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ALTERNATING CURRENT AND ELECTROLYTIC RECTIFIERS

EDGAR BERGHOLTZ

Occasions frequently arise when, for some reason or other, one desires the use of direct current, and yet the only source of supply is alternating current. Instances of this difficulty are noted in all electrolytic work, in supplying current for charging storage batteries of launches and automobiles of the electric type, and of telephone systems, as well as for copper and silver plating.

The first question which one naturally asks is: why cannot alternating current be used instead of direct? The answering of this question requires an explanation of both kinds of current: the direct is had when the flow is in one direction, with a magnitude varying periodically or remaining constant; the alternating occurs when the flow is first in one direction, and then in an opposite direction, with the magnitude varying periodically.

Direct and alternating currents have been aptly illustrated by likening them to a stream flowing into the ocean. Some distance above the mouth, where the tides have no effect, the water flows continuously in one direction, is unidirectional like the direct current. Down at the mouth of the river the tides cause the water to flow first up stream and then down, changing four times in twenty-four hours. This change due to tides is very much like the alternating current, except that the latter varies many times in a single second.

Again alternating currents are very much like a double-action pump (Fig. 1),

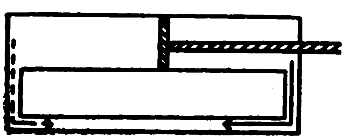


Fig. 1

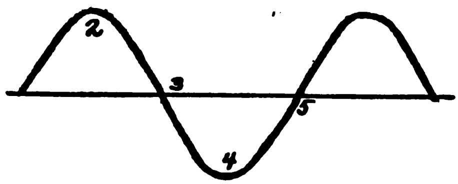


Fig. 2

consisting of a cylinder with a valve at either end; to both valves being connected the same pipe. The water in the cylinder is forced by the pushing piston in the direction of the dotted arrow; when the piston is pulled back it forces the water back in the oppostie direction, represented by the other arrow. This flow back and forth represents the alternating current.

This current can also be graphically illustrated as in the following diagram (Fig. 2). Suppose an alternating current begins at 1: it rises in intensity until it reaches its maximum at 2, and then decreases to zero. This first rise and fall represented as being above the line is called the "positive phase." After passing zero at 3, the current increases in magnitude again, but this time below the line until it reaches its maximum at 4, and then it decreases to zero at 5. This second rise and fall illustrated as being below the line has received the name of "negative phase."

When an alternating current has passed through both phases it is said to have completed a "cycle," and the number of cycles completed in one second is called the "frequency" of the current.

Now the reason why alternating current cannot be used instead of direct current in electrolytic work is because all that is done in electrolytic solutions

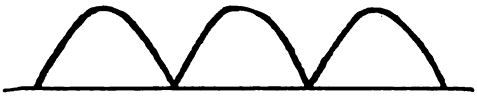


Fig. 3

by the positive phase is interrupted and destroyed by the negative and contrary phase and no more work has been accomplished after the current has passed through than before its introduction.

To overcome this difficulty, to convert alternating current into direct, the modern inventive mind has devised and introduced the "current rectifier." The real difference between the positive and negative phases of an alternating current has been seen to lie in the fact that the negative current flows in a direction opposite and contrary to that of the positive. Now if the negative phase can be changed to conform in direction to that of the positive, a direct, though pulsating, current results. To perform this operation is the purpose of the rectifier.

The converted current can be represented by diagram (Fig. 3), the negative phase being swung above the line to indicate change in direction.

The most usual frequency of an alternating current is 60 cycles, *i.e.*, the current varies through positive and negative phases at the rate of 120 pulsations a second, and in this state can be used for all electrolytic work.

The rectifier which brings about this change is divided into several classes. Excluding the rotary converter, which is, properly speaking, not a rectifier, since it does not change the direction of flow of the current itself, but produces a direct current from a direct current dynamo run by an induction or alternating current motor, the rectifier is of three types: mechanical, vapor (Hg-arc) and electrolytic.

The mechanical rectifier, as is evident from the name, is a machine constructed for current conversion, and is a purely physical contrivance. It is exemplified in the commutator of a direct-current dynamo.

Both vapor and electrolytic rectifiers are based on the principle discovered some fifty years ago that aluminum has the property of "asymmetry," *i.e.*, when a current is introduced into a strip of aluminum immersed in any one of a certain class of electrolytes (bodies which transmit current and at same time undergo chemical decomposition by it), great resistance is offered; when, however, the electric current attempts to pass in the opposite direction, *i.e.*, from the electrolyte to the aluminum, very little opposition is offered.

At first it was thought that the resistance was due to the formation of an oxide upon the aluminum electrode, but it has been lately shown that the more probable explanation is found in Schultz's theory: that the resistance is caused by the formation of a gas lying within the pores of the oxide.

For many years after its discovery, the property of asymmetry was not utilized, and it is only within the last few years that men of electrical genius have been able to build upon it an artificial contrivance for converting the alternating current.

As a consequence of these endeavors, two styles of rectifiers have been evolved, the vapor and the electrolytic.

In the case of the former, the vapor itself is not an electrolyte, since it is not decomposed on the passage of the current, but it has the property of asymmetry. The great efficiency of 98 percent has been attained by this device, and it is interesting to note that it is the most efficient artificial contrivance hitherto devised by human agency. But as this style of rectifier is difficult to make without special materials, somewhat hard to procure, and hence costly, and since special tools and apparatus are required for its production, the electrolytic rectifier is used instead, in many cases, on account of its comparatively lower cost and simpler construction.

Electrolytic rectifiers have been placed on the market, but they can be made

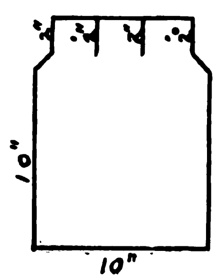


Fig. 4

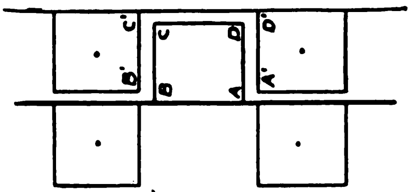


Fig. 5

very cheaply by anyone with a little care. The following is the description of one used at present in a leading American college: In this rectifier the alternating current of 60 cycles with a voltage of 108, produces a pulsating direct current of 25 amperes, with a voltage of 40, or of 1 ampere with a voltage of 100, according as may be desired. Hence the efficiency is something over 50 percent.

To hold the solution, four large earthenware jars were used, the capacity of each being 6 gallons. In the lids were drilled four holes to admit 5/16 in. bolts, which fasten the plates to the cover. This was done with an ordinary steel drill, with a lubricant in the form of a solution of turpentine, ether and camphor. It may be noted that as this process is somewhat tedious and lengthy, circular lids of wood, preferably white pine, might have been substituted, their diameter being slightly greater than that of the jars. Care should be taken, however, if wood is used, to have the covers soaked well in paraffin to render them thoroughly insulated.

The plates, four of aluminum and four of zinc, measured 10 x 13 in. They were 3/32 in. in thickness, but 1/16 in. would have done. At a distance of 1 in. from either side of the plate (Fig. 4), on one end, were made slits 2 in. long; then after measuring off 10 in. on either side from the other end, two slits were cut in such a fashion as just to meet the inmost end of the first slits.

After the corners at the end of the plate had been removed, the end was divided into three equal parts and then cuts 2 in. in length were made toward the center of the plates at the two places marking the division. In the two outer sections were drilled two holes to admit 5/16 in. bolts; these outer sections were bent back evenly and the middle one forward until they formed an angle of 90 degrees with the plates. The purpose is to make the plates rigid when they are bolted to the lid, so that they will not sway enough to come in contact with each other and form a short circuit.

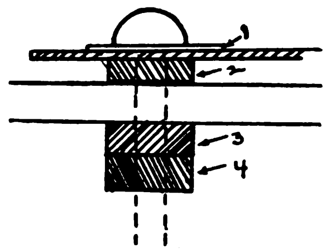
The position of the zinc with regard to the aluminum when both are bolted, can be well represented by a cross-section view of the bolted end, illustrated in Fig. 5.

The edges BC, AD, B^1C^1, A^1D^1 were then filed down so that $B\,C\,A\,D$ would fit into the space $B^1C^1A^1D$ without the touching of the plates when they were set in the cover.

The plates were then bolted to the lids, as in Fig. 6., with 5/16 in. bolts. Next to the head was placed a washer (1), and the bolt was then put through the hole in the plate and tightly clamped with a nut (2) to obtain a good electrical and mechanical contact between the bolt and the plate. The whole was then fastened securely to the lid with a second nut (3) and a third nut (4) was screwed on to act with the second (3), as a binding post. In each lid one zinc and one aluminum plate were fastened in this manner.

When the plates have been duly secured, they should be bent toward each other so that they are not more than 2½ in. apart. The efficiency of the rectifier can be still further heightened by bending them as close as possible, together, provided some insulation is put between them to prevent contact and consequent short-circuit resulting in the production of alternating current instead of the desired rectified current.

The electrolyte which is in use, is a saturated solution of ammonium orthophosphate ($NH_4H_2PO_3$), in amount about 22 liters (5 gallons) for each jar, *i.e.*, as much as would bring the solution level, 9½ in. from the submerged end of the plates. Ammonium orthophosphates is used in preference to other phosphates, *i.e.*, sodium, potassium and magnesium, for although in itself, it does not perform



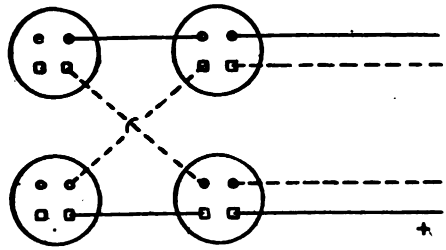


Fig. 7

its function as efficiently as the others, yet it does not undergo chemical decomposition in the electrolytic reaction as quickly and as easily as do the others.

When solution had been made and poured into the jars, the covers were put on, the lids being in solution. The plates were then connected with No. 14 wire, as in Fig. 7. The dotted line represents wire carrying alternating current, and the straight black line, the wire carrying the rectified current. The squares representing the binding posts on the lids are connected to the aluminum plates and the circles represent posts connected to the zinc plates.

The rectifier, being ready for use, was connected in short-circuit through a varying resistance of a few ohms to form the oxide on the aluminum electrode, thereby giving it the property of asymmetry. After the oxide is formed, the rectifier may be connected up to perform its work.

The rectifier as above described will run for over an hour without perceptible heating, but on a ten-hour run, if there be no system of cooling, the temperature will rise almost to boiling point.

The current which comes from the rectifier is of a pulsating character, varying 120 times in one second, when the alternating current is one of 60 cycles.

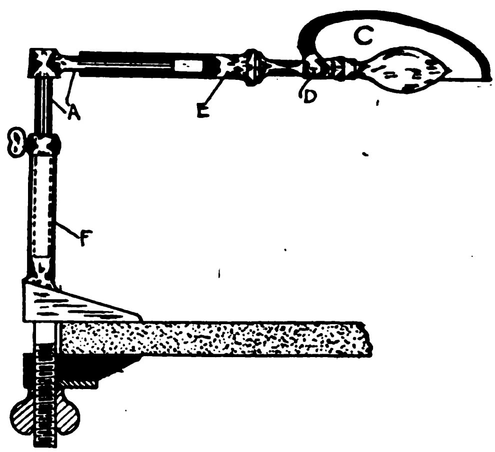
Sometimes it may happen that a steady current is needed, and the difficulty of changing a pulsating current into one of steady magnitude must be solved. This can be easily overcome by connecting the contrivance which is to receive the current to a set of storage batteries which will give the desired voltage. These, in turn, are connected to the rectifier. In this way a steady current is gained from the batteries and their loss in electrical energy is repaired by the introduction of the pulsating direct current from the rectifier. Of course, even here, some variation still continues, but it is reduced to an almost imperceptible minimum.

This rectifier will not operate indefinitely, as there is a tendency to electrolytic decomposition and to evaporation on the part of the solution and to corrosion of the electrodes. In consequence both solution and electrodes must be renewed now and then.

A STUDY LAMP

C. H. SAMPSON

A convenient arrangement for a study or drawing table lamp is shown in this sketch. The up-right F may be changed where desired on the table; the angle arm A raised to the desired elevation and turned to the angle wished for; the hollow arm E pulled out to any distance over the table, and the shade C adjusted by using the thumb-screw at D. The wire for the lamp may be introduced through a hole bored through the upper part of arm A and passing through E.



A genius makes his mark because he *hits* the mark; he applies himself to but one thing until he makes that thing the *best*—by a master stroke.

HOW TO MAKE A RHEOSTAT

H. W. H. STILLWELL

One of the most useful forms of apparatus to be found about the experimenter's shop or laboratory is the rheostat. Almost every boy having some knowledge of electricity has one or more about his shop, although they may not be very practical for various reasons. A good practical instrument of this sort is not as easily constructed as at first supposed. It is the purpose of this article to describe the construction of one or more types of these instruments that will, when completed according to these instructions, give excellent service and well repay the maker for his painstaking in the constructing of same. These instruments will be found excellent for controlling the current in connection with a medical or other coil, regulating small battery lamps or the speed of small motors.

Graphite is used extensively as a resistance, especially in medical apparatus, where it is directly in contact with the arm of the rheostat, an uneven wearing of the graphite surface is sometimes the result, which causes the current to be jerky, and more or less serious consequences might result where the apparatus is being used upon some delicate part of the body, as is very often the case with medical galvanic, faradic or other apparatus. It is to overcome this uneven regulating of the current that this instrument was designed. This tendency is entirely eliminated in the rheostat here described, as the arm of the instrument comes in contact with metal studs or buttons, which in turn are in contact with the carbon or graphite which is placed underneath.

Two pieces of well-seasoned hard wood will be required, each about 8 in. square and ½ in. thick; find the center and with a pair of compasses describe two circles, one 6¼ in. in diameter, and the other 5¾ in. Now with a small keen compass saw cut around these lines, following them as closely as possible to insure a neat job. The smallest circle should be completed first, and the round center block, 5¾ in. in diameter, should be removed and laid aside for future use. Then saw along the line of the larger circle 6¼ in.; the wooden collar formed will be of no use and may be destroyed. The

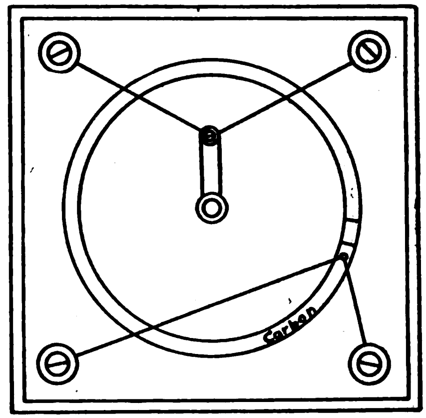


Fig. 1

board will have now a circular opening 6¼ in. in diameter. All rough edges resulting from the sawing should be smoothed off with sand-paper. Place the second piece of wood upon a flat surface and lay the piece just completed upon it and fasten to same by screws or by gluing, which is more desirable but requires more time. Now place the 5¾ in. circular piece exactly in the center of the 6¼ in. circular opening and secure as before; this will form a groove ¼ in. wide and ½ in. deep. Contact buttons must be arranged so as to enter directly in the center of this groove, which will be described later. The contact buttons may be purchased from any large electrical or experimental supply house, and can be had in a variety of sizes and shapes, or can be made by the workman himself, using brass filister headed screws ⅝ in. long under the head. 8 x 32 or 10 x 32 machine screw sizes may be used. File down the head until the slots have been taken out (see sketch), being careful to file the head as evenly as possible to get a uniform thickness. If a lathe be at hand, the process of cutting down the heads may be accomplished much quicker and more neatly than by filing. A lathe is not always at one's disposal, therefore the filing should be done carefully, and if done so, there will be little left to be desired. When the contact buttons have been finished, proceed to lay off the top board of the instrument with a pair of small dividers, which should be set so

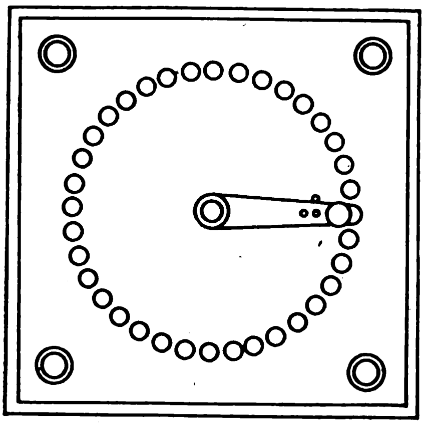


Fig. 2

that there will not be more than 1/8 in. or a little over between the buttons. When the board has been spaced off, proceed to drill the holes to receive the shanks of the buttons, care being taken not to get the holes too large, which should be dipped in a little shellac before being forced into the hole they are to occupy; this will make the buttons stay where they belong and will not make it necessary to use nuts on the bottoms to hold them in place. When all the buttons have been secured in their places, and the coating of shellac dried, care should be taken to remove all dry shellac from the ends of the shanks, which should project into the groove about 1/8 in. or a little less. This shellac may be removed by emery or sand-paper. The slot should now be filled in with graphite or carbon to a depth of not more than 1/8 in. A piece of pasteboard should be cut out to fit in the slot and upon the resistance material; this should fit closely. When this has been fitted some paraffin should be melted in a pan or kettle having a spout; if sealing-wax is at hand, this will give a much better appearance, and should come almost up to the edge of the groove. (If sealing-wax be used, an old receptacle should be used in heating same, as it is liable to be ruined by the wax adhering to it.)

The amount of resistance will vary with the requirements of the builder. It is, therefore, a wise plan not to fill in with the paraffin or wax until the instrument has been about finished, so that it can be tried, after which a greater amount of the resistance material may be added if necessary, or if the resistance already in place is found to be too small, the pasteboard should be removed and a little paraffin removed, care being taken to keep the amount as even as possible all the way around the groove. When the proper proportion has been determined upon, the wax may be filled in the groove and the instrument will be ready for use. The foregoing paragraph has been inserted as a safeguard, as it is very easy to add too much of the graphite or carbon, or on the other hand, not enough, and if the wax be left until last, the mistake can be easily remedied.

There are four binding posts shown in the drawings; but two may be used if more desirable. By using the four, two different connections may be made with the instrument, with more ease than with the two posts. This part of the construction is largely a matter of taste. If the location of the posts are not desirable as illustrated, they may be placed in a row and near each other at the top or bottom of the board. Connections can be made as shown in the drawings, or may be varied to suit the requirements of the workman.

When the location of the binding posts has been determined, and they are in position, our next consideration will be the arm. It will be noticed from the drawings that there is a spring contact in this style of instrument, a feature which is seldom found on the ordinary rheostat and one well worth the little extra trouble involved in its construction. Medium heavy brass should be used for this arm, about 1/8 in. in thickness; the length will be about 3 5/8 in. The laying out of this arm is a simple matter: a small pair of steel dividers, a center punch, a scale, light-weight hammer and one or two good files are the most necessary tools. If the arm is to be taken from a large piece of brass, it will be necessary to lay out the dimensions given on the sketch, and then saw the piece out with

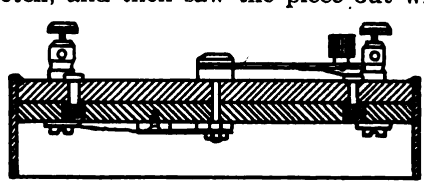


Fig. 3.

a hack-saw. The spring contact or slider will be the next to be considered, the brass used for its construction being a good grade of spring brass. The thickness should be about No. 21 Birmingham gauge .032; the bending may be done in a vise; the small shoe which slides over the buttons may be turned up at the ends, as shown, in the same manner, or a small iron or steel block can be used to hold the brass in the vise, and the shaping can be done with the hammer. It is better to allow a little in the length of this spring for the bending, as this operation will shorten the spring considerably. When the spring has been shaped to suit (the final bending can be best made when the instrument is all assembled), the holes for rivets are now drilled. These can be any convenient size to suit brass rod or rivets on hand. The rubber knob for turning the arm should be located first before the spring is riveted in place, and hole drilled and tapped for same. A very neat hard rubber knob, or one made from composition, can be purchased from any electrical supply house, or a white porcelain knob can be used, although care must be taken not to allow any metal parts to project through the knob. The center bolt, upon which the arm swivels, can be constructed by the workman, or may be obtained from some dealer handling experimental supplies; the same may be said of the heavy washers and the bridge shown in the sectional views.

The small bridge shown in the sectional view of the completed instrument is designed to prevent the wires from wearing or slipping off the center bolt, which is often the case in other types, and causes much trouble and annoyance. Two brass nuts should be used upon the bottom end of the center bolt to keep it from getting loose. If close attention is given to drawings herein, no difficulty should be experienced in making the various parts of the instrument, and when completed and finished properly, will be very serviceable and add to the other equipment, both in appearance and utility.

When completed, the edges of the boards should be carefully trued, and a neat molding should be placed about the four sides of the instrument to add to its appearance, and raise the bottom board higher, so that the bridge and other

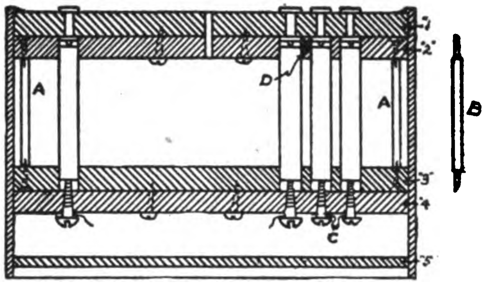


Fig 4

under parts will not come in contact with anything which might injure them. If desirable, a bottom board may be made and secured in place by small screws or nails; this will protect the instrument still more and will hide the under construction from view.

CARBON ROD RHEOSTAT

The rheostat just described is an excellent one, but there are some more or less difficult parts for the amateur to manufacture, especially if his tools are crude or not suited to such work. The carbon rod rheostat, which is here described, is an excellent instrument, and one which will not require as much labor as the one previously described, and the resulting instrument will give excellent and highly efficient service. In building a rheostat for very fine work, or measurements which require any degree of accuracy, the resistance of each step of increase or decrease in the amount of resistance must be definitely known. For such an instrument as this, a great amount of care is required in the making, and a reliable standard form of a resistance would be necessary to test each coil of wire, or whatever form of resistance was employed. The Wheatstone bridge is the standard used for such work, and is extremely sensitive and accurate and costly when purchased. For all ordinary work, however, the instruments here described will answer the purposes for which they were designed.

In the start, this instrument may be constructed much the same as the one first described, and many of the dimensions may be followed. The front board or the one containing the buttons and arm can be made exactly the same; the second lower board, however, is not cut

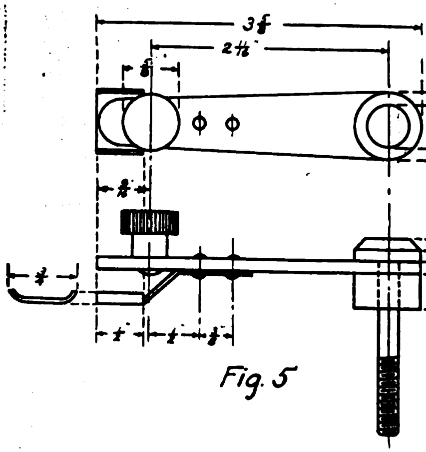


Fig. 5

out with a compass saw. The number of buttons can be varied to suit the needs of the builder. In the drawing, there are 36 points; less may be made if desirable, by spacing off the circle with a pair of dividers to the desired number. When the top board has been completed, a second board will be required. This should be spaced with exactly the same number of points as the top board, and these points must come directly beneath the ends of the buttons. Now procure some carbon rods, such as are used in city arc lamps, or better still, a smaller carbon pencil, such as may be purchased from any experimental electrical supply house. These may be had in several diameters, the size required depending upon the amount of resistance required in the completed instrument. If arc light carbons are used, it is best that they be copper-plated on one end, which is often the case, so that the wires can be soldered to them when the connecting up is done. This copper-plating is not necessary, however, as the connections can be made at the lower ends of the buttons where necessary; this is clearly shown in the drawings. In the carbon rod rheostat, the total thickness of the finished instrument will be considerably more than the other. This is caused by the carbon rods being placed upright and beneath the top board, as shown in Fig. 4. In drilling the second or under board, care must be taken to have the holes directly in line with the holes drilled in the upper board for the buttons, so that the lower ends of the buttons will come in the center of the holes. It is best to point the ends of the buttons, as shown in Fig. 4, so that when assembled, there will be a better contact between the brass of the button and the end of the carbon. The carbon rods or pencils should be cut to nearly the same length, so that the steps between the points of the instrument will be as near uniform as possible. The holes in the board marked "2" should be drilled just large enough to admit the carbons and completely through the board. A second board will be required, 3 in same drawing; this should be made at the same time as the other, as much depends upon getting the holes all in line. A very easy method is to secure the two boards 2 and 3 together with a thin nail or two, not driven all the way in, so that they may be removed when no longer needed. When the desired number of divisions are spaced off, the two boards may be drilled together and the holes will then be directly in line. Board 4 should be spaced off the same as the others; the same care being taken to get the points in line with the others. In drilling these holes, the size will be smaller than those required for the carbons, and should be made small enough so that a wood screw about size No. 6 or 8 and about ¾ in. under the head will catch a good thread. These wood screws are employed to force the carbons up to the end of the buttons, and to make contact from below, as shown.

In the assembling of the instrument little trouble will be experienced if directions are followed. When the top board is completed with buttons all in place and secured, and the arm and binding posts in place, some sort of case should be constructed to contain the instrument; and a neat molding may be placed about the top, projecting slightly over the edges of the top of board, as shown in Fig. 4. This outer case may be polished, enameled or painted to suit the taste of the builder. The interior of the case should be just a nice fit for the other boards, 2, 3, 4 and 5, so that they may be removed at any time should repairs be necessary. The top board should now be placed upper side down, and the second board 2 placed in the proper position and secured with two or three small round head screws, which should not be too long, as they would then break through the upper board of the instrument and mar the appearance of the job. It is a little difficult to assemble the various parts in the case, so this should be done before placing it in its final position. Boards 1, 2, 3 should be assembled first, 2 and 3 having a spacer *A* in each corner to hold boards in position. These spacers may be made from wood or a brass rod cut to proper length, and drilled and tapped at each end to receive a machine screw. If brass tubing is at hand, the spacers can be made from several pieces, with a rod through them, and threaded on each end, as shown at *B*, Fig. 4. The arrangement of the spacing is left largely to the workman. When 2 and 3 boards are assembled, the carbons may be placed in position, and when all in place, board 4 may be placed in position and be secured by three or four round head wood screws, as shown. The other screws may now be screwed down until the carbons are in good contact with the end of each button, as shown. A bottom board may be made, as shown at 5, which will hide all the interior of the instrument when completely assembled, and may be placed as shown in sketch, when instrument has been placed in case.

The simple wiring which is required must be done before the instrument is placed in its case. The first button may be left *dead*, if desirable, or *off*, and be marked such; no connection will be necessary with this one. Button 2 should be connected to 3 at the bottom, where the wood screws are placed; a small piece of copper wire may be soldered or wrapped about the head of the screws. From 3 to 4, the connection should be made at the top of the carbons, as shown at *D*, those following being made in the same order, bottom to top, all the way around the circumference of the circle. When completed, each button will allow one rod of carbon resistance to be added or decreased, as the arm is moved forward or backward. The complete instrument will be considerably thicker and heavier than the first one described, but the working of same will be more accurate, and if space is not any objection, we should recommend this in preference to the other.

The top board or plate may be made from hard rubber, slate, or marble, if desirable and the necessary tools be at hand to work such material. If made from such material, the finished appear-

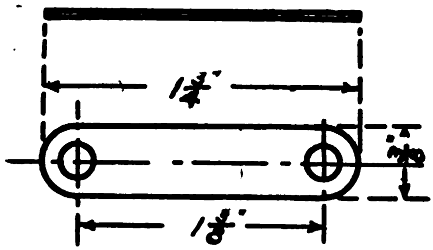


Fig. 6

ance will be very much nicer than the wood, although the wood may be finished with a fine smooth surface if properly filled and rubbed, after which it may be enameled.

There is a satisfaction which comes from putting one's best into any work which may be at hand, which is not to be considered lightly. A good instrument is more or less a difficult proposition to make, but when good service and high efficiency are desirable, this is of secondary importance. The many cheap and makeshift pieces of apparatus which are described from time to time in the magazines are good in their way, and will answer the purpose after a fashion, but if the experimenter wishes to get the most out of his work and desires to have a highly efficient equipment, he must begin with this idea in his mind and construct his apparatus from the best materials that he can procure, and tax his mechanical ability to the utmost, and the result will more than repay him for the extra labor and expense involved.

Paper Bag as a Kettle

"I had no hot water for shaving at the little country hotel, and accordingly heated some in a paper bag."

"Heated hot water in a paper bag?"

"Sure."

"How can that be done?"

"You will take a stout paper bag—or an envelope will do as well—fill it with water and hold it over a gas flame or lamp. The water heats readily. The paper doesn't burn, because it is wet, and wet paper is a singularly tough and non-combustible substance.

"Many and many a time have I heated over the gas jet an envelope or a paper bag of hot water for my shaving, and not once have I had an accident."—*Kansas City Independent*.

A HANDY LIGHTING CIRCUIT

H. P. CLAUSEN

When electric lamps are placed in telephone booths, areaways, basements and other places where a light is only required for a short length of time, the lamp is left burning practically all of the time, and it is for the purpose of providing a simple, cheap and effective arrangement that the following article is presented.

As it will be observed, the electric lamp L is connected to a contact spring K^1, the opposite contact of which connects to the electric supply line L^1, L^2, of the lighting circuit connecting to the lamp. D represents a normally closed door spring arrangement which is installed upon the door through which it is necessary to pass in order to enter the space lighted by the lamp. Push button or switch P is placed on the lamp side of the doorway; that is to say, the door must either be opened in order to permit the push button to be pressed, or the operator must be on the lamp side of the door when the door is closed. R represents a simple relay arrangement, with contact springs K^1 and K^2, these springs being so arranged that when the relay draws up its armature the normally open contact springs are closed. B represents a battery equipment, say, consisting of two or three cells of dry batteries.

The operation of the device is as follows: Assuming that the lamp is suspended in a basement, or, say, within a telephone booth, the operator passes through the doorway and, after closing the door, presses the push button P. This bridges across the break between the K^2 and K^3 contacts so that current now flows through the winding W of the relay R over wire 1 to spring D^1, through the closed contact to spring D^2 to negative side of battery B and back to the push button where the contact PX, of course, is closed while the button is being pressed. The current flowing through the winding W energizes the relay, and operates contact springs K^1 and K^2, resulting in two distinct operations: first, current from the lighting mains flows over the K^1 contact circuit and through the lamp L, lighting it. Obviously, it is impracticable to keep on pressing the button; therefore, the operator, after giving it one short push, will find it unnecessary, for the reason that when the relay R is energized the current from battery B continues to flow over the circuit, for the relay is now locked up and will keep the circuit of lamp L closed, either until the switch of the lamp socket is operated or the door D is opened.

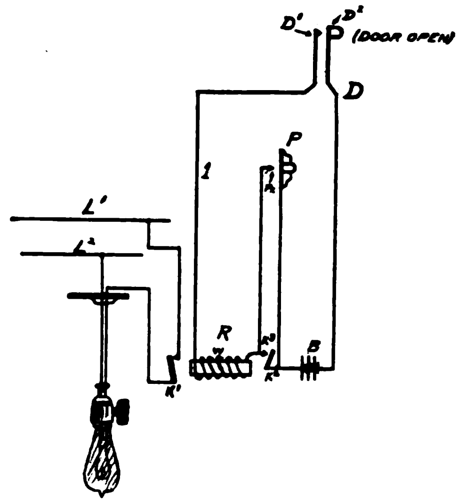


Diagram of Connections

It is the object of the system, of course, that when the party who caused the lamp to be lighted passes back through the doorway, the door spring D opens the circuit, comprising the relay R, battery B and contacts D^1 and D^2, resulting in the armature of the relay dropping back and unlocking itself, extinguishing the lamp L and permitting the door D to be closed without again lighting the lamp.

The arrangement as illustrated and described may be assembled without calling for any special apparatus other than to have a relay provided with contact springs, as shown, and wound to a resistance of about 50 ohms.

Under practical working conditions it will readily be understood that the successful operation of the device depends upon the assumption that the push button P cannot be pressed from the outside with the door closed, and that the lamp L cannot be lighted unless the push button P is pressed with the door closed.

HOW TO MAKE A USEFUL HOUSE TELEPHONE

It is proposed in this article to describe a more efficient telephone apparatus such as would be of service in a house or shop. The exterior of the instrument itself is shown in Fig. 1, and as this case contains all the working parts of the system, save for the battery, readers will see that the apparatus is extremely neat.

The first step in fitting up a system such as is about to be described is to make the two instruments, one for each end of the line, which in an ordinary house would be perhaps the dining-room or bedroom and kitchen. The cases can be made from any wood to suit the surrounding furniture or woodwork. The wood used should finish to ⅜ in. thick, and the cases should be jointed and fitted together as workmanlike as the reader can possibly manage, and finished, if desired, in an artistic manner. The sizes and shape of these cases are shown in Figs. 1, 2 and 3, which are drawn to scale, and any further dimensions can easily be taken from them. In the front view, Fig. 1, at the bottom will be seen the speaking hole or mouthpiece, and this should be finished exactly as shown.

To give the reader an idea of what the internal construction of the complete instrument is like, a view is shown in Fig. 4, with the back taken off and all the pieces of sheet brass are shown separately in the detail, Fig. 5, the letters there given corresponding with those given in Fig. 4.

The first fitting to make is the diaphragm holder *A*, which is cut out of sheet brass and stamped to the size and shape shown, and when finished should be screwed into position exactly concentric with the speaking hole, as shown in Figs. 1 and 4. We next require the brass piece *B*, 1 in. long and ⅜ in. broad, screwed on in the position indicated by the center screw.

Over the piece *B* is a spring piece *C*, 2 in. long by ⅜ in. broad, and on referring to the detail, it will be seen that the end is bent up, so it can make perfect contact with the piece *B*. This piece must be screwed to the case, as shown in Fig. 4, so that the bent or turned up end, above referred to, lies over the lower end of *C* for at least ¼ in., as shown in detail, Fig. 5, to be operated by the center stud *P*, Fig. 1. The angle piece *D* must next be cut from sheet brass, ⅜ in. wide, and of a length in the long arm *X* so as to allow the spring piece *C* to make perfect contact when it is pushed from the outside by a small push through *P*, Fig. 1. Normally, the arm *X* of this angle piece should rest about ¼ in. away from the spring piece *C*. The next fitting is the receiver hook *E*, two views being given

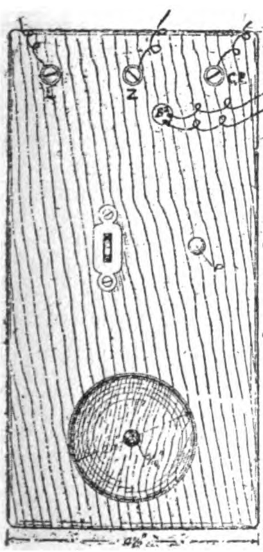


FIG. 1.

FIG. 2.

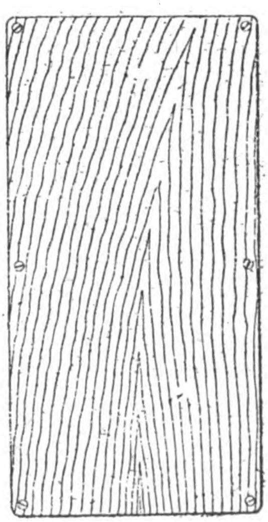


FIG. 3.

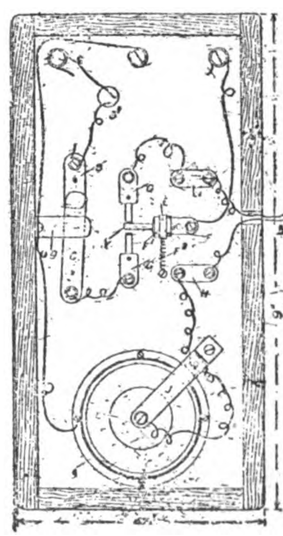


FIG. 4.

in the detail, in order to show the long pin *Y*. This hook is for the receiver to rest on, and is kept in position by passing through the center slit in Fig. 2 and 4, and then screwed to the angle brass piece *F*, by a screw F^1, the 1/8 in. hole *Z* in the piece *F* being tapped to take the screw F^1.

In connecting these last two fittings a small spiral spring, shown at F^2 in Fig. 4, is also employed. The angle brass piece *F* is secured by its screw to the wooden case, the switch hook *E*, passed through and then the screw *F* inserted to make all secure. Two brass pieces *G* are then cut to the size and shape shown, and fixed as indicated in Fig. 4, so that the projecting pin of *E* can touch one or other of the curled ends of *G*. The small spiral spring F^2 is now fitted, as shown in Fig. 4, so as to keep the pin always in touch with the upper piece *G*, and only the weight of the receiver on the other end of the hook will cause the pin to make contact with the lower piece *G*.

Two other plates must next be screwed on at *H*, and then the transmitter is ready to be finished.

Fig. 6 shows a section of the "Hunnings" transmitter, which is made by fixing a thin carbon diaphragm *U* in position under the brass ring *A*, with just a thin ring of blotting-paper *V* inserted, as shown enlarged in Fig. 7. At the back of the carbon diaphragm is a block of carbon *L*, with a serrated inner edge and kept away from the diaphragm by means of rings of cotton wool or soft felt, the felt being glued to both.

The bent arm *J* is then fitted in place,

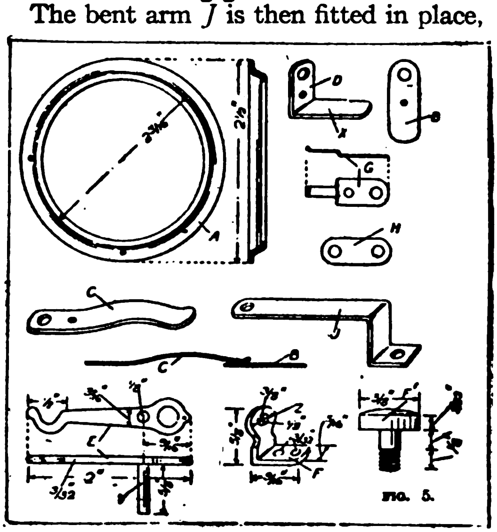


FIG. 5.

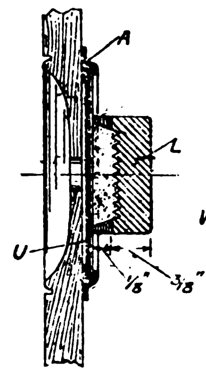


FIG. 6.

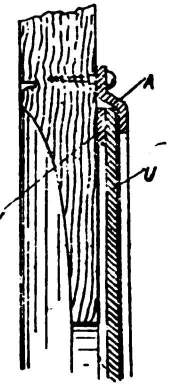


FIG. 7.

as shown in Fig. 4, and the bell fitted onto the front in a convenient place. This bell should preferably be one in which the works are under the gong itself, and these can oftentimes be picked up in the market places. However, any bell mechanism will answer, simply fixing the working parts to the front instead of to the backboard of the bell, the cover being affixed as at present adopted, or the bell can be put away in a convenient place.

The connections of the instrument are as shown, and in fitting it is of course essential that as the wire is naked in the body of the instrument, it is best to fix carefully and not to allow short-circuiting. The wires leading to outside should, of course; be covered, except where going under binding screws.

One wire starts from underneath the screw on the rim *A*, passed along the side of instrument and fixed once round under the head of the screw, fixing the angle piece *D* to the side of the case. From thence the wire goes to the center screw at the top.

Another naked wire passes from the screw of the angle piece *F*, holding switch hook *E* to the terminal at the top, as shown. Two short lengths of wire also connect *G* and *H*, and *G* and *C*, as shown, as well as a length of wire from *H* to the center carbon block at the bottom. The other wires lead outside, as shown.

We now come to the construction of the receiver. This is of the watch pattern, and is constructed briefly as follows: The outer case is cup-shape in form, as shown in Fig. 8, about 2 in. diameter, 5/8 in. deep and made from hard wood or iron, about 1/8 in. thick, holes being bored in the bottom about 7/8 in. apart for the connecting cords. The front, Fig. 9, is screwed on Fig. 8, to which is afterwards fixed the mouthpiece, Fig. 10. The circular magnets, Figs. 11 and 12, are of sheet steel; these should then be inserted, fixed to the outer case by a small screw through the top, Fig. 13 is a cross section, which should make all clear.

The pole pieces, Fig. 14, are made from soft iron, and the bobbins, Fig. 15, covered with No. 38 B.W.G., each coil being wired in opposite directions, commencing with one coil and finally finishing onto the other coil.

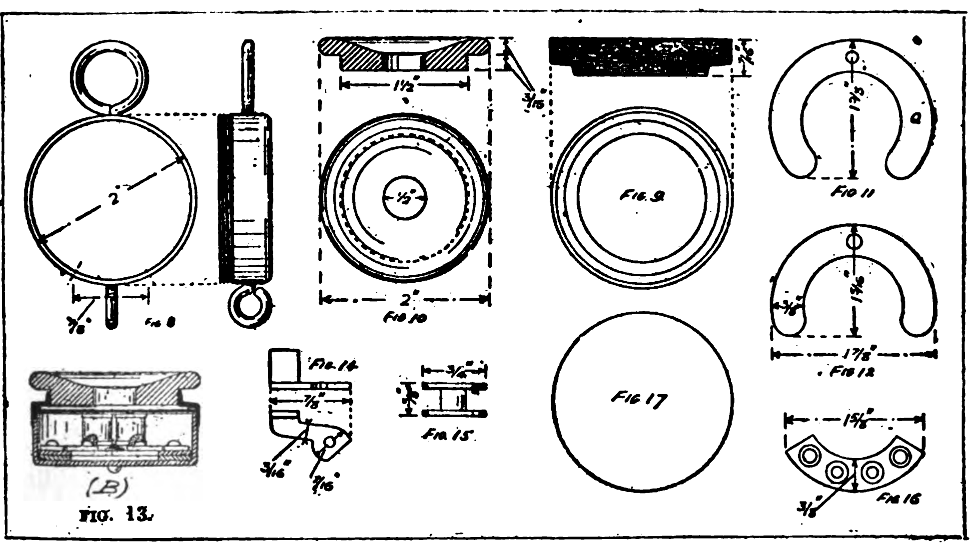
The terminals are placed onto a piece of vulcanized fiber, Fig. 16, with holes for the fixing screws, the flexible cords having their ends bared where connected underneath the heads of such screws, but covered where passing through the case (*viz.*, through the holes bored at the bottom of case, Fig. 8).

The diaphragm is fitted as shown in the side view, a ring of paper being put round the periphery at each side. To take the strain from the connecting cords, a ring is fixed at the bottom of the case for another cord which can be plaited into the other two.

The action of the instrument is as follows: Immediately the push in front is depressed, the pieces *B* and *C* make contact and the circuit to the distant bell is completed thus: Starting from carbon of battery, the current passes along up to the middle terminal at the top, from thence down the wire inside to *D*, through *C* (because contact is made) and to *G* and F^1 (because receiver is on hook) to the line wire *L* (see Fig. 1). This line wire, of course, passes to neighboring or second instrument. The current, on reaching the second instrument, passes to *C* through exactly the same channels, but instead of passing to *D* (as this push is of course not depressed) passes to *B* through bell, which it rings and thence to earth and back to original battery.

The bell has rung and the second receiver is taken from hook, as also is the first one, so that conversation can be started, and by so doing spring F^2 pulls end of *E* down and thus the pin *Y* makes contact with the upper plate *G*. The current is now conveyed through both batteries, and conversation can be heard quite plain at the receivers.

Thus only one line is necessary connecting the *L* terminals (see Fig. 1) of instruments. The middle terminal (Fig. 1) is connected to the zinc of a two-cell battery, while the other terminal *CE* (Fig. 1) is connected to the carbon of the battery and to earth. The two terminals of the bell are connected through B^1 (see Fig. 4) and the receiver cords through B^2. A suitable back board should be fitted to protect the working parts, and a nice brass plate for the receiver hook *E* to work in.



A SWITCHBOARD FOR EXPERIMENTERS

M. C. MORRIS

This switchboard is designed for electrical experimenters, and can be used for testing wireless aparatus, motors and coils. It can be used on 110 volts A.C. or D.C., or batteries of any kind, but when used on house-lighting circuit the main-line fuses should be increased to 25 amperes and the circuit feeding the board to 15 amperes.

The material needed for constructing this board is as follows: One board, 16 x 22 in. of fiber, pressed asbestos, oak, slate or hard rubber (this should be about ¼ or ½ in. thick); 10 porcelain Edison base lamp receptacles; one 15 ampere double-pole double-throw knife switch; one small single pole knife switch; one piece of brass (spring) about the thickness of cardboard and cut to the shape and size shown in diagram for rotary switch; 10 binding posts which can be taken from worn-out batteries. Binding posts with large heads or round head machine screws (brass) may be used as

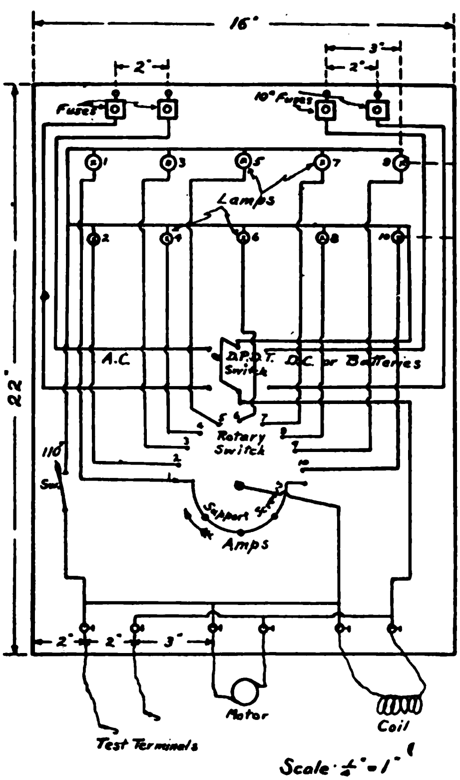
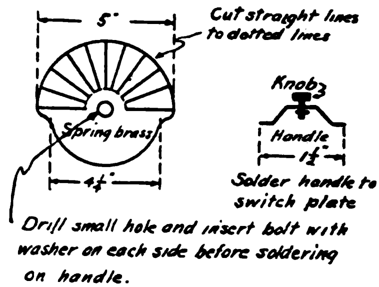


Diagram of Connections



Rotary Switch

contacts for the rotary switch, but be sure that they are all equally high above the surface of the board.

Use No. 14 rubber-covered wire when wiring the board. Connect as shown in the sketch. Mark the double-pole, double-throw switch D.C. on one side and A.C. on the other. Mark single pole switch 110 volts, and be sure that this switch is kept open except when you wish to test a high resistance, otherwise you will get a short-circuit, and blow a fuse. If 16 c.p. or 60 watt lamps are used in the receptacles, the switch on all points will give 5, amperes at the lower terminals, and if 32 c.p. lamps are used it will be 10 amperes. The rotary switch controls one light at a time so that any amperage up to the full capacity may be had at the terminals, and if 110 volts is desired straight, without the lamp bank, throw in the single-pole switch.

If batteries are connected to the switchboard, throw the double-pole double-throw switch over to the side to which the batteries are connected, and then throw in the single-pole switch. Three sets of terminal binding posts are shown on the switchboard, which will be found very convenient, although only one set is enough if not convenient to put on more.

It would be a great convenience to mount a switch and fuse-block on the board or near the board and let the feed wires come through them, so that in case of a short-circuit the house will not be in darkness until you fix a new fuse in the main line or branch circuit. Be sure to have the switchboard fuses lighter than either the main line or branch circuit fuses.

THE CONDUCTION OF ELECTRICITY IN METALS

FRANCIS HYNDMAN B.SC.

In recent years our ideas with regard to the mechanism of metallic conduction have undergone considerable change—or, rather, there are several very various methods of explaining the same fundamental facts. These methods start from entirely different conceptions, but really arrive at the same stage of exactness in explaining and foretelling the observed phenomena.

Until recent years all observations on absolute or relative conductivity were made at ordinary or higher temperatures. These show that metals differ very largely in their conductivity, both for electricity and for heat, and that, taken generally, the order of conductivity would be the same in the two cases.

In every known case the conductivity decreased with rising temperature, and in such a proportion that it might reasonably be presumed that the conductivity would gradually increase with lower temperatures, until at the absolute zero it would be infinitely good, or, at any rate, very large.

This property has been of late years used for the purposes of thermometry. The resistance (the inverse of conductivity) being measured at certain definite temperatures well known by other means, such, for instance, as the melting-point of ice, the boiling-point of water, or of other substances, such as oxygen, sulphur, etc.

The results of many accurate measurements have shown that the resistance of even the purest obtainable metal (mercury) is not simply proportional to the temperature, but that it increases more rapidly, so that if R_t is the resistance at any temperature, $t°$ centigrade and a and b are quantities which are constant for the particular wire, nearly constant for different wires of the same metal in the same state of purity, and not very different for most pure metals, then

$$R_t = R_0(i + a\,t + b\,t^2)$$

will very nearly give the value at any temperature.

There are three metals which are worth special attention, and attention may be confined to them. First, mercury, because it can be obtained almost absolutely pure, by distilling it in vacuo at temperatures of about 60 degrees to 70 degrees C., and condensing it at the temperature of liquid air − 290 degrees C. Secondly, gold, because, of the metals which can be drawn out into wire, it can be obtained purer than any other. Finally, platinum, because of its durability, and it is, in consequence, almost universally used for thermometry.

The following small table gives the relative resistances of each metal against its value at zero. The temperatures are given in what are known as "absolute temperatures," that is, temperatures as if measured from the absolute zero, which is here taken to be − 273.1 degrees C. In the next column the absolute temperatures are divided by 273.1, as it will be seen that the relative resistances are proportional to these numbers.

From observations with gold with various degrees of purity, it appears that the resistance is less the purer it is, and that the differences are proportional to the amounts of foreign metals present. This would lead to the conclusion that perfectly pure gold would have a zero resistance about 4.3 degrees Ab. It is not possible to obtain platinum at any great degree of purity; but here, again, observations on various wires of known composition would lead to the conclusion that in any case the resistance would nearly disappear at 4.3. These results are very remarkable, but their full significance is yet hardly realizable, until observations have been made on the other properties of the same metals at these extremely low temperatures. Although decreasing nearly to zero and then remaining constant, gold and platinum do not present any abnormal behavior; the case of mercury is, however, quite different. It behaves as the others until

Temp. Absolute	How Obtained	T−273.1	Platinum	Gold	Mercury
373.86	Boiling water..	1.3	1.405	1.397	—
273.1	Melting ice....	165	1	1	1
169.29	Methyl chloride	0.617	0.581	0.593	—
97.93	Oxygen..........	0.285	0.199	0.219	0.279
20.18	Hydrogen......	0.074	0.014	0.008	0.056
13.88	Hydrogen......	0.054	0.010	0.003	0.033
4.30	Helium	0.016	0.009	0.002	0.002
1.30	Helium	—	0.009	0.002	0.000

a temperature of about 4.30, being a worse conductor than either gold or platinum, from its freezing-point downwards. At this point the resistance decreases so suddenly that at 4.2 degrees Ab. its value is 0.115×10^{-5} ohms, while at 4.2 degrees Ab. it is practically zero, and it continues to have this value to the lowest measured temperatures.

These results were quite unexpected. Under various theories the resistance would be infinite at Absolute zero and under others would vanish. Neither appears to be true, and the minimum point is at practically the boiling point of pure helium under atmospheric pressure. Why this particular temperature is not known modern theories of matter and electricity suppose that the material atom consists of a negative electron enclosed in an envelope of positive electricity. The electron is free to move in the envelope, and the nature and extent of its motion are of fundamental importance. In conductors such as metals there are also free electrons, which have power to move, their passage giving rise to the phenomenon known as an electric current.

Further investigation under these conditions will certainly lead to the most fruitful results, and cannot fail to have a most important bearing on the conception of the passage of electricity in metals. It is not too much to say that they could not be carried out at all, except in one or two places in the world, owing to the impossibility of obtaining these conditions.

Not only is this the case, but they represent part of the result of twenty-five years' continuous work with one object in view, and require in themselves extreme care, patience and knowledge.

The greatest credit is due to Professor Onnes, of Leiden University, who not only first liquefied helium, but has reduced the labor of accurate measurements in it to one of ordinary laboratory routine. Such work, condensed into a few pages a year, is worth volumes of the so-called research work turned out in some other places, as it is framed on a definite scheme, and gives results which are of the greatest scientific and technical value.—*English Mechanic and World of Science.*

THE TELEPHONE AND THE FARMER

The telephone has become as great a factor of farm life as the harvester and reaper and other labor-saving devices that contribute to the farmer's prosperity. The farming implements help prepare the crop for market, but without the telephone the farmer cannot sell the crop to the best advantage. His handicap used to be that he was too far away from all agencies of business, now the agencies of business are no farther away than the telephone box on the dining-room wall.

An apple grower in an eastern state had an experience last fall that illustrated how large may be the return on the money invested for a telephone. One day when his crop was just in the right condition to market, a traveling agent offered $1.00 a barrel for the 1,000 barrels he had to dispose of. The buyer insisted that the price was as high as anybody was paying, and the deal was almost closed, when it occurred to the apple grower that it would do no harm to see how much somebody else would offer. So he called up the city commission house that had bought his fruit in previous years, and they not only offered him $1.50 a barrel, but agreed to send a man to the farm to do the packing. The additional $500 made on that transaction will pay telephone bills for a good many years to come and leave a snug little sum over.

The coming summer will no doubt see great development along electrical lines in St. John, N.B. The Intercolonial Railway has given the St. John Railway Company the right to cross their tracks at Haymarket Square. The street railway will be extended to Kane's Corner and to Fernhill. It is understood that about nine miles of track will be laid. The Railway Company, which supplies the light and power to the city, have also made arrangements for the extension of their power line to Rothesay, where many of the houses have been wired, and it is understood that several factories will operate there.

NATURAL MAGNETS

WM. A. MURRAY

Magnets may be grouped into two classes: natural magnets and artificial magnets. The particular class to which this discussion applies is the first-mentioned, *viz.*, natural magnets.

The term magnet usually is applied to any substance which possesses the property of attracting pieces of iron or steel when such pieces are placed in their immediate vicinity, and which substance will, when freely suspended, come to rest pointing nearly north and south.

The term natural magnet can be correctly applied only to a mineral substance known commercially as oxide of iron, and then only when the specimen possesses the properties mentioned above, as it has been found that some good specimens of oxide of iron do not possess the properties mentioned, and should not, therefore, be termed natural magnets.

It is generally supposed that this ore and the properties which are peculiar to it were first discovered and experimented with by the ancients who first found it in or near the town of Magnesia in Asia Minor, and derives its name from the place of its supposed origin, Magnesia.

During recent years excellent specimens have been found in various parts of the world, some having been found in the state of Arkansas.

The term lodestone, meaning leading stone, is sometimes used in referring to this ore (oxide of iron). This term derives its name from the fact that it was sometimes used by the early navigators as a guide for steering ships, its uses for this purpose being adapted to practical navigation due to the fact that it would, when freely suspended, come to rest pointing in a certain definite direction, and always with the same end pointing in the same direction. It will be readily understood from this that a navigator, by its use, could get a somewhat definite idea of the direction in which his ship or craft was sailing.

The origin and practical application of its use for the purposes just described is generally accredited to the ancient Chinese.

The commercial use of this ore is to make iron, the same in kind as is made from any other kind of iron ore, and it is said to make a very good quality of iron.

As heat alone, of sufficiently high temperature, is capable of producing the destruction of the magnetic properties contained in either the natural or artificial magnets, there is no doubt but that any magnetic properties existing in the oxide of iron are destroyed during the process of making iron from this ore.

Another property which was found to be possessed by this ore was that it could be used to impart its magnetic properties to other pieces of iron and steel, thus creating artificial magnets.

"When a bar or needle of hardened steel is rubbed with a piece of lodestone, it acquires magnetic properties similar to those of the lodestone, without the latter losing any of its own magnetism, such bars are called artificial magnets."

Lodestone is not generally used for the purpose of making artificial magnets, the principal reason for this being that its own magnetic force is not very strong, and it has been found that a more convenient means and better results may be obtained by the use and proper manipulation of the electric current.

The following described tests may be made for the purpose of determining accurately and positively whether or not a given substance is a magnet either natural or artificial. Plunge the substance which it is desired to test into a quantity of iron filings, small iron or steel tacks, or similar materials, when it will be found that a small quantity of the filings or tacks will have clung to the end of the substance under test if it is a magnet. Suspend the piece to be tested freely by means of a string or thread, and it will be noticed that if the substance is a magnet it will come to rest always with the same end pointing in the same direction; if not a magnet no certainty of its position when it comes to rest can be foretold.

Approach the piece to be tested to the points of a horizontal magnetic needle, when it will be found to attract or repel the needle according to which pole of the needle is approached; as according to the laws of repulsion and attraction: like poles repel each other; unlike poles attract each other.

FLIGHT

NEW AERONAUTICAL SPEED RECORDS

Arranged by Austin C. Lescarboura, Member of the Aeronautical Society.

The French aviator, Vedrines, on the 22d of February at Pau, France, established remarkable speed records eclipsing all speed flights made thus far in aeronautics. On January 13th, he had already established speed records for the 50 and 100 km. distances, but the aviator Bathiat had broken these records ten days later. After breaking both Bathiat's records for the 50 and 100 km. flights, Vedrines continued his flight and broke all speed flights for distances up to 200 km. The following table illustrates the comparison of the flights by the rival aviators.

Distance	Bathiat's Record (Jan. 27th)	Vedrines' Record (Feb. 22d)
50 km.	20 min. 43 sec.	19 min. 3 sec.
100 km.	41 min. 29 sec.	37 min. 58 sec.
150 km.	....	56 min. 41 sec.
200 km.	....	1 hr. 15 min. 20 sec.

The former record for the 200 km. distance was held by Tabuteau, who had made this distance in 1 hr. 54 min. and 21 sec. The speed figures made this year thus far indicate that enormous speeds will be witnessed before 1913. Already, the records in kilometers per hour around a pylon course have been broken as follows:

Vedrines (Jan. 13th)	Bathiat (Jan. 27th)	Vedrines (Feb. 22d)
145 km.	147 km.	169 km.

The records made in aviation are kept with the greatest exactness, so that they may be referred to at any time. At the end of each year, the best record in each feature of aviation competition is recorded, so that the following table is obtained from these records. This table illustrates the remarkable progress made in aviation more fully than numberless words of praise.

These figures are the official ones of the International Federation of Aeronautics, and are given in the metric system measurements. The reader may convert the kilometer figures to miles by multiplying them by .621, and the meters by 39.37 to obtain the American inches.

Year	Aviator	Date	Country	Record
		DISTANCE		
1906	Santos-Dumont	Nov. 12	France	0 kilometer, 220
1907	H. Farman	Oct. 26	France	0 kilometer, 770
1908	Wilbur Wright	Dec. 31	France	124 kilometer, 700
1909	H. Farman	Nov. 3	France	234 kilometer, 212
1910	Tabuteau	Dec. 30	France	584 kilometer, 745
1911	Gobe	Dec. 25	France	740 kilometer, 299
		DURATION		
1906	Santos-Dumont	Nov. 12	France	21⅕ sec.
1907	H. Farman	Oct. 26	France	52⅗ sec.
1908	Wilbur Wright	Dec. 31	France	2 hrs. 20 min. 23⅕ sec.
1909	H. Farman	Nov. 3	France	4 hrs. 17 min. 53⅖ sec.
1910	H. Farman	Dec. 18	France	8 hrs. 12 min. 47⅖ sec.
1911	Fourny	Sept. 1	France	11 hrs. 1 min. 29⅕ sec.
		ALTITUDE		
1906				None recorded
1907				None recorded
1908				None recorded
1909	H. Latham	Dec. 1	France	453 meters
1910	G. Legagneux	Dec. 9	France	3100 meters
1911	R. Garros	Sept. 4	France	3910 meters
		SPEED PER HOUR		
1906	Santos-Dumont	Nov. 12	France	41 kilometer, 292
1907	H. Farman	Oct. 26	France	52 kilometer, 700
1908				Same record
1909	L. Bleriot	Aug. 28	France	76 kilometer, 955
1910	A. Leblanc	July 10	U.S.	109 kilometer, 736
1911	E. Nieuport	June 21	France	133 kilometer, 136

AERONAUTICS IN THE FRENCH ARMY

The New War Establishment

For the first time in history, air craft will be definitely incorporated in the war establishment of one of the great armies. It is true that the French Army has already, and for some years now, been in possession of a splendid aerial organization, but, with the exception of the new military dirigibles completed during the last six months, it has never hitherto possessed any air craft intended for actual warfare. Steps have now, however, been taken to proceed at once with the creation of a war fleet composed of craft no longer intended for instructional purposes, but for the operations of war itself, and maintained in a state of instant preparation for mobilization.

The newly-formed French Ministry, through the War Minister, M. Millerand, have decided to ask the Chamber for an appropriation of 22,000,000 francs, or $4,400,000, for the purpose of military aviation during the present year.

It may be recalled that by the famous aeronautical program of February 25, 1910, a sum of 20,000,000 francs ($4,000,000) was voted for the construction of a fleet of war dirigibles and the accompanying sheds. This program of construction is to be completed by the end of 1913. It has already equipped the French Army with a fleet of 10 dirigibles of the most recent type—all of them launched during the last eight months—in addition to the three old training vessels, and with 11 modern dirigible sheds scattered along the eastern frontier. Further, the Army possesses three transportable dirigible sheds, while ten further sheds are privately owned and would be available in case of necessity.

Within the last few weeks the French General Staff has strongly reported in favor of the continuation of the dirigible program, an opinion largely based, no doubt, on the brilliant success of these craft in last year's manoeuvres.

Side by side with the dirigible program the Government has now instituted an aeroplane program of equal magnitude. The necessity and urgency of this program is based on the consideration that at the present time the French Army possesses not a single war aeroplane. Such a statement may appear surprising at first glance, but its correctness will be better understood in the light of previous events.

The French Army purchased its first aeroplanes in 1909. Since then the aeroplane fleet has grown according to the following figures:

1909 .... 5 aeroplanes
1910 (Feb.) .... 20 aeroplanes
1910 (Oct.) .... 32 aeroplanes
1911 (Dec.) .... 254 aeroplanes

The growth in numbers is remarkable, but—and this is the important point—the machines hitherto acquired are not military machines in any special sense, they are aeroplanes of the ordinary commercial types, and military only in so far as they belong to the Army. Now, the whole of this imposing and unquestionably efficient fleet has by one stroke of the pen been struck off the active list. Henceforward these vessels will simply be used for instructional and training purposes, and will be relegated to the schools.

Simultaneously the authorities have set to work to build up a fleet of war machines constructed solely for military purposes. Towards the attainment of this end the vote of $4,400,000 for the present year, which will undoubtedly be readily granted by the Chamber, forms the first step. This sum will suffice to equip the Army with 322 aeroplanes with the necessary shed accommodation and repair trains. These machines will be distributed among the various forts and attached to the different army corps.

A military pilot will be placed in charge of each aeroplane, which he will navigate himself on mobilization. None of these machines will be used for instructional purpose during their year on the active list. They will only be maintained in a state of efficiency and readiness by their respective pilots. At the end of the year they will be transferred to the training schools for instructional purposes, and their places taken by new machines.

The program is a magnificent one, not only in the numbers of the war fleet it will call into being, but chiefly from the standpoint of the organization it will create. By the end of the present year the French Army will possess well over 300 war aeroplanes; within another year these will have grown to 1,000. And by the side of this fleet there are the 12 war dirigibles.

THE DETERMINATION OF OCEAN CURRENTS

The officer of a vessel, who, while at sea, steps to the rail and hurls a well-corked bottle overboard, in which there is a slip of paper, is not bent on a romantic venture. Instead of a request for a letter of acknowledgment and possibly an acquaintance from the seaside maiden who might find it, perhaps a year later, that slip of paper contains the name of the vessel and its master, the date and the latitude and longitude at which the bottle began its voyage. Below this there are blank spaces for the name of the finder, the date, locality and the post office address.

At the bottom of the slip, printed in eight different languages, are these instructions: "The finder of this will please send it to any United States Consul or foward it direct to the hydrographic office, Washington, D.C."

The whole operation represents a little step in a great task upon which work has uninterruptedly gone forward for the past thirty years. It is one means of determining the direction and movement of the great as well as the smaller currents of the ocean, and it will perhaps be due to the continual varying of the latter currents that this task may never be ended.

There has always been a knowledge of the existence of ocean currents but until the early 70's it was limited. Mariners knew that on the west coast of Europe there was a force which tended to carry them southward, and that on the east coast of North America a similar force which carried them northward, but they knew neither the true set or direction, nor the drift or rate of flow.

It was the object to determine the direction and rate of flow in originating this system of bottle voyages, and while each bottle is but a little step toward a great end, those little steps have so far succeeded in establishing beyond question the true direction and speed of the great currents of the five oceans.

The advantage of such knowledge is not limited to the mere use of the direction and velocity of the ocean currents. The maritime world does, in fact, depend mostly on this knowledge in laying the courses of its vessels from and to the great ports of the world. For instance, vessels leaving New York will follow the Gulf Stream on its great curve northeastward across the Atlantic to Europe, and thus gain the advantage of its six-knot-an-hour flow, while those ships returning from the other side will lay a course much farther to the south to escape the retarding effect of the same stream.

It has been found also, that these great ocean streams have a powerful effect on the course of storms after they leave the mainland of North America. The knowledge of the direction of these currents gives an insight into the general track of these storms. The mariner, therefore, has gained much from the tale told by the little voyagers, because all of the great ocean-sailing routes which, for the past score of years have been followed by both steamers and sailing vessels alike, were mapped out with the aid of the date secured by this means.

There are twenty-seven permanent currents in the oceans of the world, and there are nearly as many more of the semi-permanent variety existing at one time. Several causes tend to originate and maintain these drifts. Uniformly directed winds have the greatest influence, and differences of temperatures, storms, polar ice and eddies each have some effect, creating usually the currents of semi-permanent variety.—*Washington Star*.

Letter Delivered after Fifty-four Years

After it had been more than fifty-four years in the mails, a letter was delivered recently to a woman in Newark, N.J. One morning the Newark newspapers reported that a letter had been received at the post-office addressed to Miss Elizabeth Garthwaite, the postmark on which showed that it had been mailed in New Orleans on December 30, 1854. The letter proved to have been written by a cousin who attended the same school more than half a century ago. The ink inside the letter was so badly faded that the letter was hardly decipherable, but the address was plain. No one was able, or willing, to offer any explanation of the whereabouts of the letter during the years that elapsed since it was mailed.

KEROSENE AS AN ENGINE FUEL

JAMES A. KING

The power obtained from any fuel depends on two things. These are the fuel itself and the engine. No more power can be obtained from any fuel than that which is stored in it. The percentage of the power stored in a fuel which is available at the crank-shaft or the drawbar of an engine depends largely upon two factors. These are the ability of the engine to burn the fuel and the amount of power required to operate its working parts.

Kerosene contains more power to the gallon than does gasoline. But most of the internal combustion engines on the market today are not capable of burning kerosene economically or successfully. This is because they are built as gasoline engines and not as kerosene engines.

The manufacturer is up against two problems when designing a kerosene engine. He must so build it that it will properly spray the kerosene and mix it with air. He must so build it that it will prevent the deposit of free carbon when the charge of mixed kerosene and air is exploded. These problems arise from the nature of the fuel itself.

Kerosene is heavier than gasoline. It vaporizes at a considerably higher temperature. It consists of a mixture of much more complex compounds which burn at a wider range of temperature. In the presence of high heat some of these more complex bodies break up into simpler ones which contain smaller proportions of carbon, therefore free carbon is deposited.

In order to burn kerosene successfully, an engine must work with its cylinders hot enough to vaporize the fuel properly, yet the cylinders must not be hot enough to bind the pistons or give pre-ignition. This means that the manufacturer must carefully design his cooling system with reference to the capacity of his engine so as to produce these conditions. To obtain the required temperature it is necessary to start an engine with gasoline and run it until cylinders and cooling system are sufficiently hot to properly vaporize the kerosene. Then the gasoline is shut off and the kerosene is turned on.

But this is not the end. If it were, then any engine that would burn gasoline could also successfully burn the heavier fuels. This is where the composition of kerosene begins to show its effect. Many engines will run successfully on this fuel for a short time, but usually a carbon deposit soon forms on the piston head and the inner walls of the cylinder. It takes but a short time for this deposit to become disastrous. All engine users know how annoying carbon deposits in their engines can be.

The reason why carbon is deposited may help one to understand how it may be prevented. Much is known about the results which are obtained when certain things are done with carbon compounds, but there is some difference of opinion as to the exact changes gone through by these compounds in reaching the final results. Consequently, I offer the following explanations as indicating what probably takes place during combustion and not as indisputably authoritative statements of what actually does take place.

It is well known that when certain complex bodies found in kerosene are subjected to temperatures as high as those found inside the cylinder of a working engine they break up into simpler compounds. Thus

$$C_{15}H_{32} + \text{heat} = 2C_7H_{16} + C$$

It is quite probable that most of the more complex bodies contained in kerosene go through some such process of breaking down as this before combustion takes place. So that when kerosene is used in an engine under the same conditions as gasoline it is probable that free carbon is deposited as above explained.

But it has been found that when a mixture of air and vaporized kerosene is exploded in the presence of a small quantity of water vapor the combustion of the kerosene is much more rapid and complete than when the water is absent.

Recognizing this fact, some manufacturers of kerosene burning engines prevent the deposit of free carbon by spraying a small quantity of water into the cylinder with the charge of fuel, using a separate water cup in their carburetor, built the same as the fuel cup.

Just how the water acts in this case is not fully known, though plenty of evidence is at hand regarding the beneficial results obtained by the use of water vapor. The following chemical equations look good to me as an explanation of the chemical actions that take place from the time the charge, consisting of a mixture of air, kerosene and water spray, is drawn into the cylinder until combustion has ceased.

(1) $C_{15}H_{32} + \text{heat} = 2C_7H_{16} + C$

(2) $2H_2O + \text{heat} = 4H + 2O$

Reactions (1) and (2) take place as sort of a preliminary to final combustion, since the temperature of a working cylinder reaches round about 3,000 degrees, sufficient to cause the splitting up of the carbon compounds and the dissociation of water into the free elements—hydrogen and oxygen.

Nascent atoms which have just been released from combination are more highly active than those which are not nascent. As a young man who has just been thrown over by one girl is caught up by another more readily than he would be had it not been for the throw-down, so the nascent oxygen from the dissociated water combines more readily with the nascent carbon from the broken down carbon compounds than would the normal oxygen of the air. Thus it seems to me that the further reactions may properly be written as follows:

(3) $C + 2O = CO_2$ (C and O being nascent)

(4) $2(C_7H_{16}) + 2O_2 =$ (finally) $14CO_2 + 16H_2O$

(5) $4H + O_2 = 2H_2O$ (H being nascent from the dissociated water and O being normal oxygen of the air.)

Another series of equations that have been advanced in explanation of what takes place in the presence of water vapor is as follows:

$C_{15}H_{32} + 15O_2 = 14CO + 16H_2O + C$

$2H_2O + \text{heat} = 4H + 2O$

$C + 2O = CO_2$ (C and O being nascent)

$4H + O_2 = 2H_2O$ (H only being nascent)

$14CO$ (in presence of water vapor) = $14CO_2 + 14H_2$

$14H_2 + 7O_2 = 14H_2O$

In championing this series of equations it is claimed that the water acts in some way as a sort of catalyzer, much as in the germination of grains diastase aids in changing starch into sugar.

At any rate, when water vapor is present the combustion of kerosene fuel is much more complete than without it. There is another beneficial action resulting from the presence of the water and the high heat of the cylinder.

As said before, kerosene consists of a mixture of complex compounds which burn at a wide range of temperatures, but in the presence of the high temperature found in a working cylinder these more complex compounds break down into simpler ones before combustion takes place. This action results in a larger amount of the charge burning more nearly at the same time and so giving a more powerful explosion than if the combustion were spread out more uniformly through the length of the piston stroke. Also it has been found that a combination of water vapor and high temperature increases the rapidity of the combustion. Thus a combined increase in the quantity of material "combusticated" and in the rapidity of the combustion increases the net power obtained from the explosion.

There is still another beneficial effect of the water. Without the presence of water when burning kerosene in an engine designed to burn either kerosene or gasoline, the combustion end of the cylinder becomes so hot that the piston binds and so reduces the net power delivered to the crankshaft. In fact, I have seen engines become so hot that they "killed" themselves. Now the introduction of water into the cylinder prevents this.

Prior to explosion a great deal of heat has been consumed to dissociate the water. Just as a great deal of heat is used up in evaporating or vaporizing the water so a great deal more is used up in dissociating it or breaking it up into the free elements—hydrogen and oxygen.

This reduces the amount of heat that must be conducted out through the cylinder walls at the combustion end and thus enables them to properly perform this part of their duties. But at the outer end of the stroke where the temperature has dropped lower than it was at the combustion end, the hydrogen, freed by the dissociation of water, combines with the normal oxygen of the air, giving out some of the heat that was used up, or stored up, by the dissociation of the water.

This heat is readily conducted away by the cylinder walls at this end of the stroke which, otherwise, would not be required to conduct so much heat. The cylinder walls in some four cycle engines are aided in this task by placing a relief exhaust port near the outer end of the stroke. This port is uncovered just before the piston reaches the end of its outstroke and some of the gases are exhausted through it instead of through the exhaust valve in the combustion chamber. Thus they take their heat out with them and it does not need to be conducted away by the cylinder walls and the cooling system.

I do not believe the combining of the hydrogen and oxygen at the outer end of the stroke, with the consequent giving up of heat, increases materially, if at all, the sum total of the pressure exerted upon the piston during the full outward stroke. The principal benefit obtained from this is the distribution of the heat of combustion over a larger area of cylinder wall, decreasing the temperature at the combustion end and increasing it at the other, thus increasing the capacity and efficiency of the cooling system by distributing the heat more uniformly over the entire conducting surface. As the physicist and the thermo-chemist would say, the endothermic action is equal to the exo-thermic. The heat absorbed by the dissociation of water at the combustion end equals that given out by the formation of water at the other end of the cylinder.

So, to sum it all up, it seems to me that the water accomplishes the following things: It increases the total gross power by increasing the completeness of the combustion of the fuel. It increases the total net power by increasing the amount of the charge of fuel that is burned at a given temperature; by increasing the rapidity of that combustion; and by increasing the efficiency of the cooling system through a more uniform distribution of the heat over its entire surface.—*Gas Review*.

A NEW RAIL BOND

A company is being organized in Pittsburgh, Pa., to manufacture a new type of rail bond for bonding track rails in cases where electric current is used. John J. Jamison, of Wilkinsburg, is the inventor of this method. He has carried out his experimental work over a period of six years, and installations have been made on several coal roads. The method, it is said, will prevent the theft of copper and eliminate practically all maintenance costs.

The bond is a bushing made of soft copper, the outside of which is slightly larger in diameter than the hole into which it is to be placed. One or more of the bonds are installed on either side of the rail joint, depending on the size of the rail and the strength of the current in amperes which is to be transmitted. The reaming insures a perfectly round hole with clean, smooth sides. The bond is forced through the rail and fish plates, and is expanded with a mandrel until the copper comes into contact with every part of the surrounding steel. The final step is to insert and tighten up the bolts.

It is claimed for the new bond that the fish plates and the copper bushing carry current around rail joints more satisfactorily than copper wires or strips. A small amount of copper only is used. It requires no soldering, extra holes or riveting, and is said to reduce the cost of installation almost 80 percent.

Unusual demands will be made upon the electrical supply houses of Pittsburgh during the next few weeks in anticipation of the electrical displays contemplated for the State Conclave, Grand Commandery, Knights Templar. This event is scheduled for the week beginning May 27th, and the electrical equipment necessary to meet the demands of business houses and the municipal authorities will make a very important total. In 1906, when the event was last held here the electrical decorations required upwards of 450,000 lamps, and at the eleventh hour it was necessary to order two carloads of equipment from distant points by express. Plans for the coming event are expected to require mearly double the equipment employed in 1906. The celebration will bring 50,000 visitors to Pittsburgh, and it is proposed to illuminate the entire down-town section of the city in their honor.

A 75 FT. POLE AND ELECTRIC LIGHT MARKS THE CENTER OF POPULATION OF THE UNITED STATES

FRANK C. PERKINS

The center of population of the United States, according to the last census, is located at Bloomington, Indiana, as seen in the accompanying illustration. At this point there has been erected a substantial and attractive platform, with a metal flag staff 75 ft. high, upon which is mounted a 120 c.p. electric light. This points out to visitors the site, and several thousand dollars have been expended in honor of the population center.

The "center" is on factory grounds, just south of the wall of a main building and fronting 8th Street. Now, no one goes to Bloomington without a visit to the famous spot, the place having been made attractive as well as historic.

About the center, a platform 10 x 12 has been constructed of cement 2 ft. high. On the center of this, is a large clock of oolitic stone, made circular; on the front and top of which is cut in letters laid in gold leaf the words "Center of Population, U.S.A. 1910 Census."

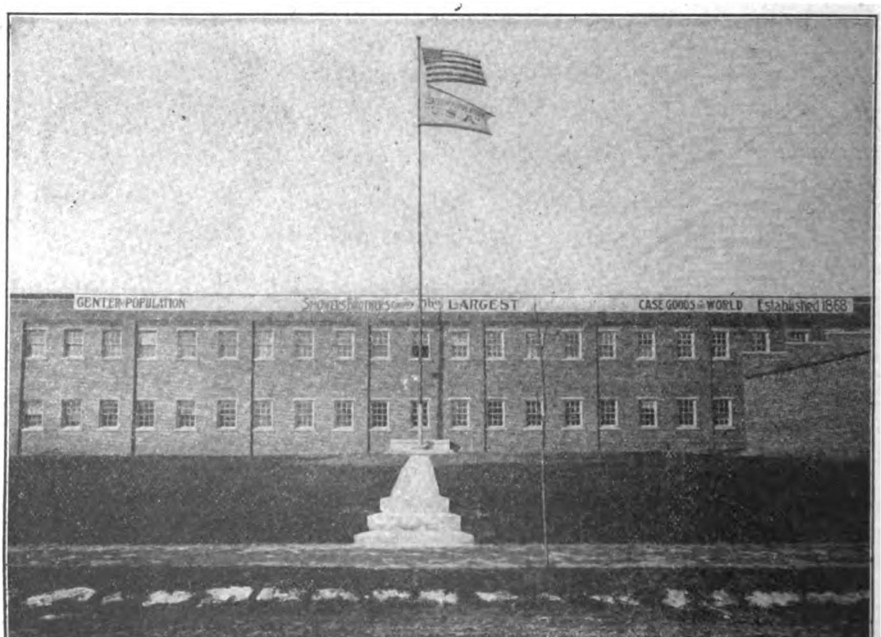
The flag staff for the light runs up from the center of this stone and from the top of the staff floats a large American flag to denote patriotism, and beneath it a pennant 8 x 14, which reads "Center of Population, U.S.A., 1910." Located on the front of the platform is a very fine block of oolitic stone and the platform is built so that people can stand exactly on the population center.

On the pretty green lawn just east of the furniture plant on West 8th Street, the exact spot indicating the center of population was mathematically located by Prof. W. A. Cogshall, chief astronomer of Indiana University, who made his observations assisted by Prof. C. A. Drew.

It is proper and in keeping that in the population center monument an oolitic stone is also displayed, and in fact the entire arrangement is in keeping with such an event, and is by far the most pretentious reception and honor that has ever been accorded the center of American population.

"Well begun is half done"; and many people stop right there.

To do work in haste well, you must have first done a large lot of work slowly.



MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

THE DRAWING MATERIALS—Continued

9. *Scales.*—The scales used in mechanical drawing are usually made of boxwood, and in many cases have white celluloid edges. They are made in two general styles, the one being flat, while the other is triangular. In most cases, however, the triangular form of scale is the one preferred, since it not only has the greater number of edges, but also because when laid upon the paper, the scale divisions will lie close to the paper and the light will fall directly upon the ruled surface. The edges of the scale should be perfectly straight and free from all nicks, while the graduations should be narrow, clean-cut lines. At times, steel scales or paper scales are used. While the steel scale is not subject to the slight variations, such as warping, of the wooden scale, yet one seldom uses the steel scale except in cases where very fine measurements must be made. The chief object in having a paper rule or scale is that the paper rule or scale will expand or contract, under the varying degrees of moisture in the atmosphere, in the same manner as does the drawing-paper.

A scale should never be used as a straight-edge or ruler, since such use would soon batter its edges and thus render it useless for accurate work.

When measuring a line, lay the scale along the line in such a manner that the desired edge of the scale is away from the body and in a good light. Always measure directly with the scale, for if measurements are taken off the scale by means of either compasses or dividers, the surface of the scale will very quickly become marred and scratched, thus rendering it unfit for use. In laying off distances, use the "needle-pointed" pencil or a pricker; a pricker being simply a needle or other sharp point, inserted in a wooden handle. In order to avoid any accumulation of errors, it is best to lay off as many dimensions as possible from the same point, each time adding successive dimensions instead of laying off individual dimensions separately. Of course this applies only when the dimensions are to be measured along the same line.

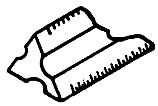


Fig. 1

For most mechanical drawing work a 12 in. architect's scale is used, and Fig. 1 is an end view of such a scale.

As is seen from the cut the scale is triangular in shape and the grooves on its faces are for convenience in handling as well as for lightness. One of its edges. divided into inches, halves, quarters, eighths and sixteenths of an inch. The other five edges each have two scales, the one being one-half the other. Small numbers at each end of each scale indicate the denomination or size of the scale, as for instance on the scale marked 16, 12 in. = 1 ft., and each inch of scale is divided into 16 equal parts. This scale is called the full size scale. On the scale marked ½, ½ in. = 1 ft., and this scale is called the one-twenty-fourth size scale. The following list gives the various marks and scales.

Mark	Size	Scale of Drawing
16	Full size	12 in. = 1 ft.
3	1/4	3 in. = 1 ft.
1 1/2	1/8	1 1/2 in. = 1 ft.
1	1/12	1 in. = 1 ft.
3/4	1/16	3/4 in. = 1 ft.
1/2	1/24	1/2 in. = 1 ft.
3/8	1/32	3/8 in. = 1 ft.
1/4	1/48	1/4 in. = 1 ft.
3/16	1/64	3/16 in. = 1 ft.
1/8	1/96	1/8 in. = 1 ft.
3/32	1/128	3/32 in. = 1 ft.

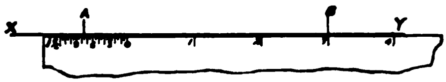


Fig. 2

If, for instance, it is desired to make a drawing one-eighth size, use the scale marked 1½, since on this scale 1½ in.= 1 ft. At one end of the scale, a distance of 1½ in. is divided into 12 parts, each part of which is sub-divided into 4 parts. Each of the 12 divisions represents an inch and the sub-divisions represent portions of an inch. Since the scales are so divided, it requires very little calculation to lay off any required distance. For example, suppose that it is desired to lay off a distance of 3 ft.—7½ in., making it one-eighth size. Use the scale marked 1½ and find the mark corresponding to 7½ in. on the end of the scale. Place this mark over one end of the desired length, as at *A*, in Fig. 2. Then the point *B*, which is opposite the mark 3 on the scale, will be the other end of the measured distance. In other words the number of feet is measured or read from the zero mark on the scale toward the right, while the number of inches are read from the zero mark toward the left.

Another type of scale which is used to some extent is the engineer's scale. This scale, like the architect's, is usually 12 in. long, and is graduated into 600 equal parts. Each inch is therefore divided into 50 equal parts, each of which is usually used to represent 1 ft. This scale is chiefly used for civil engineering work.

10. *Scale Guard.*—When the same scale is to be used for some little time, a metallic clip or guard is slipped on the scale and serves to indicate which face of the scale is being used.

11. *Curves, Splines and Lead Wire.*—When it is desired to draw lines which are neither straight lines nor arcs of circles, it is customary to use templates called curves. These curves are made of wood, hard rubber or celluloid, and their use is so obvious that but little explanation is required. One of the curves is laid along the line of points, which determine the position of the desired curved line. Starting with some one of the points, first, draw a smooth, free-hand pencil curve through the remaining points. Second, apply a portion of one of the irregular curves which seems to fit most closely the free-hand curve. Third, draw the final curve by following the irregular curve. Do not try to save time by going beyond the point where the free-hand curve and the irregular curve coincide, for, if this is done the final curved line will not be a smooth one. The curves must be adjusted carefully for good results, and the drawing of irregular curves gives excellent practice in accuracy. Be sure to always keep the pen or pencil tangent to the curve and perpendicular to the paper.

Splines are long, flexible strips of wood or rubber, from 2 to 5 ft. long. They are held in place by means of weights, and are used for drawing long, irregular curves. Spline weights have projecting metal fingers which fit into a groove on top of the spline. The spline is thus held firmly in place, while one of its edges is left free. This edge can be adjusted to any curve and a line of any length drawn.

Lead wire is often used for drawing irregular curves. A special form of this wire is an adjustable curve ruler or "snake." This consists of a lead center having thin, flexible steel strips along the two working edges and the whole covered with a rubber sleeve. Such a rule can be instantly adjusted to a curve of any shape. The working edges of the ruler are made rounded, and thus parallel curves may be drawn by merely inclining the pencil.

12. *Protractors.*—When it is necessary to lay off angles which are not given by the triangles, a protractor, such as is shown in Fig. 3 is used. Protractors are made of metal, wood, rubber, horn, celluloid or paper, but for mechanical drawing work the metal or celluloid ones are to be preferred. They are usually made semicircular in form, having a reference line near the bottom and lines on its rim, which are drawn radially from the middle point of the reference line. The various degrees are marked on the rim. When using the protractor, place the center *A* at the vertex of the desired angle, as shown in Fig. 3, and lay the base of the protractor so that the reference line will coincide with the base line of the desired angle. Now make a small mark at point *C*, which is opposite the desired angle; in this case the angle is 35 degrees. Now remove the protractor and draw the line

CA. Then the angle *CAB* is the required angle. For very accurate work it is best to use a trigonometric method of determining the angle, and such a method will be described later in the course.

13. *Thumb-Tacks*.—Thumb-tacks are tacks having large, flat heads and long, thin points. They are used for fastening the drawing-paper to the drawing-board and since the head of the tack is but little raised above the surface of the paper, the T-square will ride easily over them. Sometimes 1 oz. copper or iron tacks are used for attaching the paper to the board, but such tacks are more difficult to remove from the board, and, therefore, they are not quite as convenient as are thumb-tacks.

14. *Horn-Centers*.—When many circles are to be drawn about a common center, a horn-center is sometimes used. Such a center consists of a small, circular piece of horn, around the edge of which three small points are imbedded. The center is placed as nearly over the required point as is possible, and is held in place by the three small points. The compass point is then pressed into the horn instead of being pressed into the paper, and thus the circles can be drawn without injuring the paper and with no loss in accuracy.

15. *Lettering Pens*.—An ordinary steel pen, having a fine and yet well rounded point, is used for lettering or dimensioning the drawing.

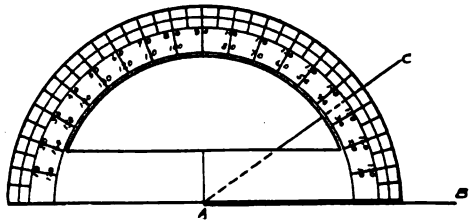


Fig. 3

16. *Two-Foot Rule*.—When making sketches or at any other time when measurements must be taken of a piece of machinery, a 2-foot rule, having each inch divided into 32 parts, will be found most convenient. It is best to use a rule having brass edges. Where, however, it is necessary to secure greater accuracy a steel rule is used.

17. *Calipers*.—Two kinds of calipers are used in mechanical drawing work, one kind being known as inside calipers, the other as outside calipers. Calipers are used for obtaining such measurements as the diameter of a shaft or the diameter of an engine cylinder. After they have been set to the diameter which is being measured, they are placed against the edge of the rule and the distance between the legs of the calipers is read directly.

Author's Note—The preceding paragraphs have described all of the more important drawing materials, and in the next installment the drawing instruments will be considered.

THE CLOCKS OF TURKEY

Fifty years ago, says a writer in *Armenia*, a watch or a clock was almost as rare in Turkey as an aeroplane is in America now. Even today, in the smaller cities and villages, house clocks are a luxury of the rich.

One of their methods of telling time by the sun is to make a kind of sun-dial of their hands. They hold their thumbs so that they touch each other horizontally and extend the forefingers up perpendicularly. Then they divide the thumb and forefinger of each hand into six parts, nominal hour points, one hand representing the morning and the other the afternoon. According to this division, where the thumbs join is 12 o'clock, the tip of one forefinger represents 6 o'clock in the morning and the top of the other 6 o'clock in the afternoon. The hours between 12 and 6 fall at different points between the junction of the thumbs and the tips of the forefingers.

Telling the time by a cat's eye sounds absurd, but it can be done. Everyone, perhaps, is not aware that the shape of the cat's eye undergoes a progressive change during the day. In the morning the pupil is round, but as the day advances it gradually narrows, until at noon it becomes merely a narrow streak. From noon to night it reverses its action, becomes oval at about 3 o'clock, and is again round at about 6 o'clock.

CROSSING THE EQUATOR

When the "Battle" fleet crossed the equator on its way to the Pacific Ocean three-fourths of the crew of 14,000 men experienced their first shave at the hands of Neptune, and although they did not overly relish the treatment received from the monarch of the seas, they took the fun with the best of grace and were thankful to receive the certificate of initiation which in the future will place them among the tormenters, not the tormented. It is a time-honored tradition in the navy that a sailor crossing the line for the first time must be shaved by "Neptune Rex." The origin of the custom is wrapped in mystery, and it is difficult to find any sea-faring man who knows it by a more comprehensive name than "initiation." Ships generally try to reach the equator at noon, and Neptune pays each ship a preparatory visit the night before reaching the line, and this is the way it is done:

A hail is heard, apparently a hundred yards from the bow: "Ship ahoy!" The officer of the deck on the forward bridge replies: "Ahoy! and who may you be?" The reply comes: "Neptune Rex, monarch of all the seas." "Come aboard, sir," says the officer courteously, at which invitation Neptune climbs on board and is met on the quarterdeck by the captain or the admiral, to whom he presents a bag of fish and a warrant of summons to be served on the unfortunate members of the crew whose names he has not yet placed on his rolls. Then with many bows and interchange of florid compliments Neptune goes over the bow again, after informing the captain of his intention to return the following day with all of his court and having received the officer's assurance that everything would be ready for his reception.

The following day the ship crosses the line and shortly after the engines slow down and Neptune comes over the bow, accompanied by his wife, clerk, barber, doctor, bears, and policemen with stuffed clubs with which to belabor the victim who may show fight. Neptune is attired as grotesquely as possible and to an elaborate degree according to the ingeniousness of the crew, and of late years the ceremony has been attended by a showing of splendid costumes and innovations never dreamed of by the older man-of-warsmen. Neptune and Amphitrite wear crowns. The barber carries a bucket and a whitewash brush and a razor usually made of wood or a barrel hoop. Preparations on deck had already been made, there being a large canvas basin filled with water, spilling line, etc. The clerk opens his books, using a coil of rope as a desk, and Neptune calls out the names of the victims, and one by one they go through the ceremony to the delight of the audience which crowds the rails, turrets, bridges and tops. If a man foolishly hides himself away the policemen go after him and whack him so that he wished he had remained to take his medicine. A victim is seated on the edge of a platform, and when he opens his mouth to answer a question a large unsavory pill, made of soap, pepper, etc., is inserted in his mouth. Then the barber gets to work and lathers him, using the whitewash brush, and covers his face and clothes with a composition of sand, molasses, flour, salt and anything that will make a disagreeable mess. With a final shove the almost initiated goes backwards into the tank where the seabears are waiting to welcome him, with brooms and swabs and a hose of running sea water. No matter how roughly some of the men may be used, none ever thinks that the trouble is not worth while the pleasure experienced when the certificate of initiation is handed him by Neptune after the ceremonies. The officers are not exempt from the initiation, and sometimes one will be found who prefers the real experience to paying a forfeit of wine, beer and cigars. Every dog has his day, and so has the enlisted man, for from the time Neptune's flag is hoisted to the truck until pipe down after the ceremonies, there is no restriction upon any reasonable amount of fun, and rank is not excused from the good-natured though respectful pranks of the petty officers and men.—*The Blue Jacket.*

Some New York boys, according to the *Sun*, have a yell which goes like this:
Pooh, Pooh, Harvard! Pooh, Pooh, Yale!
We learn our lessons through the mail!
We're no dummies; we're no fools!
Rah! Rah! Rah! Correspondence Schools

METAL DRILLING. Part II

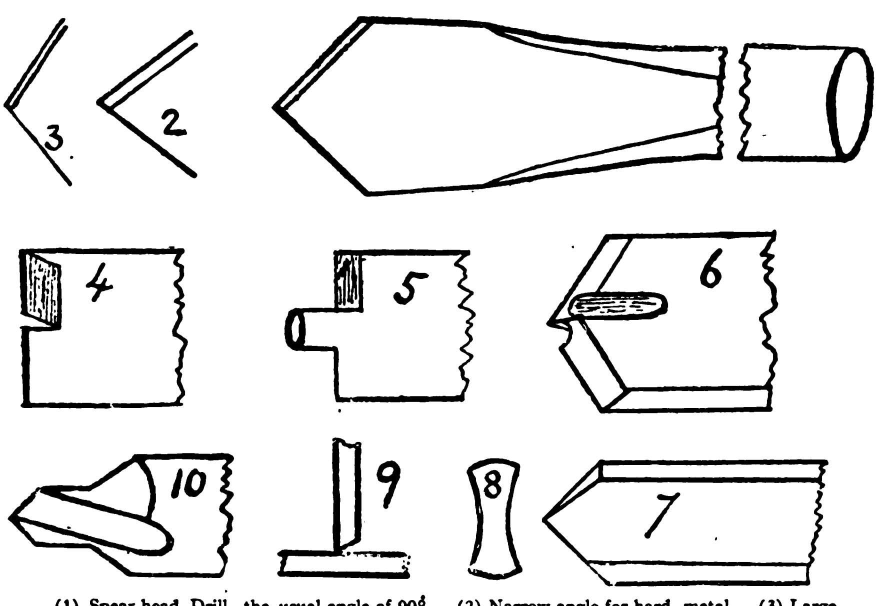
Drill-Making, Tempering and Using

M. COLE

Case Hardening.—In an emergency it is sometimes necessary to make a tool of wrought iron instead of steel; the surface may be converted to steel by case hardening. Take equal parts of prussiate of potash, sal ammoniac and salt; powder and mix them. Heat the iron to a bare red heat, dip in the powder and put in the fire so as to melt the mixture; remove and repeat process several times; then raise to a full red and temper in the usual way. Another process is with leather cuttings; but, although better, it is too slow for emergency work.

CHUCKS, DRILL STOCKS, ETC.

In their earliest forms, metal drills were only pressed against the work and turned to and fro by hand (though a form of bow drill was used by the ancient Egyptians), but it is obvious that this method is too slow for modern times. There are two methods by which a drill may be moved, viz.: continuous and reciprocating. The former is of course the preferable one, as in that case the drill cuts all the time it is moving; while by the latter it cuts only when moving in one direction, the time used in the return stroke being wasted. The fiddle, or bow drill, watchmakers' turns, and Archimedian drills belong to this class. The bow drill in its various sizes is the easiest to make. In its simplest form, the drill itself has a pulley or bobbin on which the cord of the bow works to give it motion, while the upper end of the drill is pointed and rests in a countersink in some suitably placed piece of metal. In small turns this is usually the end of the bench vise, the work being supported on a suitable block to bring it to the right height; or the work may be placed against another point in the same plane as the drill. In larger sizes it rests in the countersink of a plate of metal placed against the breast of the worker, who can thus apply pressure to the drill; this is, however, a very dangerous method, and should be avoided. The Archimedian drill stock is much safer. In all drills of this class, there is some difficulty in keeping them perfectly steady so as to drill a straight hole to any depth; they are, however, useful for thin work. The Swiss drill is used upright, and can easily be fitted with a bracket to keep it in position so as to do accurate work. It is only suitable for small holes, as there



(1) Spear-head Drill, the usual angle of 90°. (2) Narrow angle for hard metal. (3) Large Angle for thin metal. (4) Flat-end Drill for flat bottom hole. (5) Pin Drill for flat bottom or for surfacing round a hole. (6) Method of reducing size of idle point. (7) Channel Drill. (8) Section of same. (9) Cutting edge on work. (10) Combined Drill and Countersink for work to be put in lathe.

is only the weight of the tool to keep the drill up to its work. The continuous motion drill is in every way to be preferred. All modern drilling machines and drill stocks belong to this class.

Chucks.—Except in the simplest form of bow drills, etc., the drill is separate from the tool that gives it motion, and is held either in a socket that takes one size drill body, or in a chuck that will take various sizes. The Bell chuck is one of the earliest styles of adjustable chuck, and is one of the most dangerous tools ever made. The self-centering chuck is the best and most practicable method of holding a drill, and will soon be the only one.

These chucks are now very much lower in price than they were a few years ago, and can be had in all sizes, from the smallest used by watchmakers to those required for drilling the heaviest work. They can also be used for drilling work in the lathe between the centers, the shank end of the chuck resting against the running center, and carried round by a dog or carrier, the work being held between the point of the drill and the back center. For light castings where heavy work is to be drilled, it must of course be supported in the usual way.

Boring and Drilling in the Lathe.—When the chuck (of whatever form) is fixed to the head of the lathe, the result is really a horizontal drilling machine, but when very accurate work is to be done the drill should rest against the running center, and be carried round by a dog or cramp fixed to it, and driven by a pin on the face-plate. When the work revolves instead of the drill the process is boring, whether the cutter is the full size of the hole as a drill or smaller and attached to a rod as in a boring bar.

Joiner's Brace and Drills.—For odd jobs a joiner's brace of modern pattern fitted with a jaw chuck will do a large range of work. The drills have a square shank and fit well in the chuck. Twist drills should never be used in such a brace, as they are liable to be strained. Holes up to 1/4 in. in brass, or 1/8 in. in iron, are easily drilled with a brace. For larger-sized holes, a leading hole should be drilled first, say, 1/8 in., then follow with a larger drill. Those braces fitted with ratchet have the extra advantage that the hole can be drilled in places where there is not room enough for the sweep of the brace. As a good deal of pressure is required to prevent the drill slipping when drilling the larger holes, it is necessary to rig up some arrangement to get the pressure by a lever. This is easily made from a few lengths of wood.

Drilling Hard Steel.—It is sometimes necessary to drill a hole in hard steel. In tempered steel this can be done with a drill left dead hard, but the utmost care must be used not to put on much pressure or the drill will break. If the steel is too hard for this, a splinter of either diamond or corundum, mounted as a drill, must be used, or it may be done with a copper rod fed with emery powder. In this case a guide is made from a bit of wood with a hole in it the size of the drill. cramped on the work, so as to keep the drill in its place. Feed with emery of moderate fineness, and use oil to keep it in place. The grains of emery will bed themselves in the copper, but the pressure is not great enough to force them into the iron.

Very small or delicate work should be held in the fingers, the hand resting on the work bench or other support. A bow drill is best for this, the pointed end resting in a hollow in the side of the vise or other fixed object. There is so much flexibility in this arrangement that breakages seldom occur. The hole is afterwards rectified with broaches, which can be had in all sizes from the size of a fine needle upwards.

Drilling a hole in a ball is not difficult if the work is properly held. To make a ball cramp, bore holes of various sizes in two pieces of wood held together; when separated the ball can be put between a pair of holes of size smaller than itself. The boards when cramped together will hold the ball firmly and without injury, if reasonable pressure is used. Pearls are thus held for drilling, either through for beads or half through for mounting as pins.

Table B

Colors of Finest Tool Steel at various heats.

430° F.	Very pale yellow	Gravers, drills, light turning tools
457° F.	Straw yellow	Paper cutters, milling cutters
495° F.	Brownish yellow	Taps, punches, reavers, twist-drills
528° F.	Light purple	Plane irons, wood tools
535° F.	Dark purple	Wood chisels
570° F.	Clear blue	Screw-drivers, springs
600° F.	Dark blue	Saws for wood
610° F.	Pale blue	Saws for wood

Tools of awkward shape should be heated in Linseed Oil which boils at 600° F., so that the tools cannot be overheated.

Drilling Glass.—Holes can be drilled in glass with ordinary steel drills as used for metal, kept cool with either turpentine or paraffin oil, but the glass is broken off in fragments rather than cut. To start the hole, rub the glass at the place to be bored with a bit of emery cloth, then tap gently with a sharp pointed bit of hard steel, until a hollow is formed deep enough for the drill to rest in and get a grip of the glass; then proceed as in metal drilling, but using slow speed. When half way through, reverse the work and drill from the other side, to complete the hole, which can be opened to square or other shape with a file kept wet to prevent heating.

Diamond Drills are made from a splinter of the outer crust of the diamond, which is much harder than the inner parts used for jewelry. To mount it, drill a hole in the end of a piece of brass wire, insert the splinter of diamond and fill up with soft solder; then remove as much as is necessary to expose a cutting surface.

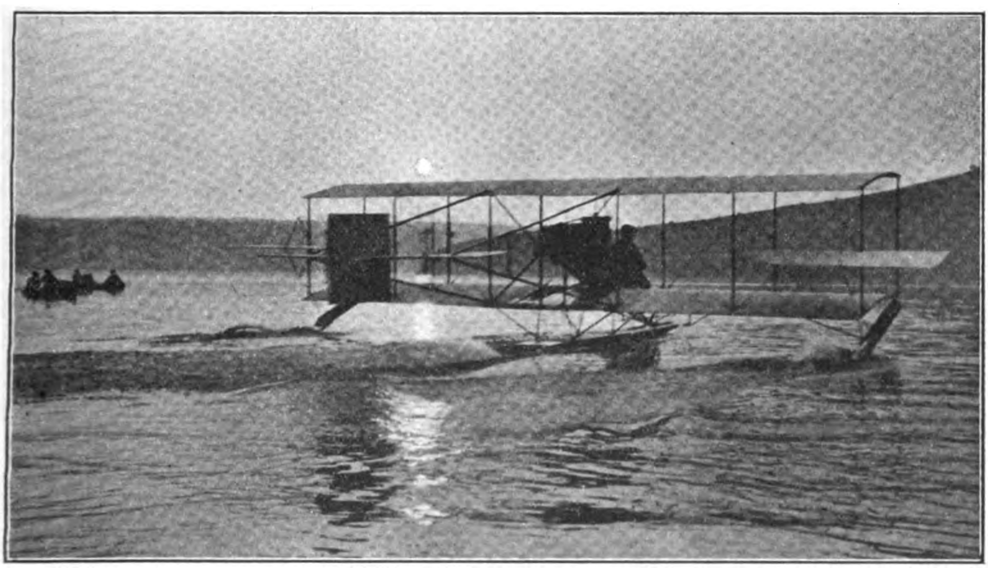
TABLE C

Speed of Twist Drills compiled by the Morse Twist Drill Co.

Diameter	Speed for Steel	Speed for Iron	Speed for Brass
1-16 in.	1712	2383	3544
1-8 in.	855	1191	1772
3-16 in.	571	794	1181
1-4 in.	397	565	855
5-16 in.	318	452	684
3-8 in.	265	377	570
7-16 in.	227	323	489
1-2 in.	183	267	412
9-16 in.	163	238	367
5-8 in.	147	214	330
11-16 in.	133	194	300
3-4 in.	112	168	265
13-16 in.	103	155	244
7-8 in.	96	144	227
15-16 in.	89	134	212
1 in.	76	115	191

It must be used carefully, as, although it is the hardest known material, it is very brittle and easily broken. A fragment of corundum is almost as good for the purpose. The diamond drill is usually kept wet with turpentine to prevent the heat produced softening the soft solder.

Drilling Fluids.—Use soapy water for wrought iron; oil for steel.



The Start at Sunset

This interesting photograph was taken by Mr. Ward E. Bryan last July, while he was camping on Keuka Lake. The lake is located in New York, and extends from Hammondsport to Penn Yan, a distance of some 20 miles. The Curtiss aeroplane factory is at Hammondsport, at one end of the lake, and a pupil of Mr. Curtiss was trying out the Hydro-aeroplane, having a naval officer from Washington as a passenger. Mr. Curtiss met them at Keuka Landing, which is half-way up the lake. The trip up the lake was on the surface of the water, but on their return from Penn Yan they flew several feet above the surface.

EXTINGUISHING A BURNING GAS WELL

Extinguishing a burning gas well which was delivering over a million cubic feet of gas per hour at a pressure of about 600 lbs. per square inch, was accomplished last winter at Vanderpool Well No. 1 of the New York Oil & Gas Company, near Independence, Kan. The well had been drilled to a depth of about 1,500 ft., and there was in the hole about 300 ft. of 8¼ in. casing when the gas was struck. The gas was, in a measure, unexpected, and certain fittings not being on hand it was decided to tube the well with 6 in. pipe and set a packer. When 1,100 ft. of 6 in. pipe were in the well and its closure seemed certain, a severe electrical storm occurred and a flash of lightning ignited the escaping gas. Forty feet of 6 in. pipe had been left extending above the ground and from the top of this there rose with a great roar a jet of burning gas 150 ft. high, which destroyed the derrick over the hole.

The problem included not only extinguishing the flame, but also preserving the well so that the gas could be finally controlled. Nine boilers, such as are used in connection with oil well drilling outfits, were collected; and eighteen 2 in. jets of live steam at a pressure of about 120 lbs. per square inch were simultaneously turned on the flame in an attempt to smother it. No impression was made and the scheme was abandoned. The two joints of pipe projecting above the ground were removed by throwing a line round the top, bending the pipe to one side about 45 degrees, and then unscrewing it close to the ground with the same line. The 1,100 ft. of pipe hanging in the well was supported by "elevators" or clamps fastened around its top and resting on the top of the 8¼ in. pipe.

It was determined to cover the well with a conical hood, through the top of which the flames could pass until the bottom should be made tight when the top could be closed and the flame extinguished. This plan was finally carried out successfully, but not until numerous unsuccessful attempts had been made and considerable special apparatus destroyed. The cast-iron hood finally used was conical in form, 3 ft. in diameter at the base and about 6 ft. high. In the top was fixed a 12 in. gate valve upon the stem of which was fastened a reel wound with flexible wire so that two men running out with the end of the wire could quickly close the valve. A crane built of 6 in. steel pipe with a mast about 50 ft. high and a boom about the same length was placed so that when the boom was swung over the well the hood would come directly above the opening. Means were provided for controlling the motion of the hood in all directions. The clamps holding the 6 in. pipe were then pried off and the pipe slipped down, causing the flame to issue solidly from the 8¼ in. casing. This made it possible to approach the well with screens and dig a saucer-shaped cavity around it, which was made muddy so that the bottom of the hood might be submerged. The latter was then lowered to place and the flame shot through the gate valve. The bottom of the hood was made tight with successive layers of earth and canvas kept thoroughly wet and wire cables were thrown over the hood and fastened to dead men buried deep in the ground. When all was ready the men who were to shut the valve were given the signal to run. The attempt was successful, after five weeks of effort, and the flame went out. Less than ten seconds later the gas broke through under the hood, but the fire being extinguished, closing the well was then an easy matter.—*Engineering Record.*

A Cure for Restlessness

(*By William Wallace Whitlock*)

Why they called Bill Meyer "shiftless"
Was a question for the wise,
For he "shifted" without ceasing
In each business enterprise.
He was first a traveling salesman,
Then a patent lawyer's clerk,
When he tired of patent cases,
For a bank he went to work.
Teacher, preacher, writer, speaker—
He was each and all of these,
But for some mysterious reason
Every calling ceased to please.
Till at last the Weather Bureau
Made a place for him, and then,
As the weather did the changing,
Why, he never changed again.

—*Judge.*

THE USE OF CONCRETE ON THE FARM *—Concluded

Equipment for Mixing Concrete

When the proper materials have been selected, the next step is to mix them properly and with dispatch. On large jobs it is more economical to mix concrete by machine, but for small jobs, using even as much as several hundred cubic yards of concrete, it is much cheaper and more expedient to mix by hand. This is, of course, especially true when only two or three men are available and the work is often interrupted. There are many ways of mixing by hand, all of which have the same good results. The way herein described is believed to be the one best calculated to obtain good results with a minimum of labor. In this description and the accompanying illustrations, a 2-bag batch of 1:2:4 concrete is taken as the basis of the calculation.

The Concrete Board.—A concrete board for two men should be 9 x 10 ft. It should be made of 1 in. boards, 10 ft. long, surfaced on one side, and should be held together by five 2 in. x 4 in. x 9 ft. cleats. If tongue and groove roofers 1 x 6 in. can be obtained, fairly free from knots, they serve very well. The boards are surfaced in order to make the shoveling easy. They are so laid as to permit the shoveling to be done in the direction in which the cracks run, so that the shovel points will not catch in the cracks. The boards must be nailed close together so that no cement grout may run through them during the mixing. Knot holes may be closed by nailing a strip across them on the underside of the board. It is a good precaution against losing cement grout to nail a piece of wood 2 x 2 or 2 x 4 in. around the outer edge of the board. Often 2 in. planks are used in making concrete boards, but these are unnecessarily heavy and very difficult to move.

The concrete board is the manufacturing plant, and the advantages of its location should be carefully considered. Generally it is best placed as close as possible to the forms in which the concrete is to be deposited, but local conditions must govern this point. A place should be selected which affords plenty of room

*U.S. Department of Agriculture. Farmers' Bulletin 41.

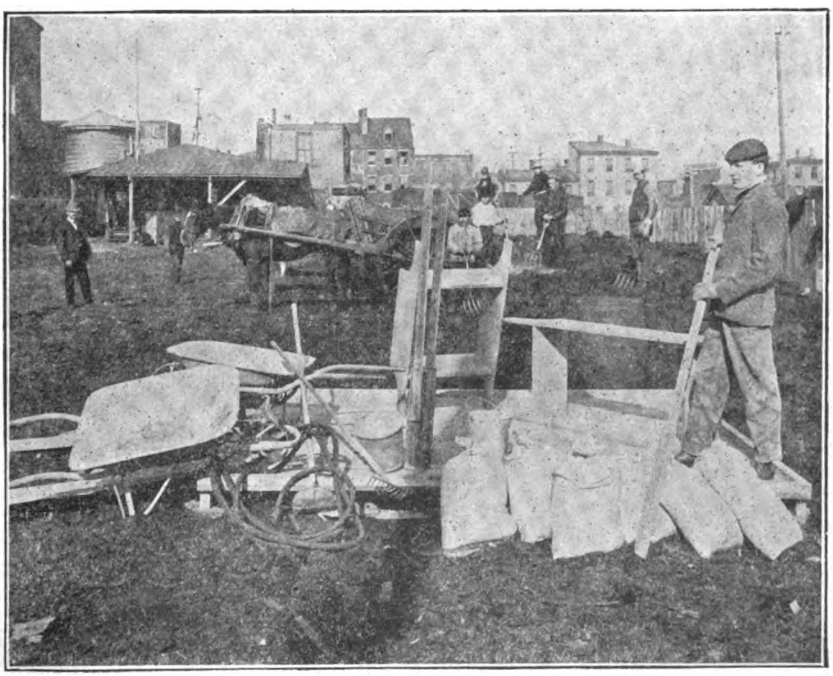


Fig. 3. Concrete Board and Various Tools used in making Concrete

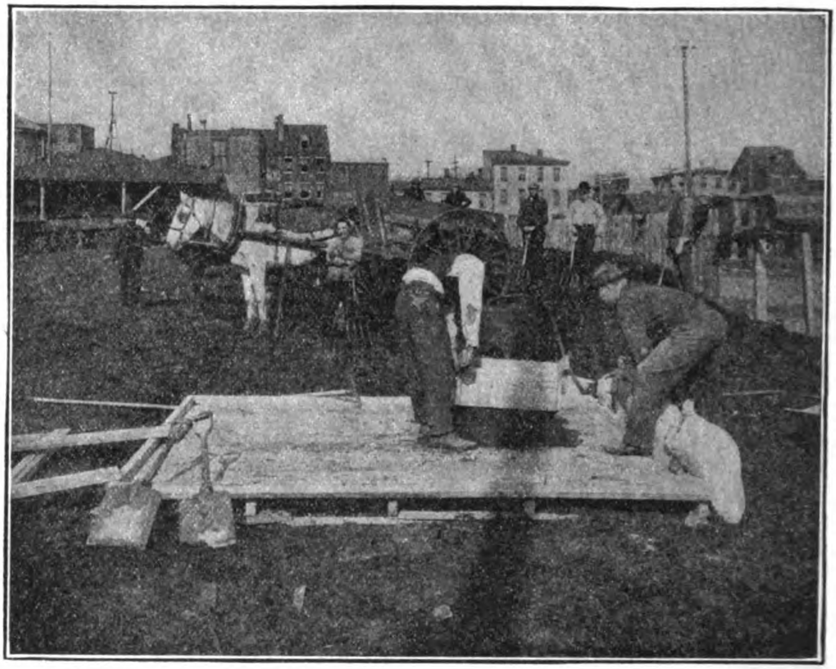


Fig. 4. Measuring Sand

and is near the storage piles of sand and stone or pebbles. The concrete board should be raised on blocks so as to be level, in order that the cement grout may not run off on one side and that the board may not sag in the middle under the weight of the concrete.

Runs.—The boards for the wheelbarrow runs should be carefully selected. The run should be well built, smooth, and at least 20 in. wide, if much above the ground. It is surprising how this one feature will lighten and quicken the work.

Miscellaneous Tools.—The following is a list of the tools and plant to be used in mixing, giving sizes, quantities, etc.

The lumber for the concrete board for a 2-bag batch, 9 x 10 ft. in size, is as follows:

9 pieces ⅞ in. x 12 in. x 10 ft., surfaced on one side and two edges*
5 pieces 2 in. x 4 in. x 9 ft., rough
2 pieces 2 in. x 2 in. x 10 ft., rough
2 pieces 2 in. x 2 in. x 9 ft., rough.

The lumber for the concrete board for a 4-bag batch, 12 x 10 ft. in size, is as follows:

12 pieces ⅞ in. x 12 in. x 10 ft., surfaced on one side and edges*
5 pieces 2 in. x 4 in. x 12 ft., rough
2 pieces 2 in. x 2 in. x 10 ft., rough
2 pieces 2 in. x 2 in. x 12 ft., rough

For the runs, planks 2, 2½ or 3 in. thick and 10 or 12 in. wide are needed.

The measuring boxes for the sand and stone or gravel should have the following dimensions:

For a 2-bag batch with the 1:2:4 mixture:
4 pieces 1 in. x 11½ in. x 2 ft., rough (for the ends of the sand and stone boxes)
2 pieces 1 in. x 11½ in. x 4 ft., rough (for the sides of the sand box)
2 pieces 1 in. x 11½ in. x 6 ft., rough (for the sides of the stone box)
(It should be noted that the 2 pieces 4 ft. long and the 2 pieces 6 ft. long have an extra foot in length at each end for the purpose of serving as a handle.)

For a 2-bag batch with the 1:2½:5 mixture:
2 pieces 1 in. x 11½ in. x 2 ft. (for the ends of the sand box)
2 pieces 1 in. x 11½ in. x 2½ ft. (for the ends of the stone box)
2 pieces 1 in. x 11½ in. x 4½ ft. (for the sides of the sand box)
2 pieces 1 in. x 11½ in. x 6 ft. (for the sides of the stone box)
(As in the preceding case, the 2 pieces 4½ ft. long and the 2 pieces 6 ft. long have an extra foot in length at each end to serve as handles.)

For a 4-bag batch (these figures can be obtained by doubling the cubic contents of the boxes as shown above)

Shovels: No. 3, square point.

* Here any width of plank may be used, but 12 in. is specified as the most convenient.

Wheelbarrows: At least two are necessary for quick work, and those with a sheet-iron body are to be preferred.
Garden rake
Water barrel
Water buckets, 2 gal. size
Tamper: 4 in. x 4 in. x 2 ft. 6 in., with handles nailed to it
Garden spade or spading tool
Sand screen, which can be made by nailing a piece of ¼ in. mesh wire screen, 2½ x 5 ft. in size, to a frame made of boards 2 x 4 in.

METHOD OF MIXING

When the mixing board has been arranged and the "runs" are made, the concrete plant is ready. The sand should first be loaded in wheelbarrows and wheeled on the board. It should then be emptied into the sand-measuring box, which is placed about 2 ft. from one of the 10-ft. sides of the board, as shown in Fig. 4. When the sand box is filled it should be lifted off and the sand should be spread over the board in a layer 3 or 4 in. thick. Two bags of cement should then be spread as evenly as possible over the sand. Two men, stationed, as shown in Fig. 6, should then start mixing the sand and cement in such a way that each man may turn over the half on his side of a line dividing the board in half. Starting at his feet and shoveling away from himself, each man should take a full shovel load, and in turning the shovel, he should not simply dump off the sand and cement, but should shake the materials off the end and sides of the shovel, so that they may be mixed as they fall. This is a means of great assistance in mixing these materials, and in this way the material is shoveled from one side of the board to the other.

The sand and cement should now be well mixed and ready for the stone and water. After the last turning, the sand and cement should be spread out carefully, and the gravel or stone measuring box should then be placed beside them and filled from the gravel pile. The box should now be lifted off, the gravel shoveled on top of the sand and cement, and spread as evenly as possible. With some experience, equally good results may be obtained by placing the gravel-measuring box on top of the carefully leveled sand and cement mixture, and filling it, so that the gravel is placed on top without an extra shoveling. About three-fourths of the required amount of water should be added with a bucket, and the water should be dashed over the gravel on top of the pile as evenly as possible. Care should

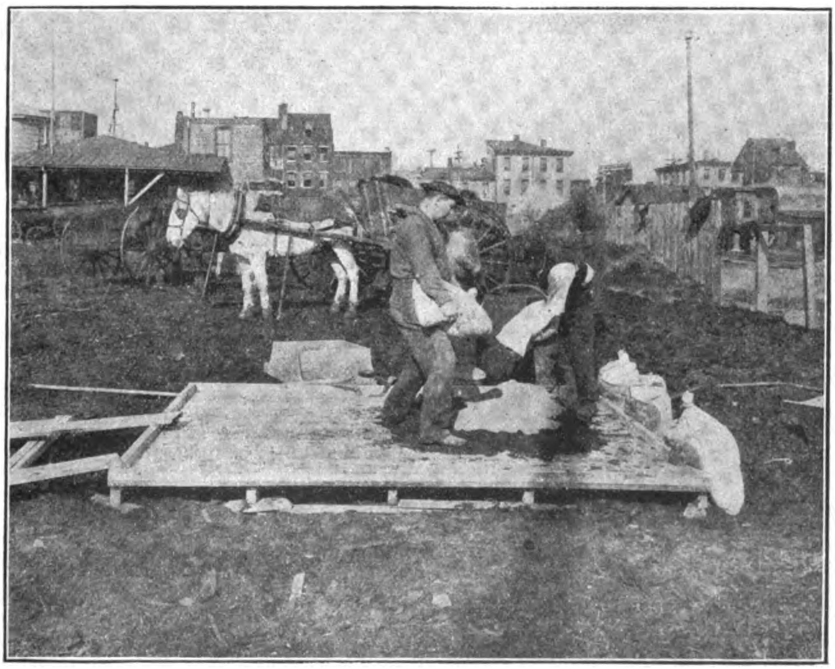


Fig. 5. Spreading the Cement on Top of the Sand

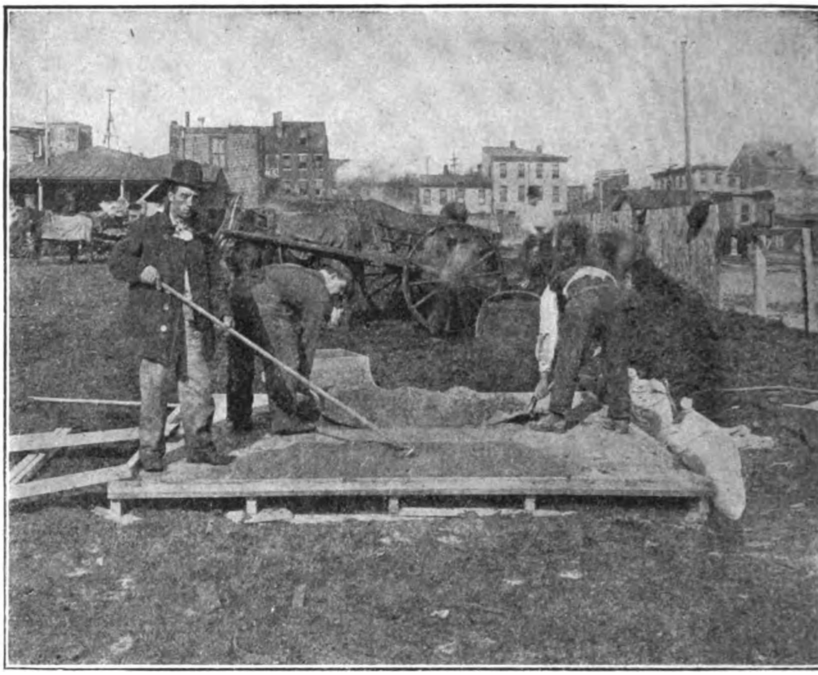


Fig. 6. Mixing the Sand and Cement

be taken not to let too much water get near the edges of the pile, because it may wash away some of the cement as it flows off. This caution, however, does not apply to a properly constructed mixing board, where water can not flow away. Starting in the same way as with the sand and cement, the materials should be turned over in much the same manner, except that, instead of shaking them off the end of the shovel, the whole shovel load should be dumped and dragged back toward the mixer with the square point of the shovel. The wet gravel picks up the sand and cement, as it rolls over when dragged back by the shovel, and the materials are thus thoroughly mixed. Water should be added to the dry spots as the mixing goes on until all that is required has been used. The mass should be turned back again, as was done with the sand and cement. With experienced laborers, the concrete would be well mixed after three such turnings; but if it shows streaky or dry spots, it must be turned again. After the final turning, it should be shoveled into a compact pile. The concrete is now ready for placing.

When a natural mixture of sand and gravel is to be used, the materials should be measured by means of the right measuring box for the proper proportion, as shown in Table No. III. The mixture of sand and gravel should be spread out and enough water added to wet it thoroughly. The cement should be distributed evenly in a thin layer over the sand and gravel and turned over, as described previously, at least three times, while the rest of the water necessary to get the required consistency should be added as the materials are being turned. It requires good judgment to prepare a natural mixture of bank sand and gravel, and, if one is at all doubtful about the concrete made from it, the sand should first be screened from the gravel as described above, and then mixed in the regular way.

For the operation of mixing, only two men are required, although more can be used to advantage. If three men are available, two of them should mix as described above, and the third man should supply the water and help in mixing the concrete by raking over the dry or unmixed spots, as the two mixers turn the concrete, and in loading the wheelbarrows with sand and stone or gravel.

If four men are available, it is best to increase the size of the batch mixed to a 4-bag batch by doubling the quantities of all materials used. The cement board should also be increased to 10 x 12 ft., In this case the mixing should be started in the middle of the board, and each pair of men should mix exactly as for a 2-bag batch, except that the concrete is shoveled into one big mass each time that it is turned back on the center of the board.

Placing the Concrete

Method.—After the concrete is properly mixed, it should be placed at once. Concrete may be handled and placed in any way best suited to the nature of the work, provided that the materials do not separate in placing. Concrete may be placed properly by shoveling off the concrete board directly into the work; by shoveling into wheelbarrows, wheeling to the proper place, and dumping; by shoveling down an inclined chute; or by shoveling into buckets and hoisting into place. Concrete should be deposited in layers about 6 in. thick, unless otherwise specified.

Consistency.—The following three kinds of mixtures are used in general concrete work:

(1) Very wet mixture.—Concrete wet enough to be mushy and run off a shovel when being handled is used for reinforced work, thin walls, or other thin sections, etc.; with it no ramming is necessary.

(2) Medium mixture.—Concrete just wet enough to make it jelly-like is used for some reinforced work and also for foundations, floors, etc. It requires ramming with a tamper to remove air bubbles and to fill voids. This concrete is of a medium consistency and would sink under the weight of a man.

(3) Dry mixture.—In this case the concrete is like damp earth. It is used for foundations, etc., where it is important to have the concrete put in position as quickly as possible. This must be spread out in a layer from 4 to 6 in. thick and thoroughly tamped until the water flushes to the surface.

The difference between the mixtures is that the drier mixture causes the concrete to "set up" more quickly. In the end, however, when carefully mixed and placed, the results from any of the above mixtures will be the same. A dry mixture, to be sure, can not be used readily

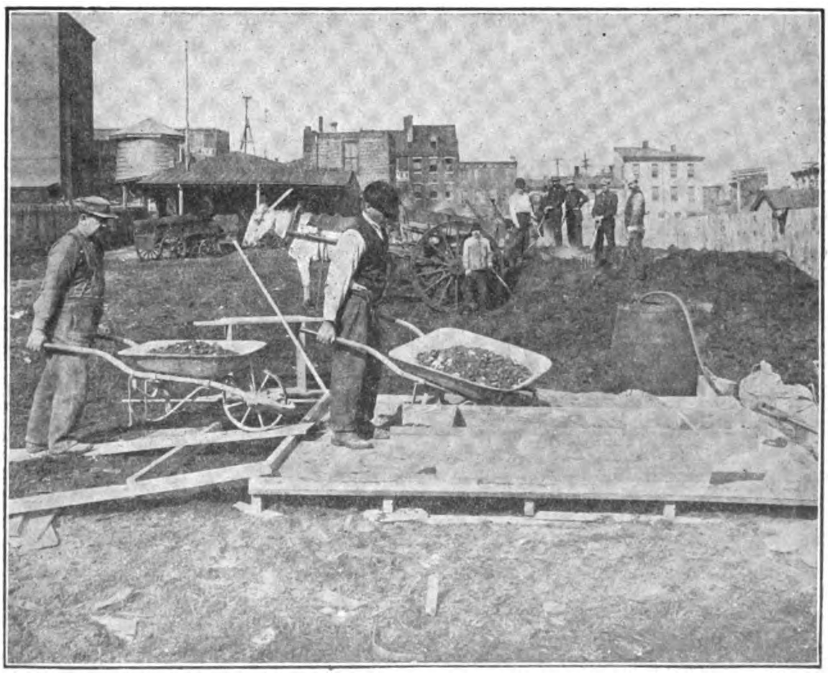


Fig. 7. Emptying the Gravel in the Measuring Box to the Side of the Sand and Cement

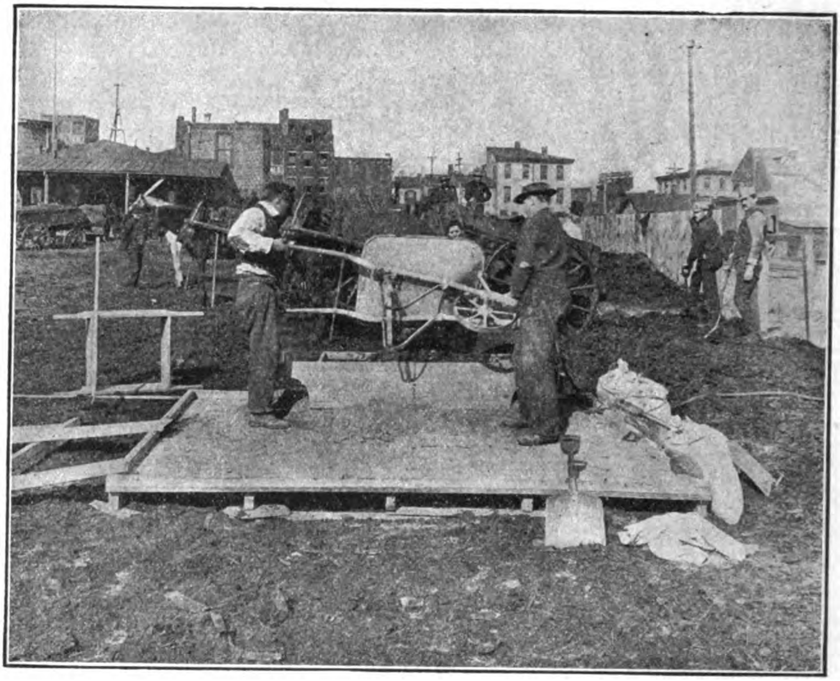


Fig. 8. Measuring the Gravel by Dumping it on Top of the Sand and Cement Mixture

with reinforcing steel, and is both more expensive and harder to handle. It must be protected with greater care from the sun or from drying too quickly, and unless spaded by very experienced hands it may show voids or stone or gravel pockets in the face of the work when the forms are removed.

Spading.—Concrete of any of the three degrees of consistency mentioned above should be carefully spaded next to the form where the finished concrete will be exposed to view. Spading consists of running a spade or flattened shovel down against the face of the form and working up and down. This action causes the stone or gravel to be pushed back slightly from the form and allows the cement grout to flow against the face of the form and fill any voids that may be there, so that the face of the work will present an even, homogeneous appearance. Where the narrowness of the concrete section, such as in a 6 in. side wall, prevents the use of a spade, a board 1 x 4 in., sharpened to a chisel edge on the end, serves as well. This board should be sharpened only on one side and the flat side should be placed against the form. In the case of a dry mixture spading must be done with the greatest care by experienced hands to get uniform results, but with a medium or wet mixture it is very easy to obtain first-class work; indeed, with a wet mixture spading is required only as an added precaution against the possibility of voids in the face of the work and is really necessary in few cases.

Protection of Concrete after Placing.—New concrete should not be exposed to the sun until after it has been allowed to harden for five or six days. Each day during that period the concrete should be wet down by sprinkling water on it both in the morning and afternoon. This is done so that the concrete on the outside will not dry out much faster than the concrete in the center of the mass, and it should be carried out carefully, especially during the hot summer months. Old canvas, sheeting, burlap, etc., placed so as to hang an inch or so away from the face of the concrete, serve very well as a protection when wet. Often the concrete forms can be left in place a week or ten days, thus protecting the concrete during the "setting up" period, and the above precautions are then unnecessary.

FORMS FOR CONCRETE

Concrete is a plastic material, and, before hardening, takes the form of anything against which or in which it is placed. Naturally, the building of the form is a most important item in the success of the work. These forms hold the concrete in place, support it until it has hardened, and give it its shape as well as its original surface finish.

Kinds.—Almost any material which will hold the concrete in place will serve as a form. Concrete foundations for farm buildings require shallow trenches, and, up to the ground line, usually the earth walls are firm enough to act as a form.

Molds of wet sand are used for ornamental work. Frequently colored sand is used for this purpose and provides both the finished surface and color to the concrete ornament.

Cast, wrought, or galvanized iron is used where an extremely smooth finish is desired without further treatment after the removal of the forms. Forms made of iron are more easily cleaned and can be used a greater number of times than those of wood. Rusty iron, however, should not be used. By far the greatest number of forms are made of wood, because of the fact that lumber in small quantities can always be obtained.

Requirements of a Good Form.—Forms should be well planned, so that there may be no difficult measurements to understand. As few pieces of lumber should be used for the work as possible, and these should be fastened together by as few nails as will serve the purpose; otherwise it will be difficult to take the forms apart without splitting them.

Forms must be strong enough to hold the weight of the concrete without bulging out of shape. When they bulge, cracks may open between the planks, and the water in the concrete, with some cement and sand, may leak out. This weakens the concrete and causes hollows in the surface, which have a bad appearance after the forms are removed.

Forms which lose their shape after being used once can hardly be used a second time. A part of the erection cost of forms is saved if the forms are built in as large sections as it is convenient to handle. This saving applies to their removal as well as their erection. Consequently the lightest forms possible with the largest surface area are the most economical.

Plans for Forms.—The first consideration in planning forms is the use to which they are to be put. Neglect of this point means waste of money and time. If they are for work afterwards to be covered

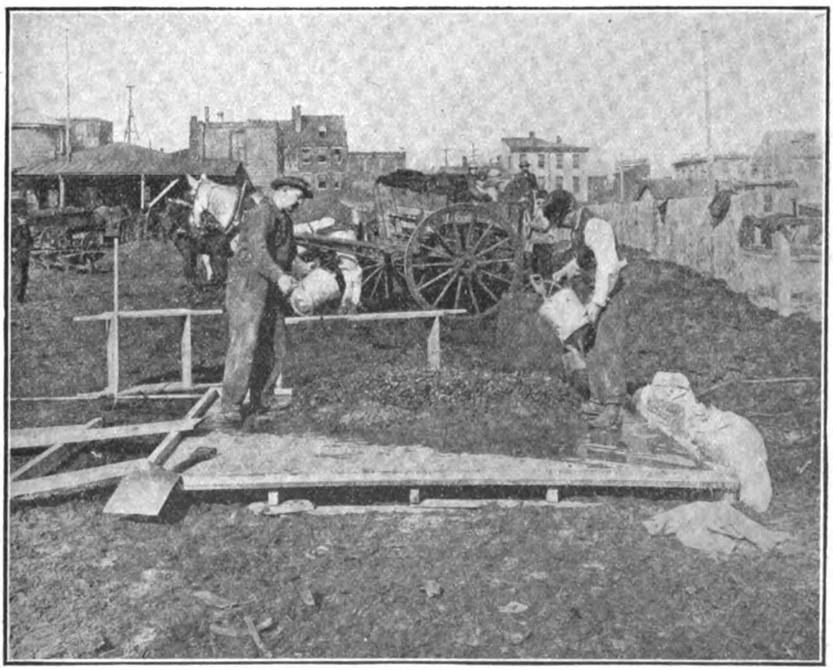


Fig. 9. Pouring Water Over the Mixture of Sand, Cement and Gravel

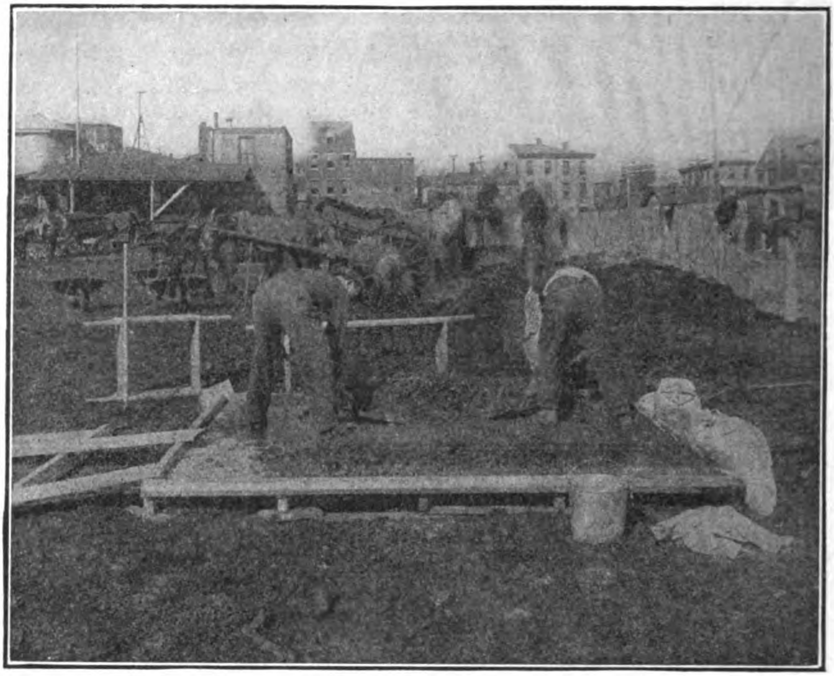


Fig. 10. Final Mixing of the Concrete

with a veneer coat, the finish of the surface is of small consideration, while the alignment of the form is all important. On the other hand, if a tank or retaining wall is to be built, the fact that the forms are not in exact alignment will hardly be noticed, but money can be saved, if the forms are rigid in alignment and surfaced.

In planning forms for large structures it should be borne in mind that if the forms are to be used several times the more nearly perfect they are the more often they can be used and the cheaper they become. If forms are to be used only once, as is generally the case on the farm, they should not be nailed so securely as to prevent them from being readily taken apart and the lumber from being used for something else. It is often better to put them together with screws, but if nails are used, they should not be driven in all the way.

Selection of Lumber for Forms.—The selection of the lumber is of importance. If the forms are to be used many times, the use of surfaced lumber, matched, tongued and grooved, and free from loose knots, is economical. If, however, they are to be used only once, almost any plank will do. Forms with bad cracks or knot-holes may be made tight by filling them with stiff clay mud and then tacking a strip over the crack and on the outside of the form.

Green lumber is preferable to kiln-dried or seasoned material. Seasoned lumber, when wet, either by throwing water on the form before placing the concrete, or by absorbing the water from the concrete, warps, and the shape and tightness of the form are damaged.

Originally, only surfaced lumber was used for forms, and this was depended on to give a finish to the work, while today, since rough surfaces for concrete are the fashion, unfinished lumber may be used. Nevertheless, surfaced lumber has some advantages for use in forms. The forms fit together better and are easier to erect. They are more easily removed and cleaned. All of these items reduce the cost of the work, but the saving effect will, of course, depend on the difference in local price between finished and rough lumber.

Method of Cleaning Tools and Forms.—At the beginning of the noon period and again at the end of the day's work all the tools, and especially the concrete board, should be carefully cleaned. Particles of concrete are also very apt to adhere

(*Continued on page* 411)

THE HOME CRAFTSMAN

RALPH F. WINDOES

THE MODERN SUBSTITUTE FOR THE APPRENTICESHIP SYSTEM

Perhaps no other tradesman has suffered more by the advent of modern machinery than the metal-worker. The all-around machinist of our fathers' time, the man who could construct an engine from the designing to the painting processes, is now almost a thing of the past. His place has been taken by the "specialist," the mere "hand," who can do but one thing and do it well; the man whose mentality stopped growing when he first pulled a lever on a certain machine, and whose mind will remain dormant as long as he does pull that lever and thinks of no good reason—outside of a remunerative one—why he is pulling that lever. By this I mean that the "hand" of today is given a machine to work at, he is shown how to run that machine, how to make a certain article, and told to keep at it. But he is not told what that article is to be used for, along with others, and very often he does not care. If such is the case he loses his interest in the work, and worst of all, he stops growing, culturally at least.

Let us consider how the conditions developed which placed the worker in such an undesirable position. Years ago we had the apprenticeship system of training. A boy was pledged to work under a master workman until he had learned all of the processes involved in the particular trade he was studying. It was a hard task, but an interesting one; as he could watch the machine grow from step to step, he could figure out the reasons for each step, and the principles upon which the machine worked when completed. He was interested in his work, and interested in his life, hence he was leading a happy existence.

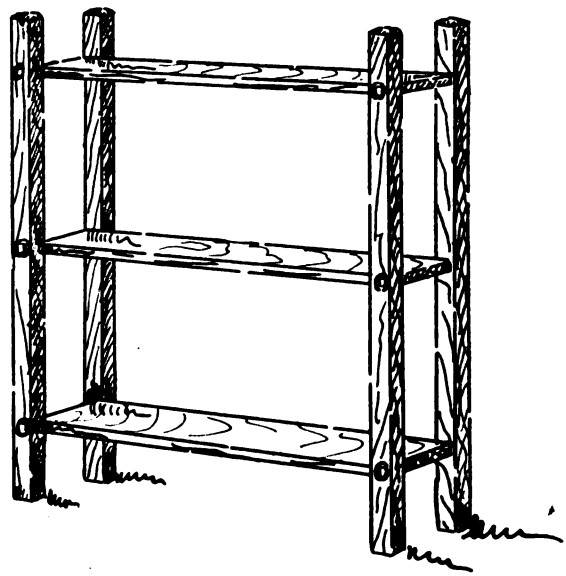
Soon the capitalist stepped in and declared this system a waste of time and material. He opened a large shop, equipped with the best machinery obtainable, and offered the apprentices wages to come and work for him. This looked tempting, so they came. He put each at a machine, made him an expert time-saver, hired a few "old hands" to assemble the separate parts and offered his machine for sale at a much lower price than the "old timer" could. The latter admitted his defeat and retired. Hence was lost to the world the all-around machinist, the deftly trained man who combined his work and his recreation and lived a happy life. In his place came the degraded, evil-voiced "hand" of today, who gets no joy from his work, his only pleasure being found in his "pay-night revels" with others of his class.

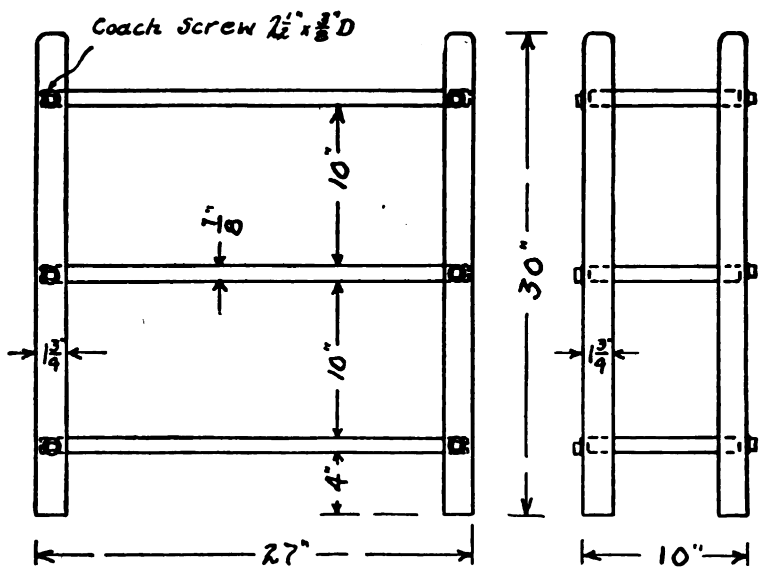
We have reached the age of specialization, and now we are clamoring for the "good old days of yore." The original capitalist is the one that is talking the loudest and working the hardest to bring about a change which will land conditions very near the point at which he began revolutionizing them. And best of all he is accomplishing this very thing—through the vocational school.

The man he wants now, the modern machinist, is the man who can run any machine in the shop; read any blue-print in the shop; talk and write intelligently upon current events; who uses no slang; neither smokes, chews, nor drinks; knows something of the raw materials which go into the article upon which he is working, and is an all-around dependable fellow. He realized the impossibility of training such a man in his factory, hence he called upon the school to do it for him. The school responded and told him that it would take the young man part time and give him the scholastic training he needed and leave him to the practice of it in the factory the rest of his time. The capitalist agreed, and we have the continuation school of today as the result.

While in school the embryo machinist

-BOOK RACK.-





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studies English, mathematics, mechanics, physics, chemistry, commercial geography, first aid to the injured, mechanical drawing, civics, American history and business methods. Every subject is given with the end in view of training the student for the practical duties of life, and not for the cultural duties as given in our classical high schools of today. He is clearly shown how the study of English, for instance, will help him when he writes a letter of application for a position, or if he is sent out on a job which will require a written report on results obtained. He realizes the practical value to him, hence he works harder to attain perfection than he otherwise would. So with every other subject on the list—practical, every one of them.

In Fitchburg, Mass., is operated a continuation school for boys, started by the Simonds' Saw Manufacturing Company, one of the largest concerns of this kind in the world. The school is run on the above plan, the boys working in the factory one week and attending school the next. They are given full pay while at work, which makes them independent and able to complete the four years required before graduation, without being forced to quit school and help to support the family, as a great many of our high school students have had to do.

Now let us see what such an education really accomplishes for the boy. In the first place it has made him open-minded; he thinks of his work as he carries it along, "uses his head," as it is commonly expressed. He knows what part his particular labor is of the whole organization and realizes the necessity of doing his work well. He also is aware of the fact that more pleasure and profit will come to him by being virtuous than by loafing around the saloons after working hours.

And what does it do for the manufacturer? To quote from Mr. W. B. Hunter,* director of the Fitchburg School: "It gives him a better class of apprentices, boys who will make thinking mechanics, not mere machines who require all the foreman's time and attention explaining every little detail of a drawing. They will be able to read a blue-print and go ahead. Foremen on every hand speak in the highest terms of the work, and they fit with the men. They are three years ahead of the ordinary high school graduate; they are working in the plant where they would have to apply for a position if they wanted work; the men know what they can do, and when they become journeymen there is no kick about paying them good wages.

"And lastly, what does it do for society? By this plan the worker is given an opportunity to continue his education, to be a better citizen as the result of his acquaintance with the civic operations of his community and their relation to the worker, to be a contented and happy being, because he can see beyond his daily task into the great storehouse of literature and history of his trade that has made possible the rise of our nation and continue his supremacy as the artisan par excellence."

* "The Fitchburg Plan of Industrial Education."

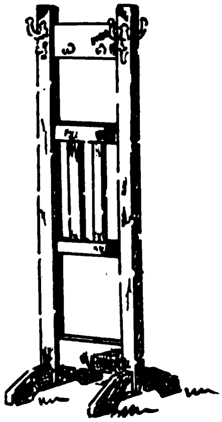
BOOK RACK

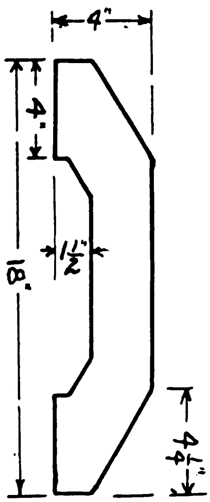
Simplicity in construction is the greatest advantage offered in the book rack here presented, as no joints are used. The three shelves are fastened to the posts with coach screws, whose square heads add much to the appearance desired. As for the utility side of the project, the rack will undoubtedly find good use if it is once constructed. The material list consists in the following:

4 pcs. 1¾ x 1¾ x 30 in. oak
3 pcs. ⅞ x 9½ x 26½ in. oak
12 coach screws ⅜ in. D. x 2½ in. long.
Stain, filler, wax, etc.

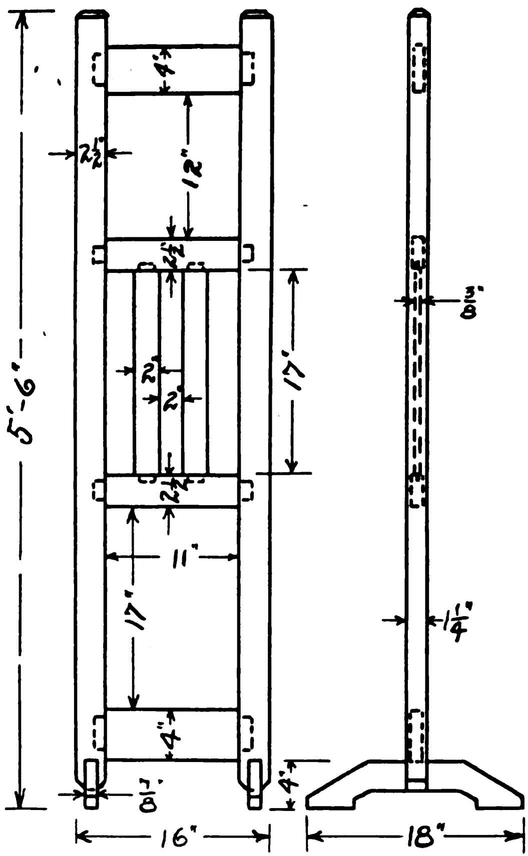
First true up the posts and round off their tops. Be sure to plane and scrape off all of the chatter marks in evidence. Next locate on the posts where the center of the shelves will come and bore holes for the screws, using a 7/16 in. bit. The shelves should now be smoothed up and the corners cut out so as to receive the posts. Do not have the edges of the shelves flush with the posts, but back about ¼ in. Place the posts and shelves into position and mark the points where the screws will enter the latter. Bore holes in them and fasten all of the parts together. Fill, stain, shellac and wax the piece as before explained, putting this material over the screw heads so as to give them a slight polish.

— COSTUMER. —





Detail of Standard.



Front Elevation. Side Elevation

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COSTUMER

Another article of distinct usefulness is the costumer, or hall tree, as it is sometimes called. It presents no new problems of construction to the craftsman, so little need be said concerning the making of it. The material needed is the following:

2 pcs. 1¼ x 2½ x 5 ft. 6 in. oak
2 pcs. ⅞ x 4 x 13 in. oak
2 pcs. ⅞ x 2½ x 13 in. oak
2 pcs. ⅞ x 4 x 18 in. oak
2 pcs. ⅜ x 2 x 18 in. oak
4 large antique copper hooks
4 smaller antique copper hooks
Stain, filler, wax, etc.

The tenons should be cut on the pieces bearing them and the corresponding mortises where they belong according to the drawing. The ends of the posts are cut out so as to receive the standards, which are shaped according to the detail. In fastening the parts together, the pieces should be glued and clamped, being sure to glue the slats in the center section before fastening the other pieces. The standards may be secured by boring holes through them and the posts and inserting oak dowel pins, whose heads are planed off flush with the sides of the posts. Use two ½ in. pins on each post and glue securely.

Scrape off all of the glue in evidence, and finish the piece. Place the hooks as illustrated, the large ones on the posts and the smaller ones on the top stringer, four on each side.

(To be continued)

THE WANING HARDWOOD SUPPLY

Although the demand for hardwood lumber is greater than ever before, the annual cut today is a billion feet less than it was seven years ago. In this time the wholesale price of the different classes of hardwood lumber advanced from 25 to 65 percent. The cut of oak, which in 1899 was more than half the total cut of hardwoods, has fallen off 36 percent. Yellow poplar, which was formerly second in point of output, has fallen off 38 percent, and elm has fallen off one-half.

The cut of softwoods is over four times that of hardwoods, yet it is doubtful if a shortage in the former would cause dismay in so many industries. The cooperage, furniture and vehicle industries depend upon hardwood timber, and the railroads, telephone and telegraph companies, agricultural implement manufacturers, and builders use it extensively.

This leads to the question, Where is the future supply of hardwoods to be found? The cut in Ohio and Indiana, which, seven years ago, led all other states, has fallen off one-half. Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, New Jersey, Tennessee, Texas, West Virginia and Wisconsin have also declined in hardwood production. The chief centers of production now lie in the Lake States, the lower Mississippi Valley, and the Appalachian Mountains. Yet in the Lake States the presence of hardwoods is an almost certain indication of rich agricultural land, and when the hardwoods are cut the land is turned permanently to agricultural use. In Arkansas, Louisiana and Mississippi the production of hardwoods is clearly at its extreme height, and in Missouri and Texas it has already begun to decline.

The answer to the question, therefore, would seem to lie in the Appalachian Mountains. They contain the largest body of hardwood timber left in the United States. On them grow the greatest variety of tree species anywhere to be found. Protected from fire and reckless cutting, they produce the best kinds of timber, since their soil and climate combine to make heavy stands and rapid growth. Yet much of the Appalachian forest has been so damaged in the past that it will be years before it will again reach a high state of productiveness. Twenty billion feet of hardwoods would be a conservative estimate of the annual productive capacity of the 75,000,000 acres of forest lands in the Appalachians if they were rightly managed. Until they are we can expect a shortage in hardwood timber.

Circular 116, of the Forest Service, entitled "The Waning Hardwood Supply," discusses the situation. It may be had upon application to the Forester, Forest Service, Washington, D.C.

ENGINEERING LABORATORY PRACTICE—Part VII

The Pelton Wheel

P. LEROY FLANSBURG

At the present time there is a very rapid increase in the number of hydro-electric plants which are being erected, and more and more of the available water power of our rivers is being utilized.

Whenever water falls from one level to another, it is possible by means of a properly designed machine, to transform the potential energy of the water into kinetic energy. For example: if there are a number of buckets fastened to an endless chain (the chain passing over two sprocket wheels) and water is allowed to flow into one of the upper buckets, the weight of the water will cause the bucket to move downward. Since the bucket is attached to the chain, the bucket in moving downward will cause the sprocket wheels to revolve, and when the bucket passes around the lower sprocket wheel, the water which has caused all of this motion will be discharged from the bucket. By so designing the apparatus, that water will flow into each bucket in turn, as it passes over the upper sprocket wheel, and will be discharged from the bucket as it passes under the lower sprocket wheel, it is a comparatively simple matter to secure continuous power from a stream of water. A water motor which is built upon this principle is known as a gravity motor.

The water motors of today may be broadly divided into two classes, the one the impulse wheel, the other the water turbine.

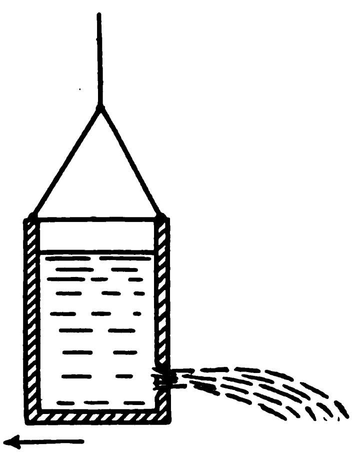


Fig. 1

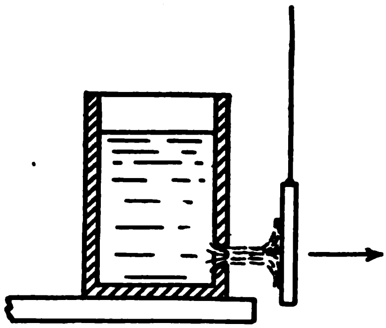


Fig. 2

The impulse type of water wheel is simply a wheel upon whose periphery is mounted a number of small curved vanes or buckets. This type of wheel is driven by a jet of rapidly moving water, directed tangentially to the rim of the wheel, and which impinges upon the vanes or buckets.

In order to more clearly understand the principle of the impulse type of water wheel, let us refer to Figs. 1, 2 and 3.

Fig. 1 illustrates the case of simple reaction. The tank containing the water is freely suspended and the water is allowed to escape through an orifice in the side of the tank. The hydrostatic pressure at the orifice accelerates the water, causing it to flow through the orifice in the form of a jet. Since action and reaction are equal, an unbalanced force equal to the force which accelerates the jet, reacts upon the tank and causes it to be pushed back in the direction indicated by the arrow.

Fig. 2 illustrates the case of a simple impulse. The tank containing the water is fixed in its position and the jet of escaping water impinges upon the flat plate which is freely suspended. The pressure of the jet of water against the plate, causes the plate to move in the direction shown by the arrow. There will be also a reactive force equal in magnitude and acting in the opposite direction to the impulse, but since the tank is immovable the reactive force does no work.

Fig. 3 illustrates the case of combined impulse and reaction forces and is an example of the forces exerted by the water upon the buckets of a so-called impulse water-wheel. The tank containing the water is, as in the last-mentioned case, rigidly fixed in position, but instead of water impinging upon a flat plate, a plate which is U-shaped is used. The jet of water striking against this curved surface is turned back upon itself through an angle of 180 degrees and leaves the bucket while moving in a direction opposite to that by which it entered. From the drawing it is at once seen that the jet acts by impulse when entering the bucket or curved surface and by reaction upon leaving it. Now, since action and reaction are equal, the combined forces which tend to move the plate in the direction indicated by the arrow are twice as great in magnitude as would be the impulse force illustrated by Fig. 2.

In practice it is not possible to turn the jet through an angle as great as 180 degrees, since if this were done, the water discharged from one bucket would be cast back against the one behind and offer a resistance to it. Generally, therefore, an angle somewhat less than 180 degrees is used.

The Pelton wheel is one of the impulse type of water wheels and it is particularly adapted for use where a high head of water is available. Owing to the simplicity and ease of operation of the Pelton wheel, it is a most satisfactory type of wheel to use in power plants. The buckets are similar to the one shown in Fig. 4, having two lobes which are nearly rectangular in form. The sharp ridge of the bucket provides for the gradual deviation of the water from its original path, and prevents eddying and consequent internal fluid friction. The dividing ridge separates the bucket into two lobes.

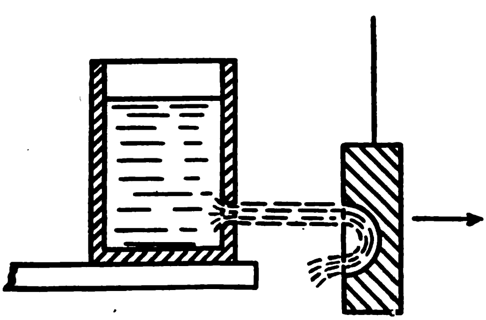


Fig. 3

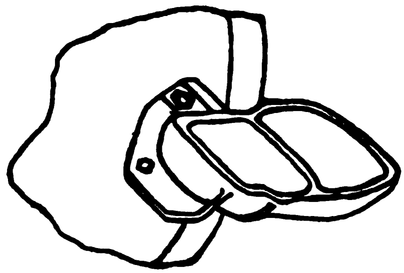


Fig. 4

To secure the best efficiency from the wheel:

1st.—The bucket should be so shaped or curved as to avoid any sharp angular deflection of the jet of water.

2d.—The bucket surface at entrance should be approximately parallel to the path of the jet.

3d.—The number of buckets should be small and the path of the jet in the bucket short, as this does away with much of the friction loss.

4th.—The speed of the center-line of the buckets should be approximately one-half the linear velocity of the water in the jet, as it leaves the nozzle or orifice.

The Pelton wheel generally employs one or more conical nozzles. To reduce the forces acting upon the wheel you can reduce the size of the jet, reduce its velocity or so divert the direction of the jet that only a portion of it acts upon the buckets.

To reduce the size of the jet an internal conical stopper or needle made of brass is commonly employed. The stopper can be moved parallel to the axis of the nozzle, and by moving it backward or forward, the size of the jet may be either increased or diminished.

To reduce the velocity of the jet it is only necessary to partially close a valve placed in the piping just upstream from the nozzle.

A diversion of the jet is sometimes resorted to, but is very wasteful of water.

The following is a test made by the author upon a Pelton wheel to determine the best speed at which to run the wheel and to find the efficiency of the wheel both at this speed and also at speeds above and below it.

TEST ON A PELTON WHEEL

The water used was supplied by a double-acting, twin cylinder Blake pump. A piezometer ring and gauge were placed just back of the nozzle to measure the pressure head. The velocity of the jet of water was practically constant throughout the test. The velocity of the wheel was varied by changing the load applied, the load being applied by means of a prony brake. The entire wheel was enclosed in a glass case, and it was thus possible to observe the wheel under operation and at the same time the case prevented the water from splashing out. The water escaped from the case through a cylindrical draft tube, which was connected directly to a weir box. The water discharged from the weir was then measured by means of a hook-gauge. To measure the revolutions per minute made by the shaft, a revolution counter was directly connected. Five runs each of six minutes duration were made and under varying loads. Readings were taken every two minutes of the revolutions per minute of the wheel, the piezometer pressure and the hook-gauge. In working up the report the average piezometer pressure was used. The mean of the hook-gauge readings was also used. The speeds of the wheel were such that for the first two runs, the rim velocity was less than one-half of the jet velocity, while in the last two runs the rim velocity was greater than one-half the jet velocity.

A general, diagrammatic sketch of the apparatus as used is shown in Fig. 5.

DATA

Diameter through center line of buckets	3.70 ft.
Diameter of nozzle	0.1147 ft.
Diameter of piezometer	0.50 ft.
Width of weir	2.00 ft.
Circumference of brake arm	16.50 ft
Tare load on brake	31⅛ lbs.
Height of gauge above center-line of piezometer	1.00 ft.
Zero reading of hook gauge	0.853 ft.
One cubic foot of water weighs	62.30 lbs.

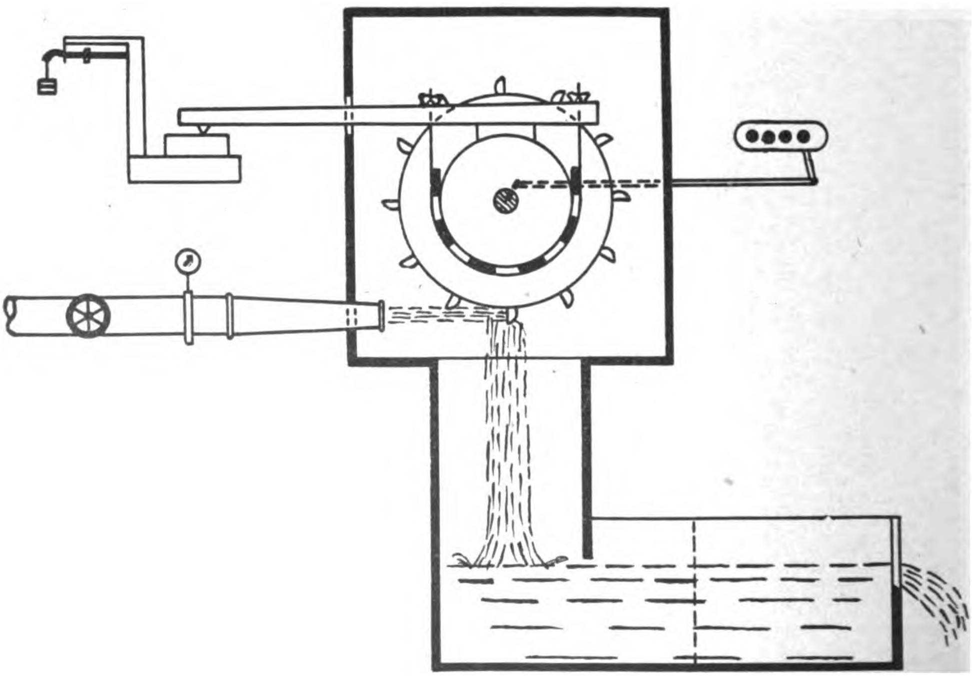


Fig. 5

Arrangement of the Apparatus During the Tests

Observations

Test No.	I	II	III	IV	V
Piezometer pressure (lb.)............	39.2	39.5	39.1	37.1	36.0
Hook-gauge reading (ft.)............	1.075	1.076	1.075	1.072	1.069
Revolutions per minute.............	126.5	147.3	146.5	196.8	237.0
Load on brake (lb.)................	89	64	59	49	39

Piezometer pressure (lb.) average...........38.2
Hook-gauge reading (ft.) average..........1.073

Calculation of Results

$$q(\text{by first approximation}) = C(2/3)(b)(\sqrt{64.4})(H^{3/2})$$
$$= C(4/3)(8.04)(H)^{3/2}$$
$$= 10.7\,C\,H^{3/2}$$

Test No.	I	II	III	IV	V
H..............................	0.222	0.223	0.222	0.219	0.216
C..............................	0.624	0.623	0.624	0.628	0.632
q..............................	0.698	0.703	0.698	0.688	0.672

Adding .43 lb. to piezometer reading to correct for height of gauge above the center of piezometer.

Piezometer reading (corr.).........	39.63	39.93	39.53	37.53	36.43

Average piezometer reading.............(38.20 + .43)=38.63

Mechanical Efficiency

Input. $C = .974$

$$(\textit{Velocity of jet at end of nozzle}) = v = \sqrt{\frac{64.4(h_1)}{\frac{1}{C^2} - \left(\frac{d}{D}\right)^4}}$$

$$v = \sqrt{\frac{64.4\ (h_1)}{1.057 - .00275}} = \sqrt{\frac{64.4\,(h_1)}{1.054}} = \sqrt{61.0(h_1)} \therefore v^2 = 61(h_1)$$

$$h_1 = (38.63)\frac{144}{62.3} = 89.3 \text{ ft.}$$

$$v^2 = 61(89.3) = 5450 \text{ and } \frac{v^2}{2g} = \frac{5450}{64.4} = 84.7 \text{ ft.}$$

$$\text{H.P. Input} = \frac{q \times 62.3}{550}(84.7) = 9.6\,q$$

Test No.	I	II	III	IV	V
H.P. Input	6.70	6.75	6.70	6.60	6.45

Output.

$$\text{H.P.} = \frac{2\pi RNP}{33{,}000} = \frac{(\text{cir. of brake arm})(N)(P)}{33{,}000} = (.0005)(N)(P)$$

Test No.	I	II	III	IV	V
H.P. Output.	5.63	4.72	4.32	4.82	4.63

Efficiency = *Output* ÷ *Input*

Test No.	I	II	III	IV	V
Efficiency	84%	69.9%	64.5%	73.0%	71.8%

Velocity of Center-line of Buckets

$$\text{Vel.} = (\text{r.p.m.})(\pi d)$$
$$= (\text{r.p.m.})(11.62)$$

Test No.	I	II	III	IV	V
Vel. in ft./min.	1470	1714	1705	2290	2760

Results

Test No.	I	II	III	IV	V
Mechanical efficiency..............	84.0%	69.9%	64.5%	73.0%	71.8%
Velocity of center-line of buckets....	1470	1714	1705	2290	2760
Velocity of jet at end of nozzle......	Average..............73.8 ft./sec.				

PROTECTION OF CHEMICAL GLASSWARE

Undoubtedly many of the readers of this magazine do more or less experimenting with chemical apparatus, and have had much trouble and inconvenience when using glass-ware which had to be heated to obtain a desired result, often causing breakage and considerable expense. It is usually customary to put a coating of clay upon glass-ware that is to be exposed to a temperature that would soften or melt the glass, or where they are liable to be broken or otherwise damaged by draughts of air. It is customary to add cow's hair or asbestos to the clay which strengthens it, but this practice is not always satisfactory, inasmuch as checks and cracks are liable to form and the mass is very liable to scale off and breakage to result. A mixture of infusorial earth and water glass when properly applied will last for weeks, and hence is not expensive, while the strength and protection it affords surmounts all considerations of expense. In mixing this, it is very important to follow these simple directions to obtain the most satisfactory results. A mixture of one part infusorial earth with 4 or 4½ parts of water glass will answer very well. This should form a soft and somewhat elastic, but not liquid, mass.

The vessel to be treated is covered with a coating of from one-fifth to two-fifths of an inch, and dried at not too high a temperature; a drying closet will answer admirably, or the vessel may be supported over a stove. If the temperature is too high at first, air bubbles will form in the mass and the results will not be as good. If bubbles should appear, they should be pressed out with the finger, care being taken not to burn one's self, and if a crack should appear, it can be filled with the mixture and allowed to dry again. It is often desirable to have some parts of the vessel transparent. This may be had and at the same time protection may be obtained by applying several thin coats of water glass alone and allowing each coat to dry before adding the next.

This mixture, although a little expensive, has been used to good advantage upon gas retorts, furnaces, stoves, and for a variety of other purposes. The results have been just as satisfactory as for glass and porcelain vessels.

In using the first mentioned mixture of clay, water, sand and hair, the disadvantages before mentioned may be overcome by adding a little glycerine. This preparation is cheap and easily prepared and applied where desired. The danger from cracking or checking is overcome, and always retains its softness.

WIRELESS TELEGRAPHY

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

A COMMERCIAL AND ACTUAL INTERFERENCE PREVENTER

A. L. PATSTONE

As the number of wireless telegraph stations have enormously increased during the past year, because of the recent Act of Congress, the demand daily increases for a very efficient tuning device capable of eliminating that "bane" of all wireless operators—interference. Although much attention has been devoted to the loose coupler or transforming tuner in past issues, all fail in the excess advantages described herewith, which have become a complete and concluded success with the omission of a variable condenser, and should strongly appeal to the advanced commercial operator.

We know it is almost impossible to find two stations having exactly the same wave length, but on account of the close coupling of many stations, which is always detrimental to sharp tuning, as it produces a widening of the resonance curve, as observed at the receiving station, the tuning out of such stations becomes difficult, and in some instances almost impossible, therefore it is not practicable to completely tune out every undesired station.

Using the interference preventer the signals to be received can, in nearly every instance, be found on from three to five complete different positions, a feat unknown to the modern transforming tuner, consequently during moderate interference we will find our desired signals to be audible and clearly readable on at least one of these positions. This is made possible by very fine and accurate adjustment, by the unmatched alterations of the primary coil and entire hook-up, and by the two possible paths for the signals to pass to the earth, one through inductance *A*, and the other through inductance *C*. It is supposed that the untuned discharges will divide themselves equally between the two paths in the antenna and will produce no effect on the detector circuit.

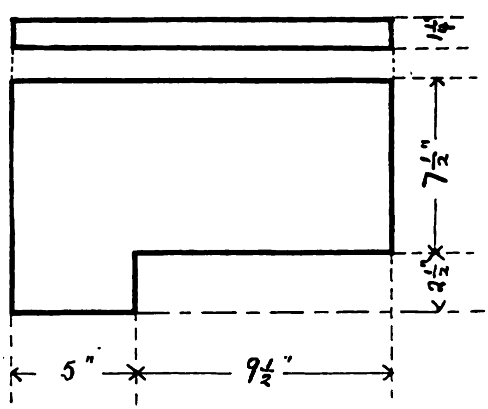
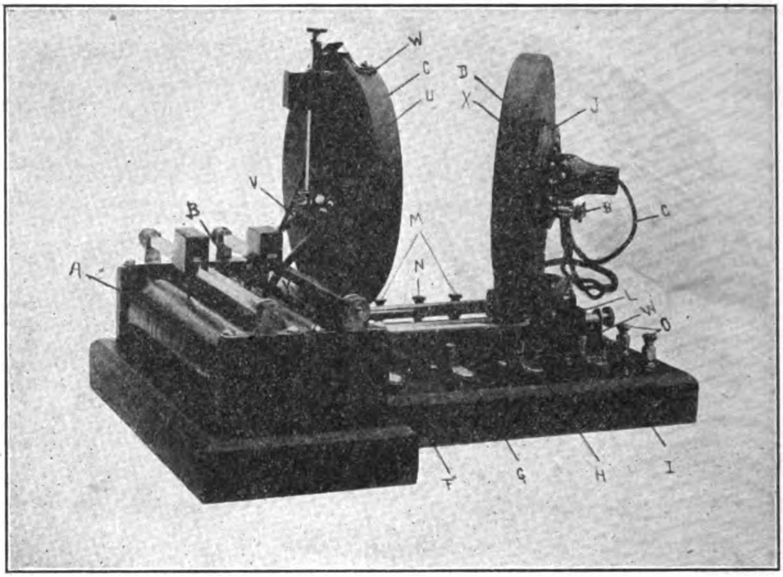


Fig. 1

One must not expect results unless he undertakes to expel the undesired by manipulating the different sliders, and should not be satisfied until successful, otherwise interference preventing is impossible. To sit there with the sliders in one position and wait for a station to come in on the set tune or wait for some intruder to become cleared before completing business, is to condemn one's self as being an inexpert operator.

After reading an article many hesitate on constructing an instrument, which, for some reason they rightly believe, will prove no more efficient than their present apparatus. By allowing plenty of time and being careful to make every part perfect and by following directions of this article, an instrument which will instantly



An Interference Preventer

demonstrate its efficiency above the ordinary type, and which will yield surprising results as an interference preventer is certain, and also with which many peculiarities will be noted after being pronounced as learned. The described instrument was designed with that end in view of obtaining the maximum efficiency in a concentrated form, to eliminate interference other than at the expense of decreasing signals, and has gained complete confidence among its operators in these respects.

A general constructional idea can be attained from the photograph, so it will be unnecessary to go into details on some of the parts on account of alterations which may be due to inconvenience.

We must employ the looped aerial or our instrument will be useless.

It should be remembered that perfect insulation is the success of all wireless instruments. The best of wood gives leakage to the weakest high-frequency currents; fiber collects dampness, rapidly rendering it worthless during the slightest damp weather; these should be avoided. To construct the entire base of hard rubber is unnecessary as well as expensive. An excellent base can be built from dry, well-seasoned wood; teak gives an admirable appearance and is easily worked, inlaid with round, hard rubber plugs at least 1 in. in diameter under all binding posts, and a strip sufficiently large enough for the front switches, both plugs and strip having a depth of ½ in. After careful fitting, these should be firmly set without the aid of glue or wedges, and when finished the base should be free from flaws which will be a safeguard against possible efficiency losses. A plane will not give satisfactory results on hard rubber when in this position, but by using a heavy file and finishing with fine sandpaper, the inlaid parts can be brought to be perfectly flush with the surface of the base. Before assembling the parts, the base should receive a smooth polished surface. A substantial finish can be easily accomplished by the inexperienced with the use of refined material from a reliable wood-finishing firm, whose advertisements may be found in the columns of this magazine. If the builder should not have any of the necessities on hand, it will be far better to wait, even a week or more, until they can be obtained, and have a perfect instrument in the end, than to use what might do for the sake of rushing its construction and when complete be dissatisfied.

All connecting wires necessary for the entire receiving apparatus should be of No. 22 flexible rubber-covered cord; those in the base to be enclosed in ⅛ in. rubber piping and embedded in sufficiently deepened grooves. All grooves and holes are to be filled with wax, which will add to its insulation, and wax covering the underneath parts of the switches will protect any of their parts from becoming loosened. Heavy cardboard secured on the base will protect all wires and sustain from injury to the table, etc.

BASE

A and *B* are cylinder coils made of non-shrinkable tubing 8 x 1⅜ in., each containing approximately 85 ft. of No. 22 S.S. copper wire wound to within ½ in. of their ends. The end pieces are of hard rubber, measuring 4 x 2 x ½ in., thereby insulating the slider rods. Spiral spring sliders have given perfect satisfaction, although any form of slider may be used, it being important that contact is made upon only one turn of wire, since contact on two turns decreases signals. When contact to slider is depended on from slider rod, more or less friction is necessary, and especially during dampness the rods become sticky, causing much annoyance. Most sliders have four small screws on their underneath side; tap one of these to ⅛ in., to which connect a piece of telephone cord under a washer. The tension on slider rod may now be lessened and perfect contact is always certain. Avoid the use of iron or steel screws throughout the entire receiving apparatus; brass is most convenient; copper is still better. Use machine screws to secure parts to hard rubber.

U, the support for the primary, shown in Fig. 2, is of ⅞ in. teak wood, with strip cut out on an angle, leaving opening 1 in. wide on back and ½ in. wide on face. Round hard rubber plugs, having a depth of ¾ in. are inlaid under slider rod supports *W*, preventing any possible leakage; screws holding *W* should be but ¼ in. long. All open spaces should be temporarily filled to make winding surface smooth. Drill a ¼ in. hole to center to take one end of primary, shellac three or four sheets of good paper on winding surface, then start winding with No. 20 S.S. wire, about 95 ft., each turn being wound on previous turn, using shellac sparingly. Wind until ⅛ in. from edge, giving entire primary a thickness equal to the diameter of the wire. Patience counts here, care being taken to have wire perfectly flat and closely wound. Too much shellac will cause uneven and open winding. Both ends of the primary extend out the back and into the base to their proper connections, the exposed wire being enclosed in ⅛ in. rubber piping, as shown at *V*. After being wound a heavy coat of shellac should be applied and the coil laid away for two or three days until thoroughly dry. If this is done it will be impossible for the slider to loosen winding. A suitable color paper secured on face of winding will add to its neatness and puzzle the inquisitive.

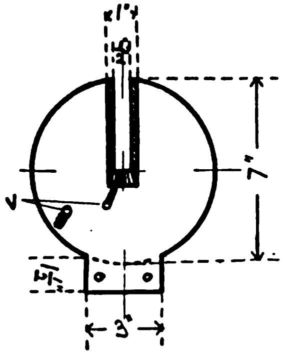


Fig. 2

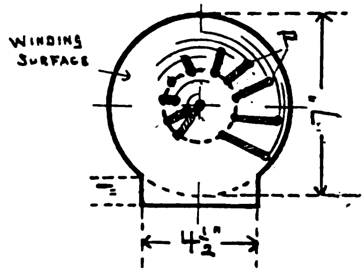


Fig. 3

X, the support for the secondary, shown in Fig. 3, is of ⅞ in. teak wood, and is wound same as primary with approximately 425 ft. of No. 28 S.S. wire. Here the greatest caution should be exercised, taking ample time to make winding perfect. When placed in position the winding is to be in opposite direction to that of the primary. Ten small holes are drilled for taps, which are enclosed in 1/16 in. rubber piping, at such distances as will give all sections nearly equal lengths of wire, as shown by *P*, Fig. 3, so as each respective tap comes directly to its proper connection under secondary switch *J*, which will

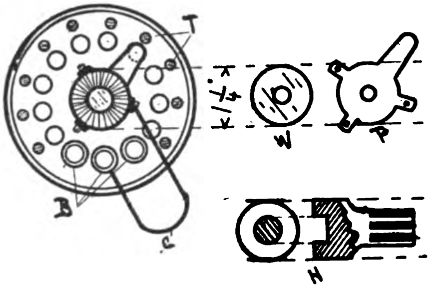


Fig. 4

leave no marks on back of support. When finished the primary winding should be directly opposite the secondary winding; should secondary winding be a trifle high the sufficient amount may be taken off the base of support *X*.

Secondary switch *J*, Fig. 4, is an ordinary 10-point switch, having hard rubber base. Three binding posts *B* are added to the base: *W* being washer, *P* contact arm of spring brass, which is fastened to hard rubber handle *H* on outside. A hole is drilled in the base of the handle to allow free movement over set-screw, which holds contact arm firmly. Small holes *T* are drilled in switch base just in front of each contact point for the taps to extend through. It will be found possible to tighten the contact points from outside by first placing the taps under contact heads and then drawing them upward until the nut catches while turning. A short piece of telephone cord *C* is connected to center binding post and moving contact arm thereby insuring perfect contact always, and making it unnecessary to remove the switch base when looking for faults that often arise from constant usage.

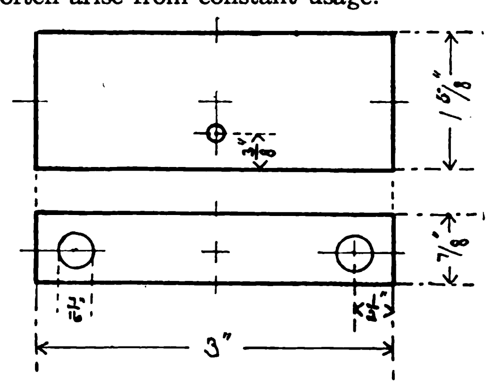


Fig. 5

L, the secondary truck, Fig. 5, is of wood into which two holes 7/16 in. diameter are drilled perfectly true.

The photograph plainly shows the manner in which the secondary support *X* is secured to truck *L*. 1/4 in. square brass rod was used and so constructed as to allow the secondary to be placed in any desired position for experimental purposes.

The secondary round brass guide rods are each 3/8 x 7 1/2 in. Two holes, 2 in. apart and 11/16 in. from base to their centers, thereby allowing sufficient clearance from base for truck *L*, are drilled in primary support *U*, 7/16 in. diameter into which the guide rods are inserted 1/2 in., thus giving 1/16 in. play, which will allow free movement should the drilling

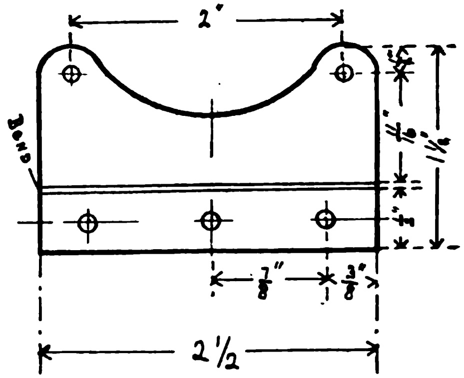


Fig. 6

in truck *L* be slightly off-centered. At the opposite end the guide rods are drilled and tapped slightly off-center to afford proper adjustment, and are secured by thumb nuts on a brass support *W*, which is 1/16 in. in thickness. Notice that 1/16 in. is allowed for bending.

W, brass guide rod support.

Y, wood block secured to base and against which is fastened primary support *U*.

F, 3-point switch controlling coil *A*, looped, straight and open leg antenna connections.

G, 2-point switch controlling coil *B* for long wave lengths.

H, 2-point switch allowing discharges to enter at center or outside of primary coil.

I, 2-point switch to alter direction for induced currents in secondary coil.

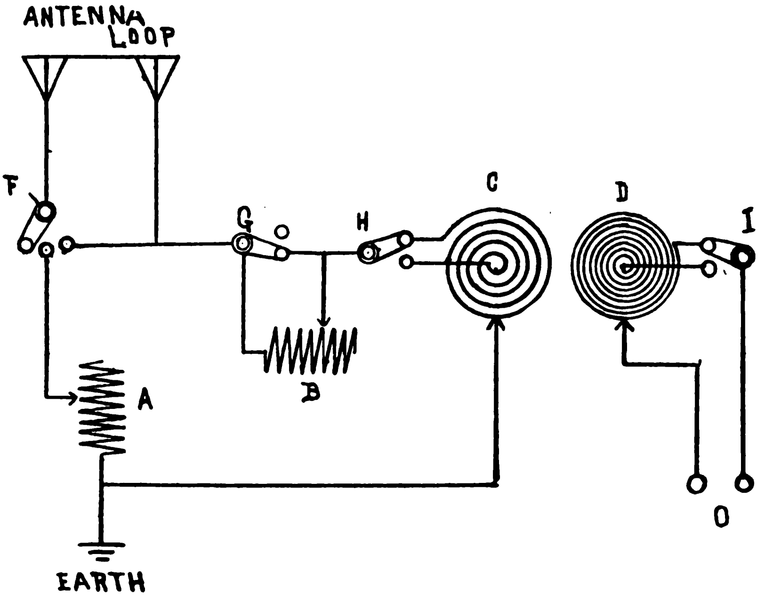


Fig. 7. Wiring Diagram

M, aerial connections.
N, ground connection.
O, secondary terminals for connection to detector circuit.

It will naturally require some little time to master the instrument, and on account of so many possible changes every effort should be put forth to find stations at their loudest, when note should be taken or positions memorized. Placing sliders on positions shown with coil *B* cut out, discharges entering outside winding of primary, and using coil *A* will probably give best results for trial; adjusting only coil *A*, secondary inductance and the degree in coupling. Long wave lengths are best obtained when one leg of antenna is open and adjusting coil *B*. Should any station's signals increase when connection is made from one leg of the antenna to one terminal of the secondary circuit, the right terminals to be determined by experiment, it will indicate that a better tune can be obtained by adjusting the sliders. In some instances interference can be eliminated by this connection when impossible otherwise.

Wireless instruments, like all others, depend for their efficiency on their condition and amply repay good care. All sliding contacts should be clean and bright and free from foreign matter.

At all stations the best results are invariably obtained and the most satisfactory service given by alert and careful operators who take pride in the condition of their instruments.

The Use of Concrete on the Farm

(*Concluded from page* 396)

to the forms. In order to prevent this the surface next to the concrete should be given a coat of oil or soft soap. Linseed, black or cylinder oil may be used, but never kerosene.

Before erecting, the forms should be painted with an oil or soap and then carefully protected from dust or dirt until erected. If chips or blocks of wood fall inside the forms while erecting they must be carefully removed. Upon removal, the forms should be immediately cleaned of all particles of concrete adhering to the surface. A short-handled hoe will remove the worst, while a wire brush is most effective for finishing. In cleaning, care should be taken not to gouge the wood, because this spoils the surface of the next section of concrete.

[*Editor's Note*.—Owing to the fact that volume xxiv of this magazine closes with this issue, this article on "Concrete" has been made complete in two installments, rather than in three, as was first intended.]

A REVIEW OF THE CRYSTAL DETECTORS

CHARLES BEALS

In my experiences in operating both commercial and amateur wireless stations, I have found that the best results have been obtained with the following types of solid rectifying detectors, in sensitivity, reliability and in ease and permanence of adjustment. Below is given a description and notes on operating each of these:

Perikon—consists of a crystal of either bornite, chalcopyrite or copper pyrites in contact with a piece of native zincite. A small applied e.m.f. increases the efficiency of this detector nearly 20 percent, the current flowing from the bornite to the zincite. A detector stand that allows the bornite to come in contact with any part of the surface of the zincite with a moderate spring pressure gives best results. This detector is extremely sensitive and easy of adjustment, but is usually "knocked out" in sending.

Pyron—consists of a piece of "ferron" or "pyron" in contact with a sharp metallic point. No local battery is used. This crystal varies greatly in sensitivity, and it is difficult to secure a good piece, but one is amply repaid for his trouble. It is very sensitive and keeps its adjustment for a long time, being but little affected while sending.

Galena—consists of a piece of galena or lead sulphide in contact with a light coil spring of about No. 30 copper wire. No battery is used. It is easily constructed, and nearly as sensitive as the perikon and pyron, but is so delicate that it must be readjusted after each period of sending.

Silicon—consists of a piece of metallic silicon in contact with a sharp metallic point. No local battery is used. I have not found this as sensitive as any of the previous types, but crystals above the 90 percent grade show more uniform sensitivity, and it keeps its adjustment fairly well. It is a suitable detector for amateur use where great range is not required.

Carborundum—consists of a crystal of carborundum or carbide of silicon in heavy contact with a blunt brass point. There are at least three distinct varieties of this material, one vari-colored, blue predominating; one a solid light green, and one jet black. A large piece should be secured and a small piece should be broken off the end that is coated with graphite. This end is packed in tin-foil and the rectifying terminal is the surface opposite this, and at right angles to the parallel of the grain. In practice I have found the green and black crystals to give the best results. Local battery is imperative for long-distance work, and voltage must be very carefully regulated. The polarity of the crystals vary even if broken from the same piece. More skill is required in using this detector than in any of the other types, but I have found it the best crystal for general use. It is not easily disturbed by either mechanical or electrical disturbance, and it compares favorably with the others in sensitivity.

From these results it would seem that an ideal combination for general use would consist of one of the more sensitive types, as perikon, pyron or galena, in connection with one of the more stable types, silicon or carborundum, the former to be used for long-distance receiving and the latter for copying local messages.

A low melting point alloy for mounting these crystals may be made by melting commercial solder and adding about 30 percent of mercury, previously heated in a separate vessel.

With a well-developed piece of any of these minerals I have been able to copy 1,200 miles with a 50 ft. antennae elevation, using a modified Marconi multiple tuner and Sullivan receivers.

Transatlantic Wireless

A notable advance in wireless telegraphy has been achieved in the last three weeks in the adoption by the New York *Times* of a daily transatlantic wireless service for European news.

The *Times*, which was the first newspaper to foresee the possibilities of development in the wireless telegraph, has itself been one of the most active and important factors in that development. For three weeks the *Times* has received no special cables from London, all its news dispatches, approximating 20,000 words a week, being transmitted across the Atlantic by wireless.

THE NEW WIRELESS LAW AND THE TITANIC DISASTER

FRANK ROY FRAPRIE, S.M., F.R.P.S.

We published last month a letter of protest in regard to the so-called Alexander Bill for the regulation of wireless telegraphy. In the meantime the terrible disaster to the *Titanic* has again focused public attention on the utility of wireless telegraphy as a means for the saving of lives at sea and also on the necessity for more efficient wireless service than is now given. Naturally, following the disaster, the first news of which was given to the world by means of wireless telegraphy, there was an enormous amount of activity in the line of wireless communication. The press was filled with accusations and recriminations of all kinds, charges of interference on the part of amateurs, of transmission of false messages, of failure to pay attention to distress signals and especially of failure, on the part of the operators on the *Carpathia*, to transmit press intelligence or to answer questions. In the maze of conflicting accounts, a few facts seem to have been established. In the first place, the *Carpathia* had but one operator, and it was by the merest chance that he received the distress signal which resulted in saving what passengers were rescued; ten minutes later he would have retired for the night, and the *Carpathia* would not have been the rescue ship. While the *Titanic* was fitted with modern high-power apparatus, fitted for long-distance communication, the *Carpathia* had one of the older sets, with a sending distance of from eighty to one hundred and twenty miles, and consequently was out of range of land most of the time after the rescue until she docked in New York. During all this time, however, the operators on the *Carpathia*, one belonging to the ship and the other rescued from the *Titanic*, utilized their instruments almost constantly in sending off lists of the rescued and personal messages from the rescued to their friends ashore. Press matter was not sent, and the operators seem to have paid little attention to messages directed to them asking for details. It is probable that they were justified in thus acting, both by the rules of their company and by the orders of the commander of the *Carpathia*, but considerable ill-feeling arose because of their apparent disregard of questions sent from United States naval vessels at the instance of the President of the United States. The operators later claimed that they answered these questions, but stated that the work of the operators on board the United States ships was so inefficient that they found it impossible to keep up satisfactory communication with them. The Navy Department claims that its operators are of the highest efficiency, but the testimony of the commercial companies and also of government officials, as given in the hearings before the Committee on Merchant Marine and Fisheries of the House of Representatives, seems to indicate that the operators on the naval ships cannot always satisfactorily communicate with commercial operators and are not of a sufficiently high standard to secure employment by the commercial companies after discharge from the navy.

A very unfortunate feature was the bringing out of the fact that the operators on the *Carpathia* had been advised by the chief engineer of the Marconi Company to hold their news for sale to the newspapers at a personal profit; and at the hearings before the Senate Committee this fact was brought out and Mr. Marconi himself admitted that the practice was injudicious and would probably be forbidden in the future. The precedent was set at the time of the disaster to the *Republic*, when Operator Binns was allowed to sell his story to the newspapers; but the general opinion of the press and of the public is that operators should not be allowed to hold back news of such a disaster for the sake of personal profit.

As a result of the facts brought out, public opinion has been aroused to such an extent that new regulations for the handling of wireless on passenger ships will doubtless be made effective, and it seems certain that all passenger ships will be required to carry two wireless operators, to keep apparatus working constantly, and to be equipped with apparatus capable of communicating over a distance of one hundred miles under the most unfavorable conditions, that is, in the day time. Such sets will probably be capable, under favorable conditions, of transmitting messages at night from two hundred to five hundred miles and should be far more effective than the present sets on many of the older steamers.

Coincident with the hearings on the *Titanic* disaster, the report of the Committee on Merchant Marine and Fisheries of the House of Representatives on the Alexander Bill was issued, and on April 20th the amended bill was reported to the House, committed to the Committee of the Whole House of the State of the Union and ordered to be printed. While this by no means insures the passage of the bill, it is probable that owing to the state of feeling on the subject, it will be passed through both House of Congresses and become a law at this session, and it is not likely that serious amendments will be made.

An analysis of the amended bill shows that it is a far more effective measure than that introduced by Mr. Alexander in December, and that it is drawn up with scientific care and with reasonable regard for the rights of all persons concerned. We have not space to reprint the bill or to analyze it in detail, but every reader who is interested may obtain from his Congressman the bill and the reports on it if he will write for a copy of HR 15357 and Report No. 582, to which he may add a request for the hearings before the Committee if he sees fit.

The bill requires that every station, for either sending or receiving, shall be licensed. The license is to be issued by the Secretary of Commerce and Labor, but he has no discretionary power and is required to issue a license to every applicant who complies with the provisions of the law. Every station in operation at the time of the passage of the bill, whether amateur or commercial, will be entitled to a license, provided it is operated by an American citizen or corporation, and the restriction of American citizenship also applies to operators.

The bill goes much further than the original bill, in prescribing regulations for the use of wireless instead of leaving these to the discretion of the President or a government department, although a certain latitude is allowed to the Secretary of Commerce and Labor for cases of emergency. Amateurs will be required to use wave lengths of two hundred meters or less, and cannot use a transformer input of more than 1 k.w. or of more than ½ k.w. within five nautical miles of a naval or military station. They are also, and this is a very important requirement, confined to the use of pure and sharp waves. This regulation will almost completely eliminate the danger of interference among stations and it applies to all stations, commercial, naval and military, as well as amateur. From the reports it appears probable that the Bureau of Standards will issue pamphlets for the instruction of amateurs and experimenters, giving advice on the construction and arrangement of their apparatus to meet with the requirements of the law, and it is certain that amateurs who do adjust their stations and apparatus to the requirements of this law will learn far more and become far more efficient operators than when working with the present inefficient apparatus which may be found in common use.

Another very important clause of the law states that every operator shall be obligated in his license to preserve and shall preserve faithfully the secrecy of radiograms which he may receive or transmit, and for failure to preserve such secrecy his license may be cancelled. This will prevent such cases as occurred on the Pacific Coast recently, where amateur operators intercepted an important message and sold it to a newspaper, and will also do away with other abuses which need not here be described. Willful or malicious interference, such as has too frequently occurred between operators of rival commercial companies, will become a serious offense, punishable by both fine and imprisonment. The sending out of a false message, signal or call, whether a distress signal or not, will also become a most serious offense, punishable by a fine up to **$1,000**, or imprisonment up to two years, or both. The operation of wireless instruments, whether for sending or receiving, without a license will be punishable by a fine of not more than **$500**, and the forfeiture of the apparatus.

There are numerous other provisions of the act which are of less importance to amateurs, but which provide for the needs of commercial companies and the government departments. The army and navy have received far less than they asked for, but all that they need to enable

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A NEW WIRELESS STATION WHICH OPERATES AT 100,000 VOLTS

FELIX J. KOCH

Wireless telegraphy has become a most efficient aid for commercial as well as for military purposes. The plant described below is one of the strongest stations in the world and was installed lately by the French Army at a cost of several hundred thousands of dollars, at the summit of the Eiffel Tower, about 1,000 ft. above the ground. Its strength

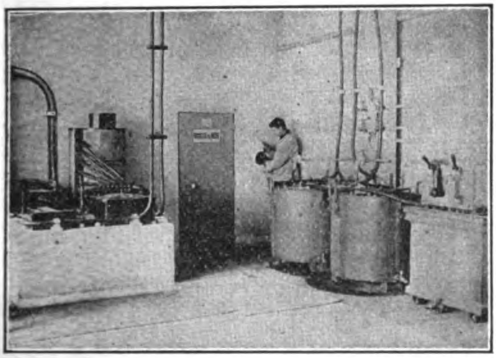

Fig. 1
Room where the high tension current is produced

allows it to communicate with the Marconi station at Glace Bay in Canada, about 7,500 miles away.

The cuts show the most important parts of this plant, by means of which the Old and New World can be connected in a few seconds.

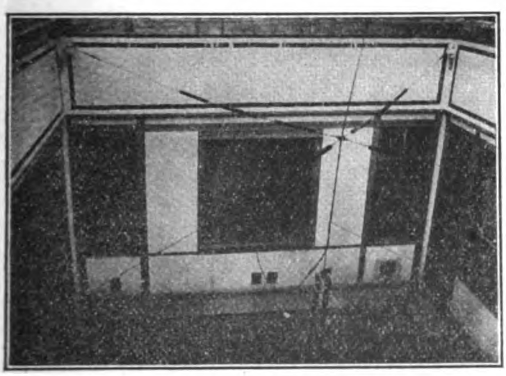

Fig. 2
The receiving cables and yard with four metal doors

In Fig. 1 we see the chamber, where the current of such a high tension is produced. The walls of this chamber are covered with a thick layer of felt, in order to weaken the strong sounds of the electrical discharges, which are as loud as those of a big gun. Fig. 2 shows the receiving cables for the station. The

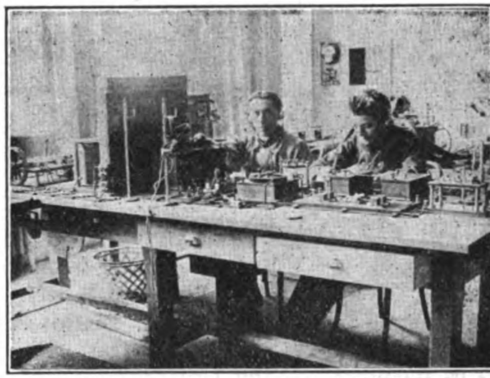

Fig. 3
Room where the messages are received

four doors of this yard being made of metal, and which establish the connection with the different parts of the wireless

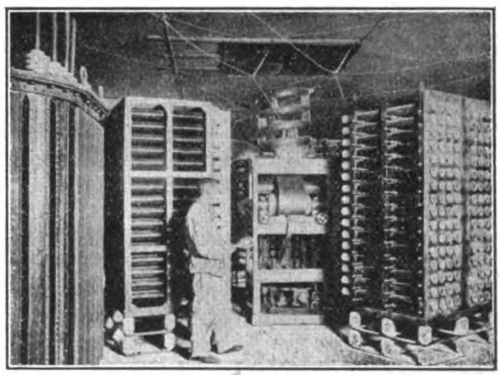

Fig. 4
Apparatus, switchboard and other accessories for high tension work

station, have to be closed, when the current of high tension is turned on, in order to prevent any accident. In Fig. 3 is

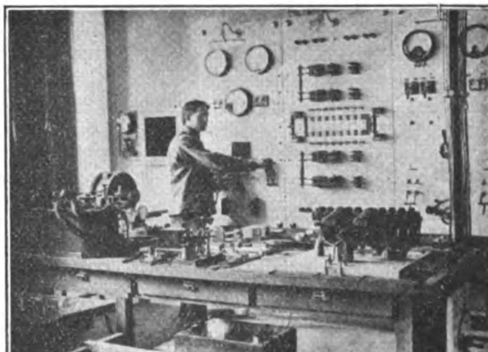

Fig. 5
The Switchboard

shown the receiving room. A wireless message can be received by four different operators, who thus check each other. The receiving is carried out by an electric apparatus, which was invented by the commander of this military post.

In Fig. 4, the apparatus and accessories of the high-tension chamber are demonstrated, while Fig. 5 shows the moment when the current is turned on and telegraphing is started. In the middle of this room we see a device which is one of the most improved and by means of which the radiotelegrams are sent out. The other connections are used to turn on or shut off the current.

LIST OF INTERNATIONAL RADIOTELEGRAPHIC STATIONS

The official list of radiotelegraphic stations open for international traffic has just been published by the International Telegraph Bureau in Berne. The countries included are the United Kingdom, Germany, Russia, Austria, Italy, Spain, Denmark, Sweden, Norway, Belgium, Holland, Japan, Uruguay and Chili. The catalogue does not include stations in the United States, as the government of this country did not ratify the adhesion of its delegates to the convention. Canada and France are also missing from the list. The particulars of each station whether on the coast or on board ship, are entered in eleven parallel columns, and give its geographical position, call signal, normal range, system employed, wave-length, nature of service, *i.e.*, whether public or restricted hours of working, and charge per word. The number of stations in the list reaches the total of 690, although the war vessels of several of the countries are omitted. Of these 690 installations, 124 are coast stations, the majority being open to the general public, and the remainder to messages from ships in distress only. In the latter class are the naval and military coast stations and those on lightships. The list does not include any inland stations, since these do not come within the purview of the convention. The distribution of the stations on the coasts of the various countries is as follows: Great Britain and Ireland, 35; British West Indies, 4; Gibraltar, 1; Malta, 1; Italy, 23; Germany, 15; Tsing-tau, 1; Russia, 13; Denmark, 7; Japan, 5; Norway, 4; Austria, 3; Holland, 3; Chili, 3; Spain, 2; Uruguay, 2; Belgium, 1; Brazil, 1. Roumania, 1. Even without counting the British stations in Canada and elsewhere, which do not appear in the list, it is clear that Great Britain has realized that wireless telegraphy is of far greater importance to her than to any other country. In the matter of ship stations she is also well ahead, the totals for Great Britain and Germany being: Great Britain, warships, 176; merchant vessels, 86; Germany, warships, 95, merchant vessels, 53. It is interesting to note that among the coast stations in Great Britain there are four which conduct the ordinary telegraphic business of the Post-office, taking the place of a wire or cable. These stations work in pairs, one pair communicating across the Wash and the other between Mull and the Outer Hebrides.

New Wireless Law and Titanic Disaster

(*Continued from page* 414)

them to have uninterrupted communication, without committing them to the indefinite preservation of antiquated apparatus. Their apparatus will have to be of modern types to comply with the requirements of the act, and only by such compliance can there be any possibility of proper functioning of naval and military wireless service in case of war or of deliberate interference by an enemy. The commercial companies are given full opportunity for carrying on their work, and every amateur is entitled to a license, which cannot be denied him, provided he has apparatus of a character which will give others the right to use the ether properly. A set with 1 k.w. input and two hundred meters wave length will carry over the larger part of any ordinary city and give ample scope either for play or for serious experimenting.

ELECTRICIAN AND MECHANIC feels gratified that the rights and needs of the amateur have been so fully met in the conflict of selfish demands brought before Congress, and trusts that this bill will be passed without serious amendment, believing that it will result in a great stimulation to wireless experimenting.

WIRELESS NEWS

CHICAGO WIRELESS ASSOCIATION

Athenaeum Building
18-26 E. Van Buren St., Chicago, Ill.

The present organization is a re-organization of the old Chicago Wireless Club, formerly affiliated with the Electrician & Mechanic Wireless Club of Boston, Mass. The club was reorganized about two years ago, and the name changed to the Chicago Wireless Association.

The officers are: J. Walters, president; E. I. Stein, vice-president; C. Stone, treasurer; F. Northland, recording secretary; R. P. Bradley, corresponding secretary; W. J. McGuffage, chief operator; P. Pfiffer, and Geo. Blackburn assisting chief operators.

The regular membership is about seventy members, with a large number of irregular members who attend the meetings frequently.

The members of our association control and operate stations having power ranging from a ¼ in. spark coil to a 2 k.w. transformer.

The rules which are printed in the Call List were adopted after much discussion, and we are enforcing them with very good success. In the evening, there are always two chief operators upon the job, the chief operator being on duty all evenings, while the assistant chief operators alternate. The city is divided into two divisions, one of which is under the supervision of the chief operator, and the other division is under control of the acting assistant chief operator.

The members also transmit messages for each other and for outsiders, free of charge, using a regular message blank and envelope.

The Association is also attempting to get a relay route established between Chicago and New York, in this way being able to transmit messages from Chicago, and points between, to New York and vice versa.

As soon as this route is completed and in good working order, we will, no doubt, co-operate with the Tri-State Wireless Association of Memphis, Tenn., in regard to establishing another relay route to New Orleans, thus giving us a complete route from New Orleans to New York City. And once we have reached New York, it ought to be an easy matter to make up a route from New York to Boston.

At the present time, we have no stations on our Call List which use three-letter calls. There will, no doubt, come a time, though, when we will have to go into three-letter calls, so as to avoid using two-letter calls which are the reverse of each other. We have also cut out all calls which are duplicates of or the reverse of the calls of the shore stations or boats in our vicinity.

The Association has made arrangements with a number of supply houses whereby the members of the Association are enabled to buy all supplies at a reduced cost, upon presentation of an order from the Association.

Wish to say that we had a map of Chicago and its suburbs mounted and dotted with pins, representing the amateur stations in the city, almost a month before a similar one was started by a club in Boston. The map is brought out on meeting nights, so that a member may see where another member lives, in relation to his own location, and so as to tell just how many miles the two stations are apart. The map is 48 in. wide by 72 in. long, on a scale of 2½ in. to the mile.

ROBT. P. BRADLEY,
Cor. Sec'y.
4418 Wabash Ave., Chicago, Ill.

WIRELESS ASSOCIATION OF BRITISH COLUMBIA, VANCOUVER, B.C.

We have received from the above-mentioned Association, of which C. C. Watson is president, a list of about thirty members with the call letters of their individual stations, also the rating power. To anyone interested we will be pleased to give the names and addresses with call numbers, or they may be obtained by communicating with Harold J. Bothel, corresponding secretary, 300 14th Ave. E., Vancouver, B.C. In the Province of British Columbia wireless stations are limited to a power not exceeding 1 k.w. and an aerial length of about 30 ft.

THE MANCHESTER RADIO CLUB

Manchester, N.H.

We are now corresponding with a number of other clubs throughout the United States and are glad to add new ones to our list, and we will appreciate any information you can give us.

Our club has decided to put up a new sending and receiving station and the work is now in progress. The sending outfit will consist of a closed core 1 k.w. transformer, a large, air-cooled, glass condenser, a specially-constructed heavy, key, brass strip oscillating sending helix, and three spark gaps, quenched spark gap, rotary spark gap, and a series spark gap.

The receiving station will consist of double-slide oscillating transformer (2,000 meters wave-length capacity) one fixed condenser, one variable condenser, three detectors, a silicon, a carborundum, and an electrolytic detector, potentiometer and battery, and a pair of 2,000 ohm receivers.

Our aerial is 100 ft. long, 100 ft. high and has five copper wires, five apart. We are progressing very fast and expect to have it in operation by the first of May. Our call letters are MRC.

The officers are elected semi-annually, in January and in July. The present officers are as follows: Homer B. Lincoln, president; Clarence J. Campbell, vice-president; Earle Freeman, secretary; Elmer Cutts, treasurer; Clarence Campbell, assistant secretary; Harold J. Wiggin, chief operator.

EARLE FREEMAN, *Sec'y,*
759 Pine Street.

AN EXPERT'S VIEWS

April 18, 1912.

Dear Sir:

The danger of ill-advised legislation by the Federal government, tending to regulate and limit the use of wireless telegraphy in this country, is a constant menance to the development of this new and important art; an art to which is already to be credited the saving of very many lives and numerous vessels at sea.

Since the sinking of the *Titanic* on Sunday night last, those interested in having restrictive legislation enacted have redoubled their efforts and are making use of the fact that there was more or less interference with the operation of certain United States government stations by amateur operators as an argument for wholesale restrictions. The danger of hasty legislation in this regard is now, I believe, imminent.

1st.—There seems to be a probability that our government will join with other powers in subscribing to the so-called "Berlin Treaty," and in imposing certain restrictive regulations upon the use of wireless telegraphy in this country conforming to practice in European nations.

2d.—That there seems to be a likelihood that one or more bills for imposing restrictive regulations upon the use of wireless telegraphy, which have been presented in the House of Representatives, may be enacted into law.

Under ordinary circumstances, the scientific and technical staffs of the departments of our national government might be expected to be fully competent to advise the House and Senate sufficiently upon scientific and technical matters; but, in the present instance, the Department of the Navy appears to have, or appears to feel that it has a strong interest in restricting, almost to the point of suppressing commercial wireless telegraphy, or, in fact, all wireless communication other than governmental messages between its stations on land and afloat.

I am informed that so preoccupied are the wireless companies of the United States in litigation and in recovering from the financial crises through which most of them have passed, that they have, for the first time, failed to take active part in the discussion of the matter at the hearings which have been held on the subject before the Committee on Merchant Marines and Fisheries of the House of Representatives.

The excuse for restricting wireless telegraphy arose some years ago, as you are probably aware, from the much advertised "Interference" between messages. It is in devising and perfecting means for overcoming and preventing this interference that the future utility of the art to mankind chiefly depends. Most of the "interference" at present experienced is entirely due to the use of apparatus which is out of date, in that it makes inadequate provision (*a*) for excluding extraneous "interfering waves"; (*b*) for minimizing the power of interference of the waves it sends out.

The provisions of the so-called Berlin Treaty are such as to stifle the progress of the art by making the natural development of non-interfering apparatus useless and unprofitable. It tends to take away from the inventor, the engineer and the manufacturer all incentive to perfect the art to that point at which mankind may be able to profit to the maximum from this wonderful, flexible and economical mode of instantaneous intercommunication. Where many progressive but separate and distinct nations are crowded together on a continent, as are the European nations, such a convention as the Berlin Treaty may, perhaps, to a certain extent, be excused in spite of its unnecessarily restrictive character; but, for the United States, having for itself the greater part of a continent—far remote from these nations—to join with them in such a convention would be, I believe, a grave and inexcusable mistake.

The experts in wireless telegraphy of the United States Navy would like to have such laws enacted as would give the United States Government unrestricted use of all wave lengths between 600 meters and 1,600 meters. This would leave only the least desirable wave lengths for the use of the wireless business of the country, and bring about an altogether intolerable condition in the transaction of business by wireless telegraphy. Moreover, it would free the United States Navy from the necessity of using any but the cheapest and least efficient wireless apparatus and would tend to indefinitely postpone progress in the art.

If the United States Government's naval stations and ships were equipped with as efficient wireless apparatus, *i.e.*, as "selective" wireless apparatus, as that used in the German Navy, they would not be so easily interfered with by every little amateur's station in their neighborhood. In this connection it is to be remembered that the amateur of today will be the inventor and engineer of tomorrow, and if he be prevented from freely experimenting now his attention and interest will probably be permanently diverted from the subject of wireless telegraphy with loss to himself and the community at large.

I ask you to recall the "interference" that used to be experienced between the old grounded circuit telephone lines, in the first ten or twelve years of the history of that art. Circuits a quarter of a mile or more apart used to interfere so much with each other that it was often impossible to tell whether the voice you heard in your telephone was that of the man at the other end of your line or whether it was the voice of someone carrying on a conversation on a totally different line a quarter of a mile or more away from yours. Suppose the government at that time had enacted restrictive laws, prohibiting the establishment of telephone lines within a half mile of each other; would we today have cable lines with 100 telephone circuits all within a circle of 2 in. diameter, so cleverly arranged in metallic circuits and twisted relatively to each other that not a sound passes from one of these circuits to any of the other 99 circuits? I am of the impression that we would not, and that the great benefits which we today enjoy from the commercial development of the art of telephony would have been indefinitely postponed by any such legislation.

I feel that the *Boston Herald* will be doing service to mankind and certainly to our nation if it is instrumental in checking this tendency to stifle progress in this new art which is daily growing in flexibility, in range and importance to us all.

Yours truly,

JOHN STONE STONE.

QUESTIONS AND ANSWERS

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

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

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

1780. **Engine Drive.** J. L. B., Thiep River Falls, Minn., has charge of running a supposedly 200 k.w. 250 volt direct current generator, the drive being by belting to a double engine with 18 x 26 in. high pressure cylinders. The engine has ample power, but evidently the generator is badly designed, for at even ⅞ load heating and sparking are severe. Engine runs at 135 revolutions, and the question is asked if at this speed the operation would be sufficiently steady to permit the removal of one connecting rod, and using of the other half of engine only. This would result in considerable economy of steam. Ans.—Your proposal is not an unknown one, and your correspondent has seen the procedure, years ago, in two different electric light stations. During daylight hours, when the load was light, one-half the double engine was used; then as afternoon came on, the load would be shifted to a somewhat larger engine. The connecting rod of the first would then be put on, and for the peak of the evening load, as well as for caring for the street lights, this engine was ready for its full capacity. An objection is, that the crank-pin bearing is a rather troublesome one to adjust, and once in good condition, an engineer dislikes to disturb it. A little taking-up is always in order, but the fresh set, every day, invites the chance of either a hot box or a loose one, and once the engine is started for its night's run, no stop is to be permitted. Perhaps in your case, with water for the principal power, a short shut-down of the steam engine for readjustment would be perfectly allowable. As a permanent arrangement, the proposition is entirely feasible, for, at the stated speed, there should not be noticeable flickering of the lights, with even a single cylinder acting. If you really wish the full ouptut of the generator, the case would properly belong to the dynamo builders to remedy, and any concern that valued its reputation would be anxious to set the machine a-right.

1781. **Alternating Current Motor.** L. Bernadin, Lawrence, Mass., has a General Electric fan motor, form D, that has been rewound. On 110 volts direct current, the speed is 3,500, but on alternating current, only 400 is reached. He asks if he can wind the motor so it will act synchronously on the alternating current circuit. Field magnet is bipolar and laminated, and armature has 11 slots. Will an induction motor be as good as one of the synchronous sort for operating a rotary spark gap for wireless telegraphy? Ans.—You can try the motor in the manner you propose without rewinding, but if it works the rest of the apparatus satisfactorily, it will be more economical for regular use to substitute such special windings as we will describe when you are ready. Fit two brass or copper rings over the commutator, being insulated from the segments and from each other by fiber or paper. One small headless set-screw is to be provided for each ring by which it is electrically connected to some particular segment, and the other ring to the segment most nearly opposite. Provide a copper brush for each ring, and to these the alternating current is to be led, but with provision for including one or more incandescent lamps for safety. Field is to be separately excited from the direct current supply, lamps being also included in this circuit. Have a small double-pole switch, one blade of which can connect with the d.c., other with the a.c., other two wires being without switch. To start motor, it may be speeded to as near 3,600 revolutions as can be judged, by hand or foot, say through the mechanism of some old sewing machine, and then the switch being closed, the driving belt being at the same time automatically slackened. An induction motor will not be suitable for operating the spark gap if latter is connected to the alternating current supply. If direct interrupted currents are used for operating the primary of induction coil, an induction motor will be as suitable as any other. With the alternating currents it is important to have the impulses come at critical instants, and this result will be attained when both coil and rotary spark device are operated in synchronism.

1782. **Fan Motor.** W. A., Cambridge, Mass., has a 6-pole, 110-volt direct-current fan motor, five of the field coils of which are wound with copper wire of the size of sample sent, while the sixth is of the same size, but of German silver wire. Everything else appears to be right. What is the reason for this construction? Ans.—This method of winding is not new, but merely makes a field coil take the place of a starting rheostat. If it were not for the undesirable heating produced in the machine, the scheme might be used on other than fan motors. In this case the breeze has not only to keep the user cool, but to keep the fan cool. If you put a pulley in place of the fan and tried to use the motor to drive some light machine, the coils would get intolerably hot. Evidently you have a larger motor than we at first supposed, for it is unusual to have desk fan motors for direct currents with more than two poles. The size of wire is No. 21, and this indicates a motor larger than the common fan size.

1783. **Induction Coil.** B. H., Wilkes-Barre, Pa., wishes to make a coil for wireless messages, using about 1 lb. of No. 34 d.c.c. wire for the secondary. He asks for directions and dimensions. Ans.—If you follow directions given in various articles that have appeared in this magazine you will be likely to get a reliable coil. Two articles of value are in the February and March, 1910, issues. For your case, the iron core should be about 8 in. long, 1 in. in diameter. Primary coil should consist of two layers of No. 16 wire, secondary of the 1 lb. of No. 34. Condenser may have 100 sheets of tin-foil, each 5 x 7 in. Using three or four large bichromate or small storage cells, you ought to get 1 in. sparks, but we do not know for what range of messages the coil will work.

1784. **Gauge.** H. J. T., Loudonville, O., asks where he can find directions for making a gauge or instrument that will indicate the reading on another instrument half a mile or a mile away. Ans.—This is not the first time a request of this sort has been made, yet we regret to state we do not know of anything on the market. The Weather Bureau at Washington would probably send on request a description of their distant recording instruments, but these would undoubtedly prove too expensive. Of course two wires at most should do the work. A single wire and the ground would prove unreliable for some sort of signals or currents in the only practical device we could suggest. This might consist, at the operating end, of a float that would raise or lower a slider on a row of electrical contacts, such as are used on a rheostat. Resistance coils would be connected between these contacts, and at the receiving end considerable electrical energy could be introduced into the circuit, say from 110-volt direct current lighting mains. Alternating currents would not work as well. A low scale ammeter could be specially graduated to read in any particular units you pleased, and the varying position of the pointer, dependent upon the current flowing, and that in turn by the particular amount of resistance in circuit, would give the indications desired. There would be the undesired errors introduced into the circuit by the varying resistance of the wire in different seasons of the year, and at different times of the day, due to changes of temperature, by the varying leakages at the insulators in dry and wet weather, and by variations in the operating voltage. In the absence of other sources of direct current, you might use gravity batteries, provided they were always kept in circuit and in good order, with a milli-amperemeter for indicator, but the readings might be more in error.

1785. **Battery Charging.** R. H., Newport, Vt., asks: (1) Is it a better plan to recharge storage cells, say those of the "Exide" sort, in an electric launch, after every short run, thus keeping them nearly charged all the time, or use from them until practically exhausted? (2) Can it be shown that a piece of hardened steel that has been run for some time in a bearing without showing signs of wear has actually changed in size? (3) In which sort of vessel will water boil more quickly, and why,—one with dull, rough sides, or one brightly polished? Ans.—(1) Just what you mean by a short run is rather indefinite, but if such use approximates half a discharge, you will greatly improve the working of the battery by charging it without further delay. The complete discharges are what tell on the life of the cells, 300 such being often as the legitimate limit. Department stores that use electric delivery wagons, with supposedly battery power for a whole day's run, find it highly desirable to put in even a partial charge during the noon hour. (2) Yes, with a micrometer caliper. (3) The rough dish, for it presents a greater heating surface, and also allows points from which the steam can be directed. The case is not so marked with water as with some liquids that have a habit of "bumping." That is, even when the temperature at which the liquid is supposed to boil has been passed, yet no evolution takes place until all of a sudden such a mass is converted into vapor as to drive all the liquid out of the dish, and the experimenter may feel fortunate if he escapes a scalding. Beauty marks on the ceilings of chemical laboratories are silent witnesses to escapades of this sort. To avoid accidents, it is customary to put glass beads or broken bits of glass in the flasks used for boiling such misbehaving liquids, whereby the greater area and numerous sharp points will encourage the escape of vapor when the boiling temperature has been reached.

1786. **Molding.** L. O., Vernon, Tex., asks for directions for making plaster of Paris or ordinary sand molds for casting brass. Ans.—To give adequate directions in these columns would be quite impossible, and we shall have to refer you to some book, say the "Pattern Maker's Handbook," price, 50 cents. The November and December, 1909, issues of this magazine contained good chapters on this subject.

1787. **Wireless Transmitting Station with Induction Coil.** W. R. T., Fair View Ranch, Wash., says: A friend and I living two miles apart have wireless outfits. Our aerials are 50 and 125 ft. long. We have double slide tuning coils, 1,000 ohm receivers, silicon detectors, fixed condensers and 1 in. spark coils, but we cannot get each other. (1) How can we tune our transmitting sets? (2) Explain how sending helix is adjusted to change wave-length. (3) Will the difference of our aerials (which are 50 ft. high) in length affect the wave-length? Ans.—(1) With spark coils you cannot use the commercial "hookups" to advantage. The station having the 50 ft. aerial will need a helix consisting of a great number of turns put in series with the aerial and one side of the spark gap, and the ground connected to the other side of the gap. The spark gap should be connected right across the secondary of the spark coil and *no* sending condenser should be used. With these connections you will have a set that is always in tune. The station with the 125 ft. aerial need use no helix, simply put aerial on one side of the gap and ground on the other. (2) To lengthen the wave put more turns of the helix in the aerial circuit, and to shorten wave take out some of the turns of the helix in the aerial circuit. (3) Yes, decidedly so, because the wave-length is determined by the length of the aerial and the number of turns of the helix in series with it.

1788. **Wireless.** L. R. J., Lynn, Mass., (1) Can you tell me the nature of calorite? Its temperature coefficient and electrical properties? Who manufactures it? (2) Give call, wave-length, height of aerial, power and make of wireless station on Board of Trade building, Broad St., Boston. Ans.—(1) Calorite is used by the General Electric Co. in heating devices. It is an alloy that is "practically indestructive" when used for heating purposes. For further information write to the General Electric Co. Heating Dept., Lynn, Mass. (2) Call "FBN"; 2,200 meters wave-length at present. A 5 k.w. Fessenden set owned by the National Electric Signalling Co. Towers are 75 ft. high above the roof of the building.

1789. **Wireless and Batteries.** M. V. P., Chesaning, Mich., asks: (1) In the electrical catalog of J. J. Duck, Toledo, O., page 248, a 1 in. spark coil for wireless is advertised for $4.25. On page 135 is advertised an induction coil (1 in.) for $17.00. What makes the difference? (2) Could the wireless 1 in. spark coil be used with the Tesla coil described in this magazine recently, if protected by the device used on ½ k.w. transformer? (3) In Carhart & Chutes high school physics book, on page 338, it says "The copper plate is the positive electrode or cathode and the zinc the negative electrode or anode," and in Newel's Descriptive Chemistry, on page 121, it says, "It is customary to speak of the current as entering the electrolyte by the anode or positive electrode and leaving by the negative electrode or cathode." In a book I have by Alinger Small, it shows a diagram as follows: In this the same plate is both positive and negative which would explain the seeming contradiction above. Which is right? Please state your authority. Ans.—(1) The induction coil is finished more elaborately, but probably would not be any better for wireless than the $4.25 one. (2) No, it gives too limited a supply of energy to be used for this purpose. (3) That plate or piece of metal by which the current leaves the cell is called the cathode, while that piece of metal or plate in a cell by which the current enters the liquid is called the anode. The plate by which the current leaves the cell is not dissolved and in some cases receives a deposit on its surface. Authority—Silvanus Thompson. It is customary to speak of the cathode or plate by which the current leaves the cell as the positive plate meaning that the current leaves from the cathode, flows through the external circuit and then returns to the anode. In order to complete the circuit, the current must now pass from the anode through the liquid (or electrolyte) and then to the cathode.

1790. **Wireless.** J. A. S., Allegheny, Pa., asks: (1) Kindly explain how the telegraph key (as advertised in *Electrician and Mechanic*) called the "Mecograph" works. Are the dots and dashes made by the hand the same as with the ordinary telegraph key, or does the "Mecograph" make the dots and dashes automatically? I have one of their booklets, but it does not give any information as to how it works. (2) Is there any way to connect a telephone receiver to a telegraph circuit that the telephone receiver will make the dots and dashes like a telegraph sounder? The back click in a telephone receiver is several times louder when the circuit is broken than when the circuit is closed. Would a condenser be of any use, and if so, how could it be used? (3) There is a wireless station about two miles from my home. This station has a tower about 80 ft. high. My home is about 300 ft. higher than the top of this tower (wireless station is in a valley.) What instruments would I have to have in order to receive a message from this wireless station? Ans.—(1) If you will write directly to the manufacturer, Mecograph Co., 321 Frankfort Ave., Cleveland, O., they will be very glad to give you literature and information regarding same. (2) You can connect the telephone receiver in place of the sounder and get a click every time the circuit is made or broken, but it never can sound much like the clear click of a sounder. A condenser shunted directly across the telephone will help out. (3) A two-slide tuner, silicon detector, fixed receiving condenser and a pair of 75 ohm telephone receivers will do the work fine.

1791. **Wireless.** C. C. B., West Dennis, Mass., asks: (1) I am building a wireless receiving apparatus as follows, and would like any suggestion that would improve my receiving station. I have a tuning coil 12 in. long, 4½ in. in diameter with two slides, one condenser, glass type, 10 pieces of glass 4 x 5 with tin-foil alternated between each piece of glass, detector electrolytic type, and a pair of electro government phones 1,500 ohms each. I want information in regard to a 50-mile sending set. (2) I have a 2 h.p. gasoline engine that I can bring into play if I know what kind of a generator to get to make the amount of current I would need to operate my station with. What other machine would I need to complete my 50-mile out set? Ans.—(1) A much better receiving set would consist of the following: An induction tuner made by winding a layer of No. 22 wire on a tube 4½ x 8 in. and a layer of No. 28 wire on a tube that will just slide easily inside of this one. A sliding contact is placed on the 4½ x 8 in. coil and about eight taps brought out to an 8 point switch from the inside winding, which is called the secondary; a variable condenser connected right across the secondary of the inductive tuner, and a silicon or perikon detector. Use your glass plate condenser across the telephone receivers. (2) You will want a 1 k.w. alternating current generator, a 1 k.w. transformer, spark gap, sending condenser, helix and key.

1792. **Wireless.** E. T. D., Cambridge, Mass., asks: (1) Can copies of the "Manual of Wireless Telegraphy for Naval Electricians" be obtained, if so, where and at what price? I understand it is issued by the government. (2) Where can I obtain information as to the instruments and methods of connection employed by the important commercial wireless companies? (3) Where can I obtain specific information concerning the Telefunken and Von Lepel systems of wireless telegraphy? Ans.—(1) We can supply this to you for $1.50. (2) The "Manual of Wireless Telegraphy for Naval Electricians," gives diagrams of all the commercial companies' connections. (3) I have seen no "specific information" outside of a few paragraphs in the "Manual of Wireless Telegraphy for Naval Electricians," regarding these systems.

1793. **Condenser.** J. M. L., Ashland, Wis., asks: I am building a 12 in. coil on the plan of Mr. Stanleigh's 6 in., given in the spring numbers. Would you please answer the following about the condenser? (1) Is this piece of paraffin paper too thick or too thin (for the dielectric)?

(2) Is the tin-foil found on tobacco good for this purpose; if not, would it be all right if several thicknesses were used as one sheet? How many? (3) What advantage has the heavy foil over the thin? Since the charge is only on the surface, it seems as though either would be good. Ans.—(1) While the sample you send us is rather thick for use in making a condenser, still it will undoubtedly be satisfactory providing you increase the number of sheets in order to get sufficient capacity. It is preferable to use two or more thicknesses of very thin paper between condenser plates in order to lessen the danger of breakdown through flaws in any one piece of paper. (2) The tin-foil you mention is quite satisfactory, and it is not necessary to use more than one thickness. (3) For a primary condenser the thinnest grade of foil is electrically all right. It is difficult to handle, however, and the medium grade will be found to be better for this reason.

1794. **Transformer Construction.** H. W. S., Columbus, O., asks: I am having some difficulty in making a ½ k.w. stepdown transformer to step 220 volts from the three-wire lighting circuit to 110 volts to use on my laboratory switchboard. In a back issue of your book *Electrician and Mechanic*, dated September, 1911, page 203, under an article by Stanley Curtis: "For the Laboratory. Experimental High-Frequency Apparatus—Part IV," you give the figures and formulas for calculating a transformer. I tried to design my transformer like this one, but I do not get the full amount of current through it. These are the dimensions of it: core, No. 24 gauge, soft enameled sheet iron, 2 in. square; length of winding space 4 in., outside dimensions are 8 x 6 x 2, window is 2 x 4 x 2, primary 660 turns of No. 16 wire or 10¾ layers. Secondary is 330 turns of No. 13. This is the way I figured it from the formula you gave in the book I referred to. I have been testing the transformer very close. So far I find 40 watts loss. I get the desired voltage on my secondary—110 volts; but when I go to put a load of lamp bank on, I have not enough current to light four 120 watt lamps and on a short circuit I can get 4 and 5 amperes. I can light two 120 watt lights bright. I have a ¼ k.w. stepdown transformer that I bought, and I have found that a short circuit over it will easily blow a 6 ampere fuse, 110 volts or pull about 8 amperes. Of course this is not all good for the transformer, but I have had it to happen once in a while and that was the result. I beg for any suggestion you might give on the subject from the data I here enclose. Also I would like to have some tables telling about the core density per square inch and different cycles and voltages. I am very much interested in this data in your magazine. Ans.—We assume that you have built your transformer with the primary on one leg of core and the secondary on the other leg. This is good practice in the case of the transformer to be used for charging condensers or for an arc compensator where very loose coupling or, technically speaking, poor regulation is highly desirable. In the case of the power transformer, however, the regulation between light load and full load must be as near perfect as possible, the proper method is to place primary and secondary on the same leg or in the case of a core type converter such as you have constructed, to place half of each on the respective legs. The core should also be made as compact as possible and the magnetic circuit as short as is practicable. Better still is the shell type construction shown in the drawing. In this type, the primary is usually divided in two sections which are placed on either side of the secondary. The windings are completely surrounded, except at top and bottom, by the iron core, and such a transformer gives splendid regulation if well constructed. The core is more difficult to cut and assemble, however, and this probably accounts for the fact that amateur builders prefer the simpler core type. The construction shown in Mr. Stanleigh's article in the January, 1911, issue combines both the simplicity of the core-type and the regulation of the shell type transformer, and we suggest that you look up the article. This construction is known as the "Ferranti," and for small transformers it is very useful. For a table giving the core loss at various frequencies, we refer you to Twining's "Wireless Telegraphy," which we can supply at $1.50.

1795. **Tesla Coil.** W. H. L., Napa, Cal., asks: (1) Is it true that distilled water is a good dielectric to use around high-frequency coils of the immersed type? (2) Will a Tesla coil of this description give a 64 in. spark from an alternating current of 20,000 volts: Primary, 15 turns No. 6 wire wound double to form a coil 22 in. in diameter and 28 in. high; secondary wound on open fiber frame placed inside. Primary: 580 turns No. 26 wire, core 17 in. diameter, 28 in. long. (3) What would be the watt consumption of above coil? Ans.—(1) This is a new one on us. It is usually conceded that water or even moisture is best kept away from apparatus of this kind. (2) It most assuredly would not. (3) With a 2 k.w. transformer you might obtain a 30 in. spark, providing the Tesla coil was immersed in transformer oil and properly tuned to the transformer and condenser.

1796. **Wireless Telegraphy.** R. J. B., Eau Claire, Wis., asks: (1) Do you think I would be able to use antenna 60 ft. high at both ends, 6 wire, 75 ft. long, and 2,000 ohm receivers, series connected with aerial and ground to hear the static or splashing of an electrical storm 500 miles radius? Am situated about 70 ft. below the hilltops of this section and the hills are about 2 miles distant in any direction from my station. (2) Are wireless signals weakened by having five or more connections or contacts between antenna and detector? Ans.—(1) You will have to use a detector, preferably either carborundum or silicon, in series with the aerial, telephone receivers, and ground. The hills will decidedly cut down the radius of receiving. (2) Not if the contacts are as near electrically perfect as possible.

1797. **Wireless "Swinging."** (1) G. H. J. Seattle, Wash., asks: Why do wireless stations north of here die out when listening to them? For instance, Tatoosh Island, N.P.D. or Point Esteven U.S.D. come in so one can easily read them, but gradually die out so you can hardly hear them. It is not my aerial or set. I lay it to the location and conditions of the weather. Ans.—This peculiar phenomenon is technically called "swinging." As yet it has had no satisfactory explanation, but is probably due to the fact that the air varies in density at different instants and therefore varies in its reflective ability toward the ether waves, thus making the signals "swing" in and out. "Swinging" is more marked from stations north and south than from those east and west.

1798. **Armature Connections.** R. J. B., Eau Claire, Wis., asks: (1) How should I connect the armature coils to the commutator in the dynamo-description below: Armature laminated, 12 slot, 2¼ in. wide, 3¼ in. diameter, ½ in. slots, 24 segment commutator. Ans.—(1) If your armature is a single parallel wound armature, that is, has only one coil of wire in each slot, connect the two leads of each coil to *adjacent* commutator segments.

1799. **Transformer Design.** H. S. M., Syracuse, N.Y., asks: In the article in the September, 1911, issue of *Electrician and Mechanic*, where the author assumes an efficiency of 94 percent, does he not give the reader the idea that the design as worked out in the article will come up to that efficiency? The author divides the losses into core and copper loss, and then figures his core so that its loss comes within the predetermined figure. If the author desires to base his design on efficiency, should he not design the copper so that its loss comes within the required figure, just as in the case of the core? Using the size and length of wire designated by the author, the primary RI loss at 20 C figures 17.5 watts and the secondary loss 27 watts, making the total copper loss 2.6 times that assumed at the start, and reducing the efficiency of the instrument to below 90 percent. In order to be logical, should not the author assumed an efficiency of 90 percent and taken the copper loss as 75 percent of the total loss, to justify the design as given? The analysis of this problem brings out a very interesting fact. For instance, the transformer as designed actually has an efficiency of about 90 percent, which is very good for a ½ k.w. instrument. Now to bring the efficiency up to the figure where it should have been if the design as assumed were carried out, the copper losses, as we have shown, would have to be reduced to $\frac{1}{2.6}$ of their present value, which would mean that the weight of wire used would be 2.6 times as great. This would require the use of 37¾ lbs. of wire instead of 14½. Figure the difference in cost for yourself. Does it not show that when we have an efficiency approaching unity, that to raise this efficiency only a few percent requires the expenditure of a large amount of money in proportion to the results attained? With small apparatus for amateur use it appears from this example that, in general, it is better to sacrifice a few percent in efficiency for the sake of first cost. Ans.—Your points are well taken and the author agrees with you that the average reader might be given a somewhat incorrect impression. On actual test the design as given produces a transformer having an efficiency of about 90 percent when the best grade of silicon steel is used in the core and when the workmanship in assembling the core is up to a certain standard. The principal object of the article in question was, however, not to provide any very complete data on power transformer design, but rather, to give the man with little or no technical education a simple and reasonably accurate method of designing small transformers suitable for wireless telegraphy or high-frequency work. The multitude of questions on the order of "How many turns shall I use?" received by the author of the article suggested that a few simple instructions on this subject would be very acceptable. That the instructions were acceptable and adequate is evinced by the large number of amateurs who have built transformers from the design given and by the reports of highly satisfactory operation of the instruments.

1800. **Armature Construction.** C. M. C., Fulton, N.Y.: In reply to query No. 1735 would say that "Dynamo Electric Machinery," Sylvanus P. Thompson; "Dynamo Electric Machines," A. E. Weiner; and Vol. 13 C of the International Library of Technology, issued by the International Correspondence School, will furnish information. The International Correspondence School will not sell a single volume, but W. H. B. may purchase same from Geo. F. Williams whose ad. appears in Sale and Exchange Department.

1801. **Motor Design.** W. H. H., Fort Wayne, Ind., asks: (1) What changes would be required in the design of the motor as described by Louis Potter in September, 1911, issue of *Electrician and Mechanic* to make a 1 h.p. motor. Could a 1 h.p. motor be made over same diagrams by increasing the length and not the diameter? I would like to have a 1 h.p. 60 cycle 110 volt or 220 volt. What would be the comparative difference in 25 and 60 cycle machines, same horse-power? Ans.—(1) Can be increased in length only, but better by about 30 percent in length and diameter both. Use wire three sizes larger, with about 60 percent less turns. For 25 cycles, the design should have but two poles, and in other respects the design would be considerably changed.

1802. **Motor Design.** E. B. K., Missoula, Mont., asks: I wish to build a ¼ h.p. motor to run on single phase, 60 cycle, 110 volt A.C.; laminated field having two poles, and armature being wound and having a commutator and brushes. (1) Is there any book published which would tell me how to make this motor? (2) What would be the proper dimensions and sizes of wire for this machine? (3) How should the armature be wound and how connected to the field? Ans.—Your proposed motor would be essentially of the direct-current sort of construction. We wonder if you really mean this or do you wish one of the "induction" type? A commutator motor operated on alternating currents sparks horribly. A machine of the induction type was described in these columns recently under the head of a "Vacuum Cleaning Outfit." We are expecting soon to have a publication in much greater detail.

1803. **Dynamo Design.** W. H. B., Chicago, Ill., asks: Please advise if you have a book in regard to armature and field calculations. I want a book that will tell me just how to calculate the size and amount of wire necessary for armature and fields of motors and dynamos; also how to calculate how much current a dynamo is generating. Ans.—This question involves the whole field of dynamo design, and no one book or short course of reading will give the information desired. Underwood's book on the "Electromagnet," Hobart's "Armature Construction" and "The Electric Motor" are first class, but perhaps beyond the scope of the average enquirer. I would recommend a course in direct current dynamo design in one of the Correspondence Schools.

BOOK REVIEWS

The Application of Hyperbolic Functions to Electrical Engineering Problems. By A. E. Kennelly, M.A., D.Sc. London, University of London Press, 1912. Geo. H. Doran Company, N.Y., American Agents. Price, $2.25.

To all who are familiar with electrical engineering research, Professor Kennelly's name is well known; with the publication of these lectures, his work should rapidly get from the lecture room and study into the laboratory and field. The use of hyperbolic functions should not deter readers from the book, for these funtions are similar to the trigonometric and in reality are nothing but convenient combinations of the exponential or logarithmic; rather may it be said that the neat formulas which the author derives are ample justification and reward for any time spent in the study of the functions.

The fundamental idea underlying the lectures is that the theories of D.C. and A.C. phenomena may be combined into a single theory by the use of vector diagrams and complex numbers, so that the formulas for alternating currents may be derived from those for direct currents by substituting imaginary numbers for real. From the point of view of the computer, whether he works graphically or arithmetically, the fundamental and neatest thing in the book is the manner of replacing an actual line by what Professor Kennelly calls equivalent T's or Π's, which are lines of particularly simple type.

The theory is developed in intimate connection with the applications which include D.C. lines of uniform resistance and leakance, A.C. power transmission lines, wire telephony, and wire telegraphy. To aid the reader of the work there is at the end a complete list of symbols with their definitions, a long and complete bibliography, and an excellent index. This book and Professor Kennelly's theories have a brilliant future before them.

Knots, Splices and Rope Work. By A. Hyatt Verrill. New York, Norman W. Henley Pub. Co., 1912. Price, 60 cents.

A most practical treatise giving complete and simple directions for making all the most useful and ornamental knots in common use, with chapters on splicing, pointing, seizing, serving, etc. The book is well illustrated with 150 original cuts, showing how each knot, tie or splice is formed and its appearance when completed, and it is well adapted for the use of travelers, campers, yachtsmen, boy scouts, and all others having to use or handle ropes for any purpose.

House Wiring. By Thomas W. Poppe. New York, Norman W. Henley Pub. Co., 1912. Price, 50 cents.

This book treats in a clear and non-technical manner the subject of house wiring. It describes and illustrates the most up-to-date methods of installing the wiring, and the methods described do in no way conflict with the rulings of the National Board of Fire Underwriters. It will prove of special value to electricians, apprentices and helpers, while even the advanced electrical worker will find many things in it which will interest him, as many labor and time-saving operations and diagrams are illustrated and described.

Brazing and Soldering. By James F. Hobart. New York, Norman W. Henley Pub. Co., 1912. Price, 25 cents.

This little, well-illustrated booklet of about 50 pages is one of the few reasonably priced books upon the subject of brazing and soldering. It explains how to handle any job of brazing or soldering that may occur; tells what mixture to use, and also how to make a furnace if one is needed. The booklet has recently been entirely revised and enlarged.

Practical Lessons in Electricity. By F. B. Crocker, L. K. Sager, H. C. Cushing, Jr., and Harris C. Trow. Chicago, American School of Correspondence Pub. Co. Price, $1.50.

An excellent working guide to the fundamental principles of electrical science and one especially adapted for purposes of self-instruction and home study. The book serves the purposes of a working guide for the beginner as well as a manual of information abounding in suggestions of much practical value to the more experienced electrical worker.

The authors are men well qualified to write such a book, since they thoroughly understand both the practical and theoretical sides of electrical engineering. They have explained the theory by means of simple language and a copious use of illustrations, adequate explanation being given of the fundamental principles and mechanical instrumentalities involved in the production and transmission of electricity.

The latter half of the book is devoted to the more common applications of electric energy and there are chapters devoted to the construction and use of Storage Batteries, and to the installation of conductors for power, lighting and other purposes.

The Slide Rule Simplified. By Geo. W. Richardson. Chicago, Geo. W. Richardson, 1912. Price, $1.00.

This book, as its title signifies, explains the how and why of the slide rule. In it, is given an excellent description of the Richardson Direct-Reading Slide Rule, and by means of the numerous illustrations and text matter, even the novice can readily grasp the method he should use in solving the various technical or practical problems which may confront him. As our readers are always desirous of learning of any time or labor saving device, a good clear description of the slide rule should prove most interesting to them. It is also well to note that the book is supplied free to all purchasers of either the 5-inch or 10-inch Richardson Direct-Reading Slide Rule, advertisement of which appears elsewhere in these pages.

"*Train Lighting Lamps,*" is the title of a bulletin recently issued by the Engineering Department of the National Electric Lamp Association, which is sustained by certain works of the General Electric Company, covering the description, performance and economy of Mazda and Gem lamps in train lighting service. Copies of this bulletin may be secured free from the Engineering Department above mentioned.