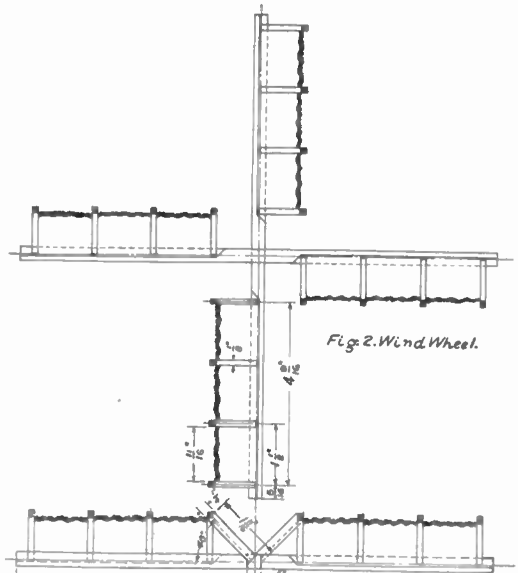


Fig. 2. Wind Wheel.

Fig. 3. Shaft.

Fig. 4. Shaft Bearings.

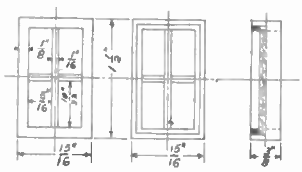


Fig. 5. Upper Windows

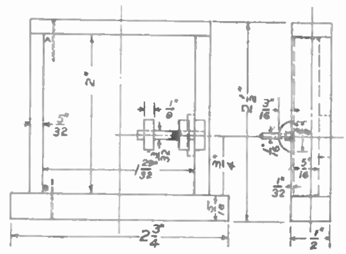


Fig. 6. Lower Front Door.

parts are finished they are fitted and glued together.

The shaft, Fig. 3, is a steel wire ⅛ in. in diameter or No. 12 Birmingham steel wire and 6 in. in length. The shaft bearings are brass tubing ⅛ in. inside diameter and 5/16 in. in length. The shaft is held in place by a drop of solder on each end of the shaft or small washers of sheet brass or tin soldered next to the bearings on each side. A 3/32 in. diameter hole is drilled in the centre of the windwheel for the shaft. The end of the shaft may be riveted over or a small washer soldered on each side of wheel and as a still further security against slipping four small brads may be driven into the arms through one of the washers.

When all is finished the appearance of the model may be greatly enhanced by painting the windmill in two colors. The lower story and its base and the tower is painted a brick red, while the lower front door and the two windows and the door in the tower and its windows as well as the tower steeple and the railing and its base is painted a dark brown.

He Needed Help

Little Harry startled his nurse the other night as he finished his evening prayers by saying: "God bless papa and mamma and Margaret and us boys; and—and—God, please make me strong like the big bear in the park, 'cause I got to lick Charlie White in the mornin'."—*The Delineator.*

DESIGN AND CONSTRUCTION OF MODEL AEROPLANES—Part III

EXPERT

Materials

For small models it is necessary to have the lightest materials, but due regard must be made to their strength; of all materials for the main surfaces of models there is no material to equal wood, but owing to large surfaces weighing much more in proportion to fabric covered ones, this material may only be used in models up to 2 ft. or so across, although larger models have been made the liability to break the places and have all the work of preparing new surfaces over again does not encourage one to make them much above the length mentioned above.

There are three different timbers which are particularly useful in making small aerofoils: yellow pine, American white wood and cedar. They may all three be had within boards ⅛ in. and 3/16 in. thick quite free from knots and they weigh very little as will be seen by the table given below.

Yellow Pine.—This is the lightest wood to use. It is very straight-grained and when thoroughly well seasoned will not warp or twist. It may be steamed and will retain its shape well.

Cedar.—This is also a straight grained and light wood, steaming well and most suitable for making planes. It is usually very pretty and requires careful planing.

American Whitewood.—There are at least three different timbers sold under this name. Originally the name was given to the timber of the American lime tree. This is fairly soft, straight-grained and planes up to a good surface. A very similar wood, but together in the grain, and most suitable for aerofoils is the timber of the tulip tree also known as American whitewood. It is possible to tell the difference between the two timbers owing to the brilliant "sheen" on tulip wood when planed. This must not be confused with the tulip wood sold for inlaying which is much heavier and not at all suitable for our purpose.

American white poplar is also another tree to which whitewood is given. There is little difference between any of them, but if possible the wood with the most "sheen," when planed should be used.

For framework there are several kinds of wood suitable; namely, spruce, birch, beech, mahogany, elm, ash, hickory and black walnut.

Spruce is very cheap, light and straight-grained. It is not possible to get very long pieces without knobs, but for small models there is nothing to equal it for framing.

Birch is fairly heavy, but very tough, compared with spruce. It is nearly half as heavy again, but where strength is required and weight not so important an item, it will prove a splendid wood for framework.

Beech is a little heavier than birch, but has the advantage of being less brittle. For wooden bearings, cleats and small work it is very suitable as it is nearly as strong in the short as the long way of the grain.

Honduras Mahogany.—This is another very suitable wood, but is not so easy to plane as the above woods. It is lighter than birch or beech, but heavier than spruce and cedar.

Elm.—American elm is suitable for framework, but is not particularly straight-grained. It is very tough and about the same weight as mahogany.

Ash.—Well seasoned American ash is a useful timber. Austrian ash is perhaps a little lighter, but is more brittle. It steams well and retains its shape and is certainly a good timber for any curved framing if used in small sizes about 3/16 in. in square.

Hickory.—This is another good timber for bending; is a little heavier than birch, but is fairly straight in grain and easy to work.

Walnut.—Black walnut is a straight-grained wood. It bends well and is a little lighter than mahogany. If well seasoned it will not warp and when once shaped may be relied on to keep in shape.

The writer has experimented with all the above timbers and for plane surfaces cedar, American whitewood or basswood and yellow pine are greatly in favor.

For framing, spruce, walnut, mahogany and birch have been mostly used.

FABRICS

There are a large number of fabrics on the market, but there are only two or three materials that the model maker need use, and they are rubber-proofed cloth, such as "Pegamoid," and the material known as "rain soak," treated with fine copal varnish. There are many fabrics which weigh a fraction of an ounce per yard less than others, but there is not so much in the actual weight of the covering material, within limits, of course, as many people consider.

We may as well consider those on the market.

"*Pegamoid*."—This in its thinnest form is an ideal covering for models and works out very cheaply.

Aero Cloth is a waterproof material which may be bought in several thicknesses and qualities and made of cotton or other materials covered with rubber. It is fairly expensive, but forms a good covering material. It requires care in attaching rubber to cloth to the framework, but when well secured does not give at all.

Jap Silk.—This is a material often used, but is very difficult to apply well. It should be waterproofed with oil, wax or varnish, but it has not the strength of an aero cloth although lighter.

Tracing Paper and Cloth.—These materials are often used for covering, but are not satisfactory. They cockle with the damp and tear very easily.

Fine Linen.—This makes a fine covering and should be treated with hot paraffin wax thinned down with methylated spirit. Squeeze as much of the surplus liquid out of the material as possible, and carefully hang up to dry, stretching it so that it dries evenly without creases.

OTHER MATERIALS

Bamboo.—Wide bamboo splits very easily and may be planed to square pieces about 1/8 to 3/16 in. thick. It is rather heavy, but is very tough and can stand considerable strain.

Cane.—The ordinary round cane may be planed round or square, but it is advisable to have a grooved piece of wood to plane it on.

Thin Bamboo is also useful. It may be planed down and makes good uprights for bi-planes.

Hollow Reeds.—These are also useful for uprights, and are very high.

Aluminum.—Although this metal is not suitable for aerofoil it is very useful for making all kinds of joints. Small pieces of several gauges should be in every model maker's work shop.

Magnaleum.—This is a lighter metal than aluminum, but within sheet there is so little difference that the extra expense is hardly advisable when the latter metal will do as well.

Tinned Sheet Iron.—This is useful for making joints; it may be easily soldered; an advantage over aluminum.

Brass.—Sheet brass and hard brass wire are necessary materials. The former for bearers and the latter for spindle.

Steel.—Steel in the form of wire, either in short length will often be used.

Piano Wire.—Several gauges should be kept at hand not only for use as stay wire, but to make small bolts.

Cycle Spokes.—Small spokes will be found very useful in many ways. The screwed end and nipple are very useful and saves a lot of work. The wire is of mild steel, easily bent and forms an ideal propellor shaft.

Fretwork Nails.—These are useful, but all nails should be avoided as much as possible particularly in thin wood. The wood is so apt to split where the nail goes through that special care must be taken in driving any nail or pin in.

Small Screws.—These are generally not so useful as pins, but small sizes, both flat and round heads are sometimes required.

Washers.—These may be of leather, wood or metal. For small pins there is nothing better than "spangles." This may generally be obtained from a draper.

Glue, Fish Glue and Seccotine.—The latter forms of adhesive are more useful to the model maker. They are easily applied, do not require heat and stand as well as glue. For joining surfaces that have afterwards to be steamed seccotine is the best.

Varnishes.—To finish the surfaces of wooden aerofoils, a fine shellac varnish or French polish (white) are the best kinds of varnish to use. A varnish containing linseed oil is much too heavy for aeroplane work.

Table of weights of various timbers in lbs. per cubic ft.:

*Yellow Pine	28
*Spruce	31
Black Walnut	31.5
*Cedar	33
American Whitewood	35
Honduras Mahogany	35.5
Elm	35.75
Sycamore	38
Birch	45
Lancewood	45
*Yew	45.5
*Yellow Deal	46
Hickory	49
Lime	50
Ash	52
Beech	53

Methods of Propulsion

The work of providing an efficient means of propelling model aeroplanes opens out a large field for experiments. With the exception of rubber, which is at the best a very poor method, there is no cheap and efficient motor power on the market. There are, no doubt, at the present moment a considerable number of model makers hard at work with every means of producing power, and it is well worth the continued effort of any engineer, model or otherwise, to invent either a light and effective clockwork, or a small petrol, gas or condensed air engine, or an electric motor with a light accumulator.

The writer has spent a lot of time in experimenting with clockwork and geared elastic motors and will later on give the readers the results of his experiments.

We may as well take the various methods of propulsion, and show what has been and what may be done with them.

RUBBER MOTIVE POWER

As rubber is the only practicable motive power at present, it is necessary to make the most of it. It has several advantages, for it is clean in use, cheap and easily procurable, simple in action and easy to apply, and also comparatively light. Against this we must put its liability to perish, and the purer the rubber, the quicker it will go; also, it loses in strength after every full winding; after being used about a dozen times quite one-quarter of its elasticity is lost.

Another disadvantage is that the power developed is not constant; during the untwisting it commences to drop at once and a proportion of the revelations at the end of the run will be found to have no effect. It is not possible to get elastic to run any length of time, and taking a certain number of lengths as untwisting in a certain time, it will be found that adding to the number of strands increases the power, but diminishes the number of revolutions possible.

This leads on to the consideration of suitable forms of gearing, for while direct attachment of the rubber to the propeller is most simple, the number of revolutions is limited to the length of rubber and the power required.

Taking the rubber directly attached to the propeller shaft, we have the friction at the propeller bearing to overcome. (Fig. 1.) To relieve the pressure thrust blocks of glass beads or metal rings, should be used with a good lubricating oil that will not clog.

It is a difficult thing to get glass beads sufficiently true, but rings may be easily made by twisting hard brass or steel wire round the propeller shaft to form a spiral (Fig. 2*a*). Saw this along with a fretsaw as shown at *b*, and solder the resulting ring *c* with soft or silver solder.

Increased efficiency may be gained, with directly attached rubber, by the use of ball-bearing thrusts. They require careful work, but are not beyond the skill of the model maker. Several forms of ball-bearing thrust blocks are on the market, but they all have the disadvantage of considerable weight. Three forms of these blocks are shown at Figs. 3 and 4, the latter being very simple, requiring a cycle spoke, a piece of thin ½ in. brass tube, 1 steel washer, a pair of spoke nipples, ½ doz. small steel balls and a little wire about 1/16 in. in diameter.

The brass tube should be cut off to ¼ in. long, and inside one end solder a ring made of the wire as shown at Fig. 5*a*. Next fit in the steel washer *b*, filing the outside quite true, and polishing up the surface quite smooth. This washer should be slightly domed, and

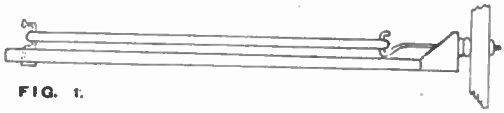


FIG. 1.

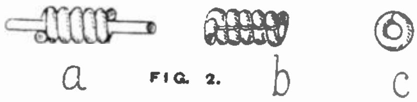


FIG. 2.

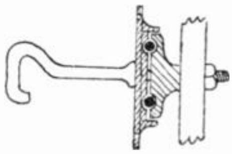


FIG. 3.

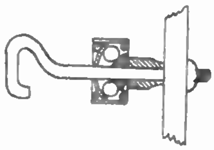


FIG. 4.

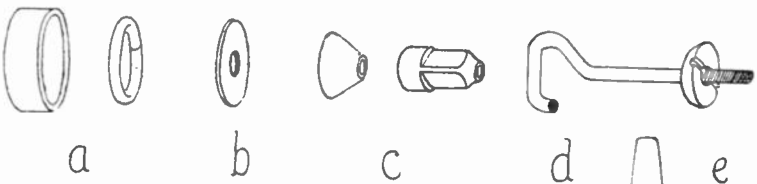


FIG. 5.

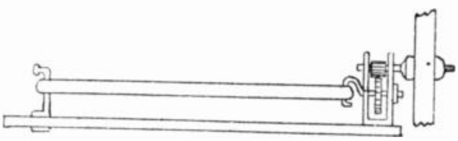


FIG. 7.

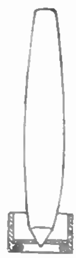


FIG. 6.

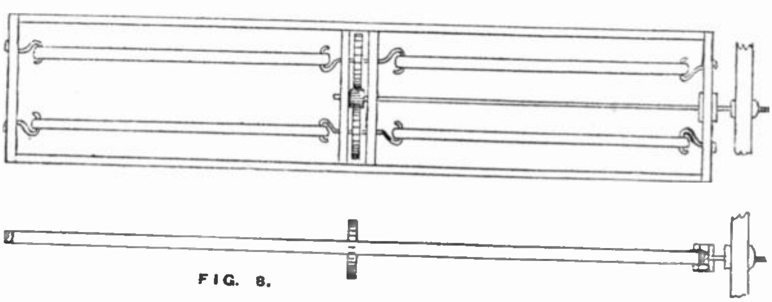


FIG. 8.

this may be done by putting a large centre punch through the tube, rest it on the washer and give it a sharp blow when in the position shown by section (Fig. 6).

Now prepare a nipple for the other bearing. First saw off the wide end and fix it in the lathe or the end of a brace or drill, and true it up to a point as shown at *c*. Now solder another ring in the other end of tube, insert the balls and cut off a length of spoke, bend one end for the rubber, and leave the other for the propeller to be screwed onto as shown at *d*, utilizing the spare end of nipple as shown at *e*, to screw the propeller up to. This bearing weighs, when completed, under ½ oz., and only costs a few pence to make.

To obviate the necessity of using a thrust block, the rubber may be geared as shown by the illustration (Fig. 7). We have in this case no direct thrust on the propeller bearing, but a certain amount of friction to overcome. This is compensated by the increased number of revolutions possible.

Practically, geared rubber motors do not give the results that they theoretically should, for the friction involved means a considerable loss of power; but with a low gear and well-cut gear wheels, there is a lot to be said in their favor.

The great advantage lies in the fact that several separate skeins of rubber may be geared on to the same propeller and give a considerably longer run. Fig. 8 gives a sketch of a simply made geared elastic motor with no end thrust. This may be fitted to a monoplane with a double frame, but with considerably more weight than the same length of rubber. Exclusive of framework, the rubber and wheels will be quite 4 oz. for a 24 in. frame.

Working details will be given later on of several kinds of geared elastic motors with exact weight, so that model makers can see exactly what type is suitable, and know the weight and torque of each motor.

CLOCKWORK MOTORS

There are several clockwork motors on the market, but they are either too heavy for model aeroplanes, although highly suitable for model boats, or they are not powerful enough to drive a propeller of any size.

PETROL MOTORS

For small petrol motors there is certainly a great want. The difficulty of model aeroplane flying will be greatly overcome when one is able to use a light and effective motor. There is no doubt that before long we shall be able to describe in these columns a suitable motor for large models, and this will give model makers encouragement to build and fly much larger models than is possible under the limitations of rubber.

A CHEAP NINE-INCH REFLECTING TELESCOPE—Part V

Apparatus for Testing Lenses

M. A. AINSLEY

Continued from August

Presuming that the reader has mastered Part IV, giving the theory of the pinhole test at the centre of curvature, I will briefly describe my apparatus: It simply consists of a wooden baseboard (metal would be even better) to support the lamp, taken from a cheap bicycle, which gives a flame ½ in. wide. Immediately in front of the flame is a vertical wooden board (4 in. x 2½ in.), which has a ½ in. hole level with the brightest part of flame. This supports, on the flame side, a brass plate with a hole 1.160 in. in diameter. This I got drilled by a watchmaker with a drill .15 m.m. in diameter. The plate with a hole in it can be easily removed or placed in position, and a screen of tin round the lamp shields the eye from its light.

Immediately to the left of this lamp, and so that its centre line is not more than 2½ in. from the pinhole, and on the same level, is a brass tube supported on two wooden Vs, and, of course, parallel to the line joining flame, pinhole and mirror. A line is cut round the tube, accurately at right angles to its axis, as an index, and the position is measured by an ivory millimeter scale attached to the Vs; 1 m.m. = 4/100 for all practical purposes, and it is easy to estimate to ¼ m.m., or 1/100 in. The mirror is supported against a stout board and rests on a shelf on the board. It is placed at a somewhat lower level than the apparatus. If the tube used is, as in my case, the "draw-tube" into which the eyepieces screw, an efficient "occulting screen" be made by removing the lenses of a low-power eyepiece and using the diaphragm or stop, which limits the field of view.

The testing apparatus and speculum should be supported on firm supports, tripods if possible, on a stone floor; but testing may be carried on, as I found, even in an upper room, if it is done late at night so that no one is moving. The distance between pinhole and speculum is approximately twice the focal length; not exactly, because the image of the pinhole is a few inches further from the mirror than the pinhole itself. This makes no practical difference in testing, though if

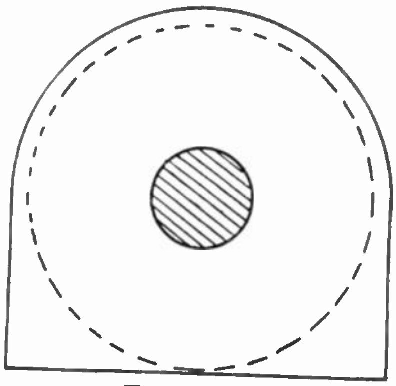


FIG. 1.

the pinhole were much nearer the mirror, the formula for aberration would have to be altered.

The screens used for hiding the parts of the mirror are two in number (Figs. 1 and 2), and, these may, with advantage be combined into one (Fig. 3). The central slide may be 2 to 2½ in. in diameter, and the segment left in the outer zone, (Fig. 2,) may be 1 in. broad and 3 in. long. I found the combined screen easiest to work with. Provide also, a white paper cap to fit over the front end of the tube; this is useful in adjusting the position of the apparatus.

Light the lamp and see that the brightest part of the flame is opposite to the pinhole. Remove the pinhole and let the light shine on the mirror through the hole in the vertical board; place the tin screen round the lamp to darken the room; the room, of course must be otherwise dark, or nearly so. Then place the apparatus at a distance from the mirror, approximately equal to twice the focal length of the mirror, *i.e.*, the radius of the curvature. Move the mirror about until the image of the flame, seen through the ½ in. hole, is received on the paper cap at the end of tube; remove the paper cap and view the mirror through the tube, taking care that the tube is accurately pointed to the centre of the mirror. Move the apparatus to or from the mirror until the image of the hole is at the eye end of the tube; insert the plate with the pinhole in the testing apparatus and focus the image with eyepiece or lens of some sort.

We may now take a preliminary examination of the image. As in Part IV, the appearance of the image inside and outside the focus will give an idea of the class to which the curve belongs, remembering that Class A (oblate spheroid) gives bright centre outside and dark inside focus; Class B (sphere) gives the same uniform appearance inside and outside focus; Class C (ellipse, parabola, hyperbola) give bright centre inside and dark centre outside the focus.

Next, remove the lens, or lenses, and bring the image, by moving the apparatus to the edge of the screen used for testing; *i.e.*, if the diaphragm of the eye-piece is being used, bring the image to the right-hand side, so that further movement of the apparatus to the left will cut off the light. The image must be kept level with the centre of the tube, and the whole apparatus packed with paper until it is so. A slight pressure with the hand on the left-hand side of the baseboard will just cut off the light, and the tube is pushed or pulled until the illumination of the mirror disappears, as evenly as possible, the eye being meanwhile placed as close as possible to the image, so that the mirror is seen, as it were, flooded with light.

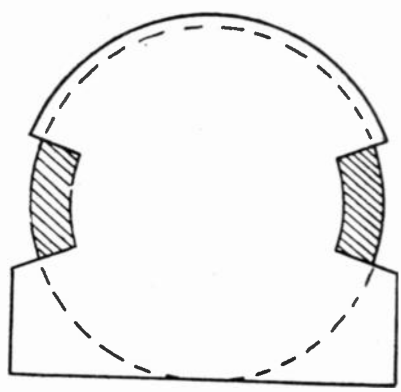


FIG. 2.

It is important that the mirror rest against a backing of uniform color, a piece of black velvet or cloth being most suitable; also it must be left to get thoroughly cool after polishing, or the image will be irregular and the testing unsatisfactory.

The mirror must be handled as little as possible. A finger placed on the surface for a half minute produces a slight elevation which is easily visible in testing; in fact, once the mirror is in position, it ought not to be touched at all until testing is completed.

The adjustment of the mirror to reflect the image through the tube is a long job at first. A large sheet of white paper held behind the testing apparatus to receive the image of the hole is a great help.

I assume now that the polish has become perfect all over the glass. This is a question of time; but if the polisher is properly made, should not take more than four hours, and that the curve is either A or B, *i.e.*, still on the safe side

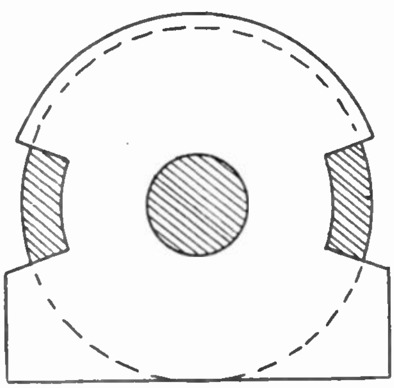


FIG. 3.

of the sphere. We may now bring the mirror screen into action. First of all, place the testing screen (by which, to save confusion, I shall denote the diaphragm in the eyepiece mount placed close to the eye, as described in my last) as near as possible to the image of the pinhole, and observe whether the shadows seen on occulting the image are regular. If, owing to the faulty construction of the polisher, any rings or irregularities appear, it may be necessary to return to the latter stages of the fine grinding; but such irregularities are easily perceptible in the earlier stages of polishing, and can be avoided by care in making the polisher and in adjusting the position of the central square, as before described. I have not been troubled with "rings" in my own work, and I believe they can always be completely avoided with care.

Now put in front of the screen No. 1, or if one screen only is to be used, No. 3, and gently and slowly alter the position of the tube in its Vs until the testing screen, when brought across, darkens the central part of the mirror uniformly. By keeping up an intermittent pressure with the hand on the left side of the base-board of the testing apparatus, the mirror may be made to darken and brighten alternately, and the tube is moved very gently with the right hand until the appearance of a shadow advancing across the mirror, or rather the central portion left by the mirror screen, is lost, and the darkening is even all over. Read the scale, estimating to ¼ m.m. or 1/100 in. This should be repeated many times, the testing-screen being placed, to start with, alternately outside and inside the focus. The mean of all the reading is then taken.

Now concentrate attention on the outer zone. As will be seen in Figs. 2 and 3, only two segments of this zone are visible, one on each side, and to get the best results, the testing screen, at the point where it occults the image, must be vertical; *i.e.*, the image must be level with the centre of the aperture whose edge is being used for testing. A vertical bar across the end as the tube does as well as the eyepiece diaphragm; but I found the latter more convenient. The scale is read again when the two segments are found to darken simultaneously; and, from the greater convergence of the rays from the two sides of the mirror, it is rather easier to observe the exact focus than when the central 2½ in. of the mirror is observed; in any case, however, the mean of several readings should be taken.

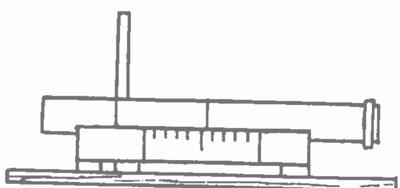
The difference between the final means gives the actual difference between the focus of the mirror (for rays diverging from the centre of curvature, of course) for the centre edge of the mirror. If the focal length for the centre is large, *i.e.*, if the first reading was greater, the mirror belongs to class *A;* if the focus is the same for both, the mirror is spherical, class *B;* and if the reading for the outer zone is greater than for the centre, class *C*.

It is desirable, after reading off the scale for the outer zone, to make another set of observations of the centre, to make certain that the testing apparatus has not shifted. It should be heavy enough to remain still. The use of the combined mirror screen (Fig. 3,) I found a great advantage, as I could remain perfectly still during the whole time, and thus risk of shaking mirror or testing apparatus was avoided.

We know exactly what sort of curve we have got, and we now want a formula which will give the exact difference between the readings ("aberration" is the name commonly used) for the parabola, C^2.

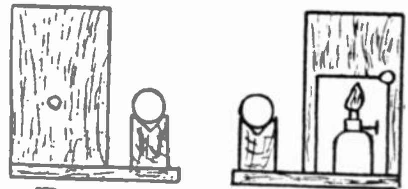
The formula giving the necessary aberration for the parabola is $\frac{D^2}{8F}$, where D is the mean diameter of the zone, and F the focal length. It may also be written $\frac{r^2}{R}$, where r=means radius of zone, and R=radius of curvature of the mirror, which is twice the focal length ($=2F$).

N.B.—The distance from pinhole to screen is equal to the radius of curvature. Either formula gives the same result, but I prefer the former. It will be noticed that the aberration is twice the depth of the centre of the mirror below the line joining opposite middle points



LEFT SIDE

of the zone, *e.g.*, if the zone used on a 9 in. mirror of 6 ft. focus is 1 in. wide, its mean diameter is 8 in., and its depth, measured from the plane of the 8 in. circle, is $\frac{(8)^2}{16 \text{ x } 72} = \frac{1}{18}$ in., while the aberration to be aimed at in the figuring would be $\frac{(8)^2}{8 \text{ x } 72} = \frac{1}{9}$ in. = 11 in., or



FRONT BACK

3¼ m.m. It will be seen that this is but a small quantity; but it must be measured accurately, as on it depends the whole performance of the mirror.

It must be noticed, however, that this is the theoretical value. As I was told by an expert: "Here, mathematics must take a back seat," and he further told me that the practical value is somewhat less. I did not find it so; but, in any case, it is safest to carry on the figuring process (to be described later) until the aberration is about ⅔ of this, or, in the case under consideration, about .08 in. The final testing must, after all, be done in a telescope, on a star, and with a good eyepiece. I would again quote Sir J. Herschel: "That is a good form which gives a good image." If the aberration becomes too great at any time, the curve becomes C^3 (the hyperbola), and it is very difficult to get back. *A*, *B* and *C* all mean safety; but C^3 means danger. When my mirrors appeared to give perfect results in the telescope, I found, in testing with pinhole and screen that they gave the theoretical aberration.—*English] Mechanic.*

In connection with the explorations which are being carried on in the old cemetery of the church of St. Seurin at Bordeaux, a vessel of green glass, containing a quantity of lees, or incrustations, was found in a sarcophagus which appeared to date from the first century of the Christian era. The deposit has been analyzed, and the results lead to the conclusion that the vessel originally contained wine, the evaporation of which has left traces of chromotannic matter, more or less covered with carbonate of lime, and which has also deposited very sharply defined and characteristic grains of cream of tartar.

SOME USES OF PLASTER OF PARIS IN PATTERN-MAKING

A. T.

Many model engineers, no doubt, when they wish to make a model to their own design, find the pattern-making a stumbling-block. The object of this article is to describe some of the methods in which plaster of Paris is used for pattern-making, and probably help some model-maker out of a difficulty.

As most model engineers' lathes will not swing a fly wheel, say, for a small gas engine, Figs. 1 and 2 show how to make the pattern without a lathe. A board (*A*, Figs. 1 and 2) is required; it must be flat and fair, and should be 3 or 4 in. larger each way than the wheel pattern is to be; also a template *B*, shown in position in Figs. 1 and 2, and at Figs. 3 and 4. Draw the half-section of the wheel on it, as at Fig. 3, and cut it to the outline of the lower half of the wheel, as shown by the full-line lower outline in Fig. 3. Chamfer the edge, as shown in the sectional end elevation (Fig. 4), and drive a metal pin *C* in on the centre line. The cross-piece at the end is to keep the template from tilting when in use. A wooden plug (*D*, Fig. 1) of suitable height—the diameter is not important (but it should be smooth and tapered as shown, so that the pattern will slip off it)—with a hole in the centre, to suit the pin in the template, is now attached to the centre of the board, so that the template can be rotated round it. Now where the under side of the template stands up clear off the board, drive a dozen or so nails into the board, leaving the heads projecting, but not sufficiently high to keep the template from rotating, and having liberally coated with oil the wooden plug *D*, the template *B*, and the part of the board *A* it bears on when being rotated, gauge some plaster of Paris and apply, keeping the template rotating, so that it will scrape the plaster to its outline. It will probably require two or three gaugings to bring this part—which is called the block—to a finished surface. Do not allow the plaster time to harden between the gaugings.

When the block has hardened, give it a coat of shellac varnish and cut the template to the outline of the upper side of the wheel, as shown by the upper dotted line in Fig. 3. Again oil the template, the board, and also the varnished plaster block this time, and proceed to sweep up the thickness. This will be the wheel pattern. As the spokes have to be cut out—or, rather, the material between the spokes has to be cut out—see that the plaster is well gauged, of equal consistency, and free from lumps (usually called knots). When the thickness has hardened, remove it from the block; if it holds fast, rap the board with a mallet or hammer to start it: do not strike the plaster. Now wipe the block free from oil, and proceed, with dividers and draw-point, to mark off the spokes. If the spokes are straight, as shown in Fig. 2, the centre lines may be drawn, using the template in position as a straight-edge. If curved spokes are required, it will be easiest to make a thin wooden template to the outline of one spoke, and having marked the centres of the spokes on the thickness, place the template in position and mark off each spoke. To finish the spokes, bore or cut a hole through the waste material between each spoke, and saw round, keeping close to the lines; then, with a chisel and gouge, pare square through exactly to the lines. Next proceed to round them off to the desired section, using a small wooden template as a guide. Ordinary woodworking tools are used for cutting and sawing the plaster; a pocket-knife is also handy. If a port or other small saw is not at hand, use a brace and a centre-bit or a gouge to remove the portions between the spokes. Finish the pattern with sandpaper, and give it two or three coats of shellac varnish. Send it to the foundry on the board it was made on, as the molder will want it to support the pattern when he is ramming the drag half of his flask.

An alternative method of making the pattern, which would be better if the required spokes in the wheel are very thin, would be to make the boss and spokes of wood and check them into the plaster rim. The template for the rim would be made as shown by the lower dotted lines in Fig. 3 and following the lower outline of the rim; then, after the block is swept up, cut it to the upper outline and sweep up the rim. The ends of the wooden spokes should be of the form shown dotted on two spokes in Fig. 2. Have them tapered so that the checks in the rim will be as shown in Figs. 5 and 6, and it will be found much easier to make a good fitting job. It is not necessary to attach the spokes to the rim, but the spokes and boss should be in one piece. Cross-check the spokes in pairs, and fix patches for the boss on each side in the centre. If three or four pieces of wire are bent to the shape shown in Fig. 7, and let into the rim, they will be found convenient for drawing the pattern from the sand when it is being molded. The best way to put them in place is to cut recesses in the block in suitable positions, invert the loop of a wire into each recess, leaving the ends projecting, and putty up the recess over the loop previous to sweeping up the pattern. When the plaster for the pattern is applied, it will run round and effectually fix them. The putty is, of course, cleared away when the pattern is first lifted off its block, and the loops of wire are left projecting.

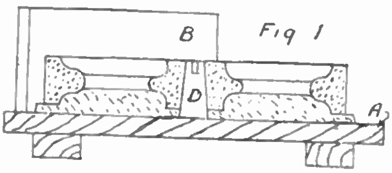


Fig 1

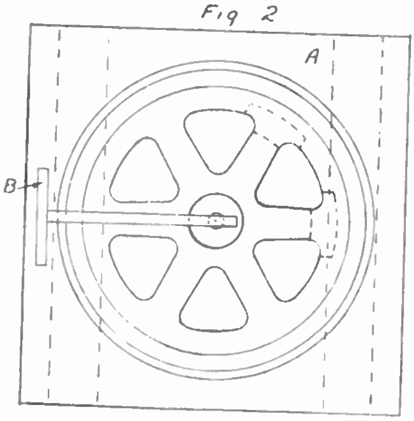
Fig 2


Fig 3

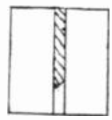


Fig 4


Fig 5

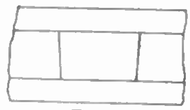


Fig 6


Fig 7

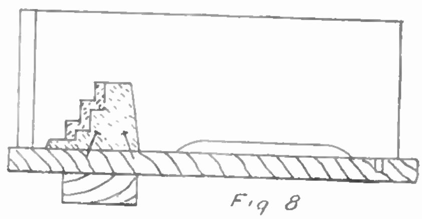


Fig 8

Fig. 8 shows how the rim of a three-speed wheel would be swept up. The spokes should be made of wood and arranged to slip into position against one of the checks in the inside of the rim after the molder has turned over the drag part of his flask and removed the board with the block attached. The rim will then be inverted from the position shown. As this rim will probably be of large diameter and thin in section, the molder could not conveniently withdraw it from the mold if left whole; so cut it into segments about 12 in. long, drive a wire nail through each into the block, leaving the heads projecting so that the molder can withdraw them when required. The slanting nails in Fig. 8 show how the block is held to the board. If, instead of using the wooden edge of the template for a sweep, a piece of sheet zinc is cut to the proper outline and screwed to the face of the template, the edge of the template being cut back to about ⅛ in. behind the edge of the zinc, a smoother surface will be got on the plaster.

Figs. 9, 10 and 11 show a method of making a corebox which will specially appeal to those who have not a large stock of woodworking tools. The corebox illustrated is for a piston valve casing; an amateur would probably find such a box troublesome to make accurately in wood, though he had the necessary tools. To make the box in

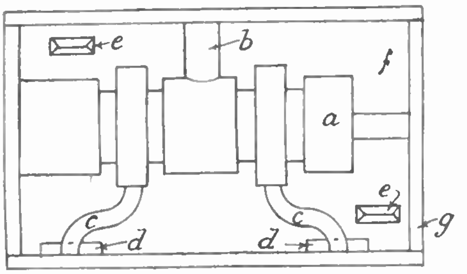


Fig 9

plaster of Paris, first loose-dowel two pieces of wood of suitable size together, as for a split pattern, and turn the main portion *a* (Figs. 9 and 10), also the branch *b*; next cut out pieces for the ports *c*. Those pieces are the shape and size of the interior of the casting required. Make also the small pieces *d* to fit against the ends of *c* and the pyramid-shaped pieces *e*. Now varnish them and assemble one-half of each part on a board *f*, screwing them from the back of the board, and erect a framework *g* round them, as shown in Figs. 9 and 10. Then give the whole interior a good coat of oil, gauge sufficient plaster, and pour in until the framework is filled to a height of from 1 to 2 in. above the parts screwed to the board. When the plaster has hardened, turn upside down, and remove the screws holding the pieces *a*, *b*, *c*, and *d*. Lift off the board *f* and shift the frame *g* to the position shown in Fig. 11, after giving the joint of the corebox a coat of varnish.

h, Fig. 11, is a section of the half of the corebox which has been cast with the halves of the core pattern pieces *a*, *b*, *c*, and the pieces *d* still embedded and showing the remaining halves placed in position ready to cast the second half of the corebox. To prevent them floating when the plaster is poured in, put screws into them from

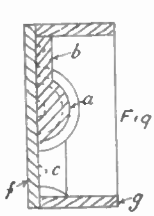


Fig 10

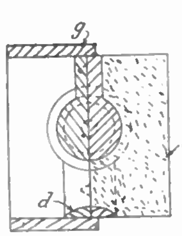


Fig 11

the outside of the frame *g*. As the pieces *e* were not removed from the board *f*, the plaster forming the second half will fill the impressions left by them in the first half, and form pins to guide the halves of the box to their proper position. After the second half has hardened, remove the framework *g*, lift the halves of the corebox apart, and withdraw the pattern pieces. They will probably require to be rapped on the ends to loosen them; if they cannot be got hold of to withdraw, put a wood screw some distance into each part, and grip it with a pair of pinchers or pliers. Any parts that may require it should now be smoothed off. Should any corners be accidentally broken off, stick them with thick spirit varnish, and finish by giving the whole interior two or three coats of varnish.

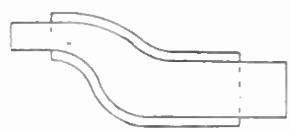


Fig 12

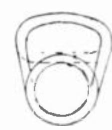


Fig 13

The pieces *d*, it will be noticed, are used to make the side of the corebox curved, so that the port cores *c* will fit against the main cylinder core. When many cores are required of a box such as this, each half is reduced to about ⅜ in. thick all over, and iron castings made off them, suitable lugs or feet being cast on them, so that they will sit steady on the core-maker's bench.

A variation of the above method of making a corebox is shown by Figs. 12, 13, 14 and 15. Figs. 12 and 13 represent a pipe pattern, with the thickness of metal required sown. Owing to the irregular shape of the core, it would be difficult to make an accurate pattern for it, as was done for the former core, so a mold is taken of the entire pattern in the same manner as the previous corebox was cast; *a* (Fig. 15) shows one-half of the mould in section. Now prepare a board *b* (Fig. 14), and attach strips *c* to it. The strips must be the same thickness as the metal of the required casting. Procure some clay—either ordinary blue clay or modeling clay will do—work it up fairly stiff, put it on the board, and with a roller resting on the strips, roll it to the required thickness. Now cut it into suitably sized pieces and line each half of the mold, except at the core prints. Close the mold, stand it on one end, and fill it with plaster, which, of course, when hard, will be the shape of the required core. To prevent the plaster running out at the bottom of the mold, putty it round with some of the clay. As any roughness on the plaster core can easily be smoothed off, it is not necessary to be very particular in jointing the clay when lining the mold. When the core is finished and varnished replace it in the clay in one half of the mold, as shown at Fig. 15 (*a* is the mold, *e* the clay, and *d* the core). Cast the first half of the corebox; when hard, removed the mold *a* and the clay *e*, and proceed to cast the second half as described for the former corebox.

In conclusion, superfine plaster of Paris—to be obtained from plasterers, modelers or lime merchants—is the most suitable for pattern-making. To gauge or mix it, sprinkle the plaster into the water. Do not pour water into the plaster: it will be about the proper consistency when the plaster rises to the surface of the water. Stir well—there ought not to be any lumps—and it should coat any article dipped in it with a body like cream. Enameled iron or earthenware vessels are most suitable for gauging it in.—*The Model Engineer and Electrician.*

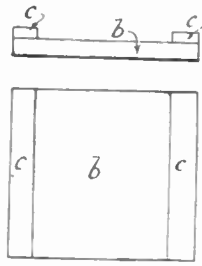


Fig 14

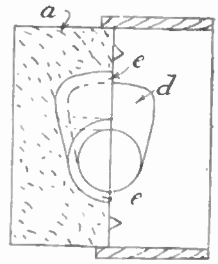


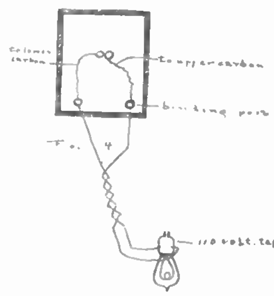
Fig 15

A HOME-MADE ARC LAMP

DOUGLAS HILLYER

Many electrically inclined experimenters have, at different times, desired to make an arc light, but, either from lack of material, "juice," or other reasons, have not been able to construct it. An arc light, as described herein, is very inexpensive, but at the same time, practical and instructive.

Fig 3



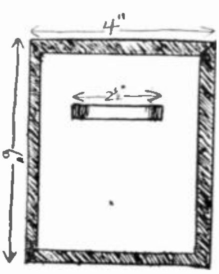


Fig 1.

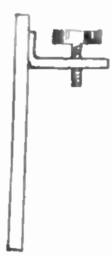


Fig 2.

The first thing necessary for its construction is enough hard fibre to construct the frame, or base.

The base is 6 in. long and 4 in. wide (see Fig. 1), and ¾ in. thick; 2 in. from the back an upright piece 5 in. high and 2½ in. wide is fastened (Fig. 1); ¾ in. from the top a brass strip ⅛ in. thick and 1½ in. long is fastened; ½ in. from the outer end of this strip a hole is drilled and tapped to take a thumb screw (see Fig. 2), with a shank ¾ in. long.

1¼ in. from this bracket, *i.e.*, below it, a fibre bracket 1½ in. wide and 2 in. deep is fastened, after drilling a hole in the centre just big enough to admit with some friction, a small pencil carbon, about ¼ in. in diameter; 1½ in. below this, another similar bracket is fastened,

Continued on page 163

MACHINE SHOP
THEORY AND PRACTICE

Edited by Oscar E. Perrigo, M.E.

THE CARE OF MACHINES

In the machine shop and the manufacturing plant it is safe to say that as many machines are permanently injured or disabled from doing first class work efficiently, by lack of proper care or by improper handling, as are worn out in legitimate use. In other words one-half the machines are *worn out* and the other half *spoiled by carelessness* and *abuse*.

And this does not refer to ordinary machines of moderate cost and value, but extends all the way through the list from the ordinary speed lathe, often costing less than a hundred dollars, to the largest planer costing from eight to ten thousand dollars.

The proper care of machines should be understood and practiced in a somewhat systematic manner, and therefore the various points necessary to be observed will be described in a similar way, so as to be more easily remembered.

If shop work and duties are attended to in a methodical manner and at regular fixed times, as far as possible, it will be found in practice that they are done much easier and that they are much more readily remembered. It must also be remembered that method and system do not mean red tape or fussiness. Neither is it a hair-splitting nervousness over unnecessary trifles or imaginary troubles, but means the giving of the proper amount of attention to real and necessary duties and to do this at the proper time.

To properly care for a machine and to keep it at all times in condition for efficient work is the duty of the man who runs it. Should any accident or break occur which he cannot readily make good he should report the fact at once to his immediate superior, usually the foreman of the room. If, for better supervisory control, the room has been divided, the different sections working under the supervision of an assistant foreman or "gang boss," the report will be made to him. His responsibility in this respect having been discharged the workman waits for orders.

Upon arriving at his machine in the morning it is the duty of the workman to quickly look over his machine and see that it has not been disturbed or changed since he left it the night before. He will then proceed to oil up the machine in all its wearing parts, cleaning out the oil holes where necessary, but always being certain that the oil reaches the bearing. He should have with him not only his oil can, but what is quite as necessary, a piece of waste, and wipe up all spots of surplus oil, since it looks very slovenly to have oil drizzling down on various parts of a machine.

If the machine is a new one, or one he is not yet thoroughly familiar with he should be very careful in looking for the oil holes so as not to miss any of them. There will be proper means provided for oiling all wearing surfaces, whether flat or cylindrical. Shafts will usually have at least two bearings, sometimes more, so that if one bearing is found he will always look for the other.

This duty having been done he will start up his machine slowly so as to ascertain if all the parts are in proper working condition, before putting the usual working load on the machine. In doing this he will see that no "feed" is on the machine, so that there may be no danger of breaking or otherwise injuring tools. The machine appearing to run properly he may put on feed and proceed with the usual work.

During the usual running of the machine he should be careful to notice that the bearings do not get dry from lack of oil and "cut" or "rough up," as this is a particularly unfortunate and sometimes expensive matter to put in proper order. This difficulty generally occurs in two classes of bearings: first, heavy bearings carrying large weights, as the front bearings of large lathes, boring mills, milling machines and the like; second, small and rapidly running shafts from whose bearings the oil works out rapidly. Loose pulleys are frequently troublesome in this way, particularly if running at high speed.

If the machine is a planer he will be careful to keep the V's or "ways" well oiled, using a thicker oil than on the other parts of the machine as these surfaces are subjected to greater pressure. If an unusually heavy load is placed upon the planer table some pulverized graphite or black lead should be mixed with the oil for the ways. This will very materially add to its "body" or its lubricating qualities under great pressure.

In a similar manner, but in lesser degree, attention should be given to the wearing surface on the ram of a shaper, particularly if it is a large one or is taking a proportionately heavy cut.

The wearing surfaces of the tables of milling machines, horizontal boring machines, and the like, will require but little lubrication, since their movements are very slow, and there is little tendency for the oil to work out.

The teeth of all metal gears should be oiled occasionally. If subjected to heavy pressure, heavy oil, or oil mixed with graphite should be used. Worm gears and spiral gears are always subjected to considerable friction and should be kept well lubricated. Frequently, the machine is so designed that these gears run in a bath of oil so as to insure their thorough lubrication.

Screws, particularly those of sharp pitch, should be thoroughly lubricated. These are conspicuous on the rapidly revolving feed screws of turret lathes.

During the "cutting time" of a machine there is generally ample time in which to keep the machine clear of chips and other refuse, and this should be attended to so that there will be no accumulations where they will be either troublesome or detrimental to the efficient working of the machine. This will be absolutely necessary in the use of jigs and fixtures, whether for milling or drilling operations, for the reason that accurate work cannot be done unless these accessories are entirely free from chips and dirt. If oil is used in the cutting operations the cleaning of the fixtures will be more difficult, but just as imperative. This cleaning should be done every time a piece is removed from the jig or fixture and before another piece is put in.

While giving attention to his machine the workman should not neglect his other immediate surroundings, but keep the tools and fixtures in good order and condition when not in use, and the material or pieces of work in progress properly cared for and arranged in a neat and orderly manner.

The floor and such benches, racks and other conveniences under his charge should always be kept free from dirt, chips or similar obstructions and always in proper condition for use, with a special place for such tools and machine accessories as belong to the machine, in their proper places and readily found when needed.

Proper attention to the foregoing paragraphs will develop the methodical workman, prompt and efficient and always ready for any duty that he is called upon to perform. Hence, the successful workman upon whom the management can always depend.

The Value of an Exchange of Ideas

It is a noticeable fact that among practical mechanics, those who work at the bench, those who stand day by day at the machines, and those who as foremen have the active direction of every day's work, the features of a mechanical publication which are intended to give "the greatest good to the greatest number" are liable to be more or less misunderstood.

The "letters upon practical subjects" are generally from men of ripe experience who endeavor to write on such matters as may be useful to many of the younger mechanics who are ambitious to profit by the experience of their elders, as well as to "find out things for themselves," frequently seem to them to be written "to fill up," or to "get their names in print." Probably nothing could be further from the writer's thoughts.

Those who write these letters generally have something to say worth reading by a large number of people. They do not aim to write of matters absolutely *new*, or of subjects upon which no one has ever written before. Very few things are really new. Solomon said there was "no *new* thing under the sun." But there are a great many things learned by experience that are of considerable benefit to younger students and mechanics.

We often hear the remark by experienced men in the shop: "Why, I see lots of things in that magazine about my business that I knew twenty years ago. I don't see anything new in that, and never thought any one would think of writing about such a simple thing."

The good man forgets that while many of these things are not new to *him*, there are hundreds of younger men in the business to whom they *are* new, and who gladly avail themselves of the opportunity thus afforded to get new ideas. The articles were not written for the older men who *know*, but for the younger men who do *not* know.

The older and more experienced man might as well say to the young, "What is the use of studying school books? We knew all about the subjects in them years ago." Certainly, but there are thousands of young persons growing up who do not know these things and must learn them, and the school teacher might as well say, "Everybody knows the things I teach, why should I go on teaching the same things year after year?" Simply because *everybody* does *not* know these things.

It would seem to be the duty of those who have through education and experience learned of these matters to "pass along" the information to the many younger persons who have not had their experience and to many who have not had their opportunities.

And it would seem to be a most worthy ambition on the part of the editors of mechanical papers to try to teach practical matters to practical young men and thus extend "the greatest good to the greatest number," as well as to record the new discoveries and inventions and to produce wise desertations on deep and erudite subjects.

Laying off Angles

A recent article says that "there are many ways of laying off an angle, such as by means of different instruments, but the average person does not need such great precision as when a transit or compass is used, or does he have them if he should need to use them. There is a very simple way of laying off angles

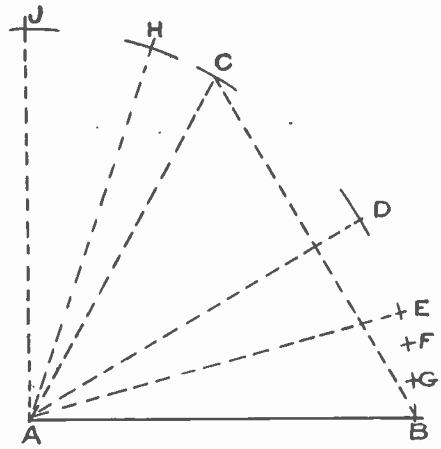


Fig. 1.

to a large scale in which a 100 ft. tape line and a few surveyor's pins are used;" and then cheerfully proceeds to needlessly revel in somewhat intricate geometrical problems, and in the end does not carry the work through to a practical conclusion.

If really simple methods and yet comparatively accurate results are desired, there is no need of elaborate calculations, just a little mental arithmetic and common sense, and we can lay off any angle, by using degrees, as follows:

Assuming that the lines are of such length as to require a 100 ft. tape line, let AB, Fig. 1, be the original or base line. Place a pin at each end of the line. At C place another pin at equal distances from both A and B. This forms a triangle of 60 degrees at each angle, or an equilateral angle.

Now if we set a pin at D at the same distance from A that B and C is, and also at an equal distance from B and C, we have an angle of 30 degrees.

In like manner we may set pins at F and G, dividing the distance from B to E in three equal parts, being careful to have the distances from A to E, and from F to G equal to that from A to B. This gives us three spaces of 5 degrees each.

The distance from B to G may be divided in 5 equal parts, which will be degrees. This will give us degrees from 1 to 5. Also 10, 20 and 30 degrees. Having single degrees which we may add to these we lay off any angle up to 60 degrees. If we desire to lay off an angle greater than 60 degrees, such portion of the angles already found may be added to the 60 degrees at C. For instance, if 70 degrees are required we set a pin at H, distant from C equal to the distance BF (10 degrees), being careful that its distance from A is equal to the distance AC.

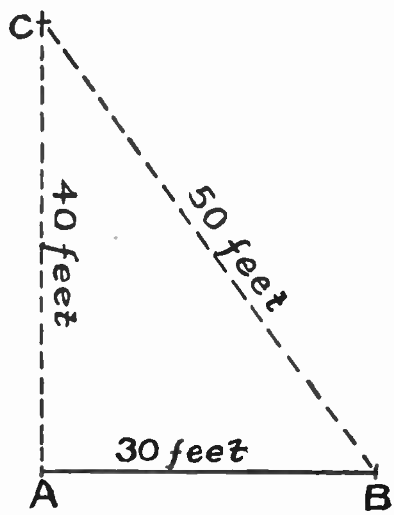


Fig. 2.

If a square corner, or 90 degrees is required, we add from C the distance from B to D (30 degrees), setting the pin at J, with the distance AJ equal to AC.

There is, however, a much shorter method of laying off a square corner, or right angle, of 90 degrees. Suppose the point A, Fig. 2, is to be the corner. Measure along this line 30 ft. to B and set a pin. Measure from A to C, 40 ft. and set a pin. Measure from B to C 50 ft., moving the pin at C to the right or left until the distance is correct. Measure again from A to C to make sure that the distance is exactly 40 ft. and if so an exact right angle is produced at A.

In laying out angles it does not matter what sort of a measure is used, whether a tape line, a 10 ft. pole, a 2 ft. pocket rule or a draftsman's scale, anything which is graduated in equal parts, as feet, inches or any other dimensions, the kind of measure being adapted to the size or extent of the work, from laying out a piece of land, the corner of a building or the angle on a drawing, since the principles and methods are the same in all cases and so plain and simple that a school boy can readily understand them.

MACHINE SHOP PRACTICE—Part IV

The Milling Machine

P. LE ROY FLANSBURG

We have seen in our previous articles on "Machine Shop Practice," that in the case of the Planer, the work traveled horizontally toward the fixed tool; in the case of the Shaper the work was held stationary while the fixed tool traveled across it, and we shall later see that in the case of the Lathe, the work revolves while the tool is held stationary. In the Milling Machine, however, we find that two of these motions occur; namely, the work travels while the tool revolves.

The principles of the milling machine have been known for a very long period of time, but it was not until milling machine cutters could be correctly and cheaply produced by means of emery grinders, that the present form of milling machines was introduced. We see

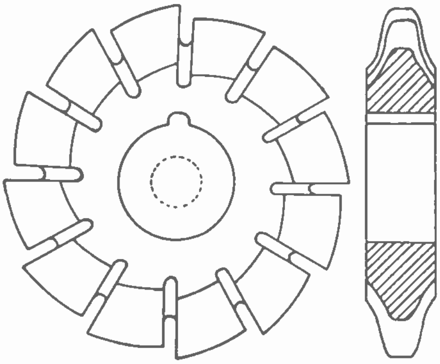


Fig. 1

the same primary principle in the action of the circular saw that the revolving milling cutter possesses and it is highly probable that the earliest form of a milling machine was but a hand lathe in which was mounted a circular saw, ground and hardened to cut metal.

It is easily possible with the modern milling machine to exactly duplicate pieces of work and this is the chief advantage that the machine possesses.

In the process of making cutters (or "mills," as they are sometimes called); the "blank" used to form the cutter is turned to the correct diameter while yet soft. The teeth are then cut and the blank is tempered to a straw color. After the blank is tempered the edges of it are finished by grinding them with a small emery wheel. A space is allowed between each two teeth to permit the admission of the small emery wheel which is used in grinding the faces.

The cutters (or mills) are keyed to a mandrel or cutter spindle which is either rotated between centres or else one end of the mandrel (or spindle) is fastened to a catch plate while the opposite end is centered.

Because of the facts that the same cutter is used both for various materials and also for pieces of work not of the same character, it is impossible to give any very definite rules either for the angle of the cutter tooth or for the speed at which a cutter should be run. However, good practice for ordinary size cutters is as follows:

Angle of relief........... 10° to tangent
Cutting angle........... 80° to tangent
Front rake............... 10° to radius

These angles give a tool angle of about 70 degrees. Small cutters are made with radial teeth, corresponding to a cutting angle of about 85 degrees or 90 degrees. On a finishing tool, the teeth should be cut either obliquely or spirally and given a side rake, 10 degrees.

Very often difficulty is experienced in hardening milling cutters without cracking them. The cause of this cracking is found to be largely due to unequal heating as well as to unequal cooling. To overcome the effects due to unequal heating, a bath of molten lead kept at a very high temperature is often used.

In practice there is quite a variation as regards the speeds at which cutter tools are used. The following list gives the result of experience and is fairly correct.

	Roughing Cut	Depth of Cut
Machinery steel	35 ft. per min.	1/16 in.
Wrought iron	40 ft. per min.	1/16 in.
Cast iron	55 ft. per min.	3/16 in.
Gun metal	80 ft. per min.	3/32 in.
Brass	90 ft. per min.	3/32 in.

The travel of the work while taking these cuts should be about 1½ in. per minute. When the finishing cut is taken, the speed of the cutter should be increased about 10 or 15 ft. per minute.

Fig. 1 is a mill which is used for cutting spur wheel teeth.

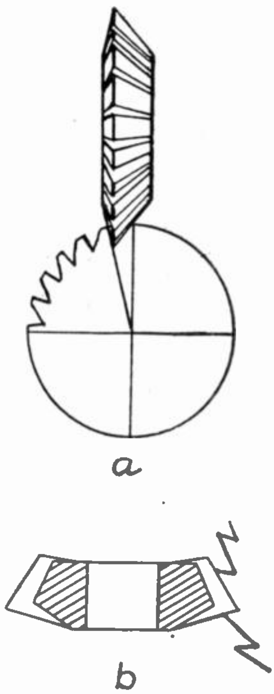
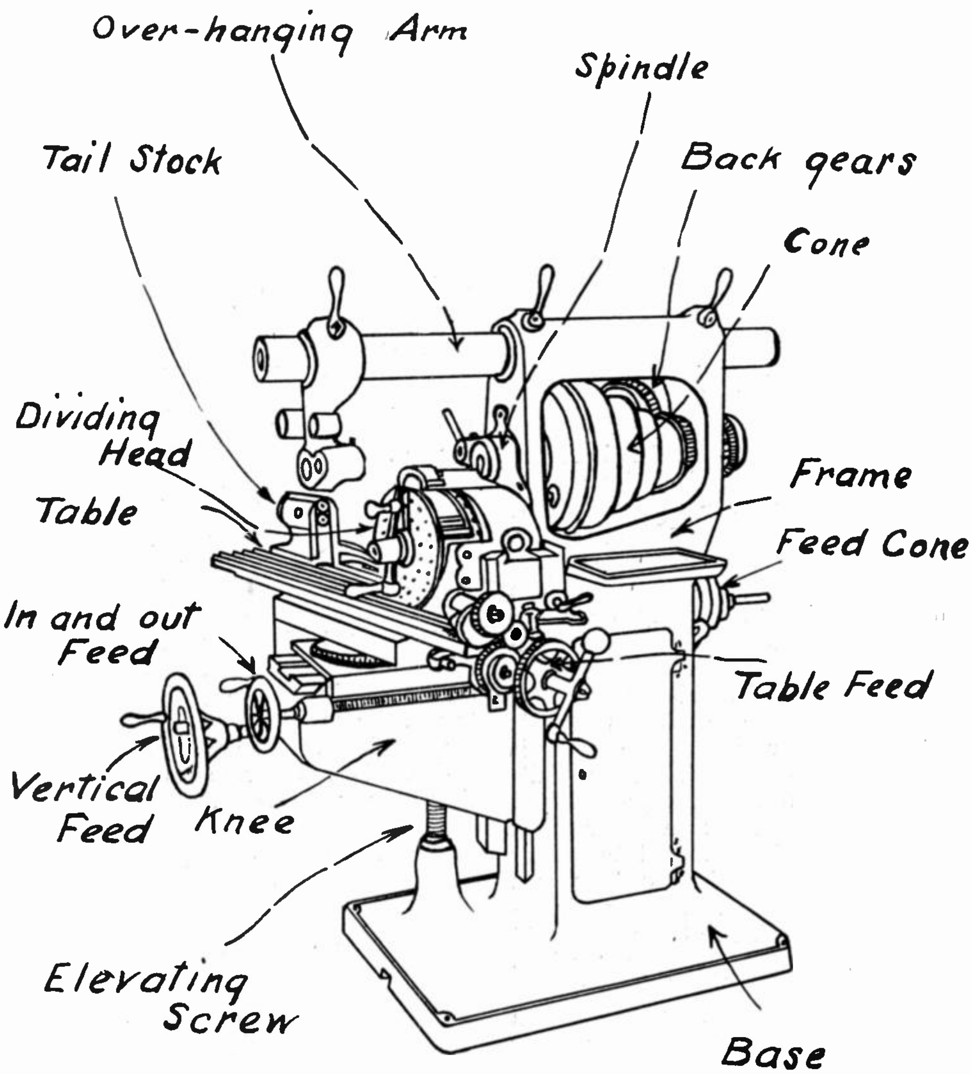


Fig. 2



The Milling Machine

When feeding work to a milling cutter always make sure that the direction of motion of the work is the reverse of that of the cutting tooth. If you do not take this precaution, the cutter will ride upon the work with a great deal of pressure and the chances are that its teeth will be broken. Also care must be taken, where a helical cutter is used, to make certain that the direction of the helix is such as will force the cutter on and not off the spindle.

The milling machine has been found so useful that heavy milling machines are being manufactured to supplant planers, shapers and slotters, even for ordinary unrepeated work. Fig. 2 shows an angular mill used for cutting the teeth of other mills. Fig. 3 shows a mill which is being used for grooving a screw tap. Fig. 4 shows a mill being used to flute a rimer.

One of the most common types of milling machines is the "Universal Milling Machine." This machine was invented by an American. Other forms of milling machines are the "Profiling Machine" and the "Vertical Milling Machine." The profiling machine is usually small and has a vertical mill traversed by a hand lever which allows it to be used for intricate pieces of work.

In the vertical milling machine the spindle to which the cutters are fastened is vertical while the table is given two separate feeds, the one traverse and the other circular.

One of the common uses of a milling machine is to cut spirals as for instance

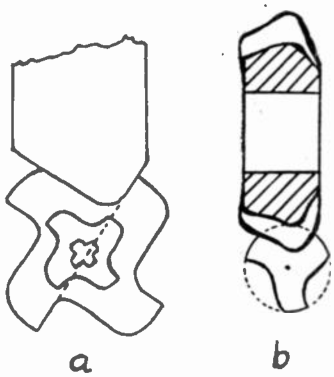


Fig. 3

in the "fluting" of an ordinary twist drill. Before beginning the work of cutting the spiral the "lead" of the spiral must be determined. For instance, if a bolt has 10 threads per in. each revolution of its nut must move it $\frac{1}{10}$ in. This is called the lead and must be calculated in order to cut the spiral. The lead of the spiral really corresponds to the axial distance between centres of two threads of a screw.

One of the common ways to calculate the lead of a spiral is to set the table at an angle corresponding to the one between the development of the spiral and its axis; namely, let the base of a right-angled triangle be equal in length to the lead, given by one complete turn of the spiral and let the circumference at one-half the depth of the spiral groove, equal the perpendicular leg of the triangle in length. Now, after drawing the hypotenuse of the triangle, measure the resulting angle between the base and the hypotenuse and this will prove to be the angle at which the table of the machines should be set. In order to select the change-gears, reference may be made to a "Table of Leads." When the work of milling the first flute has been completed the piece of work may then be indexed and turned in the regular way.

For pieces of work which are too small to be fastened directly to the table of the machine, or to facilitate the setting

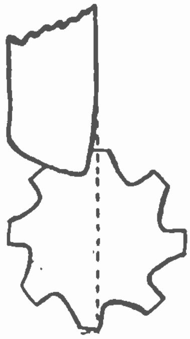


Fig. 4

and re-setting of work, the machine vise is a most useful appliance. This vise is either the same or similar in design to those which are used on shaping and drilling machines. When a vise is used, care should be taken to see that the piece of work is firmly bedded on the surface of the vise. This is of the utmost importance.

A dividing head is used on a milling machine in order to allow the piece of work to be turned exactly the desired amount each time. The small holes in the dividing head, represent various exact divisions of its circumference, and by allowing a pin to enter these holes it is easily possible to set the spindle in the desired position. Knowing the number of spaces in the wheel to be cut, or flutes to the rimer, the dividing head (or plate), can be placed in each position, in turn, and a cut taken.

A Home-Made Arc Lamp

Concluded from page 156

after being drilled to admit another pencil carbon. This will complete the frame which will then look like Fig. 3.

The carbons are connected by wires to binding posts on the base, and from there to the 110 volt a.c. main as in Fig. 4. The lower carbon is stationary, but the upper one may be lowered by the action of the thumb screw.

A reflector placed behind the arc, on the back, throws the light ahead. This little arc light, though simple, gives a brilliant, white light, steady and penetrating, and will light a large room, may be used for a searchlight, stereopticon, and many other things. It is of the hand-feed variety, and this is easily operated by any one.

EDITORIAL

On another page will be found the announcement of the change of both size and price of the *Electrician and Mechanic* which we intend to make on the first of January, 1911.

A change in the size of the magazine has been contemplated for some time, for each month we have had to crowd out articles which we should have liked to give to our readers, but could not do so because of limited space. Then when it was decided to add more pages to each issue we found that unless we raised the price of the magazine the increased cost of its production would prohibit its enlargement. Hence the new selling-price, 15 cents per copy, $1.50 per year. We give all of our readers and subscribers, however, a fair chance to subscribe now for as many years as they wish, at the rate of $1.00 per year, with the understanding that the subscription is to begin when their present one expires.

The Harvard–Boston Aeronautical meet is now taking place as this issue goes to press, and of all the awe-inspiring sights, the flight of the "Man-Birds" is the greatest we have ever beheld. To see three and four machines in the air, dipping and soaring, as gracefully as any gull, as the fliers did on Labor Day, was a sight which will long be remembered by those who were fortunate enough to be present. C. Grahame-White won the plaudits of the audience time and again with his skillful flying, both in his Farman and Bleriot machines, and his bomb throwing was almost perfect.

Curtiss in his speedy little racer also won his share of applause by his skillful manoevering. An eye-witness of the flights would say that flying in heavier-than-air machines is a very simple thing to do, judging by the ease in which the various aviators handled their machines. At one time, C. Grahame-White passed by the grandstand waving both hands to the cheering multitude beneath him.

For beauty and gracefulness the Bleriot machine of Grahame-White is the best of them all. When up in the air, at a distance far enough away to hide the various braces and guy wires, the machine looks for all the world like some enormous dragon fly.

We would like to hear from those of our readers, whether subscribers or not, as to the addition of a regular Aeronautical Department to our magazine. We have for some time published practical articles pertaining to the art of flying, and if we find the interest sufficient, we will be glad to introduce a complete Department of Aeronautics. Let us hear your views on the subject.

We would like to call attention to the fact that in sending in questions to be answered in our department of Questions and Answers, the writer must attach to each separate sheet of questions his name and address. When you write us, enclosing other matters besides your questions, it must be remembered that part of the letter goes to one department, part to another, and hence if the name of the writer is not placed on each sheet confusion and trouble are bound to arise.

We are always glad to receive suggestions from our readers as to improvements which might be made in the *Electrician and Mechanic*. We are always searching for new ideas. If you have a desire to see some new department in our magazine let us know of it. We have spoken above in regard to the establishment of a Department of Aeronautics, and if we find that a sufficient number of our readers are interested we shall act accordingly. But if you are not interested in aeronautics, let us know in which direction your tastes do lie.

The *Electrician and Mechanic* will be represented at the coming Boston Mechanics' Exposition, October 3–29, 1910, to be held at the Mechanics Building on Huntington Avenue. Here the *Electrician and Mechanic* will be glad to welcome all of its friends and subscribers. We intend to have an exhibition which will be of interest to many of our readers, announcement of which will be made later.

WIRELESS TELEGRAPHY

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

A COMPACT WIRELESS RECEIVING SET

EDWARD H. GUILFORD

Some time ago the author had occasion to design and construct a receiving set of wireless telegraph instruments, the main requirements being that compactness and a saving of space should be secured, together with the fact that the set should be light enough to be used as a portable set should the occasion for so doing arise. The following is a description of the result of his labors, the outcome of which was highly successful. Needless to say, the set was comprised of the most up-to-date instruments, a fact which was verified when it was awarded first prize for wireless instruments at the Boston Electrical Show.

The set is composed of the following instruments: tuning coil, doughnut transformer, two variable condensers,

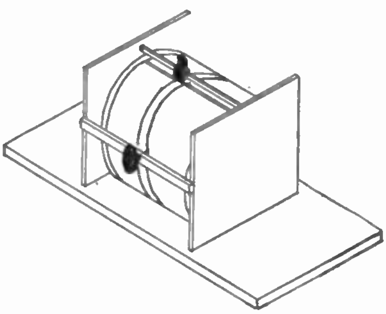
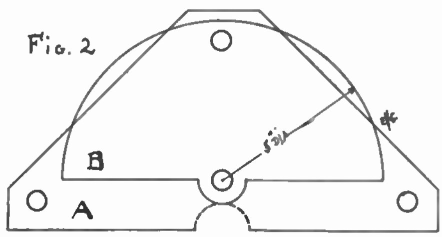


Fig. 1

potentiometer, and various switches so arranged that a number of different receiving systems might be followed.

The tuning coil and doughnut transformer are complete in one instrument, and are the same as the instrument described under the heading of "A Doughnut Transformer," in the November, 1909 issue of the *Electrician and*

Fig. 2



Mechanic. The cut, Figs. 1 and 2 show the transformer and its method of construction, but two sliders instead of one, as the drawing shows, are used. Further details of the method of construction of the tuning coil and transformer may be readily obtained in the above mentioned issue of this magazine.

The potentiometer is of the usual design; a cylinder of wood or cardboard is wound with a layer of No. 22 German silver wire, about 40 ft. of wire being used. The coil is about 8 in. long, and 1 in. in diameter, and just before winding, is covered with a thick layer of shellac. This provides a firm bed for the wire to become set in and at the same time provides a means of insulating each successive turn of wire. The potentiometer was wound in a screw-cutting lathe and each turn of wire was accurately spaced from its neighbor.

The variable condensers, of which there were two, were alike in design, but one had just twice as many movable (12) plates, and hence twice the capacity of the other. The stationary plates, Fig. 2, *A*, were cut with a pair of tin shears from sheet aluminum about 1/32 in. thick. The holes were bored after all the plates had been cut out and assembled in a bunch. The movable plates (5 in. in diameter) were shaped according to the design shown in Fig. 2, *B*, and were also cut out with tin shears. The edges were smoothed with a file after the plates had been stacked into a pile. Both the stationary and the movable plates were accurately spaced the same distance from each other by means of small sections of brass tube, Fig. 3, all cut to the same length. A more detailed description of the construction may be had from the author's article under the heading, "A 1,000 Mile Wireless Station," published in the February, 1910, issue of the *Electrician and Mechanic*.

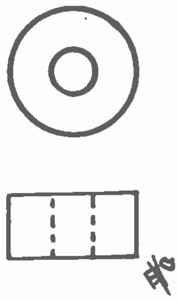


Fig. 3

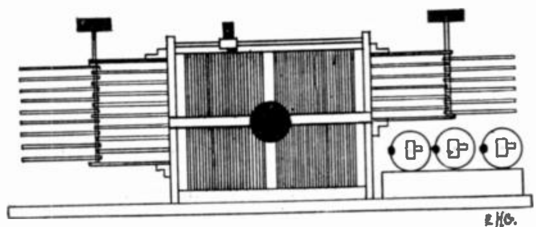


Fig. 4

The instruments were assembled as shown in Figs. 1 and 4, the doughnut transformer being placed exactly in the middle of the base board, with the condensers hung by means of brackets from the ends of the transformer. The space under one condenser was used to set a fixed condenser and three batteries, while a compartment for the telephone receivers was placed underneath the other condenser. Access to both the phones and the batteries was obtained by placing two small doors in the front of the mahogany case, as shown in Fig. 5. This construction might be improved by making drawers of the proper size to open out in place of the doors.

The case itself measured 20 x 8¾ x 8 outside dimensions, while the cover measured 20 x 8¾ x 3. Fig. 5 gives a good idea of the set looking down upon it, and also a side view. The cover is not shown. With the exception of the bottom upon which the instruments were placed, the case was made of mahogany ⅜ in. thick, the cost of the wood alone amounting to a little over three dollars. The top of the case was fitted with a mahogany board, through which slots and holes were cut for the sliders of the tuning coil and the handles of the condensers. The cover was used solely for the purpose of protecting the top from injury and dust. Fig. 6 shows the case with the cover down. The bottom of the case was made to fit in such a manner that it rested inside the box, as did also the top (not the top of the cover but of the *case*). Thus by loosening the screws which held the top and bottom in place the case itself could be lifted away from the instruments without disturbing the wiring. This allowed the operator to examine the instruments and make any changes he might desire. Fig. 4 gives some idea of the set with the case removed. It does not, however, show the top of the case through which the handles and slider project and upon which was placed the various controlling switches and the potentiometer. The wiring was all done inside the case, none of it showing from the outside.

Fig. 5 gives a good idea of the layout of the top of the set. At the back are the double throw double knife switch, for changing over from the tuning coil to the doughnut transformer; the potentiometer, switches for breaking the battery circuit, and of the testing buzzer. In front of the potentiometer are the two slots through which project the handles which operate the sliders of the tuning coil. In front of these slots are the switch and contact points, by means of which the number of turns of wire on the doughnut are varied. At the end of the top, to the reader's left, are the binding posts for the aerial and ground, the handle which is used to turn the condenser.

At the end of the case, to the reader's

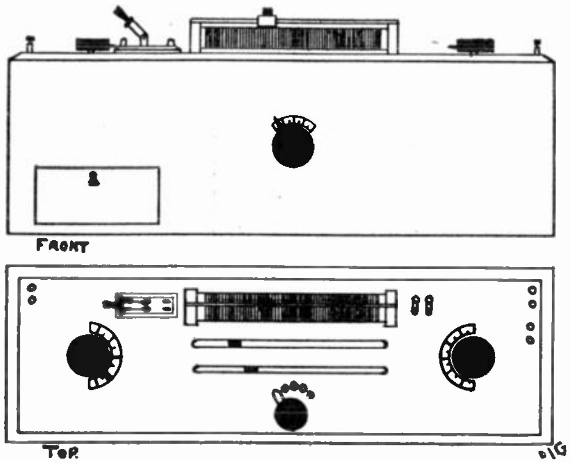
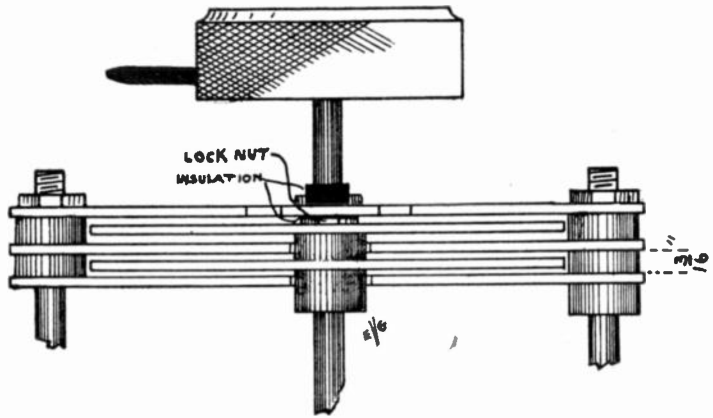


Fig. 5



SIDE VIEW OF CONDENSER. PARTLY ASSEMBLED

Fig. 9

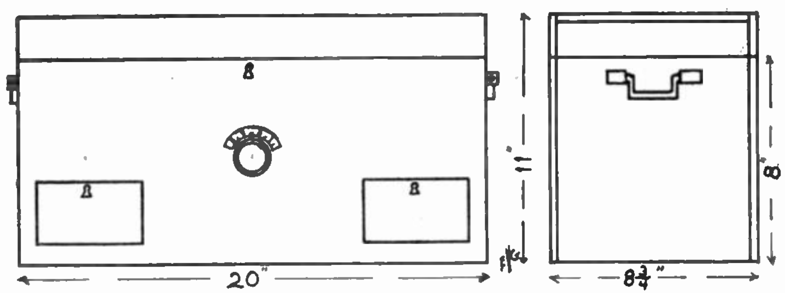


Fig. 6

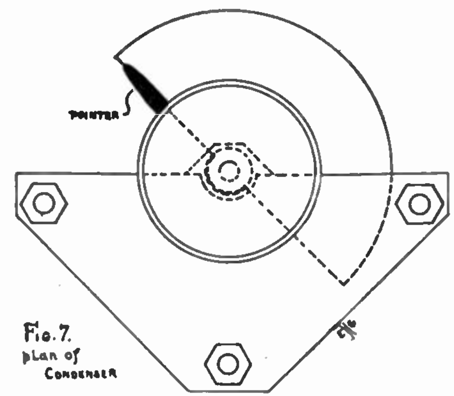
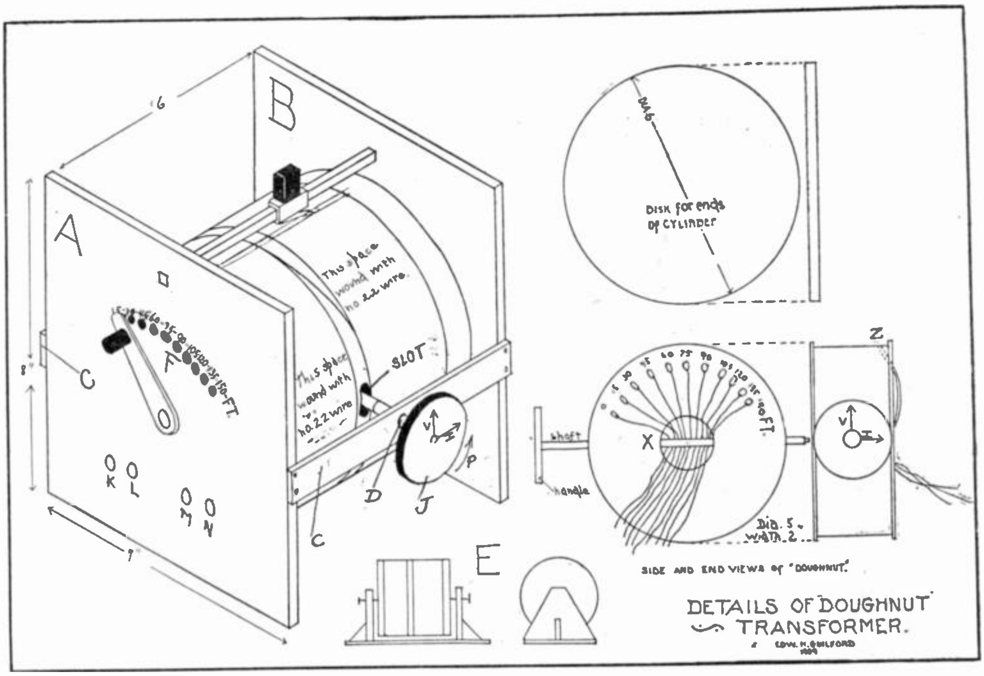


Fig. 7. plan of Condenser



right, may be seen the binding posts for the telephones and the detector, and the handle for turning the variable condenser. Thus any detector and any make of telephone may be used. If the detector is one which does not require a battery, the switch at the end of the potentiometer may be thrown over and the battery current cut out. In front, the handle of the secondary of the transformer projects through. When

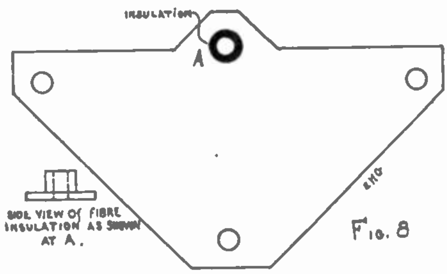


Fig. 8

it is desired to move the set this handle may be unscrewed and put inside the case, thus protecting it from injury.

For all "listening in" the tuning coil is used, for it does not tune sharply and hence distant stations may be heard if the receiving instruments are slightly out of "tune" with the wave length of that station. When the operator desires to cut out interference the doughnut transformer is thrown into circuit. This particular type of transformer tunes very closely, and the beginner may at first have some difficulty in "picking up" the desired signals, but a little practice will soon enable the operator to do good work with it.

It has been the author's idea to give the main details of the construction, leaving the minor points to be worked out by the reader. There are two good reasons for this: first, a greater number of the more important details of design and construction may be set forth in a given space, and second, the reader usually has already discovered a way of doing actual construction, such as winding coils, making sliders, etc. Even the details given above may be altered within certain limits to fit the reader's own requirements.

The hydraulic turbines at the Feather River station of the Great Western Power Company of America are considered to be the most powerful in existence. When running under a 525 ft. head at 400 revolutions per minute, they are rated at 18,000 h.p. each. Under the reduced head of 420 ft., each turbine develops 14,000 h.p.

CONSTRUCTION OF AERIAL TOWERS FOR WIRELESS TELEGRAPH STATIONS—Part II

W. C. GETZ

All the dimensions as given on the drawings have been carefully figured out, and the experimenter should have no difficulty in putting these together.

In Fig. 8 is given the manner of placing the masts prior to raising. In this case it should be stated that the strain on the masts should always be in line with the joints. In other words, looking at Fig. 7, we are looking at right angles to the facing of the joints, so that in placing that mast and tower in position we would want the other mast to the right or left of it and not towards us.

Towers in Position to Raise

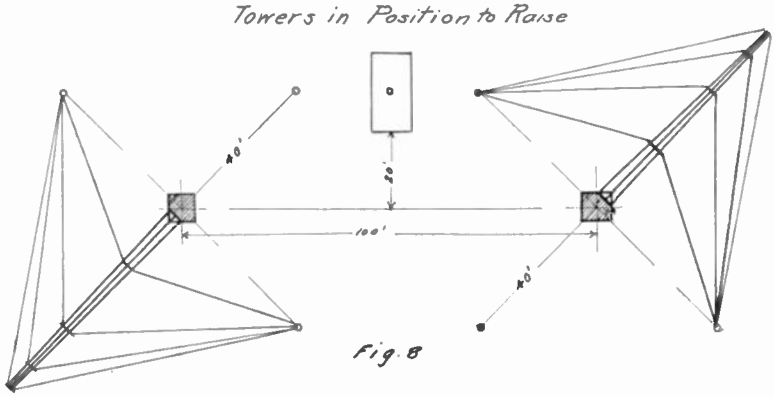


Fig. 8

W. C. G.

In Fig. 8 the guy points for the towers are also shown. The guy points are four in number for each tower, and are placed on a 40 ft. radius from the tower. It will be noticed that these guys are 45° on either side of the line of the aerial, and when placed this way there is less danger of interference with the aerial in raising or lowering same.

The towers, after being constructed, are carried to the positions as shown, the channel corner of the concrete base being on the side near the tower. Two heavy blocks of wood are then bolted to the base of the tower so that the end of one block may be fitted in the channel and having a 2 in. hole bored in it, the pin previously mentioned may be inserted, and thus making a hinge, the tower being one side, as shown in Fig. 9.

We will now consider the guying as the guys must all be placed in position before raising. Referring again to Fig. 4, we find that each corner of the tower has four guy-wires and the mast two, lettered from *a* to *f* inclusive. In order to eliminate inductive effects, these guys are broken at suitable intervals and strain insulators are inserted. In this case the insulators are inserted approximately at every 20 ft. The accompanying table gives full information as to the size of guy-wires, length, etc., number of insulators, type and all information the experimenter requires at this point.

The electrose insulator was specified, as it is believed to be the most satisfactory type for wireless installations as yet devised, and is superior in all respects to the hard-rubber insulators formerly used in many stations.

In Fig. 10 is shown an electrose insulator cut into a guy-wire near the guy-anchor. This is one of the four guy wires that hold the wireless tower at Fort Levett, shown in the previous photograph. The heavy guy-wire is carried through the end of the insulator and is then bent back and held in place with two "Crosby" clips. The anchor is equipped with a turn buckle for tightening up on the guy-wire. A "missing-link" is used between the insulator and turnbuckle so that the eye of the turn buckle would not have to be opened to insert the insulator.

Fig. 11 gives a sectional view of this

GUY WIRES AND STRAIN INSULATORS FOR AERIAL

Letter of Guy	Perpendicular Distance to Ground	Guy Wire Required Per Guy	Guy Wire Required Tower	Guy Wire Required Total	Size Wire	Weight Per Guy	Approx. Cost
a	20	45	180	360	12/32	15 lbs.	$7.20
b	40	57	228	456	12/32	17 "	9.12
c	55	70	280	560	8/32	10 "	
d	60	72	288	576	8/32	10 "	23.50
e	80	106	424	848	8/32	15 "	
f	100	108	432	864	6/32	8 "	6.91

Letter of Guy	Maximum Allowable Strain	Electrose Insulators Total Number Required	Electrose Insulators Type Number	Size	List Price
a	4,700 lbs.	8	44	2½ in. x 11½ in.	$30.00
b	4,700 "	16	44	"	
c	1,750 "	16	17	1½ in. x 10½ in.	
d	1,750 "	16	17	"	27.75
e	1,750 "	24	17	"	
f	1,000 "	32	71	1½ in. x 5½ in.	7.60

type of anchor. When properly made this type of anchor has very great holding powers. The bottom of the hole for the anchor should be at least 5 ft. below the surface of the ground.

The W. N. Mathews Co., of St. Louis, Mo., also make an excellent type of anchor, known formerly as the "Stombaugh" anchor, which is largely used by the telephone and power companies for guying heavy pole lines. They recommend their 10 in. and 12 in. types of anchor for wireless towers. The 12 in. anchor has a safe holding power of 1,000 lbs. in ordinary earth, when buried all the way. As our towers each weigh over 1,500 lbs., two of these anchors should be used on the end where the lifting tackle is to go, and one is sufficient at each of the other guy points. The feature of the Stombaugh anchor is that it can be screwed down into the earth without digging a hole, unless there is exceedingly rocky ground. The earth should be carefully tamped around the anchors, no matter what style is adopted.

Having placed our guy-wires with

Method of Raising Towers.

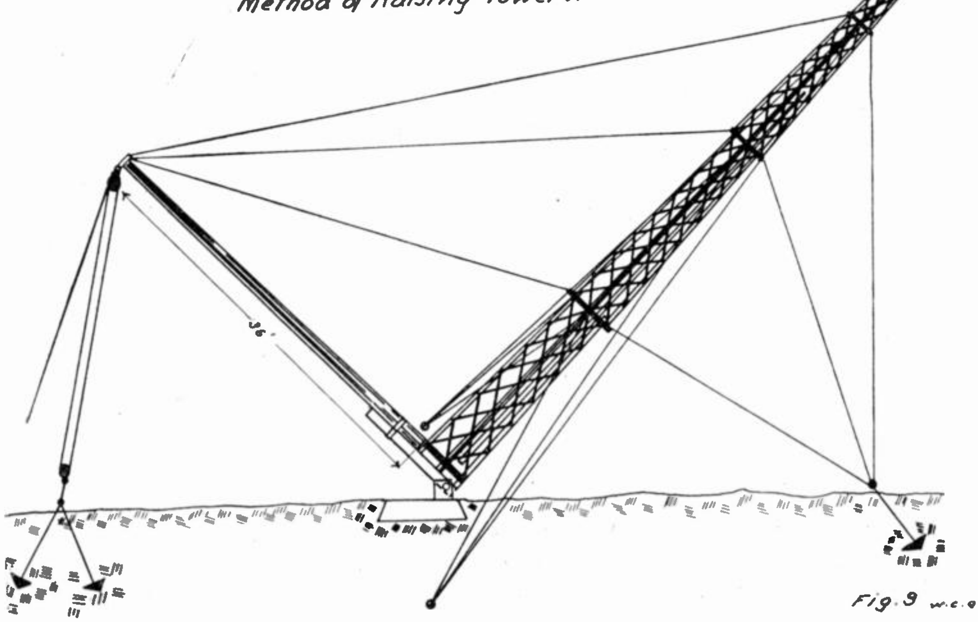


Fig. 9 W.C.O

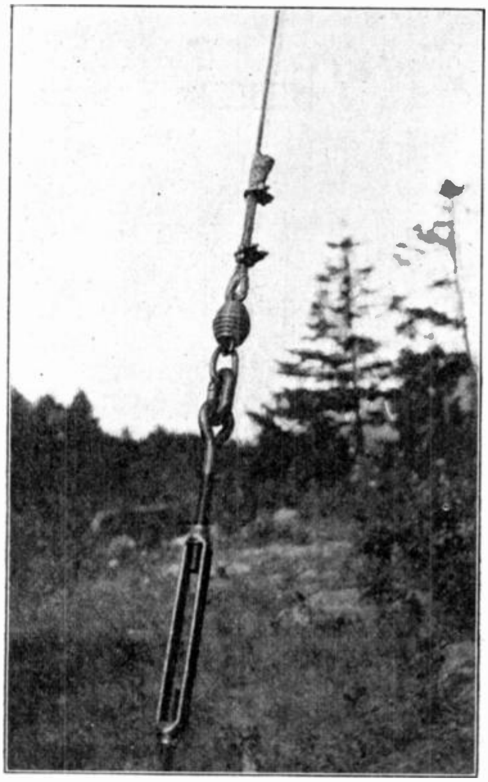


Fig. 10

the insulators inserted as directed and planted our anchors at each guy-point we then fasten the two sets of side guys to their respective anchors, as shown in Fig. 8. Then we secure a stout telegraph pole, 35 or 40 ft. long, and lash it upright to the base of the tower as shown in Fig. 9. The front guys we carry to this pole, and stretch them so that they will be equally tight when the strain is put on them. From the end of the pole we fasten a block and tackle (using at least a 2 in. rope and triple blocks) to the two anchors previously set. The free end of the rope may be also fastened to a chain-block, and one man will then be able to raise the tower with but little difficulty.

A man should be stationed at the back guy point to slowly let out the guy wires from that place as the tower ascends. Our 46 ft. mast has been laid inside our tower before raising. This is shown in Fig. 9. Slowly raise the tower by gradually pulling down the telegraph pole with the tackle. After the tower has been raised to about 60° to the perpendicular, the man at the back guy-point should make his guys pass through his anchor, so in case the mast should tend to fall over forward he would be able to stop it.

The side guys being placed before raising, there is no danger of any tendency to fall that way.

The importance of having all the front guys brought up tight to the raising pole cannot be too greatly emphasized, as any slack in one of them would impose an unequal strain on all the others causing, perhaps, the tower to break at that point.

The towers being in position, all guys should then be made fast to the anchors, and the pole used for raising removed. The tower can be straightened up perfectly by letting out a little on one set of guys and taking up on the opposite set, until it is perpendicular. The tower is then strong enough to support several men on top; but as only one man is needed there, he can go up and make ready for placing the mast in position on top of the tower.

Now, as the mast was placed inside the tower before raising, it is in an upright position ready for raising. To the point *L–J* at the top of the tower, place a block, and tie one end of the rope to the base of the mast. The other end of the rope can be handled by a man on the ground, and the mast is slowly raised, the end being passed

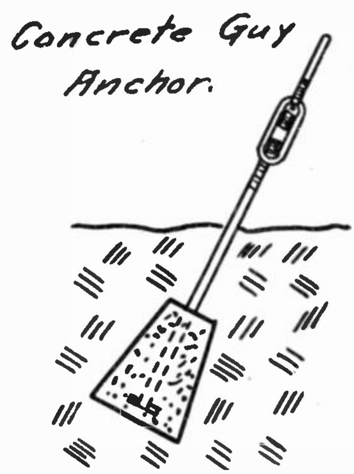


Fig. 11.

through the braces at G–H and the blocks at I–J. A ring should be procured, as shown at Fig. 11, and this placed on the top of the mast, and made fast. A pulley and halyard should also be fastened to the ring at this time.

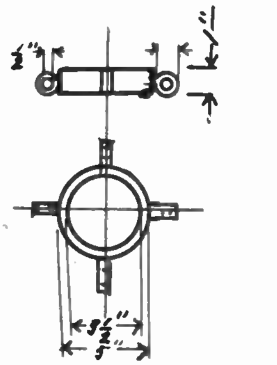
The pulley should be a heavily galvanized iron type, and the halyard a 200 ft. length of ⅜ in. rope, the free ends being spliced after passing through the pulley to prevent them from getting loose.

Before placing this ring on the pole a ring similarly made, but about 5 in. in diameter (inside), should be slipped on the mast. This is for the *e* guys at the 80 ft. point.

Having made the top ring fast and placed the pulley and halyard, after painting the iron work, fasten on the four top guys to the respective eyes in the ring. A man at each guy point below, should pay out these guys until the mast has been raised 20 ft. when the other guy-ring is made fast, and the *e* guy wires affixed to that. The mast may then be raised until it has reached its right height. The man on the tower should then tighten up the braces at G–H, and then after truing the mast up, as we trued up the tower, make fast the blocks permanently at I–J.

The guy-wires can then be made fast and this tower is ready for the aerial wires. Proceed with the erection of the other tower in the same manner exactly.

We will now consider the aerial wires. As we have decided on a flat top aerial, and have situated the towers equidistant



Guy Ring.
Fig. 12 W.C.G.

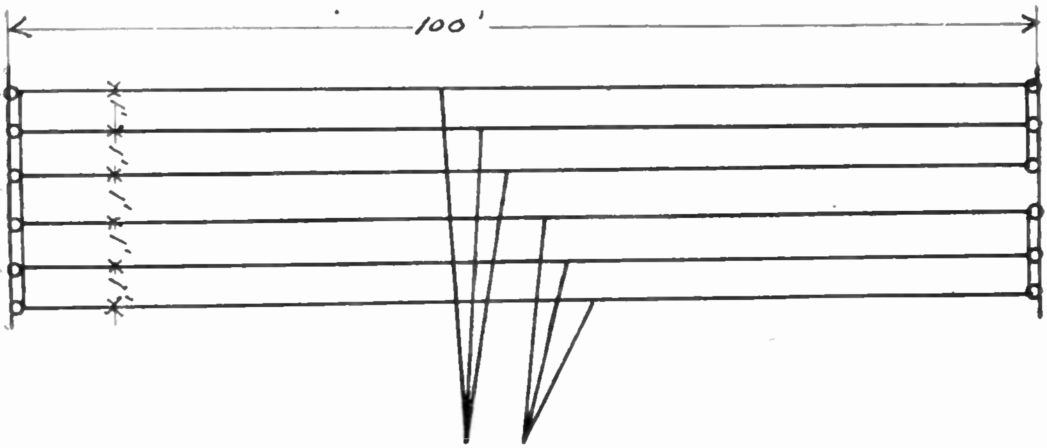


Fig. 13.

on either side of the station, we can have either a "T" or a "7" aerial. As a "T" aerial looks more symmetrical we will adopt that form, as shown in Fig. 4. In Fig. 13 we are given the diagram of the aerial. As is seen, the vertical risers and one-half of the horizontal aerial form a loop, while the other half of the horizontal aerial is left as free ends of two sets. This may be changed to suit the experimenter.

(*To be continued*)

Soldering Fluids

Many of the soldering fluids in common use are injurious to tools, as well as to parts that have been laid on the bench where such fluids have been used.

REFLECTION OF ELECTRIC WAVES

It is hoped that this explanation will answer the question (see August number) which has arisen as to the change in strength of the signals sent out from the New York wireless stations.

It is obvious that some force or property is working upon or against the electric waves of these stations. Now it seems probable that this change is due to one or more of the following reasons,—reflection, refraction, or absorption. Eminent scientists have brought forward the fact that ether waves have the power to pass through all substances and still are subject to reflection, refraction and absorption. Now, first let us take these properties in their order as given above.

Reflection.—Supposing we have a high cliff with a wireless station situated at its foot and another station some few miles inland, the former calling the latter. Now it was found by Marconi that signals were not noticed or detected at the inland station; this he found was due to the waves being reflected away from the cliff. Air at atmospheric pressure (76 centimeters of mercury at sea level) is an insulator. This pressure decreases as to the distance above the earth's surface, and its insulating qualities decrease with the decrease in pressure. At a height where the pressure is about 1 or 2 mm. of mercury the air becomes a good conductor and is still transparent to short ether waves, but with long ether waves it partly reflects or absorbs them. Now let us suppose that somewhere between New York and Boston the sky is overcast by clouds, some of these carrying heavy charges of electricity, or large bodies of air are electrified. It seems probable that some of these waves from the New York Stations strike against these bodies and are reflected, and as the angle of incidence is equal to the angle of reflection these waves are directed in an entirely different direction from whence they came, and as these bodies change in position their angles are changed giving us signals of great strength or vice versa. These waves may cause interference between the direct waves and the reflected waves and practically neutralizing them or casting a shadow, *i.e.*, may not be detected. Some may re-enforce the direct waves like the rarefaction of sound waves.

Refraction.—When ether waves strike or impinge on a transparent body at an angle other than normal, and this body's density is different from the medium through which it has been passing, then the portion of the waves that enter first become retarded by the resistance that this body offers to the waves, or, we may say, its velocity is changed, so that the latter portion of the waves gain on the former. This action will affect each portion of the waves as they enter the body, and in turn, their direction will become changed. This bending effect is known as refraction. Now, electric waves that travel through air whose density varies at different points are subject to refraction. This is no doubt a reason for the dying away of the New York signals.

RAYMOND U. FITTZ.

THE FADING OUT OF WIRELESS SIGNALS

In the August number of the *Electrician and Mechanic* an explanation is asked for the alternate dying away and coming back of signals from distant stations.

Having seen no published explanation of this phenomenon, the writer would make some suggestions that may help to an explanation, though it would seem that a systematic investigation with the co-operation of several properly distributed stations would be required in order to arrive at a complete understanding.

It may be recalled that in the early hertzian wave experiments, short waves of a meter or less could be refracted and reflected, and also polarized, in a manner analogous to light waves. Now, with the long waves at present used in signalling, we may expect the same laws to hold good, but the conditions are varied, for where refraction could be proved with very short waves by passing them through refracting prisms of pitch, within the confines of a building, we now have the long waves which require very much larger space for their observation and study. To cause refraction, in place of prisms of pitch, we have masses or currents of air of different densities as they naturally occur in the path of the waves. The refraction may be slight but in the long distance involved the effect can be quite noticeable.

Reflections may also occur and change the path of the waves. A colder stratum overhead may reflect downwards, and it is not impossible that polarization may sometimes have an influence.

We may get some suggestion of what happens to an electric wave during its passage by noting the effect of rising heated air currents on luminous waves as they reach our eye through a telescope directed at a distant land object. The image dances and becomes blurred. We may have a short period of extra good definition just as the sun is setting, when a balance occurs for a time in the atmosphere. Astronomers have no end of trouble from these air eddies and currents, and observations taken looking towards the horizon are to be avoided if possible as the troubles are intensified in that direction; but this is the direction in which we are obliged to receive wireless messages.

The mirage, which can often be seen with a telescope when looking across the water, though ordinarily it is not noticed by the unaided eye, may possibly have its effect on wireless waves. A reflection downwards may possibly take place under the conditions which produce the inverted image of the mirage.

It is well known that sounds used for signalling are often strangely stopped or diverted, and again sometimes intensified by invisible modifications in the density of the air. From this, it is plain that the light waves are much less affected than the sound waves, by the refraction. The electric waves are probably much less affected by refraction than are the light waves; but, even then, a very small deviation by refraction at a distance of two or three hundred miles or so, might throw a shadow over a limited space surrounding one station, while another station not very far distant, might not miss the signals which were lost to the first station.

If two or more stations in ready communication should care to test this point, it would be easy to set time pieces to correspond, and let each observer keep a record of stations and times of fading out of signals. If it is found that separate stations, not too far apart, and not in line with the distant sending station receive the signals alternately, some good may come from the experiment. The stations on both ocean coasts are nearly in line. The case would be different with a steamship at sea where a choice of direction in sending and receiving could be had. It may be that the experience of operators on steamships would be of interest in this connection.

Speaking of land stations, some localities may have obstacles interposed in certain directions. The obstacles may not be altogether visible mountains, but also invisible air banks, or prevailing winds which refract from their density. Mountain regions would furnish dense currents of this nature that might help or hinder the transmission according to the position of the station in relation to them. JOHN M. BLAKE.

Wireless Telegraph Dept.,

Referring to your note of late inst. as to the names of officers elected in our Club, they are as follows: R. W. Yeaton, *president;* R. W. Yeaton, *treasurer;* John J. Kehoe, *vice-president*. New members: DeSalle Roche, No. 285 Clark St., Jersey City; Peter Roche, No. 285 Clark St., Jersey City; W. F. Burton, No. 118 Grant Ave., Jersey City.

Would like to see something in reference to the installation of wireless stations of the John Wanamaker stores in your magazine.

Respectfully,

JEROME J. KEHOE.

Sampson Publishing Co.,

Gentlemen: I see by your editorial in *Electrician and Mechanic* that you request notes on the subject of wireless signals decreasing in intensity at times. The location of my station is about twelve miles from New York and I have noticed this occurring in signals from the 2 k.w. station at 42 Broadway. Ordinarily this station sounds very clear, a musical note. At the time I was using a loose coupler and perikon detector but the phenomenon was unaffected by tuning.

I am interested in the discussion of legislation and also agree with "Washington Amateur's" solution of the problem.

Yours truly,

CORNELIUS C. VERMEULE, Jr.

De Forest also discovered that by using a vertical wire, to which is attached a pivoted horizontal wire, with the usual detector in the vertical wire, signals are received, the strength of which "vary according as the position of the wires approach or depart from a position of parallelism with the direction of travel of the waves."

PANCAKE SENDING HELIX

In some cases the experimenter does not care to use the well-known form of "helix," which is cylindrical in form, and the "pancake" will answer the purpose, owing to the simplicity of construction, as well as securing mechanical strength; and this form of helix possesses all of the inductive effect of the other, besides taking up less space.

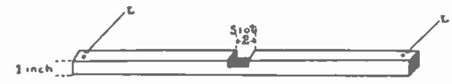


Fig I.

Secure two pieces of dry oak 16 in. long, 2 in. wide, and 1 in. thick. In the centre of each piece cut a slot 2 in. long (Fig. 1) and ½ in. deep. Fit one piece into the other, forming a cross, nailing together with ¾ in. brads; 1 in. from the end of each section bore a ¼ in. hole *L* (Fig. 1) for screws to fasten pancake to the wall when completed. Two or three coats of good shellac should be given wooden form for insulation.

The wire for this helix can be any of the following: Nos. 14, 12, 10, 9, 8, or 6, and may be of copper, brass or aluminum. For coils of ¼ in. to 1 ½ in. Nos. 14, 12 and 10 will do, but for greater power Nos. 9, 8 or 6 should be used. No. 6 will take care of a ¼ k.w. transformer very nicely. The writer used No. 6 spring brass wire, owing to the fact

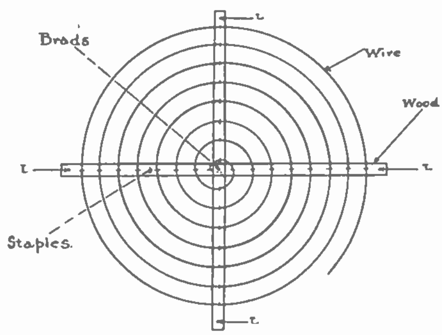


Fig II.

that it does not corrode easily, and retains its shape on the form.

Place one end of the wire near the centre of the frame (Fig. 2) and fasten with a staple; now bend the wire, forming a circle, and staple same to each section of the frame.

The pancake is now finished, and can be mounted on top of the condenser, table or wall by inserting screws in holes *L*, and connect the pancake in the sending circuit.

Good adjusting clips can be gotten from an old pair of suspenders, and should be soldered to connecting wires, or, in other words, one clip from aerial, and the other to ground, as shown in diagrams previously published.

H. I. REISER.

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.

1462. **D'Arsonval Galvanometer.** C. H., Des Moines, Iowa, asks: Explain the making as clearly as possible of the D'Arsonval galvanometer, or some very sensitive instrument of this kind and is it necessary to allow for temperature? Ans.—The D'Arsonval galvanometer is made as follows: Between the poles of a compound permanent steel magnet of V-shape is suspended by very thin hard drawn silver wires, an open coil of very fine wire wound on a light rectangular frame. The current is led to and from the coil by the suspending wires. Within the suspended coil is a cylinder of soft iron, supported from behind, to concentrate the magnetic field. The vertical parts of the coil then hang freely in the two narrow gaps where the magnetic field is very intense. The force tending to turn the coil is proportional to the current to the number of winding, and to the intensity of the magnetic field, so that by making the magnet very powerful the instrument becomes very sensitive. This galvanometer is independent of the earth's magnetic field, is not affected by magnets in its neighborhood and is remarkably dead-beat. No temperature correction is necessary.

1463. **Rewinding Motor.** S. K., Highlandtown, Md., has a 110 volt direct current "Towle" series fan motor. Armature has 12 slots wound with No. 32 wire; the field coils with No. 28. He wishes to rewind it for 12 to 18 volts, and drive it from storage batteries. What sizes of wire should be used? Ans.—If you desire to keep the series principle, the number of turns can be in direct proportion to the voltage. For about one-eighth of the present voltage you will need but one-eighth of the number of turns. As this gives you a chance to use a wire eight times as large in cross section, you will increase the ampere capacity of the machine in direct proportion, as desired. This will mean No. 23 wire on armature, No. 19 on field. If you prefer the shunt winding on field, you can use the coils of No. 28 wire, but connect them in parallel with each other rather than in series, as at present.

1464. **Multiple-series and Series-multiple.** J. A. K., St. Louis, Mo., asks: (1) for diagrams illustrating these connections. (2) How to change a 220 volt d.c. fan motor to a 104 volt 60 cycle a.c. (3) How many ohms resistance has a standard 16 c.p. 110 volt carbon filament lamp? Ans.—(1) Perhaps we can make the case clear without the expense of reproducing diagrams. It may be that writers are not agreed as to the entire distinctions between the two expressions, and it is true that either when carried to an extreme overlaps the other. The former was used to denote the early method of street lighting with incandescent lamps. Alternating current generators of 1,000 to 1,100 volts or for direct currents at 1,200 volts were employed, and the systems were listed as "municipal." 40 or more 25 volt 3 to 6 ampere lamps were put in a series circuit, whereby the series part of the name was explained. Quite a number of such circuits were connected in parallel to the same generator, whereby the other part of the name is seen applicable. The series character of the circuits was looked upon as the important part, for the voltage was relatively high, and each lamp was provided with an automatic cut-out, to act in case the filament broke. In the station an ammeter was kept in each circuit, and resistances varied to preserve a constant current. In the multiple-series case, the multiple is the important principle, and is well illustrated by the method of wiring street cars, with 5 lamps in a series, and connecting the group as a whole to the general 500 volt parallel system. If you should leave out the neutral of a 3 wire system you would then have a multiple-series arrangement. (2) It cannot be done. (3) When hot, about 250 ohms.

1465. **Small Motor.** H. B. D., Lake George, N.Y., asks for directions for designing a motor to run from a rectified alternating current circuit. He proposes one with an outer field ring 6 in. in diameter and about ½ in. in radial thickness. What should be the other dimensions and the winding? Ans.—With this meagre start, it is considerable to design and explain the rest in the small space allowed in these columns. So many good designs have already been published that you can get much better assistance from them. The 75 watt rotary converter just described in our magazine will give you some good ideas, but we would think the ¼ h.p. dynamo designed by Watson would be as good as you need. The revolving part you could copy without change, and if you preferred a different sort of field magnet, it would operate quite as well, so long as you kept the same amount of iron and copper. The 50 volt winding would be most appropriate.

You must recognize, however, that the rectified current is not free from pulsations, and if the field magnet is composed of solid iron, there will be production of eddy currents and loss of power. To avoid this, the structure of the field magnet should be laminated.

1466. **Electric Lamp Operation.** J. A. W., Cincinnati, Ohio, asks: if a 110 volt lamp can be lighted with the help of an induction coil, and if so, how many dry cells will be necessary? Ans.—An induction coil may increase the voltage of an electrical supply, but it cannot increase the total power. Rather, it loses power, and the ordinary induction coil is very wasteful, returning, say, not over half the energy delivered to it by the batteries. An ordinary electric lighting transformer may waste not more than 5 per cent. To represent the matter more clearly, the secondary wire is so fine as to have a high resistance and a very small current capacity. The lamp you propose requires half an ampere, and this much is quite beyond the power of the coil, for a very much smaller current than that would certainly melt the wire. If you light from batteries do not interpose any other devices.

1467. **A.C. Motor.** G. O., New York City, writes that he has a fan motor with an iron-clad field magnet very much of the shape of Watson's 1 h.p. machine, but of about one-half the size. He gives some of the important dimensions, and asks what he should do to fit the machine for operation on a 110 volt 60 cycle circuit? Ans.—Your description is good, and but for one important defect, we could definitely advise you, and that is the field magnet is of solid iron. For alternate currents the field must be laminated, and for 60 cycles preferably with four poles.

1468. **D.C. and A.C. Motors.** T. J., Parlin, N.J., asks: if a 220 volt direct current series wound motor can be operated on a 220 volt 60 cycle alternating current? Ans.—For the particular application you probably have in mind, no; but specially designed machines will be adapted for both kinds of current as notably in the case of the New Haven Railroad locomotives.

1469. **Choke Coil.** E. T. Z., Buffalo, N.Y., asks for data for making a choke coil, for use on a 104 volt 60 cycle circuit, capable of giving any desired current from 10 to 30 amperes. Ans.—As you do not state through what external resistances you wish to drive the current, we shall have to use some guesswork in our determinations. You will find the advice safe, however, and further, the apparatus will be capable of considerable adjustment. Make a wooden form of three strips of wood, such that the whole structure will be 10 in. to 12 in. long, 2¼ in. square, and capable of running between lathe centres. Of the three pieces, one can be straight while the other two are slightly wedge-shaped. This will enable you to be able to drive out the centre one, after the winding is on, and let the form collapse. Build flanges around this, with mitered corners, of ⅞ in. stock, about 3 in. wide, leaving 4 in. between them for the winding space. Put the whole together with screws, not nails. Now wind on about twenty turns of a bundle of three No. 10 wires. The ends can well be soldered, so as to make one layer, in a strip of tinsmith's sheet copper about ½ in. wide. This coil will occupy two layers. Do not cut the wire, but put a second band of the sheet copper around the group, leave out an end several inches long, cut off one of the wires, and wind two more layers of the twin conductor. Put on a third band, cut one of the wires, and put on two more layers, or about sixty turns, of the single conductor. Finally, you will have four ends to be attached to binding posts, and the windings will readily allow 30, 20, or 10 amperes. Remove the wooden supports cautiously, and tape the coils, or wind them with twine. Shellac or other waterproof varnish may then be used in several coats. Next cut out a mass of square-cornered U-shaped sheet iron to make a stack 2 in. thick. Outside dimensions will be about 5½ x 8 in., and the piece to be removed will be about 1½ in. x 6 in. The side cuts can be made with shears, the cross cut at bottom with a sharp cold chisel against one of the jaws of a vise. After assembling and clamping the stack, ½ in. holes may be drilled in the corners, and hard wood pins driven in. Do not use metal. The centre pieces may also be similarly assembled, and used for an armature across the ends of the U, with any desired thickness of wooden spacer between. The coil will occupy one leg only of the U.

1470. **Rebuilding a Relay.** C. W., Spokane, Wash., asks: (1) What will be the efficiency of a relay if two ordinary telephone magnets, 1,600 ohms each, are used, provided the rest of the relay is O.K.? (2) Should the magnets be connected in series or multiple? (3) Give a formula to find the ratio of the spark length to the voltage in air. Ans.—(1) This should make the relay very efficient. (2) The magnets should be connected in series. (3) There is no formula, merely this simple rule: For every inch distant between needle points the voltage is approximately 22,000, so multiply this figure by the number of inches the spark will jump.

1471. **Wire for Tuning Coil.** R. A. P., No. Dartmouth, Mass., asks: (1) About how much bare No. 22 copper wire is needed to wind the tuning coil of the "doughnut transformer" described in the November, 1909 issue of the *Electrician and Mechanic*? (2) With instruments connected as shown in page 163 of the same issue, where should the phones be placed? (3) Would the variable condenser described on pages 39 and 40 of the July, 1908 issue of *Electrician and Mechanic* be suitable for use with the "doughnut transformer," or if not, where can I find a description of both variable and fixed condensers that are suitable? Ans.—(1) About 250 ft. (2) If no potentiometer or battery is used the telephone may be bridged around the fixed condenser. If it is desired to use battery see wiring diagrams of May, 1910 issue. (3) No. I consider that a variable condenser is very inefficient. In the February, 1910 issue is a description of a variable condenser.

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TRADE NOTES

The L. S. Starrett Co., of Athol, Mass., have just published a circular descriptive of their Starrett Steel Pocket Tape. This little pocket tape is of a most convenient size, easily carried in one's vest pocket, is nickel-plated, and moreover, possesses the advantage of rewinding by merely pressing the button in the centre of the case. The Starrett Company are an old and reliable concern and their tools are of the dependable kind.

The United States Civil Service Commission announces an examination on October 5, 1910, at the places mentioned in the list printed hereon, to secure eligibles from which to make certification to fill a vacancy in the position of electrical assistant in the Signal Service at large, at New York City, at $1,500 per annum, and vacancies requiring similar qualifications as they may occur in any branch of the service, unless it shall be decided in the interest of the service to fill the vacancy by reinstatement, transfer, or promotion. Applicants should at once apply either to the United States Civil Service Commission, Washington, D.C., or to the Secretary of the Board of Examiners at any place mentioned in the list printed hereon for application and examination Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington prior to the hour of closing business on September 24, 1910. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

"The Pacific Coast electrical exhibition to be held at the Colliseum, September 17 to 24, will be participated in by more than 500 different electrical concerns throughout the world, and from the list of exhibitors now in the hands of the committee there is every promise that the display will outrival anything of its kind ever held in the United States. This will be the first electrical exhibition to be held west of St. Louis.

"Important displays from the army, navy, manufactories, universities and individuals will be shown. Every imaginable contrivance from a flat iron to a delicately adjusted Limousine car, will be on exhibition.—*San Francisco Call.*

Henry Disston & Sons, of Philadelphia, have just announced that they are beginning the distribution of two new saw clamps made so light and compact that they can be carried in a tool chest with no trouble or inconvenience.

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Disstons are also making a new No. 6 Saw Clamp which is of the same general design as No. 5 with the addition of screw lugs for fastening to the bench. The lugs fold snugly to the body of the clamp, thus taking up small space in a tool chest.

In the great Mechanics Exposition to be held in Mechanics building, Huntington Avenue, Boston, Mass., from Monday morning, October 3, until Saturday night, October 29, patrons will have the finest opportunity to see and study the greatest assembly of practical working exhibits ever shown in Boston. The Edison Company will make a special exhibit of the very latest inventions of the "King of Inventors," among them the new storage batteries and talking machines and other laboratory products so extensive as to occupy the big stage in Grand Hall, all of the rooms in the rear and all of the adjoining floor space. The United Shoe Machinery Company will demonstrate the elaborate process of making a Goodyear Welt shoe from the flat leather to the finished product. One of the Boston daily newspapers and allied press and type making concerns will practically illustrate how a daily paper is gotten out from "copy" to the folded article ready for free distribution every day. There will be over two hundred practical working exhibits. The basement of the entire building will be devoted to an automobile department with a first showing of 1911 models. Among the great attractions, for all of which there will be no extra charge for seats, there will be concerts by the famous United States Marine Band, of Washington, D.C., by special permission of President Taft. These concerts will be given afternoon and evening in Grand Hall, for the first two weeks. For the final two weeks the celebrated band of the 75th Regiment of Canada, from Lunenberg, Nova Scotia, will play, while every morning, afternoon and evening during the whole time of the exposition the Edna Frances Simmons Ladies Orchestra will give concerts in Exhibition Hall. This exposition will in no sense be a food fair. The management confidently asserts that it will be the greatest *Mechanics* Exposition, a veritable old-time "Mechanics Fair," ever seen in Boston.

BOOK REVIEWS

Electric Wiring. By Joseph G. Branch, B.S., M.E. Chicago, The Branch Publishing Co., 1910. 300 pages. Price, cloth $2.00.

This book should fill a long-felt want of all those who desire information in any branch of electric wiring. The author has given a clear explanation of the theory and properties of direct and alternating currents, and of electricity in general. The book fully covers outside and interior wiring, power plant works, surface and elevated electric railways, telegraphy, telephony and wireless telegraphy. The text consists of a series of questions and answers, and is written in clear and simple language.

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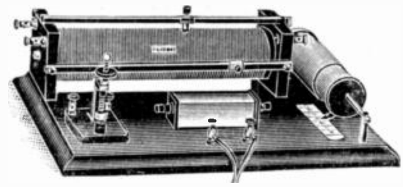

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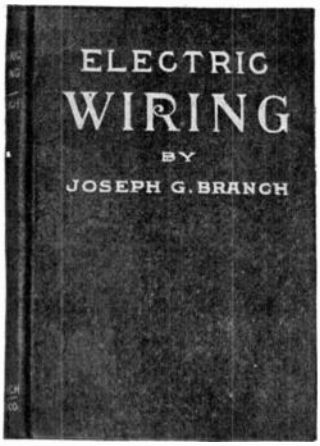

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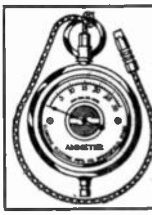

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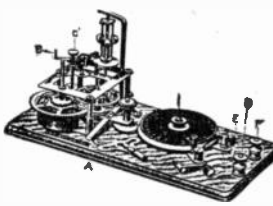

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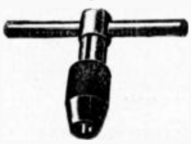

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