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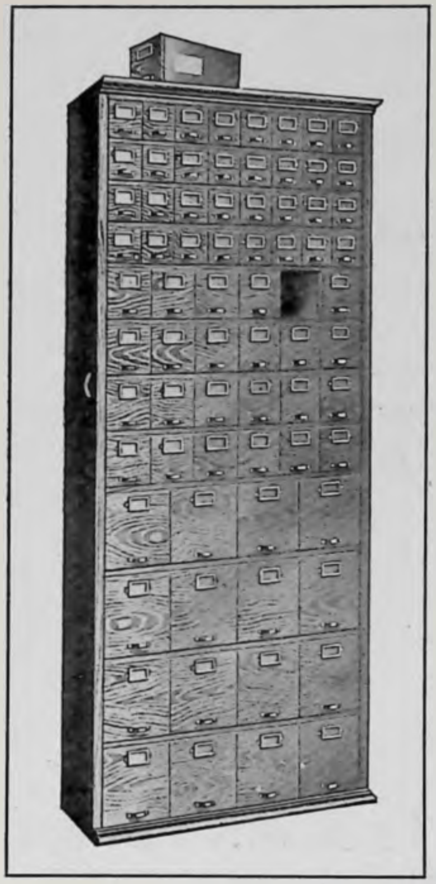

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A. E. WATSON, E. E. Ph.D.
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Electrician and Mechanic

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INTERIOR ELECTRIC LIGHT WIRING—Part IV

G. J. KIRCHGASSER, E.E.

METAL CONDUIT SYSTEMS

There are two kinds of conduit in extensive use today, the rigid and the flexible. Flexible tubing, which has already been referred to, is called non-metallic flexible conduit, but this is not included under the heading of conduit systems. There are also many kinds of underground conduits for use in power and light transmission systems, telephone work, etc., as fibre, creosoted wood, vitrified duct, concrete and others.

For interior wiring, paper conduits were at one time tried around which later brass armor was placed to form a protection, but this type of conduit was replaced by lined iron conduit which has in turn been supplanted by the unlined steel conduit. The conduit with its fittings is first installed complete forming a channel or raceway into which the wires can be drawn and from which they can be withdrawn. Figs. 38 and 39 represent sections of rigid conduit and flexible steel conduit.

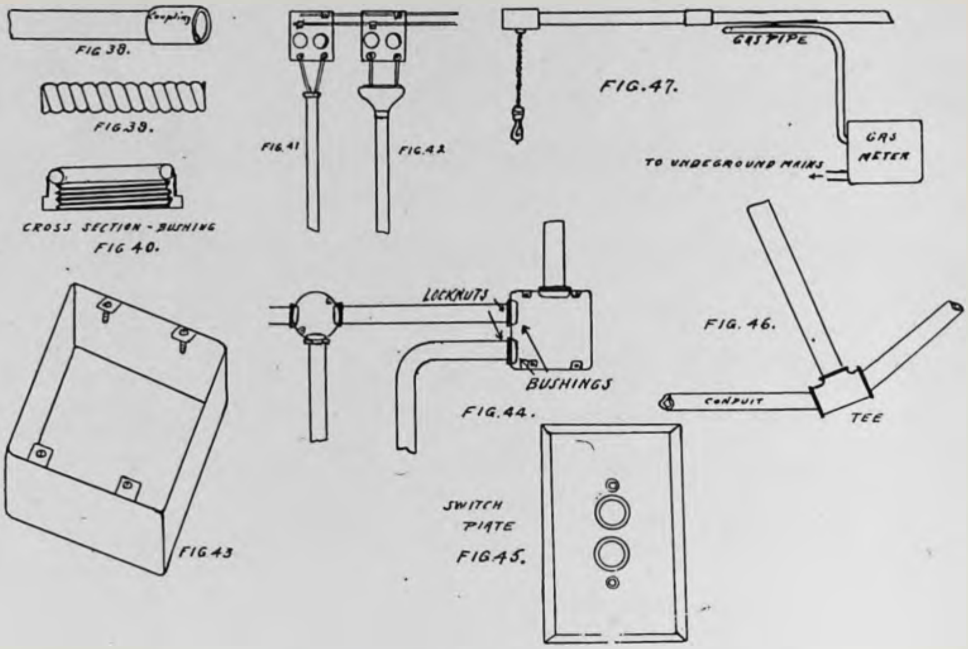
Iron conduit as the rigid type is usually called is really a steel pipe with an enamel or other coating to protect it from rust and corrosion. There are about a dozen or more makers of iron conduit whose product is inspected from time to time by representatives of the Underwriters' Laboratories of Chicago and which is tagged with the Underwriters' label. As this pipe is to afford protection to the enclosed wires, it should be strong, should not rust or corrode, not be too hard or brittle, nor too soft. The interior surface should not be rough, but smooth and uniform. Mild steel tubing is used by all manufacturers, but different methods of protection are employed. The treatment or coating is to prevent deterioration of the pipe as in some building materials as cinders and concrete traces of acids are found. The coating of the pipe must also be able to stand the handling by workman and not flake off when bent. Conduit protected by enamel is in more danger of rust than other types as the enamel is chipped off by the electricians' wrenches and other tools, and especially near outlet and junctions. The National Metal Molding Company treat their Sherarduct conduit in the same manner as their molding; that is, it is sherardized. Soapstone is blown into the pipe also giving a smooth surface. Some conduits are galvanized on the exterior and enameled on the interior, and others are enameled on both surfaces.

As all conduit with the Underwriters' label attached conforms to the best specifications, it is needless to go into details of wall thicknesses, etc. The trade sizes, approximate weights of 10 ft. lengths of rigid conduit with one coupling for each length, and the internal diameters are given in the following table:

Trade Size Inches	Approx. Int. Diam. Inches	Wts. 10 in. lengths Pounds
½	⅝	7.5
¾	.82	10.5
1	1.04	15.0
1¼	1.38	21.0
1½	1.61	25.0
2	2.06	35.0
2½	2.46	51.0
3	3.06	71.0
3½	3.54	

The thickness of the walls varies from 1/10 to ¼ of an inch. Rigid conduit is put on the market in 10 ft. lengths, threaded at each end in accordance with the U.S. Standard for number of threads per inch for different pipe sizes and provided with one coupling for each length.

The conduit system as at present installed is the one used in all new large buildings and offers the best solution to the proper protection of wires, both



for concealed and exposed work. The chance of mechanical injury to the conductors while the building is in course of construction and later is reduced to a minimum. In making repairs to a building in which a "knob and tube" system is installed, the wires being unprotected might be unknowingly injured, but with conduit a strong fireproof raceway is provided. In case of accident or breakdown of the insulation the outlet or junction box covers can be removed, the old wires pulled out and new pulled in. For protection in factories and shops near belting and moving machinery conduit offers the proper protection.

The conduit is first installed complete, the couplings joining the separate lengths and locknuts and bushings securing the pipe to the outlet, switch and junction boxes. The bushings, see Fig. 40, are made of tinned malleable iron or brass and prevent the insulation of the conductors from being injured when being pulled in. The conduit is also reamed out to take off the sharp edge that sometimes is produced from rethreading. At all ends of conduit, terminal boxes must be used or similar fittings,—the bushing to be used where the pipe enters the box, but not being considered a terminal fitting itself. For exposed work probably the condulet as made by the Crouse-Hinds Company of Syracuse has come into the most extensive use as a conduit fitting. Two were shown in the illustration of service entrance. Fig. 36 of Part III, and many different types are made. Two methods of terminal fittings were also shown in Part I, Plate 11. An incorrect method of using a bushing for a terminal fitting is represented in Fig. 41, and one which makes a proper terminal for a type "A" condulet in Fig. 42. If the cutout blocks and fuses were placed in a metal cabinet the bushing could be used inside the cabinet.

A switch outlet box was shown in a previous installment and its use is to enclose the flush switch entirely. The conduit is provided with bushings where entering, and secured outside the box by locknuts. The switch box is supported independently of the conduit and is always accessible by simply removing the surface plate. Outlet boxes are used where fixture or light outlets are wanted and of course are always accessible. The same methods of securing the conduit are used as for switch boxes. There are different sized and shaped boxes in use of which the 3 in. and 4 in. round and same sized square are most common. The depth is about 1½ in., but where this box cannot be used, shallow boxes (1½ in.) or plates are allowed. In all cases conduit boxes or plates must be so installed that the one edge will be flush with the finished surface, as for instance, the plastered wall or ceiling. Fig. 43 shows a square outlet without cover, the "knockouts" represented by the dotted line can be easily removed by the blow of a hammer. Where a fixture with canopy is to be installed the cover is not used, but if a drop light is wanted, the cover can be screwed on and the cord for the lamp brought out through a battery bushing of hard rubber or porcelain as shown in Fig. 47.

Junction boxes are often ordinary outlet boxes used at a junction of several pipes and in which joints or splices are often made and which are also used in the fishing-in of the wires. In large buildings where there are many circuits junction boxes are of large size. Fig. 44 gives some idea of a junction box, two being shown. As the joints and splices are sometimes located in these boxes, and as they are necessary in pulling in or out the wires, they should never be concealed in walls, etc., but should be accessible.

Most boxes made today are of pressed steel of No. 10 or 12 B. & S. Gauge, and are treated to prevent deterioration in the same ways as described for conduit.

As the method of using the switch box has been referred to, it might be pertinent to discuss the switch which it encloses. Fig. 45 illustrates a flush push button switch made by the Hart Mfg. Co. and Fig. 45a one for use where space prohibits the deeper box. The mechanism is enclosed in porcelain and the current carrying parts insulated by sheet mica. To the small screws shown in the front near the push buttons, the circuit wires are secured. There are also, rotary flush switches which are operated by the turning of a small switch handle and other switches which are not enclosed in switch boxes in the wall, but which set on the surface and are called surface switches. Fig. 45 shows a wall plate for use with a flush switch.

In making bends in conduit a radius, for the inner surface, of 3½ in. is specified as the minimum. The pipe would tend to flatten like hose, the enamel would be more apt to flake off and much difficulty would be encountered in pulling the wires through the pipe if a smaller radius of bend was used. The smaller sizes of conduit, ½ in. and ¾ in., are easily bent in a vice; but for the 1 in., 1¼ in., and 1½ in. duct a steam pipe tee with a pipe handle as seen in Fig. 46 serves to make the desired bend. For larger conduits special bending devices must be used.

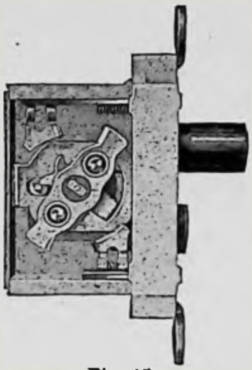


Fig. 45a

It can readily be seen that with the bends, offsets, etc., found in a conduit system, it would be impossible to push the wires into place unaided. "Fishing" is resorted to,—a stiff wire as a No. 10 gauge galvanized steel wire or a flat steel ribbon wire can first be pushed into the conduit and the conductors attached to those or to a separate pulling wire or rope. If the ribbon wire is used and many conductors are to be pulled-in, a separate pulling-in wire would have to be fished, as the ribbon wire is not strong, but the galvanized wire being stronger can be used to a greater extent for pulling in. Heavy and many conductors require tackle blocks and considerable pull to draw them in place. Oils and grease are sometimes applied to the conductors to make them pull easier, but they are injurious to the insulation. Soapstone is better and does no harm.

Double braid, rubber-covered wire should be used for conduit systems, the second or outer braid being necessary to prevent possible injury to the insulation when the wire is being drawn into the system. For branch circuits, No. 14 twin conductor as described under Metal Molding Wiring is used almost exclusively. The two wires of a lighting circuit on an alternating current system must be placed in the same conduit to prevent induction trouble which would be aggravated should each wire be enclosed in a separate pipe. For a power 2 or 3 phase system, the three or four wires would have to be placed in the same conduit. Several circuits of the same system can be run in the same conduit, but not of different systems. By putting both wires of a circuit in the same conduit, the distance between the conductors is a minimum, and as the inductance on alternating current circuits is less when this separation is least the reason becomes obvious. Increasing this separation and placing each in a separate metal conduit increases this effect many times because the metal has that quality that aids this induction. Conduit should not be run too near steam pipes and other sources of heat, as the insulating compound of the wire would become soft and run.

In the modern sky-scraper, the conduits running to the upper floors are of great length and the conductors very heavy. For this reason methods of supporting the conductors in the conduit risers must be employed. Junction boxes are installed at intervals on the different floors containing insulating supports to which the conductors are secured. A right angle turn of a conduit is also considered as supporting the weight. According to the Code conductors from No. 14 to 0 gauge should be supported every 100 ft. and gauges No. 00 to 0,000, every 80 ft.

It may appear inconsistent that for open wiring, the conductors must be well supported and insulated from foreign materials while in conduit wiring the wires are in contact with each other and the metal conduit. But the fact is that we know exactly where the wires are, that they are enclosed in a strong fireproof raceway, and free from danger of mechanical injury. If the installation is up to present requirements, the safest and most satisfactory method of wiring is assured.

Grounding of the metal conduit system is one of the most important requirements, without which a serious defect would be introduced. The conduit and the boxes should be thoroughly joined to form a continuous metallic circuit and the boxes secured to the gas pipe at the outlet boxes. Enamel from the threads of enameled duct should be removed. Grounding is usually done in the basement by connecting a No. 4 B. & S. gauge copper wire to the water pipe on the street side of the meter and valves by the use of ground clamps. The water pipe running into the earth makes a good ground connection. A ground clamp consists of a tinned copper band with clamp and lug into which the ground wire can be sweated.

If no ground connection were provided for the system shown in Fig. 47 and the insulation of the conductors should fail, current would be carried by the conduit. As the gas ,pipe is in very slight contact with the conduit, an arc might jump across, or if the contact was the least bit better, a small amount of current would flow seeking earth, which connection the gas pipe would provide. But heat would be generated and a hole might be burned in the pipe, allowing the gas to escape and be ignited. If the contact between the pipes were better, more current would flow and the fuses be blown in the branch. Therefore the object of a good permanent ground as described above is to furnish a path of low resistance to the earth so that enough current can flow, in case of breakdown, to blow the protecting fuses. If the ground connections are poor and the ground wire small, the resistance will check the flow of current so that the trouble will not be discovered at once by the blowing of the fuses. The contact as shown in the figure can also happen, for instance, in an outlet box, if the gas pipe and box are not firmly secured to each other.

Many of the points related about rigid conduit also relate to flexible conduit, but their uses differ somewhat and the details will be left for a later installment.

To ebonize wood, dissolve two ounces of shellac with one ounce of borac in a quart of water; boil until a perfect solution is obtained, then add two tablespoonfuls of glycerine. After solution, add a sufficient aniline black soluble in water, and then the mixture is ready for use.

PRACTICAL ELECTRICAL TESTING—Part II*

W. C. GETZ

TESTS WITH THE DIRECT CURRENT GALVANOMETER, VOLTMETER AND AMMETER

The use of the galvanometer as an electrical testing instrument extends over a greater period of time than does the use of any other individual type of electrical apparatus. The galvanometer used in the experiments of forty years ago is used in the practical tests of today, and while the instrument has been improved, in many ways, it is still recognized as the only accurate gauge of the various units of electrical apparatus.

Originally only used by scientific men in research and experimental work, it is now, in one form or other, used universally by all who have to deal with the study and application of electricity in its many branches.

Briefly speaking, the galvanometer is a device for indicating the presence of an electric current. This indication may be merely for the purposes of identification, or it may be in certain arbitrary units or factors thereof, and thus give the galvanometer the function of a measuring device. According to its type, the galvanometer has received various names, such as voltmeter, ammeter, etc., having its indicating needle move over a scale calibrated in volts, or amperes, respectively.

No detailed description of the various commercial types of galvanometers, voltmeters or ammeters will be given in this article, as a discussion of the construction of these types would necessitate a special article in itself. A small detector galvanometer, which the experimenter can easily make, will be described, in order that some of the tests may be tried by those who have no access to standard instruments of this character.

The best results in anything are always attained with care on the experimenter's part, and the use of reliable instruments. While not many experimenters, in fact only a very few, can obtain the use of standard instruments, all are more or less familiar with the cheaper electrical instruments of the "battery meter" type, and most of these little instruments give results satisfactorily accurate for all practical purposes.

Referring to Fig. 1, there is given a sketch of a small testing galvanometer, that is easy to make, and may be of service in a number of the experiments described in this article, where no definitely graduated instrument is required.

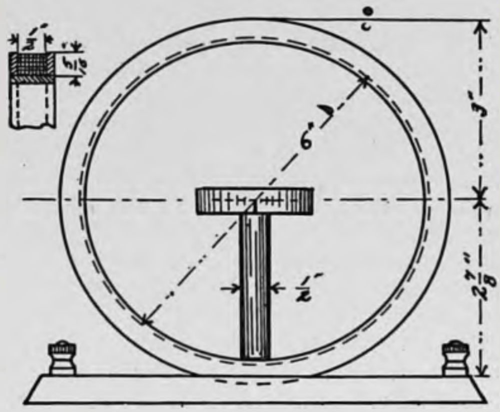


Fig. 1.

A wood form, having its winding surface, 6 in. outside diameter, and ½ in. wide, is provided with flanges on either side, so that the cross-section of winding space is $\frac{5}{16}$ in. x ½ in. This may be made of stiff cardboard, if no woodworking apparatus is available.

On this form are wound 450 turns of No. 30, B. & S. gauge, single, cotton-covered magnet wire. This gives a resistance of approximately 75 ohms. The form is then fastened to a baseboard, and the terminals of the winding are carried to suitable binding posts mounted on the base. A small wooden upright in the centre supports an ordinary compass. This compass should have a needle not over 1¼ in. long. The upright should be so proportioned that the needle swings in a horizontal plane equidistant from the upper and lower portions of the winding.

This galvanometer will be found remarkably sensitive for testing through high resistance windings. While its form is not suitable for graduating to a standard unit, it is of value in numerous cases where no definite knowledge of the unit value is required.

*Continued from September, 1909.

In Fig. 2 is given the continuity test. This test was given in detail in the previous article of this series, describing this test in connection with the telephone receiver, so that there

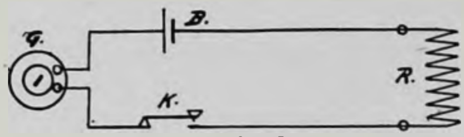


Fig. 2.

is no necessity of stating the various instances in which this test figures.

The galvanometer previously described may be used advantageously, or either a voltmeter or ammeter of suitable range. When a high resistance is being tested, it is advisable to use more than one cell of battery with the galvanometer. The key, K, may be omitted, if desired. A cell of dry battery is convenient for this work. On extremely high resistance windings, the detector galvanometer may be of better service than a telephone receiver, though while not as sensitive as the telephone, it does not indicate when the winding is open. On the other hand, the telephone receiver might give a "capacity click" on an open winding, which if of high resistance, would be difficult for any but an experienced testman to tell from the faint "continuity click."

Fig. 3 shows the correct way to connect a voltmeter and an ammeter in a direct current circuit. In this sketch, G represents a shunt-wound generator which charges a storage battery, B. This battery, B, discharges over the line wires, WW, to the load, L. It will be noted that the voltmeter, VM, is connected directly across or shunts the line wires, while the ammeter, AM, is in series with the load, L, and the source of power.

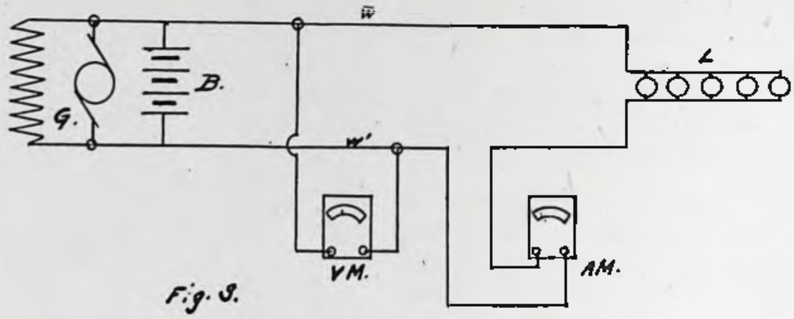


Fig. 3.

The voltmeter should always be connected across the line as shown, when the line voltage is desired. That gives the effective working potential of the lines. The ammeter should never be connected across the circuit. This is because the ammeter is of low resistance, and the sudden flow of current if connected directly across the circuit, would equal almost a dead short-circuit on the system. This would not only seriously injure the instrument, but would ruin the storage battery, and perhaps the generator.

Where the voltage to be measured is known to be greater than that of the instrument's capacity, additional resistance may be proportionally added, that will increase the range of the meter. Such resistance units are called multipliers, and are connected as shown in Fig. 4. Suppose the wires, WW, carry

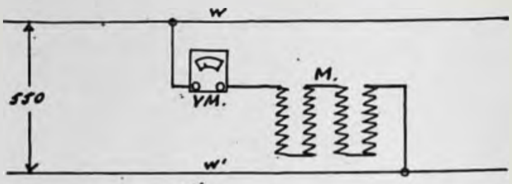


Fig. 4.

a voltage of about 550. The voltmeter, VM, has only a range of 150 volts. To insert it in the circuit would manifestly injure the instrument, unless we can so reduce the potential that it will not throw the needle off of the scale.

Suppose the voltmeter has an internal resistance of 1,000 ohms. Now, if we wish to increase its range five times, we must have five times the resistance. So we add four coils of known resistance in series, these multiplying coils, M, each being 1,000 ohms. Then these coils plus the voltmeter resistance equals 5,000 ohms, and we can safely place it in the circuit. However, the reading we get on the voltmeter scale must be multiplied by five, to be correct.

In a like manner, to increase the range of an ammeter, we can use certain shunts. For instance, in Fig. 5, say the range of our ammeter, AM, is only

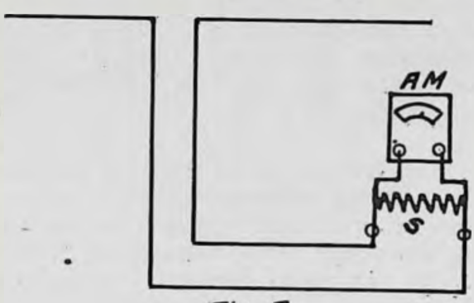


Fig. 5.

25 amperes, and we wish to use it on a circuit carrying 200 amperes. As this is almost ten times as great as the ammeter will carry, it is necessary that we use a shunt that will not allow more than 25 amperes to flow through the ammeter. Now, if the resistance of the ammeter is $\frac{1}{10}$ ohm, the resistance of the shunt should be nine times less or $\frac{1}{90}$ ohm. Then nine times as much current would flow through the shunt as would flow through the ammeter. Thus on a circuit of 200 amperes, the shunt would take 180 amperes, and the ammeter, 20 amperes. As in the case of the voltmeter, the ammeter reading must be multiplied by ten to get the correct result.

It should be always seen that the voltmeter and ammeter are properly poled, as otherwise the needle may be injured by connecting the instrument wrong in the circuit. Usually every instrument has the positive and negative side plainly marked, and these must be connected to like sides of the electrical circuit.

In Fig. 6 is given a method of measuring resistances, using the galvanometer previously described. G represents the galvanometer; B, several cells of dry battery; S, a two-point switch; X, the unknown resistance; and R, an adjustable resistance of known values. R can be of a form similar to the potentiometer used in wireless work.

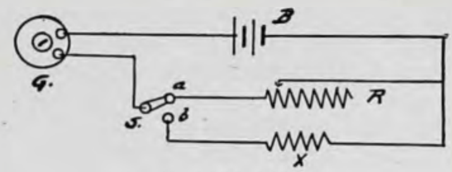


Fig. 6

A good proportion for R is as follows: Let the winding be on a 2 in. mandrel of dry, well-seasoned wood. The length of the mandrel will depend on the resistance the experimenter wishes to have. This is given in the following table, the calculations being based on an exact 2 in. diameter. It is advisable to use insulated wire, and the winding should be well shellacced before scraping the space for the sliding contact. The sliding contact should extend the whole length of the winding, and make perfect connection with the successive turns of wire. The data is as follows:

Diameter of core of mandrel, 2 in.

Wire, No. 30 B. & S. gauge 18% single, cotton-covered German silver magnet wire.

Turns per inch, 70. Feet per ohm, 5.15.

Resistance in Ohms	Feet of Wire Req.	No. of Turns Req.	Length of Winding
1	5.15	9.85	.1403 in.
10	51.5	98.5	1.406 in.
50	257.5	492.5	7.12 in.
100	515.	985.	14.25 in.
200	1,030.	1,970.	28.3 in.
500	2,575.	4,925.	70.5 in.

In the last column, under length of winding, is given the length in inches that the mandrel should be for a given resistance. This also gives a means of graduating the slide rod, as the length in inches from one end, when stepped off as noted above, will give the various positions necessary for the respective resistances.

Now, referring back to Fig. 6 again, we place the blade of the switch, S, on point, Z, and take the reading of the deflection of the galvanometer, G, through the unknown resistance, X.

Then place S on a point, a, and adjust the resistance, R, until the same deflection is obtained that was had with the unknown resistance. Then the known value of the resistance, R, is equal to the unknown resistance, X.

Before leaving the subject of the adjustable resistance, it would be well to add that this should be made up of several units if more than a range of 100 ohms is desired by the experimenter. In fact, it is a good plan to make an adjustable resistance of only 100 ohms, and then wind coils of 200, 300, 500, etc., as fixed resistances, as in this way the resistances would not be so bulky, and would allow just as much latitude in obtaining the various ranges.

It frequently happens that the experimenter is using a galvanometer whose internal resistance is unknown. As it is essential to know the internal resistance of the galvanometer in many problems, the following method is applicable for obtaining this quantity in the cases of galvanometers, voltmeters and ammeters.

In Fig. 7, G is the galvanometer or voltmeter whose resistance we desire to know. R is an adjustable resistance of known value, such as previously

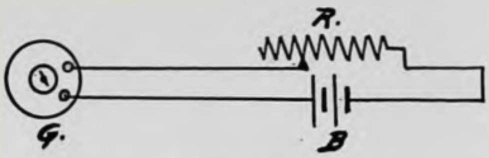


Fig. 7.

described. B is suitable battery for the given instrument. Now with the resistance, R, at a certain point, say 10 ohms, we get a deflection, D, of say, 20 scale divisions. Now we increase the resistance, R, until we get a deflection of ½ D, or 10 scale divisions. We call this new resistance, R′, and assume in this example that it equals 30 ohms. Then the resistance of the galvanometer, G, may be found as follows: R″ equals R′—2R; that is, R″ equals 30—(2 x 10) ohms, or 10 ohms.

If it is desired to measure the internal resistance of a battery or a dynamo, we can easily do so with a voltmeter. In this case, we connect up as shown

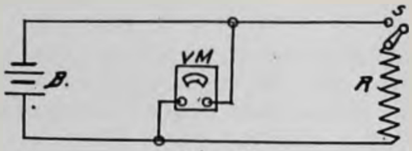


Fig. 8.

in Fig. 8. B is the battery (or dynamo) whose resistance we desire to determine. VM is a voltmeter of suitable range. R is a known resistance. And S is a switch or key to cut R, in or out of the circuit.

With the switch, S, open, we get the potential across the battery or dynamo, and call it D. Then close the switch, S, and get the potential across the circuit while the current is flowing through resistance, R, calling this D′. Then the unknown internal resistance R′ equals $\frac{D-D'}{D'} \times R$.

It should be stated that the resistance R should be sufficient to allow a flow of current equivalent to the general working amperage of the battery or dynamo.

The voltmeter forms a ready means of measuring the resistance of a coil, etc., when the resistance of the meter is known. In Fig. 9, VM is a voltmeter whose resistance is R; B, a battery, dynamo, or other source of direct current; S, a two point switch; and R, a coil or winding whose resistance is desired.

Now, with these instruments connected as shown, we first place the switch, S, on the point a, which connects the voltmeter, VM, directly across the

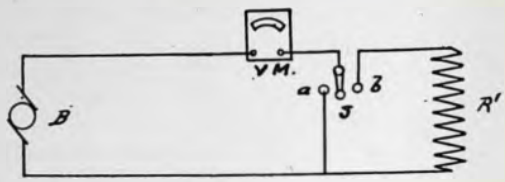


Fig. 9.

supply circuit. Say, our reading, V, is then 110 volts. Then we place the switch, S, on point B, and get another reading, V′, of say 70 volts. Now the resistance of our meter is 10,000 ohms. Then we use the formula

$$\text{Unknown Res.} = \frac{V-V'}{V'} \times R.$$

That gives us $\frac{110-70}{70} \times 10{,}000$.

Which is equal to 5,714·3 ohms practically. This is the resistance of the coil.

For low resistances, the use of the voltmeter and ammeter simultaneously gives very accurate results. In Fig. 10, R is the unknown resistance; B, the battery or source of direct current supply; VM, the voltmeter; and AM the ammeter.

Having connected up as shown, we take a simultaneous reading on both instruments. Say our current, C, is 4 amperes, and the potential, E, is 12 volts. Then by Ohm's Law, since $R = \frac{E}{C}$, we get our unknown resistance as $^{12}\!/\!_4$, or 3 ohms.

With the same connection, the watts may be calculated. As the wattage, W, equals the product of the potential, E, and the current, C, we are using 12 x 4 or 48 watts in the resistance, R, of 3 ohms.

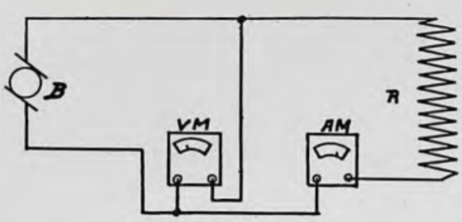


Fig. 10.

If we have a known resistance at hand, it is possible to calculate both the voltage and amperage of a circuit, with only a voltmeter connected. In Fig. 11, VM is a voltmeter; R, a known

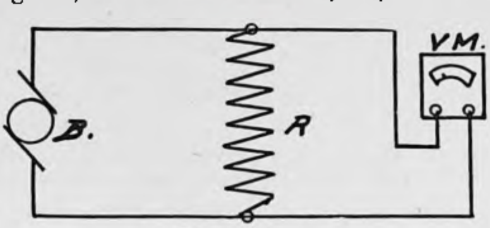


Fig. 11

resistance; and B, the source of direct current power. Since by Ohm's Law, $C = \frac{E}{R}$, if our resistance is say 12 ohms, and our E.M.F. 48 volts, our current in amperes is then 48 divided by 12, or 4 amperes. In a like manner an ammeter could be substituted for the voltmeter, but connected in series with the battery and resistance, and the potential could be calculated from the product of the resistance and current readings. From these the wattage could be figured as shown above.

To measure the capacity of a condenser, a sensitive galvanometer or voltmeter is connected as shown in Fig. 12. B is the charging battery; C, the condenser to be measured; C′, a standard condenser of known capacity; S, a two point switch; K, a double contact key; and G, the galvanometer.

With switch, S, on point a, and key,

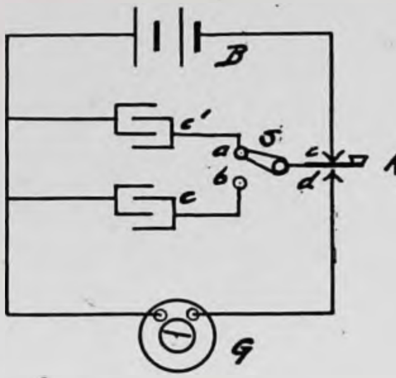


Fig. 12.

K, on c, we charge the standard condenser, C′, for say half a minute. Then we press K, so that it disconnects from c, and connects with point, d, and note the deflection of the galvanometer, G, caused by the standard condenser discharging. Call this deflection, D′. Now place the switch, S, on point, b, and with the key, K, making contact with c, charge the condenser, C, for half a minute. Discharge it through the galvanometer, in the same way, by pressing, K, and call this deflection, D.

If C′ is the capacity of the standard condenser in microfarads, then the capacity of the condenser, C, will be:

$$C \times \frac{D}{D'}$$

With a sensitive galvanometer, the various capacities of condensers, cables, etc., can be calculated with great accuracy by this method.

There are many other tests that can be made with the instruments described in this article, but as those given are the tests in the most general use, it is thought unnecessary to give any additional ones at this time.

Another article of this series will deal with the Wheatstone Bridge, and its modifications, with particular reference to the location of defects in cables.

FORGING FOR AMATEURS—Part XIV

F. W. PUTNAM, B.S.

TOOL FORGING

CENTERING TOOL

Fig. 162 shows a tool which is used for starting holes on chuck and face plate work and is known as a centering tool. The forging of this tool is done in a very similar way to that of the boring tool shown in Fig. 158. As will

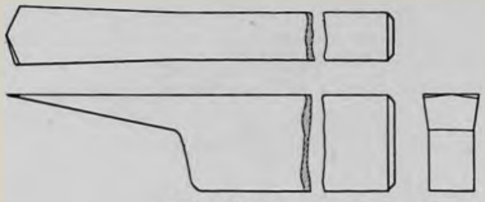


Fig.162

be noticed, the end is flattened out quite thin and trimmed to a flat drill shaped end with a hot chisel. The right hand side of this end is to be cut from the top side and the left hand edge from the other, so as to leave the end of the same shape as a flat drill. The tempering of the centering tool is exactly the same as for the other lathe tools, previously described.

FINISHING TOOL

Fig. 163 shows a finishing tool, which is used for taking off a very fine shaving,

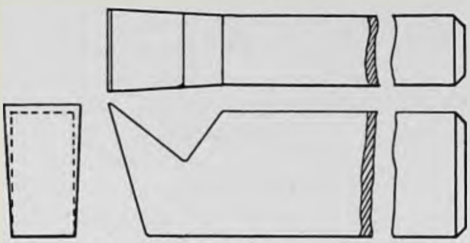


Fig.163

in order to finish up a casting to size. This tool is forged by bending the end of the stock down over the edge of the anvil, in precisely the same way as in the forging of the diamond point.

In Fig. 164, at A, is shown the method by which with a hand or set hammer, the end is flattened and widened out. After this work has been done, we find that the end is bent out practically straight, in fact too straight. After the end has been shaped, we then bend it into the proper angle, as shown at B, Fig. 164.

This bending of the tool will probably cause the cutting end or blade to bend very nearly as shown at C. This can be readily straightened, however, by a few blows with the hammer, striking at the point and in the direction indicated by the arrow in C, thus straightening the end out, and finally leaving it as shown at D. The tool is then trimmed and smoothed up, after which it is ready for tempering. Temper this tool so that the very lightest yellow shows at the cutting edge. If a tool

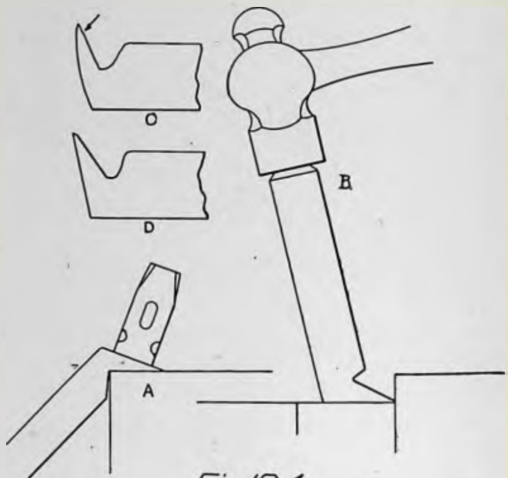


Fig.164

of this kind is to be used on a planer, make the front end much more nearly a right angle with the bottom surface. This of course reduces the front "rake" or "clearance."

FLAT DRILLS

Fig. 165 shows what is known as a common flat drill. The forging and shaping of this tool are very simple and need no explanation. The drill end is to be trimmed exactly the same as was the end of the centering tool. The size of these flat drills is always measured or determined by the width, A. This, of course, should be the same

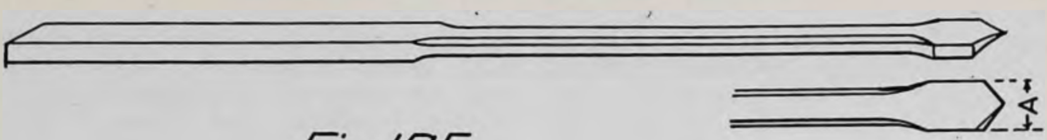


Fig.165.

size as the hole which the drill is intended to make. In tempering this tool, make use of a rather dark yellow scale, as the proper point for cooling.

There are other machine tools which I shall take up in detail later, but the next logical tool which I should discuss is perhaps the hammer.

The hammer has been called by someone, and justly so, I believe, the king of tools. Some of the most beautiful and delicate work that has ever been produced by the hand of man has been wrought by the hammer, and the skillful hammer man is well worthy of admiration.

We are apt to look upon the hammer as a rude instrument, and apt to overlook the scientific principles involved in its construction and use, and to pay too little attention to the materials of which it is fashioned, and the forms in which it is made. We frequently look upon it merely as an adjunct to other tools and forget that it is entitled to consideration as a final tool.

In some handicrafts, involving a high class of finished work, the hammer is the only tool employed. That artistic skill in the use of the hammer as a finishing tool can be acquired, is clearly shown from the many beautiful specimens of repoussé work to be seen in silversmiths' shops. The details of the ornamentations are not only minute, but they so harmonize as to give elegance and expression to the metal, exclusive of the form of the articles themselves.

A glance into the art stores in any of the cities will reveal many specimens of hammered work of this sort, or of duplications of them made by electroplating or by stamping with dies. The excellence, and consequently, the value of these copies depends naturally upon the closeness of imitation to the originals, and as they are for the most part very clever specimens in this particular, we have almost as good illustrations in point as the originals.

Those of my readers who are interested in the capabilities and possibilities of the hammer will be interested in an examination of some of these pieces of work. They are mostly of brass and copper, and in both originals and copies, even the tool marks are faithfully preserved. The esteem in which they are held may be judged from the statement that a piece of work of this kind, about one-third the size of one of these pages, brings as much as $25, while shields of a larger size frequently sell for three and four times this sum. Originals are cherished in museums and are beyond the reach of money to buy.

There are, of course, several kinds of hammers used both by the blacksmith and machinist, and in one of the first of my articles on forging, I gave numerous illustrations of the shapes commonly used by the blacksmith. Let us consider two or three kinds of hammers and study them a bit, trying to find out what work every kind of hammer should be capable of doing, and thus find a reason for the making of the hammer in some particular shape.

First, take the blacksmith's sledge, where we find the handle is much nearer to the pean or narrow end than to the thick, broad, end. In looking for a reason for this, we soon observe that the blacksmith's helper or striker delivers most of his blows in a vertical direction and uses the face end, not the pean of the hammer. By having the eye and therefore the handle nearer to the pean, the face naturally hangs downward. This is because the face end as held by the handle is the heavier, and as a result the blacksmith needs by this method but little, if any effort to keep the face downward.

The machinist's hammer, also, is made heavier on the face than on the pean end, so that the face end he uses the most will hang downward without any special effort to keep it so. His chip hammer, which he also uses for many purposes, weighs in the heaviest kinds, about 1¾ pounds, the handle for which is about 15 in. long. He wields it for heavy shaping with all his force he can muster, obeying the law that it is velocity rather than weight that gives penetration. As an example of this, let us suppose a hammer weighing 75 lbs. is travelling at a velocity of 15 ft. per minute, and the power stored up in it is 1,125 lbs. Another hammer weighing 1 lb., and travelling 1,125 ft. per second would also have stored up in it 1,125 lbs. Now the power is equal in both, but the effects of the blows would be quite different. If both hammers struck a block of iron, we should find that the result of the quick moving hammer would be much deeper, but it would spread out less sidewise, giving to the hammer a penetrating quality.

The slow moving one would affect the iron over a much wider area, but sink into the iron less deeply. Here is an important operation, in which this principle is clearly shown, and must be recognized.

Let us suppose that we have a wheel upon a shaft, and that the key is firmly locked between the two. In driving it out, we know, that if we take a heavy hammer and strike slow moving blows, we shall soon spread the end of the key, thus lifting it up and making it more difficult to drive out. We therefore take a hammer having less weight and swing it more quickly.

In whatever form we find the hammer, it is used for three purposes only: namely, to crush, to drive and to stretch. The most interesting of these operations are stretching and driving. The gold beater, the blacksmith, the shoe-maker, the machinist, as well as many others, employ the hammer to stretch; while the carpenter, the machinist and many others use the hammer to drive.

Nearly everyone has noticed the name of David Maydole stamped upon hammers. David Maydole made hammers the study of his lifetime, and after many years of thoughtful and laborious experiment, he had actually produced an article on which, with all his knowledge and experience, he could suggest no improvements. He came to think of making hammers as a means of livelihood in a rather peculiar way. Sixty years ago, he lived in a small village in the state of New York, where there was no railroad, and the Erie Canal many miles distant. He was the village blacksmith. His establishment consisted of himself and a boy, whose duty was to blow the bellows. He had a great deal of trouble with his hammers. Sometimes the heads would fly off. If the metal was too soft, the hammer would spread out and soon wear away. If it was too hard, it would break off.

At that time, blacksmiths made all of their own hammers, but he knew very little about mixing ores so as to produce the toughest iron. His greatest trouble was with the hammer flying off the handle, a mishap which could well be dangerous as well as inconvenient. One hammer which he used had an iron rod running down through the handle, with a nut screwed on at the end, while another was entirely composed of iron, having the head and handle all in one piece. There were various other devices too, some of which were exceedingly clumsy and awkward. After a good deal of experimenting, he at last hit upon an improvement which led to his being able to put a hammer on a handle in such a way that it would stay there. He made what is called an adze-handled hammer, the head being attached to the handle after the manner of an adze, the improvement consisting in simply making a larger hole for his handle to go into, by which device it had a much firmer hold on the head and could be made extremely tight. Each hammer was hammered out of a piece of iron and tempered over a slow charcoal fire, the man doing the tempering looking very much as if he were actually cooking his hammer on a charcoal furnace and watching it until the process was completed, just as a cook watches his fry pan.

The neighborhood in which David Maydole lived would scarcely have required half a dozen new hammers in a year, but one day six carpenters came to work on a new church and one of these men left his hammer at home, and so came to David Maydole's blacksmith shop to get one made. The carpenter was delighted with it, and when the other five carpenters saw it, they came to the shop the next day and ordered five more hammers made. They did not understand at all the blacksmith's notions about tempering and mixing the metals, but they saw at a glance that the head and the handle were so united that there never was likely to be any trouble from them. To a carpenter building a house the removal of that one difficulty was a great boon.

A dealer in tools in New York City saw one of these hammers, and then David Maydole's fortune was made. He immediately ordered all the hammers the blacksmith could make. In a few years he made so many hammers that he was obliged to employ nearly 200 men.

Before taking up the forging of hammers, I want to explain some of the common methods made use of by blacksmiths for the dressing up or facing of the old hammers.

Frequently blacksmiths find that their hammers have become rough and broken on the corners so that they cannot do good work, or so much of it in a day. Every man who considers himself a good blacksmith should be capable of dressing his hammers, so I give below what I consider should be sufficient directions for this work.

First, open the middle of the fire and fill it up with charcoal, using the mineral coal only for backing. Heat only the piece you wish to dress, as by so doing you will not change the shape of the hammer or disturb the eye.

Next, upset on the face and draw down on the sides. Should the face be broken very badly, it will be necessary to trim off a little, but by upsetting and drawing down several times, you can usually get a large break out without very much trimming. After the forging is completed, it is a good plan to put the hammer in the dust of the forge and let it anneal. It then can be trued off with a file, and then ground off perfectly smooth. To temper it, heat only the part you wish to harden to a good red. Next, dip and hold under water until cold. Then have a thick ring, such as an old ax collar of sufficient size that the face of the hammer will go through while the sides come in contact with the ring. Heat the ring red hot and place it over the hammer, turning the ring slowly, so as to keep the heat even on all sides at once. Do not draw until it shows a red color, trying the edge with a fine sharp file. When you can make the file take hold, we consider that it has been drawn enough.

There are, of course, many grades of steel and many different temperatures of heat and water, so that you cannot always rely on the colors.

The centre of the face should be left just as hard as you can keep it, and if you let the heat from the eye part run down and draw the face, it will be much too soft and will probably settle, leaving the outside circle the highest. Should the tool be tempered first, do all the forging and finishing before the final tempering is done.

Then, after you have tempered the largest face, wind a wet cloth around it and keep it cool while you are heating the other face. I believe that round sides with the outside edge rounded somewhat, stand up better than with the square or octagonal form.

The next article will take up in detail the forging of various kinds of hammers. I give below a set of questions and answers concerning steel and the hardening and tempering of it, which I believe will be of much value to my readers at this time.

STEEL AND STEEL-WORKING

What is steel and how produced? *Ans.*—Steel hardens and anneals better than other metals. It is made by adding carbon to wrought iron.

What are the different kinds of steel? *Ans.*—Blistered, shear and cast.

How are these produced? *Ans.*—Blistered steel results from a process of cementation; shear steel is blistered steel hammered, and cast steel is blistered steel melted and then forged or rolled.

What is the practical difference between cast iron, wrought iron, and steel? *Ans.*—Cast iron may be hardened by sudden chilling, but this cannot prevent cracking in thin springs or tools.

What is the usual test of a sufficient

degree of hardness? *Ans.*—Trying with a file.

What are the principal requisites of hardening? *Ans.*—That the cooling medium should reach all parts at once and suddenly.

What fuel is best for hardening? *Ans.*—Coke or charcoal, as they contain no sulphur.

Why should forge scales be removed? *Ans.*—That the water or other cooling stuff should touch all the surface at the same time.

Why should the proper heat for hardening be carefully ascertained? *Ans.*—Too little heat will not produce hardness and too much will form scales and prevent uniform cooling.

What is the risk attending hardening? *Ans.*—Cracking the metal by sudden contraction. The cracks would come at the angles or where the work becomes thinner.

What heat should be used? *Ans.*—Low red heat can sometimes be used, but even lower should be tried first.

Why should edges of cutting tools be left thick? *Ans.*—Because if they are overheated or burned it injures the edge. Better to grind them thin afterwards.

What materials are used for annealing? *Ans.*—Any bad conductor of heat, the most usual way being to cover with ashes. To make steel very soft it is covered with powdered charcoal, heated to a red heat and allowed to cool in the furnace.

What is the difference in effect of the annealing process with iron and steel? *Ans.*—Heating and dipping in water scarcely affects iron. Cast iron when annealed becomes malleable.

What are the means of finding the proper temper? *Ans.*—It is usually ascertained by the color of the steel. Pale yellow for cutting tools. Darker yellow for cold chisels and wood cutting tools. Brownish purple for stone cutting tools. Bluish purple for saws and springs. Dark purple for springs and saws that bend. The first color is obtained at 430° and the last at 630°.

How is tempering performed? *Ans.*—As only moderate heat is needed, it is sometimes obtained by (for instance) hardening a chisel, rubbing it on stone till it is polished enough to show the color and dipping in water when the right color comes. Thinner articles are covered with oil and heated a short distance from the cutting point and then hardened and tempered at one time.

What fuel should be used for tempering? *Ans.*—Coke or charcoal.

What materials are used for tempering? *Ans.*—Water for extreme hardness and oil or grease when elasticity is needed. Work is less apt to crack when oil is used, as it cools more slowly.

What is the use of a muffle? *Ans.*—It is best to protect small articles from the fire by putting them in an iron pipe.

How should the heat be applied and why? *Ans.*—Slowly, both for hardening and tempering, to prevent surface being heated first.

What is case hardening and how performed? *Ans.*—Case hardening coats iron with steel to make it take a polish. The iron is raised to cherry heat and rubbed in yellow prussiate of potash and then plunged in water. Sometimes it is enclosed in a close box with coarsely powdered bone, heated and plunged in water.

Is it of any value for cutting tools? *Ans.*—The effect is only on the surface which would be removed by grinding.

What is galvanizing? *Ans.*—The iron is covered with a coating of zinc to prevent rust. Unless well done, the zinc is easily removed.

What is its effect on the working of metals? *Ans.*—Effect varies on different irons. Usually it is difficult to afterwards be softened. Steel can be softened by annealing. Chilling does not affect wrought iron.

What is the chemical difference between wrought iron, steel, and cast iron? *Ans.*—Wrought iron has no carbon. Iron becomes steel when it has ½ of 1% of carbon. When it has 1% or over, it is at its best for hardness and strength. When it has more it is difficult to weld, and when it reaches 2% it is cast iron and cannot be drawn out by the hammer without breaking.

What quality makes steel so useful? *Ans.*—It hardens when suddenly cooled, can be softened by annealing and tempered to any degree of hardness between the two extremes.

Are other metals affected in the same manner? *Ans.*—Some resemble it, but steel excels them all.

What care is necessary in working steel? *Ans.*—It will not bear as much heat as iron and is harder to forge; but it will bear hard work under the hammer. Should be worked at lowest heat possible.

How may the working heat be found? *Ans.*—By finding the lowest degree at which it will harden and keeping below that.

Should frequent re-heating be avoided? *Ans.*—Yes. Fewest heatings possible is by all means the best, and heating without hammering injures it. Each re-heating causes a loss of carbon.

What is the effect of overheating steel? *Ans.*—It loses strength, gets a coarse grain and possibly melts.

Can it be restored after heating? *Ans.*—If only surface is affected, careful heating and hammering may restore; but if grain is coarse and earthy, it is useless.

What is the difference between rolled and tilted steel? *Ans.*—Rolled steel has not been hammered first as tilted steel has.

Which is the best for tools? *Ans.*—Tilted steel, in square, hexagonal or octagonal bars. Rolled steel is round and used for bolts and pins.

What is hammer hardening? *Ans.*—Hammering at a low temperature.

What is its effect? *Ans.*—Closing the pores of the metal and making it harder and denser; and changing the grain.

Can it be carried too far? *Ans.*—Tool steels are improved, but so called "mild steels" are injured.

What is the difference between fire and hammer hardening? *Ans.*—Hammer hardening makes it smaller and less crystalline. Fire hardening the reverse.

Why are they not equally useful? *Ans.*—Hammer hardened steel is less elastic, but hammering will restore elasticity lost in grinding to thin work like springs.

What is the operation of hardening? *Ans.*—Cooling suddenly when at proper heat.

What is the operation of annealing? *Ans.*—Heating metal and letting it cool slowly.

What is the operation of tempering? *Ans.*—Stopping the annealing at the right point to make it proper degree of hardness.

What is the effect of each process? *Ans.*—Hardening makes steel hard and brittle as glass. Annealing softens it, and tempering leaves it hard enough to use, but elastic.

What difference in the effect of annealing and hardening on different metals? *Ans.*—Steel is hardened by heating and dipping in cold water. Some metals (as brass) soften under this treatment.

What materials are required for hardening? *Ans.*—Water at 40° is most usual, but placing between a cold hammer and anvil will do. Mercury, salt water, acids, and oil are used.

What is the difference of effect of these? *Ans.*—Salt water and acids produce rust unless lime water is used afterwards. Oily mixtures get a good weld.

What is Bessemer steel and how produced? *Ans.*—Pig iron, free from sulphur and phosphorus, is melted in a cupola furnace, run into a converter where air blows into it and dissipates the carbon, and the right amount of carbon is then added. The blast is renewed to mix it properly and it is then run into moulds; then heated and hammered to drive out the air.

For what is it used? *Ans.*—Rails, tires of wheels, common cutlery, and sometimes for roofs, bridges and boiler plates.

What is Siemens-Martins steel and how produced? *Ans.*—Scrap iron and steel are added to pig iron at high temperature. Right amount of carbon added and then run into moulds.

For what is it used? *Ans.*—Ship building, boiler plates, forgings for machinery, bridges and engineering work.

What is mild steel? *Ans.*—It is called homogeneous metal. Can be welded but not tempered. Stronger than hard wrought iron, often used instead.

Can steel be welded? *Ans.*—The hardest steels cannot be welded, as when raised to welding heat they break under the hammer. Mild steel welds. Flux, usually borax, is required.

What is a general rule concerning the character of steels? *Ans.*—Those

Concluded on page 255

FLYING MACHINE RECORDS

The following table, compiled by the Boston *Transcript*, gives a complete list of aeroplane distance records:

Date	Aeroplanist	Place	Time h. m. s.	Dist. Meters.
Oct. 14, 1897	Ader	Satory	....	300.0
Dec. 17, 1903	O. Wright	Dayton	0.00.59	260.0
				Kilom.
Dec. 17, 1904	O. Wright	Dayton	....	4.5
Sept. 26, 1905	O. Wright	Dayton	0.18.09	17.9
Sept. 29, 1905	O. Wright	Dayton	0.19.55	19.5
Oct. 3, 1905	O. Wright	Dayton	0.25.05	24.5
Oct. 4, 1905	O. Wright	Dayton	0.33.17	33.4
Oct. 5, 1905	O. Wright	Dayton	0.38.03	38.9
Sept. 14, 1906	S. Dumont	Paris	0.00.08	....
				Metres
Oct. 24, 1906	S. Dumont	Paris	0.00.08	50.0
Nov. 13, 1906	S. Dumont	Paris	0.00.08	60.0
Nov. 13, 1906	S. Dumont	Paris	0.00.08	82.6
Nov. 13, 1906	S. Dumont	Paris	0.00.21 1–5	220.0
Oct. 15, 1907	H. Farman	Issy	0.00.21	285.0
Oct. 26, 1907	H. Farman	Issy	0.00.27	363.0
Oct. 26, 1907	H. Farman	Issy	0.00.31 3–5	403.0
Oct. 26, 1907	H. Farman	Issy	0.00.52 3–5	771.0
Nov. 9, 1907	H. Farman	Issy	0.01.14	....
Jan. 11, 1908	H. Farman	Issy	0.01.45	....
				Kilom.
Jan. 13, 1908	H. Farman	Issy	0.01.28	1.5
Mar. 21, 1908	H. Farman	Issy	0.03.31	2.0
Apr. 10, 1908	Delagrange	Issy	....	2.5
Apr. 11, 1908	Delagrange	Issy	0.06.30	3.9
May 27, 1908	Delagrange	Rome	0.15.25	9.0
May 30, 1908	Delagrange	Rome	0.15.26 4–5	12.7
June 22, 1908	Delagrange	Milan	0.16.30	17.0
July 6, 1908	H. Farman	Issy	0.20.19 3–5	19.7
Sept. 6, 1908	Delagrange	Issy	0.29.53 4–5	24.7
Sept. 9, 1908	O. Wright	Fort Myer	0.57.31	....
Sept. 9, 1908	O. Wright	Fort Myer	1.03.15	....
Sept. 10, 1908	O. Wright	Fort Myer	1.05.52	....
Sept. 11, 1908	O. Wright	Fort Myer	1.10.50	....
Sept. 12, 1908	O. Wright	Fort Myer	1.15.20	....
Sept. 21, 1908	W. Wright	Auvours	1.31.25 4–5	66.6
Dec. 18, 1908	W. Wright	Auvours	1.54.53 2–5	99.8
Dec. 31, 1908	W. Wright	Auvours	2.20.23 1–5	124.7
Aug. 7, 1909	Sommer	Chalons	2.27.15	....
Aug. 25, 1909	Paulhan	Betheny	2.43.24 4–5	133.6
Aug. 26, 1909	Latham	Betheny	2.17.21 2–5	154.6
Aug. 27, 1909	Farman	Betheny	3.04.56 2–5	180.0
Nov. 3, 1909	Farman	Mourmelon	4.06.25	232.0

THE DEHYDRATION AND TESTING OF TRANSFORMER OILS

PROF. WILLIAM R. BOWKER

In the utilization of oils, in which transformer coils are immersed for electrical purposes, one of the chief and imperatively essential conditions to be fulfilled by the oil is that it should successfully withstand high voltage pressures. This condition can only be attained when the oil is practically entirely free from occluded moisture.

Up to very recent times the oils used for transformer work have not possessed consistent insulating properties with the practical result (on its action when high voltage secondaries of transformers were connected in circuit) that many serious and expensive breakdowns have occurred. This defect in insulating properties is principally due to the presence of moisture in the oil (mechanically occluded); a very small percentage of which (*i.e.* moisture) reduces its insulating properties many percent. This uncertainty of the action of transformer oils led to many tedious experiments, the object of which is to dehydrate or practically eliminate all the moisture; and a very successful and entirely reliable method for the treatment of such oils is here described. This treatment consists in passing the oil through alternate layers of unslaked lime and absolutely dry sand of suitable size and relatively disposed to each other so as to act efficiently.

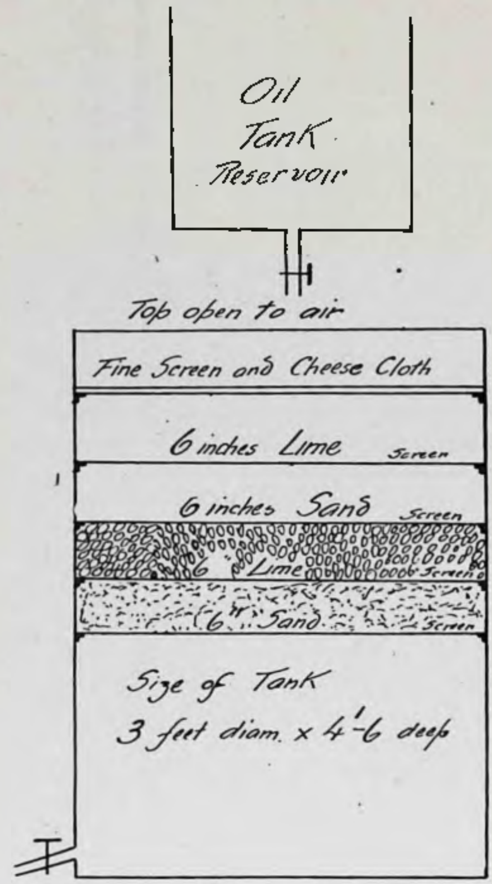


Fig 1.

A "treatment tank" made of metal (galvanized iron will do) of dimensions of approximately 3 ft. diameter and 4 to 5 ft. deep is fitted with metal sieves, or screens, on which rests the lime and sand. (This is simply illustrated in Fig. 1.)

The top of the tank being wholly open to the air, the oil first passes through a very fine metal screen which supports a layer of cheesecloth; this entraps or prevents the passing through of mechanically suspended particles and dirt. After gradually passing through this top screen, it comes into intimate contact with quick acting unslaked lime, and afterwards dry sand of appropriate consistency or size, after which it again passes through a second (and possibly a third) alternate layer of each.

The lime acts by chemically combining with the occluded moisture contained by the oil, and the dry sand prevents any of the lime passing along with the oil, and both the lime and sand act as clarifiers.

The lower half of the tank acts as a reservoir for the dehydrated oil; the oil previous to treatment being stored in and supplied from an oil tank placed directly above.

The size of the pieces of lime and particles of sand are important; for the treatment is more or less efficiently done, according to such details.

No powder is allowed in the lime

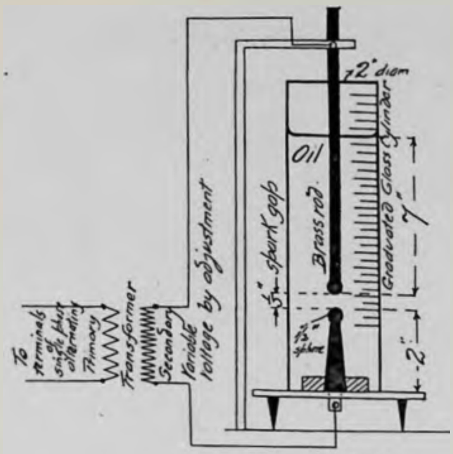


Fig 2

and it is thoroughly picked over, and only pieces used about the size of walnuts or cube sugar. As before stated, the quality of lime must be very quick acting as regards its slaking action. The sand is handled several times; first being screened through a fine mesh sieve, so as to eliminate all fine sand and finally screened through one of about a $\frac{1}{16}$ in. mesh; the particles of sand leaving it of approximately uniform size and about the consistency of coarse oatmeal. So as to eliminate any moisture that may be in the sand, it is thoroughly soaked and washed in gasolene, and afterwards dried in a heated oven, just previous to use in the oil treatment.

The rate of flow of the oil whilst undergoing treatment is important; for if the oil passes too rapidly, the whole of the moisture is not eliminated, owing to it not being in contact with the lime for a sufficient period of time; and if it passes too slowly, it becomes sticky. The proper size of the sand particles in combination with the depth of 6 in. act as a regulator to attain the proper rate of flow. With this size tank, approximately 100 gallons of oil are treated in 10 hours.

After treatment (and before it is put into practical every day use in the transformer coil chambers), the oil has to be subjected to a high voltage breakdown test, to see if it fulfills the essential requirement of high insulating properties; and for this purpose the simple and effective apparatus shown in Fig. 2 is used, a description of which is as follows: A graduated glass cylinder about 2 in. in diameter and 12 in. long is rigidly supported on an insulating stand. Fixed at the bottom of the cylinder is a cone-shaped brass terminal rod, about 2 in. long; and placed directly above it, and in the same straight line is a solid brass cylindrical rod, which can easily be lifted and removed from the inside of the cylinder. Both the top (removable) rod and the lower fixed rod terminate in brass spheres of ½ in. diameter; and when the oil is under voltage test are always separated at a constant distance apart;—in this apparatus, ⅕ or $\frac{2}{10}$ in. These two brass rods act as terminals, and are connected one to each terminal of the secondary circuit of a high voltage transformer, which transformer is so constructed that the secondary (breakdown) voltage is adjustable. The primary circuit of the transformer is connected to a single phase alternating current supply.

To conduct a voltage breakdown test, the oil chamber (*i.e.*, the graduated cylinder) is cleaned and freed from all traces of moisture, and the oil poured in to a depth of about 7 in. above the "spark gap" between the two brass rods, and the top rod is lowered into the oil, until it is at a distance of

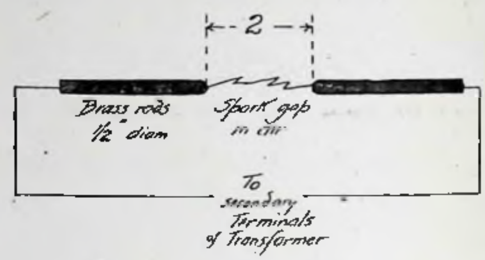


Fig 3

⅕ in. from the lower one. The circuitis now completed, and the voltage regulated, until a breakdown of insulation is noticed, which occurs when small bubbles of gas and oil pass from one terminal to the other, and at the same time a cracking noise is heard, and the oil appears to vaporize as cloudy or smoky bubbles. The point at which rupture of insulation occurs is noted by a voltmeter. The results of several tests which actually occurred in practice are as follows. Test of a mineral seal oil after treatment, and collected in barrels:

Oil from No. 1 barrel broke down at 48,000 volts.

Oil from No. 3 barrel broke down at 55,000 volts.

Oil from No. 4 barrel broke down at 55,000 volts.

Oil from No. 5 barrel broke down at 63,000 volts.

The oil from a No. 2 barrel broke down at 30,000 volts, and had to be retreated.

This same mineral seal oil before treatment, as received from the manufacturers, would only withstand a breakdown test of from 15,000 to 20,000 volts; so this illustrates very clearly the advantages and results accruing from a dehydrating treatment.

The effect of moisture is so great, that if you take a treated oil, which breaks down under the high voltage of 40,000, and then simply breathe in the glass cylinder and subject to a second test, the same oil will break down under a voltage of 15,000 (all due to the presence of a minute volume of moisture emitted by the breath). To realize the high insulating properties of this treated oil, a breakdown test was conducted with the spark gap in air (as shown in Fig. 3), the terminals of the same transformer being connected to two brass rods of ½ in. diameter. A voltage of 33,000 broke down the air insulation over a 2 in. spark gap, and 40,000 broke through a 2⅞ in. air gap. Yet at the same time, it required from 48,000 to 63,000 volts to break down the insulating properties of this treated oil, with a spark gap of only ⅕ in.

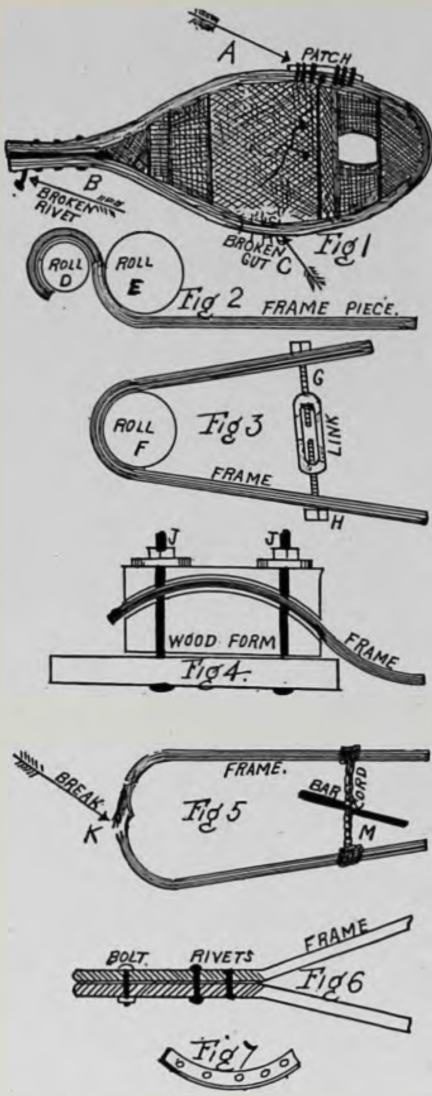
A PROFITABLE SIDE LINE FOR THE BACK SHOP

GEORGE RICE

At this season of the year, a great deal of repair and construction work is done on snowshoes for the next winter. Persons using snowshoes usually turn them in to the nearest boot and shoe repair shop for overhauling, previous to storing away for the summer season, or just before using them again the next winter. Sometimes both spring and fall remodelling and resetting of the snow shoes is done. Repair work on the modern snowshoe is profitable. For this reason, many of the boot and shoe repair shops cater for this trade, just as they cater nowadays for repair work on roller skates, etc. Fig. 1 is a drawing of the way in which the snowshoes are frequently turned in to the repair man. The frames are often broken off short or splintered and ready to break. The novice usually endeavors to make a temporary repair. Sometimes he secures a strip of hard wood along the fracture as at *a*. The repairman is obliged to remove this patch and set the frame to rights by fitting a strip of sheet metal securely to the fractured portion with rivets. Or the part may be recessed and a section of hard wood applied in the recess. Then with glue and wire nails or rivets, the joint is secured. Or the trouble with the frame may be in loose rivets as at *b*, at the heel. These may be restored by using new rivets. Or as some do, employ small bolts which may be turned down tight. Or screws may be substituted. At *c*, in same sketching is shown a portion of broken gut. Shoe strings, cords and ribbons may be found in use for patching the gut netting.

Belt lacing leather is often employed. The repairman must remove all these combinations and proceed in the proper way to interlace and save the network if possible. Slight breaks may be repaired readily. Bad breaks may make it necessary to remove the entire section of the stringing, in which case it is a costly piece of work, as it takes time to properly string a snowshoe.

There are times when the wood framework must be bent in making repairs, or in the manufacture of a frame complete. You need a steamer first, and this can be constructed in the form of a closet of ample size to receive the timber needed for making snow shoe frames. This chamber should be tight. The steam pipes lead into it from the source of steam supply. The front



part is arranged for opening, so that the work can be placed within and the same subjected to steaming, until the wood fibre is soft. Then the wood can be bent over forms as shown in the next drawings. In Fig. 2, the frame is bent over, rolled and placed under pressure. The pressure is simple, as it involves only the use of common wood clamps by which the wood is held in the correct position against the roll during the drying out process. The rolls are hard wood, marked *d*, *e*. In Fig. 3, the roll is marked *f*, and the link and threaded bolts, *g* and *h*, are used for holding the bent form as shown. A solid wood bending form is shown in Fig. 4, consisting of the blocks held down on the frame by bolts and nuts, as exhibited. In bending without a form, you often get the result shown in Fig. 5.

Selected second growth split ash is used for most of the frames, and this material can be bent in the proper way on forms. But when you try the scheme shown in Fig. 5, and draw the ends of the frame with a cord and bar as at *m*, the chances are that the frame will splinter at *k*. You will find that snow shoes will be brought to the shop with the heel pieces adjusted with screws, bolts and rivets as shown in Fig. 6, and in making repairs you need these articles in stock. Occasionally a frame will come in with wire binding instead of rivetted ends, and then fine copper or brass wire may be used for making the parts secure if they are weakened.

For general patching purposes, the little metal plates of the pattern in Fig. 7 may be kept in stock, in readiness to screw to the side of a frame at any juncture desired. Of course there is much odd work to be done in the snow-shoe line. Sometimes you are requested to make sled-like shoes as in Fig. 8. It is difficult to get the wood properly seasoned for this work. The ends of the shoe are liable to split as at the toe at *p*. The wood warps and swells freely, unless it is thoroughly dried out before using, and try your best, you have trouble in getting such wood. They will tell you it is kiln dried. But when you make the stock up and put it out, in course of time the purchaser comes back with the shoe sprung out of shape, often with an artistic turn. Sometimes the wood will of itself split, as at *r*, and you must do some patching with cleats on top as at *s*. You can assist the split proper to close with staples driven and clinched over the same.

The shoe in Fig. 10 was made to order to suit the fancy of a certain patron. Ash stock was used and made up like a little ladder with the rungs adjusted in quite the usual way. These rungs were then strung with the catgut. On top of all was placed a felt pad for the rest for the sole of the shoe. The user was able to go sledding along in good form on these shoes, but he was the only one that could. You have to

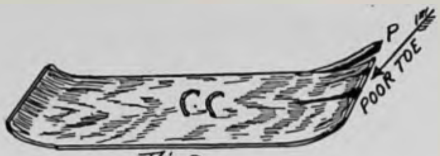


Fig 8.

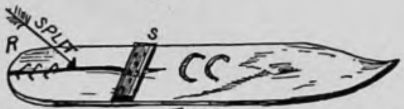


Fig 9

Fig 10.

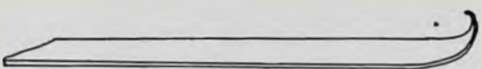


Fig 11

Fig 12

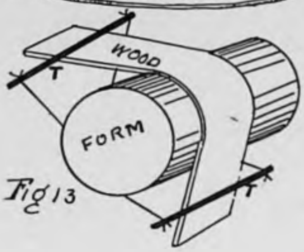


Fig 13

be in shape to turn out ungainly snow shoes of varied patterns.

One man desired two long, slender shoes of the character exhibited in Fig. 11. The maker had to devote an hour or more to the selection of the stock to use. Then considerable time was consumed in working the stock down to the right proportions. Hence the expense ran high, and the customer objected. You have to get used to these objections. The average user of snow shoes is aware that when he wants a specialty, that he must pay additional money for it. There are not many cranks.

The shoe in Fig. 11 was fitted with the toe and ankle straps in the customary way, and proved to be a speedy shoe for the user.

Some people want the leather shoe made to the snowshoe frame as in Fig. 12. Ladies frequently require work of this character. Usually the shoe of the patron is obtained, and this shoe is secured by means of loops to the catgut of the snow shoe. The heel, of course, is left free, so that the user can rise on the instep at each movement. A specially elastic shoe is made for this service. As the shoe is kept for this work, the sole and heel are not liable to be worn unevenly, and therefore the adjustment is perfect as it should be. This avoids many of the annoyances which follow when you jump upon the snowshoes with your everyday shoes on your feet

From the handy snow shoe, the step is short to the tobogganing sled. Hence, in Fig. 13, we exhibit a form for bending larger pieces of wood. The board is steamed, and when soft is gradually drawn about the wood cylinder by means of the metal cross bars, *t*, and the cords. The cords are taken up slowly and the board is drawn closer in, until the desired curve is obtained for the shaping of the nose of the sled.

Forging for Amateurs

Concluded from page 249

having most carbon are hard, strong, brittle and easily melted. Those having less are tougher, more easily worked and more elastic.

What is the difficulty of welding iron to steel? *Ans.*—Steel melts at the heat iron needs for welding, so great care is needed. A flux is necessary.

What are the tests of steel? *Ans.*—It differs from iron by being harder to forge; gives a clear ringing sound when struck and retains magnetism.

What is a chemical test? *Ans.*—Diluted nitric acid will blacken steel but does not affect iron.

What is the appearance of the fracture? *Ans.*—It is bright gray in color and very straight granulations in cast steel, without the brilliant grain of iron.

The General Electric Company sold, in the fiscal year ending Jan. 31, 1909, $44,540,676. During recent months it has been making sales at the rate of $52,000,000 per annum.

HOW TO MAKE A GLIDING MACHINE

A. RUSSELL BOND

The time is surely coming, and is not far distant, when flying-machines will be almost as common as automobiles. But the schooling of the flying-machine chauffeur will have to be much more rigorous and thorough than that of the ignorant dare-devil who is the terror of the present-day pedestrian. Not only must the "sky-pilot" know all about gasoline engines and airship machinery, but he must have a sea-captain's weather experience and a balloonist's knowledge of air-currents; and, above all, before he even attempts his first sail, he must learn to be perfectly at home in the air, so that he can intuitively balance his machine just as a bicyclist balances his wheel, without stopping to give the matter a thought. Now, if a man should try to learn all this on a flying-machine, he would probably break his neck before the end of his first lesson. But there

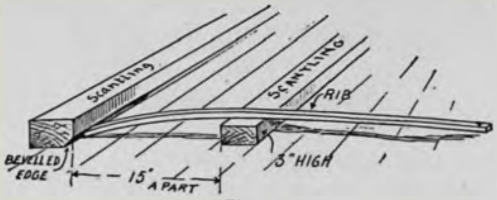


Fig. 1

is an apparatus called a gliding-machine, which can be used by beginners to teach them many things about aeronautics without imperilling their lives.

A gliding-machine is not a flying-machine; for it has no motor to raise its rider in the air, and is only intended for skimming or gliding down a gently sloping hill, never more than a few feet above the ground. It is really a very simple contrivance, something like a huge box-kite, and any boy who is handy with his tools can make one. Even though he may never care to try a flying-machine, he will be sure to have lots of fun with a glider; and if he uses ordinary horse sense, he will run no risk of injury.

The best material for making the frame of a gliding-machine is spruce wood. The sticks necessary for the frame are given in the following list, and they can be procured from any sawmill. Four main bars, 15½ ft. long, ⅝ in. thick, and 1¼ in. wide.

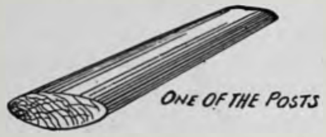


Fig. 2

Two rudder bars, 4 ft. long, ⅝ in. thick and 1¼ in. wide. Four heavy posts, 3 ft. long, ¾ in. thick, and 1½ in. wide. Eight light posts, 3 ft. long, ½ in. thick, and 1⅛ in. wide. Thirty-nine ribs, 45 in. long, ¼ in. thick, ½ in. wide. Four rudder framesticks, 12 ft. long, ½ in. thick, ½ in. wide.

The main difficulty in constructing the gliding-machine will be found in bending the ribs to the proper curve, as shown in the illustrations. It will be best to leave this to the experienced hands of a carpenter or a cabinet-maker, who will bend them for a small charge. However, if the enterprising boy insists upon doing the work himself, he may secure fairly good results by carefully following the instructions here given. Before the sticks can be bent, they must be soaked in a tubful of boiling hot water for an hour or two. In order to get a uniform curve in all the sticks, nail a 3-in.-sq. scantling on the barn floor and secure another scantling parallel to it and 15 in. away from it, as shown in Fig. 1. The latter scantling should be cut away, or beveled, at the inner, lower edge. Now hook each rib under this beveled edge, bend the sticks over the 3 in. scantling, and nail the outer end to the floor. The ribs should be left in this position until they are thoroughly dry, when they will be found to have the desired set.

Before fastening the frame members together, first round off the upper edges of the main bars, as shown at *a* in Fig. 3. Now place these bars on the floor 30 in. apart, with the flat sides uppermost and, beginning at the ends, glue the ribs to them. The ribs should be laid on with the curve turning upward, and at each end should project about 6 in. beyond the bars. They should be spaced a foot apart, except at the

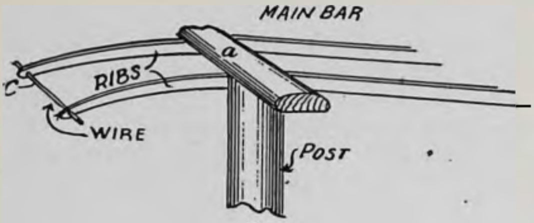
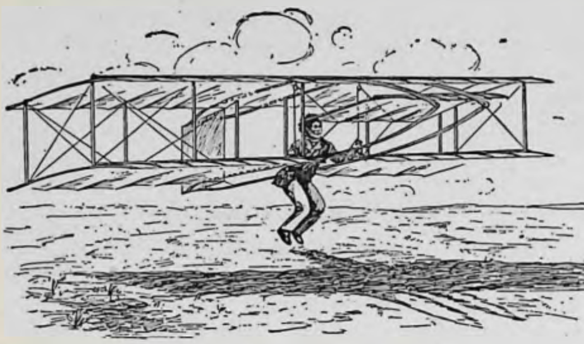


Fig. 3

centre, where they are 9 in. apart in the upper frame, while in the lower frame a space of 18 in. is left for the rider. In order to get the ribs evenly spaced, the bars should be marked off beforehand. In addition to gluing them, the ribs may be held in place with brads. When all the ribs have


The Gliding Machine in Operation

been fastened on, brace them with diagonal guy lines, *b* (Fig. 6). These guy lines should be No. 16 steel piano wire, and, in order to make them perfectly tight, wooden wedges should be driven between the wire and the frame. The forward or curved ends of the ribs should be connected by a wire, *c* (Fig. 3) running the full length of the machine.

This will complete the two-sail frames, and they should now be covered with

done, they are connected by the posts (Fig. 4), the heavier posts being placed at the centre, 18 in. apart, while two of the lighter posts are placed at each end, and two under the fourth rib from each end. In this position, they are firmly glued and nailed, after which the two sail frames are securely guyed in all directions by means of piano wire,

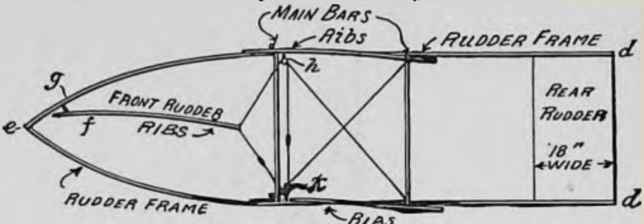


Fig. 5

which is tightened in the manner just described. The posts, before being nailed in place, should be rounded to the form shown in Fig. 2.

The next part of the frame to be built is the support for the front and rear rudders. The 12 ft. sticks are threaded through the sails at each side of the centre posts, passing under the front main bars, and over the rear main bars, to which they are glued, as shown in Fig. 5. The sticks should project about 4½ ft. beyond the sail frames in front. At the rear, the two upper sticks are bent and fastened together, and then the two lower sticks are fastened together, *d* (Figs. 5 and 6), while at the forward end, each of the upper sticks is bent down and fastened to a lower stick, *e* (Figs. 5 and 7). The rear rudder is merely a strip of percaline stretched between the upper and lower members of the rudder frame, as shown in Figs. 5 and 6. This rudder cannot be moved. In fact, the young aeronaut

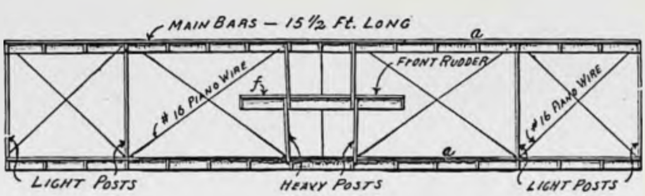


Fig. 4

cloth. The best cloth for the purpose is light percaline, which should be smoothly glued to the ribs on the concave or under side of the frames. About twenty yards of the cloth will be required. When the two sail frames are

will find his hands more than full tending to the front rudder. The front rudder is built up of five curved ribs which are attached to the two short bars, *f* (Fig. 6). This rudder is hinged to its frame by means of a pair of screw-

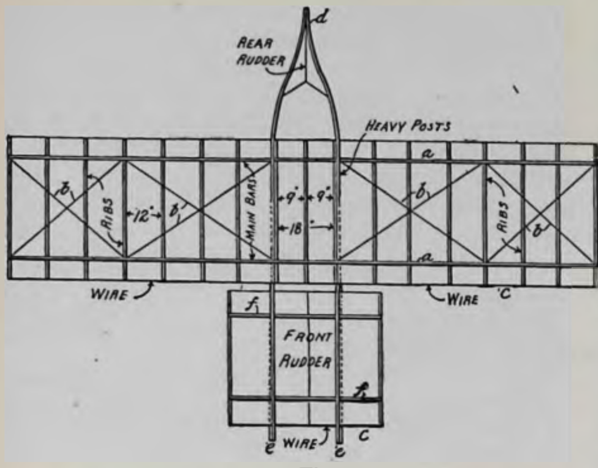


Fig. 6

eyes which are threaded into the rudder frame and the inner ribs of the rudder, g (Fig. 7). The screw eyes on the rudder are pried open, linked through the screw-eyes on the frame, after which they are hammered shut. The inner end of the front rudder is connected to two cords which are passed over pulleys, *h* (Fig. 5) at the top of the machine, down under pulleys, *k*, at the bottom of the machine, and back to the rudder.

In use, the young aeronaut slips his shoulder through the opening in the centre of the lower sail frame and rests his arms over the two centre ribs, grasping the rudder cords. Then he runs along the ground until the machine begins to lift him off his feet. The machine will probably show a tendency

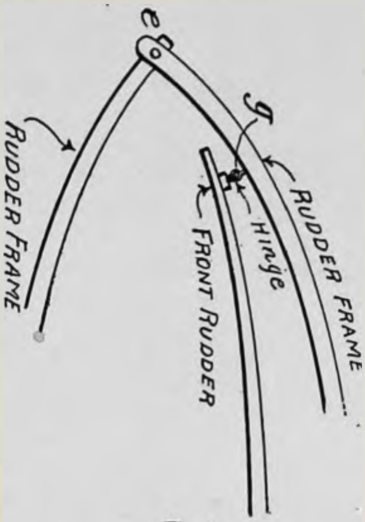


Fig. 7

to tip up at its forward end, so that if he is not careful, he may be thrown over backwards. To overcome this, the front rudder is raised. If the machine tries to duck down, the rudder should be lowered. It will take quite a little practice to acquire an exact balance, so that the machine will glide at a uniform height above the ground.

One thing that must be borne distinctly in mind. This machine is not a parachute, and it will surely wreck the fool-hardy youngster who attempts to fly with it off the roof of a barn, or any other high place. At first, it will not be wise even to run down hill with the machine; but lots of fun can be had by running along the level ground. After a great deal of experience has been acquired, it will be safe to try very gentle slopes, but never try jumping off any great height.

For Etching Tools

Take 4 ounces bluestone, 2 ounces salt and ½ pint rain water; let it stand about 12 hours or longer, as the mixture becomes stronger with age.

Cover the parts you wish to protect from its influence with paraffin, soap, or some other similar substance. Take a sharp-pointed instrument and scratch your name or design upon this; then put on the acid. After the tool has been exposed to this liquid for a few minutes, the acid is poured off and the tool washed with clean water and thoroughly dried.—*American Carpenter and Builder.*

The recent declaration of Prime Minister Asquith that in the future the British government will accept the two-power standard of naval strength as implying a preponderance by ten per cent. over the two next strongest navies, has aroused no little interest in naval circles. If the "two next strongest navies" is intended to include that of the United States, which stands second in power to the British navy, the government is committed to a very large increase over its normal rate of construction, involving an additional outlay of from $25,000,000 to $30,000,000 annually.

A PORTABLE WIRELESS OUTFIT

SAMUEL F. KERR

A portable wireless telegraph outfit comes in very handy, quite frequently. The uses to which such an outfit could be applied by the amateur are numerous. Supposing he has made or invented a detector, and wishing to see if it is sensitive enough to receive a certain distance from his transmitter, he takes it to the point in question, puts up his temporary aerial if there is no other amateur's handy, and proceeds with his experiments.

'Again, supposing that his antenna is not suitable for long distance receiving, and he wishes to see if his instruments are sensitive enough for that kind of work, all he has to do is to take his portable along with him to some other amateur's station, where the antenna is high enough, connect the antenna to one binding post, the ground to another, and then proceed to tune.

However, the use to which the portable outfit described below, was put, was quite different from the above, and very novel. An ambitious signal corps of a boys' brigade saw an exhibit of the U.S. Signal Corps, where a field wireless outfit was displayed. Being well equipped with heliographic and other signalling devices, they saw no reason why they should not have a field wireless outfit also.

It may interest amateurs for the same or different reason, and a description is given below.

The requirements were that each outfit (transmitting and receiving) should be placed in a box, the dimensions of which should be about the same or not much larger than those of an ordinary suitcase. The size of each box was 24 in. long, 8 in. deep, and 12 in. wide. The box opened in half, so that each half has a depth of 4 in. The different instruments must be placed in such a position that the box will shut without the instruments in the top and bottom sections touching each other.

The complete outfits are shown in Fig. 1. In the receiving outfit, T.C. is the tuning coil; Po., the potentiometer; E.D., electrolytic detector; S.D., silicon detector; P., push button; B., buzzer; C., condenser; and G., ground.

The ground consists of a piece of gas pipe about 2 ft. long, which is driven into the ground. A binding post is placed near the top for connection.

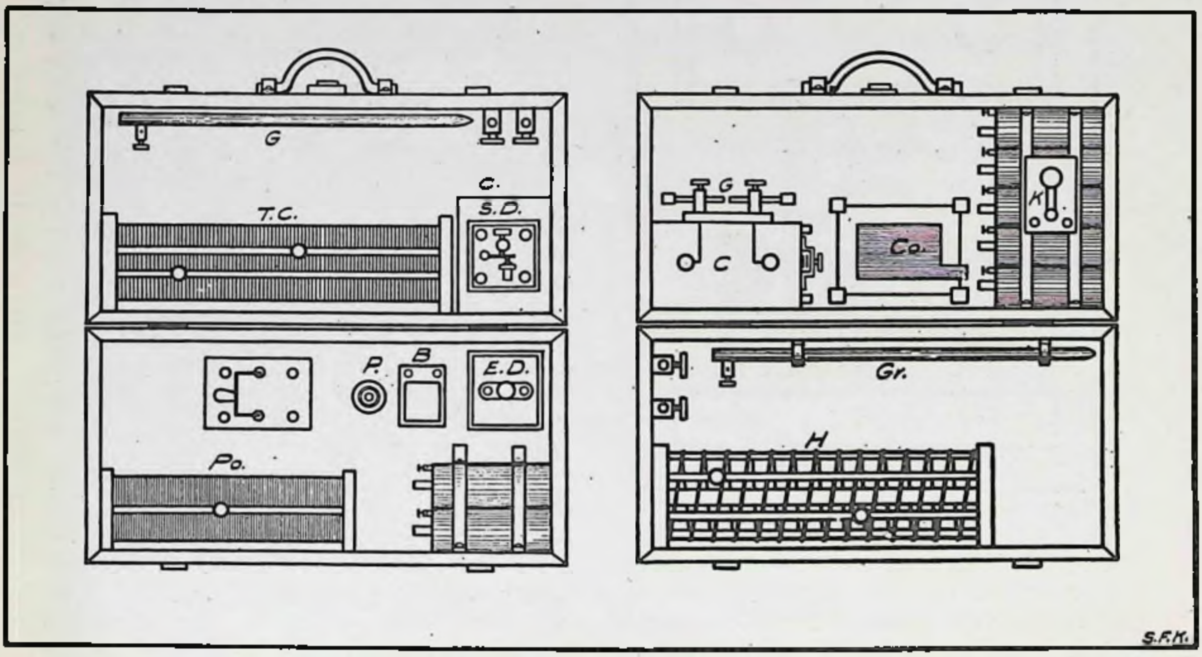


FIG. 1.

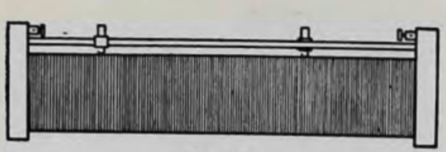


Fig. 2.

The push button and buzzer are for testing the detectors.

As the diameter of the tuning coil could not be very large, the coil was made long to get enough wire on it. It is shown in Fig. 2. The drum was 3 in. in diameter and 18 in. long, and was wound with No. 20 cotton-covered wire. It was provided with binding posts on the ends for connections and was of the double slide type.

The silicon detector is shown in Fig. 3. It consists of a piece of springy brass strip mounted on a brass pillar. The springy piece has a screw in one end

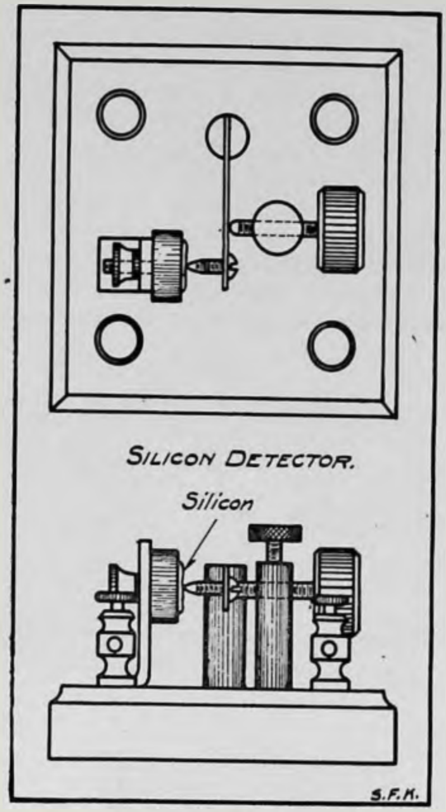


Fig. 3.

tapered off to a blunt point. The point rests on the silicon button. The cup in which the silicon is placed is mounted on a brass strip which has a slot cut in it. On the back of the cup is an 8–32 screw which passes through this slot and is held fast to the brass strip by a thumb nut taken from a dry battery. By loosening the thumb nut,

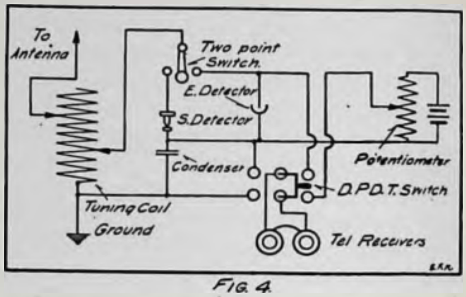


Fig. 4.

the cup can be slid up and down so that the point may bear on any part of the surface, as some parts of the silicon are more sensitive than others. The movement of the springy strip is regulated by a hard rubber thumb screw.

With the silicon detector no potentiometer was used, but one was made for use with the electrolytic detector. It is made somewhat like the tuning coil. It is 14 in. long and 2½ in. in diameter, and wound with No. 30 German silver wire, cotton-covered. If bare wire is used, it will, of course, have to be spaced. Only one slider is necessary.

The method of connecting the receiving outfit for the two detectors is shown in Fig. 4. By throwing the two point switch and the D.P.D.T. switch to the left, the silicon detector may be used. By throwing both switches to the right, the silicon detector is thrown out of the circuit, and the electrolytic is cut in, also the potentiometer and batteries. The same fixed condenser is used for both detectors. Instead of using both switches as shown, a three-pole switch may be used, the extra pole taking the place of the two point switch. In this way, the detectors may be thrown out or in by one switch.

In the transmitting outfit, Fig. 1, C is the induction coil; G, spark gap; Co., plate glass condenser; K, key; H, helix; and Gr., ground. The coil used was a 1½ in. spark for which five batteries were sufficient, the batteries being fastened down to the box by metal bands.

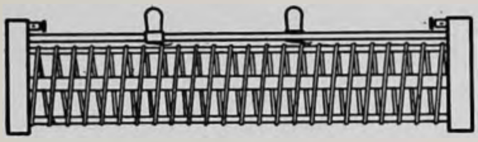


Fig. 5.

The size of the drum on which the helix is wound is the same as the receiving tuning coil. The wire used is No. 10 copper, each turn being spaced ¾ in. apart. Two contacts are provided. The helix is shown in Fig. 5.

The plate glass condenser consists of six 5 in. x 7 in. plates, on which pieces of tin foil, 3 in. x 5 in. are pasted. Each sheet of tin foil has a tongue projecting out for connection. The alternate sheets are all connected together. The condenser is shown in Fig. 6. The plates are ½ in. apart. The condenser may be made variable by using two 6-point switches; in this way one plate may be cut in at a time. This size of condenser is not necessary for a 1½ in. coil, but it was made this large for the reason that a larger coil was sometimes substituted. When the smaller coil was used, just a few of the plates were used; but when the larger one was used, all the plates were cut in.

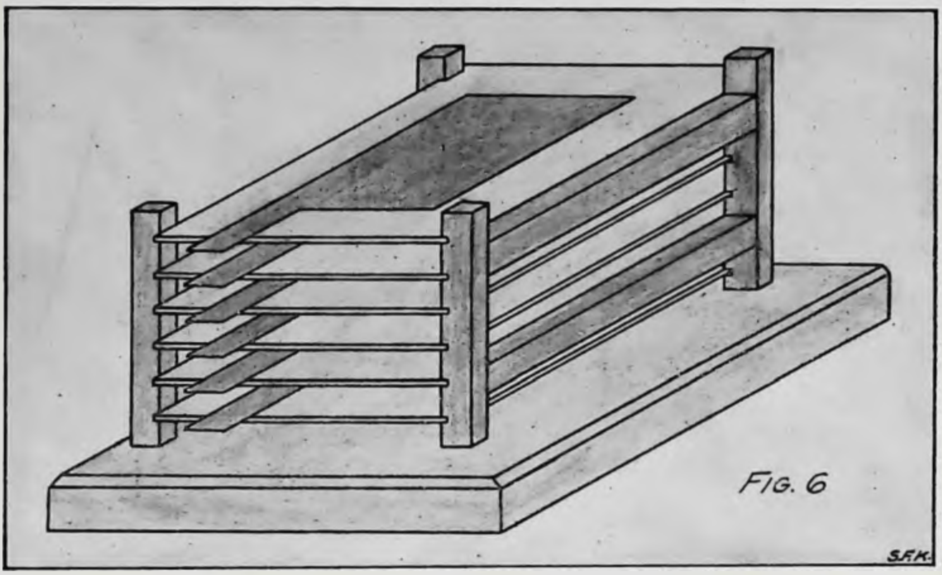


Fig. 6

The diagram of connections is shown in Fig. 7.

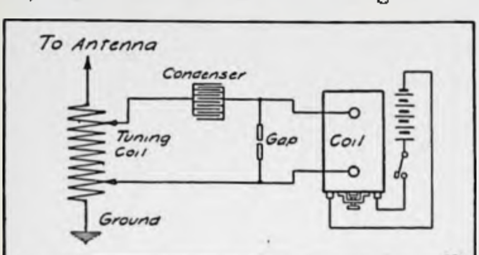


Fig 7

The mast for suspending the antenna was made of seven sections. Each section was 6 ft. long and 2½ in. thick. The method of putting the sections together is shown in Fig. 8. Each section was made half round at the ends, the length of the half round part being 1 ft. On one end a cylinder of sheet iron is fastened by screws. The half round end of another section is fitted into the cylinder and should make a tight fit.

Fig. 8.

The method of erecting the mast is very simple, and it can easily be done by three or four persons. The sections are put together on the ground. The guys are then fastened to the mast, three at the top and three at the middle. Sash cord is about the best thing to use for the guys, and it is a great deal easier to handle than wire.

A small hole is dug at the foot of the mast, its purpose being to serve as a butt for the mast when being raised. One person goes to the top end of the mast, while two others take hold of two of the lower guys. The person at the top end then raises the mast above his head and starts walking to the foot of the mast, lifting the top end higher and higher as he goes, the same way one would do when raising a heavy ladder against a wall. Meanwhile, the two persons holding the guys are pulling them in, standing in such a position that the pull tends to bring the mast to an upright position, and also taking the strain off the other person.

When the mast is nearly in an upright position, a fourth person takes hold of the remaining lower guy, standing in such a position that his guy counteracts the pull of the other two, so that when the mast is vertical, there will be an equal pull on the three guys, thus preventing it from toppling over. The guys are then fastened to their stays. After the bottom guys are fastened, the top guys may then be fastened to the same stays. In the outfit in question, snap hooks were provided so that any slack in the guys could easily be eliminated.

The antenna first used was the inverted L type, but later it was changed to the umbrella type, which was a great deal more efficient. The latter type is somewhat more elaborate than the inverted L type, and takes longer to

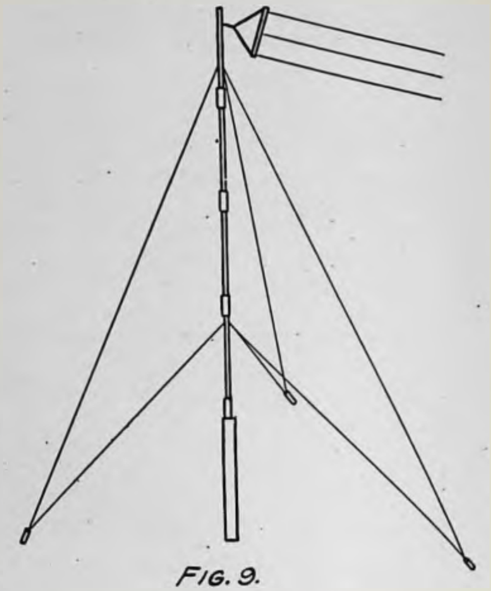


FIG. 9.

erect, but where there is plenty of time to put up the antenna, the results justify the change.

When the inverted L type is used, such as is shown in Fig. 9, a pulley will, of course, have to be used at the top so that when the mast is erected, the antenna can easily be hoisted to its position.

THE SIMPLE ORIGIN OF GREAT DISCOVERIES

Important results are often reached under what appear to be most unfavorable conditions, just as men of humble origin, with apparently everything against them, often accomplish things of which those more highly favored are incapable. Some of the most important discoveries in science have had humble beginnings; indeed, it is probably true that most important discoveries have depended very little upon elaborate and expensive apparatus and surroundings.

A few illustrations taken from the history of chemistry and physics will show that great men have achieved great results with simple appliances. The English chemist, Dalton, was a schoolteacher. He worked without a laboratory and with crude apparatus mostly made by himself from simple materials. Here is an example described in his own words:

"Took an ale glass of a conical figure, 2½ in. in diameter and 3 in. deep; filled it with water that had been standing in the room, and consequently of the temperature of the air, nearly; put the bulb of the thermometer to the bottom of the glass, the scale being out of the water. Then, having marked the temperature, I put the red-hot tip of the poker ½ in. deep in the water, holding it there steadily for half a minute; and as soon as it was withdrawn, I dipped the bulb of a sensible thermometer into the water, when it rose in a few seconds to 180°."

He then determined the temperature of the water at the bottom after five minutes, after 20 minutes and after an hour, and found that it rose gradually from 47 to 52°. This simple experiment proved that water has the power to conduct heat, which had been denied by no less an authority than Rumford.

In much of his work, Dalton used only a few vials and tubes with perforated corks, and frequently, instead of glass tubes, he used clay tobacco pipes with long stems. Such pipes, known as "churchwarden pipes," have been used by later workers, as notably in the remarkable work of Sir William Ramsay on argon. As a grand result of his investigations on gases and liquids, Dalton gave the world the atomic theory, which has probably had a greater influence on the science of chemistry than any other theory that has been put forward.

This is not the place to discuss the atomic theory in detail. It will suffice to point out that it is a simple thought that helps chemists at every turn. It gave them a language that is intelligible, and suggested many important inquiries which in turn led to important experimental work. One biographer says: "Dalton's results stand out the greatest landmarks in our science (chemistry) . . . . . To him is due the glory of placing the science on a firmer basis."

Scheele was perhaps the greatest discoverer of facts the world has ever known. He was a Swede who lived during the latter half of the eighteenth century. Throughout his life he had to contend with sickness and poverty. He was obliged to carry on the business of an apothecary on a small scale in order to keep the wolf from entering the house—he never succeeded in keeping it from the door. His great delight was to investigate things chemically and to find out all he could about them. It was simply astounding to learn how many discoveries of the highest importance he made. The most important one was oxygen—a discovery that was made at the same time independently by the English clergyman, Priestly.

Oxygen was the most important single discovery ever made in the field of chemistry. It is the most widely distributed and most abundant substance in nature. It is necessary for the breathing of animals, and for most of the chemical changes that are taking place upon the earth. A knowledge of oxygen and of the ways in which it acts has done more than anything else to give chemists an insight into chemistry, and therefore has contributed more than anything else to the development of this science. Operations that had before appeared mysterious, suddenly became clear, and everyone engaged in chemical work was helped in many ways.

The moral of this story is found in the fact that this great discovery was made under the most unfavorable conditions, in a small apothecary shop, by a man in poor health, who could provide himself with only the simplest apparatus.

But this is only one of many important discoveries made by Scheele. Another that may be mentioned here is that of chlorine. This discovery ranks with the most important and the most valuable of chemical discoveries. That of oxygen outranks it certainly, but it falls in line not far behind. While Scheele himself had not thought of any practical uses to which chlorine could be put, it proved eventually to be of the highest practical value, and today it plays an exceedingly important part in practical affairs. It is the great bleacher, and as such is used in enormous quantities, especially for bleaching straw, paper and different kinds of cloth. Then, too, it is one of the best disinfectants, and is contributing to our welfare by interfering with the spread of disease. Further, it is essential to the manufacture of chloroform, which is of such inestimable value as an alleviator of pain. And it is now used extensively for the purpose of extracting gold from its ores.

Berzelius was another Swedish chemist who achieved great results with simple things. Early in the last century, while Dalton was working, and not long after the death of Scheele, he was engaged in important investigations, the results of which advanced chemistry greatly. We have an interesting description of his laboratory in a letter written by Wohler, one of the greatest German chemists, who went to Berzelius in 1823 to study chemistry.

"With a beating heart," he says, "I stood before Berzelius's door and rang the bell. It was opened by a vigorous and portly man. This was Berzelius himself. As he led me into his laboratory I was as in a dream, doubting if I could really be in the classical place which was the object of my aspirations. . . . I was then the only one in the laboratory. . . . The laboratory consisted of two ordinary rooms, furnished in the simplest possible way. There were no furnaces or draft places, neither gas nor water supply. In one of the rooms were two common deal tables. At one of these Berzelius worked, the other was intended for me. On the walls were a few cupboards for reagents; in the middle was a mercury trough, whilst the glass-blower's lamp stood on the hearth. In addition, there was a sink with an earthenware cistern and tap standing over a wooden tub, where the despotic Anna, the cook, had daily to clean apparatus. . . . In the adjacent kitchen, in which Anna prepared the meals, was a small and seldom-used furnace and a never-cool sandbath." This was the laboratory in which one of the greatest chemists did his magnificent work. Nothing could have been simpler. The work could not have been better.

Liebig became the leading chemist of the world, and yet he worked under as unfavorable conditions as Berzelius. When he began the study of chemistry, there was not a laboratory in Germany. He tried to get the instruction he wanted, but had to go to France to get it, as Wohler, also a German, had to go to Sweden. Liebig tells us that when a boy he saw a man at a country fair make an explosive substance for crackers. He soon learned how to make this substance, and one of his first investigations was due to the suggestions that came to him at the fair. In fact, some of his most important work came from this humble beginning. When he returned to Germany from France, at the age of twenty-one, he was appointed professor of chemistry in the little University of Giessen. There was no laboratory. There was none in Germany, as has been said. He proceeded at once to fit one up with inadequate means, and therefore the simplest apparatus.

Liebig's most important work was done at Giessen. As time passed on, he got a better laboratory, and finally he was called to Munich, where everything possible was done for him by the king. He now had a fine laboratory, a fine, almost palatial, residence, unlimited funds—in short, ideal conditions, and what followed? Why, from that time to the end of his life—a period of twenty-one years—his contributions to chemistry amounted to very little. His best work had been done under the unfavorable conditions.

In a recent address, Lord Rayleigh, the distinguished English physicist, said he thought "it just possible that nowadays scientific work was made too easy, or, at all events, too mechanical, for the full advantage of it to be reaped, and that the scientific spirit and method were, perhaps, better cultivated by the less perfect appliances of the past." He stated that many of the great experimenters had "worked with exceedingly homely apparatus." Among those named by him in this connection was Clerk Maxwell, who had always got along with simple things, and yet was one of the greatest physicists of the last century. Another great experimenter who achieved much with little was Hughes, "the father of many electrical inventions."

Lord Rayleigh called upon Hughes one night, and found him working at the microphone, which he had invented. He says: "Hughes had no apparatus at all. A few match boxes, a stick or two of sealing wax, some nails and a single cell of a battery made up in a bedroom tumbler constituted the material of his invention."

The late Professor Rowland, of the Johns Hopkins University, had to a remarkable degree the power of making what he wanted out of what he found at hand. Some of the important pieces of apparatus with which he either carried out or started his investigations, were apparently thrown together in the most haphazard way, yet the essential constituents were there. His early work was done without a well-equipped laboratory—some of it in a kitchen, and a poor kitchen at that. Like other great experimenters, he could help himself.

When Dalton began his simple experiments on gases and liquids, he had not a thought that he was laying anew the foundations of chemistry. His great thoughts came to him as his work went on. Scheele had no idea that his experiments would lead to the discovery of oxygen and chlorine. He did what his hands found to do and he had the power to appreciate his results and to interpret them, although he never could have realized the importance of his fundamental discoveries. Even now, we do not realize their full importance. A good illustration of the way in which a simple observation may lead to important results is this:

In the early part of the last century, at a ball given at the Tuileries in Paris, the guests were much annoyed by something irritating in the air. The source of the trouble was found to be the wax candles. The matter was referred to the principal chemist of the day, who in turn entrusted it to his son-in-law, who happened to be Dumas, then quite a young man. Dumas found the explanation. The wax used in making the candles had been bleached by chlorine. But the chlorine had not only bleached the wax, it had found its way into the wax, and when the candles burned, it was given off in the form of a compound that was irritating to eyes and throat. This led Dumas to study more thoroughly the effect of chlorine on wax, and results followed that practically revolutionized the views of chemists and contributed very largely to the advancement of chemistry.—*The Keystone.*

MISSION SEWING STAND

RALPH F. WINDOES

Few articles of mission furniture compare in beauty and usefulness with the sewing stand herein illustrated. With the top down it serves very acceptably as a tabouret, and with the top up it is a delight to any feminine eye. For them it changes the labor involved in sewing, to pleasure, as every article has a place in the stand and it is very easy to keep every thing in its place.

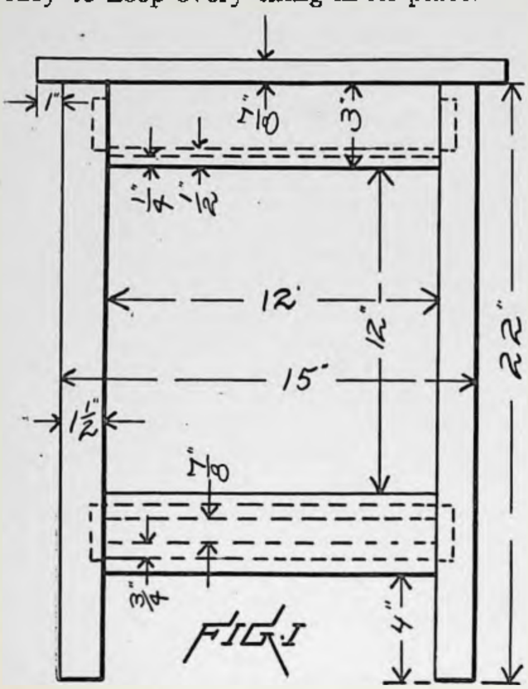


FIG. I

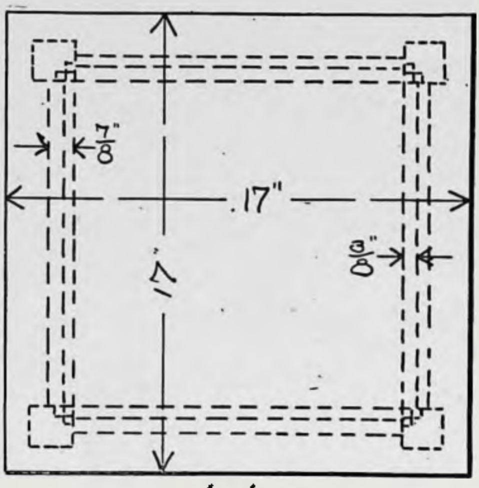


FIG. 2

It should be made of quarter-sawed, white oak, a stock list of which follows:

4 pieces 22 in. x 1½ in. x 1½ in.
8 pieces 13 in. x ⅞ in. x 3 in.
4 pieces 13 in. x ⅜ in. x 12 in.
1 piece 17 in. x ⅞ in. x 17 in.
6 pieces 1¾ in. x ¼ in. x 12 in.
4 pieces 3 in. x ¼ in. x 12 in.
2 pieces 12 in. x ¼ in. x ¼ in.
2 pieces 12 in. x ¾ in. x ¾ in.
1 piece 12 in. x 12 in. x ⅞ in.

In Fig. 1 is given an elevation of a

side, in Fig. 2 a plan, in both of which the tray is removed, and in Fig. 3 is shown a detail of the tray. In all the figures no brass fittings are shown, as these have little to do with the construction and would only serve to com-

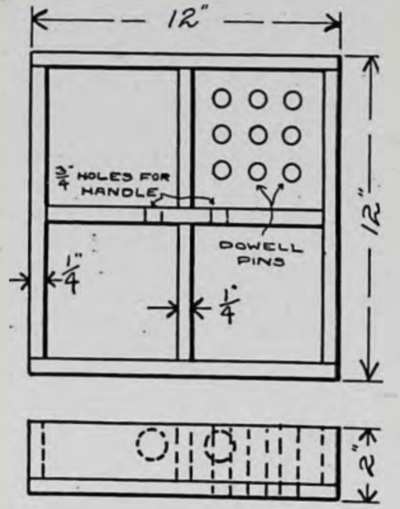
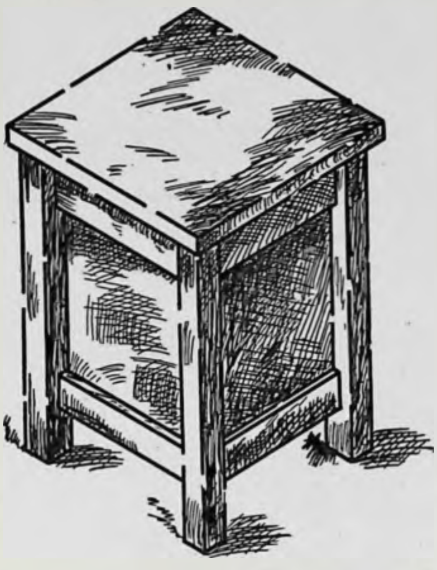


FIG. 3

plicate the drawings. These fittings consist in a pair of hinges, two drawer pulls and a piece of light chain. The pulls, which are used as handles to carry the stand, and the hinges are



screwed into place, while the chain can be fastened with large headed tacks. It is used on the inside of the cover to prevent its swinging back too far and loosening the hinges. On the inside of the cover, a piece of leather is fastened in such a way as to provide pockets for three pairs of scissors. In the tray dowell pins are used to keep the spools in place as shown in Fig. 3.

The stand should be finished on the outside with a coat of mission stain and two coats of prepared wax, but on the inside with nothing but two or three coats of shellac.

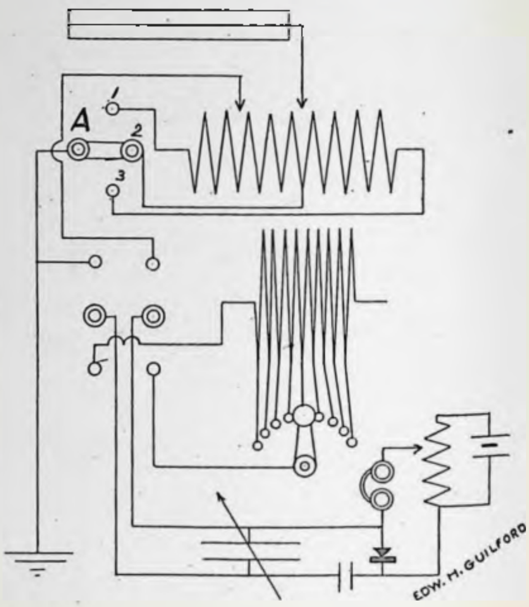
When the tray is removed, the bottom part of the stand is used as a scrap basket or a storage for patterns.

IMPROVEMENT IN THE WIRING OF THE "DOUGHNUT TUNER"

EDW. H. GUILFORD

By the addition of the three-point switch, A (see drawing), more efficient tuning may be had. When receiving from stations having a short wavelength, the switch should be on point 2. This will bring the few turns of inductance in use immediately around the secondary or "doughnut," and thus prevent any loose-coupled effect, which would happen were the end of the primary used instead of the middle.

This switch is not necessary when the primary is used as a tuning coil alone.



A 1,000 MILE DETECTOR

BY EDMUND BURKE MOORE
President Wireless Society of the Massachusetts Institute of Technology

One of the greatest difficulties that the amateur meets in constructing an efficient wireless telegraph outfit is a detector. To a beginner, it is rather a hard task to know just what type to adopt. Even then his limited experience is usually such that the proper care and attention is not given to its fine adjustment and protection. The wireless operator will find the 1,000 mile detector here described unusually efficient, and as mechanically perfect as constant use and experimenting would develop.

In this "pericon" detector, so called, zincite, chemically known as zinc oxide (ZnO) and bornite are used for the two crystals, and in contact with one another present a remarkable power of rectifying electrical oscillations. The zincite has a very reddish appearance and when scaled along its natural faults shows a slight metallic luster. Considerable care should be used in selecting a satisfactory crystal. This cannot always be accomplished in the first trials. A few pieces should be tested and the one taken that has the greatest number of active spots producing the maximum rectifying effect. Experience has shown that the most sensitive pieces, upon analysis, contain ZnO, 92%; MnO, 5.0%; and FeO, 2.5%. These quantities are not definite, and a variance may possibly be found either way.

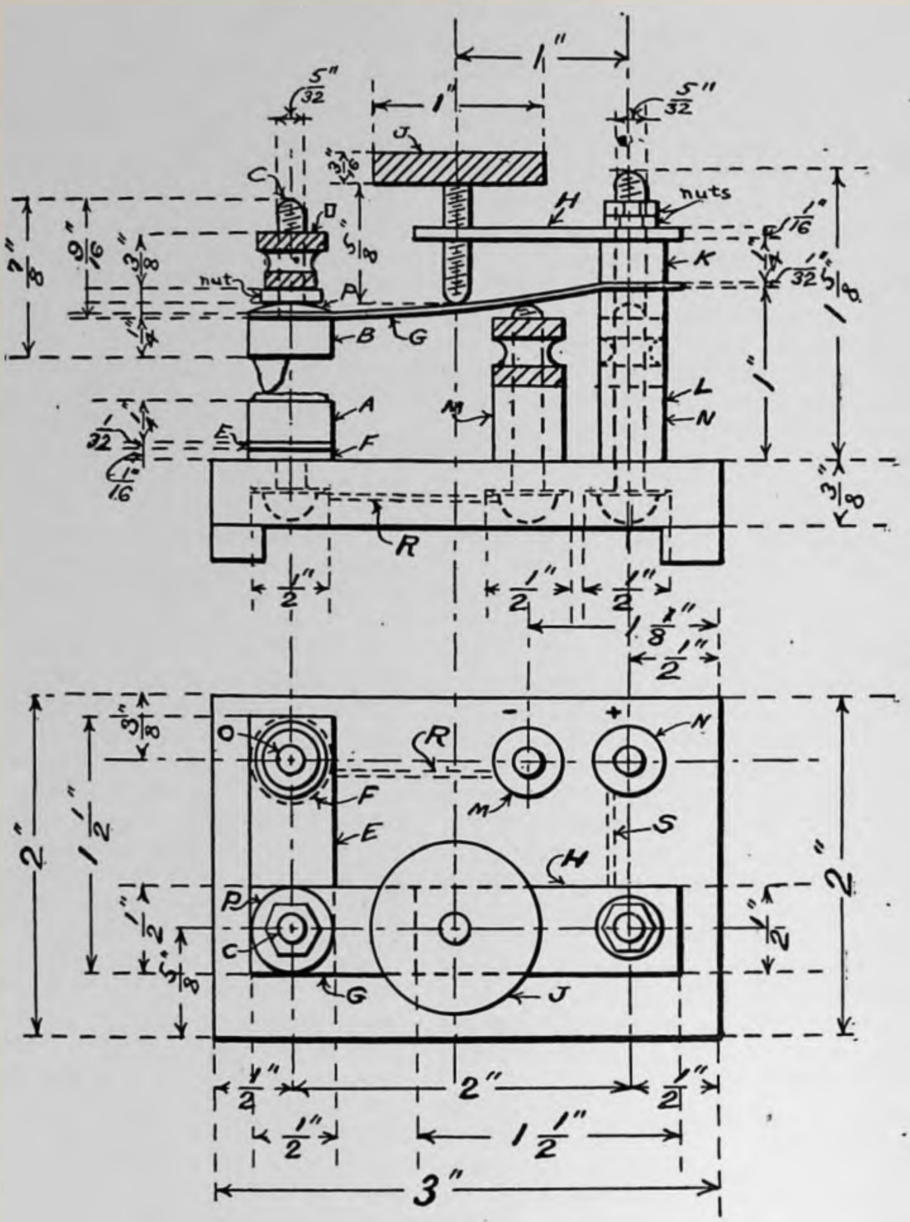
The zincite crystal should be handled with great care. The fingers should not come in contact with the active surface, as the volume of tone in the telephones is lessened by so doing. The surface should not be scratched or cleaned in any way. When in use the bornite must come in contact with only the natural split surface of the zincite.

The bornite is a dark purple mineral and when brought into a strong light shows a greenish crystalline appearance over its entire surface. Different pieces will produce slightly different results, and here again great care should be taken in the final choice of piece. It is a delicate mineral and should be handled accordingly. The surface of the bornite can be cleaned without destroying its efficiency.

The accompanying working drawings being very complete and self explanatory, little need be said about the actual assemblage and construction of the mechanical parts of the detector. The two crystals are mounted on two brass cups, A and B, the crystals being set in Wood's metal (bismuth, 1 part; lead, 2 parts; and tin and cadmiun, 1 part each). The zincite in the lower cup, A, should present a flat surface and be allowed to project about 1/16 in. The bornite is placed in cup B, and projects downward 3/16 in. with rather a blunt point against the zincite. The bornite should be set off the centre of cup B, so by turning the cup a greater area of the zincite can be gone over when testing for sensitive spots.

The two cups, A and B, are screwed upon two spring brass arms, G and E, as shown in the lower figure. The lower arm is pivoted at F, and considerable lateral movement is possible. The washer, F, raises the brass arm, E, above the base of the detector, and gives a slight tension to the spring arm. The cup, B, is held to the arm, G, by two set-nuts at the top. The concave washer, P, allows the top to be rotated when experimenting, and at the same time is held perfectly rigid. The tension of the bornite upon the zincite is obtained by the adjusting screw, J, which is mounted upon the 1/16 in. brass arm, H, securely bolted to the brass stud, K. This stud is made up of two brass collars, K and L, on the bolt, passing up through the base. The spring brass arm, G, is firmly held between K and L, and when the nuts are tightly screwed down at the top, an apparently solid stud is formed.

Two standard brass binding posts, M and N, are mounted upon the base in the position shown in the drawing. Connections are made by wires, R and S, to the crystals, the zincite being connected to the binding post, M, and the bornite to the post, N. It is also exceedingly important that strips of felt be glued under each end of the base



to protect the detector from jar and other outside disturbances.

The adjustment of this detector is so fine that the slightest vibration will disturb a perfectly balanced circuit and render signals less distinct. Patience should be exercised in setting this instrument into the receiving circuit and in its proper adjustment. The bornite or post, N, is connected to the positive (carbon) pole of the battery, and post, M, to the negative (zinc) pole. About 1/20 of a volt should be allowed to pass through the crystals; regulation being obtained by a variable potentiometer bridged across the battery circuit. One side of the telephone receiver is connected to the movable contact of the potentiometer, and the other terminal of the phones to the opposite side of the detector. After all the necessary connections have been made, the crystals should be spotted; that is, the most sensitive spot found for electrical rectification. The slider of the potentiometer should be moved so to prevent all buzzing or humming sounds in the telephones. If the buzz continues, too great a current is being used on the batteries. A little experience in the regulation of the current and the spotting of the detector will enable the operator to readily bring his detector up to the maximum efficiency.

One of the valuable points of this detector is that the battery is not necessary in order to get audible sounds from powerful stations within a radius of 100 miles, providing the aerial is of the proper height and length. However, for weak stations and those at great distances, the battery circuit should by all means be used. The increase in the volume of the sound in the phones will be distinctly noticeable. It may be found necessary to re-spot the detector from the effects of a near and powerful station. It is sometimes convenient to shunt a resistance across the crystals so as to protect them from the larger stations. The coil can be cut out for long distance work.

This 1,000 mile "pericon" detector is a very sensitive instrument and the operator should not get the idea that one can adjust the detector and balance the receiving circuits in a few trials. It sometimes takes weeks before obtaining a satisfactory adjustment of the receiving circuits. So carefully can these be balanced that by touching the bare finger to any of the metallic parts of the apparatus, the equilibrium of the system will be upset. A large number of these detectors are in use daily by members of the Wireless Society of the Massachusetts Institute of Technology, and have taken the place of numerous other common types. Receiving messages 800 to 900 miles under adverse conditions is regular work for this style of instrument, when the other parts of the apparatus are brought up to the same high degree of efficiency. A distance of 1,400 miles is a record for this detector under normal conditions in the winter season. With care and patience in the use and operation of this rectifier, remarkable results can be expected.

THE LIQUEFYING OF HELIUM

Few more telling examples of the modern physicist's dogged patience can be found than Onnes's feat in liquefying helium. The achievement is noteworthy, says the *Scientific American*, not because any new light was shed on the physics of gases, but because of the painstaking methods employed. Dr. Onnes started at six in the morning. For 7¾ hours he labored to get 20 liters of hydrogen before the real experiment could begin. Between 70 and 100 liters of liquid air were necessary for the cooling of the helium gas. Liquid air boils at 60° centigrade absolute; hydrogen at 23° centigrade. The difficulty was to lower the helium down this heat precipice. Under the intense cold, the pressure of the helium fell from 100 atmospheres to 40, and still there was no trace of the formation of a liquid; but as the last lot of liquid hydrogen was introduced, the temperature fell to 5° absolute, and then with difficulty Dr. Onnes was able to discern the layer separating liquid from gas. It stood out with the sharpness and precision of the edge of a knife—about 60 cubic centimeters of liquid, which the physicist kept under observation for about two hours. He exhausted it with a pressure of between 2.3 centimeters and 7 millimeters of measure; but no solid was formed, and the liquid remained mobile, with a density of 0.15, the ratio of its volume to the volume of the gas being as 1 to 11. At the temperature achieved in this experiment, hydrogen would become as solid as granite. There is great need for further investigation. As Sir James Dewar remarked before the British Association, it is fitting that the final resolution of the last recalcitrant gas should be the work of a Dutch scientist, for it was on the work of Van Dir Waals that the methods for the liquefaction of gases were largely based.

Four thousand incandescent lights at the recent Omaha electrical show were controlled from a wireless telegraph station at Fort Omaha, five miles distant. The lights were turned on and off at the will of the inventor of the system, Dr. Frederick Millener.

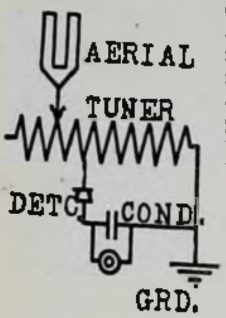
QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent 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.

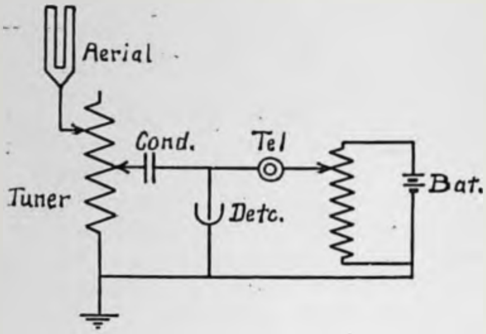
If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will in every case be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1198. **Wireless Telegraphy.** J. S., Lynn, Mass., asks: (1) Will you please give me diagram for connecting antenna 4 No. 14 aluminum wires, 50 ft. high running vertically to a window 20 ft. above ground, double slide tuning coil, silicon detector, fixed condenser, 1 - 1,000 phone? (2) To what part of the silicon detector are connections made, and how does the improved detector differ from the ordinary? (3) How much of No. 20 bare copper wire would be needed for a 1,000 metre tuning coil? Ans.—(1) Attached sketch gives best diagram to use with your instruments. (2) To binding posts connecting to point and base of crystal. The Improved silicon detector is made from especially sensitive silicon and is about 500% more sensitive than the ordinary crystal detector. (3) Since 1 ft. = .3048 meters, about 3,280 ft. is required. This would be about 10 lbs. of No. 20 bare wire.



1199. **Wireless Telegraphy.** W. H. M., Fall River, Mass., asks: (1) I have quite recently completed my wireless receiving station, but I must say that the results thus far are entirely unsatisfactory. I am using a bare point electrolytic detector, a 500 ohm non-inductive potentiometer, a double-slide 400 meter tuning coil and fixed condenser and two 75 ohm S.P. receivers. My aerial is 50 ft. long, 50 ft. high at highest point and 18 ft. high at lowest point. It is made of two wires, No. 18 bare copper, 15 in. apart. I use the gas pipe for a ground. Please advise me as to the trouble, as I cannot hear a ½ k.w. set only 5 miles away. (2) My aerial extends from a pole on the roof to a post in the yard, a distance of 50 ft., and from the post back to my room, a distance also of 50 ft. Please advise me whether my aerial is really 50 ft. or 100 ft. long. Ans.—(1) You cannot expect to get results with your low resistance receivers. You should get a pair of high resistance double-pole receivers. Your detector may also be insensitive. (2) Your aerial is about 50 ft. effective length.

1200. **Wireless Telegraphy.** H. J., Lexington, Mass., asks: (1) How far could I receive with the following outfit: Loose coupling tuning coil, a variable and fixed condenser, improved silicon, pericon and electrolytic detectors, a pair of 3,000 ohm receivers with "gold" diaphragms, a potentiometer and three dry cells with an aerial, consisting of two strands 60 ft. long and from 40 to 45 ft. high? (2) Will you please tell me how to connect a potentiometer to the following diagram? Ans.—(1) From 500 to 1,200 miles. You should get excellent results as you have a very good outfit. (2) The potentiometer is not necessary with diagram sent. From potentiometer connect as shown on attached sketch, using silicon instead of electrolytic detector.



1201. **Wireless Telegraphy.** A. B., Chestnut Hill, Mass., asks: How far could I receive with 125 ft. antenna, 4 wires, primary and secondary tuner, 1,000 ohm receiver, pericon detector? (2) How far could I send with ¼ k.w. transformer, primary and secondary helix, condensers? Ans.—(1) Probably from 500 to 1,000 miles. (2) From 50 to 150 miles according to local conditions.

1202. **Wireless Telegraphy.** R. R. G., Hartford, Conn., asks: (1) What would be called the length of the above aerial; is it 185 ft. or is it 560 ft.? (2) What is called its length when it is used as a loop aerial, two leading in wires? Ans.—The length would be 185 ft. with loop aerial, 370 ft. with straight aerial.

1203. **Wireless Telegraphy.** H. L. B., Mayville, N.D., asks: (1) Would a 1½ k.w., 2,200 110-volt transformer be much good for wireless telegraphy and high frequency experiment? (2) How far would it transmit with a 30 ft. aerial composed of 4 aluminum wires, 15 ft. long. (North Dakota is prairie.) (3) Could I make a transformer to take 2,200 volts primary and give about 12,000 volts secondary? Ans.—(1) Yes, if you rewind the secondary to give about 20,000 volts. 2,200 volts is not a high enough potential for wireless work. (2) Not over 15 or 20 miles at greatest with aerial described. (3) Yes; but it would be safer to rewind the original transformer as suggested in (1) to rewind; use a wire size that will give ten times as many turns for a given cross section area as that at present used on the secondary.

1204. **Wireless Telegraphy.** J. R. J., Birmingham, Ala. In explaining in the Electrician and Mechanic how to renew dry batteries, you do not state how many ounces or pounds of each ingredient is required to make one cell. I wish to make a large cell and wish to have it the power of a certain number of batteries, say 10 or 12. Ans.—You cannot make a large cell that will be as practical, as the internal resistance of the battery increases so rapidly with a large diameter that the power of the battery is mostly all wasted in overcoming this resistance.

1205. **Wireless Telegraphy.** H. M. S., San Mateo, Calif., asks: (1) What would be the amount of wire needed in the secondary? What would be the output of the same in series with an interrupter on 110 v. A.C.? (2) Would a telephone condenser of 2 m.c. be all right shunted to the transmitting key of the above? (3) Would No. 16 and No. 26 E.C. wire be good sizes for a loose coupling tuning coil? Ans.—(1) and (2) This is not complete. What are you talking about? (3) Yes.

1206. **Storage Batteries.** E. L., Ft. Moultrie, S.C., asks: (1) Why are shunt wound generators instead of compound wound machines used for charging storage batteries? (2) In compound wound generators a short circuiting resistance coil is put in the shunt field; why is this? (3) What is the highest voltage at which current is generated for power at the present date? Ans.—(1) Because better regulation is obtained with a shunt wound dynamo and, what is most important, should for any reason the power be cut off of the dynamo, the current flowing from the battery would flow around the shunt field in the same directions as when charging, and would not reverse the polarity of the dynamo if shunt wound, as would happen with a series of compound wound machine. (2) (No data available.) (3) 100,000 volts.

1207. **Auto-transformer.** A. J., Salt Lake City, Utah, has made a small one, consisting of an iron core of strips of sheet iron, laid around in the form of a rectangle. Part of the strips are 5 in. long, the rest 3¾ in., and interleaved at the corners. The resulting section is 1 in. x 7/16 in. On one limb is a spool containing 220 turns of No. 16 magnet wire, with taps left out at various points for experimental purposes. When connected to the circuit, 110 volts and 60 cycles, the lights burn low, and the meter makes a rumbling noise. What is the matter? Ans.—The transformer is altogether too small to fit your conditions and it is almost a short circuit to your mains. It is a wonder that you have not burned out something. Though the overall section of the iron core is 1 in. x ⅛ in., the empty spaces reduce the actual amount of magnetic material to the dimension we have stated, and this is only about a thirteenth of what you should have, *i.e.* 6 sq. in. By doubling the number of turns, using 440 instead of 220, you can get along with an actual section of 3 sq. in. It will be well to dip the sheets in thin asphaltum varnish before assembling.

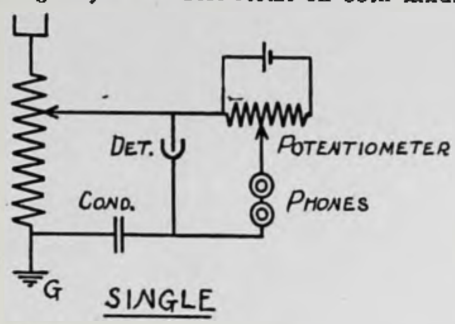
1208. **110 Volt Circuit Control.** S. P. C., Boston, Mass., asks how to cut such a voltage down so as to allow safe use of 40 to 50 volts for operating a coil? Ans.—There is a good description of a method in the July, 1908, issue of this magazine. By varying the number of lamps, their size and selection of voltage, you can secure almost any gradation of control you may desire. If your supply is with alternating current, a reactive coil with taps brought out at various points may be more economical, but the lamp method is safe and effective.

1209. **Magneto Generator.** C. H., Chico, Calif., is proposing to make a magneto generator of ancient design, and wishes to know if the proposition is good. Ans.—As we have suggested, your design imitates the constructions adopted in the very earliest machines, but now abandoned for better ones. Yours is apparently like Clarke's model of 1839, and shown in Fig. 5, page 35, of the August, 1906, magazine. The unbalanced end thrust on the shaft, the small area of the exposed ends of the armature cores, and the limitation to relatively low speeds are the chief defects of this construction. Considering the weight of the materials employed, the electrical output is very small. The only points you can find in favor of it are that no great equipment of machine tools is needed for the building, and when done the principle of operation is well illustrated. If you have the means we would certainly advise you to abandon the proposed design and substitute the Siemen's shuttle armature, and have suitably curved pole pieces attached to the poles of magnet. Have, say, three magnets, bent flatwise. Very effective ones can be made from old files. A shuttle armature 1¼ in. in diameter and 4 in. long will make a vigorous dynamo.

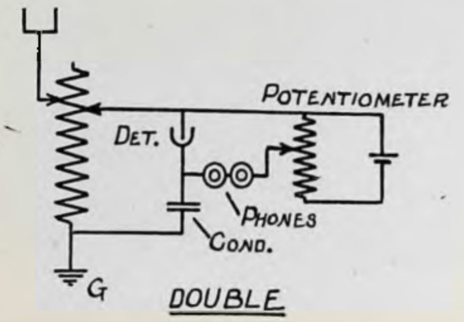
1210. **Small Induction Motor.** J. R. E., Christiansburg, Va., is making such a one, using for the motor a stack of punchings taken from a General Electric fan motor. They are 3½ in. in diameter, have twenty-nine ¼ in. round holes, and occupy 2⅛ in. space axially. He asks if it is desirable or necessary to insulate the copper rods that form the electric circuit, also if his proposed design for the stator is good? Ans.—In such small motors it is not customary to insulate the rods, but more complete direction is given to the paths of the currents if you take the precaution of somewhat insulating them, and the motor will thereby be given a little higher efficiency. For the stator you have imitated the ordinary fan motor construction, with but four poles and the "shading-coil" for introducing a self-starting principle. Both these factors militate against the highest economy of operation, for the concentrated pole winding gives a bad wave form, and the short circuited coil on corner of pole tip is equivalent to a short-circuited turn in the main winding. Perhaps this construction is the one most practicable, however, for you to adopt. We advise a few changes in the shape of the stator sheets. The pole pieces are too short, and the breadth of iron in the metal joining the poles is unnecessarily great. Keep the outside dimensions of sheet about as at present, but diminish the ¾ in. portion to ½ in., and let the gain in space go towards increased length of polar space for the winding. You will need about 150 turns of wire on each pole, using the largest wire that will fit.

1211. **Tinned Copper Wire.** G. Z., New York, N.Y., asks: Kindly inform me as to where I can get tinned copper wire, preferably a wire consisting of seven strands of No. 21 wire as described in your answer column in June, 1909, issue of Electrician and Mechanic. New York stores do not keep this wire, because I have tried in a great many electrical supply houses. Ans.—John J. Roebling's Sons Co., of Trenton, N.J., make this wire. It may also be purchased from Mr. H.E. Kirwan of West Arlington, Md.

1212. **Wireless Distances.** J. N. B., Jersey City, N.J., asks: Would you kindly let me know the following questions: (1) How far can I receive with my aerial 50 ft. high and 50 ft. long, and the following instruments; electric tuner, electrolytic detector, long distance wireless No. 1101 condenser, with 1,000 or 1,500 ohm receiver? (2) Kindly give a diagram as to how to connect the same. Ans.—(1) Your receiving distance is 100 to 200 miles, according to the tuning coil and the size of wire in your electrolytic detector. You do not say whether the tuner is single or double slide. The following diagrams will give you the best result on both kinds.



SINGLE



DOUBLE

Would advise the use of a double slide coi if you have not one now. Also for best results your antenna should be longer (100 ft. if possible).

1213. **Capacity.** W. N. C., New York, N.Y., asks: (1) In answer to W. C. B. R. Co., (Nov. issue), where is spark gap, if any, in Fig. 1? (2) In Fig. 3 of above, what is capacity of condenser (area of foil)? Ans.—(1) The spark gap should be placed between the condenser terminals and the inductance coil or helix. It does not matter on which side of the condenser it is placed. (2) A quart fruit jar covered two-thirds up with tin foil will be large enough. The capacity can then be calculated by the formula

$$C = \frac{2248 \text{ K a}}{\text{d } 10^{10}}$$

C—capacity in microfarads.
K—specific inductive capacity of dielectric.
A—area of dielectric in square inches.
D—thickness of dielectric in inches.

1214. **Wave Lengths.** R. K. F., Tacoma, Wash., asks: (1) In articles on wireless, continual reference is often made to tuning coils 600 meters wave length or 1,500, or other numbers as the case may be. The wave length given generally does not agree with either the natural wave length of the coil or its inductance in hundreds of centimeters (c. g. s. units). How is it determined? (2) On estimating the distance over which messages may be received with a given aerial what power do you assume at the sending end? Ans.—This is an erroneous manner of referring to tuning coils. A tuning coil should be rated by its inductance in centimeters or henries. See article in December, 1908, issue on the calculation of wave lengths, by W. C. Getz.

1215. **Transformers.** J. W. G., Baltimore, Md., asks: (1) In your October issue: Query No. 1151, question No. 2, how many pounds of secondary wire are needed? Query No. 1154, question No 1, what is diameter of secondary? Also in your November issue, Query No. 1178, question No. 1, how many pounds of secondary wire are needed? (2) Is this classed as an open or closed core type transformer (primary 17 x 1¼ in., 325 turns of No. 12 wire. Secondary No. 28–3,000 turns) and how many pounds of secondary wire are needed and diameter of secondary, whether secondary is made in sections, and whether primary and secondary wire is double cotton, single silk or enameled? (3) Can any of the above coils be used on 110 volts (alternating current) without a vibrator, or should a resistance be in series and how many ohms should be used? Ans.—(1) Query No. 1154, about 2 lbs. or so. Query No. 1151, with amount of wire given it could not be much over 2 in. Query No. 1178, about 12 lbs. needed. (2) Open core, secondary; inside diameter 2½ in., outside diameter 4 in; make up in $\frac{5}{16}$ in. sections of single silk covered or enameled wire. (3) Lamp bank resistance should be used for safety. No vibrator required.

TRADE NOTES

Selling Furnaces Direct

Nothing is more essential to home comfort and good health than proper heating. The problem of which system to install is not given as careful study and attention as it should have by many home builders. Too frequently the purchaser depends upon those not trained or qualified to know the *actual* necessities in the matter of the size furnace required to properly heat a given space and in the plan by which the heat is to be distributed after it is generated in the furnace. Whether the building is a five to twelve room house, a large store, church or school; a specific, definite *heating plan* should be made, based on careful study of the plans of the building from basement to garret. The heating plan should be laid out by a *heating expert*. In very rare instances does an architect, contractor or furnace dealer possess the special knowledge and experience necessary to qualify him to properly prepare the best heating plan. Of course lots of them *guess* at it and come near enough to prevent discovery by the owner of the fact that his building *is not* heated as *perfectly* or as *economically* as it could be, had the heating been planned by a *real specialist* in this particular and important work.

The remarkable success of the Hess Warming & Ventilating Co., of Chicago, who for the past seven years have sold furnaces *direct from their factory* to the customer, lies in the fact that no heating equipment is sold or shipped by them until they have had one of their own experts make a study of the plans of the building and then draw a separate and exact heating plan for each outfit ordered. This plan is followed in preparing the pipes, flues, fittings and registers and shows the exact location of every foot and inch of the outfit as it is to be located in the building.

The Hess Warming & Ventilating Co. has been manufacturing heating outfits for thirty-six years, and long ago discovered that the furnace manufacturer, with a product of real merit, must see to it that the heating outfit is properly made and installed and that the *only* satisfactory way to protect his reputation and give the customer complete satisfaction, was to sell the customer *direct* and thus become *directly* responsible for results.

To do this meant that a very broad guarantee, without any strings to it, must be made a part of the selling conditions. How unquestionably fair and broad is this company's proposition, is shown by the following statements quoted from their advertising and circular letters:

"Hess Furnaces for the past seven years have been sent to customers in every state in the union, freight prepaid, *on approval*, and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled."

"We do not ask you to believe a lot of theories. We don't ask you to send us your money before you see the goods; we won't ask you even to pay the freight charges on our heater. All we ask of you, if you need a furnace, is to investigate;—to put your name on a postal card, mail to us and ask us for our booklet on Modern Furnace Heating. This booklet, which has been issued in numbers exceeding 100,000, is an authority on furnace heating, and copies have been requested by many colleges, libraries and other educational institutions, for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It's free, on request."

"When you read what we have to say, *you* will be interested, but you need not accept our statements. Just inquire from any of the thousands of satisfied customers, whose names we will supply you, and you will get reports which *will compel belief*, and will be convinced that the *Hess Furnace* stands for success, simplicity, efficiency and economy; and that of all furnaces offered you, none can excel in the features that go to make a furnace desirable and satisfactory."

"If you want to go further into the matter with us, send us a rough sketch of your building to be heated, and we will advise you how to arrange the heating apparatus, and what a Hess Furnace, with all pipes and registers, will cost, laid down at your station. You may set up and test the furnace before the money is sent us, your own local banker to hold the money while you make the test."

"We sell to consumers, *direct from our factory*, not through middlemen, and our prices are not inflated with the usual costs for salesmen, branch stores, agents and dealer's profits. The factory profit, only, satisfies us, and you will be surprised to know how much we can save you, in cost."

"Moreover, we lend you our expert skill—the result of thirty-six years of furnace-making—in planning for the heating of your house, which means comfort to you for all time, and without which many furnaces fail. Then when all is settled, our broad guarantee, with 60 days free trial before payment, assures you a satisfactory heating-plant."

"Isn't this worth looking into? Could we offer such liberal terms if we didn't *KNOW* that the goods will please, and that we do not risk a loss in each sale? Ask us more about it. A postal card today will serve the purpose."

It is a fact that no purchaser of a furnace and heating outfit from The Hess Warming & Ventilating Co. runs any risk of loss or dissatisfaction in doing business with this company. Their reputation and financial standing in the business world insures the full performance of every promise made. If in need of a furnace write The Hess Warming & Ventilating Co., 908 Tacoma Bldg., Chicago.

* * *

The L. S. Starrett Co., Athol, Mass., has just issued a supplement to their catalogue No. 18, containing descriptions of a number of useful tools recently added to their list. If you are interested in tools, write for it, and the general catalogue, if you haven't had one.

BOOK REVIEWS

The Young Train Master. By Burton E. Stevenson. Illustrated by Henry Goss. Boston, L. C. Page and Co., 1909. Price, $1.50.

This is the third volume in a series of books for boys on railroading. In the previous volumes the hero has started as a section-hand and worked his way up to train despatcher. In this book he takes another step in the line of promotion, becomes train master, and sees his division through a strike. The book is full of the actualities of railroading, and discloses many details of railroad operation which are a sealed book to the average man. A most commendable sort of story for any live boy.

Henley's Twentieth Century Book of Recipes, Formulas and Processes, containing nearly 10,000 selected scientific, chemical, technical and household recipes, formulas and processes for use in the laboratory, the office, the workshop and in the home. Edited by Gardner D. Hiscox. 787 octavo pages. Illustrated. New York, The N. W. Henley Publishing Co., 1909. Price, $3.00.

This is a marvellous collection of recipes and formulas for every kind of operation and process which is likely to come up in daily life. It contains material for everybody from the artisan who wishes to make babbitt metal or bicycle varnish to the actress who desires to tint her lips red, or the housewife who is making cheese. The formulas, etc., have been carefully collected and edited from many reliable sources, and form a handy mass of information scarcely to be found in a hundred volumes elsewhere. There is no workman in any trade who will not find in it information for himself worth many times the price.

The Dynamo: its Growth and Construction Simply Explained. By Joseph G. Branch. The Branch Publishing Co., Chicago, 1909. Price, 50 cents.

This is one of Branch's Chart Book Series, manuals designed to show by clear, simple illustrations and practical questions and answers, the historical development and growth and the present form of modern prime movers. This book details the growth of the dynamo from its starting point, the influence of a wire carrying current on a compass needle, and its study will render the principles and construction of the dynamo perfectly clear in a very short space of time. The book may also be had in cloth binding at 75 cents.

Telephone and Telegraph Engineers' Pocketbook. A handy reference book for all persons interested in telephone and telegraph systems, location of faults, electricity, magnetism, electrical measurements and batteries. Scranton, Pa., International Textbook Co., 1908. Price, 50 cents.

There is no other book on this subject to compare with this at anything like the price. The 400 pages are packed full of information of the most practical kind. A few days ago a U.S. government inspector happened to open his testing kit in our office, and snug on top lay a copy of this manual. "Yes," he said, "it is the only book I carry with me and I find it contains everything I need. The only book that can compare with it is Miller." There could be no higher praise.

Mechanical World Pocket Diary and Year Book for 1910. London, Emmott and Co., Ltd.

This is the twenty-third year of publication of this useful handbook, which we have reviewed in previous years and highly commended. The present volume contains all of the useful features of the earlier ones and considerable new matter has been included. A number of sections have been thoroughly revised, and the book should be useful even to those who have previous volumes. The American price is only 25 cents, and one wonders how the publishers can afford to give so much for the money.

Mechanic's Handbook. Scranton, International Correspondence Schools, 1909. Price, 50 cents.

The popularity of this most useful little book may be judged by the fact that 317,000 have already been printed, and that it has been reprinted 20 times. It contains, in spite of its pocket size, an enormous amount of valuable information for every one interested in engineering in any of its various forms. The book contains so much information that it is difficult to give a summary of its contents. Besides a large number of mathematical tables and formulae, we may mention that there are sections on mensuration, mechanics, strength of materials, boilers, machine design, electricity and surveying.

Electrical Engineer's Handbook. Scranton, International Correspondence Schools, 1909. Price, 50 cents.

This is a later book on the same general plan as the *Mechanic's Handbook*, but intended particularly for students and practitioners of electricity. It is a concise reference book and covers almost every question in ordinary electrical practice which is likely to puzzle the worker. It is marvellous value for the price, and it is safe to say that the publishers cannot expect to make any profit from the sale of the book.

* * *

Mr. Melville Eastham, of the Clapp-Eastham Company, Boston, Mass., addressed the New England Wireless Society at its eleventh regular meeting held on Friday evening, December 3, 1909, at Young's Hotel, Boston, Mass., on the subject of *Transformers for Wireless Telegraph Purposes.*

He opened his address with a discussion of the "electron theory" and gradually led up to commercial transformers, a subject upon which he is particularly well informed, having been engaged in the design and manufacture of wireless and X-Ray apparatus for several years past.

Mr. Eastham's remarks were of very great interest to all those present, the majority of whom were engaged in some branch or other of the transmission of intelligence without the use of wires.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Get out of the "bunch"—the malcontents—the "grouches"—the "never-get-theres." Thousands of others have done it through I. C. S. help—*you* can. On an average, 300 students

UP FROM

When I enrolled for the Electric Lighting and Railways Course I was motorman on the lines now owned by the I. U. T. Co., of Indiana. After finishing my Course, all but drawing, I asked for and received a letter from the schools; this I showed to the General Manager of the General Electric Co., Fort Wayne, Indiana, and got a position at once, worked eight days and got a foremanship of a department at $75 per month. Worked one month and was offered $80 to take charge of the shops for the Conneaut & Erie Traction Company, accepted and worked for them six months and got a raise to $90. (Signed) E. H. CLARK,
N. Girard, Pa.

When I enrolled I was an instrument man in the service of the St. Louis Terminal R. R. I have been in the Civil Engineering Department of the Mo. Pac. Ry. Co. for the greater portion of the past six years and am now Assistant Engineer of same. When I applied for a position with this road, I showed my I. C. S. Certificate and, after a perusal of same, the representative of the Company said to me: "I guess you will do all right. When can you report for duty?"
(Signed) W. H. MOORE,
404 14th St., Alexandria, La.

At the time I enrolled in your School of Mines, I was loading coal in a mine, but before I had more than half completed the Course, the position of Mine Electrician and Mine Boss was given me on account of my knowledge of electricity and electrical machinery that I received from the Schools. Just as I was completing the Course I was given the position of Mine Foreman.

My salary has been increased, the enjoyment of living has been doubled on account of the mental training I received from my Course, to say nothing about the facts learned about the Science of Mining. (Signed) H. W. MERRIMAN,
Dell Roy, Ohio.

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(Signed) CHARLES HAGERTY,
Montpelier, Ohio.

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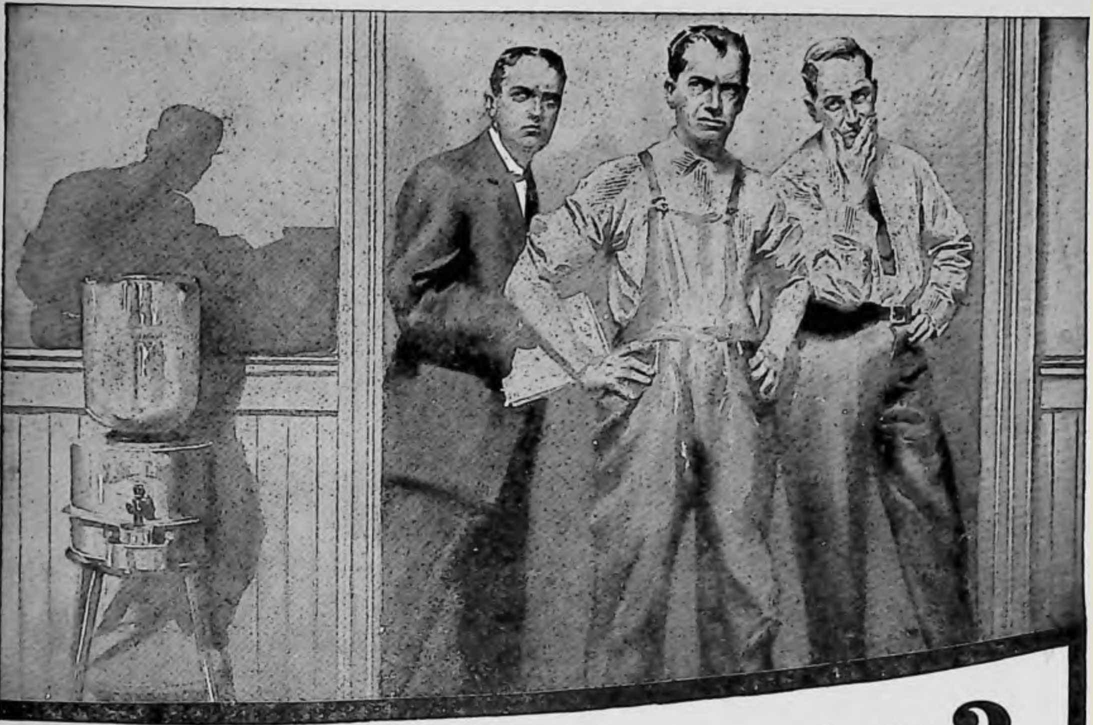

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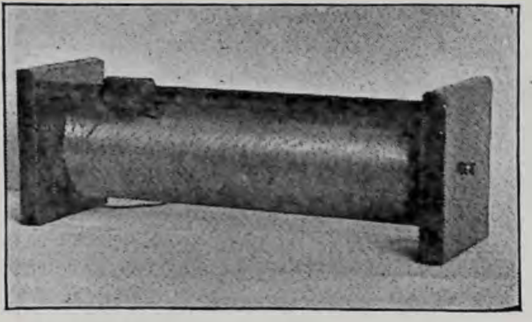

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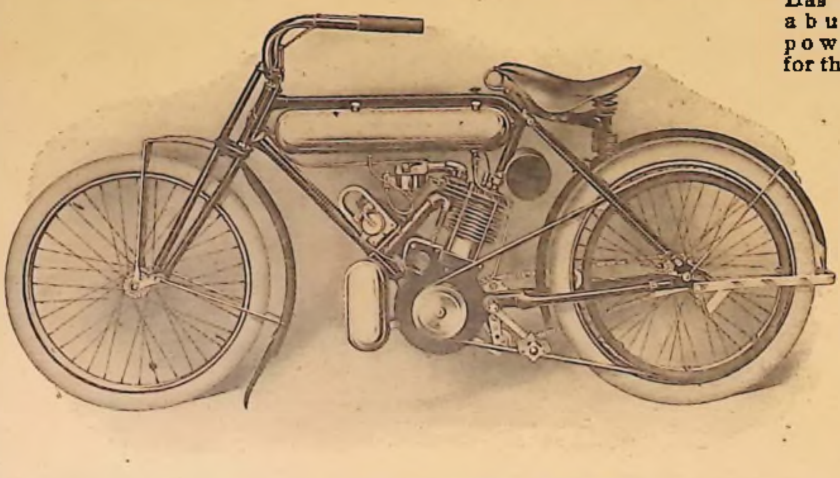

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