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# ELECTRICIAN & MECHANIC

Interior Electric Light Wiring

Forging for Amateurs

Breech Loading Cannon

Concrete in the Electrical Business

Efficiency of Wireless Equipment

Polarity Indicators

An Aerial Switch

PUBLISHED MONTHLY BY
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# ELECTRICIAN AND MECHANIC

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M. O. SAMPSON
} *Editors*

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VOLUME XX OCTOBER, 1909 NUMBER 4

## INTERIOR ELECTRIC LIGHT WIRING—Part I

GEORGE J. KIRCHGASSER, E.E.

Before taking up the different kinds of wiring, let us stop to consider some of the points of advantage of electric lighting that have caused its use to increase so rapidly. A treatise could be written here, but we will just tabulate as follows:

1. There is no exposed flame.
2. No matches are needed.
3. No oxygen is taken from the air.
4. No smoke or soot formed to dirty the walls and ceiling, or to contaminate the air.
5. Cooler.
6. It is the only light safely used in clothes closets and in presence of other combustible material or gases.
7. No danger from asphyxiation as with gas or explosion as with oil lamps. Over 300 people reported dead by asphyxiation in New York City in 1907.

A few analogies and definitions of the fundamental electrical terms will, we think, help to more clearly understand what is to follow.

Voltage corresponds to the difference of level or head of water, or if the water is flowing in a pipe, its pressure is analogous to the voltage of electricity flowing in a wire. This pressure or voltage is different on different systems, the higher voltages being used on transmission lines, on motor circuits (that is, for power) and on series arc-light circuits. For incandescent lighting, the pressure is usually 110 or 220 approx.

If we measure the quantity of water passing from some outlet in a water main, we can get the quantity per unit time; in the same way, we can measure the amount of electricity consumed in the lighting of an electric lamp, in the heating of an electric flat-iron, or in the running of an electric motor. This quantity is expressed in amperes. An ordinary 16 c.p. incandescent lamp uses ½ an ampere on a 110 volt circuit, so if we have, say, 10 of these lamps on a circuit, 5 amperes will flow through the wires to feed them when they are all turned on. This type of lamp would be called a 55 watt lamp (110 volts x ½ ampere).

The watt is the electric unit of power and for direct current circuits equals the product of the volts x amperes. For alternating current circuits, the real power or wattage is practically always less than the product as above, the equation being (volts x amperes x power factor), the power factor varying usually between .75 and .95 approx. In small interior wiring for alternating current lighting, etc., this factor is ignored, calculations being made the same as for direct current.

The Tungsten lamps are rated according to the number of watts they consume, as 25, 40, 60, 100, 250, etc., and this amount divided by the voltage of the circuit on which they are used gives the amperes of current consumed. If we have *ten* 100 watt lamps burning for one hour, 10 x 100 x 1=1,000 watt hours; or, 1 kilowatt hour would be used. (1 kilowatt equals 1,000 watts, and 1 kilowatt of current used for 1 hour equals 1 kilowatt hour.)

As a water pipe offers resistance to the flow of water, so also does a wire resist the flow of electricity. Copper wire has a low resistance, and is efficient mechanically; therefore its large use. Aluminum wire is also used, though its resistance is higher. A large pipe resists the flow of quantities of water, less than a smaller one. With electricity, the same reasoning holds, that is, the resistance of wire of large cross-sectional area is less than a smaller one. For feeder lines and others carrying heavy current, we find heavy wires, and for branch circuits, where the amount of current flowing is small, smaller wires are satisfactory.

The Ohm is the electrical term used to express unit of resistance. A No. 14 B. & S. Gauge copper wire has a resistance of 2.53 ohms per 1,000 ft. In a water pipe system, the pressure is decreased as we leave the source of pressure; toward end of system, several pounds have been lost, due to resistance of pipe, and the longer the pipe, the more resistance and greater loss of pressure.

With an electric system, the resistance of the conductors causes a loss of pressure also, that is if, say, the voltage at the station where the electricity is generated is 115 volts, the resistance of the wires would decrease this so that if a measurement of the voltage was taken somewhere out on the system, probably we would find the reading to be 110 volts. The drop in pressure depends on the length of the wires, their cross-sectional area, and on the temperature (because the resistance increases as the temperature rises).

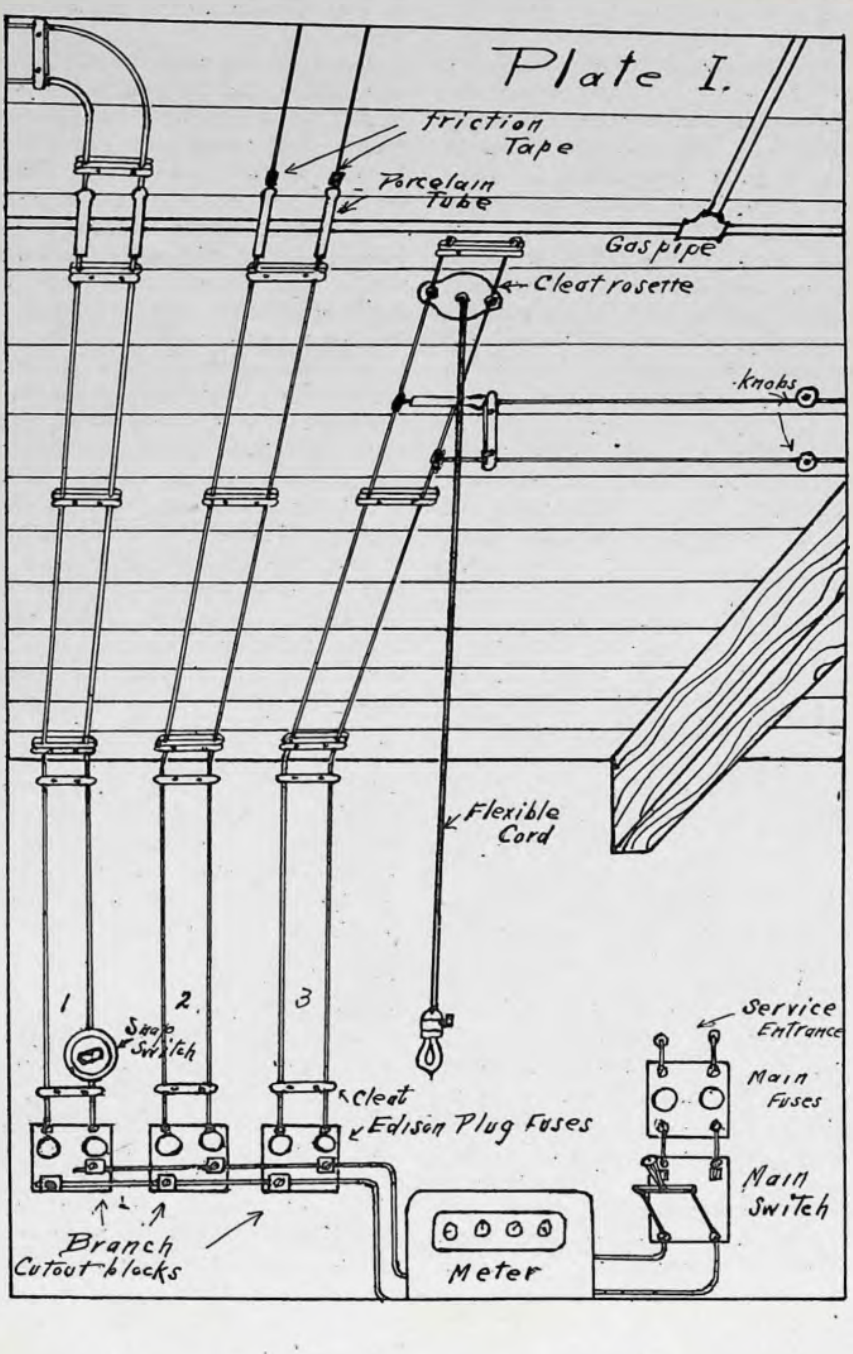
When electric lighting and motor systems were first installed, considerable trouble was caused, due to fires resulting from lack of knowledge at that time. According to a report of Mr. J. C. H. Woodbury, Engineer for the Manufacturers' Mutual Insurance Company of New England, in the year 1881, out of 65 installations of electric lighting in mills in the New England states, 23 fires resulted in about six months. The progress of interior electric lighting was jeopardized by these hazardous conditions, so a set of rules was drawn up by Mr. J. C. H. Woodbury in co-operation with Edison, Weston, Dr. Brush of the Brush Arc Light Machine Company, and Professor Thomson, inventor of the Thomson Wattmeter. As more equipments were installed, more knowledge of the work was gained, electricians became more skilled, and the whole science advanced very much in all directions. Amendments and changes were made to this first set of rules to keep apace with the growth, new uses, and new circumstances which arose from time to time. In 1897, the National Conference on Standard Electric Rules drew up the first National Electrical Code, Prof. Francis B. Crocker of Columbia University as chairman of the code committee. The National Conference Committee is composed of a long list of associations, among them being the American Institute of Electrical Engineers, Amer. Inst. of Architects, Amer. Soc. of Mech. Engineers, Amer. Inst. of Mining Engineers, National Electrical Contractors Ass'n, besides the Underwriters' Ass'ns. The National Electrical Code is used as authority for standard construction all over the United States and some parts of Canada. It is not statuory, nor has any fixed force of authority to compel compliance.

The different systems of interior light wiring may be classified as follows:

1. Open work (a) supported on cleats. (b) supported on knobs.
2. Moulding, wooden and metal.
3. Concealed knob and tube.
4. Iron conduit.
5. Flexible steel conduit.
6. Armored conductor.
7. Mixed wiring, in which the different kinds mentioned above are used for different portions of the work.
8. Fished wiring. This is usually part of an installation and really is not a system of wiring.

In open wiring systems, the wires are supported on walls, ceilings, etc., by porcelain insulators, the wires being held away from the surface wired over ½ in. if cleats are used, and 1 in. in the knob system. This open style is used where good appearances are not essential, or where the work is done in old buildings. We find open cleat and knob work mostly in mills, factories, store rooms, barns, open sheds, rear rooms of stores, etc., where the low cost of installation is also thought to be an advantage. Plate No. 1 shows a part of an open cleat wiring system as might be found, for example, in a wholesale paper store. Note where the wires pass over the gas pipes, porcelain tubes are slipped over the wires to thoroughly insulate them, the tubes being held in place, in one case by cleats placed on each end of them, and in the other, by cleats at one end and friction tape wound about the wires at the other. The object is to insure having the tubes remain where they are wanted for insulating the wires, so any method which will do this is acceptable. Tubes are also used where one wire crosses another, and anywhere else if a contact is liable, and where a permanent separation is desirable. An idea of the appearance of a knob system is shown in the tap made from circuit No. 3. Notice also the method of taking the strain from the binding screws of the rosette. A cleat is used beyond the rosette, and the wire secured and curled about the cleat.

Fig. 1 shows the common two-wire cleat in which the wires are firmly held 2½ in. apart and ½ in. from the bottom. Where the voltage does not exceed 300, this type of cleat can be used. There are two parts, two screws holding the top and the wires in place. and the whole cleat to the surface. A three-wire cleat is used on the three wire Edison system and is similar to the two-wire type, except a third notch is between the two outside ones. The

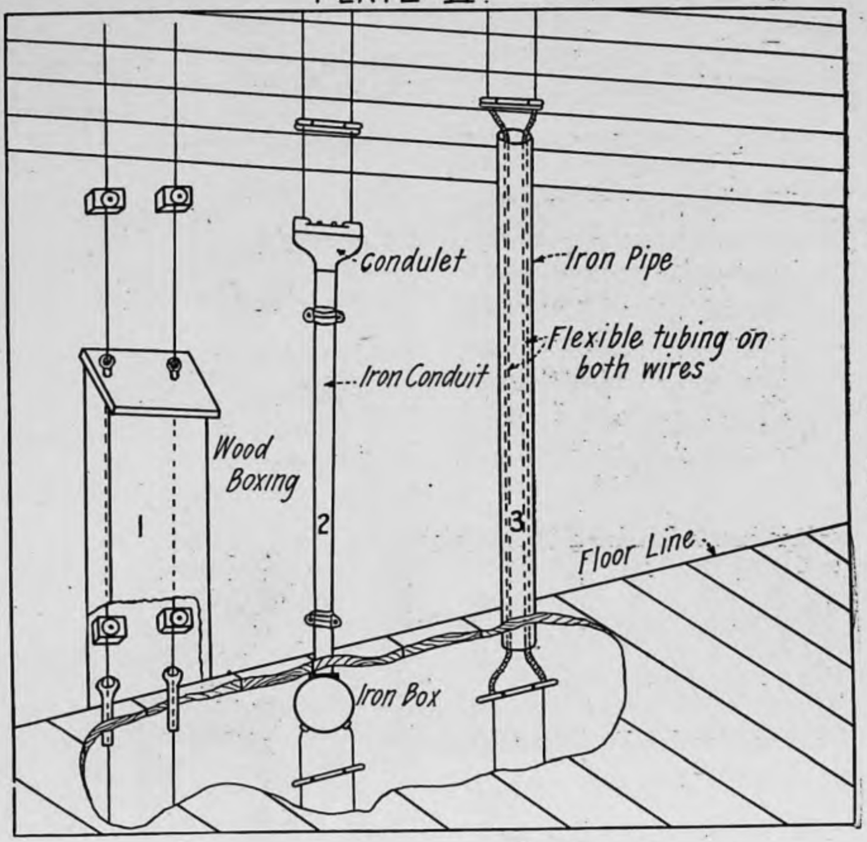


neutral wire is placed in the middle notch where the voltage between the two outside wires is not over 300, and the distance is not less than 2½ in., as in the case of the two-wire cleat between the outside wires. Single wire cleats are sometimes used where the wires and cables are larger than can be accommodated in the ordinary cleat or knob. The cable or wire holes in cleats and knobs vary from ⅛ in. to ⅝ in. (larger in special types) and are corrugated to grip the wires. See Fig. 2.

Open cleat wiring should only be run where there is no danger to the wires from mechanical injury, and only in comparatively dry places, because moisture is a good conductor of electricity, and since the wires are only 2½ in. apart and but ½ in. away from the surface, wired open cleat work is not desirable. For this kind of wiring, rubber-covered, slow-burning weatherproof, weatherproof or slow-burning insulation can be used. The wires should be well supported, that is, in some cases a cleat every 3½ ft., and in others, a spacing of 4 to 5 ft. is sufficient. Porcelain tubes are used to insulate the wires where they would come in contact with foreign material, gas, water, other pipes, I beams, and other conductors. They are also used where passing through partitions, beams, walls, floors, etc.; one method of bushing a hole through a partition being shown in Fig. 3, top. Porcelain tubes are made in different sizes, and wherever used for bushing, a hole should be long enough to bush the entire length. The wrong method of using two short tubes is seen in Fig. 3, middle. Tubes are manufactured in lengths from 1½ in. to 24 in., the diameter of the hole, thickness of walls, and external diameter varying in proportion. The tube mostly used in open wiring, and also in concealed knob and tube work is the 3½ in. size. In this, the diameter of the hole is 5/16 in., the external diameter varies between 9/16 and ⅝ in. (a ⅝ in. hole is usually safe for passing through obstructions), length of head, ½ in. and rest of body 3 in. The ends of the tubes are rounded off, so as not to injure the insulation of the wire. Fig. 4 shows a commercial tube. A method of bushing, a hole through a wall, that is not used very much, but is allowed by the National Electric Code, is illustrated in Fig. 3, bottom. An iron pipe is fitted into the hole, and two short porcelain tubes are butted from each end. When tubes are used to protect wires passing through an outside wall, the tubes should be pitched downward, toward the outside, the head being placed on the inside, holding the tube in place. A drip loop, as shown in Fig. 5, drains the moisture from the wires.

Cleat wiring must never be concealed, and where run in places where the wire might be subject to mechanical injury, guard strips are run parallel with the wires, one on each side. They should be from ¾ in. to 1 in. thick, and for cleat wiring, about 1 in. high. Anything passing near the wires would hit the strips and save the wires. Another method where, for instance, we have an open finish ceiling, is to first secure a wooden strip to the bottom of the joists. This strip (about ¾ in. thick and between 4 and 5 in. wide) being wider than the cleats takes any side blow, and being back of the wires prevents the wires from having things hung over them. When the wires are liable to severe mechanical injury, as near belting, on low ceiling in basements used for storage, on side walls within 6 in. from the floor, in elevator shafts, etc., some suitable boxing or iron conduit must be used. It is specifically stated in the Code that nothing but metal conduit is standard for elevator shafts. Open knob wiring is practically the same as cleat, except the knobs are substituted, holding the wires 1 in. away from the surface wired. The methods used to protect wiring from mechanical injury is the same as described above. Figs. 6 and 7 show views of the split knob having one groove, although those with four grooves are probably more in use as the grooves are of different sizes to accommodate different gauges of wires. The two wires of a circuit are not to be supported on one knob, as shown in the top view, Fig. 8. The tie knob is not used to a great extent for electric wiring any more and is not recommended. The circuit wire is secured to the knob by

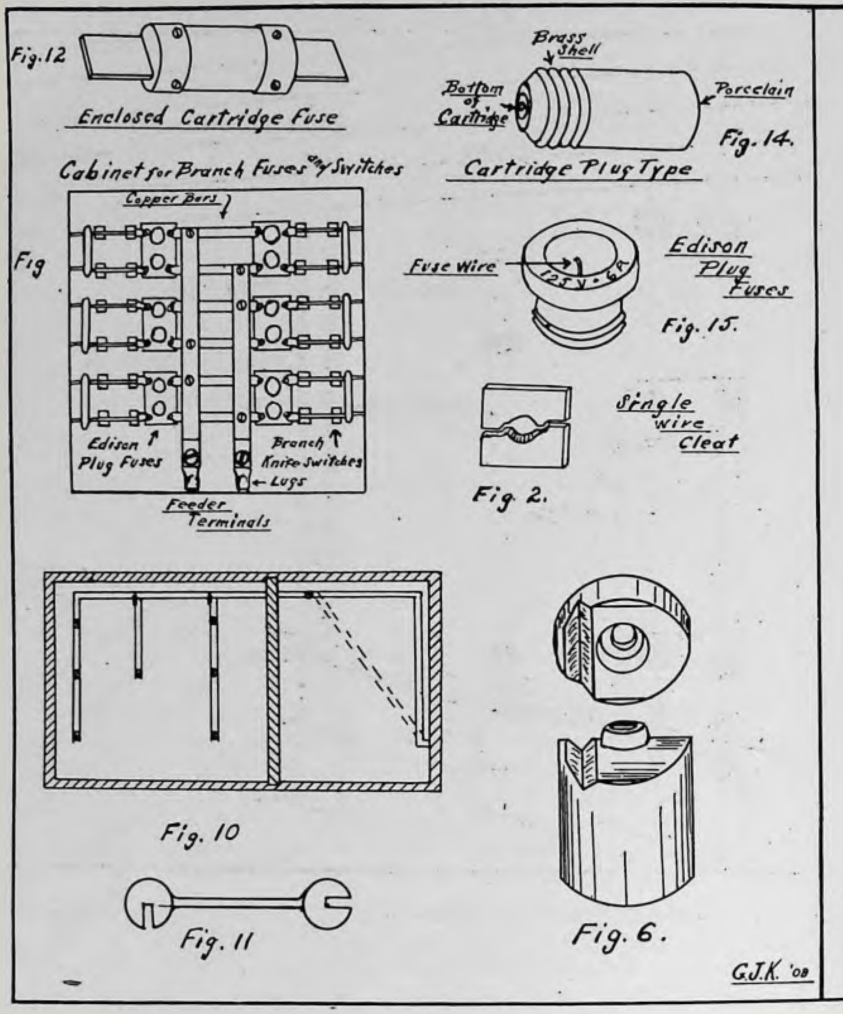
PLATE II.




a tie wire which should have an insulation the same as the circuit wire, so as not to cut into or injure the insulation of the latter. Fig. 9 illustrates this type.

Up to a voltage of 300, the 2½ in. separation of the wires in cleats is sufficient, but above 300 and up to 550, knobs must be used for open work, and the separation between the knobs holds the wires at least 4 in. apart (usual run is 5 in. apart), the separation from the surface wired being 1 in. The reason for the greater separation for the higher voltages is that they will sustain an arc a greater distance than lower voltages, and there is a greater tendency to leak through the insulation. In damp places the 1 in. separation from the surface, secured by using the knob, is better than ½ in., because of the conducting properties of moisture. Rubber insulation has been found to be the best to use in damp places, because it excludes moisture better. Where acid or other fumes are present, either weatherproof or rubber-covered wire can be used.

Methods of protecting open wiring, either cleat or knob, on side walls are shown on Plate II. Case 1 makes use of a wood boxing (¾ in. wood), with the top slanting to prevent dust from collecting, and also to prevent it being used as a shelf. Porcelain tubes are used to bush the holes and taped to keep out dust. The second case shows a piece of iron conduit which is a very good method. A type "A" condulet fitting is used at the top (and could be also at the bottom, but we attempt to show another fitting there), and an ordinary conduit box at the bottom. Battery bushings are used where the wires leave the box below. Of course either of these fittings could be used at both ends. Where unlined conduit is used, double braid, rubber-covered wire must be used. In Case 3, an iron pipe is used, large enough




to accommodate the two wires, each enclosed in a single length of flexible tubing. This tubing acts as an extra insulation on the wires and should butt against the last cleat or knobs, as the case may be. The protection of the wiring should be carried up 5 ft. or more, if the circumstances warrant.

Open wiring is cheaper than other wiring, with the possible exception of wood moulding, which also runs low, and for some purposes is entirely satisfactory. It is easier to install (although a good man's work can readily be distinguished from an amateur's or from a careless workman's), and takes less time. To look neat, it should be strung tight and be run in straight lines, taps be run at right angles and be looked after from time to time. Diagram No. 10 gives an illustration, the dotted lines showing a poor way of running the wires. Circumstances and conditions are factors in the life of open work, but if repairs are made when defects first show up, cleats or knobs replaced when necessary, the life will be greatly increased.

Now that we are well into our subject, a little about installations and wiring in general seems pertinent, before taking up the other systems. Wires, themselves, will first be discussed, and as copper is used for all inside work, all that follows will relate to that kind.

The weight of a copper wire 1 in. in diameter and 1 in. long is 3.028 lbs., so one foot of No. 0000 B. & S. gauge weighs a little under ¾ lbs. The following formula can be used to get the weights of copper wire: $D^2 \times L \times .000003028 =$ pounds, where D = diameter in mils and $D^2$ = circular mils as given in Table, p. 10, and L = length in feet. In the table following, we find the diameter in inches for the No. 0000 wire to be .46; to change to mils (1 mil = 1/1000 in.), we multiply by 1,000, making the result 460 mils; squaring this, gives us 460 x 460 or 211,600 circular mils. The weight of 200 ft. of No. 10 wire would equal 6¼ pounds, according to the above formula, where D is, as found in the table, .10189 in. (diameter in inches x 1,000 equals diameter in mils) and L = 200. The equation would read (101.89 x 101.89) x 200 x .000003028 = 6¼ lbs. The electric resistance of copper increases slightly with increase in temperature; about .002% per degree Fahrenheit, or about .004% Centigrade. If through a small wire, a large amount of current is drawn, the wire will heat, and the heat will, in turn, increase the resistance of the wire, resulting in still a greater rise, the action being cumulative. In the table following, it will be noticed that a greater carrying capacity is allowed for wires other than rubber-covered; the reason being that by making the limit low, there is less chance of the temperature getting anywhere near 150° F., at which point the insulation would deteriorate. The values for the current for rubber-covered wire are 60% of the values which Mr. Kennelly found would increase the temperature 75° F. above the surrounding atmosphere, so in case of change of lamps, additions, etc., the limit would not be reached or passed. The rise in temperature for weatherproof wire is about the same as the rubber insulated, but as this is to be used only for open wiring, the heat, if any, generated, is radiated to the surrounding air and not confined, as in concealed wiring. The carrying capacities in columns 3 and 4, cause a rise in temperature of about 29° F., which is inappreciable, but doubling the current quadruples, the degrees rise; *i.e.*, if a No. 10 wire is made to carry, say, 48 amperes, which is twice the amount noted in Column 3, and which we said causes a rise of 29° F., the rise above the surrounding air would be four times 29°, the heating varying as the square of the current. Between 70 and 75 amperes would cause the insulation to smoke, or three times the value given in the table.

The carrying capacities are for interior wiring and for copper wires of 98% conductivity, according to the standard adopted by the American Institute of Electrical Engineers. For outdoor conductors, a more liberal carrying capacity is allowed as the wires are continually cooled by the winds, but as we are only treating of interior work, conditions which determine the size of outside wires will not be considered. For the same reasons other wires will not be discussed, although it might be noted that an aluminum wire having the same insulation as the wires in the table would have a carrying capacity 84% of those values.

No. 14 wire is the smallest wire to be used for circuits, as the Nos. 16 and 18 are not thought to be strong enough, and are only used in wiring fixtures and for flexible lamp cords. If used on circuits of any length, their high resistance would also cause a large drop in voltage, which is not desirous.

| B. & S. Gauge | Circular Mils. | Amp. Rubber Insula'n | Amp. other Insuls. | Diam. In. | Resistance per 1,000' at 75o Fahr. | Wei't per 1000' |
|---|---|---|---|---|---|---|
| 18 | 1,625 | 3 | 5 | .040 | 6.21 | 4.5 |
| 16 | 2,583 | 6 | 8 | .050 | 3.97 | 7.8 |
| 14 | 4,106 | 12 | 16 | .064 | 2.53 | 12.5 |
| 12 | 6,530 | 17 | 23 | .080 | 1.589 | 19.8 |
| 10 | 10,381 | 24 | 32 | .101 | 1.000 | 31.5 |
| 8 | 16,510 | 33 | 46 | .128 | .63 | 50. |
| 6 | 26,250 | 46 | 65 | .162 | .392 | 79. |
| 5 | 33,100 | 54 | 77 | .181 | .31 | 100.0 |
| 4 | 41,740 | 65 | 92 | .204 | .248 | 126.0 |
| 3 | 52,630 | 76 | 110 | .229 | .197 | 159.0 |
| 2 | 66,370 | 90 | 131 | .257 | .157 | 200.5 |
| 1 | 83,690 | 107 | 156 | .289 | .123 | 253.0 |
| 0 | 105,500 | 127 | 185 | .324 | .099 | 319.0 |
| 00 | 133,100 | 150 | 220 | .364 | .077 | 402.0 |
| 000 | 167,800 | 177 | 262 | .409 | .063 | 506.0 |
| 0000 | 211,600 | 210 | 312 | .460 | .05 | 640.0 |
| | 400,000 | 330 | 500 | .633 | .025 | 1211.0 |
| | 500,000 | 390 | 590 | .708 | .02 | 1514.0 |
| | 600,000 | 450 | 680 | .774 | .0168 | 1817.0 |
| | 700,000 | 500 | 760 | .836 | .0143 | 2120.0 |
| | 800,000 | 550 | 840 | .895 | .0125 | 2422.0 |
| | 1,000,000 | 650 | 1,000 | 1.000 | .0100 | 3028.0 |
| | 1,200,000 | 730 | 1,150 | 1.095 | .0084 | 3635.0 |
| | 1,400,000 | 810 | 1,290 | 1.18 | .0071 | 4240.0 |
| | 1,500,000 | 850 | 1,360 | 1.224 | .0066 | 4545.0 |
| | 1,600,000 | 890 | 1,430 | 1.264 | .0062 | 4840.0 |
| | 1,800,000 | 970 | 1,550 | 1.342 | .0055 | 5450.0 |
| | 2,000,000 | 1,050 | 1,670 | 1.413 | .0050 | 6056.0 |

This table will be referred to from time to time, but it might be here stated, that Cols. 3 and 4 give the information about wires for the ordinary interior job.

### INSULATING MATERIAL AND INSULATED WIRES

The most common insulating materials are glass, marble, slate, mica,

FIG 7
SPLIT KNOB

FIG 9
TIE KNOB

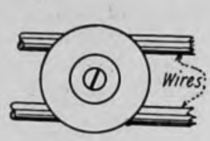



FIG 8.
WRONG METHOD


FIG. 13.

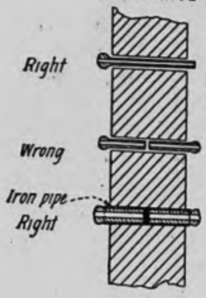



FIG 3

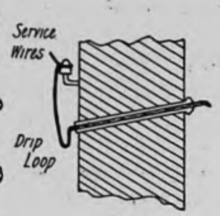



FIG. 5

FIG 1
PORCELAIN CLEAT

FIG 4
PORCELAIN TUBE

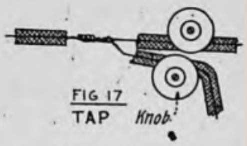



FIG 17
TAP

FIG. 16
SPLICE

porcelain, asbestos, asphaltum, paper, rubber (natural and vulcanized), gutta-percha, besides many others used in dynamo and motor construction. Heat decreases the electric resistance of all insulations, time affects some, while others are readily affected by moisture, the absorption of which, due to the conducting properties, decreases the value of the insulation. For interior wiring, rubber-covered, slow-burning weatherproof, slow-burning, and weatherproof insulations are used. The copper of rubber-covered wire is tinned before the insulation is applied, so as to prevent the composition of the insulation from attacking the copper. The white surface of the tinned wire can be seen by cutting away the rubber and braid, and the characteristic color of copper will be exposed on scraping the wire with a knife. There are six principal processes in the manufacture of rubber-covered wire:—tinning, mixing and applying the compounds, vulcanizing, braiding, waxing and smoothing the outer surface. The thickness of the insulation varies with the size of the wire, and also with the voltage of the system for which it is designed; a thicker insulation, of course, being used on the higher voltages. The thickness of insulations on wires to be found used mostly in interior lighting work, that is, Nos. 14 to 8 and Nos. 6 to 2 is 3/64, and 1/16, respectively. For conduit and metal moulding systems, a second braid is used to protect the insulation when the wire is pulled into the pipe, and because of the conductivity of the metal moulding; this wire is called double-braid rubber-covered wire. Single-braid rubber-covered wire is used in the open cleat and knob styles of wiring, especially in the location subject to moisture or acid fumes, for knob and tube systems, and is the only wire approved for wooden moulding work (double-braid rubber-covered, of course, could be used but it is more expensive).

Slow burning weatherproof wire has two coatings, the inner one, weatherproof, and the outer one fireproof. The braid of the inner coating is saturated with a moisture-proofing mixture and the outer is filled with a fire-resisting compound.

Slow burning wire has several braids filled with a fire-resisting compound and has a strong outer braid, which is finished smooth. The last two wires mentioned are used to a great extent for open cleat wiring in hot, dry places.

Weatherproof wire has all its braids filled with a moisture-proofing compound, and has a slick outer finish. This wire can be used for open wiring, especially where acid vapors are present and for outside wiring. Where a large number of wires are grouped in open style wiring, it is best to use as little rubber-covered and weatherproof as possible, as both have insulations that burn easily and with a dense smoke.

## FORGING FOR AMATEURS—Part XI

F. W. PUTNAM, B.S.

### TOOL STEEL

The use of tool steel is one of the most interesting parts of the work of a good blacksmith, since tool steel is used in the making of tools and parts of machines where great wearing qualities are required. It is used for tools intended for cutting, pressing or working metals, or other hard materials to shape. In order to successfully work tool steel, one must gain a practical knowledge of some of its peculiarities. Ordinary tool steel is practically a combination of iron and carbon. There are many varieties of tool steel which are distinguished or designated by the percentage of carbon which they contain, and firms who make a specialty of producing tool steel for use in making tools, usually label the steel with the percentage of carbon it contains, and the purposes to which, in the firm's opinion, steel containing such percentage of carbon is applicable. The following is a list of perhaps the most useful "tempers" of cast steel:

Razor Temper, 1½% carbon.—This steel is so easily burnt by being overheated, that it can only be given to a very skillful workman to use. If properly treated, it will do about twice the work of ordinary tool steel for turning chilled rolls, etc.

Saw File Temper, 1⅜% carbon.—This steel requires careful treatment, and although it will stand more heat than the preceding temper, it should not be heated above a cherry red.

Tool Temper, 1¼% carbon.—This is perhaps the most useful temper for turning tools, drills and planing machine tools that are used by ordinary workmen. Steel of this temper can be welded, but it takes considerable care and skill to obtain a perfect weld.

Spindle Temper, 1⅛% carbon.—This is a very useful temper for mill picks, circular cutters, very large turning tools, taps, dies, etc. Steel of this temper may be welded, but requires considerable care in its use.

Chisel Temper, 1% carbon.—This is an extremely useful temper and combines great toughness in the unhardened state, with a capacity of hardening at a low heat. Steel of this temper may also be welded with comparatively little difficulty. For this reason, it is particularly well adapted for tools where the unhardened part is required to stand the blow of a hammer without bending, and where a hard cutting edge is required, a good example being cold chisels.

Set Temper, ⅞% carbon.—This temper is made use of principally for tools where the heat of the work comes upon the unhardened part, such as cold sets, which have to withstand the blows of a very heavy hammer.

Die Temper, ¾% carbon.—This is probably the most suitable temper for tools where the surface only must be hard and where the capacity to withstand great pressure is of considerable importance, as is the case with stamping or pressing dies, etc.

Both of the last two tempers named may be easily welded by any mechanic accustomed to welding cast steel. Steel which contains a large amount of carbon is known as "high" carbon steel, and steel having a small amount of carbon is called "low" carbon steel. Manufacturers of tool steel use the word "temper" as referring to the amount of carbon a steel contains. Thus a steel manufacturer will speak of a high temper steel, meaning, when he does this, a steel containing a large amount of carbon. The property of tool steel, which makes it especially valuable, is the fact that it can be hardened to a greater or less degree, as may be necessary to fit it for the purpose for which it is intended.

The consumers of steel, we may divide into three general classes. First, those who use their own judgment as to the percentage of carbon they require and instruct the manufacturer to send the steel of a specified temper. Second, those who leave the selection of the temper to the judgment of the manufacturer, and then instruct him to send the steel for a particular specified purpose. And third, those consumers who merely order steel of a special size, leaving the manufacturer to guess for what purpose it is to be used. Usually, however, the size and shape will generally furnish a good conclusion to the purpose for which it is really to be used. For example, oval steel is almost sure to be used for chisels, and small squares for turning tools.

When the tool steel has been delivered to the consumer, the first process which it undergoes is the forging of it into the shape required. This process is made up of two processes, first that of heating it to make it malleable or soft, and second, that of hammering it while it is hot into the specified shape.

The most particular rule in forging, as regards the use of tool steel, is to heat the steel as little as possible before it is forged, and to hammer it as much as possible in the process of forging. The very worst fault that can be committed is to overheat the steel. When steel is heated, it will become coarse-grained, its silky texture becomes changed, and can only be restored by hammering or else sudden cooling. If the temperature be raised above a certain point, the steel becomes "burnt," and the amount of hammering which would then be required to restore to it its silky, fine grain, would necessarily reduce it to a size considerably too small for the required tool, and the steel must then be condemned as spoiled.

It will be found that overheating in the fire is the primary cause of cracking in the water. If steel has been hammered or forged into the shape required, it has been hardened to such an extent as to make the cutting of it almost impossible, or at least difficult. It must consequently then be annealed. This process like the preceding one, is a double process. The steel must be reheated just as carefully as before, and then afterward cooled down as slowly as possible. We now come to the crowning point in our manufacture, where the invaluable property which distinguishes steel from wrought iron or cast metal is shown. That part of the tool which is to be hardened, must be heated through very evenly, but, on the other hand, must on no account be overheated. The tool should be finished at one blow, a blow caused by the sudden contraction of the steel, produced by its sudden cooling in the water, and if this blow is not sufficient to give to the steel a fine grain and silky texture, if, after the blow is given, the fracture, where it is broken in the hardened part, should show a coarse-grained and dull color instead of a fine grain and shiny lustre, our tool is spoiled and must be thrown away. There are many dangers which must be avoided in hardening each kind of tool, but these can only be learned by experience. Some tools will warp if they are not plunged into the water in a certain way. Tools of one shape must cut the water like a knife, while those of another shape must stab it like a dagger. Some tools must be hardened in a saturated solution of salt, others can be best hardened under a stream of running water.

This hardening and tempering of carbon tool steel is a problem that has given constant thought to mechanics and metallurgists form any years. Various conditions have a practical bearing on the subject which are very essential to the successful development of treating tool steel.

In some tools where their peculiar shape necessitates a great difference in the rapidity of cooling. It is advisable to drill holes in the thicker parts where they will not interfere with the practical use of the tool, with a view of equalizing the rapidity of the various parts, in order to distribute the area of tension, and so decrease the risk of cracking in the process of hardening. There are so many causes which may produce water cracks, and it is often difficult to point out the exact cause in any given case. Perhaps the most common cause is overheating the steel in one or more of the processes through which it passes in the blacksmith's hands, or overheating in the process of rolling it into the dimensions required while in the hands of the manufacturer. A second cause may be sometimes discovered in the addition of too much manganese, which has been added by the manufacturer for the purpose of preventing honeycombing in the ingot of cast metal. A third cause may curiously enough prove to be a deficiency of carbon, while on the other hand, in some cases too much carbon will produce the same effect. The fourth cause may be the presence of too much phosphorus in the steel.

When the process of hardening has been successfully accomplished, our difficulties in the preparing of the tool for the workmen are not yet over. Our steel, when annealed, became nearly as soft as lead. It now becomes as hard as glass. To reach its proper condition for use, our tool must then pass through the familiar process, that of *tempering*. If the piece of hardened steel is heated slightly, and then allowed to cool again, it becomes tempered. It suddenly changes from glass to whalebone in nature, and in this process of changing, it very fortunately changes its color, so that the workman can judge by the particular color shown, as to the extent of the elasticity which has been given to it, and so can give to each tool the special degree of temper which is most adapted to its special purpose. The various colors through which the tempered steel successively passes are straw, gold, purple, violet and blue. It must be understood, of course, that in passing from one color to another, the steel passes really through an infinite series of colors, of which the five just named are selected as convenient stages. We may say that the maximum of hardness and elasticity combined is properly obtained by tempering down to a straw color.

In tempering steel, particular regard must be paid to the quality most essential in the special tool to be tempered; for example, a turning tool must be very hard, and is usually taken hot enough out of the water, so as to temper it down to a degree so slight that no perceptible color is apparent, while, on the other hand, a spring must be very elastic and may be tempered down to a blue.

Another way of treating steel is to harden it in oil. This appears to a certain extent to reach but one process, the change from the lead into the whalebone stage, without passing through the intermediate glass stage. This is of great value for hardening tools.

### TESTING TOOL STEEL

I know of no easy method of testing tool steel. The amount of breaking strain and the extent of the contraction of the area of the fracture are, of course, easily determined for steel which is not hardened and not required to be used in a hardened state. But this method for testing, hardening and tempering steel is practically useless. It is a difficult thing to harden and temper two pieces of steel to exactly the same degree. One single test is of comparatively small value, because a second-rate quality of steel frequently stands up very well the first time it is hardened, but deteriorates very rapidly every time it is re-hardened, which is not the case with high-quality steel. I question whether the breaking strain is ever a fair test of the quality of steel. For many tools, a capacity to withstand a high amount of breaking strain slowly applied is not so much required as is its capacity to withstand a sudden shock. The appearance of the fracture is often deceiving. The fineness of the grain and the silky gloss which appears is, of course, very pleasing to the eye, but this can be produced by hammering cold. The practical consumer of steel must make up his mind to buy that steel which his workmen tell him is full of "nature" and "body," or in other words, that steel which contains the necessary properties for successful annealing, hardening, reheating, and tempering.

I have said that carbon is the element in tool steel which makes it possible to harden it by heating to a red heat and plunging into a cooling bath. A bar of steel coming from the rolling mill is nearly decarbonized, on its outer surface, and consequently this portion will not harden, or, if it does, the results will not be satisfactory. For this reason, if a tool is to be made, having cutting teeth on its outer surface, it becomes necessary to select stock of somewhat greater diameter than the finished size, so that this outer portion of decarbonized steel may be removed. Tool steel is furnished to the trade in almost any form or quality, being usually finished in round, octagonal, square or flat bars. There are many tool makers who prefer to use octagonal steel for tools which are to be made circular in shape, but steel of various shapes of the same make does not differ very materially, provided the quality and temper are the same.

HARDENING

I have already given a definition for the hardening of tool steel, and have also explained what is meant by the process of annealing. From what I have said, it will be clear that the *speed* at which a piece of steel is cooled from a high heat determines its hardness. Thus, if we cool steel very quickly, it becomes very hard. If we cool it very slowly, it is softened, and so the hardness of the steel may be readily changed by varying the speed of cooling. It will be seen, too, that the proper heat from which or to which point the steel should be cooled, varies directly with the percentage of carbon in the steel. Usually the greater the amount of carbon present, the lower the hardening heat, or in other words, a high carbon steel will harden at a much lower temperature than a low carbon steel. The successful hardener is the blacksmith who finds out what particular quality is needed in the piece he is to harden. He must know the method to use in producing the desired result, either extreme hardness, toughness, elasticity, or a combination of any two of these qualities is desired. He must take into consideration the shape of the steel, the brand of the steel, as well as the particular use to be made of the tool. He must, of course, be governed considerably by the kind of fire he is to use. I have already said that some kinds of tool steel will not stand the amount of heat that others will without injury, although I do not mean by this that any brand of steel should be given an unreasonable heat in the fire. There are certain makes of steel which give off their surface carbon much more readily than will others, so that it is not safe to harden in the open fire in direct contact with the flame, since the producing of combustion will extract the carbon to such an extent that the surfaces will be soft. If the tool is to be ground, this might not materially injure it, but if the tool were a tap or milling cutter, which could not be ground on the outside surface, this would probably seriously injure the tool. When a tool of this description is to be hardened in an open fire, it must be heated, either in a tube, or some recipient which will prevent the fire from coming in direct contact with the tool. There are many gas and gasoline hardening ovens on the market which are made with a muffler which holds the work, the fire and hot gases circulating around the outside of the muffler. These furnaces give excellent results if the front can be covered with a door. If the door has one or more large holes drilled in it, and the holes are covered with mica, the blacksmith at any time can see his work without letting the outside air come in contact with it.

This taking of the carbon from the steel is not the only injury which is done to good tools when heated in the ordinary blacksmith's forge. If the tools are heated in a small fire, the work comes in contact not only with the surrounding air, but with the cold air from the blast, which will cause all sorts of trouble. Repeated heating by the fire and successive cooling by the blast will make very small surface cracks, looking as though the steel were full of hairs. The only way by which to determine the proper heat to which to harden any particular kind of steel is, of course, by experiment. Take a small piece of the same kind of steel as that to be hardened, and hammer it out into a bar about ⅜ in. square. Heat the end of this bar until it shows dull red, and then cool it in cold water. Try this end with a file for hardness, and break off about ¼ in. of it over the corner of the anvil. The results of this test will probably show that the steel may be filed and breaks with difficulty, the grain of the broken end being a little coarse and a little stringy. The results shown are not satisfactory, if, as suggested above, and the same experiment must be repeated at a slightly higher heat. This time the steel will be considerably harder, which is shown by its being harder to file and more easily broken. The grain of the fracture will be somewhat finer. This experiment must be repeated, raising the heat slightly each time, until such a heat is reached as will, after cooling, leave the steel so hard that the file will slip over without catching at all, and yet so brittle that it will snap very easily. Under these conditions, when broken, the fracture will show a very fine, even grain. This is the proper heat at which to harden that particular brand of steel, and is called the "hardening" heat for that steel. Should this experiment be continued, we should find that every additional increase of temperature above this hardening heat will increase the coarseness of the grain and make the steel very brittle. This indicates that the steel, if it be hardened at these higher heats, grows coarser in texture and, as a result, is not as strong. Nor will it hold as good a cutting edge as if it were hardened at the proper "hardening" heat. In other words, the proper heat to which any particular kind of steel is to be heated for hardening that steel is that particular heat that gives to the steel the finest grain and leaves it hard. From the above, we deduce two general laws of hardening. First, the more carbon a steel contains, the lower the heat at which it may be properly hardened. Second, steel will become harder the faster it is cooled from the hardening heat.

In all hardening work, a great deal depends upon the uniformity of heat. The piece of steel must be given the uniform heat throughout. The edges and corners must be no hotter than the centre, while the interior should be of the same temperature as the surface. If this is not the case, the piece will very likely crack in the cooling bath, because of the uneven changes which take place within it.

#### COOLING

It is not sufficient to simply heat the piece uniformly, it must be plunged into a suitable bath to give it the proper hardness. It must be worked rapidly up and down or around in the bath, in order to get it away from the steam which is generated by the red hot steel coming in contact with the liquid, and also that it may constantly come in contact with the cooler parts of the bath. If the tool is long and slender, it must be worked up and down. If it is short, with teeth on the outer edge, as a milling cutter, it must be worked around rapidly, so that all the teeth may be cooled uniformly. If it is flat and has a hole through it, whose inside walls must be heated, it must be swung back and forth, so that the bath may pass through the opening and at the same time strike both faces. If, on the other hand, a tool is not to be hardened all over, and it becomes necessary to heat it higher than the point where the hardening is to stop, it may be dipped in the bath at a point a trifle higher than usual, and then worked up and down a little. Failure to do this will cause a line where the piece is contracted on one side and expanded on the other. The tool is very likely to crack at this line, which is usually called a "water line." Very fine tools, or those tools having long projections or teeth, should preferably be dipped in a tepid bath.

#### TEMPERING

A tool made of steel is said to be "tempered" when it has been given the proper degree of "hardness" to do the work for which it has been made.

Steel-makers use this word "temper" in a decidedly different sense than do the steel-workers. "Temper" is used by the tool-smith or tool-maker as meaning the hardness of a tool or piece of tempered steel, without any regard to the amount of carbon it contains.

Tools that are hardened by heating to a hardening heat and cooling in cold water are usually too hard and brittle for most purposes, and must be softened considerably to make them fit for the work they are called upon to do. These tools which must be softened slightly, go through the process of "drawing the temper," which is accomplished by slightly reheating the previously hardened steel.

If a piece of steel be heated to about 425° F., we find that it has been slightly softened and toughened, and of just about the right degree of hardness for engraving tools, small lathe tools, etc.

If we now raise the heat to 465° F., or even up to 500° F., we have a hardened steel suitable for taps, dies, drills, etc. Reheating to 550° F., makes the steel just right for cold-chisels, saws, etc., and a temperature of 575° F., leaves very little hardness in the steel—

just the thing for springs.

If we raise the temperature to 650° F., it will be found that the "temper" is now all gone, and the steel has become soft enough, so that it can be readily filed. Should we increase the temperature only a little above this point, the steel becomes red-hot.

We can measure these temperatures to which the steel is reheated by several methods. One method is to heat a bath of oil to the proper temperature, and, after hardening, dip the tools in this until they are of the same temperature as the bath. This method is satisfactory for tempering on a large scale, but, of course, unsatisfactory for use with only a few tools.

The steel itself furnishes as easy a means of determining the temperature, as any other method could. When a piece of steel is polished bright and then heated, a thin scale will form on the outside; this scale will change color as the temperature increases. The scale commences to show at a temperature of about 425° F., and is a very pale yellow in color; as the temperature increases and the scale becomes thicker, this yellow becomes darker, changes into chocolate, which becomes tinged with crimson, turning into light purple, dark purple, and finally blue.

These colors are due to a thin oxide or scale, which is formed, and show nothing except the temperature to which the metal was last heated. A piece of soft steel or wrought iron, when heated, will show these colors as well as tool steel. The colors are permanent, and remain after the metal is cooled. This colored scale, however, is very thin, and may be readily removed by polishing.

Note this fact, that if the tool has not been properly hardened in the first place, the fact that it has been given, and shows the proper temper color on the outside, will mean absolutely nothing.

Filing a tempered tool is about the only way to really test the temper of it, and even then the grain may be much too coarse, due to hardening at too high a heat.

Should there be any doubt as to the proper heat to give any piece of steel to harden it, the tool much better be hardened at too low, rather than too high a heat, for if the heat used is too low, the tool may be reheated and again hardened at a proper heat, but if a too high heat was first used, there is no way of detecting the fact, and the tool will probably break as soon as it is used. We find that generally when a tool has been hardened at too high a heat, it will have a scratchy and crumbly cutting edge.

If the amateur tool-maker is obliged to use a blacksmith's forge, he must have on hand a good supply of hardwood charcoal. If the tool to be hardened or tempered is of any size, make a large, high fire and place the tool in the fire, high enough up from the tuyeres so that it will not be cooled by the blast of air, and using only enough heat to keep a lively fire sufficient to bring the work up to the proper heat.

For forging, iron and low brands of steel, coke and blacksmith's coal are very useful, but are not of great value, in my opinion, for heating tool steel for hardening. As I have before pointed out the *lowest* heat that will give the desired result is the one to be used. You will find that the majority of steel-makers in their instructions say to harden at a *low cherry red;* this is a very uncertain degree of heat. It is generally understood that the proper heat for steel in hardening is when the black has just disappeared, leaving a very deep blood red. Under no conditions, however, should a piece of steel be dipped in the bath while there is the slightest trace of *black* in it.

It will be found that some brands of steel will not harden at this heat, but require a somewhat higher heat. Of course the higher the steel is heated (up to a certain heat), the harder the surface of the tool will be; but if we use a greater heat than is necessary, we open up the grain of the steel and the result will be that the tool will be much more liable to flake off under strain. If we have heated a tool for a hardening heat, too hot, we must always allow it to cool down to a black, and then reheat to the proper degree.

Always harden on a "rising heat," and never on what is usually known as a "lowering heat," as in this latter case the grain of the steel will be open; if, on the other hand, we allow it to cool gradually, until the red has disappeared, and then re-heat, the grain will be fine.

### TEMPERING TOOLS

We may divide tools that are tempered into two general classes:

1st. Tools which have only a cutting edge tempered, such as most lathe tools, cold chisels, etc.

2d. Tools that must be tempered to a uniform hardness throughout, or for a considerable length at least, such as dies, reamers, taps, milling cutters, etc.

The method of tempering a cold chisel will serve as a good example of the tempering of tools of the first class, the only real difference in the tempering of other tools belonging to this class being, of course, the temperature to which the tools are re-heated, which is shown by the "temper color."

After forging the tool, allow it to cool until black. Next, heat the cutting end to the proper hardening heat for 2 or 3 in. back from the edge, taking care, however, not to heat the steel *above* the hardening heat.

We are now ready to harden this heated end by cooling about 2½ in. of the point in cold water, leaving the end in the water just long enough to cool it. Next withdraw the chisel from the water and polish the end with a piece of emery paper, or on an old grindstone.

Part of the chisel is still red hot and the heat from this hot part will gradually reheat the cold end, and so "draw the temper." The "temper colors" will begin to show next to the heated part, and as the cold end becomes reheated, the band of colors will move toward the point of the chisel. When a deep bluish purple color is seen at the cutting edge, the tool must be again cooled, in order to prevent any further reheating and softening of the steel.

If a portion of the chisel should still be red hot, when the end has been cooled the second time, we must dip only the end of the chisel in the water, and hold the tool there until all the chisel becomes black, when the entire tool may be plunged into the water.

If we were tempering a lathe tool, instead of a cold chisel, the process would be exactly the same, except that the tool should be cooled the second time when the *yellow* scale appears at the cutting edge.

When you harden the ends of tools, as just described, keep the tool in constant motion while in the water, so as to prevent the cooling of the steel along a sharp line, as well as to keep a continual circulation of water about the cooling metal.

The next article will explain the tempering of tools of the second class (hardened all through), lead hardening and tempering, annealing, etc.

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### How to Paint a Bath Tub

Assuming that it is an old metal tub which has never been painted. First—the tub should be thoroughly cleaned. To do this, wash it with soap and water, or with soda, or with sapolio, in order to get off the grease; then rinse out with clean, hot water, wiping dry with dry cloths. Then roughen up the surface of the tub by going over it with fairly coarse sandpaper, and wipe out the little dust and dirt produced by the sandpaper with a dry cloth. The tub is now ready to be painted. The first coat should be white lead in oil thinned with turpentine, using a flat bristle brush in putting it on and being careful not to get on too thick a coat. Allow this coat to dry for at least 24 hours, when a second coat of this same lead should be applied in the same way and allowed to dry also for at least 24 hours. The tub is now ready for the coat of enamel, using a kind especially made for such purposes. Open the can, stir the enamel thoroughly and apply with a flat bristle brush, carefully and evenly. One coat of this enamel is sufficient, which should now be allowed to dry from four to six days. When you again commence using the tub do not allow *hot* water to run into it first, as it may soften up the enamel. If the tub has been painted in the past, the old paint should be scraped and sandpapered off before painting.

## HOW TO MAKE A BREECH LOADING CANNON FOR 22-CALIBER BLANK CARTRIDGES

T. COVEY

The perspective view shows the appearance of the completed article, also gives an idea how to construct the carriage. All the parts necessary for the cannon are shown on the detail drawing, of which Fig. 2 is an assembled view of the breech block as it would appear if the block and plug were cut in half on a vertical plane. To make it clear, I will designate each part and its place. A is the breech block. A' shows an end view of it without the rest of the mechanism. B is the breech block plug; an end and side view of this is also shown in detail in Fig. 3. C is the hammer, shown also in Fig. 4. D is the hammer handle, Fig. 5. E is the spring, Fig. 6. F is the trigger, shown without its spring in Fig. 7. G is the firing pin, Fig. 8.

Fig. 10 shows the details of the trunnions, of which two are required, They are screwed into the sides of the gun barrel, as will be seen by an inspection of Fig. 1.

To make one of these guns a lathe is needed, and if your lathe will cut threads, it will be best to cut the threads in the breech of the gun and on the breech block in the lathe. The first thing to make is the breech block: Take a piece of soft steel about 2 or 3 in. long and large enough to turn up ½ in. in diameter. Clamp it in the chuck, face the end and turn it down to ½ in. for about 1 in. from back the end. Cut a thread, 12 to the inch is about right, on it; then cut a round groove, as at H, Fig. 2, leaving ½ in. of the thread intact; then turn it down, ½ in. or so further, to the size of the bottom of the thread; knurl this portion, as it will be more convenient to operate the block; cut the block off about ¾ in. long over all, lay it one side and make the gun barrel. Take a piece of soft steel 4 in. long, and large enough to turn to ¾ in. in diameter, and centre it; face the ends and turn it off to the shape of the outside of the gun barrel. Then chuck the small end true, and run the large end in the

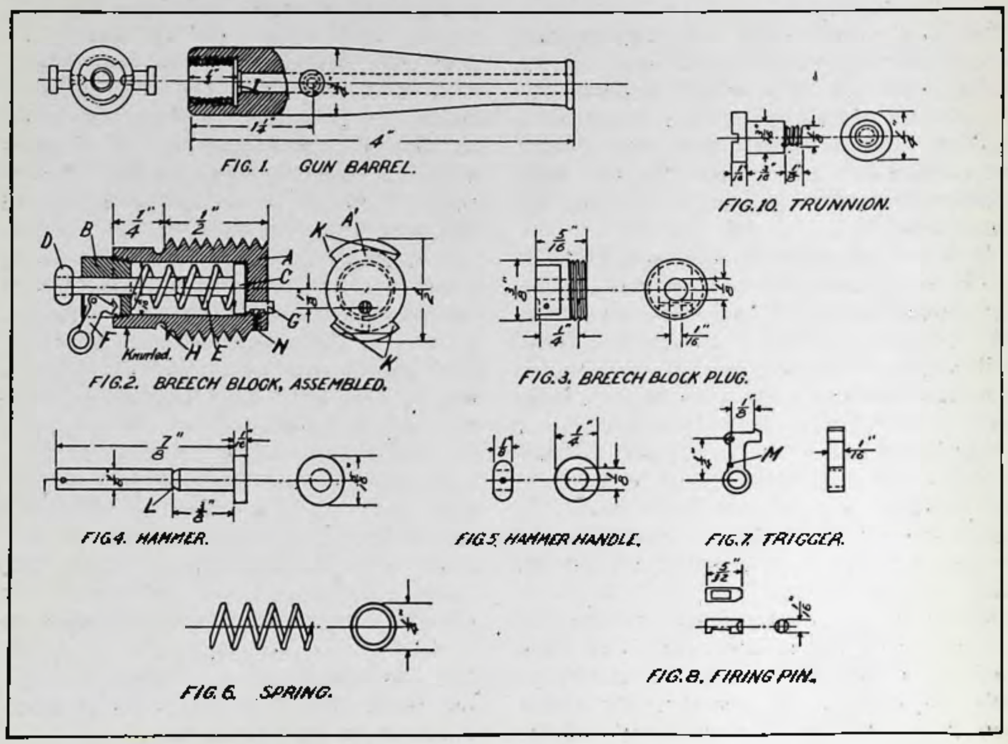



FIG. 1. GUN BARREL.

FIG. 10. TRUNNION.

FIG. 2. BREECH BLOCK, ASSEMBLED.

FIG. 3. BREECH BLOCK PLUG.

FIG. 4. HAMMER.

FIG. 5. HAMMER HANDLE.

FIG. 7. TRIGGER.

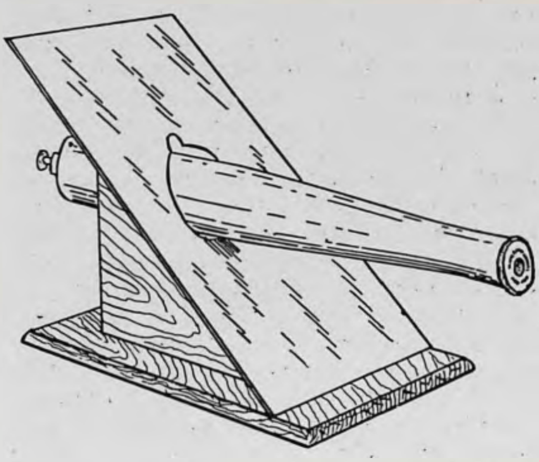
FIG. 6. SPRING.

FIG. 8. FIRING PIN.

steady rest. Get a 22-caliber shell, and select a drill, just a little smaller than it measures, and drill a hole clear through the gun barrel; then, with a boring tool, bore out the end the same size as you turned the knurled portion of the breech block, or the size of the bottom of the thread of the breech block, for ½ in. deep. Cut a recess the depth of the thread and wide enough for your thread tool to clear in, and thread it out large enough to allow the breech block to screw in freely.

Now bore out the gun barrel with a small boring tool, so that the 22-caliber shell will slip in easily. Then make a recess, as at I, Fig. 1, for the flange on the shell to enter; it should be just large enough and deep enough to allow to go in until it is just flush with the end of the breech block chamber. Next screw the breech block in. If you cut out a round disc of thin leather the right size and put it in first, you can remove the block without trouble. If you don't do this, the block is liable to become screwed in so tight that you cannot get it out without damaging it. Drill in to the block 21/32 deep with a ¼ in. drill, bore out with a boring tool to 5/16 diameter and 21/32 deep, making the inner corner square. Set your lathe up to cut 20 threads to the inch, and thread the outer end of this hole about 3 threads deep. Now screw out the breech block and lay the barrel and block one side, and make the breech block plug, Fig. 3. Chuck a piece that will turn to ⅜ in. diameter, turn and thread one end so that it screws into the breech block quite snug; bore a hole in it ⅛ in. in diameter and cut the plug off 5/16 in. long. Next make the hammer, Fig. 4; and the hammer handle, Fig. 5; also the trunnions, Fig. 10.

Now you are ready to do some assembling. You will need a small V block and a surface or scratch gauge. Clean the threads in the breech of the gun, and on the breech block, screw the block into the gun as tight as you can with your fingers, and be sure that it bears on the bottom of the breech block chamber. Now place the V block on a flat, true surface and lay the gun in it; set the surface gauge scriber to the height of the centre of the gun. An accurate and convenient way to do this, is to guess as close as you can and scribe a line across the end of the gun, then turn the gun over and scribe another line, then set the scriber point half way between these two lines and repeat the operation; if the gauge is set correct, but one line will be made. After getting the gauge properly set, scribe a line across the breech end of the gun, and let it come also into the round groove on the breech block on both sides; turn the gun until the line just scribed is in a perpendicular position, and scribe another line in the same



manner. These two lines are to lay out the sectors of the breech and the breech block threads, and they should be just 90° apart from one line to the next. Now remove the breech block from the gun and place it in the V block with one of the lines in a horizontal position, and set the scriber to the height of this line and transfer it around the threaded end of the block; turn the block until the other line is in a horizontal position and transfer it also. Now take a file and file off all of the thread on the block between two of these lines; then file out that portion of the thread between the two lines opposite. You should file just deep enough to take out the threads, and just a little wider than the lines. When this is properly done, the block should have an outline like the right hand view of Fig. 2, when you look at the block from the end. Now screw the block back into the gun and make a mark on the gun to designate the portion of the thread to be removed, which should be between the *same two lines* as it is on the breech block. Remove the block, and file out the marked portion of the thread in the gun. This will probably be a tedious job. You may find a small cold chisel handy to rough out with; but if you use one you should be careful not to jam that portion of the thread that is to be left intact. When it is properly filed out, it should look like the left hand view of Fig. 1. Now file off enough more from the block and gun to allow the block to slide into the gun without screwing; round the ends of the threads, at K, Fig. 2, so that the corners will not catch, then you can slip the block into the gun and give it a quarter turn to the right and it will be secured in position. Now screw the breech block plug into the block, insert the block in the gun, secure it and place the gun in the V block again. Set your surface gauge scriber to the height of the centre of the gun, and set the gun in the position shown in the left hand view of Fig. 1, so that you can scribe a line just half way between the lines you already have, and scribe a line on both sides of the gun. These lines are to lay out the position of the trunnions. Now turn the gun ¼ over, and scribe a line on both sides of the breech block and plug. One of these lines is to be used to lay out the slot for the trigger in the breech block plug, the other will designate the top of the gun and should always be made to match when the breech block and plug are screwed together. Now flat off two sides of the plug parallel to the top and bottom lines, leaving it flat, and about 3/16 in. thick, for about half of its length; replace it and transfer the side lines to the flat portion of the plug. Leave the gun set in this position and lower the point of your scriber ⅛ in. and scribe another line on both sides of the flat portion of the plug. This line is to lay out the hole for the trigger pin. Now remove the breech block plug, and cut the slot for the trigger. To do this, make four small prick punch marks on the line coming on the bottom of the plug; the first one, 1/16 in. from the end of the plug, and the rest 1/16 in. apart, take a 1/16 in. drill and drill four holes at these marks; then file out until you have a rectangular slot 1/16 by ¼ in. Next make the trigger; take a piece of steel that will file up 1/16 by ¼ by ½ in., and fit it into the slot; place it in the slot and measure off 5/64 in. from the end of the plug on the trigger pin line; make a small prick punch mark, and drill through both plug and trigger with a 1/32 in. drill, then remove the trigger and shape it up like Fig. 7, working from the hole; put it in place with a pin in the hole, and see that the hammer slides freely past it, and that it will catch in the notch on the hammer at L, Fig. 4, then remove it and saw a slot, as at M, Fig. 7; take a small piece of corset steel, and make a spring about 3/16 in. long, place one end in the slot and secure it by closing the slot with a hammer and set. The hole in the lower end of the trigger is to form a place to secure a string for firing; in gunner's language, this string would be called a lanyard.

Now place the hammer handle on the end of the hammer and drill a pin hole through both; then make a spring of 1/32 in. piano wire, like Fig. 6; place the spring on the hammer and pass the end of the hammer through the breech block plug; put the hammer handle on and secure it with a pin; put in the trigger and fasten it with its pin. Work the parts a few times, pulling out the hammer until the trigger catches and then firing it; if it works all right, lay it aside and proceed with the breech block and gun. Lay the breech block in the V block, and set your scriber to the height of its centre; then transfer the lines representing the top, bottom, and sides to the inner end of the block, letting them cross in the centre. Now measure down on the bottom line ⅛ in. from the centre where the lines cross, and make a prick punch mark; drill through here with a 1/16 in. drill, for the firing pin; then place the breech block in the gun in its proper position; grind your 1/16 in. drill until it will cut very nearly flat across the bottom, and drill into the gun about 3/64 in., letting the drill run through the firing pin hole. Remove the breech block, and you should have a hole about half in the shell recess and half in the breech block chamber bottom and $\frac{3}{64}$ in. deep. This hole is a very important feature; it forms a safety device to prevent the gun from being fired before the breech block is properly locked. In as much as the firing pin is so placed that half of it comes against the bottom of the breech block chamber, it is evident that it would not be able to reach the shell, except in the place where the drill has cut out a portion of the gun, and it is over this place only when the breech block is properly locked in position. When the gun is loaded and the breech block properly locked, pull out the hammer until the trigger catches, then pull the trigger and the hammer will strike the firing pin and force it into the rim of the shell, thus firing it.

Now make up a firing pin like Fig. 8; it should fit freely in the firing pin hole. File off enough of the first thread on the block, across the bottom, so that you can start a drill for a small hole to tap out for the screw N, Fig. 2; this screw is to keep the firing pin from falling out of its place, and may be any small size convenient; the end next to the firing pin should be flat across, and small enough to allow the pin to work endwise, until its end may be flush with the block. Put the firing pin in and secure it; then you are ready to put on the trunnions. Measure off $1\frac{1}{4}$ in. from the breech end of the gun along the side lines, and make a prick punch mark; drill in $\frac{3}{16}$ deep with a $\frac{3}{32}$ in. drill, and tap out $\frac{1}{8}$, then screw in the trunnions, which completes the gun proper.

A base should be made for mounting. This will be a simple matter after having made the gun, and it may be made to suit the taste. The one in the drawing is composed of three pieces of wood, and a thin piece of steel for a shield. The bottom piece is about 4 x 4 in., and the two uprights for supporting the trunnions are made by sawing a square piece, 3 x 3 in., and $\frac{3}{16}$ thick, diagonally from one corner to the opposite; these were laid one top of the other and a hole laid out about 2 in. from one side and $\frac{1}{2}$ in. from the other, and a $\frac{3}{16}$ hole bored through both pieces; fasten these pieces to the sides of the gun by screwing the trunnions into the guns through the holes, then fasten the pieces to the bottom in about the position shown. Take a piece of sheet metal about 4 x 5 in. square and cut an oblong hole in the centre, which makes the shield. Fasten it on with small screws or nails. This completes the cannon ready for business.

It may be well to say that for safety, the breech block and gun should be made of steel, and not for a larger caliber than 22, with the sizes given. Nothing but blank shells should be used.

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### A Short Cut

The board was 10 in. and a fraction in width, and the carpenter's apprentice with his ruler and a pencil was trying to divide it into three equal pairts.

"Hang it," he said, impatiently, figuring away, getting bigger and bigger fractions, and still far from the accurate division that he sought. "Hang this business."

"Here's the way to do it," said the old carpenter.

And he took a foot rule and laid it across the 10-in. board obliquely, so that the oblique measurement just made 12 in. Then he marked off three equal divisions, one at the 4-in. line the other at the 8.

"You will find that divides your board quite accurately," he said. "It is the easiest way for carpenters to make divisions. It works on any width or any number of desired divisions. To divide a $9\frac{3}{4}$ in. board in four parts, for instance, you'd make your ruler measure obliquely just 10 in. across the board, and then you'd mark off your division at $2\frac{1}{2}$, 5, $7\frac{1}{2}$. This is a handy thing to know. It saves a man many a quarter-hour of tedious ciphering."—*American Carpenter and Builder.*

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The government proposes to stop further "irregularities" in the weighing of imported sugar by the use of an electrically operated automatic type of scale.

## TO TEST IMPROVED WIRELESS

Both the scout cruisers Birmingham and Salem are now being fitted with what is claimed to be the most powerful wireless system yet devised and, as the apparatus is installed, a very extensive test will be made with the ships thousands of miles apart, and under all conditions of weather. In this test the battleship Connecticut, Rear Admiral Schroeder's flagship, and the wireless station at Brant Rock will also take part. Although the orders have not been given out yet, it is thought that the scout cruisers will go across the Atlantic, and from some port in Europe will proceed to tropical seas. Anyway, the test calls for the sending of messages over 1,000 miles under any conditions, and 3,000 miles under favorable conditions, so that the ships will have to be these distances apart.

At present, the two scout cruisers are at the Charlestown Navy Yard, and work has just begun in putting in the new equipment. The topmasts of the Birmingham have been removed, to be replaced by larger and heavier ones, in order to support the larger spread of wires and the heavier wires which the system calls for. The system which is being installed is a ten kilowatt set, and is considerably different from the other types. In the first place, it requires two houses on the deck, one for receiving messages and the other for sending them. The apparatus must be eighteen inches from any iron work, for the spark is so powerful that it could easily jump that distance. Furthermore, all the rigging of the masts will be of hemp cordage, in order to keep the induction down. Even with the present Shoemaker system, which is the one installed on the Birmingham,the steel rigging gets charged, and it is possible to receive a quarter of an inch spark by putting one's finger close to one of the stays. The new system has a direct current motor attached to an alternating current generator. The spark gap is attached directly to the generator and revolves with it. This is done in order that the points may be kept cool. The condensers are separated by compressed air. Overhead, the system calls for a fifteen-foot spread of large wires, thus making heavy topmasts necessary.

The battleship Connecticut now has a fifteen kilowatt Fessenden set which, it is claimed, sends messages over 2,000 miles. On this ship, the necessary machinery has been installed in the coal bunkers, and it is thought that such a position is detrimental to its efficiency, since power is lost while getting the current to the masts. The Salem has now a Pierce apparatus of five kilowatts, and it has succeeded in sending messages for 2,000 miles, while the Shoemaker system, which is on the Birmingham, has sent them 1,800 miles. There is also a five kilowatt set, and both will be removed.

A more thorough try-out of a wireless system than the one contemplated has not been made by the naval officials before. In the days when the wireless was first coming into prominence, the Dixie and the Prairie used to go off Annapolis, and the officers on board would make experiments. This time, the ships will make an extended tour shortly after the Hudson-Fulton Exposition, which will last a month. After trying messages across the northern seas, the ships will go South, where the static is much stronger, being nearer the equator. Tests will be made in every kind of weather, and under all conditions, with the exception of during thunderstorms, when the whole apparatus has to be disconnected to save it from possible destruction.

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### Transparent Leather

A new process in the manufacture of transparent leather is as follows: after the hair has been removed from the hide, the latter, tightly stretched upon a suitable frame, is rubbed with a solution of glycerine and numerous acids, and afterwards placed in a room where the rays of the sun do not penetrate; it is then saturated with a solution of bichromatic of potash. When the hide is dry, an alcoholic solution of tortoise-shell is applied to its surface, and the transparent effect is thus obtained.

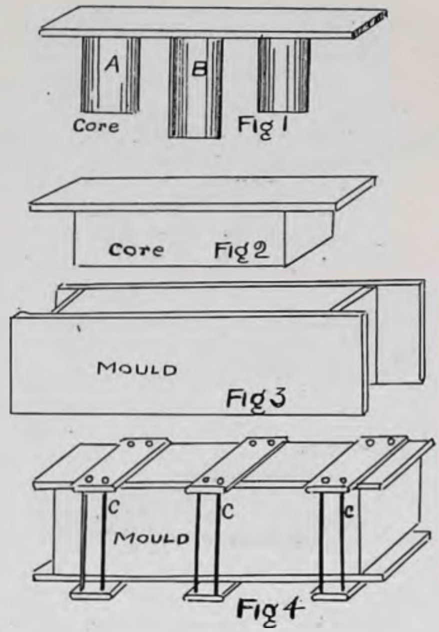
## CONCRETE IN THE ELECTRICAL BUSINESS

GEORGE RICE

The electrician, the plumber, the carpenter, the engineer, and gas fitter and practically all of the artisans of the land, find themselves confronted with problems of concrete very frequently. In the past, there were masonry walls, steel partitions, wooden structures and stone walls to perforate, surmount, undermine or otherwise pass in order to install electrical wires or fixtures. But in recent times, the electrician finds that he is often up against quite a tough proposition of cement. The tools that would cut through brick and mortar, fail to pass through the steel-like walls of hard-finished and well constructed concrete. There are specially devised tools needed. Specific lines of work must be undertaken in order to get wires into, through or along certain cement walls.

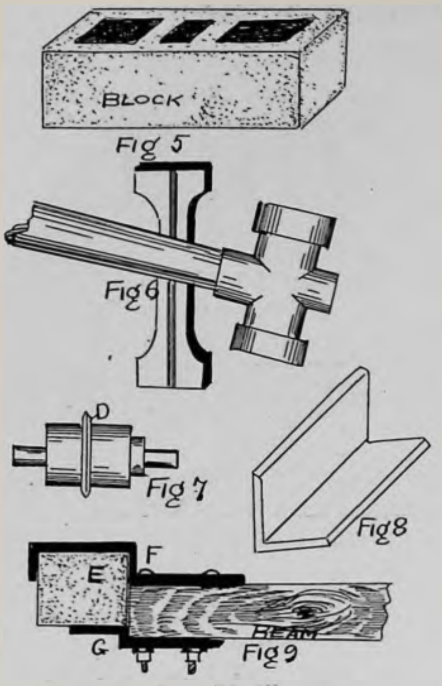
Oftentimes, the electrician is handicapped because of lack of proper tools and devices with which to work. Sometimes he is not familiar with the concrete wall and hesitates about boring through it. Now and then, he finds that it becomes necessary to remould certain portions of a concrete structure which he may have been obliged to tear out for the installation of certain electrical wiring. It behooves the practical electrician of today to know something concerning the handling of these perplexing problems which arise relative to a concrete wall, floor, ceiling, box, fireplace, chimney or what not.

Hence in this article, we have undertaken to introduce some of the fundamental points most useful in view of the end sought. In making up your concrete, for the purpose of restoring a defect you may have created in a portion of the concrete structure, you use about four parts of sand to one of cement. And I would buy the sand as well as the cement from responsible parties. There is some mud-like cement on the market, and it is best to be sure of the genuine Portland kind, used from original barrels. The sand can be obtained from dealers, ready for use. The water is run into mixture and puddling begins. Do not make your mix too doughy or too sloppy.




If you have some moulding to do, an excess of water will cause the concrete to stick to the interior of the moulds and create much trouble. The blocks will be soggy if too wet. Then, if you do not get the stock wet enough, cracking may result. Hence, practice and patience are quite essential in order to make the concrete come out right.

In moulding for electrical wiring, you may have to produce hollow blocks on the plan which will result from the use of the core shown in Fig. 1. Here you will see the extensions A and B. This core will be used in case three holes are required directly through the block to carry electrical wires. On the other hand, a slotted interior may be needed in the block, and the core may be the shape shown in Fig. 2. The mould is shown in Fig. 3. The tamping is important, and should be done evenly and carefully. I saw one man pour the mixed sand and cement, and rely upon the pressure of the stuff itself, for consolidation. Many of the blocks warped, sagged and fractured during the drying. It is best to tamp the stuff and get it packed well in the moulds.




You must press all the air out and avoid air holes in the completed block. After the stuff is completely tamped, you float off with a scraper, so as to get the surfacing level with the top edges of the mould. Then lock up. The locked mould is shown in Fig. 4. The locking devices are the bolts, c, c, c.

Then in due course, you can turn the mould, unlock and remove the core. Then lift off without marring the edges of the block. Then comes the curing. Your block may be as in Fig. 5, a. There are apertures through it, and therefore opportunities for the carrying of wires. The curing is effected by careful and even piling where the blocks may dry out. Meanwhile, it may be necessary to pattern the block, in order to make it possible to use the block for special electrical service. Some of the tools available for this purpose are next shown. Fig. 6 is one of the convenient forms of hammers. A tamping tool is shown in the same cut. A jointer is shown in Fig. 7, with the circular rolling, cutting or defining edge, d. A guttering contrivance is shown in Fig. 8. Fig. 9 shows how the concrete block is locked to a beam head.

The block is signified E. The black portions, F and G, represent wrought iron. These pieces are formed to fit well to the beam and block. A few bolts are passed through the wrought iron clamps at the beam, thus assuring steadiness.

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"Liquid chalk" is a handy thing to have on the bench where there is much work to lay out on castings or sheet iron. The "liquid chalk" is a mixture of chalk, glue and water. Take a pint can and powder enough chalk to fill two-thirds of it; add clean hot water until the can is almost full, and then add about two tablespoonfuls of liquid glue and mix thoroughly while it is hot. This is much more handy than solid, is it can be put on with a brush in the same way as paint. It will not rub off in handling, and gives a nice surface to work on. The chalk must be powdered very fine or it will be rough when dry.

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## Tinting a Cement House

It frequently happens that in building a concrete house, the cement will dry out in several colors or shades. It may be desirable to tint the entire surface of a uniform color that shall not be paint, but practically a part of the house itself. This result may be secured by washing the whole house with cement, but there is a trick in doing this properly, that is not always understood. The cement wash is made by mixing two parts of Portland cement and one part of marble dust with enough water to reduce it to about the same consistency as whitewash, and is applied with a whitewash brush. The wall must be thoroughly wet with water for several hours before the wash is applied, and kept constantly wet during the application, and for at least a day afterward, says *American Carpenter and Builder*. The important thing to remember is that the wash must not be applied to a dry wall, as it will not adhere. This work will be worth at least a dollar a square-yard, or more, according to the price of labor, but the result will fully justify the cost.

# INCREASING THE EFFICIENCY OF THE AMATEUR'S WIRELESS EQUIPMENT

S. FULTON KERR

In view of the fact that the electrical periodicals are making the problems of wireless telegraphy clearer and plainer in every issue, there should be no greater difficulties to the amateur experimenters than those encountered when experimenting with photography, or some other common hobby. But, if one should take wireless up as a hobby, he should stick to it, as there is bound to be some trouble and aggravating failures before he gets the "hang" of it.

Some time ago, a friend of mine, being interested in electricity, but not understanding it to any great extent, decided that he would take up wireless telegraphy as a pastime. Not knowing enough about the subject to make his apparatus, he bought an outfit; one of these outfits that sell for $8 or $10, and consist of a small induction coil, coherer and relay. These outfits are just the kind to buy when beginning, but in the case of my friend,—he worked the outfit from one room to another in his home, instead of doing all kinds of "stunts" with it, such as seeing how far the transmitting and receiving radius was, and so on, and in about a week the novelty had worn out, and the apparatus was laid away. Now this is the case with many experimenters—they get discouraged if their first efforts are not crowned with success, like other amateurs they read of; others do not experiment enough to keep them interested, and consequently the novelty soon wears off. But returning to my friend again—he visited me some time later, and after being shown my station, which consists of all modern and up-to-date tuned apparatus, and after hearing messages come in from a long distance commercial station, his interest was reawakened, and he saw the real beauty of it. Instead of using his discarded instruments, he built himself a complete set of tuned instruments, patterned after my own, except the transformer and telephone receivers, which he found impossible to make. Today, he is one of the most enthusiastic wireless fiends I have ever seen.

Inasmuch as I have been studying wireless for a long time, I do not want other experimenters who may read this article to think that I am boastful, or in any way egotistical, in saying that I have the best equipped amateur station in the city in which I live, and it is no small city at that. It is a matter of pride with me to keep up with the procession, and if it were not that I had stuck to it from the beginning, I could not lay claim to the above fact.

Now, there are many experimenters whose interest has become aroused by the numerous articles on wireless, published lately in the electrical magazines, and who are just beginning to take this very interesting subject up; for them, the following suggestions are intended. No attempt has been made to describe the construction of the apparatus in detail, as that has already been done very thoroughly by this magazine, but it is merely a summary of the essential instruments needed, and giving a few suggestions which, if employed, may increase the efficiency of the amateur's outfit.

A few suggestions concerning the aerials, I think, will not be out of place. When I built my antenna, which consists of four parallel wires running horizontally between two poles, I put a pulley on each pole, so that the antenna may be lowered whenever desired. In this way, the connections can be altered with very little difficulty. That is, the four wires can be connected in multiple, or connected in series, so as to form a loop antenna, or any other connection that one may think of. Thus one can see, with what type aerials he obtains the best results. However, I get the best results with the loop antenna. This type antenna should be used when one lives near a car line, or other power line, as it does away with all induction. Where one lives in the country, or a large open place where there can be no induction from power lines, the antenna may be of the multiple type, that is, the parallel wires connected in multiple, and a lead taken from the end nearest the instruments. It should be well insulated, and should not rub against anything, but should swing free in the air; and where the lead is brought into the operating room, extra care should be used to see that it is insulated properly, where it passes through the wall. If a porcelain tube is used, the wall of the tube should be ½ in. thick.

It does not matter how good the instruments are, good results can not be obtained with a poor antenna. It should have the same care bestowed upon it, as the other apparatus. Some amateurs take much care constructing their instruments or else spend a large amount of money to buy them; they then put up an antenna, without much regard to the insulation, and then wonder why they cannot secure good results. If the antenna is to be used only for receiving, there does not have to be so much care taken in its insulation, but if it is to be used for transmitting also, great care should be used to insulate it properly, as before stated.

In regard to detectors, there seems to be a wide difference of opinion as to their sensitiveness. Some amateurs claim that the silicon detector is the most sensitive, and a great many claim the same for the electrolytic. From experience, I have found that long distance messages come in plainer with the electrolytic than with the silicon, but as conditions vary throughout the country, I will not venture to say that the electrolytic is the best under all conditions.

If it were not for the fact that the acid corrodes the metal parts of the instrument so quickly, and that it has to be renewed very frequently to get the best results, the electrolytic detector would be an ideal instrument. As the Wollaston wire is eaten away by the acid, it has to be lowered into the solution, and consequently has to be frequently adjusted. When the detector is in use, the positive pole of the battery should be connected to the Wollaston wire electrode, as it will not work otherwise. The Wollaston wire should be the smallest obtainable, at least .0001 in. The acid solution should be taken from the containing vessel when not in use, and a new solution put in at least once a day. The solution is made up of 20% nitric acid and 80% water.

The silicon detector, as is well known, operates on the principle that two dissimilar metals, when joined and heated, will produce a small amount of electricity called thermo-electricity. In this case, the silicon crystal and the point or electrode, as it is called, that makes contact with the silicon, act as the two dissimilar metals. The oscillations from the transmitter striking the antenna, come down, and pass through these two dissimilar contacts, thereby setting up a small degree of heat, and producing a very small thermo-current, which is detected in the telephone receivers. As this detector generates current itself, it is not necessary to use a battery or potentiometer, although some experimenters claim that with two dry cells and a variable resistance of about 400 ohms shunted across them, they get better results.

The carborundum detector is also very popular, and works on the same principle as the silicon, the only difference being that carborundum is substituted for the silicon.

Although I do not use the coherer-decoherer outfit for practical work, I use it for demonstration purposes and wireless control experiments, such as controlling miniature railways, firing gun powder, etc. I find that a telegraph sounder pounding away, worked of course by wireless, impresses the person to whom you are demonstrating the apparatus, much more than the buzzes in a telephone receiver. Of course, the coherer-decoherer is not practical for long distance work, as it is not nearly so sensitive as the electrolytic detector, and it has also the disadvantage of being very sluggish in its action, making it utterly impossible to read messages sent by a fast operator.

The telephone receivers should have a resistance of at least 1,000 ohms each, preferably 1,500 ohms, to balance the resistance of the detector circuit. Many experimenters have realized that the 75 ohm receivers are entirely useless for practical long distance work, and have thrown them in the junk pile.

If the amateur is going to make a tuning coil, I advise him by all means to make a double slide one, as the results obtained will justify him in taking the little extra trouble. Adjustments can be made with the double slide that could not be made with the single, and it also allows of a very great variety of connections. Many experimenters are discarding this type of tuning coil for the so-called receiving transformer or selective tuner, as it is sometimes termed. It consists of two coils similar to the single tuner, one coil being stationary, and the other sliding on a central rod and small enough to slide inside of the other coil, so as to vary the coupling. Each coil is provided with a sliding contact to vary the inductance. With this type of inductance, the range is increased considerably, the signals come in much stronger and plainer, and much sharper tuning and selectivity are made possible. However, it is not advisable for the beginner to start with one of these inductances before he becomes experienced in the use of the single or stationary type.

The potentiometer should have a resistance of about 400 ohms, and where a finely balanced circuit is not necessary, it may be of the common cylinder type wrapped with German silver wire, contact being made by a slider. But where the circuit must be nicely balanced, a potentiometer of the non-inductive type must be used.

An amateur's station is not complete without a variable condenser and at least one fixed condenser. With these condensers, a great variety of connections can be made. The condensers are used to tune out all atmospheric disturbances, such as static electricity, and the oscillations set up by trolley flashes, etc. The plates of the variable condenser should be as close together as possible without actually touching each other, and they should be so mounted that they will intermesh each other smoothly and evenly, so that they may be easily adjusted.

When considering the source of the transmitting energy, the question arises in the amateur's mind which source to use: the high-potential transformer, or induction coil. If he wishes to transmit messages a distance of only ten miles or so, the induction coil answers the purpose admirably; but for longer distances, the transformer is much better, and much more economical, both in the first cost, and in the cost of operating it. I am speaking of the closed core transformer, as the open core type is not very efficient, owing to the fact that it takes several times as many turns of wire to produce a certain potential as are necessary on the closed type, on account of its open magnetic circuit. This means that the loss is several times as great, due to the resistance of the extra turns of wire. The fact that the induction coil has been discarded for the closed core transformer by the commercial companies is due to the latter's much higher efficiency, and many amateurs are doing the same. The average amateur is just as ready to discard his apparatus for something more efficient (providing, of course, that his financial circumstances will permit it) as the commercial companies are.

The high potential condenser should be given the same consideration as any of the other transmitting apparatus. It can be either of the Leyden jar or glass plate type. The glass plate type has several advantages over the Leyden jars, namely, that the cost is much less than that of a battery of Leyden jars having the same capacity, and it also takes up much less room. Some manufacturers claim that the efficiency of the transmitting circuit is often doubled when the glass plate condenser is used. To prevent "brushing" at the edges, which is detrimental to the successful operation of the transmitter, the glass plates should be either immersed in oil or be cast in some insulating material. This material should be non-hygroscopic, or, in other words, should not have the property of absorbing moisture from the atmosphere.

Nothing much can be said in regard to the transmitting helix, except that it be of sufficient capacity. The spark gap may be mounted inside the helix, although it is not of much material advantage to do so, except that it saves space. A type of transmitting inductance, that is finding favor with many amateurs, is the oscillation transformer, consisting of a primary and secondary coil, each of the coils having contacts to vary the inductance. This type inductance permits of fairly loose coupling, and very sharp tuning between the open and closed oscillating circuits can be obtained. This insures the radiation of the energy in the form of waves, instead of wasting it in the form of heat at the spark gap.

If the experimenter has a small outfit that he wishes to use for demonstration purposes or for very short distances, as from his home to the house next door, he need not put up any elaborate antenna. A piece of brass rod about 5 ft. long will suffice for the antenna, but hollow spark balls should be used, about 1½ in. to 2 in. in dia., as these in themselves act as a capacity. However, if the amateur is going to use his apparatus for the maximum sending distance, as most experimenters do, solid brass or zinc balls, about ¾ in. in dia., should be used, or better, the spark should jump between 2 zinc rods, 5/16 in. thick.

Except in cases where the power used to radiate the energy is small, the sending key must be provided with heavy platinum contacts. If contacts of some inferior metal are used, they will corrode so quickly that it is necessary to file them clean every two or three min. When using a transmitter that consumes ¼ k.w. or more, the platinum contacts are absolutely essential.

No doubt, many experimenters having a low power source of transmitting energy, such as a small induction coil, with an anchor gap connected in the antenna, wonder why their transmitter radiates so feebly, even if they are using a tuned system. The fact that the anchor gap is taking up a considerable amount of the energy never occurs to them, probably, but, nevertheless, it is true. However, when a large induction coil or closed core transformer is used, the amount of energy taken up by the anchor gap is so small, compared with that radiated in doing useful work, that the loss is negligible.

It is, therefore, not advisable for amateurs having a low power transmitter to use an anchor gap for this reason; but they should use a double-throw double-pole switch which makes it very easy to throw the antenna and ground on either the transmitting or receiving circuits, as desired. This performs practically the same functions as the anchor gap without its subsequent loss of energy.

All adjustable contacts, such as the sliders on the tuning coils, potentiometer, etc., should be equipped with hard rubber handles, so that any adjustments may be made while the instruments are in operation, thereby preventing any leakage of the current through the body to the ground.

The importance of a good ground can not be over estimated. The wire to the ground should be as short as possible. If it is soldered to a water pipe, it will make an excellent ground. Do not ground the instruments to a gas pipe. If no water pipe is handy, a copper plate as large as possible, at least 3 ft. square, will have to be buried about 4 or 5 ft. deep in permanent moist earth.

Some experimenters are a little timid about putting up a high antenna, for fear it may be struck by lightning, which may damage the instruments or the building; but on the contrary, if the antenna is properly grounded during a storm, it acts more as a protection against lightning. It performs the same duty as a lightning rod. If the instruments are grounded inside the house, as to a water pipe, an outside ground will have to be used in case of an electrical storm, so that in case the lightning does strike the antenna, it will have no chance of entering the house, but will go direct to the ground. Of course, after the storm, the antenna should be disconnected from the outside ground and connected to the instruments. A piece of gas pipe, about 5 ft. long, driven into the earth will suffice for the outside ground. Some amateurs advise lowering the aerials during a storm, but if this method is used it is not necessary to do so.

As to which wireless system is the best for the amateur, I would advise him to try all the systems to see which one gives him the best results. As stated before, conditions vary throughout the country, and one system may be used by one amateur where no results at all could be obtained by another, using the same system. The height of the antenna, the surrounding country, the weather—all have to be taken into consideration.

If you can not obtain satisfactory results at first, don't get discouraged and quit, but stick to it. In fact, if it were not for the occasional failure of the instruments to work properly, there would not be much interest in wireless at all. What interest would there be in doing experiments when you knew what the results would be beforehand? It is the uncertainty of the results of the experiments that is one of the most interesting features about wireless.

## POLARITY INDICATORS FOR ELECTRIC CURRENTS

HOWARD M. NICHOLS

The ordinary form of polarity indicator consists of a tight glass tube, filled with a blue liquid, and having a platinum wire leading into each end, the wires being separated by about ½ in. of liquid. When this indicator is connected in a circuit, in which there is an electric current flowing, the liquid surrounding the positive pole will turn red. The liquid used in this indicator is a solution of blue litmus and some neutral salt, such as common table salt (sodium chloride).

When an electric current passes through this solution, it breaks the salt up into hydrochloric acid and sodium hydrate; according to the following chemical equation, $NaCl + H_2O = HCl + NaOH$. Sodium chloride + water, when subjected to an electric current, breaks down into hydrochloric acid and sodium hydrate.

The hydrochloric acid is set free at the positive pole; and it turns the litmus solution red in the vicinity of the positive pole, it being one of the peculiar properties of blue litmus, that it will turn red when treated with an acid. On removing the tube from the circuit and shaking it, the sodium hydrate and hydrocholric acid recombine, to form the neutral salt, sodium chloride, and under these conditions the litmus solution will become blue again.

This indicator can not be used on an alternating current circuit, as in this case the direction of flow, and consequently the polarity, is reversed a large number of times every second.

A cheap, and fully as useful polarity indicator, as the standard form described above, can be made from ordinary red litmus paper. The paper should be soaked in a solution of common salt, and then allowed to dry.

When it is desired to determine the polarity of any circuit, take a small piece of this treated paper, moisten it, and place the 2 wires of the circuit about ½ in. apart on it. The paper around the negative wire will turn blue. The principle on which this indicator acts is the same as the one described above, except that the sodium hydrate (NaOH) formed, turns the red litmus blue, while in the indicator, described above, the acid (HCl) set free, turns the blue litmus red. In all cases, the acid appears at the positive pole, and the alkali at the negative pole, and the pole at which the indication appears depends on the original color of the litmus.

Polarity paper can be made from blue litmus paper in a similar manner, but I have found, in practice, that it does not give quite as good results with low voltages as the red litmus paper.

This polarity paper will give good results on circuits having a difference of potential of from 2 volts to 250 volts. With the higher voltages, the wires should be kept farther apart, and care should be taken not to touch them together, as sometimes a short circuit on 100 volts or more, will do considerable damage in the way of burns, etc.

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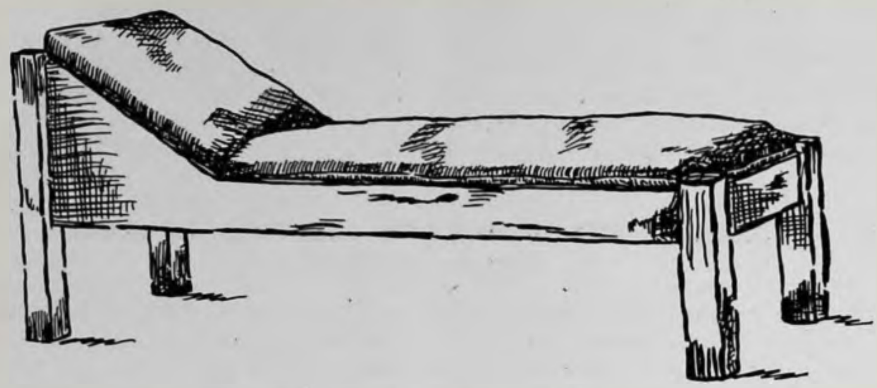
To clean oil paintings take two or three old potatoes and peel them. Rub the potato over the painting (with very little water), then cut off a slice and continue rubbing. As you go on, the lather should be wiped off with a very clean and very soft wet sponge. When sufficiently rubbed, the surface of the painting should be washed with tepid water, and then rubbed gently with a soft silk rag, which will remove all dirt.

## A MISSION COUCH

RALPH F. WINDOES



One of the most easily made pieces of mission furniture that the amateur is capable of constructing, is herein illustrated. It makes a beautiful appearance when finished, and fitted with cushions of roan skin, or the cheaper grade of chase leather cushions, though canvas cushions make very good substitutes. Quarter-sawed white oak should be used in its construction, and ball-bearing castors should be put on the legs for convenience in handling. Below is given a bill of the lumber needed, and the oak stock should be well sanded before leaving the mill.

QUARTER-SAWED WHITE OAK

2 pieces 30 in. x 4 in. x 4 in.
2 pieces 18 in. x 4 in. x 4 in.
2 pieces 72 in. x 18 in. x 1 in.
3 pieces 24 in. x 6 in. x 1 in.
1 piece 22 in. x 6 in. x 7/8 in.
1 piece 22 in. x 1 in. x 7/8 in.

PINE STOCK

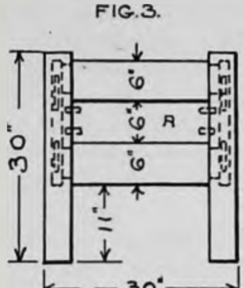
2 pieces 76 in. x 1½ in. x 7/8 in.
10 pieces 25 in. x 8 in. x 7/8 in.

The sides, which are given as being 18 in. wide, can be made up at the large end, as they are but 6 in. wide for most of their length.

All joints are mortise and tenon, except on piece A, Fig. 3, and this is doweled as shown. The pine boards on the top are set ¾ in. below the upper edges of the sides, so as to prevent the cushions from sliding off. They are nailed to cleat B, Fig. 2, which is held in place by being screwed into the sides. Fig. 1 is a plan of the frame, and Fig. 4 is an elevation of the foot.

Stain it a color to match the cushions and finish with prepared wax, according to the directions found upon the can.

FIG. 3.



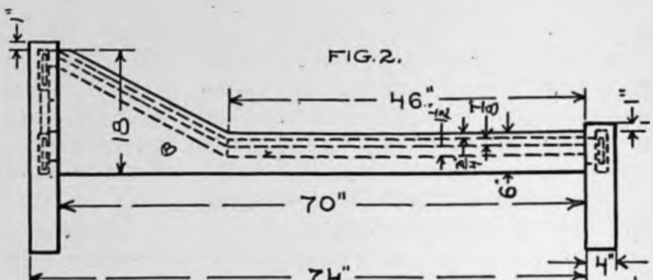




FIG. 2.

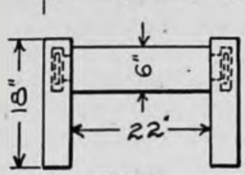



FIG. 4.

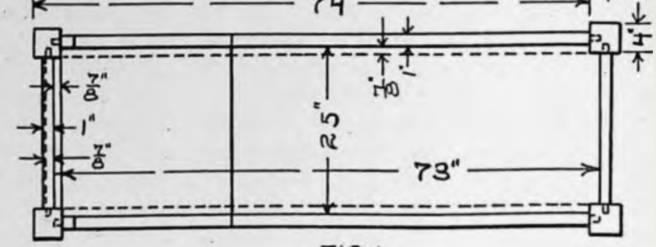



FIG. 1.

## HEAT AND ITS USES IN THE EXPANSION OF METALS

DONALD A. HAMPSON

The expansion of metal under heat, is one of its most useful properties, so useful, that at times a knowledge of its possibilities is of great practical value. Aside from the process known as "shrinking," which involves both expansion and contraction, there is a large and ever growing list of opportunities where heat can be applied in the removal of tightly fitted and rusted parts.

An example or two from the writer's experience are indicative of the general application of this great force of nature A score of years ago, a power plant system of piping was made up, a part of it being buried in concrete. When alterations became necessary recently, there was no way, short of actual breakage, by which the fittings could be removed, except to build a fire around them and take them off hot. Pulleys, collars, etc., closely fitted and long since rusted on their shaft are readily loosened by heating; in the case of smaller pulleys, handwheels and the like, the flame of one or more blow torches directed on the hub soon produce the desired result, it being possible to regulate and concentrate the flame so as to get the maximum efficiency at the hub. When an open fire has to be built about a pulley on a shaft, or coupling on a pipe, some means have to be provided for cooling the interior piece and keep it from expanding with the exterior one. This can be done by repeatedly cooling the shaft or pipe with water, and by applying some fireproof material so that all adjacent parts except that to be heated are protected. Herein lies the secret of heat's success with rusted parts, success which is not approached even by kerosene; the expansion of the hotter part, drawing away from the cooler, breaks the grip of king rust.

As the parts in contact are seldom made of the same metal, it is important to know something of their comparative action under heat; an instance will serve to show the need of such fundamental knowledge: a workman in attempting to remove a cast iron handwheel from a brass screw, put both in the fire, and though it (the wheel) was raised to a red heat, it failed to screw off. The trouble was this: for the same rise in temperature, brass expands nearly twice as much as cast iron, and though the screw had not been in actual contact with the fire, it had received some heat from the flame and more had been conducted to it through the wheel, so that its temperature had been raised not as much as the wheels, but enough for its double relative expansion to hold as tight as ever.

The decimal part of an inch which any substance expands for a rise in temperature of 1° Fahrenheit is called its "coefficient of expansion." The linear, surface and cubic expansion of the common metals is given here:

| | Linear | Surface | Cubic |
|---|---|---|---|
| Cast Iron | .00000617 | .00001234 | .0000185 |
| Wrought Iron | .00000686 | .00001372 | .00002058 |
| Steel | .00000599 | .00001198 | .00001798 |
| Brass | .00001037 | .00002074 | .00003112 |
| Copper | .00000955 | .00001910 | .00002864 |

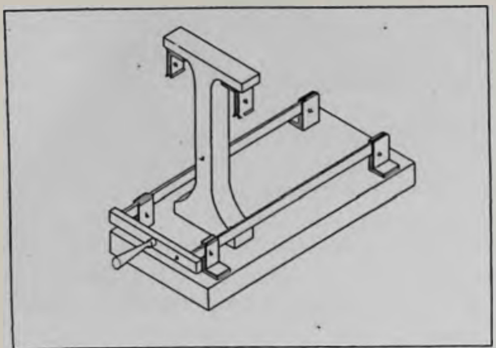
The size of any body after expansion is then found by multiplying its original length, area or volume by the coefficient of linear, surface or cubic expansion respectively, and by the number of degrees Fahrenheit rise in temperature.

### Wireless Telephony

In the hurrying succession of events that nowadays briefly touch our consciousness and hasten rapidly on to give place to newer impressions, things of much importance are sometimes given but little attention. Perhaps not a few of us have the idea that wireless telephony is, as yet, a denizen of the laboratory. It will then be interesting to note that clear and accurate voice communication has been maintained between two British warships, separated by a distance of 60 miles, and that from the Paris Eiffel Tower station, voice communication has been successfully maintained at distances of from 60 to 100 miles. The range of communication, it is perfectly reasonable to suppose, will increase with the development of the apparatus, and already the uses of wireless telephony are important.—*Electrocraft.*

## THE CONSTRUCTION OF AN AERIAL SWITCH

EDWARD H. GUILFORD



Except in stations equipped with a break in key, it is absolutely necessary to use a double-throw double-knife switch to change the aerial and ground wires from the sending to the receiving instruments. Such a switch as I am about to describe may be made for less than a dollar, and cannot be purchased for anywhere near that sum. This type of switch is thrown over much quicker than an ordinary D.T. D.K.

Take a piece of hard rubber or fibre, 3¼ in. x 6½ in. x ½ in., and bore a hole, N, at each corner, ¼ in. from the side and ⅝ in. from the end. Countersink the bottom of each hole, so that the head of a bolt for a binding post will set in. Bore 2 more holes, hh, each 1¾ in. from one end, and 1 in. from the side. Countersink these holes also. These last 2 holes are hh, those through which the screws are placed to hold the standard, S.

Procure about 15 in. of strip brass or copper, ½ in. wide, and about 1/32 in. thick, and cut from it, 8 pieces, 1⅛ in. long. Bend a right angle in each piece with sides ¾ in. and ⅜ in. Take a pair of these, and with their equal sides together, punch or ream a hole through the shortest side about 3/16 in. from the end. The other 3 pairs should be treated in the same manner. Two of these metal angles are to serve as pivots, aa, and should have another hole 3/16 in. in dia. punched in the longer side, ¼ in. from the end. The other 2 pairs, bb, are to receive the switch blades in their down position. They should have their upper ends bent at an outward angle, so that the blades will slip in easily. Four more pieces, QQ, 1¼ in. long, must now be cut from the metal strip, and bent like the former ones, in the form of a right angle, with sides ¾ in. and ½ in., 5/16 in. from the end of the shorter side of each pair, a hole should be punched ¼ in. in dia. Bend the edges of the longer sides at an outward angle like those of bb.

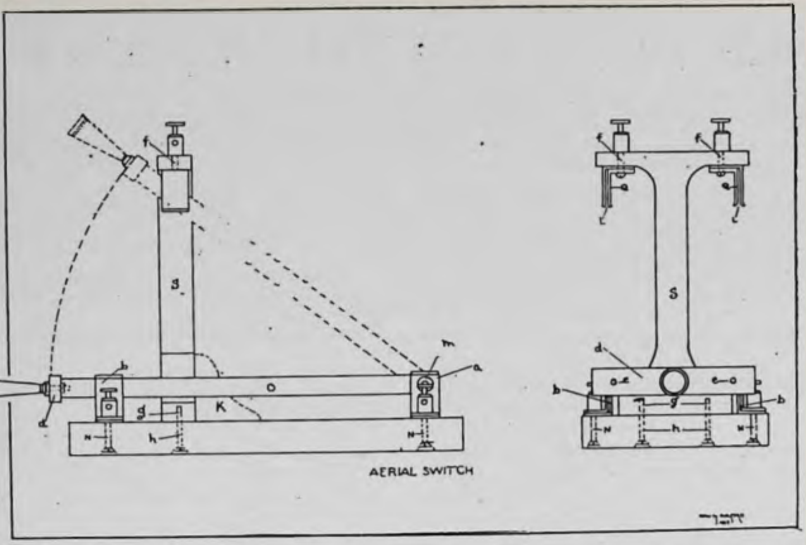
The switch blades, or knife blades, as they are usually called, may now be made. They are 6⅜ in. x ⅜ in. x 1/16 in., and may be cut from sheet brass or copper or a strip of either metal may be bought, 12¾ in. x ⅜ in. x 1/16 in., and cut in half. File the edges smooth and bore a hole 3/16 in. in dia., ¼ in. from each end. Then bend a right angle at one end of each blade with a side ⅜ in. The cross bar, d, is to be fastened at these ends of the blades.

The standard, S, may now be made. It should be sawed from hard rubber or fibre, and then its edges should be thoroughly sandpapered. The screw holes, gg, and the bolt holes, ff, may now be reamed, gg each ⅜ in. from the end, and ff each 7/16 in. from the end. Care should be taken that the holes, gg, coincide with the holes, hh.

The cross bar is also made of hard rubber or fibre, and its dimensions are 2¾ in. x ½ in. x 3/16 in. Reserve the ream of the holes, ee, until later.

The switch may now be assembled. Start with the pieces, aa and bb. Fasten them to the base by a long bolt and a binding post. The blades can be put in next. Take an ordinary binding post and cut or file it down until it is about ⅜ in. long. This will serve as the pivot, m. Now place the blades in the down position, and then mark on the cross piece where the holes, ee, come. Ream a hole at each of these marks, and then fasten the cross piece to the blades with 2 short bolts, or binding posts. Take a handle from some old switch, and, after boring a hole in the middle of the cross piece,d, fasten the handle there with a short screw.

Now screw on the standard, S. If




it is unsteady, screw a brace, K, of hard rubber or fibre against it. Fasten the angles, QQ, with bolts and binding posts. Since the holes through which the bolts pass are ¼ in. in dia., the angles may be moved, until the distance between the slots, LL, is equal to the distance between the blades.

To operate, first attach the ground wire to one of the binding posts at the pivot end of the blades, and fasten the rat tail (the end of the aerial), to the other binding post. Then attach the 2 wires from the sending instruments to the binding posts on the standard, S, and the 2 wires, from the receiving instruments to the 2 remaining binding posts. When sending, throw the switch to the up position, and when receiving put it in its down position.

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The largest steel box girders ever used in a building, formerly part of the construction of the San Francisco City Hall, and built at a cost of $62,500, are being cut up on the ground for junk, valued at $8 a ton. The girders were each 126 ft. 9 in. long, 5 ft. thick, and 6 ft. 5 in. high. Each weighed 125 tons, and 38,000 lbs. of 7-in. rivets were used in their construction. The cost of taking them down was $1,500, and in cutting them up so they can be removed, riveters are employed at a total cost of $100 a day.

On account of the fragility of the metallic filament lamps there is a tendency in some places where alternating current is used, to install small transformers so as to use lamps adapted to lower voltages (25 to 80). Even a small transformer for a single chandelier or for each lamp holder has been brought out. In these cases, the lamp sockets are made only for the voltages indicated. The price of the tungsten and tantalum is being gradually marked down and the lamps improved.

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To tan a skin, take one pound of sumach and ½ ounce of powdered saltpetre, mix together till you have a paste, and lay on the flesh side of the hide. Rub this in with the hands or a brush, roll the skin up for a week, opening it every day to damp the paste and rub it into the skin. Take a pail and put four pounds of sumach into it, on it, pour boiling water and stir altogether. When the water has cooled sufficiently to put the hand in it, dip the skin in a few times, and then lay it in the liquor. At the end of a week take out the skin, and warm the tanning fluid. Before returning the skin the water must be cold. Each day take the skin out of the liquor for a few minutes to give it air. In three weeks the skin will be tanned. To soften the skin, rub it on the flesh side with pumice stone.

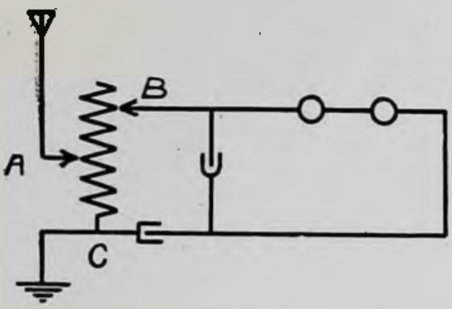
# QUESTIONS AND ANSWERS

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 letter, and only three questions may be sent in 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.

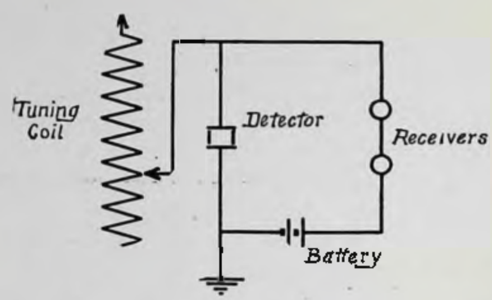
1135. **Receiving Connections.** B. D. N., asks: (1) Why can one receive better with the variable contact A between B and C? (2) How can the wave length of a receiving station be found when the diagram above is used? (3) Where can crystals of iron pyrites C.P. be obtained? Ans.—(1) Because the stations which you are receiving are in




tune with your apparatus when you are getting the best results with the sliders in this portion. (2) By determining the amount of inductance in your receiving coil and the capacity of your antenna. (3) Iron pyrites may be had of the Long Distance Wireless Inst. Co., Boston, Mass.

1136. **Transformer.** A. C. G., Springfield, Mass., asks: for data for building a 1½ k.w. transformer for wireless telegraphy. Ans.—We would by all means advise you to purchase this transformer from a reputable builder. You will get it much cheaper than you could build one, and it will be certain to work in a satisfactory fashion. A competent mechanic would not be able to build a single transformer of this size, nearly as cheaply as he could buy one, for the reason that elaborate dies and forms are necessary in the construction, which would render the cost of building a single machine prohibitory.

1137. **Wireless Connections.** D. H., New Brighton, N.Y., asks: (1) What is the best way to connect the following instruments in order to secure the greatest range in receiving: 3 wire aerial 30 ft. long, 60 ft. high; medium-sized tuning coil 1 ft. long, 1½ in. diameter, No. 24 wire, single slide; carborundum detector; two 75 ohm telephone receivers, 1 double and 1 single pole; small dry cell; good ground connections? (2) Should both ground and aerial be tuned?




(3) What is the extreme (practical) range of a ¼ in. spark coil with suitable condensers, 5 dry cells and aerial as above? Ans.—(2) By using a double slide tuning coil, you can tune both aerial and ground, and will give finer tuning. (3) With a ¼ in. coil and best conditions, it should transmit ½ mile.

1138. **Potentiometer.** H. D. G., Philadelphia, Penn., asks: Would be pleased to have you publish in one of your coming numbers a method of arranging a slider for the potentiometer described in the June, 1909, issue, on page 528. Ans.—The simplest way is to let the slider run on a piece of stiff copper or iron wire which may be fastened by two ordinary binding posts screwed to the base, one of which will also serve as a connection.

1139. **Wireless Distances.** G. A. R., Little Rock, Ark., asks: (1) What will my receiving distance be, with aerial 600 ft. long, 100 ft. high at highest point, 30 ft. at lowest, 3 strands No. 14 aluminum wire, with following instruments: 2,000 ohm receiver, 400 meter tuner, variable condenser, fixed condenser, potentiometer and silicon or electrolytic detector? (2) With aerial as above and ½ k.w. transformer coil, what should sending distance be (2 in. coil)? (3) Notice that by touching slide bar on tuner or potentiometer, on wire leading from any of the receiving instruments, the static hum is increased 100%, also the signals come on much louder. Please explain. Ans.—(1) With instruments as described, your distance should be as follows: improved silicon detector, 1,000 to 1,500 miles; improvised detector, 200 to 350 miles; electrolytic, 1,000 to 1,200 miles. (2) With ½ k.w., distance should be from 50 to 200 miles. (3) This is due to capacity of your body. It shows that your receiving circuit needs more condenser in it.

1140. **Electrolytic Rectifier.** C. W. H., Slatington, Pa., asks: Some time ago I wrote to you in regard to the rectifier described in your November issue. I must say that after spending a great deal of time and money, we are having a very expensive article, which is practically of no use unless the trouble can be remedied. You advised me that the heating would not harm the rectifier. That may be true, but who wants to bother with it when it continually boils over and causes a shell to form on the plates, which can be removed only after a great deal of labor and time has been lost. Can you give me the cause and remedy for same? After being used for about one hour, the deposit on the plate is heavy enough not to pass any current. I hope you can explain the above and let me know by return mail. Ans.—This trouble you speak of, is unavoidable in any type of chemical rectifier. It is evident that your plates are too small in proportion to the amount of current you are trying to use. Make them larger, and use larger jars. Remember that you cannot get more out of a thing than you put into it.

1141. **Wireless Distances.** R. A., Chicopee, Mass., asks: (1) How far can I receive with an aerial 50 ft. high at both ends and four strands of aluminum wire, 100 ft. long, 20 in. apart? The cross-arms are connected to the poles by cord, my instruments are 30 ft. from the aerial, and are composed of a double slide tuning coil, which has a wave length from 100 to 2,000 meters, a silicon detector and condenser for same, and pair of 1,000 ohm receivers. (2) How far can I send with same aerial with 1¼ in. spark coil run by dry cells, condenser and helix. The aerial and ground are connected to a D.P.D.T. switch. Ans.—(1) If you use the Improved Silicon Detector, your receiving distance should be from 700 to 1,200 miles. With an improvised detector, probably 200 or 300 miles. (2) About 25 or 30 miles.

1142. **Tuning Coil.** E. S. S., Los Angeles, Calif., asks: Kindly state what length of No. 18 B. & S. gauge copper wire would be one meter in constructing a tuning coil? Antenna 75 ft. high and 80 ft. long with six wires and 60 ft. from antenna to instruments. Ans.—One meter is 39.37 in. in length, according to the English system. The wave length of your aerial depends on the inductance and capacity of your open and closed oscillating circuits. See article by W. C. Getz, in December, 1908 issue, on calculation of wave lengths.

1143. **Figuring Current.** O. B., Austin, Texas, asks: In the July number of Electrician and Mechanic, on page 20, second column, you say "The current delivered by the secondary will be about .015 amperes." Will you please explain how that is figured? Ans.—As the amperage is the result of dividing the wattage by the E.M.F. in volts, and as we can approximately judge these quantities, from the primary ratios, the above answer is sufficiently accurate for all practical purposes.

1144. **Tuning Coil.** C. T. B., Cincinnati, Ohio, asks: What proportions would be necessary for a loose coupling tuning coil as described in the September issue of the above named magazine, to tune to a 3,000 meter wave length? (2) Are the following proportions correct for a coil to be used in wireless sending—core length 15 in., diameter 1⅜ in., primary 2 layers, No. 14 enameled wire—insulating tube glass, 2¼ in. outside diameter,—secondary 4½ in. outside diameter, 10 in. between coil ends. No. 32 enameled wire? Ans.—(1) Make the primary of No. 16 wire on a tube 4 in. diameter, 22 in. long. Secondary to be 3½ in. in diameter, 4 in. long, of No. 26 wire. (2) Your core should be about 1⅝ in. in diameter. Other proportions are very good.

1145. **Regulating Wave Length.** E. P. P. Houston, Texas, asks: Please give me a short explanation in simple language, how to regulate the wave length of the aerial, with a sending inductance. I know what the inductance is for, but how to vary the capacity in any known amount, I do not know. I have made one as described in the June Electrician and Mechanic under "25 Mile Wireless Outfit," and as the wave length of my aerial is about 61 meters and my friend's 92 meters, I would like to know in what position do you place the movable contacts? (2) Can ordinary window glass be used to make the condenser as described in the "25 Mile Wireless"? (3) What will be my receiving radius, with the following: 1,500 meter tuner, wound with 26 enameled wire, electrolytic detector with micrometric adjusting screw, variable condenser and fixed condenser, receiver of 1,200 ohms resistance with gold diaphragm, potentiometer and battery with 5 wire aerial, 50 ft. high? Ans.—(1) This is done in the cut and try method, as described in the September 1908 issue, by Mr. W. C. Getz, using a Hot Wire Meter. Each station has a different adjustment, and it is necessary to keep trying out each until the right position is reached. (2) Yes, though it is not as good as plate glass. (3) From 450 to 700 miles.

1146. **Wireless Troubles.** G. D., Nicolet, P. Q., Can., asks: I take the liberty to ask some questions about my wireless station. I have no difficulty in receiving from large plants 100 miles away nor in sending for very short distances up to one mile, but I cannot be heard by a very sensitive receiving set only 10 miles away from here with a 6-in. coil working on ten storage cells and giving easily, 4 in. spark. I use a variable oscillation condenser, good spark gap and a tuning coil for sending. My ground is very good and I tried to tune in every possible manner. My aerial is composed of four strips, No. 12 copper wire, 70 ft. long and carefully insulated. There is a large church with steel framing and galvanized iron roof, near the house. The roof of the house is also iron. Is the trouble there? Now I would ask if it would be better to use some other points, such as the steeple of the church, to support my aerial. And in this case, what kind of aerial would you suggest to send 25 miles with ⅓ k.w. transformer and tuned circuits? Does it make any differnece if I send in the direction of the plane of my aerial or in a direction perpendicular to this plane? You would help me very much in giving me any advice you think proper in my case, in the columns of your excellent magazine, *Electrician and Mechanic*, which I read every month with great interest. Ans.—Your trouble may be due to the fact that you have not your circuits in proper tune. You should see that your transmitting and receiving sides are in resonance. While there might be some loss due to the absorption of the energy, it looks more like a case of bad coupling. If you use the same form of aerial you now have, only swing the four wires across between the two steeples, and bring your two lead wires down, you should get excellent results. In this case, use a tinned copper cable, made of 7 No 21 stranded copper wires.

1147. **Wireless Radius.** R. B. L., Leominster, Mass., asks: (1) What, should be the receiving radius of a wireless station having the following instruments? Aerial 43 ft. high at one end, 25 at other end, 45 ft. apart, with 5 No. 16 bare copper wires. Tuner 1,200 ft., No. 28 single cotton covered copper wire wound on 5 in. core, with double slide electrolytic and silicon detectors. Fixed condenser. Double 2,000 ohms receivers (1,000 to each side). (2) What are the high power stations other than Marconi and Fessenden, that I should be able to catch and at what hours? (3) What additions or improvements would materially increase the receiving radius? Ans.—(1) From 900 to 1,200 miles. (2) Broad Ex. Bldg. in Boston, BX; Manhattan Beach, N.Y. DF; DuPont Bldg. in Wilmington, Del., DU; and others along the coast. (3) Inductive tuner, Improved Silicon Detector might increase your range considerably.

1148. **Wireless Telegraphy.** O. S. E., Danvers, Mass., asks: (1) Does the accompanying sketch of a slide contact infringe on any patents, and if so, may I make one for my own use? (2) Where a D.P.D.T. switch is used in wireless telegraphy, with transmitting side connected to one end and receiving set to other end, does the switch have to be thrown as soon as through sending, to receive the answer? (3) What is the wave length of a tuning coil containing 225 ft. of No. 22 wire, and how is the wave length estimated? Ans.—(1) No. (2) Yes, generally, though a nearby station might come in well with switch open. (3) This may be easily calculated from Mr. W. C Getz's article in the December, 1908, issue, of this magazine.

1149. **Transformer.** S. W. D., Battle Creek, Mich., asks: (1) What is the cost of constructing the transformer, according to the directions recently given? (2) What other uses can it be put to, other than for wireless work? State a few uses, please. (3) If not handled intelligently, would it result fatally to an experimenter? Ans.—(1) The one given in July and August issues, costs about $9.00 for materials. (2) High Frequency experiments, Tesla Coil energy, etc. (3) Most assuredly.

1150. **Protecting Detector.** R. H. B., Washington, D.C., asks: (1) What will my receiving radius be? Two masts, 70 ft. above ground, 70 ft. apart, 4 wire aerial, electrolytic and silicon detector, loosely coupled tuned, variable condenser one 1,000 ohm? (2) In what way can I protect my silicon detector, with which I use no bottery, from the effect of my sending spark? (3) What is the call letter and rating of the station in this city run by the U.S. Signal Corps? Ans.—(1) About 1,000 to 1,200 miles. (2) Move button so point rests on lead, not on silicon. (3) Apply to Chief Signal Officer, 1714 Penna. Ave., Washington, D.C., for this information.

1151. **Wireless Distances.** A. H., Coronado, Cal., asks: (1) How can I receive with an aerial 50 ft. long, 35 ft. high with two wires No. 14, 2 ft. apart, a tuning coil, carborundum detector and two 75 ohm receivers? (2) Will a transformer with an open core ¾ x 8 in. primary of two layers of No. 16 D.C.C. and a secondary of 3 sections of No. 34 enameled wire, sections to be each 2 in. long and 1 in. deep, transmit 10 miles with the aerial described? (3) Will it be necessary to put insulation between the layers of the secondary, if one use enameled wire in the transformer described in question No. 2. Ans.—(1) About 10 miles. Get more sensitive detectors, and high resistance receivers. (2) Yes, if you have a good ground. (3) Not if you wind it in sections.

1152. **Spark Coil.** R. C. B., Paymya, N.J., asks: (1) Dimensions of 5 in. spark coil, same to be wound with No. 30 S.S.C. wire? (2) Size and quantity of primary wire, number of volts to operate same? (3) Do you vouch for the responsibility of firms who advertise in Electrician and Mechanic? Ans. —(1) This information can be best obtained by consulting Series D, Construction Drawings of Electrical Apparatus by W. C. Getz. A brief description herewith given: Core, 18 in. x 2 in.; Primary 3 layers No. 14; Micanite Insulating Tube, ½ in. thick; secondary in sections having outside diameter of 6 in.

1153. **Transformer.** P. L., Hoopeston, Ill., asks: (1) Can you use a transformer on a wireless telephone the same as an induction coil? (2) If so, in what uses are they? Ans.—(1) No. (2) Only on wireless telegraph transmitters.

1154. **Spark Coil.** H. B. D., Westfield, N.J., asks: I have 3 pounds of No. 34 D.C.C. magnet wire to be used as the secondary of a spark coil, and would like to know how much and what size wire to use for the primary, and what the dimensions of the core should be to best suit such a secondary. I intend to use the coil for wireless. (2) About how long and thick should the spark be, if the coil is made properly. (3) Would a spark coil be less liable to break down if put in boiled linseed oil, rather than sealed in with wax? Ans.—(1) Core, 12 in. x 1 in. Primary, 3 layers No. 14. Make secondary in sections. (2) About 2 in. (3) Yes.

1155. **Perikon Detector.** E. E. K., Los Angeles, Cal., asks: (1) Please tell me the ohms resistance of a phone manufactured by the Western Electric Co., No. 128 w.? (2) How far could I receive with the following instruments: a fan aerial 105 ft. long, suspended from a pole 50 ft. high, two tuning coils, silicon detector, a fixed condenser, and 2 of the head phones mentioned above in first question, using the loop aerial system of W. C. Getz in the 1909, May issue? (3) What is a perikon detector, and what are the minerals used in it? Ans.—(1) 86 ohms resistance. (2) About 10 or 15 miles as the resistance is not high enough. (3) The trade name of a sensitive detector made by the Wireless Specialty Apparatus Co., of New York. The minerals are Copper Pyrites and Zincite.

1156. **Spark Coil.** E. H. W., Havana, Kans., asks: (1) Will you tell me where I can get a ready wound secondary coil for a 1 in. spark or over? (2) What is the best size of copper wire for a choking coil? Ans.—(1) Wireless Equipment Co., of West Arlington, Md., have a number of coil parts for sale. (2) About No. 14, if current is not over 8 amperes.

1157. **Wireless Telegraphy.** C. R. B., Lawrence, Kans., asks: Could you recommend a book upon the subject of wireless telegraphy, also treating of wireless telephony somewhat, fulfilling the following conditions; giving a fairly comprehensive history of wireless telegraphy, and of the development of the various systems, explaining the various systems in operation at present, and giving data on the amount of power and kind of apparatus necessary for transmitting various distances, and general data of all kinds of apparatus necessary for working up to 200 miles. (2) Does the Bellini-Tosi radiogoniometer concentrate all the energy of the sending station in one direction, thereby increasing the range of the station, or does it merely serve to cut off all radiation except in the direction desired, without any increase in range? The receiving form of that instrument could have no advantage except in increasing selectivity? (3) Could not the balanced tuned circuit receiver described by Mr. W. C. Getz in the May, 1909, issue of Electrician and Mechanic be arranged with only one tuning coil, by adding a third slide, as in the following diagram? Ans.—(1) Collin's work on wireless telegraphy would be best for you. It may be purchased of our book department for $3.00. (2) While the imventors claim the ability to concentrate the energy in one direction, it is evident that much of the original energy will be lost, due to the divergence of the waves from their original shapes. (3) Your scheme would work, but the results would not be as good, owing to the absence of the condensive effect.

1158. **Spark Coil.** R. E., Monett, Mo., asks: I would like to know how long a spark this coil will give, core 8 x 1 in., 2 layers of 14 size wire for primary, insulating tube, 7½ x 1⅓ in., ⅛ in. in thickness. Sections 6 wound with No. 30 size wire, 1,500 sq. in. of tinfoil for condenser, coil is 3 in. in diameter. Ans.—For a small coil, the proportions are very good. Would make the secondary in more sections.

1159. **Induction Coil—Helix.** C. M., Louisville, Ky., asks: (1) Is the induction coil described in your July number by Kenneth Richardson, a tuning coil also? Or is an induction coil and a tuning coil the same thing? (2) Is an induction coil sometimes called a helix, if not, how does an induction coil differ from a helix, and how is the helix connected in the receiving circuit? Ans.—(1) No. (2) An induction coil is used to produce the energy for transmitting, while the helix is used to tune to some wave length by using a fixed capacity, but either can be changed. A helix is only used in sending, while a tuning coil is a form of helix, but this term is not used.

## BROCKTON FAIR

The Brockton Fair is planning this year, to hold the greatest outdoor Athletic meet ever held in New England. They have gone to a great expense to build a ¼ mile cinder track within the oval of the Fair Grounds, with a good building for training quarters, supplied with shower baths, and other accommodations. Having this ¼ mile track, they are enabled to have a more complete meet than in former years, when they were dependent on the horse track for their use. There will be another departure this year, the athletic games taking place on THURSDAY, Oct. 7, one of the big days.

On Tuesday, the first day, there will be the usual Children's sports of all kinds, with basket ball and foot ball games: On THURSDAY, the 7th annual Athletic meet of the Brockton Fair: On Friday, the 2nd Annual Marathon race.

The athletic events have come into such prominence, that the best athletes in the country are glad to come and take part in the games and races.

The standard of the prizes, established years ago by the Brockton Fair, has always been maintained, and when an athlete says he has won a prize at the Brockton Fair, his friends know that it is of the value claimed.

Among the events that are to take place on THURSDAY are the 100 yd. dash, 220 yd. run, 440 yd. run, 880 yd. run, 1 mile, 3 mile, running high jump, running broad jump, pole vault, shot put, 120 yd. high hurdle, 220 yd. low hurdle, and a 1 mile relay race, open to all Colleges, Athletic Associations, and Y. M. C. A.'s. The above makes a fine list of attractions, and assures all those interested in athletics, that they will have a good day's sport, if they attend the Brockton Fair on THURSDAY, Oct. 7th.

## ELECTRIC SHOW, BOSTON

An attraction that will draw thousands of visitors to the Mechanics Building in November, will be the great Electric Show which will be held in Boston, November 15 to 25th. Already hundreds of electrical novelties have been submitted to General Manager Chester I. Campbell, and from present indications, the highest attainments and most modern electrical achievements will be represented. The space is being rapidly spoken for by the largest electrical interests in the country, and, as the members of the

Association giving the exposition are composed principally of the exhibitors, unusual interest is being manifested on the part of the trade in general.

Manager Campbell has evolved an entirely new scheme for decorating and illumination, which will give the exhibition floor, and in fact, the whole interior, not only a uniform, but extremely harmonious and beautiful aspect. Approximately, one hundred thousand incandescent electric lights will be used, presenting a sight never before witnessed.

Particular attention is being given the industrial exhibits which will represent manufacturing processes of all kinds in actual operation, and show the great strides that have been made by the manufacturers since the electric motor has been in use.

There will also be comprehensive exhibits of modern electrical appliances in everyday use, and when it is realized to how many uses this power is now put in modern housekeeping, it will astonish even those who have thought they were up-to-the-times. There will be something of interest to the layman, the expert, the manufacturer, the jobber, the housekeeper, the ladies and even the children.

## BOOK REVIEWS

*Elementary Electrical Calculations.* By T. O'Conor Sloane, A.M., E.M., Ph.D. New York, D. Van Nostrand Co. Price, $2.00 net.

Dr. Sloane is well-known as the author of several electrical text books, and he has performed now, a most useful task in a most excellent manner. The book gives in simple form a basis for the study of the mathematics required by electrical calculations. As it is intended for those who may not be expert mathematicians, it is written so that almost the whole of the calculations needed may be performed without even the use of algebra, and what algebra is used is mostly of a very simple character, within the capacity of every electrical student. It is, of course, necessary in certain chapters to use somewhat more complicated mathematical expressions, but these chapters come at the very end of the book. Some higher mathematics are given in the appendix for the benefit of more advanced students. The book is carefully arranged, and thoroughly practical. Many problems are given, and the student who works through it will have a very comprehensive knowledge of electrical calculations.

*Mission Furniture: How to Make it. Part* I. Chicago, Popular Mechanics Co., 1909. Price 25 cents.

This attractive little book, well bound in cloth, gives working drawings and full directions for the construction of a large number of pieces of mission furniture, all described in an attractive fashion. The articles were originally published in *Popular Mechanics*, and the book is intended to be the forerunner of a number of others, reprinted in like fashion.

*Elementary Lessons in Electricity and Magnetism.* By Silvanus P. Thompson. Revised and enlarged by Prof. Otto H. L. Schwetzky. Chicago, Chas. H. Thompson Co. Price $1 50.

This is a new American edition of this book of which more than 100,000 copies have already been sold, but which has been fully and carefully revised to bring it up to date. The book is intended to be used as a text book for beginners, and is written accordingly in clear and lucid language. Necessarily, some algebra in the form of simple equations, and some elementary geometry, are used, but not enough to present serious difficulties to those who are not expert mathematicians. The chapters include Frictional Electricity, Magnetism, Current Electricity, Electrostatics, Electromagnetics, Measurement of Currents, Heat, Light and Work from Electric Currents, Thermo-electricity, Electro-optics, Induction Currents, Electro-chemistry, Telegraphs and Telephones, Wireless Telegraphy, X-rays. The Central Station and Modern Dynamos and Motors.

We have on our shelves a stock of a book called "Questions and Answers on Electrical Apparatus," which we are quite confident is the book that a great many of our readers have been looking for. We wish you could all see it, and we are sure that most of you would buy it, that is, if you are interested in electrical apparatus. The book was written by two young electrical engineers to answer ALL the questions about apparatus which are constantly cropping up in the testing department of the General Electric Company. It must be a pretty good book if that is its scope, and we have it on good authority that it does just this. If there is anything bothering you in relation to motors of any kind, or transformers, or rectifiers, or lamps, arc or incandescent, meters or instruments of any kind, or steam turbo-generators, just send us one dollar and get your book which will solve your difficulty.

## TRADE NOTES

The L. S. Starrett Co. of Athol, Mass., have issued circulars descriptive of several new tools, which they will mail on request. The tools are as follows: Telescoping inside gauges for measuring the exact size of holes or slots, by means of outside calipers or micrometers, accurate to a thousandth of an inch or less; Tool Makers' buttons with screws and washers for jig work; Carpenter's scratch guage, made entirely of steel, with two bars, making two marks at once, if desired; new taper guage, for measuring fractions of an inch from 1/16 to 1 1/16.

* * *

The Keuffel and Esser Co. of Hoboken, N.J., have ready for distribution a new catalogue of blueprint papers and cloths, describing and pricing all their various brands and grades, of various speeds and weights. Their reputation in this line is well known.

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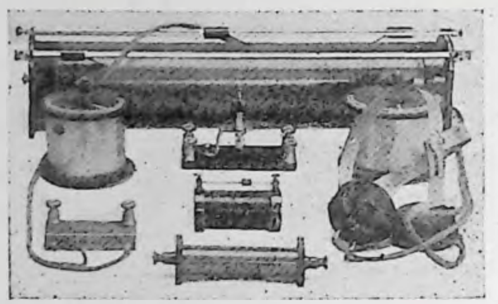

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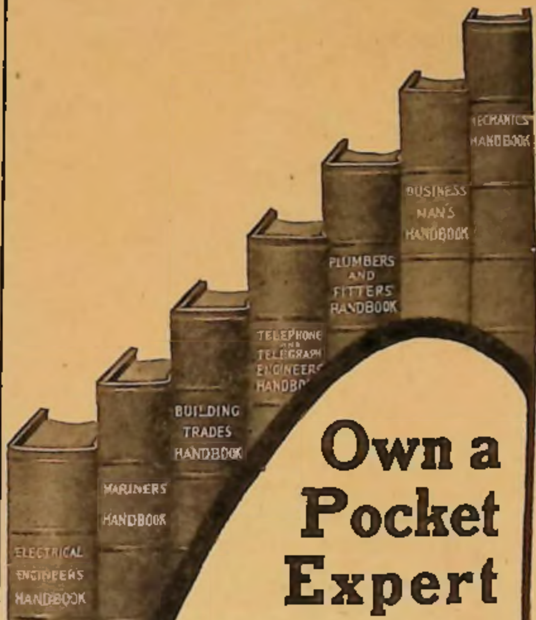


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