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May, 1910

ELECTRICIAN & MECHANIC

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Cheap Reflecting Telescope

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A Loud Speaking Telephone

A Mission Footstool

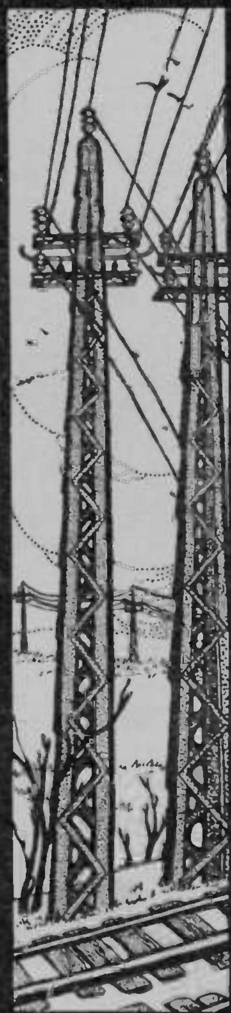
Troubles on Arc Lamp Circuits

Selection of Stationary Motors

Wireless Department

Insulation of the Induction Coil

Construction of Wireless Station



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Electrician and Mechanic

VOLUME XX MAY, 1910 NUMBER 11

CONSTRUCTION OF A 75 WATT ROTARY CONVERTER—Concluded

P. LE ROY FLANSBURG

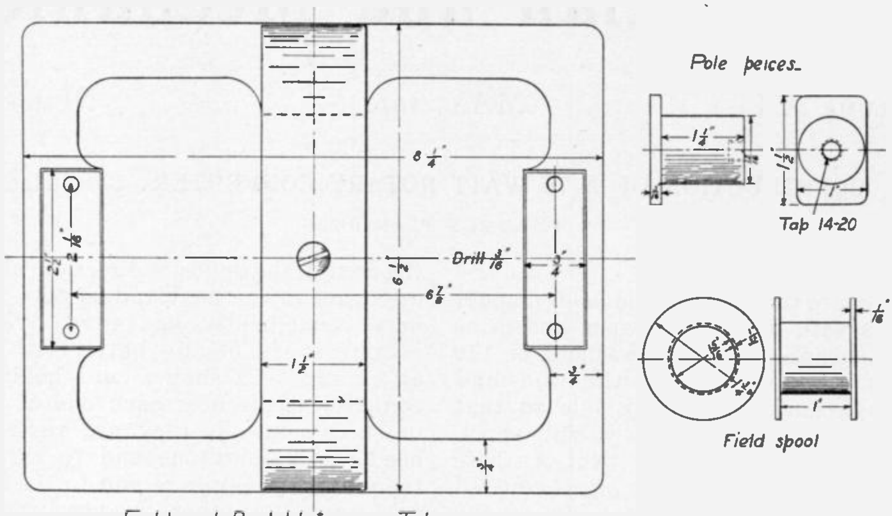
WINDINGS

Insulate the heads of the field magnet spools with heavy red paper known as press board. Cut out washers of the paper of the same size as the heads and make a cut through one side so that they can be slipped over the spool. Each end should have two of these washers so that the cut in one is covered by the other one. The body of the spool is covered with four layers of ordinary wrapping paper held down with a little shellac.

The winding consists of No. 20 single cotton covered magnet wire laid on in even layers. It should be possible to get ten layers on. The "start" end is brought up between the two paper washers on one end and the "end" is fastened by laying in a loop of ¼ in. wide cotton tape before the last six turns are put on and winding these six turns over it, leaving out a good sized loop through which the end is passed and held tight while one of the free ends of tape is pulled until the wire is drawn into position by the loop. The ends of the tape are then cut off close to the wire and the winding given a coat of orange shellac. The two ends of wire should come out from the coil about ½ in. apart and on the same end. The six magnets are all wound just alike and slipped over the pole pieces with the ends of wire opposite to the screws in the field terminal blocks. The ends of the wire are cleaned, formed into a loop to fit around under the screw head and the screw clamped down, there being a small brass washer under the screw head. The terminal blocks are then connected with short pieces of wire as shown in the diagram of connections. When all is completed the wire should be traced out to see that the connections are correctly made. The current should flow around one magnet in one direction and around the next in the opposite direction, changing again in the next and so on. They may conveniently be tested by connecting a cell of any battery to them all in series as shown, and holding a compass needle near each one of them in succession. If they are right, the needle will point one end to three of them and the opposite end to the alternate ones. Another good way to be sure of correct connections is to connect first two inside ends of adjacent spools, then at the next place, two outside ends, and so on, when finally two outside ends will lead to connection board.

Before starting on the winding of the armature the connections between the collector rings and the commutator must be made. By reference to the drawing it will be seen that each collector ring connects to three equidistant commutator bars. These connections must be made precisely as in the table given. Drill small holes, just large enough to take a No. 18 wire, in the back ends of the commutator bars indicated. Take for instance collector ring No. 1, which connects to bars 1–13–25. Drill the hole in bar 1 large enough for three wires, then run a short piece of No. 18 fixture wire from bar 13 to bar 1, and another from bar 25 to bar 1, then from bar 1 run a piece long enough to reach the collector rings. These wires must all be soldered in and great care taken that they connect only the bars indicated. The long wires are then passed through the holes in the armature sleeve and attached to the leading wires from the collector rings, the joint being well soldered and taped.

The armature coils are next to be made, each coil consisting of 20 turns of No. 24 single cotton covered magnet wire and 36 coils being required. They are to be wound on the form shown, all in the same direction and the be-



Field and Bed plate. Top view.

P. LeRoy Flansburg

ginning end so marked that it can be identified. Before removing the screws from the clamp the coil should be tied tightly in several places with thread so as to hold it to shape. After removing from the form the coils are to be thoroughly taped with ⅜ in. silk tape, the coils dipped in thin shellac and then hung up to dry. Before they are dipped, however, they should be bent into nearly the shape shown, and if they are too thick to go into the slots, the sides should be clamped between the boards until they are thin enough to go in easily. The coils are placed on the armature with the lead wires towards the commutator and arranged as shown in the drawing. Begin by placing one side of a coil in one slot, leaving the other side out, then place another coil in the next slot letting it lap over the first coil and continue this until ten or twelve coils are on and then begin to lay both sides of the remaining coils in. It will be seen that a coil occupies the bottom of one slot and the top of another, there being five slots between the two, not counting those occupied. When nearly all the coils are on, it is necessary to raise upon one side of those first put on to enable the last ones to be placed under, after which the remaining sides of the first coils are laid down. Great care is necessary to avoid injuring the tape on the coils when they are placed in the slots. If care has been taken in laying the coils in the slots the armature should present a symmetrical appearance. Select inner end of any coil and bring it down to a commutator segment directly in front of where it emerges from the coil, and to this same segment bring the outer end of the next coil. Continue this all around so that each segment will have the beginning of one coil and the ending of the next. Solder these wires to the bars, being careful that the solder does not connect two bars. Wind a band of a few turns of tape around the ends of the coils to keep them in place and give the completed armature a coat of shellac.

The d.c. brush holders are to be connected as shown in the diagram of connections, that is, three alternate holders are connected together and to one main terminal, the other three being connected together and to the other main terminal. These connections are best made with No. 18 fixture wire, but it should be left slack from the terminals to the holder in order that the arm may be adjusted. Connect the field terminals to the main terminals as shown, adjust the brushes and the machine is ready to operate. It runs as a motor on four or five cells of storage battery. As a generator it will give about 10 volts at 2,000 revolutions per minute, but the speed can be increased, raising the voltage considerably. Eight amperes can safely be drawn from it.

EXPERIMENTS

The drawings show the connections of a shunt wound machine on the d.c. side. If we connect this to a battery of sufficient power, the machine runs as a motor. Now if we reverse the battery it still runs in the same direction, but if we reverse the brush connections so that the current flows through the armature in the opposite direction, leaving the fields as they were, the direction of rotation is reversed. Again, if we reverse the connection to the fields, leaving the armature as it was, the direction of rotation is reversed, therefore we see that reversing either field or armature reverses rotation, but reversing both has no effect.

We may make a series motor of it, arranging the connections so that the entire current flows through first the fields and then the armature, instead of dividing between them as in the shunt machine. Now we find that the same law of change holds good and that we can reverse the direction of rotation the same as with the shunt machine. For practical use as a series machine, the six-field coils should be connected in parallel with each other rather than in series.

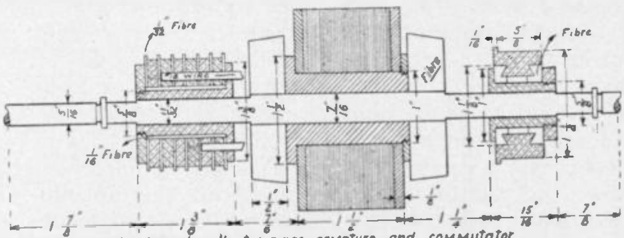
With the machine connected in shunt, place an ammeter or any instrument which will show a change in the current strength in series with the field so that all the current which flows through the field will flow through the instrument. Put a load on the machine by holding a block of wood against the pulley and there will be no change in the field current, but place the instrument in series with the armature and repeat the experiment and it will be seen that the current increases with the load. This is explained as follows: a motor running acts not only as a motor but as a dynamo as well, generating an electromotive force in the opposite direction to that supplied to the motor. This counter electromotive force, acting against the incoming current, reduces its strength. Now the voltage of a dynamo is proportional, among other things, to its speed, and when the load comes on the speed falls, the counter electromotive force decreases and a greater current rushes into the armature, tending to give the machine more power; thus a shunt machine is self-regulating for speed. With a series machine the case is different: we have the counter electromotive force the same, but this acting on the incoming current tends to weaken the field, and when the field of a dynamo is weakened the voltage is lowered. If the load is thrown off, the field is weakened and the machine speeds up, for, if the load permits, any motor will run faster with a weak field. A series motor will run away if the load is thrown off, and therefore is suitable only when the load is always on, such as in railway work, fans, etc., while a shunt machine is suitable where a constant speed is required under varying load.

Start the machine as a shunt motor, and, while it is running, open the field circuit. If the bearings are free the speed will increase, this being due to what is known as the residual magnetism of the fields, that is, the magnetism of the iron is retained but is much weaker, causing the increase in speed as explained above. This experiment should never be tried with a large machine, as the increase in speed is liable to be so great as to wreck the machine.

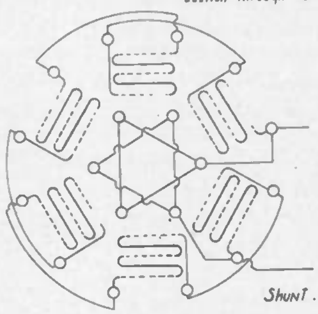
Connected in shunt this machine makes an excellent dynamo. It delivers direct current from the d.c. end, and from the a.c. end we can get between rings 1 and 2 or 3 and 4 a single phase current; between rings 1 and 2 and 3 and 4 together we get a two-phase current, and between rings 1–5–6 we get a three-phase current. There is a fixed ratio between the d.c. voltage and the voltage of the a.c. side. The a.c. voltage can be obtained at any time by multiplying the d.c. voltage by 0.707 for a single or 2-phase and by 0.612 for 3-phase; but the effects of armature resistance and inductance somewhat modify these ratios.

The most interesting experiments with alternating current have to do with the induction motor, and these may be performed with very simple apparatus.

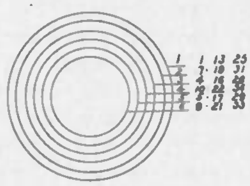
Take a good pocket compass and wind around it, parallel with the needle, a coil of 20 or 25 turns of magnet wire,



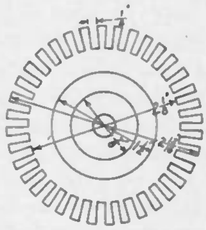
Section through collector rings, armature and commutator



Shunt connection.



Collector ring connections.



End view of armature

P. Le Roy Flansburg. 1909.

about No. 30. At right angles to this coil wind another similar one and lay the compass down flat, connecting the ends of one coil to brushes resting on rings 1 and 2, and the ends of the other coil to brushes resting on rings 3 and 4. Connect the d.c. side to a suitable battery and the machine will run as a rotary converter giving 2-phase a.c. to the compass motor, which will run at high speed. If it does not start off at first, hold the hand on the pulley slowing the machine down until the needle begins to revolve. The explanation is as follows: consider coil 1 with a current flowing in it, the needle tends to point at right angles to it. At the same instant there is no current flowing in coil 2, the nature of a 2-phase current being such that as one phase has maximum current the other has none. The next instant coil 2 has current and coil 1 has none, and the needle will swing to right angles with coil 2. The next change and coil 1 again has current, but in the opposite direction, and the needle swings to right angles with it, but in the opposite direction to its first position. The next change and coil 2 is again energized but oppositely to its first direction, and the needle is at right angles with it but opposite to its first direction. The next change brings us back to the starting point, and the needle has made one complete revolution. In the commercial induction motor the same principle is used but the needle is replaced with a heavy iron rotor carrying large copper bars embedded in the iron and the radial field coils are replaced with a heavy sheet iron stator carrying many coils of wire resembling in shape those on the armature of this machine. If the ends of one of the coils on the small motor be reversed, leaving the other as it is, the direction or rotation is reversed. To reverse the direction of rotation of a 2-phase motor reverse the two wires of one phase.

Take the same compass and wind three coils as before, but placed 60° apart, and connect the beginning of one to the ending of the next all around, making one continuous wire. From each of the three joints attach a wire, one to ring 1, one to ring 5, and one to ring 8; run the machine as before and the needle revolves. We now have a 3-phase motor whose principle is the same as the 2-phase above described. To reverse a 3-phase motor, reverse any two wires.

In a six pole machine every revolution of the armature gives three complete cycles, and in the little motors just described every cycle gives one revolution, hence the needle will run three times as fast as the armature of the rotary converter.

The small toy motors sold to run on one or two cells of battery will run on the single-phase current taken from rings 1 and 2 or 3 and 4, showing that a direct-current motor will operate on alternating current; but in commercial machines it is necessary to laminate the fields, that is, to construct them from thin sheet iron to prevent heating. Many a.c. fan motors run on this principle.

Disconnect the d.c. brush holders from the fields and short circuit all the brushes together by connecting two adjacent holders with a short piece of wire. Connect the field to an ordinary a.c. lighting current through a few ohms of resistance to keep the current down and adjust the rocker arm until the motor runs at best speed. It will stand this for only a few minutes, for as the fields are not laminated they will heat. The armature gets its current by induction from the a.c. fields, and as it is short circuited at the brushes it causes rotation.

If the machine is connected as a series motor it may be connected directly across a 110 volt a.c. circuit without other resistance, and runs like a d.c. machine. This experiment shows to good advantage the fact that, in coils surrounding iron, there is a greater apparent resistance to the a.c. than to the d.c. If the machine were supplied with d.c. it would require about 8 or 10 volts while it stands 110 volts a.c. It would be completely wrecked by 110 volts d.c.

The design of machine was made by Mr. Edward E. Sheldon of Albany, N.Y.

INTERIOR ELECTRIC LIGHT WIRING—Part VIII

Miscellaneous Fittings—Continued

GEORGE J. KIRCHGASSER, E.E.

FIXTURES

The fixture is really the weakest part of a lighting equipment. Abrasion of the insulation of the wires or the drying

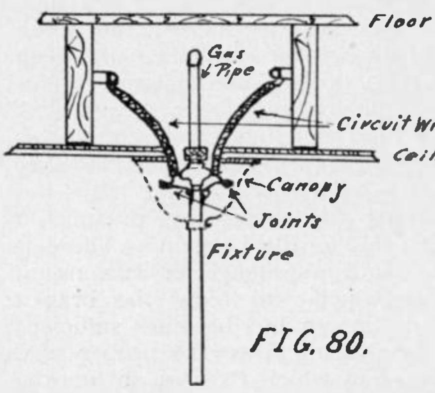


FIG. 80.

out of this insulation may allow a leakage of current, which will be stopped from flowing into the gas piping system by the insulating joint. Where the wires pass out of the fixture, as seen in Fig. 81, at top of shell, some protection is required so that the insulation of the wires is not injured. A small fitting, sometimes called a "crab" or "hickey," is employed for this purpose.

When installing a combination fixture care should be exercised in applying the white lead, which is a conductor, so that none will be forced through the joint and span the insulation. This would cancel the function of the insulating joint, making a metallic circuit from the fixture to the gas-pipe system.

An insulating stud is used with straight electric fixtures for insulating them from conducting materials. A straight electric fixture consists of a shell which encloses the fixture wires. This is sometimes of brass as used on combination fixtures and sometimes of heavier metal. A substantial support should always be provided for straight electric fixtures; this can be concealed in the wall or ceiling, or can be mounted on the exterior. A hard wood block, of ¾ in. stock, is satisfactory. A loose fixture wears on the insulation of the fixture wires. Outlet boxes, as shown in Part III, provide a proper support for the fixtures and no blocks are required.

In Fig. 80 the method of connecting and installing a combination gas and electric fixture is shown. The canopy is indicated. This must be insulated from any material which has current-carrying properties. An insulating ring is used for this purpose. It is made of hard rubber and comes in different diameters to accommodate different sized canopies. Between the canopy and the ceiling the insulating ring is shown: As conducting material is employed in the building of fireproof buildings the canopy must be insulated as well as the fixture stem. If no ring were used the stem of the fixture would be in mechanical connection with the wall or ceiling (of metal or metallic lathe), and the insulating joint or stud would be of no value. Insulating rings should also be used with insulating joints or studs where fixtures are located on metal ceilings or walls or on outside brick walls.

Above the insulating joint in Fig. 80 a piece of flexible tubing is shown

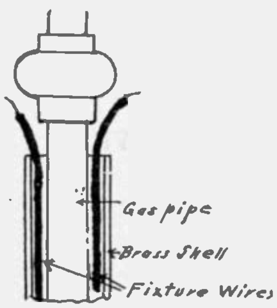


FIG. 81.

around the gas pipe. This serves to keep the circuit wires and the splices, which are sometimes wrapped about the pipe, free from the metallic surface. At the top of the shell the fixture wires must be protected. The circuit wires in a knob-and-tube system must each be provided with a piece of flexible tubing extending from the last supporting knob to below the insulating joint or stud. They should also be tied in place to the gas pipe by a piece of iron wire. In a conduit system the gas pipe passes through the outlet box from behind or from the side and the wires enter through the conduit, no flexible tubing on the wires being necessary. No outlet box cover is needed when a fixture is installed. The canopy as indicated in the figure serves to conceal the box, splices, insulating joint, etc.

For special uses, as in damp or wet places or for outside lights, where ordinary fixtures are not proper, waterproof fixtures of heavy construction should be used. Figs. 77 and 78 represent such types of pipe-hanger fixtures. If double braid rubber-covered wire, as used in the conduit system, is run directly to the waterproof socket, no insulating joint or stud is necessary, because the fixture is in all respects equal to the conduit system itself. It can be reasoned therefore that the insulation (through use of the insulating joint) of the ordinary fixture is necessary, mainly, because of the weakness of the fixture and of the fixture wires. Wireless clusters, as they have no wires, do not require insulation from the piping or other metal of the building.

In some kinds of ceiling fixtures and clusters, etc., the heat of the lamps is confined in such a way as to act on the fixture wires. Slow-burning, weatherproof wire is preferred to rubber covered as the latter insulation is dried out by heat.

Fixtures are approved for use on the ordinary lighting systems, 110 or 220 volts, but not on systems where the voltage is over 300. Except the special fixtures mentioned above and illustrated in Figs. 77 and 78, no fixtures should be installed outside or in other damp or wet places. The reasons for these restrictions are because of the small fixture wires, their comparatively weak insulation, and the non-moisture proofness of the fixture.

If a fuse on a lighting circuit blows an investigation should be made to locate the source of trouble. It is not remedying the defect by putting in larger fuses in the branch. There is often found a leakage of current in fixtures which will blow the branch fuses, if the ground becomes sufficient and the branch fuses the proper size. By knowing which fixtures are on the circuit in trouble and then after placing new fuses of proper size in the branch, one fixture after the other can be switched on. When the defective one is connected in circuit the fuse will blow again. Often the trouble is due to leakage from a poorly wrapped joint or from the weakening of the insulation above the shell By lowering the canopy the wires can be inspected.

After an electrical installation has been completed insulation resistance tests should be made to make sure that the wiring is free from grounds. A magneto, which is a small dynamo

	Amperes	Col. II	Col. III
Up to	5	4,000,000 ohms	2,000,000 ohms
	10	800,000 ohms	400,000 ohms
	50	400,000 ohms	200,000 ohms
	100	200,000 ohms	100,000 ohms
	200	100,000 ohms	50,000 ohms
	400	50,000 ohms	25,000 ohms
	800	25,000 ohms	12,500 ohms
	1,600	12,500 ohms	6,250 ohms

operated by hand usually, can be used for the testing. At the different outlets one wire of the magneto can be connected to each wire; if the bell rings current is passing from one conductor to the other, which should not occur. By connecting one wire to one circuit wire and the other to the conduit or in a knob-and-tube system, to the gas or water piping, the insulation from the ground can be ascertained. The fixture wires should also be tested as they are very liable to become grounded on the metal of the fixture. A test between the wires and a test between each wire and the metal of the fixture should be made.

Col. II of the following table gives the insulation (for the wiring only) required between the conductors and between the conductors and the ground, with all cut-outs and safety devices in place. Col. III, the same with fixtures, sockets, receptacles and other attachments connected in circuit.

Before beginning the installation of even the smallest electrical equipment it is well to thoroughly look over the ground and make definite plans, as this will insure better work with less disappointments and fewer changes. For large buildings the specifications should be made out by a competent man, showing location of outlets, switches, fuse cabinets, feeder runs, mains, risers, etc. Some of the principal points to be discussed and decided upon are given below:

Electric current to be supplied by whom and at what voltage. Also, whether alternating or direct current.

What system of wiring is to be employed: if different systems, how subdivided.

Method of controlling and operating lights.

Feeders, mains, etc. What size of wires necessary. Feeders and risers should, if possible, be run in such a way as to feed from central locations. For motor and heater systems separate feeders to be used.

For branch circuits, wires are usually No. 14 B. & S. gauge. If the branch fuse locations are central, circuits can be run in both directions, thus making the runs of about the same length and as short as possible. The general layout of these circuits should be known.

In a conduit system, the make of conduit might be specified and the sizes and runs of the pipe for the mains, feeders and branches.

The kind or kinds of outlet boxes to be used. Also the location of the outlets, designating on the plans what each outlet will be fitted with; if fixture, how many and what size of lamp.

Locations and uses of wall, floor, and baseboard outlets and receptacles.

Kind, size and location of cut-out cabinets.

Cut-outs, type, support, etc.

Locations, type and size of switches.

Locations, type and sizes of fuses.

If separate heater or motor circuits are wanted, locations of outlets, size of wires and other detail should be decided upon.

For elevator motors, size of feeders, voltage of service, if different from lighting service, etc., should be known.

Size and kind of lamps, method of supporting the same and fixtures complete the equipment.

The End.

Sewer system, new water system, fire alarm boxes, electric railways, telephones, new and increased electric light plant, bridges, most extensive harbor improvements and no port dues—all this going on at one time in Manila, means that the city is becoming the American Hong Kong.

A CHEAP NINE-INCH REFLECTING TELESCOPE

I. Tools and Materials Needed

M. A. AINSLEY

The telescope I propose to describe was made some two years back, and since it was finished several improvements and alterations have occurred to me: these I will indicate as I proceed. I will devote this chapter to a brief summary of the methods I used and the materials required.

The speculum (and this applies to the second 9 in. mirror also) was worked by hand on a glass tool of the same size, the latter being supported on a stout box which was fixed to the top of a cask. (The rough tool is usually turned of iron, the surface being a section of a sphere of the proper curvature. *Eds. E. & M.*) The speculum was cemented with pitch to a wooden handle until the fine grinding was completed, when it was held in a tight wooden triangle, just tight enough to hold it without undue pressure or freedom. The mirror was figured on a graduated polisher (to be described later) and tested by the Wassell method, though my apparatus was considerably simpler than Mr. Wassell's. Having nothing in the way of a workshop (in fact, a good deal was done out of doors), and only a few hand tools, I was largely dependent on the local carpenter and blacksmith, so that anyone with a small workshop and some skill as a carpenter would make a material reduction in the cost.

As to the materials, the glass will be the first thing to get. I was advised to have my 9 in. mirror 1½ in. thick; but I found a good deal of difficulty in procuring glass of this thickness, and had to be content with 1 in. This has proved ample in practice—with care in supporting the mirror, to avoid flexure—but as Dr. Common said in a letter to me: "If your 9 in. were 1½ in. thick it would not suffer from flexure, however supported." So I should advise 1½ in., or about one-sixth of the diameter of the mirror. I expect 1½ in. would be thick enough for any size up to 10½ in. or even 12 in. They should be roughly ground circular, and the sharp edges removed. Fine grinding of the edges is unnecessary.

THE BENCH OR SUPPORT FOR TOOL

An old kerosene cask was what I used; but it was not high enough for me, as I stand 6 ft. 2 in., so I raised it another 6 in. or so by means of a stout box, which should be as flat as possible, to keep the tool in place. I found this quite steady, though I think it would be better still to fill both box and cask with stones, earth or something heavy enough. The surface of the tool was high enough to be about 5 in. below the point of my elbow when standing upright. This gave command of the work and avoided stooping, while I could put sufficient pressure on the mirror during grinding to make the emery do its work. I did not find it necessary to fix the tool down (with pitch or otherwise), and if there was any flexure of the tool during the work, it has no perceptible effect on the figure of the completed mirror. The same tool was used to grind both mirrors; the second mirror, however, seemed to be quite rigid enough to impart a good spherical figure to the mirror.

THE GRINDING MATERIAL

Throughout the grinding operations I used ordinary emery. I understand that "carborundum" is a much more effective grinding material, and I am told it cuts far more rapidly; but it is much more expensive, and as yet I have not tried it; but if I do any more work of this description I shall certainly do so.

For the rough grinding, emery of the grade known as "1½" was used. Sand is a good material for the purpose. In fact, it is recommended by Dr. Common; but I had no supply on hand, and I have found from past experience that the use of it lengthens the rough grinding considerably. It cuts well when quite fresh, but very soon seems to wear down and so has to be very frequently renewed. I tried rough-grinding with coarser emeries, even as coarse as No. 4½, but the edges of both tool and mirror were badly chipped; and it appears also that if the rough-grinding material is too coarse, the mirror, after "roughing out" is not spherical, but has considerably more curvature in the centre. If a finer grade of emery than "1½" is used, the rough-grinding is much prolonged.

About 10 lbs. of the "1½" emery will be required for the "roughing-out" of the mirror. The amount required, of course, depends on the diameter and focus of the mirror, and it is not to be expected that the process should be as rapid as in the case of a mirror of smaller size. The depth of the centre of my first 9 in. mirror is about 1-12 in., the focus being 63 in.; and it is obvious that as the depth of the mirror in the centre varies as the square of the aperture, the focus being constant, the time being taken to dig out a mirror of large diameter is much greater than that required for one of smaller size. For the fine-grinding, emery of No. 46 grade was used first; when the curve became nearly spherical, emery of No. 150 grade was employed, then washed flour emery; after which I prepared the finer emeries by processes to be described later. The amount required for the 9 in. mirror was as follows: No. 1½, about 10 lb.; No. 46 about 2 lb.; Nos. 120 or 180, or anything of about that fineness, about 2 lb.; washed flour emery about 6 lb., though more may be required if the later stages of fine-grinding have to be repeated.

The exact grade of emery required for each stage is not very important. For example, an equally good result could be obtained with emery of, say, 1½, 80, 180 as with 1½, 46, 180, the main point being to insure a steady diminution in the size of the grain. There is no necessity to use many different grades; in fact, Dr. Common used sand, 150, and worked flour in succession. (I quote from a letter received from him about two years ago.)

I will defer any consideration of polishing material till later. Meanwhile I would impress upon the would-be beginners in the art the necessity for patience in each stage of the proceedings. I can speak from experience that more trouble is caused by hurry and impatience in going from one grade to the next than by anything else. "The greatest thing in mirror-grinding is to get a good surface before polishing." (Dr. Common). And I have found much reason to believe in the truth of the statement. Every stage of the work must be thoroughly done, and "More haste less speed" is never truer than in this delicate and fascinating art.

ROUGH GRINDING

In order to hold the mirror comfortably and to avoid touching it with the fingers during fine-grinding, I obtained a disc of hard wood 6 in. in diameter and ½ in. thick with a handle 1½ in. thick and 3½ in. long fixed in the centre. The glass disc was smeared with turpentine, and a pool of melted pitch nearly as large as the wooden disc was poured on, the glass having been previously roughly levelled. I strongly advise the would-be speculum worker never to omit the precaution of first smearing the glass with turpentine. I omitted it once, with the result that when the rough-grinding was nearly complete and I was lifting the mirror off the tool, I had the mortification of seeing it drop on a brick floor from a height of some four feet, and, of course, on the "buttered side." Result, a chip 2 in. square out of the face and a new disc required. If, however, the glass is smeared with turpentine, there is little fear of such a catastrophe.

Here a word concerning pitch—which will be a good friend or a bad enemy, according as we use it well or ill. The pitch was Swedish pitch, in 2 lb. cylindrical boxes. To get the pitch out, do not attempt to chip it, but cut clean through box and all with a chisel. The wood, which is very thin, will come away from the pitch easily and leave a block. I cut mine into cakes 1 in. thick and melted them in an iron ladle over the kitchen range. There should be no solder in the vessel used, and a long handle and spout are convenient; but, before all things, do not melt the pitch over an open fire, or in any place where it or its vapors can possibly come in contact with the flame. This warning has been often given before, but it is most important if danger of fire is to be avoided. Having got a pool of pitch about 5 or 6 in. in diameter, place the wooden disc on it without pressure and move it about until the wooden and glass discs are concentric; then press down firmly and leave to cool. It is important that the handle should be accurately centred; this can be tested by rolling the disc of glass along a table and seeing whether the handle rises and falls or is apparently stationary. This adjustment is of some importance, as it ensures correct centring of the concavity.

Provide a flat, broad-bladed knife (a putty-knife, for instance), an old sponge, and a basin or bucket of water (warm for choice).

Wet both tool and mirror thoroughly and sprinkle the tool evenly and closely with the coarse emery. A few drops more water from the sponge will about give the amount of moisture required. It is impossible to say on paper how much emery is required for each "wet" or how much water. This is a matter for experience. If too little water is used the grinding is stiff and unsatisfactory. Too much water or too little emery will cause most of the grinding material to be driven off the tool. Too much emery will give rise to a thick mud, which will slow down the grinding.

Having placed the mirror (or what will be the mirror) on the tool, grasp the handle with both hands, the fingers lying across the disc of wood and reaching to its further edge. Work the mirror to and fro with long, straight strokes, no side motion being given; keep the mirror revolving to the right, or left, as may be convenient, by working the fingers along the edge of the wooden disc, and at the same time walk around the cask, in either direction, so as to get around about once in 20 or 25 strokes. The exact speed is immaterial, but the motion should be continuous. All this will become quite mechanical after a few minutes' work. It will probably be found that a great deal of emery will be driven off the tool; but it can all be collected with the knife and used again, so there is not much waste. The noise made, if the emery is doing its work properly, should be considerable, and it will gradually reduce as the emery wears down. When the mirror glides over the tool nearly silently it is time to put on a fresh "wet." The mirror is slid off the tool—a band being kept under it to avoid accident—and sponged over, a fresh lot of emery is evenly sprinkled over the tool, a few drops of water added from the sponge, and the work proceeds as before. As a rough guide to the quantity of emery required for each wet, I may say that for a 6 in. mirror I used about as much as would go on a silver dollar, heaped up; but this is only a rough idea of the quantity. After every five or six wets the speculum and tool should be thoroughly washed with the sponge.

Before this has been going on long a straight-edge placed across the mirror will begin to show "daylight" in the centre, and we must begin to think of some way of testing the depth of the curve. A plan often recommended is to make templets in glass or zinc by means of a bar cut to the radius of curvatures required and used as a long beam compass, the glass or zinc being ground smooth after cutting. A plan I got from a back number of "Ours," and which proved very accurate and simple, is as follows: Find out by measurement how thick a pile of, say, 100 sheets of writing paper is (I used glazed paper which proved to be exactly 200 to the inch). Dividing by 100, or whatever the number is, we get the thickness of one sheet; in my case, .005 in. Prepare a series of strips of this about ½ in. wide; then if a straight edge of steel is placed across the centre of the mirror and strips of paper placed under its centre until it just turns about the centre rather than about one end, the depth can be easily arrived at by counting the number of strips required. The depth required, the diameter of the mirror being D and the focus aimed at F, is given by the formula $\frac{D^2}{16F}$

Thus, for a 9 in. mirror of 63 in. focus we have the depth in the centre $=\frac{81}{16\times 63}=.08$ nearly, for a 6 in. mirror of 60 in. focus $\frac{36}{16\times 60}=.0375$, and so on.

It is worth noticing that if the focal length of the mirror is made eight times its aperture, the depth required in the centre becomes $\frac{D^2}{16\times 8D}$ or $\frac{D}{128}$; and if the focal length of the mirror is made ten times the aperture, it is $\frac{D}{160}$. Thus a 9 in. mirror of 6 ft. focus would have a depth of 9-128 or 1-14 nearly. I am assuming that the reader has not got the chance of copying an already-worked mirror. If he has the following will be found very simple: Provide a piece of wood (hard for choice) 6 x 1½ x ⅜ in. Drive two 1½ in. wire nails through one end, side by side, and one through the other end, or use screws, it is quite immaterial, so as to form a long isosceles triangle. Through the centre pass a screw about 2 in. long. This will form a rough spherometer, which, if not much use for measuring the depth of a curve, is capable of testing with very considerably accuracy when a certain curve is obtained. Place it so that the points of the end screws rest on the centre screw until the whole just turns about its centre rather than one end. When the rough spherometer is transferred to the mirror being made, the curve thereof is known to be correct when it just turns about its centre as before.

When the rough-grinding is carried so far that the depth of the mirror in the centre is required, it will probably be found on testing with the spherometer that the centre is somewhat more curved than the parts nearer the edge; this will disappear in the fine-grinding, but if a definite focal length is required, it is advisable to go on rough-grinding a little more, as the effect of the fine-grinding, in my hands, at least, is to slightly lengthen the focus.

The stroke in rough-grinding may be as long as can be given without the centre of the mirror going beyond the edge of the tool. If the mirror lifts, in consequence of a too long stroke, chipping is to be feared. A certain amount of pressure with the hands is permissible; but if too much is applied, the emery is liable to be driven off the tool.

ELEMENTS OF AUTOMOBILING—Part IV

J. F. H. MCHUGH

However, we don't want to race our engine more than we can help, and we are near the top of the hill now, so we will let the throttle back and trust to the speed we have got to take us up to the level ground, and it does.

We call it racing the engine when we allow the engine to run at excessive speed either with the clutch out, or with the transmission in one of the lower speeds.

Here we are on the level again. Get into the high speed and let her go along. Advance your spark a little. Now we are getting an earlier explosion in the cylinder and you notice we are moving faster. Now we are beginning to go down hill. All right. While the clutch is engaged, the car will not run away, for its speed depends on the speed of the engine. It is like a bicyclist riding down hill, keeping his machine in control by what is called back pedalling. But throw out the clutch, and let us coast a bit. There is nothing in the way, and there is no danger. Isn't it great? But there seems to be some traffic below there, so let us get our car into control. Press the foot brake quietly. That is all right. These brakes work well. The car is slowing up. We do not want it to stop, so we let the brake grip just enough to have the car run slowly down. At the bottom we let go the brake, let the clutch in gently and run along as before.

We are in a crowded street now, and we must move carefully. Slow up by throwing out the clutch, and, when necessary, by using the brake. Do not come to a standstill if you can help it. If you do, remember to push the transmission into the slow speed before you start forward again. Get back to the high speed as quickly as you can. Keep your eyes open and your wits about you. When you see an opening in the crowd of teams, and a chance to get by, take it. If obliged to run slowly for any distance, come into the slow speed until you are out of the press.

Well, you have done well, for a first trial. You will do still better next time. Your steering will improve. You will learn soon that the best steering is done without much show of effort.

I am now going to take the liberty of reproducing the rules which Mr. Hosford, head of The Boston Young Men's Christian Association Automobile School, has prepared for guidance in starting on an automobile trip. They deserve to be written in letters of gold. I have never met a teacher who to such a degree as Mr. Hosford joined mastery of his subject to a power of communicating his knowledge. Here are the rules:

1—Fill gasolene tank.

2—See that water tank, or radiator, is full.

3—Put oiling system in order for work.

4—Retard the spark.

5—See that the transmission is neutral.

6—Turn on the gasolene.

7—Flood carburetter.

8—Open throttle.

9—Turn on battery switch.

10—Crank up.

AUTOMOBILE ILLS AND THEIR TREATMENT

With proper care, it should be possible to avoid all troubles while running your car. There are some drivers who have records of ten years without a breakdown on the road. If you ask such a man how he keeps clear of all mishaps, his answer will be summed up in one word—care. He knows every part of his car and looks after each part, correcting all defects before they can get far enough to give real trouble. He looks to everything before he starts out, and never overtaxes his machine. For him automobiling is a delightful and inexpensive sport.

But accidents will happen, and it is the purpose of this chapter to point out the course to pursue in the event of something going wrong when one is far from home.

We will assume that our car has stopped after running for some time satisfactorily.

Set your transmission lever at the neutral point, and, as an extra precaution, put on the emergency brake, gently but firmly.

Get out and take the bonnet off the engine. The first thing to do, if the cause of the trouble is not known, is to look over the firing outfit, or electrical apparatus. Examine the wiring and see that all the connections are tight. If they are not, tighten them. If the insulation can be plainly seen to have worn off any of the wires, put in new wires where needed. If the engine still refuses to run, take a look at the induction coil. Crank up. Listen to find if each of the vibrators is buzzing cheerfully, as it should. If one is not working properly, take a look at it, and find out if any dirt has gathered about. If so, clean it, using a bit of fine sandpaper if necessary. If the vibrator still refuses to work, change the adjustment by turning the thumb screw, either to increase or reduce the distance between the points which are drawn together by the magnetism in the iron core of the induction coil. This magnetization of the core, you will remember, is caused by the primary current in the induction coil, and stops the instant the current is interrupted, starting the secondary current, which goes to the engine.

If the buzzing is now resumed, and the engine begins to run again on being cranked up, our troubles are over.

But suppose the buzzing is not renewed, or suppose it is renewed, and still the engine does not run. Then we must try something else. Perhaps the commutator has got fouled with grease, or something which acts as a conductor of electricity and thus prevents the breaking of the circuit, which is the business of the commutator, or, as it is also called, timer. Clean the inside of the rim with fine sandpaper. Do not use emery paper, for emery is a conductor of electricity.

If the trouble continues, try the spark plugs. Unscrew these from the cylinders, and lay them on a board or some flat surface. Take care that the insulation is complete. Now crank the engine. Each plug in turn should give what is called a good "fat" spark. Remember that the spark in the cylinder is smaller than would be given in open air, conditions being otherwise the same. If the spark is faint, it is a sign that the battery is weak. Test the cells with voltmeter or ammeter as the case may be, and cut out those cells which give a reading below 3 amperes, or 2 volts. If it is a dry cell battery, you will have some spare cells with you. With these you can replace those cells which have run down. Or, at a pinch, you can leave out the weak cells and connect the others up to form a battery, and you will probably get enough current to take you to some base of supplies.

If a spark plug gives no spark, it may be fouled. That is to say, the spark gap has got choked up with soot, and the current, instead of jumping the gap and giving a spark, is running along the path made by the soot or carbon between the ends of the spark gap. The obvious thing to do is to clean the plug. Brighten the points of the spark gap with sand paper, and rub off all soot or other matter which may have gathered about the plug. If the mica or porcelain covering has got cracked, we must have a new plug.

If the trouble still hides itself, we will hunt for leaks in the insulation. Take a positive and negative wire of the primary battery, strip the insulating material from the end of one, and rub this bared end along the other wire. If at any point a spark is given out, it is a sign that the insulation has worn thin or bare at that point, and we must have a new wire. The wires from the induction coil can be tested in the same way. Handle these induction coil wires carefully, or you may get a strong shock.

The secret, then, of proper firing is to have all the electrical connections complete and tightly fitting. Insulation must be thorough. Spark plug, vibrator and commutator must be clean. The points of the spark plug must be from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch apart. The points of the vibrator should be adjusted so that a good cheerful hum is given out. Sometimes a weak battery may be got to give service if the vibrator points are far apart. The nearer together the points, the more rapid the vibration. Induction coils must be kept dry. If one gets damp it becomes useless.

If the electrical outfit is working properly, and still the car will not go, we will test the engine for compression. First shut off the electrical current. Then crank the engine, and, if this is done easily, there is a leak somewhere in the cylinder head. Look over the valves, petcock and spark plug, and if anything is wrong there, set it right in the manner already explained.

Perhaps there is something the matter with the carburetter. Some water may have got into the gasolene, and, if so, has got to the bottom of the float chamber, and we are getting no fuel. This is quickly remedied by opening the little cock to drain the carburetter, allowing the water to run off.

A bit of dirt may be clogging the narrow pipes through which the gasolene flows from the float chamber to the spray nozzle. A bit of wire will clean this out.

The more serious troubles which may arise on the road are usually due to ill usage of the car or defects in the parts. Remember that with a many-cylindered engine, one or more of the cylinders may come to grief; but we can still get on our way with the sound cylinders, though not so smoothly.

A driver who has studied his car is usually able to lay his finger quickly on any trouble that may arise, and remedy it.

An outfit of tools is part of the equipment of every well-regulated automobile. This will include a supply of wrenches, a screw-driver, a little vise and other articles, of which a list can easily be had. Every car should carry one or more spare tires; also spare spark plugs, cells, wires, etc.

One last word. Never leave the garage without making sure that your steering gear is in thorough order. Consider for a moment what would happen if you could not turn your car to avoid a collision or to avoid running over somebody. Keep your car always under control. In the city always slacken speed when passing street corners. Have your horn in working order and do not wait to sound it until the person before you has no longer time to get out of the way.

The End.

At a recent meeting of the New York Electrical Society one of the speakers, lecturing on the subject of domestic electricity, referred to a certain house that had been designed to be heated and lighted by electricity alone. The house contains no chimneys, stoves or coal storage room, and the saving in these requirements of the usual coal-heating system was sufficient to pay for the entire electrical installation. In regions where the cost of coal is high and water power is plentiful, electric heating and lighting is no doubt more economical than coal heating.

FORGING FOR AMATEURS—Part XVIII

F. W. PUTNAM, B.S.

When the power hammer is used great care must always be taken to be sure that everything is in the right position for striking a blow. The work must necessarily be placed flat and solid on the anvil, and the part to be hammered must be held as nearly as possible below the centre of the hammer-die. Should the work be held under one corner or edge of the hammer-die, we shall be certain to get a glancing blow which will of course have a tendency to strain the frame.

Frequently various forging tools are used with the steam hammer, and when they are used they must be held in such a position that the part of the tool that touches the work shall be directly below the point of the tool on which the hammer will strike. For instance—suppose we were to cut off a piece under the hammer, the chisel must be held exactly upright and directly under the centre of the hammer as shown at A, Fig. 191. If, on the other hand, a glancing blow is given the chisel by the hammer because of the way the chisel is held as is shown at *B*, Fig. 191, then the result of the blow would be as shown by the dotted lines, the chisel would probably be turned over and knocked flat, and frequently might be thrown away some distance from the hammer. Heavy blows should always be used to draw down a bar to any great extent and the stock being hammered should bulge out quite a little as is shown at *A*, Fig. 192; this shows that the metal has been worked through from top to bottom.

Light blows will usually result in the end of the piece becoming convex as at B; this shows that the metal on the outside of the bar has been worked more than that on the inside. If this kind of hammering is continued long enough the bar will split and work hollow toward the centre as shown at C, Fig. 192.

Round shafts, if formed under flat dies will, unless very carefully worked, frequently split in this way. The faces of the hammer and anvil dies are usually of the same width though not always

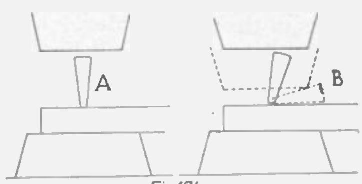


Fig. 191.

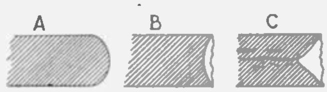


Fig. 192.

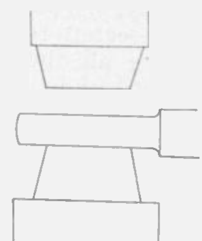


Fig. 193.

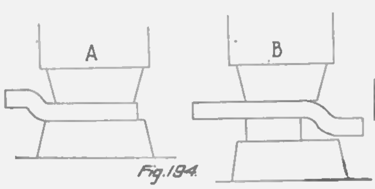


Fig. 194.

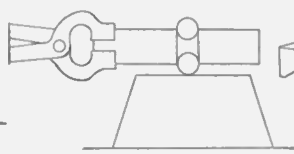


Fig. 199.

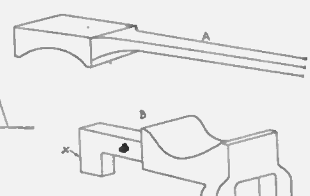


Fig. 196.

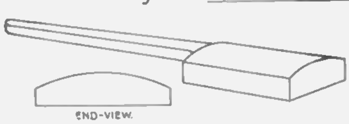


Fig. 197.

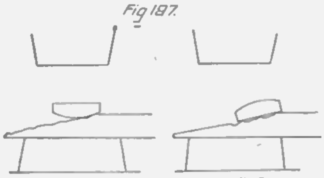


Fig. 198.

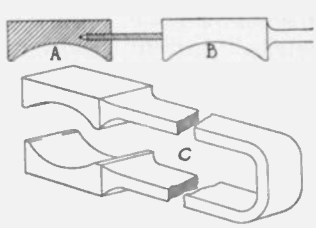


Fig. 195.

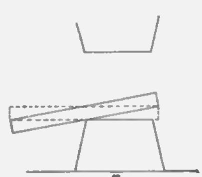


Fig. 200.

of the same length. When the hammer is resting on the anvil the front and back sides of the two dies will be in line with each other and either one or both ends of the anvil die will project beyond the ends of the hammer die. While, in many cases, we find that the faces of the two dies are of the same shape and size, sometimes it may be an advantage to have one shoulder formed on one side of the work only. If a shoulder is required on one side only, as in forging tongs, we must place the work so as to *work in* the shoulder with the top die, while the bottom die is used to keep the under side of the work straight as shown at *A*, Fig. 194. A shoulder on one side only can also be formed by using a block as shown at *B*, Fig. 194. The figure shows one way of forming the shoulders, or we may reverse the positions of work and block placing the piece with the flat side on the anvil and the block placed on top.

If a shoulder is to be formed on both sides of the piece we place the work under the hammer in such a way that the bottom die will cut in and form one shoulder while the top die forms the other. Fig. 193 shows clearly the cutting of the double shoulder, the piece being placed so that the work is done from the side of the hammer because the edges of the dies are even.

Later on in these articles I will discuss in detail the method of forming shoulders as applied to individual forgings.

TOOLS

For ordinary steam hammer work we find that the tools used are very simple in shape and few in number. Swages, commonly made as shown in Fig. 195 are used for finishing work up to say, 4 in. in diameter. The two parts of the swage are held apart by the long spring handle. This handle, frequently made as shown at *B*, is formed of a separate piece of stock and fastened to the swage, a thin slot being made in the side of the block with a punch or hot chisel, the handle being forced into this and the metal closed around it with a few light blows around the hole with the edge of a fuller.

The handle may also be made as shown at *C*, by drawing out the same piece from which the blocks are made and then hammering down the centre of the stock sufficiently to form the handle, the ends being left full size to make the swages.

Fig. 196 shows a method of making swages for large work. The one shown at *B* is made for an anvil die with a square hole very much like the hardie hole in an ordinary anvil, near one end. The horn at *X*, of course, slips into this hole and the other two projections fit, one on either side, over the sides of the anvil. These horns will prevent the swage from slipping about when in use.

FULLERING AND TAPERING TOOL

The faces of the anvil and hammer dies are flat and parallel, and so it is not possible to finish smoothly any work which has tapering sides between these parallel die surfaces. Fig. 197 shows a tool by means of which tapering work may be smoothly finished.

TAPER WORK

Fig. 198 shows clearly by the use of the tapering and fullering tool shown in the previous figure. It can be used, as the figure indicates, for roughing out taper work, in which case the tool is used with the curved side down, the straight side being held flat with the hammer die. When the taper is ready for finishing, the tool is reversed in position, the flat side now being held at the desired angle, the hammer striking the curved side. Of course there is a limit to the angle that may be made since the tool may be forced from under the hammer by the wedging action.

FULLERS

The ordinary fuller as we have been accustomed to use it for making hand-forgings is very seldom used in steam-hammer work. In place of them we use simple round bars, usually made of tool steel, if they are to be in frequent use. Fig. 199 shows one use of these round bars. Here the work as indicated in the figure has a semicircular groove extending around it, thus forming a *neck*. This groove is formed by placing a short piece of round steel of the right size in the anvil die; on this we place the work, the spot where the neck is to be made placed directly on top of the bar. Directly above the bar, and parallel to it on top of the work, we hold another bar of the same diameter. By striking with the hammers, the bars are of course driven into the work, and thus forming the groove. Care must be taken to turn the work frequently so as to get a uniform depth of groove on all sides; it is easy to see that if we held the work in one position that one bar will cut in deeper than the other.

ADJUSTING WORK UNDER THE HAMMER

It is very important when a piece of work is first laid on the anvil that the hammer be lowered lightly down on it so as to properly *locate* it first before any heavy blows are struck. This is usually sufficient to bring the work flat and true with the die faces; if this precaution has been taken there should then be very little chance of jumping, jarring and slipping, caused by holding the forging in the wrong position. This is especially true when tools are used, since great care must be taken to see that the hammer strikes them evenly. Should the first blow made be a heavy one it is easy to see, that if the work has not been placed exactly right under the centre of the hammer, there is grave danger of the piece flying from under the hammer and causing an accident. Fig. 200 shows how a piece which has been placed carelessly on the anvil may be knocked into the position shown by the dotted lines. The next article will continue with steam hammer work, taking up the making of simple forgings under the steam hammer.

Metal filament lamps are now being used on ships and railroad cars. Such uses were considered impossible a few years ago, owing to the frailty of the long filament required in these lamps, and it was supposed at the time that they could never be used anywhere but on a fixed support and hanging downward. Now the filaments are so much stronger that in a recent railroad wreck the metal filament lamps in a car that was completely overturned were found to be in perfect condition and fit for further use in the regular service.

Cost of Electric Cooking

A kitchen range suitable for four consists of a hardwood table, finished in mission style, completely wired and ready for connecting with the city lines. The utensils consist of a 2 qt. cereal cooker, a 2 qt. tea kettle, a 3 pt. coffee percolator, a 7 in. frying pan, broiler, grid, oven, toaster and a small water heater. Where the lighting plant does not connect the kitchen outfit free of cost it can be readily done by any electrician at a nominal figure. A separate meter registers the amount of electricity used for cooking purposes. Such an outfit can be economically operated at a cost averaging close to $1.25 a month per person, or $5.00 a month for four persons. The electric range does not provide hot water, but the continuous-flow water heater is used in connection with it. With this type of water heater, which is attached to the faucet, the operating of the tap turns on the electricity and the water is heated as fast as it is drawn, without a particle of wasted energy; 30 gals. can be heated in this way for 15 cents.

In one family where gas was obtainable for $1.00 a thousand ft., the average cost per month for cooking by gas was $3.12. For a time all the cooking was done on gasolene stoves; at a cost of 15 cents per gal. for the fuel the average cost per month was $3.00. A few years before, when gas was impossible, the cooking for this family was done over coal fires at a cost of $7.50 a month. Now the new electric kitchen is used exclusively at an average cost of $6.85, consuming 137 k.w. a month at a special rate of 5 cents.

Another family of two kept an accurate account and found their bills close to $3.15 a month for electric cooking. When a sister came to live with them the average increased to $4.35 a month. The average cost per person per meal was only $0.0143.—*American Review of Reviews.*

The longest bridge in the world crosses the Yellow Sea near Sangang, China. It is called the Lion bridge, and its length is 5¼ miles. It is supported by 300 huge arches, is 70 ft. above the water and is enclosed in an iron network.

A LOUD SPEAKING TELEPHONE

F. J. B. CORDEIRO

The writer remembers distinctly when he first heard of the telephone. It was shortly before the opening of the Centennial Exposition in Philadelphia. He was informed that a Prof. Bell had invented a way of transmitting speech over a wire by means of electricity. The impression he gained was that the voice was transmitted in its full volume, so that two persons could converse at a distance precisely as if they were in each other's presence. When, therefore, shortly after, he came to examine and use Bell's telephone for the first time, although the results were astonishing, imperfect as the instrument then was, still there was a feeling of disappointment that the instrument did not talk; it merely whispered. It was as if my friend had come up to me and applying his lips closely to my ear whispered something which the persons in my immediate proximity were not privileged to hear. Unless the contact between his extended lips—in this case, the receiver—and my ear was extremely close, it was impossible to hear him at all. The success of the experiment depended upon the marvellous sensitiveness of the ear to sounds almost infinitesimal, provided they originated within the outer canal. In other words, after the idea had been conceived of causing a current to follow the undulations of the voice, it was almost impossible that any form of receiver should fail, provided it were placed close enough to the ear. For instance, an iron nail with a few turns of wire about it, if thrust into the ear will allow us to hear a conversation quite satisfactorily, although not so well as the receiver which Bell hit upon in his early experimentation.

It is a singular fact that the invention and development of the telephone has depended more upon practical experimentation than upon any theoretical prevision, to a greater extent than in any other invention of modern times. Long before the coming of the telephone, there were two prophecies regarding the possibility of the transmission of speech by means of electricity. Lord Kelvin, then Sir Wm. Thomson, had stated that it would never be possible to transmit speech by electricity. On the other hand Bourseul, in 1852, had declared that the time would come when conversation would be carried on over a wire with no greater effort than that required in ordinary speech. "I have asked myself," he then wrote, "if the spoken word itself could not be transmitted by electricity: in a word, if what was spoken in Vienna could not be heard in Paris." Of these two prophecies, the first carried with it by far the greater authority.

In the evolution of the telephone, what we might call its morphology has been largely a matter of chance. Before the invention of the carbon grain transmitter with an immovable back, known as the "solid back transmitter," only whispering telephones were possible. With the first imperfect transmitters appeared the well-known Bell receivers, now in universal use in America, and its watch case variety favored in Europe and elsewhere. If the solid back transmitters had been invented before the receivers had assumed a permanent and settled form, it seems quite likely that there would have been a further evolution of the receivers. For the present receivers, though fulfilling admirably their functions in a whispering system of telephony, are neither theoretically nor practically the best forms.

The complete solution of the problem of transmitting speech by electricity embraces the problem of transmitting speech in the full volume or even in a greater volume than that originally delivered into the transmitter. Whispering telephony is only a very partial solution of the problem. This was fully realized in the early days of the telephone and many attempts were made to accomplish this end. None of these attempts, however, was successful and it has come to be considered practically impossible of fulfillment. We must note* one exception, viz.: Edison's chalk cylinder receiver, or as he has called it, the electro-chemical tele-

* The talking arc, of course, does not come in the category of a practical house telephone.

phone. This instrument was first shown at Saratoga on the evening of Aug. 30th, 1879. The event was reported in the *New York Tribune* as follows: "The town hall was crowded with people, who were all interested and amused in the exhibition and description of the new chemical telephone, Mr. Edison's latest invention. On the platform were Prof. Barker, Prof. A. Graham Bell, Prof. Borton, and Mr. Edison. . . . The comparative powers and qualities of the various forms of transmitters were tested for the enlightenment of the audience.

. . . . Finally the electro-chemical telephone was used with brilliant results. The talks, recitations and singing could be heard all over the hall, and the audience was delighted. . . . The inventor showed that it made no difference in which direction the cylinder was turned, or whether it was turned fast or slow. But if he stopped turning the crank, the sound stopped the same instant. No sound is heard until he begins to turn the crank, and the message only continues while the revolution of the cylinder is kept up. It is certainly a remarkable instrument."

The last sentences clearly show that the instrument, while interesting as a scientific toy, is not practical. It does not solve the problem of a loud speaking telephone for practical every-day use.

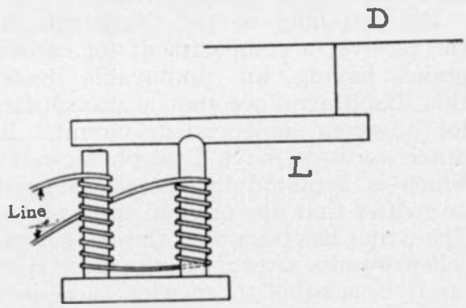
Before taking up the major problem, a few theoretical considerations will be necessary. A circular diaphragm forms the essential part of any receiver and it behooves us to consider carefully the best material for such a diaphragm. Glass, as being the most perfectly elastic substance known to us, would seem to be the best substance for a vibratory diaphragm, and practically we find such to be the case. Iron has a peculiar twang of its own which can best be described as "tin-panny." And so with many other substances—each possesses its own peculiar "timbre." Glass alone does not seem to have any "timbre," but reproduces sounds with great faithfulness, adding to them nothing of its own. It perhaps may be charged against it that it errs on the other side—polishing and beautifying a voice that lacks these characteristics.

But our diaphragm, of whatever material it is constructed, will lack volume unless it is mounted upon a resonating body or sounding box. A piano wire stretched between two vises will be barely audible when struck. Mounted upon the sounding-board of a piano, it gives out a full volume. In the same way, if a larynx could be separated from the body, although the vocal cords were made to vibrate, the sounds will be barely audible. In this case the chest acts as a sounding board and gives the voice its full resonance. Thus, although a whispering telephone requires no resonating body, for a loud speaking telephone we shall have to mount our diaphragm upon a sounding box, and this should be of thin seasoned wood. The shape of the box is of some importance—it should be circular and the diaphragm should be mounted at the centre. Although the sounding boxes accompanying tuning forks are usually oblong, it would be better to have these boxes circular, and of course of the size suitable for resonating with the fork.

We next come to the manner of producing our vibrations by means of an electro-magnet. If we use the bottom of a tin pail as our diaphragm and place the two poles of an electro-magnet near this diaphragm, but neither of them touching it, we can hear sounds (speech) transmitted over the line, provided we place our ear close enough to the pail. Our receiver here is precisely similar to the ordinary bipolar receiver in universal use. The dimensions alone are slightly different. There are two air gaps in the magnetic circuit which passes through the electro-magnet and the portion of the diaphragm immediately in front of it. That such a form of receiver, viz., the ordinary bipolar receiver of commerce, is far from efficient, we can easily convince ourselves by allowing one pole of the electro-magnet to touch the diaphragm while we leave a single air gap between the diaphragm and the other pole. The sound (speech) now becomes intensified many fold, so that we hear distinctly whatever is spoken into the transmitter several feet from the receiver or pail. We have accomplished this by simply closing one of the air gaps, thus increasing the strength of the magnetic flux in our magnetic circuit which has a single air gap. We might go further and keep, by capillary attraction, the space between our free pole and the diaphragm moistened with a solution of some paramagnetic substance, such as ferric carbonate, thereby still further increasing the magnetic flux. In practice, however, the advantage so gained is hardly worth the trouble of keeping this space in a proper condition, so that on the whole we shall prefer to keep our air gap clean and ready for use.

While our tin pail receiver will reproduce sounds loud enough to be heard over an ordinary room, it has one serious defect,—the diaphragm itself is too thin to carry the full magnetic flux. In other words its lack of substance introduces magnetic resistance; for, to allow the passage of the full magnetic flux, a certain amount of iron cross-section must be provided for its path, just as for an electric circuit we must allow a full cross-section of metallic substance in order not to reduce the current. We can best accomplish this in the following manner:

In the diagram, *D* represents a diaphragm, to the centre of which is rigidly



attached a soft iron lever *L*. This lever we must make of sufficient cross-section at its extremity to carry the full magnetic flux. One pole of the electro-magnet is slightly sunk into the lever so as to insure constant metallic contact over a broad surface. The other pole is separated from the lever by the shortest air gap possible. We have here attained the conditions of maximum efficiency. It will be seen that if we attached a moderately heavy armature to the centre of the diaphragm of an ordinary bipolar receiver, we should, notwithstanding its weight, increase the efficiency. Likewise if we actuated its diaphragm by means of a massive lever with a single air gap we should increase its efficiency greatly. But in a whispering receiver, questions of efficiency have very little, if any, importance. The ordinary Bell receiver has a low efficiency, but it whispers, and that is all that is required of it. When we get down to such vanishingly small impulses and amplitudes, the question of efficiency hardly appears. Still the receiver we have just described would work with a smaller current than the ordinary commercial receiver.

When we come to deal with a loud-speaking receiver, where the amplitudes become sensible, the question of efficiency is an important one. By mounting a glass diaphragm upon a circular sounding box and actuating it in the manner described, the writer has by means of an ordinary commercial transmitter been able to reproduce the voice with something like the intensity with which it was spoken. It must be remembered that this was merely the judgment of several persons and that the measurement of the intensity of speech by judgment is far from exact. It would be best to say that all who heard it were certain that it was *considerably* louder than the spoken voice. In clearness of enunciation there was nothing to be desired.

The diaphragms used have been from 1½ to 3 in. in diameter; the sounding boxes from 12 to 24 in., and the lever from 6 to 9 in. in length. The magnets have been rather small, the coils being about 1¾ in. in length. The resistance has been moderate—not more than 4 ohms.

The size of the magnet and the resistance seems to be an object of experimentation for each instrument. Though all magnets produce fairly good results, a certain size seems best for each individual instrument, above and below which the results are not so good.

Theoretically the loudness of the receiver would depend upon the strength of current used, but practically a limit appears in the ordinary transmitter owing to its "frying" and becoming excessively hot when very heavy currents are used.

The ordinary commercial transmitter

was designed for a whispering system of telephony and is not perfectly adapted to the loud-speaking system. However, it works here fairly well. In order to carry very heavy currents without "frying" it would be necessary to have a rather large diaphragm, preferably of thin glass, to which were attached several compartments for the carbon granules, through which the current could be divided in parallel. In other words a multiple or combined transmitter actuated through a single diaphragm. A large glass diaphragm attached to an ordinary commercial transmitter carries the voice from a considerable distance, so that it is not necessary to be very near the transmitting apparatus.

This renders the work of dictating to a person at a distance extremely easy. Both parties talk to each other as freely as if they were present in person, and meanwhile they are free to use their hands as they please and even to walk about.

The writer's house is furnished with speaking tubes, but these are now never used. Instead there is a system of loud-speaking telephones, carried by wires from one room to another. Of course it would be possible to have a system of whispering receivers as is the case now in many buildings, but this would necessitate a ringing up apparatus in every room, to say nothing of the delay of going to the telephone.

The uses of a loud-speaking telephone are manifold; a few of them are the following: In transmitting loud speech or music over ordinary telephone wires to moderate distances, say up to a mile, where the resistance is not excessive, a single direct circuit including the transmitter and receiver may be used. Where the distances are greater the transmitter must be in a local circuit of small resistance. From this local circuit the impulses are stepped up to the line circuit and at the other end stepped down again from the line circuit to the local circuit including the receiver. The electro-magnet of the receiver must be constantly polarized in one direction, which can be effected by having the cores of the magnet permanently magnetized, or, as I prefer, by having an electromotive force in the circuit which can be varied to give the maximum results as determined by experiment. For distant work there is a marked difference between the whispering and loud-speaking systems. As is well known, the stepped up currents act directly on an ordinary receiver. This is not efficient working, but as we have already seen, any current large or small, of high or low tension, can be heard in the Bell receiver. In the loud-speaking system, we must make our currents do work and therefore must step down the high tension pulses from the line. There are thus three complete metallic circuits. The writer has been able by interposing a resistance equal to the resistance of 50 miles of ordinary telephone wire, to reproduce the voice loudly at the other end.

It will thus be seen that a public speaker, if ill, or unable to reach a distant audience, will be able to address them from his home, perhaps better than if he were present in person. An orator in New York may thus address an audience in Boston. There does not seem to be any reason why he may not address several audiences at the same time in as many different halls.

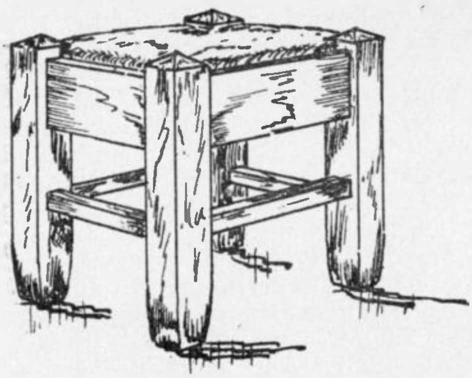
By attaching to the diaphragm of the receiver a compartment for carbon grains having an unmovable back, this diaphragm becomes a transmitter for a second independent circuit. In other words we have a telephonic relay which is actuated by energy as great or greater than the original transmitter. The writer has been able thus to get excellent results after relaying twice. How far it is possible to go with successive relays the writer does not know, but it is probable that the lack of mechanical synchronism of the parts after a few relays would quickly impose a practical limit. There is, however, little distortion after one, and even after two relays.

An excellent combination seems to be to relay once with a loud-speaking receiver and then to carry on the voice to an ordinary receiver. The tones here are especially loud, clear and polished, above anything ever heard in an ordinary whispering circuit. The battery power necessary for a loud-speaking

(*Continued on page* 415)

HOW TO MAKE A MISSION FOOTSTOOL

HERMAN FASEL



Finished. Stool.

The material necessary to make this stool can be secured at any planing-mill. The four sides can be ordered planed, as this will save a good deal of hard work, and cost very little.

The following is the list of stock to be ordered;

4 legs	12	x 2	x 2		in.
2 sides	9½	x ¾	x 3		in.
2 ends	7½	x ¾	x 3		in.
2 pieces	9½	x ¾	x ¾		in.
2 pieces	7½	x ¾	x ¾		in.
1 piece	9½	x ¾	x 7½		in.

Oak is the most suitable wood, and is very easily finished with a mission stain.

The stain can be bought at any hardware store or paint shop. Directions for using are always found on the cans.

Begin by first cutting the legs to the shape as seen in the plans. Next place them on the bench side by side, with the ends even, mark the mortise holes, using the dimensions given in the plans. These are cut ½ in. wide, and about ⅞ in. deep. Care must be taken to get a clean edge on the mortises.

The tenon ends are cut next on the rails. These are cut to make a tight fit in the mortises, and all of the same length. When these are all cut, the stool can be put together, with plenty of glue on the joints.

Next, the board to rest the cushion on can be put in place, as shown by dotted line, per plan, which rests on cleat nailed to the rails.

Now sand-paper the stool, first using a No. 1 paper and finish with a No. 00 sand-paper.

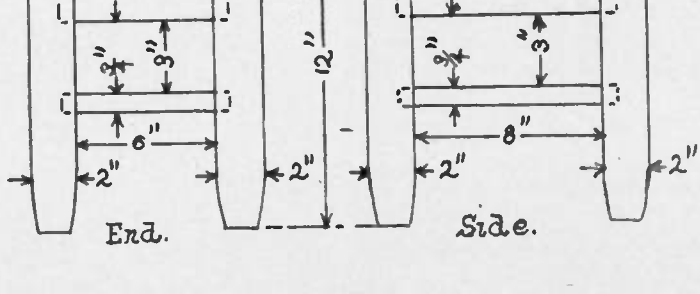
When this is done the stool can be finished as before stated.

A cushion of dark leather can be bought at a furniture store or upholsterer's shop. It can also be made with two pieces of leather 9x11 in., sewed together with leather thongs or straps and stuffed with hair or elastic cotton felt.

Chicago's street lighting arc lamps, 11,670 in number, are operated by electricity developed on the Chicago drainage canal. The current is transmitted from Lockport, 30 miles distant, on aluminum cables.

(*Continued from page* 414)

receiver is of course greater than that of a whispering circuit. In the first case considerable work is done, in the latter case the work may be infinitesimal. From four to eight or even ten Columbia cells are necessary to reproduce the voice in its full volume.



End. *Side.*

TROUBLES ON ARC LAMP CIRCUITS

J. A. S.

In connection with the maintenance and operation of electric supply systems owned by municipalities, various problems frequently arise in connection with the up-keep of circuits and apparatus for the purpose of connecting a supply of public lighting. As the troubles are in many cases entirely special to this class of lighting work, it will probably be of some interest to other engineers engaged in this work, if two or three examples of difficulties are remarked upon.

In a system which is operated by means of a continuous current at 480 volts, a 3-wire distribution is used for the lighting of houses, while it is customary to take one or more special lamp curcuits from the station at 480 volts and to connect the arc lamps in series of eight across this pressure.* The working of the whole series depends on the satisfactory performance of every part of the mechanism of each lamp, except that the equivalent resistance may be inserted in place of a lamp which refuses to function properly in order to keep the voltage right and ensure continuity of circuit in respect to other lamps of the series. In one system of this kind the series coil of one of the arc lamps developed a fault by reason of its becoming overheated. This was because the carbons had become stuck and the excess current had overheated the coil, breaking down its insulation and putting the findings to earth. The lamp was fitted with an automatic switch which, in the case of the non-striking up of the arc, should have switched the current through the compensating resistance and so put the lamp out of circuit and restored current to the remainder of the lamps. Owing, however, to the fact that it had a bad contact, this switch did not operate and the whole circuit was put out of proper action, the lamps burning very badly and unsteadily. As this occurred at a particularly awkward time when the streets were crowded and the light was urgently required, the temporary measure in order to get over the trouble was adopted of carefully short circuiting the terminals (a) and (b) in the sketch by means of a piece of fuse wire calculated to carry 20 amperes. The three leads, A1, B1, and C1, passing up to the lamp, were then disconnected and the result was that the whole lamp, with its earth, was cut out without extinguishing the circuit. In order to prevent any recurrence of a similar trouble in the future, an alteration was made in this system of supply. The lamps which were adopted after that date were not provided with automatic switches embodied in the lamp, but specially designed automatic switches were fitted in the base of the standard, where they were more accessible to examination, and owing to the greater space allowable could be made of more useful dimensions.

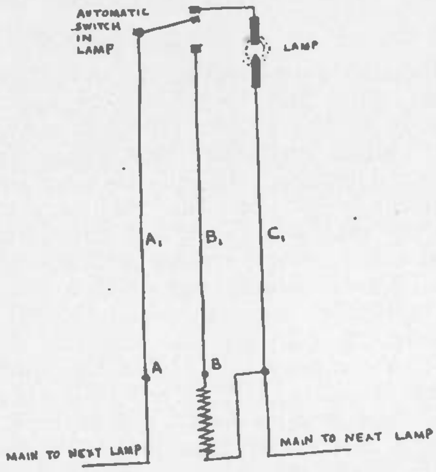
In connecting up street lamp circuits of this nature special attention should be given to the way in which the connections from lamp to lamp are laid, as quite frequently serious trouble may occur through careless handling by the cable workmen. An instance of this occurred in a widely extended system of distribution in which a special arc lamp circuit was run for street lighting in a particular district from a substation. The wires inside one of the columns became bared of insulation, owing probably to rough usage and undue strain put upon them when the wire was being pulled into the lamp column. The result was that a short circuit was set up between the two leads, and considerable excess current was developed. Unfortunately, however, the circuit fuses on the street lighting system did not blow at the substation, but the trouble went further back to the fuses on the low tension side of the transformer. These blew and put out the whole of the lighting in that particular area, causing a considerable amount of inconvenience. The trouble was put right for the time being by repairing the lamp wires as quickly as possible; and in order to prevent a recurrence, smaller circuit fuses were

* This must refer to "open" arc lamps. If modern enclosed lamps are used only four could operate at 480 volts. Such are here called "power circuit" arc lamps.—Ed.

put in on the street lighting section. The trouble therefore caused a thorough inspection of the wiring of the arc lamp posts to be made, with the result that a considerable amount of bad workmanship was discovered, and the folly of cheap labor and narrow time margin on such installation work was made apparent.

Another method by which the insulation of arc lamp cables may become defective is owing to the fact that the lamp develops an excessive amount of heat which is not sufficiently dissipated by conduction and radiation. Should the insulation of the cable be made of india rubber and the leads are conducted to the lamp in such a way that they cut the current of hot air or are in contact with heated metal, it will be found that owing to repeated heating the insulation hardens, and eventually cracks off. The bare copper may then come into contact with some portion of the column, and in this way serious earths on arc lamp circuits be caused. The only way to repair such faults when once insulation has been installed is to reinsulate the cable with rubber tape; but it is advisable, in all cases where excessive heat is to be expected, to use cable protected with asbestos braiding.

In connection with the question of faults on street arc lamp circuits it may be worth while to give a word or two of warning as to the conditions under which these should be tested. It is usual when there is an earth on street arc lamps to locate the same by means of a testing set, consisting of an ohm metre and generator. The latter instrument gives, when in operation, a pressure usually of about 500 volts, and this in itself is a dangerous tension to be applied to any workman who may be in contact with the live portion of a circuit under test, and at the same time touching the earth iron work of a lamp or its column. Cases have been known where a test of a circuit of this kind has been attempted at a time when arc lamp trimmers have been engaged in changing carbons on the circuit. The result has been that not only has the value of the test been nullified, but, what is more serious, the trimmers have received very severe shocks which might quite easily have thrown them



off the poles or ladders. It should be remembered in this connection that the effect of such an applied voltage is considerably intensified by the inductive action of the iron cores of the lamp coils, and when testing of this nature is contemplated it should be made a rigorous rule that arc lamp trimmers be warned before the testing is commenced.

The Electric Range

Cooking by electricity is already a recognized practice and the heating engineer now has a recognized profession. A great many families have already taken out their cumbersome coal stoves and odorous gas stoves and installed electric ranges in their kitchens. The complete electric range for a family of four costs about $75.00. This seems high in comparison with the cost of a coal or gas range, but it must be remembered that with the electric range comes a complete set of aluminum and copper cooking utensils, while with coal or gas you have to purchase these things extra. In most cases these ranges, once purchased, are connected free of charge by the electric lighting company, which is usually very anxious to have people do their cooking by electricity. With these companies the "day load," as the current consumption is spoken of, is very light, and it is not until after dark when the lamps are lighted that the demand for electricity really begins. Therefore, in most cases they are willing to make a low rate of 5 cents a kilowatt during the day.

—*American Review of Reviews.*

THE SELECTION OF STATIONARY MOTORS

S. H. SHARPSTEEN

Electric motor salesmen and engineers often find it difficult to select motors of the proper rating to drive the various machines that come up for consideration. In one case a certain engineer looked over the machinery of a shop that was fitting up structural steel for building purposes and secured data, for a contractor, on which to base an estimate for individual electric motors. A contract was awarded to another company that bid on the same make of motor, but agreed to do the work with smaller sizes. For example, a 5 h.p. motor was guaranteed to do the work where the first contractor had recommended one of 7.5 h.p. The purchaser, according to agreement, constructed metal bases from drawings, furnished by the successful bidder, on which the motors were bolted and geared to the cutting-off machines. When the motors were placed in service it was found that although they were practically of the same rated output as the small individual steam engines that formerly did the work, yet after a cut was made the fuses would blow before the motors could get the speed of the cutting-off tools to a rate that would allow the motors to stop the excessive flow of current. Larger motors and motor bases had to be installed before the equipment would be accepted.

The above was a case of the motor first driving a heavy wheel, the momentum of the wheel and the motor combined later forcing the cutting-off tool through the structural steel. While the tool was going through the steel much more power was required than the full-load output of the motor, and more power than could be supplied by the motor and wheel combined to keep the speed sufficiently high to prevent the fuses from blowing.

When the engine was being used it would slow down with the fly-wheel while the cut was being made and later would accelerate the fly-wheel without causing any perceptibly bad results.

If the motors had been belted with leather belts, the motor pulleys might have been able to creep under the belt sufficiently, just at the time of cutting, to save the high-current peak, but the gear compelled the motor to run at a speed having a fixed ratio to that of the cutting-off machine.

In cases of the above kind the salesman should be careful in applying the information given by manufacturers who have no record of the operation of their machines driven with individual motors.

The elevator, dumb-waiter, and other hoisting apparatus deserve special attention on the part of the persons selling electrical apparatus in order to meet successfully the competitor's price and at the same time to have the motors work properly when orders are secured for them. Since the motors used for this kind of work have such intermittent runs and are idle much of the time it is customary to rate them specially for the work. If a prospective buyer states that 10 h.p. will be required to lift a loaded elevator car, for which he wants a motor, one salesman might bid on a 10 h.p. motor, constant running, with full-load rating, and another salesman on a 7.5 h.p. or even a 5 h.p. motor rated for constant running service. Either of the motors might do the work, but one would be higher in price compared to the others. One make of motor may withstand a very high rating for this kind of work, while another one, running successfully doing various other kinds of driving, would fail to give good results, as has been proved in practice.

When the elevator people commenced the use of motors of high rating, series windings were employed to excess. The result was a varying elevator running speed. If the counterweights were sufficiently heavy to more than balance the weight of the empty car, there should be a very light load on the motor, consequently a small amount of current passing through the series winding, and as it is usual to make series field coils a part of the normal field windings, the car speed would be much above normal while ascending with the attendant only, and when descending with a very heavy load the motor might be driven as a generator, thereby sending a current in the reverse direction through the series field coils and allowing the motor and elevator to run at an excessively high speed.

In a case of the latter kind in New York City an elevator contractor disconnected the series field coils and coupled the shunt windings in multiple, thereby obtaining a much more uniform speed; but field coils working under such conditions would soon give trouble if left in circuit for much of the time.

In some cases the motor field coils are used in multiple at start, and as the car is brought to speed, they are placed in series by the elevator controller. This answers the purpose of the series field coils for start and produces a more uniform running speed. In the change from multiple to series connection of the field coils for this purpose, it might, in some cases, be necessary to use resistance in connection with the field winding to prevent too sudden speed increase.

When the electric generating plants in the navy yards were small, the naval specifications for elevator work were drawn to insure a current inrush decreased as much as possible, and they show in what respect trying to avoid one trouble may lead to another.

Several firms were awarded contracts for buildings, each building to have an elevator for freight purposes. In one case the elevator was reported as not complying with the requirements of the naval specifications. On investigation it was found that the other elevators were equipped with high-speed motors having much series field excitation, and would start in the specified time with allowable current inrush and a maximum 4-ton load, but would descend with much increased speed with the maximum load.

The equipment that was rejected had a large slow-speed motor, would take a few seconds longer to start after the switch was closed and with the 4-ton load would allow a larger current inrush than the specifications allowed, but would move at about the same speed regardless of the load or the direction of running.

When the facts were carefully placed before the officer in charge of the yard the equipment that was formerly not approved was accepted.

When induction motors are installed to operate elevators and hoists, especially when they are placed more than 50 ft. from the street or generator, care should be taken to use sufficient conductivity in the service wires, or the individual circuits, running to the motors in order to minimize the I_2R losses while the motors are starting. A certain manufacturing company near New York City installed a 12 h.p., 3 phase induction motor to operate a dock hoist. The generator supplying the energy was of 50 k.w. rating. The motor was placed approximately 700 ft. from the switchboard, the copper in the circuit being about of the same cross-section that would be used to supply energy for a direct-current machine of the same size for constant running. The lower power factor of the motor when starting under load caused so much loss of energy in the circuit that the load was excessive on the generating apparatus, even when no other motors were running.

The alternating-current generator was of a type that would maintain the proper voltage as long as the speed did not decrease too much and the engine, which had a shaft governor, was sufficiently large for the generator.

When the copper in the circuit was increased to about three times its former cross-section, the engine governor ceased knocking during the time the hoist was in use and the whole plant could be operated at one time.—*Electrical World.*

THE MAN WHO WINS

The man who wins is an average man:
Not built on any peculiar plan,
Not blest with any peculiar luck;
Just steady and earnest and full of pluck.

When asked a question he does not "guess"—
He knows, and answers "no" or "yes";
When set a task that the rest can't do,
He buckles down till he's put it through.

Three things he's learned: that the man who tries
Finds favor in his employer's eyes;
That it pays to know more than one thing well;
That it doesn't pay all he knows to tell.

So he works and waits; till one fine day
There's a better job with bigger pay,
And the men who shirked whenever they could
Are bossed by the man whose work made good.

For the man who wins is the man who works,
Who neither labor nor trouble shirks,
Who uses his hands, his head, his eyes;
The man who wins is the man who tries.

WIRELESS TELEGRAPHY

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

THE INSULATION OF THE INDUCTION COIL

HOWARD MILLER

Undoubtedly the hardest problem which the builder of a small or medium size induction coil has to solve is that of proper and adequate insulation, and in almost every case where a coil breaks down, the cause can be traced to faulty or insufficient insulation. In the early coil building practice and even now to some extent (on very large coils) it was customary to use hard rubber, gutta-percha, ebonite, etc., to a great extent in the insulation of the coil. While these substances are undoubtedly excellent dielectrics, yet their physical properties are such that they are rapidly being abandoned for use in coils such as the ordinary amateur has to deal with. These materials are hard to work with, are expensive and deteriorate gradually in insulation value, due to the slow drying action of the heat of the coil in operation and various other causes, becoming hard and brittle and even cracking, which of course would ruin the coil entirely. Also in the case of vulcanized rubber, etc., the sulphur in these substances has a very bad effect on the copper wire after a time, in some cases entirely destroying the wires and thus disabling the coil. However, very satisfactory and in some ways superior substitutes have been found for the above materials: and these are paraffin, resin, and kindred gums and waxes. When papers and cloths are impregnated with these materials, the result is an inert insulator of high dielectric strength, lasting qualities and under certain conditions very elastic. The use of these substances also renders the coil practically water-proof as well as air-tight, thus keeping the wire in first-class condition, and as these materials are inexpensive, materially reducing the cost of the coil .

In building a coil, the first insulation encountered is that between the core and the primary. As a rule this is easily taken care of by wrapping a few turns of paraffined paper around the core before winding on the primary. The loose end should be ironed down smooth and all wrinkles smoothed out as much as possible. After the primary has been wound on the core, the whole should be soaked in melted paraffin until thoroughly saturated and taken out and allowed to drain while hot so as to avoid any lumps or superfluous paraffin. Right here it might be well to say that only the best grade of white paraffin should be used, as the crude paraffins are liable to contain impurities which will affect their dielectric strength. The next step in the insulation of the coil is that between the primary and the secondary. If the secondary is to be wound directly over the primary in one mass, as in the case of small coils, this can be constructed by winding on a sufficient thickness of paraffined paper in the same manner as the primary insulation was put on, being careful to keep the paper smooth and rolled tight. This insulation should be long enough to extend some distance beyond the ends of the secondary. The whole thing should then be soaked again in paraffin and allowed to drain as before. The secondary is then wound on and between each layer of wire is placed a layer of paraffined paper. This paper should be of first-class quality, as thin as possible and carefully examined for pin holes and weak spots. After the secondary is completed, the whole coil should be boiled in paraffin until thoroughly impregnated.

In the case of the larger coils, where the secondary is built up in sections and then slipped on over the primary, the best method to pursue in insulating the primary from the secondary is to build up a tube which will just fit over the primary and on which the secondary sections in turn are slipped. The thickness of this tube will, of course, depend on the size of the coil, but should always be ample to withstand the secondary voltage with a fair factor of safety. To build this tube, first turn a mandrel of a diameter a trifle in excess of that of the completed primary. Around this the tube should then be rolled up, using some good grade of tough, soft paper, such as red rope paper, of about 5 mills thickness. The inner turn should be secured by a little shellac and the paper wound over the mandrel, keeping it as tight as possible, until the required thickness is reached. Then cement the outer turn with shellac and remove the mandrel. The tube should then be placed in the oven and baked for several hours to eliminate all moisture. While still hot, place in a pan of melted paraffin and allow to remain in this for at least six hours, keeping the paraffin hot all the while. The tube can then be removed, drained and allowed to cool. You then have a firm, durable tube, water-proof, of high dielectric strength and perfectly inert; that is, it will not affect the copper of your coil. The tube should then be trimmed up to a length sufficient to enable the tube being recessed into the end pieces of the coil, so as to securely seal the primary from the secondary (see Fig. 1).

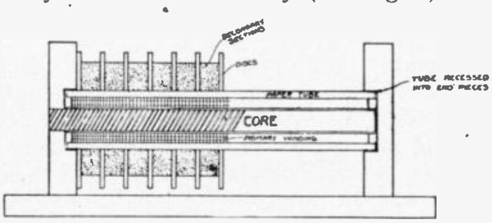


Fig 1

The next in order is the secondary, and it is here that the insulation must be given the closest attention to secure the best results. The best practice in coil building is to build the secondary up of a number of thin sections or discs each well insulated from the other (see Fig. 1). A very simple method of constructing the secondary sections, so as to get a smooth, firm coil, well insulated and which will stand a great deal of handling is the following: Construct a winding former as shown in

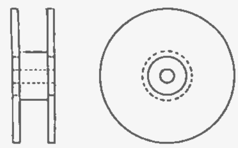


Fig 2

Fig. 2. This consists of an arbor *a* on the ends of which are mounted the discs *b b*, which may be made of heavy card-board, wood, etc. In winding the coils, first wrap a strip of lead foil smoothly around the arbor *a*, then wind the coil. After the coil is wound, the ends of the wires should be secured and the whole thing, former and coil, should be soaked in melted paraffin until all bubbling ceases, taken out, drained and allowed to cool. After the coil is cold and the paraffin well set, the sides of the former may be removed and the arbor pushed out of the centre. If the sides show a tendency to adhere to the coil, warm them slightly and they will come off nice and smooth. The tinfoil which was wrapped around the arbor will prevent the coil from sticking to the arbor. You now have a first-class coil, firm, water-proof and well insulated. These coils may be taped or assembled bare as desired, although it is advisable to tape them.

The secondary sections can then be assembled on the tube. These sections should, of course, have an inside diameter equal to that of the tube, so as to make a good tight joint. Between each coil should be placed one or more discs, cut so as to fit very tightly over the tube and at least 2 in. larger in diameter than the secondary sections. These discs may be made of heavy cardboard boiled in paraffin, mica, etc.

After the coil has been completed, all the secondaries properly connected and everything in good working order, we now come to the last step in the insulation of the coil, that of filling the secondary. Get some heavy paper, with a smooth, hard finish and cut it to a width exactly equal to the distance between the end pieces of the coil. Wrap this tightly around the coil, being sure to get it smooth and round. At the ends where the paper joins the wooden end pieces of the coil, carefully seal the joints with putty so as to make them perfectly tight. Then cut two or three holes in the top of this outer covering and by means of a funnel fill the whole space inside with a mixture of half paraffin and half good, clear rosin, or paraffin alone may be used, and quite hot so as to flow freely. In cooling, this will shrink and it may be necessary to refill it two or three times. After the whole mass is perfectly cold and set, you may remove the paper covering and you will have a solid mass of paraffin, with the secondaries firmly imbedded in it and perfectly insulated from one another and from the primary.

If in building a coil, the insulation of the coil is carried out in accordance with the above and is designed to meet the requirements of the coil, which of course will vary with the size, there should be no trouble with the secondary breaking down or puncturing the primary insulation and the wire in the secondary will remain in a perfect state for years. The subject of insulation in electric work and especially in high-tension work such as wireless, etc., is one that demands the closest attention, and no trouble or pains should be spared in building a coil or transformer to be certain that it will safely withstand the high potentials impressed upon it.

DESIGN AND CONSTRUCTION OF A WIRELESS TELEGRAPH STATION

Part IV—Adjustment of the Instruments

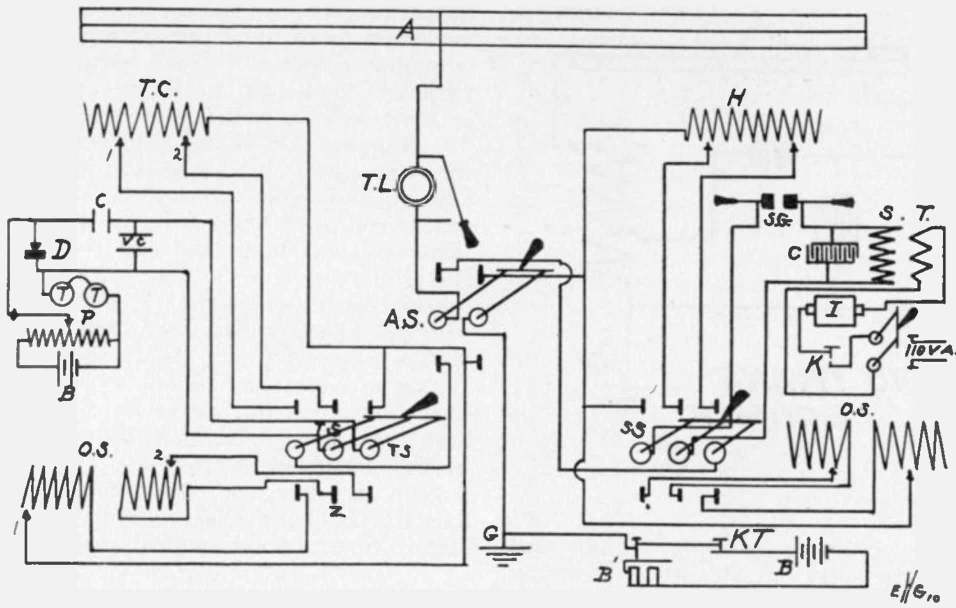
EDWARD H. GUILFORD

The diagram for wiring the various instruments described in the preceding articles of this series is shown in Fig. 1. It will be readily seen that when the double throw triple knife switch *TS* is in one position the double slide tuning coil is in the circuit, and with the switch in the other position, the receiving transformer may be used. This is probably the most popular of all the systems used by amateurs. Figs. 2, 3, 4 and 5 give the separate wiring diagrams of which Fig. 1 is a combination.

The use of a potentiometer or battery depends upon the kind of detector used. Silicon, ferron or molybdenite require no batteries, and consequently no potentiometers, hence to use the circuits shown in Figs. 4 or 5, in connection with either of the last-named detectors, the telephone should be bridged directly around the fixed condenser, the potentiometer and battery being discarded. That is, one end of the telephone cord is connected to one side of the condenser while the remaining end of the telephone cord is connected to the other side of the condenser. If either a pericon or a electrolytic detector is used, a battery and potentiometer should be used to secure the best results. The circuits of Figs. 4 or 5 are suitable for use with the above detectors.

The transmitting circuit, shown in Fig. 2, is one commonly used in the majority of stations. Where one desires to cover a wide range of wavelengths the transmitting oscillation transformer is more efficient than the helix. Fig. 1 shows a transmitting system using either helix or oscillation transformer. This is an ideal circuit for an amateur's use for this reason: a station can be called with the *helix* in the circuit, an ordinary wave-length being used, say around 500 meters. When communication is established the operator can switch over to the *oscillation transformer*, which should tune the wave to about 1,000 meters. The station using this transmitting system may then talk for hours without disturbing nearby stations, for few stations "listen in" with their receiving instruments set to receive waves as long as 1,000 meters. Fig. 3 shows a transmitting circuit using an oscillation transformer.

When sensitive detectors, such as



A, Aerial; TC, Tuning Coil; C, Fixed Condenser; VC, Variable Condenser; D, Detector; T, Telephones; P, Potentiometer; B, Battery; OS, Oscillation Transformer; TS and SS, Triple Knife Double Throw Switch; AS, Aerial Switch; TL, Tuning Lamp; G, Ground; H, Helix; SG, Spark Gap; ST, Step Up Transformer; C, Condenser; I, Impedance; K, Sending Key; KT, Testing Key; B', Buzzer.

pericon, electrolytic or silicon are used in a station having powerful transmitting instruments, they have a tendency to "blow out," *i.e.*, the contact in the detector becomes less sensitive, and some means must be provided to protect them from this trouble, otherwise a readjustment is necessary each time the transmitting instruments are used. There are several ways of doing this, one of the best of which is to use a single throw double knife switch to disconnect the two wires connected to the detector. Another way is to short-circuit the detector, while a third means of accomplishing this end where the detector must be placed very near the spark gap, as in a portable set, is to enclose the detector in a metal-lined box, the metal lining being grounded. While transmitting, the wires leading to the detector are disconnected by means of a switch.

Sometimes it will be noticed that an excessive humming can be heard in the telephones, perhaps so loud that it will drown out signals which are otherwise plainly heard. This humming is sometimes due to arc lights, but more often occurs because the wireless station is in the immediate vicinity of an Edison light circuit. The hum may be tuned out by using the oscillation transformer, or by grounding the free end of the tuning coil (marked *S* in Fig. 4). Another and still easier means of overcoming the difficulty where electric lights are used in the same house with the wireless station is to disconnect the feed wires just as they enter the house. A switch will always be found for this purpose on the board which carries the meter and the fuse blocks.

When the instruments are all connected up the operator is ready to receive. Assuming that the wiring diagram of Fig. 1 is used, first see that a battery current is flowing through the detector. A good test for this is to open and close the battery circuit which should cause a clicking in the telephone; next see that the aerial switch *AS* is in the receiving position and that the switch *TS* is thrown so that the tuning coil is in the circuit. If everything is right a click should be heard at intervals in the telephone, which is caused by the discharge of a minute quantity of electricity which collects in the aerial system. This discharge, by the way, is interesting and is worthy of a few words. Before a thunder shower it may be heard quite frequently, the discharges some-

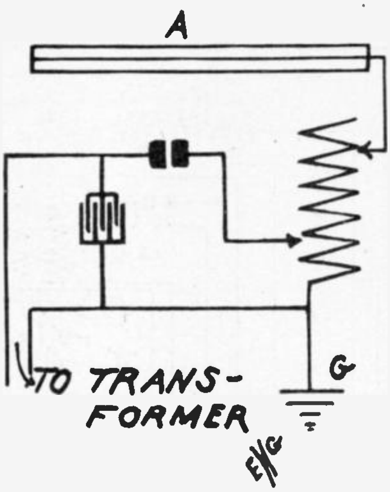


Fig. 2

times occurring so rapidly that they interfere very much with receiving. The approach of a thunder shower may be readily foretold by their presence. An approaching change of temperature, nearly always from a lower to a higher degree, may also be foretold by "listening in" at the receiving instruments. This would seem to prove that small charges of electricity float around on minute particles of moisture and dust, and coming in contact with the aerial wires, collect there, the wires of course having some capacity, although perhaps not very much. When a sufficient charge has collected in the aerial wires, the resistance through the receiving instruments is overcome, the electricity passing from the aerial to the ground, and a consequent click is heard in the telephone. If the clicking caused by the discharge from the aerial is heard, it signifies that both the aerial and the ground are connected to the receiving instruments. If no click is heard examine the wiring and see that the antenna and ground are correctly connected to the receiving circuits. Of course in extreme cases this discharge may not be present, but usually, especially in the summer, it is plainly heard. When the operator is assured that the aerial and ground are correctly connected, he should look to his detector and potentiometer. Press the test key *KT* (see Fig. 1), and adjust the detector until the resulting buzz is best heard in the telephone. Then adjust the potentiometer by sliding the contact back and forth until the strength buzz is again increased. Next adjust the variable condenser until its capacity is zero (such a position is determined by swinging the rotary plates until they are entirely without the fixed plates), and adjust the sliders of the tuning coil until No. 1 is within 10 or 12 turns of the end of the coil to which the ground is connected, and the slider marked 2 includes some 15 to 20 turns of wire. These positions of the sliders on the tuning coil are shown in Fig. 1. If now any station happens to be sending, and is within range, a series of long and short buzzes may be heard in the telephones, providing that the station is using an ordinary wave-length, say from 200 to 600 meters. If such a station can be heard, a further

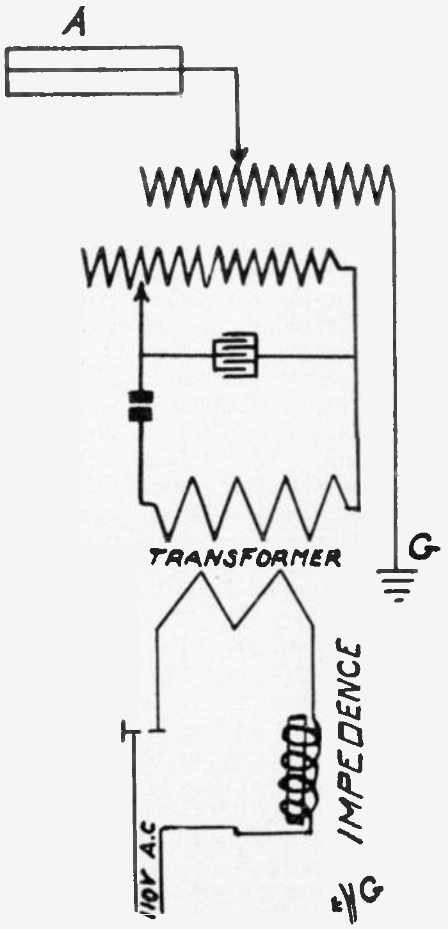


Fig. 3

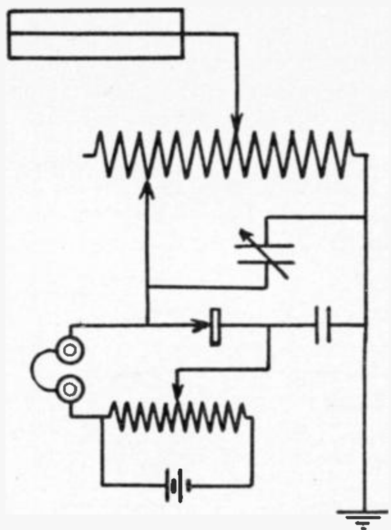


Fig. 4

adjustment of detector, potentiometer and sliders will usually increase the strength of the incoming signals. Suppose now, that some other station with a wave-length within the above-mentioned range begins sending. Provided that it is within range, interference will result. To cut this interference out, throw over the switch marked *TS* in Fig. 1 to the position 2, and with the coils of the oscillation transformer close together, adjust slider No. 1 so that it includes about the same number of turns of wire as slider No. 1 did on the tuning coil; also adjust slider No. 2 in the same way. Either or perhaps both stations will now be heard but by turning the variable condenser, readjusting the sliders, or separating the coils of the oscillation transformer, the right station will be heard plainly while the interfering station will be entirely cut out. Of course all this manipulation of sliders and coils takes time, hence it is advisable to "pick up" the station whose sending the operator wishes to hear, while that station is still sending preliminary call letters and before the operator has started the main part of his message. With a little practice this can be readily done. If interference should happen to occur while the oscillation transformer is in the circuit the interference may be instantly thrown out by adjusting either the coupling, (*i.e.*, the distance between the primary and secondary coils of the oscillation transformer) the capacity (by rotating the variable condenser), or the inductance (by moving the sliding contacts). These rules apply equally well to the use of the doughnut transformer, which was described in the November issue of the *Electrician and Mechanic*, the various degrees of coupling being obtained with the use of that instrument by rotating the secondary through an arc of 90 degrees.

To adjust the transmitting instruments, first see that the aerial and ground are connected by means of the aerial switch to the sending instruments. Then, by opening the small single throw single knife switch at *TL*, connect the tuning lamp in the aerial wire. This lamp is an ordinary 110-volt, 8-candle power electric light bulb, and except when the transmitting circuit is being tuned, it is left short-circuited. Adjust the length of the spark until it is of steel-blue color, and gives forth a sharp, crackling sound. Then arrange the contacts of the helix in the same relative position as shown in Fig. 1, the slider connected to the

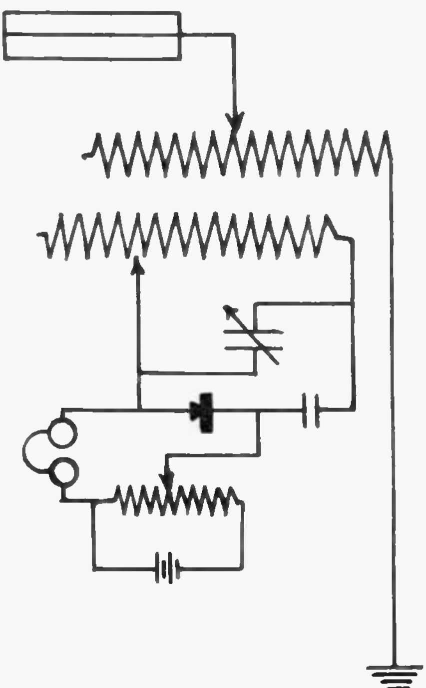


Fig. 5

condenser including about 4 turns of wire on ten helix, the slider which leads to the antenna including 10 or 12 turns. If now a long dash is sent out it will be found that the tuning lamp *TL* will light up to some degree of brilliancy. By readjusting the sliders on the helix the lamp may be brought up to its full strength, thus showing of course that the circuits are in resonance. This method of tuning by means of the lamp is a crude one at its best, and cannot compare with the method which employs a hot-wire ammeter, the use of which is recommended in all cases. Tuning by means of a hot-wire ammeter is effected in exactly the same way as with the tuning lamp. The oscillation transformer sometimes used in place of the helix is very simple to adjust. Fig. 3 shows a wiring diagram with it in the circuit. The circuits are tuned exactly the same as those employing a helix. The relative positions of the primary and secondary sliders is shown in the wiring diagram of Fig. 1.

When the sliders of the helix or the oscillation transformer are finally correctly arranged, the adjustment of the spark may sometimes be improved by increasing or decreasing its length, or by varying the amount of condenser in the circuit. A high, hissing spark indicates that the amount of condenser in the circuit is too small, while if only a deep, slow, "growling" spark can be obtained, the condenser is too large, and a section or two should be disconnected. The correct spark is one which sounds neither high nor low, but about half way between those extremes. It should be smooth and of even tone.

When the sliders and the condenser of the transmitting circuit are once fixed, the only thing which needs frequent attention is the spark. The above meagre directions will perhaps give the operator a hint of what he may expect. The best teacher is, however, practice, and the usual practice is for one station to test out his spark with another station, making changes according to the directions of the operator who "listens in."

Owing to numerous recent requests, the Morse and Continental codes are printed below. The Continental is the easier of the two, both in sending and receiving, hence it is wise to learn it first. The Morse code can be easily learned. Both codes are commonly used, the Continental being the most popular, however, with amateurs.

	MORSE	CONTINENTAL
A	. —	. —
B	— . . .	— . . .
C	. . .	— . — .
D	— . .	— . .
E	.	.
F	. — .	. . — .
G	— — .	— — .
H	. . . .	. . . .
I	. .	. .
J	— . — .	. — — —
K	— . —	— . —
L	—	. — . .
M	— —	— —
N	— .	— .
O	. .	— — —
P	. . . . .	. — — .
Q	. . — .	— — . —
R	. . .	. — .
S	. . .	. . .
T	—	—
U	. . —	. . —
V	. . . —	. . . —
W	. — —	. — —
X	. — . .	— . . —
Y	. . . .	— . — —
Z	. . . .	— — . .
PERIOD	. . — — . .	. . . . . .
INTERROGATION	— . . — .	. . — — . .
1	. — — .	. — — — —
2	. . — . .	. . — — —
3	. . . — .	. . . — —
4	. . . . —	. . . . —
5	— — —	. . . . .
6	. . . . . .	— . . . .
7	— — . .	— — . . .
8	—	— — — . .
9	— . . —	— — — — .
0	——	— — — — —

In conclusion, I would say, I shall be very glad to answer any questions regarding the instruments described in this series of articles. I have attempted to give only the most essential of details, the object being to install the *idea* in the mind of the amateur, leaving the petty details to be supplied by his previous experiences. For this reason the text may be to those who have but recently become interested in wireless somewhat vague in places.

Well, what do you think of the Wireless Department this month? Has it helped you any in your experimental work? The photograph of Mr. Ward's station is an excellent one, and gives a good idea of how a wireless station may be set up in a small space. The several short letters published tell of good ideas, and will help some of our readers who are in difficulty. We want more photographs and more letters from our subscribers. Wake up! Give us an idea of what you want. Register your kicks, and we might mention in passing that if you have a little praise we might listen to that too, accompanied of course by the proper amount of blushes.

The point is, however, we want to satisfy our readers, and in order to satisfy *you* we must know what you want. So if you have a good idea, write it up in as few words as possible and send it along. But first of all, write us a good heart-to-heart letter and tell us what your own personal likes and dislikes are. We will treat such letters in the strictest confidence. Address them in care of the Wireless Department.

Testing Telephones

Many low-priced, high resistance telephones on the market at present are wound with German silver wire. It is not the resistance of a telephone that is its virtue, but the actual number of times the wire encircles the core. Since German silver has a much higher resistance than copper, much less of it will be required to furnish the requisite 1,000 ohms than if copper were used, and at a correspondingly lower cost, but at the expense of the efficiency of the telephone. Some are now wound with German silver except on the very outside layer. This makes it difficult to determine whether or not the instrument is of honest construction with taking it apart.

The following device will show positively whether or not the majority of the winding is of copper. Connect the telephones across one arm of a good Wheatstone Bridge. Across the centre place a very delicate Mirror Galvanometer, reflecting a spot of light on a scale about 4 ft. long. Balance by inserting resistance in the other arm of the bridge until the spot of light hovers about a definite point on the scale. Allow the whole to stand for about one-half an hour to attain the temperature of the room. If the coils of the magnet are of copper the spot of light will move steadily up the scale when the current from one cell is sent through it, due to the small amount of heating which the coils undergo, which increases the specific resistance of the copper appreciably, thereby disturbing the balance of the bridge.

Since German silver undergoes an extremely small alteration in resistance with a moderate rise in temperature, if the coils are of this metal the balance will not be disturbed and the spot of light will remain stationary.

ROBT. E. BRADLEY.

Washington, April 1, 1910.

Wireless Telegraph Dept.:

I have just finished reading your excellent article in the current number of your magazine in regard to interference by amateurs and proposed legislation for its prevention. You request opinions from owners of high power transmitting apparatus, and while my opinion may not be of any great value, still I am impelled to answer your call by reason of the conditions about Washington, which are not often aired in the wireless periodicals. I have recently installed an outfit, now using about 1 k.w. of power, but which I can easily double if I wish. I have no need, however, of the increased output, in fact having found no actual need of my present power. I can receive messages from any of the high power stations on the coast from Key West to Cape Cod and Brant Rock.

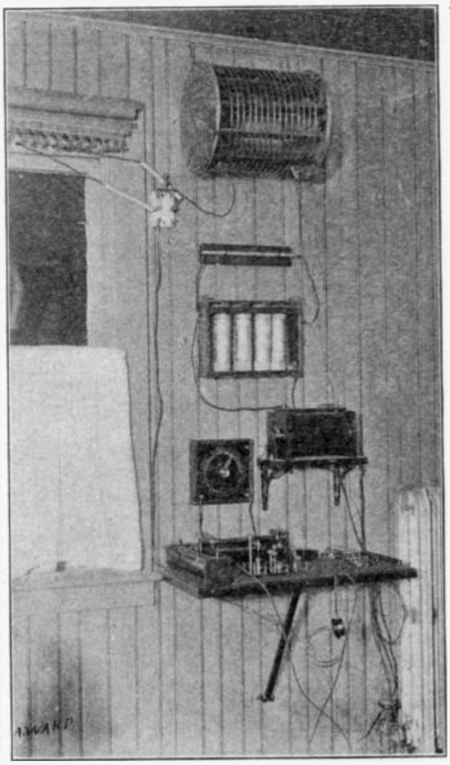
However, that is not to the point. There are hundreds of amateur outfits in and about this city; and while I am fortunate in being far enough from most of them to be able to tune them out, still I know that interference must be a serious matter with some. But the complaint is not all on one side. As an instance, the Navy Yard here is in a nest of amateur stations, and I don't think he would have much chance of doing any business if the amateurs all showed the same spirit toward him he does toward them. He has a very powerful spark and seems to take great pleasure in breaking up conversation among the amateurs by holding down his key for an indefinite period or sending a meaningless jumble of signals. Now I am acquainted with many of the owners of high power outfits here, and they are all men who have reached years of discretion, who make every effort not to interfere with the professional stations, even though they do not get the same consideration from NAL. I have no doubt that he is much bothered by smaller stations in his immediate neighborhood, but I think he could improve matters even in that respect if he showed more of a spirit of fair play.

In regard to legislation, I think that providing for a severe fine for malicious interference, and in case of repeated offense the abolishment of the offending station, *amateur* or *professional*, would wonderfully relieve the situation. I am sure all fair-minded amateurs would work for the enforcement of such a law, and the others deserve no consideration or mercy whatever.

(Signed) "WASHINGTON AMATEUR."

Electrician and Mechanic,
Boston, Mass.

Dear Sirs: I am sending you a picture of my wireless station, with which I have had good success. I made all the apparatus from descriptions in *Electrician and Mechanic*, except the rotary condenser and detectors which are of my own design. The coil is Mr. Getz's design No. 2. I have his No. 3 nearly finished. Workmanship is the best: woodwork piano polished; brass work polished, lacquered. On left side of shelf is



tuning coil; to the right is potentiometer; above it rotary condenser of my own design. In front of potentiometer are electrolytic, silicon and tantalum detectors. I find silicon as sensitive as electrolytic, but very hard to keep in adjustment. On right side of shelf is the sending key and back of it push button and testing buzzer. Above is the induction coil, wound with No. 32 wire giving 3 in. spark. Above is condenser and spark gap in glass tube and sending helix. I had hard work to get my coil to stand insulation, but after repeated attempts I designed a special insulation, which worked without immersing coil in wax. My receiver is hanging on front of shelf. It is 1,540 ohms. Antenna is four strands 50 ft. long, hung from mast 40 ft. high and dropping at angle 45° to 12 ft. pole thence, through window to D.P.D.T. switch shown in picture. I get Buffalo even in daytime 69 miles; Port Huron at night, and sometimes very faint a boat on Lake Erie. At present I am using all dry batteries which are in the cellar. My ground is on radiator shown in lower right hand corner.

About amateurs bothering stations, would say that if those stations would be kind enough to give their call letter when asked it would save lots of trouble, and I am sure it is not too much for an experimenter to ask as it enables him to determine his success.

Yours truly,
A. WARD.

Member E. & M. Wireless Club and Wireless Association of America.

Knife Switch Contact Pieces

Gentlemen: In making a knife switch similar to the aerial switches described in October, 1909, and February, 1910, issues of *Electrician and Mechanic*, I hit upon a way to make the contact pieces that worked so well, I will describe it for the benefit of others who may be making knife switches.

For a contact piece ½ in. high take a strip of brass or copper ½ in. wide, 1½ in. long

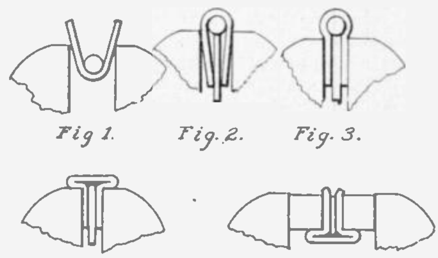


Fig 1. Fig. 2. Fig. 3.

Fig. 4. Switch Contact. Fig. 5.

and about $\frac{1}{32}$ in. thick, No. 22 gauge, open the jaws of the vise about ½ in., lay strip of brass across them. Place a round rod $\frac{5}{32}$ or $\frac{3}{16}$ diameter across strip and drive rod and strip down between jaws of vise, bending strip into a long U shape (Fig. 1). Reverse in vise, place a strip of sheet metal, same thickness of switch blades, between long ends and catch in vise just below centre of rod (Fig. 2); close vise, shaping strip into shape of keyhole (Fig. 3). Drive the rod out, leaving strip firmly held by vise, hammer round part flat, making the piece into a T section (Fig. 4).

By placing the piece between two blocks of metal ⅜ in. thick, the whole may be held in vise and upper edges bent out (Fig. 5).

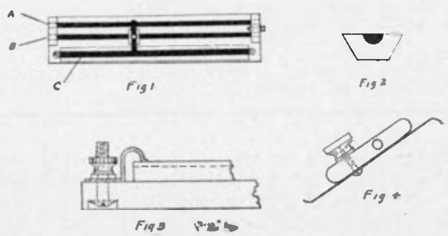
C. M. CURTIS.

A Non-inductive Potentiometer

In the following article I shall endeavor to show how a cheap and very efficient non-inductive potentiometer can be made.

The resistance is obtained from an O.H. drawing pencil, hexagonal in shape. This is cut in half, lengthwise, so that the end view appears as in Fig. 2. To cut the pencil to this shape, a very sharp knife is necessary. The pencil itself should be held firmly on a flat surface, while being cut, so that the lead will not be broken by being bent. When it has been cut nearly to the required size, it may be finished by the use of a file.

Fig. 3 shows the method of connecting the ends of the graphite to the binding posts. It consists of a piece of sheet brass about ⅜ in. wide, bent as shown in the illustration and pointed at the end which bears upon the graphite. The pencil itself is glued to the base. Then the binding posts, from an old



dry cell, are inserted through the base and the brass pieces screwed firmly into place. From the shape of these it will be seen that the spring in the curved part will always insure perfect contact.

The sliding contact is shown in Fig. 4. It is made by procuring a suitable piece of wood about ¼ in. in thickness and about ¾ in. square. An ⅛ in. hole is drilled through this, Fig. 4. A strip of spring brass, with the ends bent as in the illustration, is fastened to the under side of the slides by means of a screw which also makes fast a little knob to facilitate the sliding. The slider runs on a brass rod ⅛ in. in diameter and the contact is made on another rod of the same size.

Fig. 1 shows a top view of the completed potentiometer. *A* is the contact rod; *B* is the rod supporting the slider; *C* is the pencil. The rod *A* is connected to the binding post *E*.

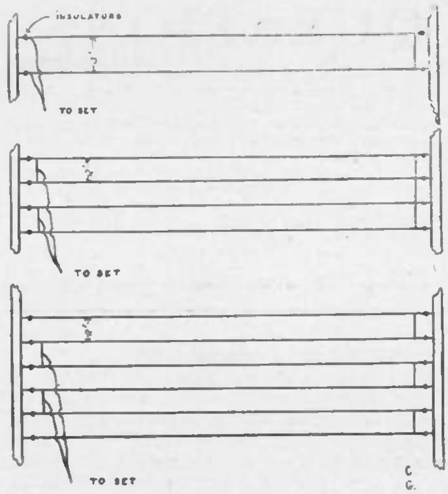
It is interesting to note the action of the brass sliding contact on the graphite of the pencil. If, before assembling, the end of the strip which touches the pencil be made smooth by rubbing on a fine oil stone, the graphite does not wear but becomes coated with a streak of brass from the contact.

C. C. WHITTAKER.

Indoor Aerials

There are many amateurs who give up their long cherished idea of owning a wireless outfit because no suitable place is at hand for an aerial. The average amateur thinks of an aerial as consisting of one or two high masts from which are suspended four or five strands of bronze, aluminum or copper wire. It is true that an aerial of this type is one of the best aerials possible, but it is also true that there are less pretentious aerials with the use of which good results may be obtained.

The aerial which I will now describe is to be installed in a house just building, a house with a large attic or any house having a similar space. If the aerial is to be placed in a house with a large attic proceed as follows: obtain either two, four or six pieces of No. 12 or No. 14 bronze, aluminum or copper wire,



each piece as long as the attic into which the aerial is to be placed. Now suspend the two, four or six wires between the end walls of the attic connecting, etc., as per diagram. In a house just being built, if there is no attic the aerial may be run through the top floor rafters or immediately under the roof. This kind of aerial is just as good as a similar out-door aerial, is not affected by weather and can't be blown down.

CHARLES W. GALE.

WIRELESS ASSOCIATION FORMED

Rhode Islanders Interested in New Science Elect Officers

The Wireless Association of Rhode Island was permanently organized at a meeting held in the Young Men's Christian Association recently. The following officers were elected: President, F. B. McSoley; vice-president, H. W. Heald; secretary, I. C. Creaser; assistant secretary, A. T. Carpenter; treasurer, H. P. Donle; managers, P. Hardaway, H. Mason and H. Scott.

The organization comprises young men in the electrical field. It was formed for the purpose of the advancement of the science of wireless telegraphy and telephony, and is growing rapidly.

The members all have stations and communicate with one another. Some have "talked" by wireless for long distances. One reason for the organization is said to be that of protection against unjust legislation. They claim that Government operators have made false reports of interference.

Some of the amateurs claim that they have picked up the Fire Island, Long Island, Manhattan Beach and Atlantic City stations, while they also have copied dispatches sent out from Wellfleet and the Government station at Brant Rock, Duxbury, Mass.

Time signals are also picked up frequently, and some of the amateurs claim that they have their chronometers set direct from Washington at the same time as other Government stations.

QUESTIONS AND ANSWERS

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

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

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

1290. **Efficient Aerial.** M. E. G., So. Ashburnham, Mass., asks: (1) What size copper wire should I use for my aerial? The aerial is made on two 6 in. cross arms, about 50 ft. high and 100 ft. long. (2) Should each strand of wire be insulated separate, or all six connected together? Ans.—(1) Insulate each wire separately from the spreaders. (2) Use No. 14 or No. 12 bare copper wire.

1291. **Receiving Distance.** J. H., Astoria, Ore., asks: (1) How far can I receive with the following electrolytic detector: Double slide tuning coil 19 in. long, wire about No. 20 B. & S. fixed condenser, 4 wire aerial about 75 ft. long and about 35 ft. high aluminum wire, No. 14 B. & S. water pipe ground, variable condenser with 150 ohm receivers. (2) 1,000 ohms same outfit? (3) 2,000 ohms same outfit. Give diagram? Ans.—(1) See article by W. C. Getz in February issue of this magazine. About 100 miles. (2) 300 miles. (3) 300 miles to 500.

1292. **Sensitive Instruments.** C. M. B., Franklinton, La., asks: Are 4,500 ohm receivers as much more sensitive than 3,000 ohm as 3,000 ohm is more than 1,500 ohm? (2) What instruments, including the doughnut transformer, are necessary, to get extra good results, receiving? (3) Please explain and diagram the best form of an aerial for me to adopt? I intend to make a good one and to have it at least about 70 ft. high, since the higher the better. The country all around here is rather level and I am in a good open place. Ans.—(1) No. (2) The "doughnut transformer" does *not* increase the receiving range. Its use is to *prevent interference*. (3) A good aerial is the "flat top" antenna; make it 70 ft. at each end, 10 wires each 2 ft. apart, leading in wire attached to middle of antenna.

1293. **Tuning the Transmitting Circuit.** R. E. T., Dorchester, Mass., asks: (1) By adjusting my spark gap and connections of helix, how can I tell when my aerial is radiating the most energy, without use of hot-wire ammeter? (2) Should the secondary winding of doughnut transformer be wound on both sides of rod which passes through diameter of doughnut or only on one side, and under what conditions is it best to use switch points 1 and 3 of the 3 point switch? (3) Would plates of glass inserted between the brass plates of a variable sliding air condenser increase the capacity? Ans.—(1) You cannot tell by adjusting the spark gap. Insert a small gap in wire leading to aerial and adjust inductance, capacity, and spark gap until largest spark is obtained in this temporary gap. (2) The secondary is wound around the rod only to hold in place. For receiving stations with a long wave-length. (3) Yes, but condensers using air as a dielectric are best in receiving circuits.

1294. **Aerial.** R. A. B., Randolph, Mass., asks: (1) I am using an aerial of six strands of No. 15 aluminum wire 36 ft. long and each 1 ft. apart. It is 65 ft. high at one end and 35 or 40 ft. at the other end. I have a single slide tuning coil, variable condenser, fixed condenser, silicon detector, and a pair of 75 ohm receivers. What is my receiving radius now as it is? I use the water pipe for a ground. (2) I propose to make my aerial twice as long and the same in every other way as at present, change my tuning coil to a double slide, use potentiometer and battery with silicon detector and a pair of 1,000 ohm receivers. What would my receiving distance be then? (3) My aerial is connected as per diagram. Is it the best way? What improvements can I make over my proposed changes? Ans.–(1) and (2) See article by Mr. Getz in February issue of this magazine. (3) If possible connect wire to instruments in middle of antenna instead of at one end. This will, if the instruments are nearly underneath the middle of the aerial, prevent directional effects in both receiving and sending. See article regarding this by Mr. Guilford in April issue of this magazine.

1295. $\frac{1}{2}$ k.w. **Dynamo.** W. F. C., Fall River, Mass., sends a sketch suggesting the construction of a dynamo much like Watson's $\frac{1}{2}$ h.p. machine. He asks what dimensions and winding to use to admit an output of 50 volts and 10 amperes? Ans.—The sketch is quite incomplete. Perhaps you intended for us to supply the proper figures. This we can do, but can do you better service, perhaps, if we suggest that you look up two publications on machines of about the size proposed, *i.e.*, those by Watson on the building of a 1 h.p. or a $\frac{1}{2}$ h.p. dynamo. Very detailed drawings and directions are given, and you can purchase any of the material you desire. The larger machine has a capacity of 10 to 12 amperes, the smaller of 7 to 8 amperes, at 50 volts.

1296. **Rheostat.** J. W. F., Williamsburg, Ohio, asks: (1) How much and what size of German silver wire would be needed to reduce a 220-volt alternating current to 10 volts and 3 amperes? (2) Can a battery ammeter be used on a 220-volt circuit without injury, provided the pointer does not go off the scale? (3) Can an electric disc heater be made for use on this circuit that will heat to the boiling point? Ans.—(1) To expend the excess 210 volts in driving 3 amperes you will need 70 ohms. No. 18 wire of 18% grade has about 25 ohms resistance per lb., so you will need nearly 3 lbs. A bank of incandescent lamps would make a safe and cheap resistance. Why not use it? A much more economical device would be a transformer, or a "compensator,"—the latter imitating the construction of a transformer, but having only a single winding with taps brought out at various places. (3) Yes, but as you do not state what quantity of liquid is to be heated, or at what rate, we cannot give much information. Even with data in this respect, the computation is very complex, and experiment would be the only safe procedure.

1297. **Burglar Alarm.** F. W. M., Belleville, Ont., asks: (1) for a diagram for connecting a burglar alarm for five points of operation, or "traps." (2) What resistance should be in circuit when the two gravity cells used for the alarm are out of use, as during the day? Ans.—(1) We suppose you intend to buy the traps, in which case, the scheme is so simple as to make a drawing almost superfluous. You start from one pole of battery, go through bell, to No. 1 trap, then to the next, and so on, through as many as you please, and finally back to remaining pole of battery. (2) A simple two-point switch in circuit between battery and first trap will be convenient. The alternative point of switch will connect to a 110-volt lamp and then directly back to other pole of battery, thus providing the circuit to keep the cells in good condition.

1298. **Rewinding Armature.** S. M. L., Midland, Mich., asks how to rewind an armature for a 7½ h.p. 500-volt motor. There are 36 slots and 72 commutator segments. It had apparently been wound in three layers. Field coils have 54 lbs. of No. 24 wire. New winding should be for 250 volts. Ans.—Before we could advise you at all with reference to the armature winding we would need a sketch showing the general dimensions of the magnetic circuit. Cross-section of field cores, area of polar face, length of air gap, and size of armature slots must be given. You can utilize the present field winding by connecting the two coils in parallel rather than in series with each other.

1299. **Toy Motor.** A. E. B., Centreville, R.I., sends a sketch of a small motor that might possibly weigh a pound when finished, and asks for directions for winding it for 110 volts, either direct or alternating. Ans.—Your design is altogether inadequate, for more than 5 or 10 volts.

1300. **Alternating and Direct Current Transformation.** H. H., Newport, Vt., asks: (1) Are there any other means of effecting this transformation than by a motor-generator, rotary converter, mercury arc rectifier, and electrolytic rectifier? (2) Is there any instrument that will indicate whether a given current is direct or alternating? (3) Is the pull of gravitation greater at sea level than on a mountain height? Ans.—(1) You have mentioned the only practical means. There remains, however, the device used by Ferranti for providing direct currents for arc lamps, when operated from an alternating current source. This consisted of a commutator driven by a synchronous motor. It is not considered practical. Too much sparking and flashing takes place. (2) Yes, there are various means. If the voltage is low, touching the wires with the fingers will give a distinctive feeling. An ammeter or voltmeter of the permanent magnet construction (Weston) will respond to the direct currents only, while one of the electro-magnetic type will be deflected by both. The decomposition of water and collecting of gases in inverted test-tubes will also give conclusive results. With direct current the quantity of gas in one tube will be twice that in other; alternating currents will give the same quantity in both,—an explosive mixture. A loose bundle of iron wires within a coil will be quiet on direct currents, but on alternating will rattle and hum. (3) Yes, but the fact that the earth is not a perfect sphere, and that centrifugal forces act in greater measure near the equator than in higher latitudes prevent a simple computation of the actual variations of the force of gravitation. It varies closely according to the law of "inversely as the square of the distance from the centre of the earth."

1301. **Induction Motor.** R. L., Moose Jaw, Sask., Can., asks for reference to some publication describing the construction of a 2 h.p. motor for a 60-cycle, 110-volt, single-phase circuit. Ans.—There is none exactly filling your specifications, but the nearest was given in the *American Electrician* for September, 1903, page 456. This describes a motor wound for six poles and 125 cycles. By grouping essentially the same winding for four poles you will get a good machine for the lower frequency.

1302. **Sheet Iron for Small Induction Motors.** P. M. D., Pittsburg, Pa., asks where such can be obtained? Ans.—We do not know where the completely prepared material can be procured except from the regular manufacturers. Sometimes they are willing to encourage the building of experimental machines by selling a limited quantity of the sheet iron. We are preparing an article on the construction of a small motor of the induction type that we think will be within the reach of almost anyone who has access to ordinary machine tools. We expect to be able to offer the sheet iron for sale at a reasonable price.

1303. **Small Dynamo.** P. B., Akron, Ohio, asks for data for making a machine with an armature 3 in. x 3 in., that will be good for an output of 6 volts and 15 amperes. Ans.—A machine of this size can be driven at a speed of 2,400 revolutions per minute.

and give a much greater output than you propose. You might follow the general scheme of Watson's ¼ h.p. machine, or we would be glad to compute some other type of field magnet that you might prefer. You can procure suitable armature discs from the W. & S. Co., of Worcester, Mass. If the output you state is all you desire, you can adopt a fairly low speed.

1304. **Wireless Telegraphy.** A. L. G., Milwaukee, Wis., asks: (1) What kind of a buzzer and key is meant on page 303, February number, bottom of first column? (2) Where can I get German silver cotton-covered resistance wire No. 28, and what would be the probable cost of about 75 ft. for making the potentiometer? Ans.—(1) An ordinary bell buzzer and the key may be a telegraph key or merely a push button. (2) Consult the columns of this magazine.

1305. **Aerial Wire.** H. L. G., Algona, Iowa, asks: (1) Would an aerial 50 ft. high and 175 ft. long be sufficient for a 1,000 mile receiving set? (2) Would aluminum wire be better than copper for an aerial? Ans.—(1) Yes. (2) The only advantage in using aluminum wire is to save weight.

1306. **Output of Storage Cells.** G. K. T., Maplewood, N.J., asks: (1) How is the maximum discharge rate of a storage cell found? Take for instance a 40 ampere hour storage battery. Can I draw 40 amperes for one hour without injuring battery or must I use only a fraction of this? (2) Please give a diagram of the most sensitive arrangement you know of for the following apparatus: looped aerial, pericon detector, double slide tuner, variable condenser, fixed condenser and 1,000 ohm receivers. Ans.—(1) Yes, the storage cell may be used drawing 40 amperes for one hour without injuring the cell. (2) For wiring diagrams see article by Mr. Guilford in May issue of this magazine.

1307. **Wiring Diagrams.** R. Y., Winchester, Mass., asks: (1) Will you please tell me how to connect the following: receiving: 1 double slide tuner, 1 single slide tuner, 3 detectors, silicon, pericon, carborundum pair of 750 ohm receivers, potentiometer and batteries, 2 fixed condensers, 1 detector tester, 1 looped aerial. Sending: 1 helix (10 in. diameter, 15 in. high, 60 ft. No. 14 B. & S. wire), 1 in. coil, 1 condenser, 1 zinc spark gap, 1 anchor gap, 3 point, 1 key, 1 electric current reducer, 1 fuse plug, 1 O.P.D.T. switch, 1 O.P.S.T. switch, 1 S.P.O.T. switch, 1 J.P.S.T. switch. Ans.—(1) See article by Mr. Guilford in May issue of this magazine.

1308. **Continental Code.** C. F., Lexington, Ky., asks: (1) Can dry batteries be used on the wireless telegraph now being described in *Electrician and Mechanic*, and if so, how many? (2) Where can I find continental or wireless codes? Ans.—(1) No, a current of about 10 amperes at an EMF of 110 volts is necessary to operate in sending transformer described in the March issue, for we presume that is what you refer to. (2) A continental code is published in the Wireless Department (page 426).

1309. **Sending Transformer.** H. S., Oakland, Cal., asks: (1) Will a transformer of the closed core type and the following specifications be good for wireless: core, iron laminations, 1½ x 1½, 10 x 10, primary, 280 turns No. 14 D.C.C. 2 layers on each leg, secondary built in sections ⅜ in. wide, 10 lbs. No. 32 S.C.C. wire. (2) What will be its power in K.W.? (3) Will a loose coupled sending set increase my range and efficiency? Ans.—(1) Yes, the transformer with above dimensions could be used for wireless work. (2) Its power would probably be in the neighborhood of ¼ k.w. (3) The sending range would not be materially increased, but a closely tuned wave would result; *i.e.*, a wave of such a character that the receiving instruments would have to be tuned very closely to get it.

1310. **Changing the Size of Core.** E. S., Providence, R.I., asks: (1) Does the size of the core in an induction coil make any difference? (2) How can I tell how many watts there are in a wireless sending set and (3) how could I tell how many ohms are there in a receiver and about (4) how many ohms are there in a common telephone receiver? Ans.—(1) Yes, size of the core makes a difference in the output of an induction coil or transformer. (2) Multiply the voltage of the primary circuit by the number of amperes flowing through it. (3) Accurate measuring instruments are necesasry. (4) The usual telephone has a resistance of 75 or 80 ohms.

1311. **Receiving Range.** E. D., Tampa, Fla., asks: (1) I have the following instruments: inductive tuner, double slide tuning coil, variable condenser, fixed condenser, one 1,500 ohm receiver with head band, silicon detector. Sending: one 1 in. induction coil, helix 12 in. diameter, 15 in. high, 14 turns No. 8 core copper, condenser composed of twelve 6½ x 8½ in. glass plates, twelve dry cells, key, aerial 56 ft. high, 100 ft. long, four strands No. 14 phosphorous bronze consisting of seven No. 21 copper wires twisted into one cable. How far should I be able to send and receive? Ans.—(1) As we have said many times, and now repeat, it is utterly nonsensical to give the receiving range of a wireless station unless the power of a transmitting station is also quoted at the same time. For instance, your station might pick up a 10 k.w. sending station 10,000 miles away, while it would not be affected in the least by a 1 in. spark 25 miles distant. If you will quote the power of one or more stations which you wish to receive, we will be pleased to tell you if your receiving instruments should be affected by them.

1312. **Condenser Construction.** I. S., Lancaster, Pa., asks: (1) Would you please tell me how a secondary transmitting current condenser may be built with less material, making it a much lighter instrument? (2) Would it be of any advantage to use two pericon detectors like the one described in January, 1910, issue, or would a cheaper detector work as well? If so, give a diagram for making it. Ans.—(1) For the transformer described in the March, 1910, issue, no lighter condenser could be built than that described. (2) Yes. Connect them so either one can be thrown into circuit.

1313. **Wireless Distances.** C. B. DeLa H., Vicksburg, Miss., asks: (1) How far should I be able to receive with the following instruments: Aerial composed of four strands of No. 16 copper wire running from one pole, 56 ft. high to another 42 ft. and 62 ft. long, situated in the highest part of "hilly Vicksburg," overlooking the river; silicon, pericon and electrolytic detectors; loose coupled tuning coil, battery and potentiometer, variable and fixed condensers and 2,000 ohm head phones. Waterpipe ground. (2) With this outfit could I get better results using the looped aerial connection? (3) Can I improve on this set without lengthening or raising the aerial? Ans.—(1) See article by Mr. Getz, in February, 1910, issue of this magazine. (2) No. (3) Use a two-slide tuning coil to "listen in" on.

1314. **Wireless Diagrams.** R. D., New York, N.Y., asks: (1) Will you tell me where I can obtain blueprints or diagrams showing the United wireless system of communication, what publishing house carries same or if you carry them? Ans.—(1) They are not published, but on receipt of 50 cents we will have them made up for you.

1315. **Wireless Troubles.** R. R. H., Brooklyn, N.Y., asks: (1) I have a wireless station composed of a large tuning coil (single slide), two 1,000 ohm receivers, electrolytic or improved silicon detector, potentiometer and three batteries, waterpipe ground and an aerial 35 ft. long, composed of four wires, 1 ft. apart and 45 ft. high. How could I improve this to receive 1,900 miles? (2) Can a tuning coil be connected in series with a receiving transformer to the aerial? (3) I have an electrolytic detector, and I mixed four parts of water to one part of nitric acid and put in the carbon cup. I wore off the silver plate and connected it up as in my diagram, putting the carbon on one binding post of the detector, and it would not work; then I put it on the other and it did not work. My connections are right. I know when there is a message on, but it is not loud enough for me to hear. Can you account for this? Ans.—(1) Add a pericon detector, make 1,000 ft. vertical antenna and change single slide tuning coil for two slides tuning coil. (2) Yes, a single slide tuning coil is sometimes used in the aerial circuit of a receiving transformer as a loading coil. (3) See April, 1908, issue, on adjustment of electrolytic detectors.

1316. **Wireless Telegraphy.** W. M. L., Ottawa, asks: (1) When using two 1,000 ohm phones should they be connected in series or parallel? (2) What are the dimensions of Electro Importing Co. ½ k.w. transformer coil, that is, core length and diameter; inside and outside diameter of secondary. How many pounds of secondary wire, also length of secondary? (3) What should the winding on a double pole receiver be, supposing the magnet was large enough to magnetize by winding wire around it and sending a current through it? Then should the winding of fine wire that stays on permanently be in the same direction or does it make any difference? Ans.—(1) Connect receivers in series. (2) We have no data covering this make of coil; write directly to the manufacturer. (3) It should be in the same direction always.

1317. **Batteries.** C. N., Davenport, N.D., asks: (1) Can common gravity batteries be used in wireless telegraphy? (2) What is the scientific way of charging batteries? Ans.—(1) Yes, an induction coil may be operated by means of gravity cells. (2) See April and May, 1908, issues of this magazine. They take the matter up in detail. (3) This question will be answered later.

1318. **Wireless Telegraphy.** G. G., Ann Arbor, Mich., asks: (1) Can I receive all messages, within 300 miles, with outfit represented? (2) We have building three stories high; how long an aerial must I have? (3) How is it to be made? Ans.—(1) No, this set is too crude for sensitive work. (2) For good work your aerial should be from 30 to 40 ft. above your instruments. (3) See article in June, 1908, issue, by Mr. W. C. Getz, on "Construction of Aerials."

1319. **Induction Coil.** J. A. M., Waltham, Mass., asks: (1) What do we need and how do we connect for a short distance (2 miles) wireless telephone? If the description of such is too long to give here, would you be kind enough to inform me where I could get book or treatise for same, or blue prints? (2) What are the dimensions for a 3 in. or 2½ in. spark coil for wireless telegraphy? What is the best material to use? Ans.—(1) This apparatus is too complicated and expensive to install unless you expect to expend about $500 or more in experimenting. Get the "Manual of Wireless Telegraphy for Use of Naval Electricians." Price, $1.25. (2) Primary 3 layers No. 14 D.C.C. wound on a core of No. 22 B.W.G. annealed iron wire, 1¼ in. diameter, 16 in. long; installing tube, micanite, 2 in. diameter, ⅛ in. wall, 12 in. long. Secondary, 10 lbs. No. 32 enamelled wire wound in sections; 2½ in. inside diameter, 4½ in. outside diameter, 3/16 in. thick.

1320. **Electrical Units.** A. R. H., New Paris, Ohio, asks: (1) Will you please explain the terms Volts and Amperes? Ans.—(1) The term volt is an electrical unit, and perhaps may best be explained if you can think of it merely as a measure of the pressure of the current which is flowing through a wire. Ampere is the measure of the *quantity* of current flowing through a wire.

1321. **Detectors.** S. F. P., Ft. Hancock, N.J., asks: (1) Is the detector described by Mr. Moore in the January, and by Mr. Guilford in the February numbers one that can be made and used by amateurs without being held liable for infringement on any patents. (2) Have read in a recent publication "How to Make a Pericon Detector," using of course, zincite and copper pyrite, but altogether differently arranged from the commercial pericon; would such a detector be held as an infringement, crystals being set in metal. Ans.—(1) Yes, for experimental purposes. It cannot be sold, however. (2) To sell any detector having as minerals those mentioned would constitute an infringement.

1322. **Wireless Distances.** L. V. B., Washington, D.C., asks: (1) How far could I receive with a 70 ft. 4 wire aerial with wires 1 ft. apart, 50 ft. high at the lowest point, double slide tuning coil, variable and fixed condensers, silicon detector and one 1,000 ohm receiver? (2) If I use the 1,000 mile detector described in the *Electrician and Mechanic* issue of January, 1910, how far can I receive with above apparatus? (3) How far can I send with a 1½ in. induction coil, ½ gal. Leyden jar, helix made of 20 ft. of No. 8 copper wire (bare), enclosed spark gap, key and aerial, same as in (1)? Ans.—(1) See article by Mr. Getz in February issue of this magazine. (2) That detector has about twice the efficiency of a silicon detector. (3) About three miles.

1323. **Wireless Distances.** W. D., Brookline, Mass., asks: (1) How far is my receiving radius with the following apparatus? Aerial 50 ft. high, about 40 ft. long, running between two poles 10 ft. high on top of house, 1,000 ohm receivers, fixed condenser, silicon detector, double slide tuning coil? (2) How far ought I to be able to send with the following instruments? Same aerial as before, 1½ in. spark coil, spark gap, 9 or 10 batteries? (3) How could I improve my receiving radius? Ans.—(1) Consult article by Mr. Getz in February issue of this magazine. (2) About 2 miles. (3) Variable condenser, pericon detector.

1324. **Wireless Stations.** W. H. C., Belleville, Ont., Can., asks: (1) What is the nearest commercial or amateur wireless station to Belleville? (2) What ships have wireless installed that run on Lake Ontario and their power and wave length? Ans.—(1) A list will be sent you by mail. (2) We have no authentic data on this subject.

1325. **Coils.** A. R. M., Kansas City, Mo., asks: (1) Do you publish a book or know of any company that does, that will give me the desired information including cuts for building step-up transformers from ¼ to 5 k.w.? (2) Also information on the construction and operation of choke coils. What advantage is there in having two Tesla coils connected together? My experience with them has been that I can get greater efficiency with one coil then I do with two, no matter how I connect them up. (3) Is there any book or paper which gives the relation of one coil to the other in the construction of Tesla coils, as regards the capacity and number of turns in either coil? Ans.—(1) There is no book published on step-up transformers for wireless telegraphy. Consult the columns of this magazine for your desired information. Articles have been already published on transformers up to 1 k.w. output. (2) No advantage can be obtained by connecting two together, since the insulation of the second coil would have to be abnormally large. (3) The output (in volts) may be found by the following equation:

$$\frac{Vp}{Vs}=\frac{Tp}{Ts}$$

Where Vp is the potential impressed on the primary, Vs is the potential at the secondary terminals, Tp the turns of wire in the primary coil and Ts the turns of wire in the secondary coil.

1326. **Aerial.** W. A. M., Elsie, Mich., asks: (1) I wish to put up a 100 mile wireless station, but do not know about the aerial. Will you kindly tell me about the kind, connections, height and length and how to put it up? The ridge of the house is 20 ft. high and 80 ft. from the back of the lot. (2) Would it be good policy to put small lumps of wax on the corners of the movable plates in the condenser described in the February, 1910, number, so as to prevent the plates touching? (3) What instruments will I need to intercommunicate, daylight and dark, over a 90–100 mile stretch of level country? Ans.—(1) Put a 30 ft. pole on your house, and run the aerial wires to another 30 ft. pole at the back end of the lot. See April issue of this magazine for the proper design of aerials. (2) Yes, if they tended to touch and the trouble could not be corrected by straightening the plates, wax or even paper might be put over the portion which touch. (3) The receiving instruments described by Mr. Guilford would probably do the work with the use of 100 ft. vertical aerials.

1327. **Plating.** C. M. K., Troy, N.Y., asks: (1) How can brass or steel be nickel plated? (2) Can the pericon detector described in the December, 1909, issue of your magazine be used for the 1,000 mile receiving apparatus described in the February, 1910, issue? Ans.—(1) Full instruction for nickel plating on brass or steel would be too long to give here. We must refer you to some of the numerous excellent books on this subject. Brass can be easily coated with nickel, and steel also, provided it is first plated with copper. We can furnish you the following books on electro-plating: "Electro-Plater's Handbook," by C. E. Bonney, 208 pp., $1.20; "Electro-Plating," by Hassluck, 50 cents. (2) Yes.

1328. **Transformer.** E. G., St. Joseph, Mo., asks: (1) I am making a transformer according to the one described in your article, "A 50 mile Sending Station," except that I have made the core 2 in. in diameter instead of 3 in. and am using 12 pounds of wire for the secondary. Is this right? (2) Kindly state some kind of oil to immerse this transformer in, that is cheap, non-inflammable and is of high dielectric value. Ans.—(1) If you make the core of the transformer 2 in. in diameter instead of 3 in., it need not be made more than 20 in. long, but probably from 400 to 450 turns of wire on the primary would be needed. 12 lbs. of wire No. 30 S.C.C. could be used on the secondary. The sections would be of somewhat outside diameter. Of course the output of this transformer would be somewhat reduced by the above changes in construction. (2) Linseed oil is usually used as an insulation bath for transformers and condensers. Such oil may be obtained from nearly any painters' supply house, but care should be taken to see that it does not contain mineral matter.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TRADE NOTES

The Modern System Correspondence School is organized along engineering lines by Oscar E. Perrigo, M.E., a member of the American Society of Mechanical Engineers and a consulting engineer of much practical experience in systematizing manufacturing business. The courses of instruction include systems of Cost Accounting, Office Systems, Shop Construction, Organization, Equipment and Management; Foundry and Pattern Shop Systems; as well as Mechanical Drawing and Engineering. There are no classes. Mr. Perrigo gives the same personal attention to students that he does to clients in his regular professional practice. Hence the instruction has a very important and practical value.

The Boston Telegraph Institute, 899 Boylston St., Boston, Mass., has recently issued a catalog describing its work in showing various types of wire and wireless telegraph instruments and home study outfits which it is in a position to furnish. The school is an excellent institution for anybody desiring to learn telegraphy, either wire or wireless. It enjoys a high reputation among the telephone companies in the proficiency of its graduates. The Western Union Telegraph Co. has employed in a single year nearly one hundred of its graduates as operators. The school is in a position to teach wireless telegraphy most thoroughly, having two high-powered stations in operation, and is also in a position to find employment for graduates with commercial companies. Any of our readers interested in instruction in telegraphy will do well to write to them for this catalog.

A little booklet published by Mack & Co., 18 Brown's Race, Rochester, N.Y., is entitled "True Stories," by various authors, mostly woodworkers, some merchants. It contains information of value on the care of tools and the value of tools made by its publishers.

If you are interested in woodworking tools of any kind, it would pay you to send for a copy of this book, mentioning *Electrician and Mechanic*.

The New York Electrical School, 39 West 17th St., New York, N.Y., issues monthly an interesting magazine, *The Generator*, published by its students. This little magazine gives interesting information about the school and the work of its students.

A very practical book of electrical subjects especially for students is entitled "Questions and Answers about Electrical Apparatus." This contains a close study of the wheres, whys, troubles and remedies of Direct and Alternating Current Motors, Constant Current and Constant Potential Transformers, Mercury Arc Rectifiers, Incandescent and Arc Lamps, Meters, Instruments and Steam Turbo-Generators,—in fact all lines of apparatus. Practically every question and trouble which is likely to occur in the testing a portion of electrical apparatus is solved by this book. It can be obtained from the SAMPSON PUBLISHING COMPANY, at the price of $1.00, postpaid.

W. F. Smith, 1158 West Hamburg St., Baltimore, has published a little treatise entitled "Lathe Gearing." This is intended for the mechanic and apparatus, and gives much valuable information on the subject treated. The regular price of the book is 25 cents. The publisher offers to send for the next thirty days a copy of it to any of our readers who will send 5 cents in postage stamps and mention *Electrician and Mechanic*.

Owners of motor cars are aware of the troubles caused by poor sparking. An instrument intended to show at all times the condition of the spark is known as "The Phelps Trouble Finder," and is sold by The New England Sales Co., Old South Bldg., Boston, Mass. This instrument duplicates the spark which occurs in the combustion chamber before the eyes of the operator, and should prove a boon to automobile users.

Full information will be mailed on request by the manufacturers who also desire to employ agents to sell this instrument. Live agents can easily make from $10.00 to $20.00 a day on this proposition.

CORRESPONDENCE

A courteous letter has been received from Mr. L. S. Bell, offering some useful criticisms of last month's instalment of "Elements of Automobiling." He finds three matters on page 323. The first of these is that the order of firing is shown on the drawing as 1, 3, 4, 2, whereas the text says 1, 2, 4, 3. This point is certainly well taken. The order should be as shown in the drawing, and not as in the text.

Mr. Bell next quotes the words, "A good time to retard the spark is when cranking the engine at starting," and asks, "Don't you think it better to say, 'The spark must always be retarded when cranking the engine at starting?' Too many broken arms your way." This is a good suggestion. In the directions for starting the car, it is made clear that the spark must be retarded before cranking up; but the fact cannot be too often impressed on the learner.

Mr. Bell thinks the directions for timing the engine are incomplete. The author still thinks they are adequate, but gladly accepts the suggestion about adjusting the gears with the aid of marks. These marks, says Mr. Bell, are usually made by the maker of the engine; but if they are not, "the beginner should mark a tooth of the gear on the half-time shaft, and the throat in which it meshes on the gear of the engine shaft." He can then readjust his gears with no trouble and with the assurance of the readjustment being accurate.

Mr. Bell can be sure that his letter has not been looked on as a "knock," but has, on the contrary, been appreciated cordially.

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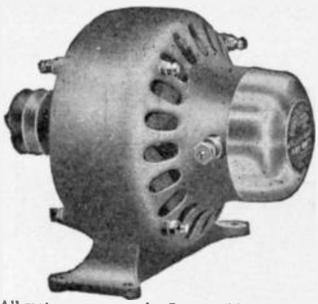

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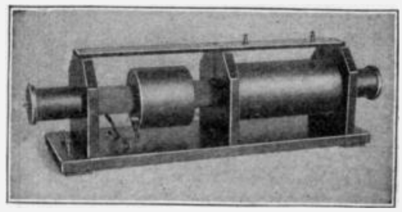

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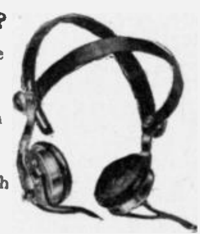

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