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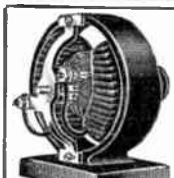

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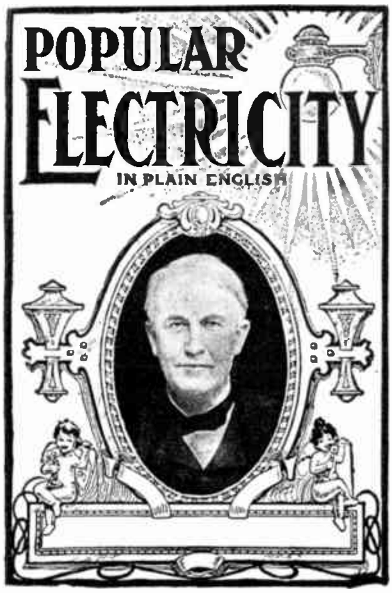

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ARMATURE WINDINGS — Chapter II

DRUM ARMATURES FOR DIRECT CURRENTS

A. E. WATSON, EE. PH.D.

DIAGRAMS representing drum windings lack the clearness of those readily drawn for the ring type. The numerous crossing of the wires makes the appearance confusing to a beginner, and even to the expert some difficulty is often presented in following the intricate circuits. In many text-books attempts toward simplification are made by showing single layer drum windings, and while such constructions have actually been made, they are not now common, and in this article special emphasis will be laid on the common practice of employing and recognizing the two layer principle.

For nearly twenty years after the invention of the drum winding it was limited to use with field-magnets of only two poles, while the ring form was with considerable success readily employed with multipolar designs. The reason lay in the fact that practical means were not known for adapting the drum winding to fit the conditions. The introduction of toothed armatures and invention of "formed" coils, soon after 1890, solved the difficulty, and the general adoption of this type of winding testifies to its excellence. Indeed, it is hard to conceive that better methods are likely to be invented.

To consider the subject in a progressive manner, let reference be given to Fig. 9, showing in perspective a drum armature core with one coil consisting of nine turns in a single layer in place. For convenience in winding, the shaft may rest between lathe centers, or better, — for a lathe is usually lacking in cleanliness and has too many sharp corners for scraping the insulation off the wire, — on some sort of a wooden fixture on a table, and as the wire is passed around the ends, the core is rocked back

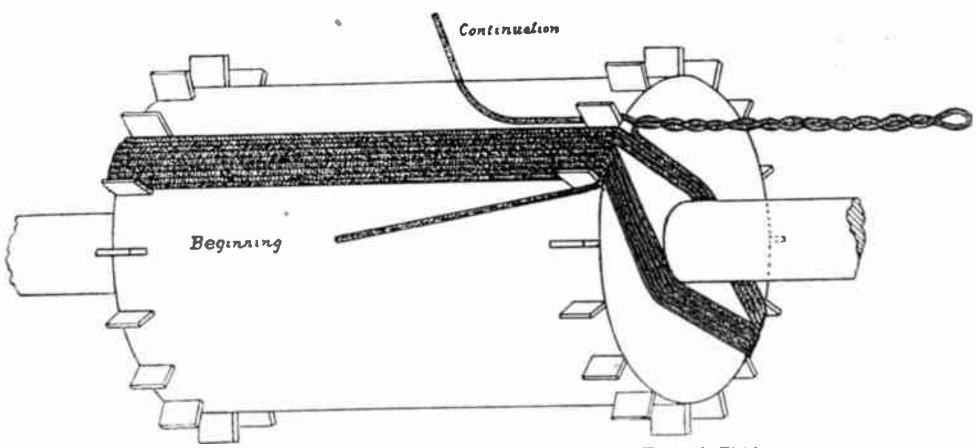


Fig. 9. First Coil of a Siemen's Drum Armature, adapted for Two-pole Field-magnet

and forth through half a turn, whereby the wire is readily kept in view. With fine wires sufficient tension can be exerted to make them lie straight, but with larger ones, a counter bend can be put in with the thumb. so as to make the straight portion hug

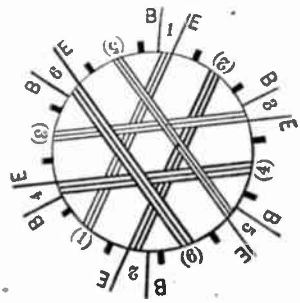


Fig. 10. Method of Winding Drum Armature with Separate Coils, and Fitting a Two-pole Magnet

closely to the core. At the ends, the first turns must pass at a sufficient distance from the shaft to allow the rest to fill in with the successive passages, else there will be an undue piling and bad appearance.

In case of a smooth surface armature like that shown in the figure, retaining pegs of fiber are driven into saw cuts made in the brass heads before the core is assembled. In addition to holding the wires in place during the winding, they are also of value in driving the conductors through the field of magnetic force when the machine is running. In case of a toothed armature, far better mechanical strength is obviously secured.

A given element of the winding may consist of more than one layer, but of course the difficulty of holding the wires in place on a smooth core is then increased; with the toothed sort, numerous layers are possible and advisable. For the single layer just described, a loop is twisted in the wire, and a similar coil wound in the next space and its opposite. That is, for a 16 coil armature, coil 1 can be placed in spaces 1 and 9, while the next will go in 2 and 10; then a second loop is made and a coil wound in 3 and 11; and so on until spaces 8 and 16 are occupied and a seventh loop is secured. The entire surface of the core will then be covered with a single layer, but only enough connections will be left out for one half the commutator segments, and these will be in a semicircle. To provide the rest of the connections, and to make the winding of the closed circuit order, it will be necessary to continue the procedure directly on top the existing wire, that on top of the first coil providing a loop next to the last one, and opposite to the beginning of the first coil. Since the full difference of potential, in case of a two-pole machine, is existent between the opposite brushes, to which these overlapping coils connect, there will always be a pressure striving to break down the insulation between the windings. This is the only serious defect of the drum winding, but with good insulation, voltages in direct current armatures of 500, and in case of alternators, of 2000, are practicable. No such high values as are possible with ring armatures are attempted with drum windings. This defect is, however, not serious, for in case of direct current armatures, limits of commutation are met before those of puncturing insulation, and with alternators, other types of winding are readily substituted.

That these halves exist is of fundamental importance in considering drum armatures, and in the example being considered, when the second part has been completed on top the first. the very end of the wire is to be twisted to the beginning, thereby making the sixteenth loop, and the whole commutator is provided with connections. Such a winding is the simplest to grasp, and is readily accomplished by a beginner, without much opportunity for mistake. It is possible, however, to wind both layers in spaces 1 and 9, then leave out a loop, skip spaces 2 and 10. and wind two layers in spaces 3 and 11. then in 5 and 13. and so on.

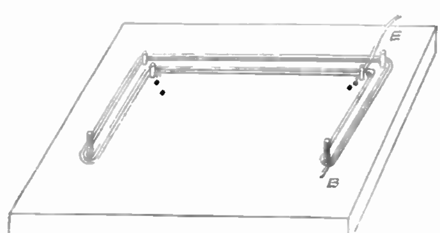


Fig. 11. Simple Form for Winding Drum Coils of Few Turns for Use with Multipolar Field-magnet

while on the second half 10 and 2 are filled, etc. The result is that only eight loops will be provided, and an 8 segment commutator needed. In general there should be a large number of segments, and in case of toothed armatures there may often be two or three times as many segments as slots. Such a winding as the one described leaves no chance of error in making the commutator connections, but it is faulty in the respect that any one coil is considerably spread out over the surface, and that most of the time the two circuits which are in parallel with each other do not have the same length of wire and, consequently, not the same resistance. Unequal currents will therefore circulate in them. The coil can be narrowed, therefore improving commutation, and the circuits more nearly evened in length, by winding the halves side by side rather than one on top the other. This involves cutting off enough wire for each coil, leaving out plenty of ends for scratching the hands and for confusing the mind. For large armatures, however, such as were used in the standard Edison and Thomson-Houston bipolar dynamos, consisting of only one or two turns per coil, and of relatively large wire, or of a bundle of smaller wires, this is the only practicable method.

For illustration of this method, let the surface of the core be divided into twice as many spaces as there are segments, say, in 12 spaces, as shown in Fig. 10. All the turns belonging to one coil are wound in a given space and the one just short of opposite; let this be called coil 1, with its beginning and end marked B and E. Now wind coil 2 parallel to 1, but with its beginning and end on the opposite side of core. The B and E of each may be twisted together, but only loosely, for the union is for convenience during the winding only, and other combinations are needed for final connections. The pair of coils numbered 3 and 4 can next be wound, finally 5 and 6. After the binding wires are wrapped around the armature for holding these conducting wires firmly in place, the various ends are to be untwisted, and the B of one coil is to be joined to the E of the *next* coil, and to one commutator segment; in the case given there will be six such junctions, therefore opportunity for six segments. In its ultimate arrangement, the winding is seen to be the equivalent of the one first described, for in that, too, the end of one coil formed the beginning of the next.

In a more useful form this second method, denoted as the "radial," as distinguished from the first or "circumferential," well fits the conditions found in toothed armature cores. In each of the slots there would be placed two separate troughs of the insulating material, and halves of the winding confined to their own compartments. A few turns would be put on belonging to one coil, then a few for the other, and so on, until both places were full, and no danger incurred of breaking down the walls between or of confusing the orderly arrangement of the wires. Successive pairs of coils would cross the preceding ones at about right angles or at 45°.

When a four-pole field-magnet is considered, in which opposite poles are, of course, of the same polarity, a diametrically wound armature such as has just been described would be quite inoperative. Electromotive forces just equal and opposite to each other would be induced in the wires of each and every turn, hence there would be no external force whatever. The conditions illustrated in Figs. 2 and 3 of Chapter I must be fulfilled: that is, ends b and d may be attached to each other, and add their electromotive forces, while ends a and c lead to appropriate commutator segments. Just which segments are the appropriate ones demands careful consideration, and will be made clearer as the explanation is developed.

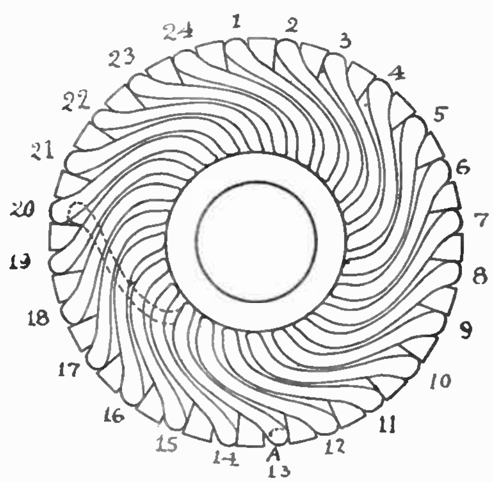


Fig. 12. End View of Scheme of Form-wound Armature for Use with a Four-pole Field-magnet

As for the actual method of winding an armature for four poles, one of the smooth core type would be quite inconvenient. Each turn, instead of passing along a diameter, must go across a chord and reach a location only one quarter of the circumference distant; to hold the wires in place against the smooth surface would clearly be difficult. Even when toothed cores are used, the wires would be disorderly, and worse than that, those passing from one slot to the one 90° distant would obstruct the entrance to adjacent slots. In addition to this there would be the further mechanical objection that the first coils would be shorter than the others, therefore lighter in weight, and leave the armature out of balance.

While some early armatures were wound in tedious manner by hand to avoid these difficulties, ideal conditions were lacking until "form" wound coils were made, the shape being such that no interference was involved nor was there lack of perfect electrical and mechanical balance. The precursor of this realization lay in the invention by Eickemeyer, in 1888. This, however, was designed for two-pole field-magnets only, and even now is practically applied to such only with considerable difficulty. The reason is that all the coils have to be placed on the coil simultaneously. Applied to multipolar field-magnets, the scheme is the only one now considered or used by any manufacturer.

Many ingenious forms have been devised for getting the coils in just the right shape, some of them only partly giving the required shape during the winding, the final bending being a separate operation, others aiming to accomplish it while in one form. Figure 11 gives an idea of a simple device available for any amateur builder, especially if only one machine is under construction. The baseboard has iron or wooden pins at proper points; those at the two loops may well be threaded and fitted with washers and thumb nuts, for securely holding the wires in proper order; at the inner corners rows of holes are provided, so as to allow for the successive turns, as they are put one within the other. First, the beginning of the wire is to be fastened under some sort of a clamp near B, and then the turns looped on, the pins being moved step by step to their inner location. If the board is mounted upon a vertical pivot, say by use of a piece of gas pipe and a floor flange, and a handle be placed upright at B, some celerity can be acquired in winding the coils. Before removing from the form, sheet lead or copper strips should be bent around the wires in a few places, so that during the winding with tape that follows, the shape may not be lost. The two loops may then be held in a wooden vise, and of the two straight horizontal portions, one may be brought toward the person, the other carried away, until they are distant from each other by an amount equal to one quarter of the circumference of the armature. When placed in the slots, one portion should be one quarter way around from the other.

If an armature of this sort is to be designed, care must be given to a consideration of the space near the shaft, to see if there will be room. The shape of coil from slots to the inner space will take an involute curve, and the builder should make an accurate drawing to predetermine as many of the factors as possible, then wind some sample coils to see if his predictions are correct. Only by actually putting the coils in place on the core will the builder fully see the method. With the four-pole machine here being considered, about one half the entire number of coils must be started before any one of them reaches its final position; for the portion that is to occupy the upper space in a slot cannot be inserted until the portion of another coil that is to fill the bottom space of the same slot is in place. A completed winding, showing how every coil is finally locked in by its neighbors, is shown in Fig. 12. A sample coil, marked A, is visible for one half its involute curve, then its other half passes beneath six other coils out of the total twenty-four, until it reaches the bottom of its appropriate slot.

To remove a coil is quite as much of an undertaking as to put one in, and makes a person eye with some suspicion the broad claims of superiority of the formed winding over any other. First the commutator connections for about one half the winding must be removed, then interfering coils bent up out of the way, when finally the desired coil may be withdrawn, as seen in Fig. 13. It is obvious that in the winding reverse steps are necessary.

When insufficient space can be found for the bunching of the loops near the shaft, the expedient now common with all builders of using "straight-out" coils is available, resulting in a "barrel" shape of winding. Of especial value is this shape in large armatures, such as was given in Fig. 21 of Chapter V in the Engineering series, for by it there is allowance for the most rigid mechanical construction. Copper bars of rectangular section are then employed, but the essential condition is merely attained, — namely, of having a given bar that passes under on pole electrically joined to a similar bar that lies under the next pole.

Without further attempting to describe the forms, it may be well to show an assemblage of wire-wound coils, really triple in its make-up, as largely used on railway motors. This

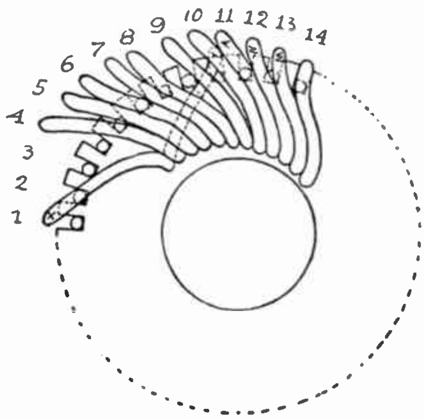


Fig. 13. Method of Removing a Coil from such an Armature shown in Fig. 12

is given in Fig. 14. Three coils, each consisting of three turns, are grouped and held under one taping. The ordinary cotton covering on the wire may be all that separates the several coils, or, in addition, there may be oiled linen between them. The outer taping is thicker, and, besides, there is the usual mica insulation in the armature slots. Such armatures must occupy the least possible space, and the device of allotting three coils per slot, with relatively large slots, reduces the diameter of the core by several inches over that required when each coil has its own slot. The full number of commutator segments is retained, with resulting good commutation at the brushes, but a great deal of slot insulation is saved.

In connecting such a winding to the commutator segments, first, all the wires from the bottoms would be soldered in, ends 1, 2, 3, of coil 1 leading to the first three segments, then similar ends of the second coil to the next three segments, and so on, until there was one wire in every segment. Ordinarily, these ends would not lead straight to the segments, but all would slant to the left at an angle of about 45°. Then end 1′, bent an equal angle in the other direction, would be joined to the segment most nearly opposite 1; similarly, until all the ends were attached, there would be two wires in every segment, and each would represent the end of one coil and the beginning of the next. Figure 15 shows a G. E. 57 armature with this sort of coils partly connected.

As will be imagined, this type of winding is of the series order, as was explained in Chapter V of the Engineering series, — though in that article the two diagrams were unfortunately exchanged, — in which a given coil connects to segments as nearly opposite as an odd number will allow. The correct diagram shows a sample coil extending from segment d to e, and to accommodate this requirement the ends of coils shown in Fig. 14 properly bend each way by the 45° angle. For clearness, the diagrams are here reproduced, with correct designation.

When the multiple-wound armature is desired, the same forms can be used, but the ends must be left out at one of the end loops rather than at the corners, whereby the essential condition may be readily given of attaching them to *adjacent* rather than to *opposite* segments. That is, referring to Fig. 14, all the wires should be included under the taping until they emerge at A.

For a series-wound armature and a four-

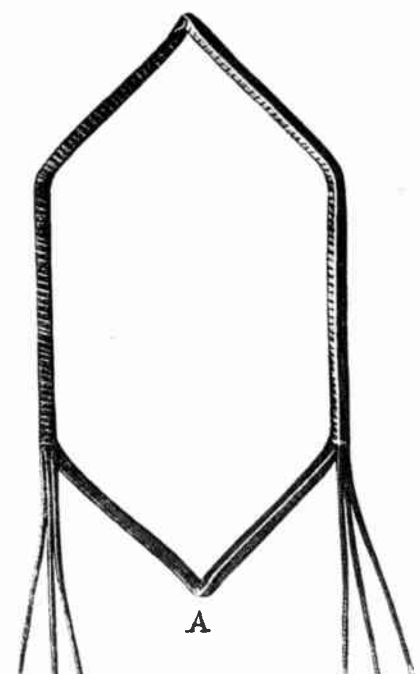


Fig. 14. Three-turn Three-coil per Slot Grouping as Largely used on Recent Railway Motor Armatures

pole field, an odd number of coils and commutator segments is imperative. The famous G. E. 800 railway motor had one hundred and seventeen, while the later types employ thirty-nine slots, with coils as shown in Fig. 14, giving the same total number of one

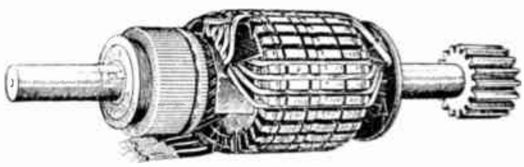


Fig. 15. General Electric No. 57 Railway Armature employing Coils as shown in Fig. 14

hundred and seventeen. With more numerous poles, the proper succession may be found with both odd and even numbers, but not all numbers are possible. The builder needs to look very carefully into the theory of such windings and to compute from Arnold's formula what the possibilities really are.

For multiple windings greater latitude is allowed, and while an odd number is permissible, as shown by the nine coils and segments of the diagram from i to h, in Fig. 17. an even number, divisible by the number of poles, is preferable.

The entire distinction between the usefulness of the series or parallel method of connecting the drum coils usually lies in the matter of number of brushes required. Sometimes a given shape of coil and particular size of wire with multiple connections will give a desired 250-volt winding, while connected in series order 500 volts will be secured; again, by winding two wires in parallel, and using parallel connections at the commutator, 125 volts will as easily be obtained. Thus economy in the number of forms is permissible. Except for this feature. the ability of the series-wound armature to dispense with brushes at other than two places on the commutator is its chief asset. For railway motors and others, in which accessibility is at best limited to one half the machine, the ability to put all needed brushes on one side of commutator, for a four-pole machine, 90° apart, is worth seeking.

Additional brushes are often placed on the other neutral points of an accessible generator with series-wound armatures, the reason being that the commutators are usually very short, and one set of brushes only would give insufficient current-carrying capacity. That the presence of these additional brushes does not constitute a short circuit sometimes puzzles an observer, but reference to the diagram in Fig. 16 will show that, while brushes are properly placed on segments e and g only, another positive one could be placed near segment a, and a negative one similarly near c; these two extra brushes would apparently be bridging the insulation between the segments, but in an actual machine the segments would be sufficiently numerous as to allow the usual contact. Between one positive brush and the next there would really intervene one armature coil, but in consequence of its being in

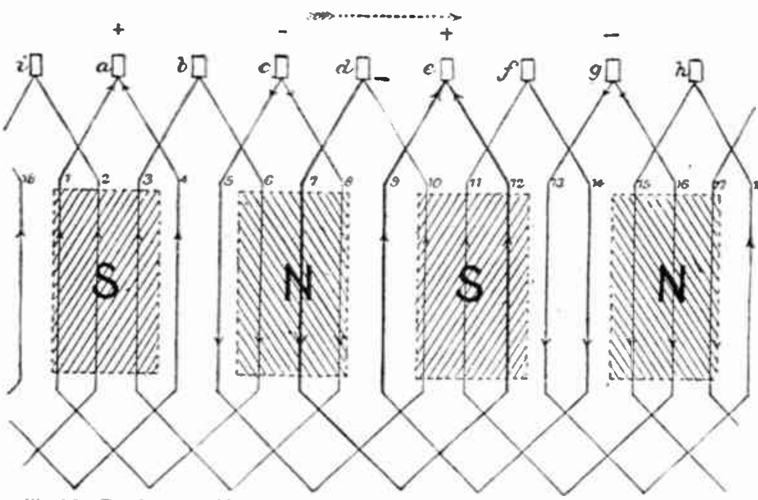


Fig. 16. Development of Multipole (Lap Wound) Drum Armature for Four-pole Field-magnet

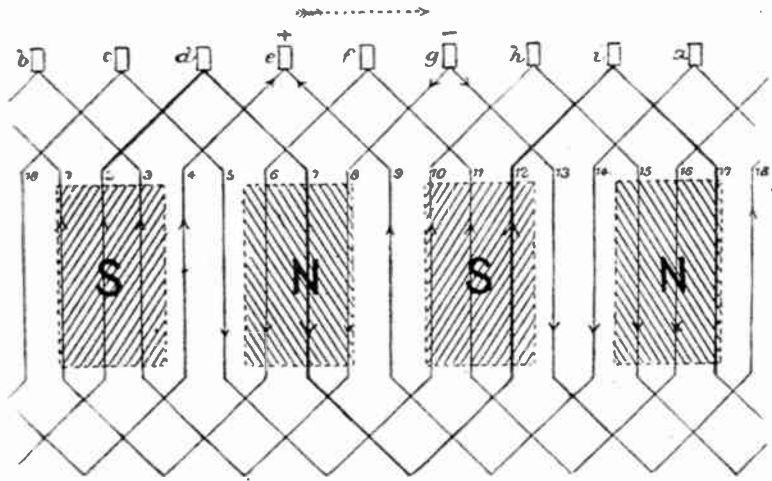
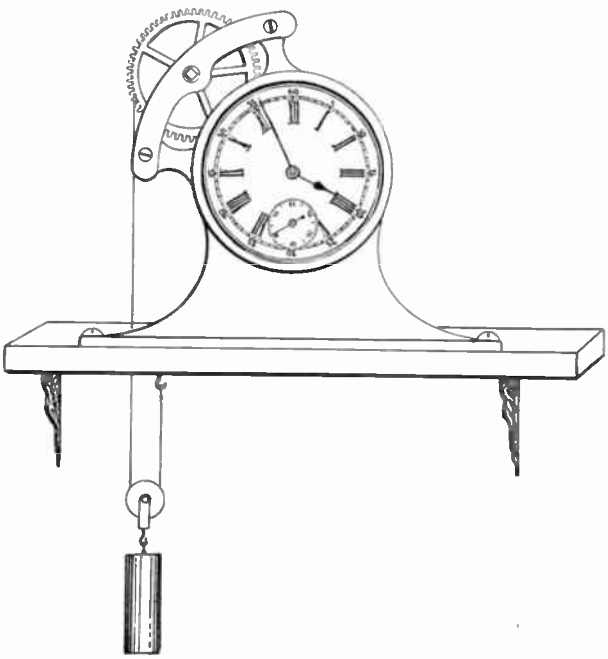


Fig. 17. Development of Series (Wave) Wound Drum Armature for Four-pole Field-magnet

the neutral portion of the field and therefore no electromotive force developed in it, no untoward results would be experienced. With multiple windings, brushes must be used in all the possible places, as shown in Fig. 17, else complete portions of the winding will be successively unused.

Thus far it has been assumed that the coils followed exact geometrical locations on the core. It is not imperative, however, in case of two poles, that the wire pass diametrically across the ends, nor in the multipolar designs that the coils extend across just one quarter, one sixth, or one eighth of the circumference. If they do, they are denoted as "pitch" windings; if with slightly different spacing, and denoted as "chord" or "fractional-pitch" windings, some advantages can be realized, principally in reduction of sparking, though with narrowing of the neutral position for the brushes. Such refinement will not necessarily be discussed here, but the reader will properly expect to find such a possibility recognized. It is often attention to minor details of this sort that gives distinction to a particular machine.

THE Midland Railway Company have now begun to work one of their branch lines by electric traction on a system which is absolutely new so far as England is concerned and is in use to only a limited extent abroad. The line in question unites Heysham, Morecambe, and Lancaster, and is some nine miles long. The equipment has been installed by the Railway Company for experimental purposes, and it may, if successful, be the forerunner of a much wider scheme of electrification. In the case of all electric railways and tramways now working in England the electric energy is used in the form of continuous current. Alternating current is largely used for electric lighting and on the Morecambe railway it is adopted for the first time in England for traction. The great feature to the observer is the range of poles along each side of the railway, united transversely by horizontal beams or gantries. From the latter are hung the overhead wires which are the working conductors. Instead of the 500 volts pressure used on tramway overhead wires, these conductors are worked at a pressure of no less than 6600 volts, which makes the transmission of the power very economical. In order to avoid risk from falling wires carrying such a dangerous pressure, and also because the district is much exposed to violent storms, the poles, gantries, wires, and attachments are of great strength. The cars collect the current from the overhead wires by a bow contact, and a transformer on the car reduces the pressure to a working level before it reaches the motors. Every possible precaution has been used for the safety of the public and of the railway employees, and this, of course, is much more necessary than in the case of railways working with continuous current at low pressure.



HOW TO MAKE A MINIATURE CLOCK

R. N.

A VERY ingeniously constructed miniature clock, made some time ago by B. F. Giddens, Lynchburg, Va., is illustrated herewith. The clock always excites the curiosity and wonder of the beholder, notwithstanding its extreme simplicity. Mr. Giddens made use of an eighteen-size movement casing in which he placed an eighteen-size watch movement. A brass stand for the casing was then constructed, both being soldered together, and the whole screwed on a small, neatly made shelf. The mainspring and winding attachment were removed from the movement, and in their stead there was attached a wheel with the same gearing, 1½ inches in diameter, to the mainspring barrel on a shafting, which acts on just about the same principle as does a weight clock.

The movement of this unique clock is operated by means of the attachment of this wheel, the power being obtained, of course, from the weight. This clock can be made to keep unusually accurate time, and can be so arranged as to run from thirty to ninety days with one winding. It is advisable, of course, to cover the clock with a glass in order to protect the movement from dust. Any type of watch movement may be used to make this miniature clock, but the key winding movements are more economical. One need not take out the winding attachment, but only the mainspring. The so-called old English movements, having what is known as a fusee wheel, can be most readily transformed into a weight clock. In order to arrange such a movement, it is only necessary to take out the chain and adjust upon the winding arbor a drum which carries the string and the weight. When the weight is sufficiently heavy to equalize the force of the spring, the change made in the movement will rather add to its perfect timekeeping qualities. First, because there is no difference in power when the watch is entirely wound up or nearly run down, and second, because the movement is not exposed to the many different motions of the average person who wears a watch. The wheel mentioned above need not be exactly 1½ inches in diameter. It can be almost any size desired. Moreover, a mainspring barrel with the same gearing will do. The drum, over which the weight winds, has a diameter about the same as that of the barrel.

FORGING FOR AMATEURS

F. W. PUTNAM, B.S.

I REALIZE, at the start, the difficulty of teaching even the elements of a trade on paper; but I hope, by the aid of numerous illustrations, to show clearly to the reader all the operations which enter into the work of the ordinary blacksmith.

While it is true that a man may work all his life at a blacksmith's forge and still have more to learn about the trade, it is also true that the real essentials of the trade are made up of a comparatively few simple operations, which may be learned thoroughly by any man who has some mechanical ability, and who is willing to give a fair amount of time and effort to the work. After this is done, skill will come with practice.

I wish, at this point, to thank the following firms who have so generously loaned me cuts to illustrate these articles: B. F. Sturtevant Co., Boston, Mass.; Allen Randall Co., Springfield, Mass.; The Atha Tool Co., Newark, N. J.

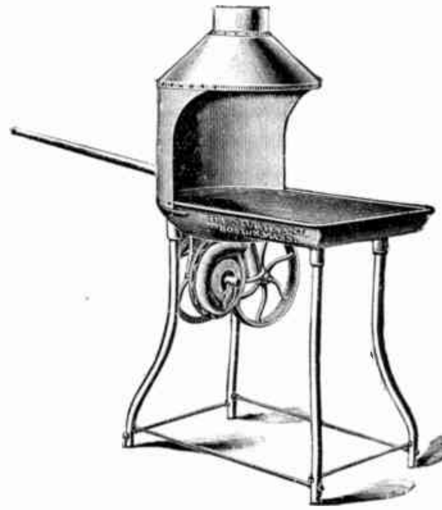


Fig. 1

A forge may be made of brick or iron, or, in case of very heavy work, a basin of sand on the ground. The ordinary blacksmith forge is of brick, 24 x 26 inches high, usually built into the base of a chimney. Iron forges

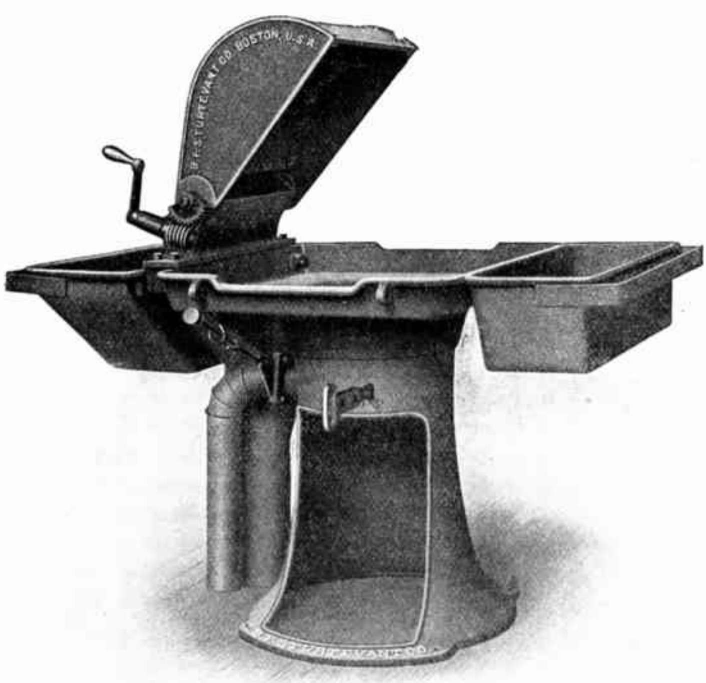


Fig. 2

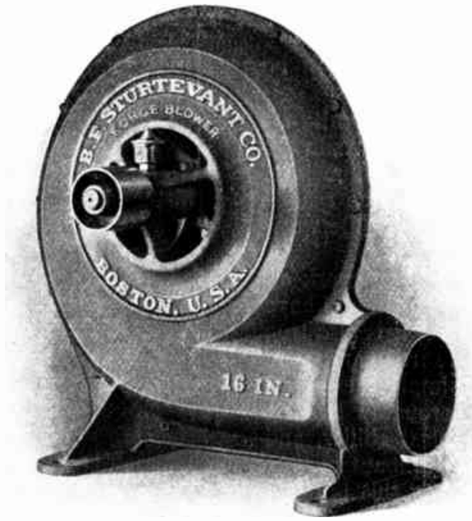


Fig. 3

consist of a cast-iron basin supported on legs or pedestals.

A tuyere (pronounced tuer) is the opening through which the blast enters the forge, and is placed in the bottom of the basin. There are various forms, from the plain, barred grate to the cone device used in the Sturtevant forges.

It is generally a cast-iron shell, with a hole through the bottom connecting with the blast pipe. In this pipe, or at the under side of the tuyere, is a shutter for regulating the air supply, which is called a gate. Besides this there is a hole in the bottom that may be opened to drop the ashes out of the tuyere into a pit below.

There are excellent portable forges now on the market, which may be bought at a very reasonable price. Figure 1 shows a portable forge having a steel plate hood, a strong running gear, and fitted with a steel pressure blower.

Blast

The blast is produced by a rotary blower or a pair of bellows. The bellows are an old-fashioned method, and consist of two parts, the lower and the upper. They are separated by a partition, and the air from the lower half is forced through the valves in the partition into the upper chamber, where it is stored for use. They are hung from the center piece by pins in the sides. As the lower board is forced up, the air is pressed through the valves into the upper chamber, inflating it and raising the top board. As the bottom board descends, the valves close, and openings in the lower board open, air flowing into the lower chamber. The blast for the fire is taken from the upper chamber, and is at nearly constant pressure.

The rotary blower has a number of blades set nearly radially on a shaft and placed within an iron casting. The inlet for the air is around the shaft, and the outlet for the delivery pipe is taken from the periphery of the casting. A blast is usually 4 to 6 ounces to the square inch.

The object of the blast is to supply more air for the fire. The air contains oxygen. Oxygen is a strong supporter of combustion, consequently there is more rapid combustion and a much hotter fire. Without draft it would be impossible to get a heat above red. It is possible to supply too much air and blow the fire out.

If an excess of oxygen is supplied to the fire, some of it will combine with the hot surface of the iron, forming iron oxide; such a fire is called an oxidizing fire. If the oxygen is all used up and there is an excess of carbon, it is called a reducing fire.

There are three general systems in use in forge shops for exhausting the smoke from the forges and supplying them with the blast. In one the exhaust and blast pipes are overhead; in the second, the exhaust pipes are overhead and the blast pipes underground; in the third, both exhaust and blast pipes are underground. In this latter system, the ducts or trenches through which the smoke is forced are made generally of brick, set in cement, sometimes of cement only, and large enough to contain the blast pipes also.

Figure 2 shows an up-to-date forge with down draft. These are also made double. Figure 3 shows a power blower for use with either an overhead or down draft system for draft.

Fig. 4

Fig. 5

A nest of tuyeres is shown in Fig. 4, air being delivered through a slot measuring $\frac{1}{2}$ x $1\frac{3}{8}$ inches. An adjustable tuyere is shown in Fig. 5, and is provided with a rod ending in a tapering key, which regulates the width of opening for discharge of air to the fire.

Figure 6 shows an oil-burning tuyere, and is a cast-iron pot designed to be supported beneath the forge and lined with fire clay and brick. A dumping tuyere is shown in Fig. 7.

Fig. 6

Fig. 7

For fuel, charcoal, coke, coal, oil, and gas are used. Charcoal is the best, as it is the purest. Coke is good if free from sulphur, and phosphorus sulphur makes the iron brittle when hot. Phosphorus makes it brittle when cold. Sulphur, lead, bronze, brass, Babbitt metal, etc., must never be allowed to get into fuel or fire where iron and steel are to be welded. I use Cumberland coal. It is bituminous, and contains many impurities, sulphur and phosphorus principally. The sulphur soon burns out, and this may be hastened by sprinkling water over the coal when burning. Never put the iron into the fire until combustion is well started.

Good coal has a bright, shining surface, a dull surface indicating slate. One may easily get coal so full of impurities that welding is impossible; the only remedy is to send it back and try again.

When starting a fire, clean out the ashes over the tuyere and put in a handful of shavings; after lighting, put on a little draft. When the fire is well started, draw the coke around the edges, piling it over the shavings, covering all but a small space in the center, until ignition begins; then cover all over and put on fresh coal. If the fire smokes badly, make an opening in the cover of fuel with a poker. Be very careful to distinguish between coal and coke when cleaning out.

The anvil is usually made of wrought iron, with a steel face welded on. Solid steel anvils are old-fashioned, and can be recognized by a ringing that can be heard long distances. This is the objection to steel. Some are made of cast iron with steel face. They are serviceable where light work is to be done.

An average anvil weighs from 150 to 200 pounds. It is placed at such a height that, when standing beside it, the knuckles will just touch the top surface. The horn is on the left side and the front of the anvil is opposite the workman.

In selecting an anvil, be sure that the face is flat and straight, and that the vertical surfaces adjoining the face are at right angles to it. The hole for bottom tools should be 1 inch square, straight, and at right angles to the face. The horn should be slim and quite pointed. Have about 4 inches of the front and back edges of the horn made rounding, so that you can remain on one side of the anvil all the time.

The hardie hole is square and holds the cutting and forming tools.

The pritchel hole is round and used when punching to drive the core through. Hand hammers are ball, straight, or cross peen. A $1\frac{1}{2}$-pound ball peen hammer is convenient for ordinary use. The eye is made narrow

Fig. 8

Fig. 9

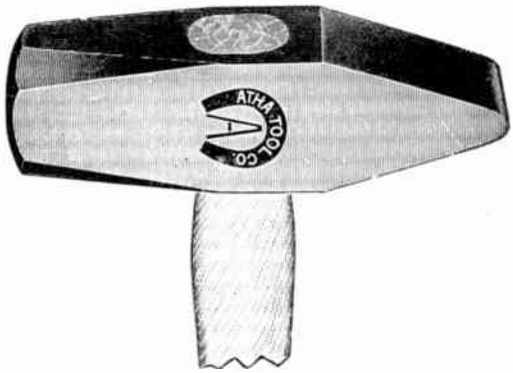


Fig. 10

at the middle, being larger at both ends. When properly wedged, the head cannot work either front or back. See that the wedges are always tight. Loose heads are extremely dangerous. A ball peen hammer has a head shaped like a ball and is used for riveting, or when it is required to stretch the metal in length and width for working a hollow.

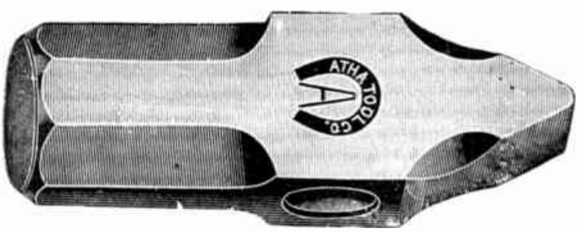


Fig. 11

The cross peen, with the peen at right angles to the handle, is used to stretch the metal lengthwise.

The straight peen, the peen being in line with the handle, is used to stretch the metal crosswise.

Figure 8 shows an adze farrier's hammer with an octagon poll.

Figure 9 shows a machinist's ball peen hammer, sometimes used by blacksmiths for light work.

A blacksmith's hand hammer, with a cross peen, is shown in Fig. 10.

The hand sledge weighs from 5 to 8 pounds, and is used by the helper. When striking, it is held in both hands, and a shoulder blow is struck without slipping the hands. Slipping the hand makes the blow inaccurate. One hand is held at or near the end of the handle; when light blows are wanted, hold the other hand nearer the head, bringing it farther away as heavier blows are wanted.

Swing sledges weigh from 8 to 20 pounds and have long handles. They are held with both hands near the end of the handle and given a full arm swing.

Figure 11 shows a cross peen blacksmith's sledge.

Figure 12 shows a double-face blacksmith's sledge.

A horse-shoer's turning sledge is shown in Fig. 13.

Tongs are made of mild steel or Norway iron. The jaws hold the stock. The reins are the handles. Various kinds are named as follows: —

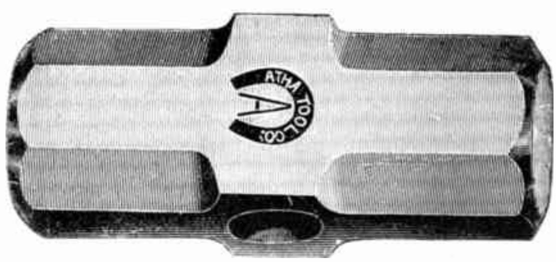


Fig. 12

Fig. 13

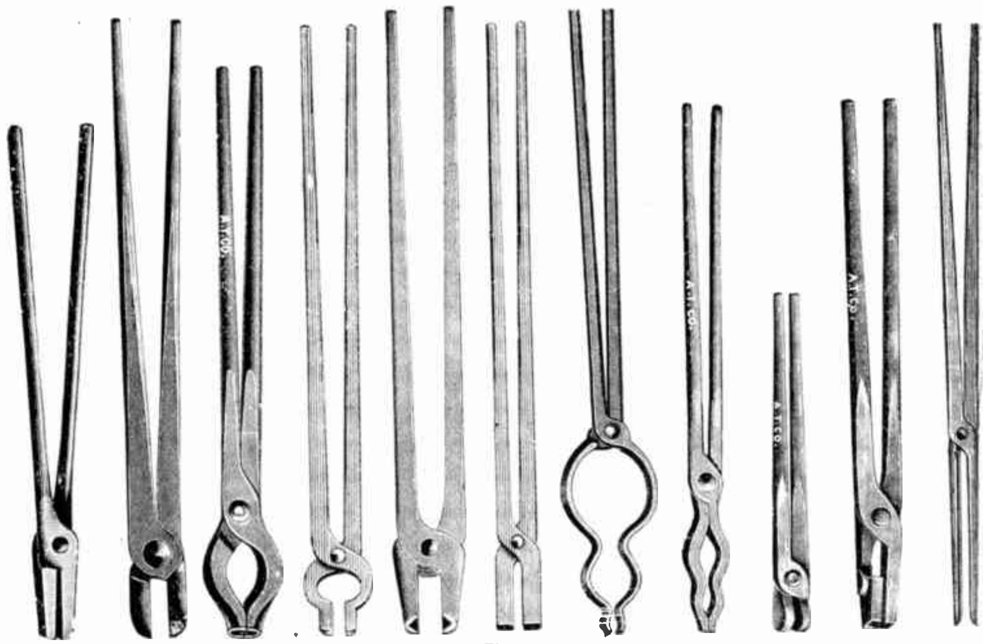


Fig. 14

Flat tongs are for holding flat iron. Gad tongs are for handling wedge-shaped stock. Curved tongs are for holding bent pieces. V tongs are for holding round or square stock. Bolt tongs are for holding pieces with a head. Pick-up tongs are for picking up small pieces or holding small pieces when tempering. Tool tongs are for holding lathe tools when making or dressing over.

A number of various styles are shown in Fig. 14 as follows, from left to right: Straight lip tongs; horse-shoe tongs; curved lip, fluted jaw tongs; curved lip tongs, to hold round stock; V-tongs; brazing tongs; two styles of double pick-up tongs; short horse-shoer's tongs; lathe tool tongs; heating tongs, used for heating bolts and tools of all kinds, such as reamers, taps, drills, etc.

Tongs should not be left in the fire, as they will bend out of shape and have to be hammered back or cooled, and the cooling makes them brittle and soon spoils them.

Do not work on a piece of stock unless the tongs hold it firmly. A coupler is a link put over the handles to keep the jaws tight on the stock and relieve the handle of the strain. It is used only on heavy work.

The set hammer has a face about 1¼ inches square. It is used to square up corners, or, when it is desired, to localize the effect of the blow. It has a handle, and is held by the smith while the helper strikes it with the sledge. (Fig. 15.)

The flatter is similar to a set hammer, but has a large face. It is used to smooth up surfaces. (Fig. 16.)

The fuller is used for spreading out iron, or making depressions in hollowing out work, or forming a shoulder before drawing out.

The swage is used for rounding stock, each being made for a certain rise. They are slightly crowned in the middle.

Fullers and swages that have handles are

Fig. 15

Fig. 16

Fig. 17

Fig. 18

called top tools and are struck with a sledge. (Figs. 17 and 18.)

Bottom fullers and swages are held in the hardie hole. (Figs. 19 and 20.)

Punches are of various forms according to the requirements. They are tapering, being small at the point. The hole is punched by driving the punch down into the stock on the face of the anvil. If it is desired to make a hole through, the stock is turned over the pritchel hole, or other form, and the core driven out by driving the punch through from this side. If the punch is driven well into

Fig 19

Fig. 20

the first side, a spot is easily seen on the other side, on which to place the punch for driving through. When punching a deep hole or large one, cool the punch occasionally, and drop some fine coal dust into the hole before retaining the punch, to prevent sticking. The hole is stretched to the desired size by driving the punch deeper.

A blacksmith's square punch is shown in Fig. 21, and a round punch is shown in Fig. 22. A pritchel is shown in Fig. 23.

The hot cutter is drawn out thin and sharp and used for cutting hot metal. Keep well cooled and lift out of the cut after each blow is delivered. (Fig. 24.)

The cold cutter is heavier and stronger and ground to a blunt angle or edge. It is used to mark iron all around, so that it can be broken. (Fig. 25.)

Both chisels are usually tempered alike The cold chisel holds its temper; but, from

Fig 21

Fig. 22

contact with hot metal, the hot chisel soon has its cutting edge softened. For these reasons, the two chisels should never be used in place of each other, for by using the cold chisel on hot work the temper is drawn and the edge left too soft for cutting cold metal while the hot chisel soon becomes so soft that, if used in place of the cold chisel, it will have its edge turned and ruined.

Hardies are used in the hardie hole and are hot and cold, being used same as hot and cold cutters. (Fig. 26.)

The heading tool is used for forming heads on the ends of rods. A tool is required for

Fig. 23

Fig. 24

Fig. 25

Fig. 26

Fig. 29

each size of stock. The hole is usually tapering and the stock is put through the small side. The tool is faced with steel and the small end of the hole is in the steel. (Fig. 27.)

Dies are forms hollowed out of steel, into which the metal is forced to take the form of the hole. Usually they are used under power hammers or hydraulic press.

Swage blocks have various shaped grooves and holes cut into them and are used like a swage heading tool. They may be rectangular or circular.

caCones, or tapered mandrels, are made of st iron and are used for rounding up various sizes of rings. They have a groove running the whole length, to allow for tongs or links of chains that may be on the rings.

Fig. 28

Figure 28 shows a tool known as a creaser, and Fig. 29 shows a die used for toe calk welding.

Fig. 27

Wood Staining

When carefully treated, birch gives a very clever imitation of mahogany, a fact well known to the craft. But the wood should possess suitable grain. Logwood gives a very good stain for this purpose; boil together equal parts of logwood chips and water, boiling the mass for about three hours. Then add sufficient chloride of tin to give the shade of color desired; add the chloride while the mass is hot. Apply the stain only after it has become cool, and as many coats as may be required to give the depth of shade desired. The filler may be made with raw or burnt sienna and umber. Finish in any way desired.

THE INSULATION OF SPARK COILS AND OTHER ELECTRICAL APPARATUS

"ZODIAC"

OWING to the exceedingly high voltage to which the insulation of spark coils, Tesla coils, etc., is subjected, careful insulation is absolutely essential, and nothing can be more disheartening to the amateur than the laborious unwinding of a spark coil that has proved a failure, owing to defective or wrongly applied insulation. In this article it is proposed to deal with the various insulation materials and point out their properties and the care that must be taken to avoid spoiling their insulating qualities. Quite recently the writer had an 8-inch coil submitted to him by a reader, in which the defect was clearly due to the paraffin wax having been overheated and ruined during the winding; while a Wimshurst machine with ebonite plates failed because of the employment of a black varnish in which lead driers had been employed.

Insulation Resistance and Dielectric Strength. — All insulators are in reality very poor conductors, that is to say, their specific resistance is enormous as compared with that of, say, copper or silver. For instance, the specific resistance of shellac is several billion times as great as that of silver. But specific resistance must not be confused with dielectric strength. For example, air has a very high specific resistance indeed, but not very much dielectric strength, being easily broken down by a spark. On the other hand, glass has a large dielectric strength, but not nearly as high a specific resistance as air. The *specific resistance* determines the amount of current (negligibly small, of course, in the case of a good insulator) that can flow through the insulator and thus leak away, while the *dielectric strength* is the ability of the material to stand the mechanical and electrical stresses due to the voltages to which it is subjected. Then we have *surface leakage*, owing to which the current leaks over the surface of the insulator without passing through the material. Paraffin wax has a larger surface insulation than glass, but not so high a specific resistance as good crystal glass. Hence the reason for coating Leyden jars, etc., with paraffin wax or with shellac varnish. Placing the materials in the order of their specific resistances, we get: dry air, crystal glass, paraffin wax, ebonite, shellac, gutta percha, and mica. As regards dielectric strength, however, as seen from Fig. 1, mica easily stands first, while air is the worst of all. Hence the importance in spark coil construction of filling in the spaces between the windings with wax and excluding air as far as possible.

Sparking Distance in Air. — Different experimenters give varying results for the dielectric strength of air due probably to variations as regards shape of electrodes, etc. The American Institute tests, using sharp needle points and sine wave alternating current, are given below: —

Spark Length in millimeters.		Disruptive Voltage
180 (=7.1 in.)	....	80,000
5.7	....	5,000
25.4 (=1.0 in.)	....	20,000
62.2	....	40,000
301	....	120,000
380 (=15 in.)	....	150,000

A. Siemens, using a point and plane with alternating current, obtained the values 10,000 volts for 5.78 millimeters (0.228 inch) and 25,000 volts for 22 millimeters (0.866 inch).

Sir W. Preece states that a voltage of 300 to 400 volts is necessary to start a spark in air at all, however short the spark-gap may be. Once a spark has passed, it is easier for a second to follow; the first spark probably produces chemical dissociations in its path which do not instantly pass away. The arrangement of the coil electrodes so that the spark-gap cannot be increased beyond the limit of the coil's capacity, is a very great safeguard against breakdown. A perfect vacuum has infinite dielectric strength; no spark can cross it. Increase of air pressure also raises the resistance to the passage of a spark. Cailletet compressed dry air to 40 or 50 atmospheres (about 700 pounds per square inch) and was unable to spark across a 0.05 centimeter gap (0.0196 inch, or approximately $\frac{1}{50}$th inch), although using a very powerful induction coil.

A Wimshurst machine, when enclosed and worked in compressed air at even low pressures of 15 to 20 pounds per square inch, will give nearly double the length of spark that

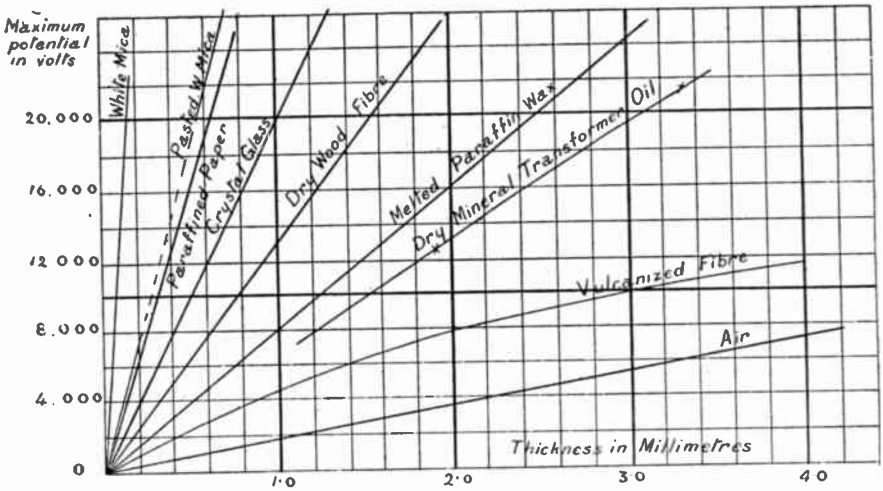


Fig. 1. Distributive Strength of Various Insulating Materials

it will yield when worked in the open, the sparking balls being of course brought outside the case.

Figure 1 shows the dielectric strength of various materials, the voltages being the maximum values. From this curve it is evident that mica easily stands first, while paraffined paper comes very near to it.

Steinmetz gives the following disruptive or dielectric strengths for various materials at a thickness of 0.05 millimeter: —

Material	Disruptive Strength in Max. Volts per Mm.	Remarks
Air	1,670	
Mica	320,000	
Vulcanized fiber	5,200	(red) slightly damp
Dry wood fiber	13,000	
Paraffined paper	33,900	
Melted paraffin	8,100	65° C.
Boiled linseed oil	8,000	21° C.
Turpentine oil	6,400	
Copal varnish	3,000	
Ebonite (1 mm. thick)	53,000	T. Gray's result

The striking distance depends upon the maximum potential, and is therefore approximately the same for an alternating voltage (R.M.S. or effective or virtual value) as it is for a continuous voltage 1.41 times as great. This is, however, not strictly true in the case of solid insulation, due to the fact that an alternating current heats up the insulation. White glass, for instance, 0.3 millimeter thick, will resist 20,000 to 25,000 volts D.C. pressure, and is only pierced when subjected to an oscillating condenser discharge. Professor Elihu Thomson found that oil is not so good an insulator for low as for high frequencies, hence the success of oil as an insulator for Tesla coils. With 100 cycles one third the thickness of air was found to withstand the voltage, while with 50,000 to 100,000 cycles from 1-20th to 1-60th was a sufficient barrier.

Thickness of Dielectric. — The breakdown strength per unit of thickness is generally (but not always) greater as the thickness of insulation is decreased. An infinitely small thickness of some insulators may thus have a very high disruptive strength per millimeter. The disruptive strength of melted paraffin, paraffined paper, dry air for thicknesses exceeding 10 millimeters, and mica for thicknesses exceeding about 0.75 millimeter, obeys a straight line law, *i.e.*, the disruptive strength varies directly as the thickness.

It is therefore evident that a coil wound in, say, 40 sections, will be much better insulated than one wound in 20 sections with double the insulation between each section.

Specific Inductive Capacity. — For a given condenser (with fixed size of plates and distance apart), the capacity is dependent upon the nature of the dielectric between the plates, *i.e.*, proportional to the specific inductive capacity of the dielectric. It will be presently shown that this inductive capacity has a very important bearing on the insulation question. The specific inductive capacity of the various insulators is given below: —

Dry air	1
Glass	6 to 10
Solid paraffin wax	2.29 to 1.97
Paraffin oil	1.92
Shellac	2.95 to 3.15

Ebonite	2.21 to 3.15
Mica	5 to 6.64
Sulphur	3.97
Petroleum oil	2.03 to 2.07
Turpentine (commercial)	2.16 to 2.23
Resin	2.55
Gutta percha	3.84
Pitch	1.8
Ozokerit oil	2.16

From the above the advantage of glass as a condenser dielectric is obvious, and also the advantage of thoroughly excluding air by soaking a spark coil condenser in melted paraffin, its capacity being by this means nearly doubled. Immersion in oil would, of course, have a similar effect.

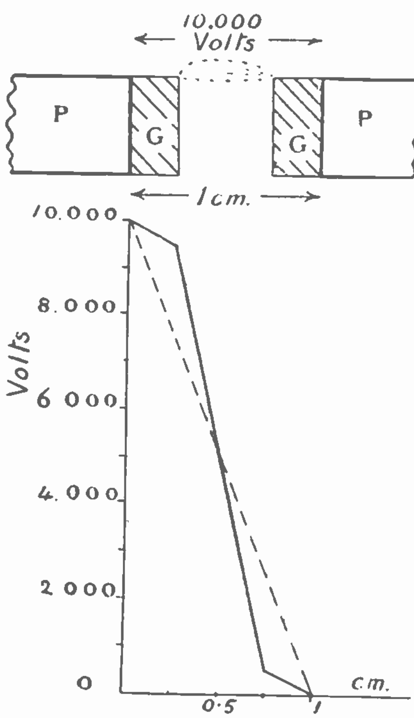


FIG. 2.

Fessenden's and Tesla's Experiment. — Suppose we take two plates, P P in Fig. 2, 1 centimeter apart, and connect them to the terminals of a 10,000-volt alternator. We then get a potential gradient across the 1 centimeter air gap of 10,000 volts per centimeter, as represented by the dotted line. Suppose the dielectric air to withstand fifty per cent more than this pressure, for an indefinite time. If now two plates of glass G G, be introduced, each 0.25 centimeter thick, and having a specific inductive capacity eight times as great as air, the insulation breaks down, although the glass is more volt-resisting than the air. *The voltage divides itself up inversely as the inductive capacity*, so that the fall of volts across each glass slab is 500 volts, while that across the air gap (now reduced to 0.5 centimeter) is 9000 volts, or at the rate of 18,000 volts, per centimeter. Now, as the air can only support 15,000 volts per centimeter, the potential gradient in the air gap as shown by the solid line is too steep, and the spark can jump the air gap. At every alternation a spark will jump across which will quickly heat up the glass, so that this will give way and the whole insulation be thus broken down. Hence, unless the whole space is filled up, the introduction of a good insulator may actually weaken the insulation as a whole. This weakening is not always apparent at once, as the spark takes some time to eat its way through the dielectric, hence the reason why induction coils very often give way after a few years in use. The foregoing experiment was wrongly taken by Tesla to show that ebonite and glass, etc., were less insulating than is generally assumed; it is, however, of the greatest importance, for it clearly shows that in spark coil insulation we must observe the following rules: —

(1) The dielectric should be homogeneous throughout as regards its specific inductive capacity; the impregnating oil or wax having approximately the same specific capacity as the paper.

(2) Air-bubbles in the insulation should be very carefully avoided. The more completely air can be excluded from between the layers of paper, etc., the better.

For further details as to the "grading" of insulation so as to obtain specially high dielectric strength near the wire (where it is most wanted), the reader should refer to a very interesting paper by O'Gorman in the *Journal of Electrical Engineers*, Vol. XXX, 1901, page 608, *et seq.*

Heating of Dielectric. — When an insulator is subjected to a high alternating potential a certain amount of heat is generated in the dielectric itself, due to (1st) current that manages to get through the insulator; (2d) dielectric hysteresis, owing to the alternation in the electrical stress. If this heat is not dissipated as fast as it is generated, then the insulation heats up and ultimately breaks down. This heating-up may be very rapid, especially with high tension apparatus, or where large capacity is present, the center portion being badly charred before the outside shows any visible heating effects. The amount of heat so generated in a dielectric increases at least as fast as the square of the voltage. Increase in temperature rapidly lowers the dielectric strength of an insulator; for instance, even mineral insulators become fairly good conductors when raised to high temperatures, as seen in the Nernst lamp. The insulation of a spark coil may thus be easily ruined if worked for lengthy periods off a high-voltage circuit with an electrolytic interrupter, owing to the exceedingly high periodicity (some 1500 to 2000 per second) produced by this form of interrupter.

Effect of Heat on Insulation. — Providing that no moisture is present (in which case, of course, heating would improve the insulation by drying out the moisture), increase of temperature lowers the dielectric strength; in some cases enormously so. Overheating may permanently ruin the dielectric strength; paraffin wax is turned from a white to a yellowish color, and ruined if heated much above 100° C. (212° F.), and should not be kept heated up even to this temperature longer than necessary, or its insulation qualities will be permanently affected. Nor is there any reason to heat it up to this temperature, seeing that paraffin wax has a melting point of 46° C. (114° F.). It should always be melted over a water bath, glue-pot fashion, care being taken that no steam can reach any part of the insulation material. Bee's-wax melts at 150° F. or 65° C.

Cotton-covered wire gradually deteriorates if subjected to even 100° C. (212° F.) for any great length of time, while above this temperature the cotton turns brown and becomes carbonized pretty rapidly. The practice of passing the wire over a Bunsen burner in order to melt the wax when coil winding, is a bad one, as the excessive temperature is almost certain to seriously affect the insulation. By far the better plan is to run the wire through the hot wax and then straight on to the winding former.

Moisture has always a very bad influence on the dielectric strength, and should therefore be entirely removed from the cotton or silk, wood, etc., preferably by vacuum drying, of which more will be said later on. Few people realize that the atmosphere usually contains at ordinary temperatures from forty to sixty-five per cent of the maximum moisture the air can take up (*i. e.*, saturation point); that perfectly dry (vacuum-dried) wood, will, under quite ordinary climatic conditions, reabsorb fifteen per cent at least of its own weight in moisture within forty-eight hours; and that most paper contains at least five to ten per cent by weight of water.

Oil is very seriously affected by moisture (even the moisture of saturation), 0.01 per cent (one-hundredth of one per cent) being sufficient to lower the disruptive strength of a perfectly dry oil from 24,000 to 12,000 volts, while one-tenth of one (0.10) per cent will lower it to about 1800 volts; hence the need for carefully boiling and keeping Tesla transformer oil quite free from moisture. To simply soak, say, ordinary undried wood or paper in melted wax merely imprisons the moisture within the material, while if the temperature is raised above the boiling point of water (212° F., or 100° C.) so as to expel the moisture, the insulating qualities of the paraffin wax are ruined in the process.

Vacuum Drying. — The writer strongly favors the vacuum drying of all paper, wood, etc., before waxing, while for his large coils he always again soaks the secondary, after winding, in melted paraffin wax in vacuum, thus expelling any air-bubbles. After half an hour's vacuum waxing, the pan is opened, and when the wax is just on the point of setting, the coil is removed. Of course, the coil must be so built that the sections are well supported by the paper disks and cannot be displaced even when the wax is all melted. With a 28-inch vacuum the boiling point of water is reduced to 38° C. (100° F.), while with a 29-inch vacuum it is only 25° C. (77° F.).

As the pressure is only approximately 15 pounds per square inch, the construction of a small vacuum pan for coil work does not present any difficulty, while a simple Grove single valve type air pump with vertical barrel (the top of the piston-rod and plunger being kept tight by a layer of very thick cylinder oil) will readily give the desired vacuum. A reasonably well-fitting lid clamped on with a ring of oiled brown paper packing will be quite air-tight and readily renewed. The writer's vacuum pan was made from a worn-out float type steam trap picked up from the scrap heap. The thermometer tube is brought out through an asbestos-packed stuffing box. To build any coil above 4-inch spark without such a vacuum pan is false economy. As regards the insulation materials themselves, it will be better to deal with them under their various headings.

THE CONSTRUCTION OF AN ELECTROLYTIC RECTIFIER

W. C. GETZ

THERE are many people, outside of electrical experimenters, who require a cheap yet efficient method of changing alternating current to direct current. While the experimenter is the most interested in any apparatus of this kind, there are numerous owners of storage batteries who have access to an alternating current lighting circuit, but still have no means of converting same to a suitable current for battery charging. In fact, the majority of automobiles and power boats run by gasoline engines use the storage battery for ignition, and a majority of the owners pay exorbitant prices to have the batteries recharged.

There are several ways of changing alternating current to direct. The most efficient way is the use of the motor-generator, or rotary converter. As the efficiency of either of these types is not good on small outfits, considering their high initial cost, it is therefore unnecessary to discuss same.

The next type of apparatus to commend itself favorably is the mercury arc rectifier. The cost of this is also prohibitive to the average experimenter.

A less efficient means of making this change is with the electrolytic rectifier. When properly made, its efficiency may not exceed fifty-four per cent, but its cost is a trifle compared to the cost of even a small dynamo. Although this rectifier has been on the market for several years under various names, it has only recently come into general use.

The principle of this rectifier is based on the fact that when an aluminum plate is submerged in a suitable solution, together with another plate of a different metal, a current of electricity can be passed from the other metal to the aluminum, but no current will pass from the aluminum to the other plate.

Thus it is seen that the aluminum plate acts in a manner similar to a check valve—permitting a flow of current in one direction, but stopping it in the other. If an alternating current circuit should be connected to the two plates, during the half cycle that the current was positive to the other plate but negative to the aluminum, there would be a flow of current through the circuit. but when the cycle changed over to make the aluminum plate on the positive side, the current would not pass from the aluminum to the other plate, and hence there would be no current flow in the circuit.

The other elements used in these rectifiers have been usually lead or iron for the metal plate or negative pole, while various mixtures of water and ammonium carbonate, ammonium oxalate, ammonium nitrate, ammonium phosphate, sodium sulphate, or sodium phosphate have been used in the solution.

The sodium phosphate solution with lead plates gives about the best results, although the other mixtures are also very efficient. As we are not particular from the strict scientific standpoint, we will therefore use a solution of 10 ounces of sodium phosphate to about 7½ pints of water. If battery jars, 6 inches in diameter by 8 inches deep are used, the water should be within 1½ inches of the top to have the right proportion.

As the best results are obtained with lead plates, we will specify 1-16th inch sheet lead, which may be purchased at any metal supply house.

There are numerous ways of connecting up these rectifiers. Figure 1 shows a method of connecting a single jar rectifier, having one lead and one aluminum plate. As this type only utilizes one half of the alternating current cycle, it is not very efficient.

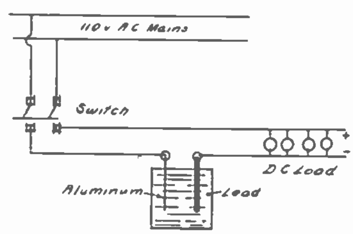


Fig 1

Figure 2 shows a single jar rectifier with two aluminum plates and one of lead plate. It is necessary to place an auto-transformer or reactance coil with neutral tap across the circuit, as shown, the lead plates and the tap from winding going to the direct current load.

Figure 3 shows the most economical arrangement possible with the electrolytic rectifier, where it is desired to use a low-voltage direct current for battery charging, and yet have little loss in bringing it down from 110 volts alternating current. Where with Fig. 2 the reactance in the circuit reduced the voltage to a suitable point, the loss due to this reactance was also very great. Now in Fig. 3 the primary of a small static transformer is connected to the 110 volt alternating current circuit, and the secondary of

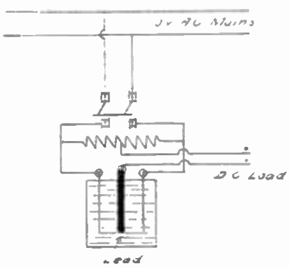


Fig. 2 W C E

the transformer is so proportioned to reduce this high voltage to about 20 volts across the outside terminals, or 10 volts on each side of the winding, from the center tap. Thus, from A to C the voltage is 20, but from A to B, or B to C, the voltage is only 10. If the primary of this transformer is designed to carry 2 amperes, which a 1-5th kilowatt transformer will easily do, the secondary can produce a current of 10 amperes under an

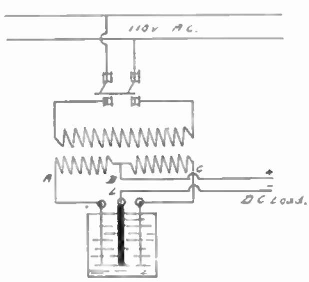


Fig. 3 W C E

e. m. f. of 20 volts without heating. Now by connecting A and C to each outside aluminum plate, and connecting B and the lead plate L to the direct current load, a current of from 1 to 10 amperes under an e. m. f. of from 8 to 10 volts will flow from the terminal B, which is positive, to the plate L, or negative terminal, thus being a direct current.

By connecting the positive pole of a 6-volt storage battery to B, and the negative pole to L, as shown on Fig. 4, with a low reading voltmeter and ammeter connected properly, the charging of the battery can be accomplished with ease, and is thus under constant observation. A small battery rheostat, R, should be inserted in the circuit between B and the battery, so that the normal charging rate of the battery may be maintained constant, thereby compensating for any change in voltage.

This transformer can be made by any electrical experimenter at a very low price. The cost of the materials will not exceed $6. Complete data and dimensions of this transformer may be found in the "Series E" Construction Drawings of Electrical Apparatus, the same retailing at a very reasonable price.

While it is desired to use the 110-volt alternating circuit current without the trans-

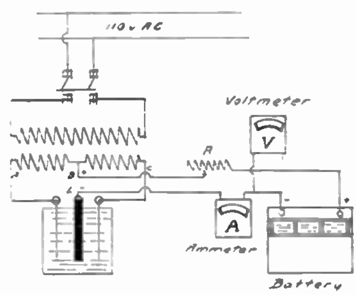


Fig. 4 W C E

former, the three-jar rectifier shown in Fig. 5 is serviceable. Two of these jars have an aluminum and lead plate only, but the center jar has two aluminum and one lead plate. Trouble is often experienced with overheating of this center jar when used continuously. For charging storage batteries, it is necessary to put a bank of 6-32d c. p. 110-volt lamps in circuit as shown. This allows a direct current flow of about 4 amperes. If lamps are not available, a non-inductive resistance of 15 ohms may be used. This resistance must be made of wire heavy enough to carry a current of 10 amperes without undue heating.

To overcome the difficulties of the three-jar rectifier, the plan shown in Fig. 6 is excellent. In this case, four jars are used, each jar having one aluminum and one lead plate. The method of connecting, while seemingly complex, is really very simple. It greatly resembles the wheatstone bridge, the direct current load being in the place of the galvanometer circuit, while the alternating current feed occupies the position of the battery circuit on the bridge.

As in the case of the three-jar rectifier, if it is desired to be used for battery charging, a bank of 6-32d c. p. lamps should be used, or a non-inductive resistance inserted. Without this lamp bank or resistance, if a low resistance is placed across the direct current side, the rush of current will be sufficient to burn out the wires, if the alternating current side is not fused or equipped with circuit breakers. A low-resistance path on the direct current side is just as dangerous as a dead short-circuit on the alternating current side, if there is no means of controlling the current flowing into the jars.

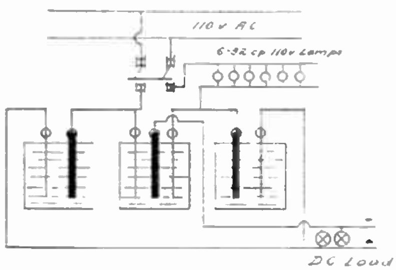


Fig *5 W.C.E.

However, when the lamp bank is inserted as shown, no matter how low the path on the direct current side may be, the only current to flow through will be that allowed to pass by the resistance. Thus, where a short circuit might cause a momentary flow of 100 amperes on the main circuit, when a resistance of 10 ohms is placed in series and the short occurs at a point beyond the resistance from the supply source, the largest current flow in the circuit under an e. m. f. of 110 volts, could not exceed 11 amperes.

Another very important point to be observed is, if a low reading voltmeter is used when charging a storage battery with a rectifier that is connected other than shown in Figs. 3 or 4 (where the alternating current is first reduced to low voltage through transformer), the voltmeter should never be connected to the direct current terminals of the rectifier unless the battery is first connected, and the voltmeter should always be disconnected before the battery circuit is broken. This is because that, although the direct circuit current cannot exceed the current flowing through the lamp bank, the direct current voltage is but a little less than the alternating current voltage. As in the case of charging storage batteries from a 110-volt direct current circuit, when the battery is connected on through lamp resistance, a voltmeter reading will show but a drop of, say, 6 volts; but if the circuit be opened, there will be the 110 volts potential difference, and the low reading voltmeter would be ruined outright, or very badly injured.

When the battery is placed in the circuit, the drop in voltage across the terminals should be but little more than the voltage of the battery, and within the range of a low-reading meter. The battery being disconnected, allows the direct current voltage to rise to about 106 volts, there being a loss of several volts in the rectifier.

Figure 7 shows the dimensions of the plates for all of the types of rectifiers whose connections have been given in the various drawings. If an ordinary Fuller battery jar is used, which is 6 x 8 inches, the plates are 4 x 6 inches, as shown, with an ear in one corner $1\frac{1}{2}$ x 1 inch. This ear is drilled with a $\frac{1}{8}$-inch drill, and is then bent over at right angles on the dotted line.

Wooden tops can then be made for the jars. These are constructed as shown in Fig. 8. The holes shown are drilled $\frac{1}{8}$ inch

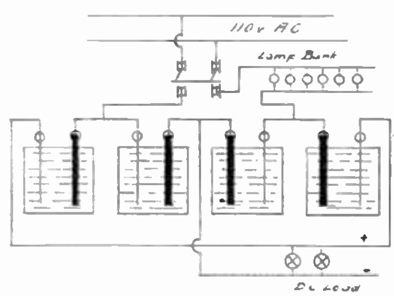


Fig *6 W.C.E.

for binding post screws, and the plates must be fastened in the positions indicated by the dotted lines. If two plates are used, space as shown on A; if three plates are used, take dimensions given on B.

The solution used for all these types is 10 ounces of sodium phosphate to $7\frac{1}{2}$ pints of water. This solution will last for about fifty hours' continuous service on 3-amperes load. Loss of solution from

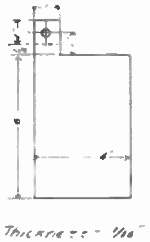


Fig. 7

evaporation, due to heating, should be replaced at intervals, with water. The wooden tops should be thoroughly boiled out in hot paraffine wax, and then covered with a coating of insulating paint, to prevent any leakage from the absorption of moisture. "P. B.," or "Mica Insulator Compound," are well adapted for this purpose, though dipping the tops in hot asphaltum will also do.

In charging storage batteries, be sure that the positive pole of the battery is connected to the positive pole of the rectifier. This can be found by putting a voltmeter first across the battery and then across the rectifier. (In last case, high reading scale should be used, if rectifier is not used with transformer.)

After noting the deflections, connect so that the deflections of each one will be in the same direction — that is, the terminal of the battery that gave a deflection to the right with a certain voltmeter lead on it should be connected to the terminal of the rectifier giving a deflection in the same direction with the same voltmeter terminal on it. As the lead plate is always the negative terminal, this is unnecessary with the single-jar rectifier.

Another easy way to tell is to put the terminals of the battery in a glass of water containing a slight trace of acid. The negative pole will then give off much more gas bubbles than the positive. This polarity should be carefully ascertained before connecting the battery, as a reversal of the charging current from the proper direction would ruin the battery.

The ammeter should be connected only in series with a storage battery, and load when discharging, and in the circuit between the battery and rectifier when charging. Never place the ammeter directly across the battery terminals. This does not give a true reading of the amount of charge in the battery, and it is liable to burn out the ammeter, or cause the battery plates to "buckle." Any person who wilfully places a direct short circuit on a storage battery displays ignorance equal to that of a man who will tie down the safety valve of a boiler to see what pressure it will stand.

In charging, use sufficient resistance on the alternating current side of the rectifier, so that the normal rate of charge may be maintained. To this end, the lamp bank is to be preferred, as lamps may be turned on one at a time until the proper value is reached. If the battery is of the 6-volt, 20-ampere hour type, the normal rate would be about 2 amperes for twelve hours. Thus, with the ammeter in series, adjust the lamp resistance until the reading shows a flow of 2 amperes. The voltmeter should show a charging e. m. f. of from 1.8 to 2.5 volts per cell according to the degree of charge. When fully charged, the voltmeter will be about 2.5 volts per cell, and the specific gravity will be about 1.21. The battery will be gassing freely, the electrolyte assuming a milky-white appearance. A battery should never be discharged below 1.8 volts per cell. After completion of charge, the voltage will slowly drop from 2.5 to 2 volts per cell within an hour or so, and the voltage will remain at this point until the discharge begins.

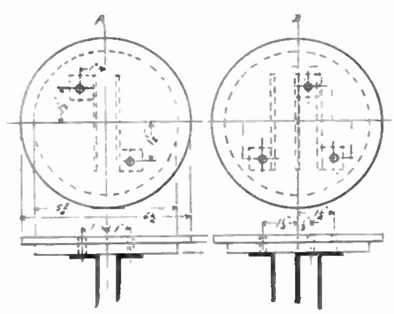
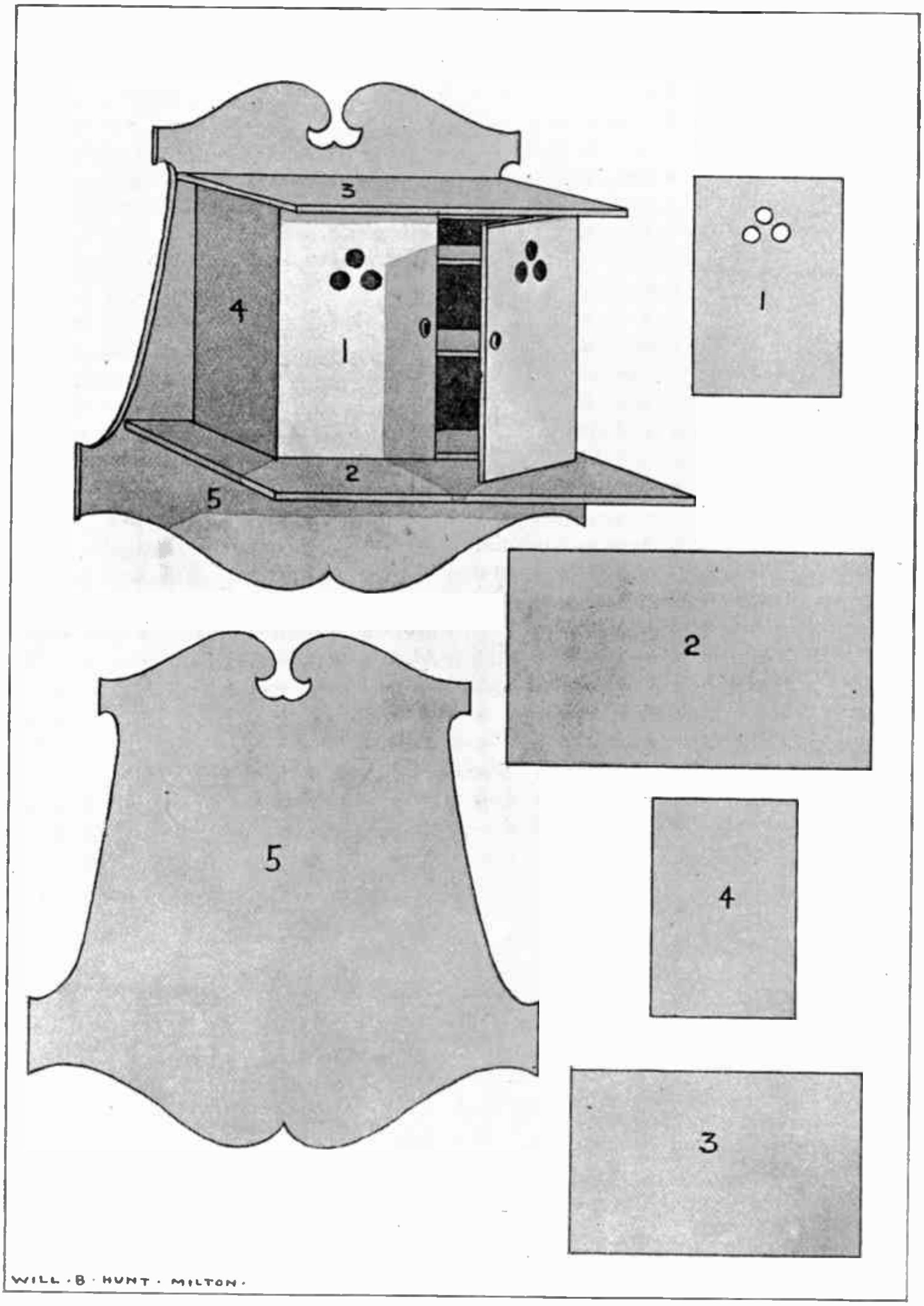


Fig. 8

The other uses to which the electrolytic rectifier may be put are numerous. For running motors, bells, electric trains, and toys, etc., they are much cheaper than batteries. For use with induction coils on stationary gas engine ignition, they effect a great saving. Altogether, they form a valuable asset in any experimental or electrical "den" where alternating current is available.



MISSION MEDICINE CLOSET

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FURNISHING THE DINING ROOM AND KITCHEN—Part V

MABEL V. H. HUNT

THE dining room needs no burlap on the walls, which should be of matched boards, stained green. Red is often chosen for the dining room walls, but it is a scientific fact that red is a color which greatly stimulates the nerves, and unless the shade selected be a deep, dull tone, it is unadvisable for this room, which is one where considerable time is spent.

The table should be in Mission style, square, solid, and firm; the sideboard should be small and simple, without silver, which is not suitable for a summer cottage. Designs and descriptions of table and sideboard will appear in a later number of the ELECTRICIAN AND MECHANIC.

We are showing this month a sketch of a china closet, which may be built at home. When fastened to the wall of the dining room, it forms a convenient place for dishes, and is a thing one needs, since there is no closet shown in the plan.

This room has four windows, and since it is open directly into the living room, it is a good plan to have the draperies match those of that room.

It is unnecessary to provide any floor covering, it being much easier to care for the smooth surface; and for wall decorations, a few simple photos and a clock. There are many odd styles of timepieces to be found in the shops, one which is suitable for this room being in the form of a frying pan. Next issue of this magazine will contain a design for a tall wall clock.

The chairs should match the table in color, at least, and if one does not care to buy or make Mission chairs, ordinary leather-seated ones, stained dark, may be used instead.

The dishes need not be expensive; any of the pretty dinner sets from $15 upwards will do. The chief thing to avoid in getting it is an overabundance of decoration. The prettiest, by far, have merely a narrow band of some color, or a fine design along the edges of the different pieces.

Be sure to provide plenty of drinking glasses, summer time being the season when tea, coffee, and cocoa are often frowned upon when served hot. Several glass fruit dishes are needed, fruit being a natural dish,—home-picked berries taste so much better than boughten ones.

To save laundry work, why not patronize the crêpe paper manufacturers? Table cloths and doilies and napkins come in many attractive styles, and though they are not durable, they are not expensive, and it is easy to keep the table always looking fresh and clean.

It is not often that a regular meal has to be eaten in summer by artificial light, but in case of a late meal, something must be provided. Some people like a lamp in the center of the table, in which case the one described in this number will do. Oftener, however, a hanging lamp is more to be preferred. One of dull black iron, with a good oil tank and fairly large chimney, is suitable. It may be provided with a fancy shade.

When not in use, decorate the center of the table with a jar of wild flowers, fresh every day.

In the kitchen there should be a range (a No. 7 is usually large enough), with six holes and a good oven. The chimney may be of galvanized iron, connected directly with the funnel and projecting through the roof.

If near the salt water, do not attempt to keep the stove blacked with polish, but grease it with lard or tallow every day, to prevent rusting. There are ranges made especially for country houses, with a tank holding five or ten gallons of water attached to the back, thus providing continuous hot water, as long as there is a fire, without plumbing.

There are also cook stoves built expressly for wood burning; these are very convenient where coal is scarce.

In case neither of these is desired, a blue-flame oil range is very satisfactory.

It is not supposed that there will be running water in the house. If there is, so much the better; but in either case there should be a sink built under the window for convenience to the stove and to secure plenty of light. The drain may be an ordinary pipe leading out into the yard.

The back door should be provided with screen, and it would be pleasant to have an awning over the top of the steps. An inexpensive one may be made from burlap, stretched over a home-made wooden frame.

Against the wall of the bedroom a good-sized wooden table with one large drawer may be placed. The drawer is to hold knives and forks, aprons, towels, etc.

Over the table hooks may be screwed to the walls, and on them should hang pots, pans, kettles, egg beater, molding board, rolling pin, bread and cake pans, cream whips, strainers, sieves, and other kitchen utensils. A closet may be improvised from a tall, narrow packing case, with shelves built in, and with a door made of wire netting on a frame.

A food closet of this kind is a very convenient article for the keeping of cooked stuff which may not need to go into the ice chest. It, as well as the refrigerator, may be provided with keys and kept locked, so that they may stand out of doors, — on the platform.

For the pantry, one must use his own discretion in stocking, much depending upon the length of stay and the distance from the stores. Of course, every one knows that it is cheaper to buy in quantity, and having things on hand often prevents much worry in case of sudden advent of guests or failure of goods to arrive from the stores when ordered.

Washtubs should be kept outside the house, on a bench made for them.

Porch Settle

In this number there is given a design for a graceful settle, which may be made to exactly fit into the space between the right-hand pillar and the corner of the house.

This settle has curves which give it an artistic effect, yet it is not difficult to build from the given plans.

Porch blinds are suggested for the screening of the sunlight. These may be bought from a Japanese dealer, or made from burlap. Two or three lengths, stitched together and decorated with stenciling, make a very pretty, simple, and serviceable blind.

The settle may be furnished with bright red cushions or pillows.

Furnishings for Living room

Somewhere, upon the wall of the living room, because of its accessibility, should be hung a medicine chest, made from the model shown in the July number of the Electrician and Mechanic. This should be kept well stocked with ordinary family remedies. It is very important to keep a good supply of these, for as a general thing a camp is at some distance from doctors and druggists, and a simple drug immediately used will often prevent a severe illness.

For the living room we are showing a Mission lamp-stand, made from smooth ½-inch stock and stained to suit the taste. The opening in the top is of a size to hold an ordinary quart, glass kitchen lamp, which is hidden by the frame, thus making a very handsome lamp at an extremely low price.

The shade is made from cardboard, mortised, with the openings filled in with crêpe paper. This paper comes in so many colors and combinations, and is so inexpensive, that it is possible to have numerous shades, which are easily replaced when torn or faded.

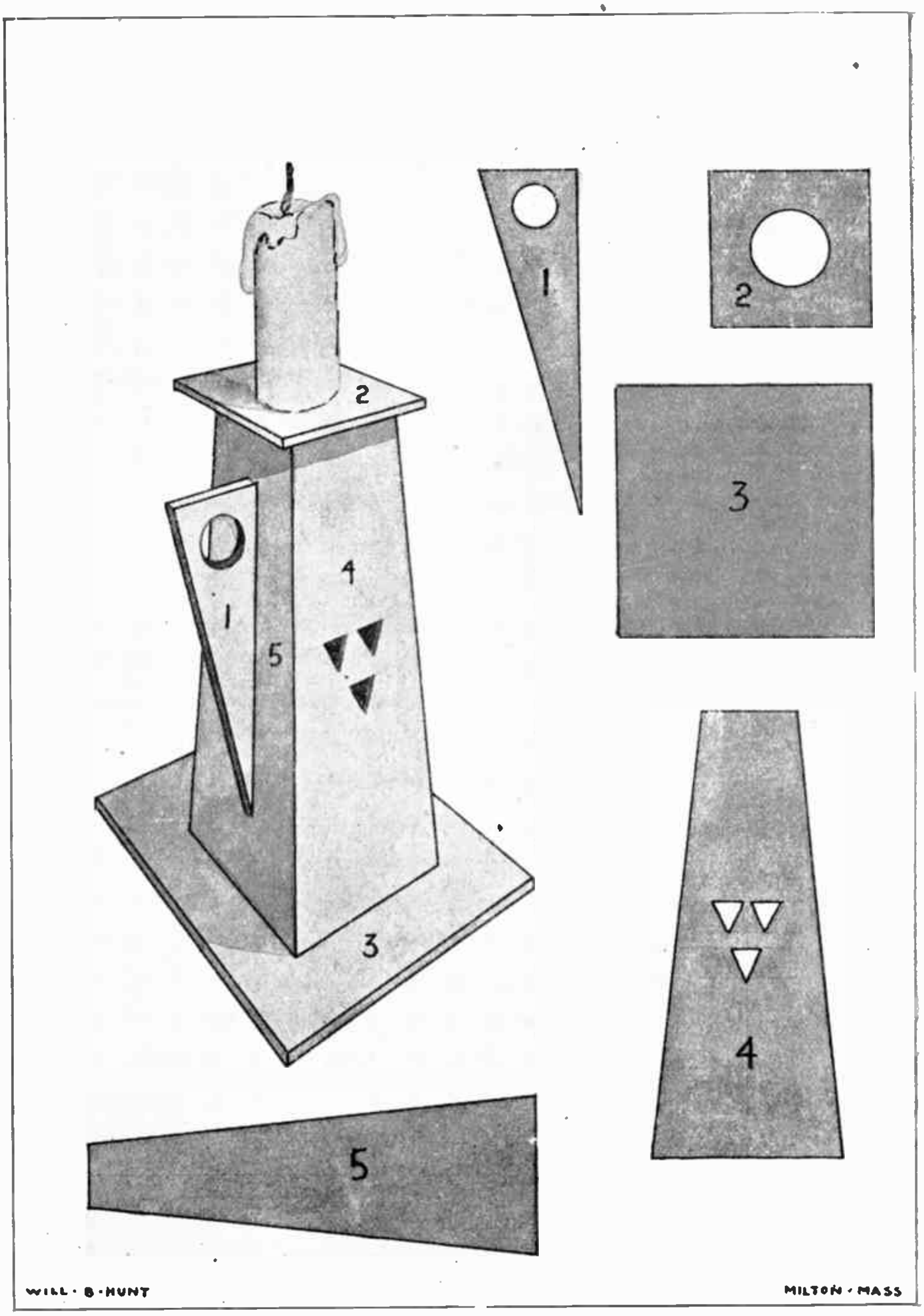
Furnishing the Sleeping Rooms

Now that the living room is completed, we turn our attention to the bed chambers of the bungalow.

Let us suppose the one next the kitchen to have a northerly exposure, with but little sunlight. This, while making the room delightfully cool for summer time, necessitates some touch of warm color to make it cheerful for the early fall days, which are invariably chilly.

The walls of this room, unless left bare, should be of golden brown burlap to the wainscotting, or the entire height of the walls if desired. It is much prettier to have the burlap extend but part way from the top, the remainder of the walls being of matched boards, shellacked.

At the joining, a shelf about 5 inches wide makes a convenient rest for an occasional



MISSION CANDLESTICK

photo or knickknack; but, above all things, avoid an overcrowded appearance. A sleeping room should be restful and harmonious, which it cannot be, filled with numerous articles of various sorts.

A Fisher or Wenzel sketch or two, and a sepia print of some country scene, such as a group of birches, passe-partouted in brown, with a lighter brown mat, will help to make the room cozy, and yet will not detract from the quietness.

Since this is a rather dark side of the house, it will be well to have the dresser and other furnishings in white enameled wood. A dresser with a good smooth mirror and with two small and two large drawers is the most serviceable. One standard chair and one rocker, cane seated, cushioned if desired, and white enameled, are also suggested.

Built-in closets are not specified in the plan, though they may be added at the builder's discretion; but in case of their not being built, it is well to arrange something for the hanging of clothing.

This may be done in at least two ways. A corner of the room may be fitted with a triangular shelf at a height of 7 feet from the floor, another shelf placed a foot beneath it, thus forming a resting place for hats. Hooks may be screwed into a cleat joining the lower shelf, and the whole may be hidden from view by drapery attached to the upper shelf either by brass tacks or strung on wire.

In place of a washstand, a similar shelf may be arranged in another corner, placing the board lower, and hanging the valance from it to the floor.

The other way is to build a portable closet of boards or from a packing case, fit it with hooks, and drape the opening. This has the advantage of utilizing space other than corners, but the outside of the box must be stained, or, in this case, painted white to correspond with the furniture. A clothes-tree is useful, but is not an actual necessity.

The bright tones of the color scheme may be further carried out by means of bureau and commode covers and bed spreads made from cretonne, having a white background, with a delicate yellow vine for its design. Ruffled muslin window draperies, with a straight valance and side curtains of thin yellow silk, give a good effect.

Two long rugs of green or brown filling for the bedsides, and two smaller ones for before the bureau and commode, form the floor covering.

Just a word concerning the beds. Have them all of heavy iron tubing, without any brass knobs or trimmings, — they wear so much better than the others. Also get the best of springs and good-quality mattresses and pillows — it pays in the end. Should white spreads be preferred, it would be a good idea to have an extra puff at the foot of each bed, embodying the color scheme of the room.

A full toilet set should be supplied for each room, and hospital ware is suggested as a substitute for china; it is unbreakable, and comes in white and colors.

The middle sleeping room will look well done in pink and green, with oak or white furnishings. Have green burlap on the walls, oak dresser, commode, and clothes-tree, one oak chair and one green wicker chair, green rugs, and hangings of cretonne with rose pattern.

In the front chamber a departure from the burlap walls is shown, as this is to be a blue room. It has a south exposure, and needs no warm color to brighten it. Delft blue denim will make a good wall covering, and a Mission-style dresser in Flemish oak finish is to be preferred to white, here.

The draperies may be of sateen or cretonne, having white background, with decorations in Dutch blue.

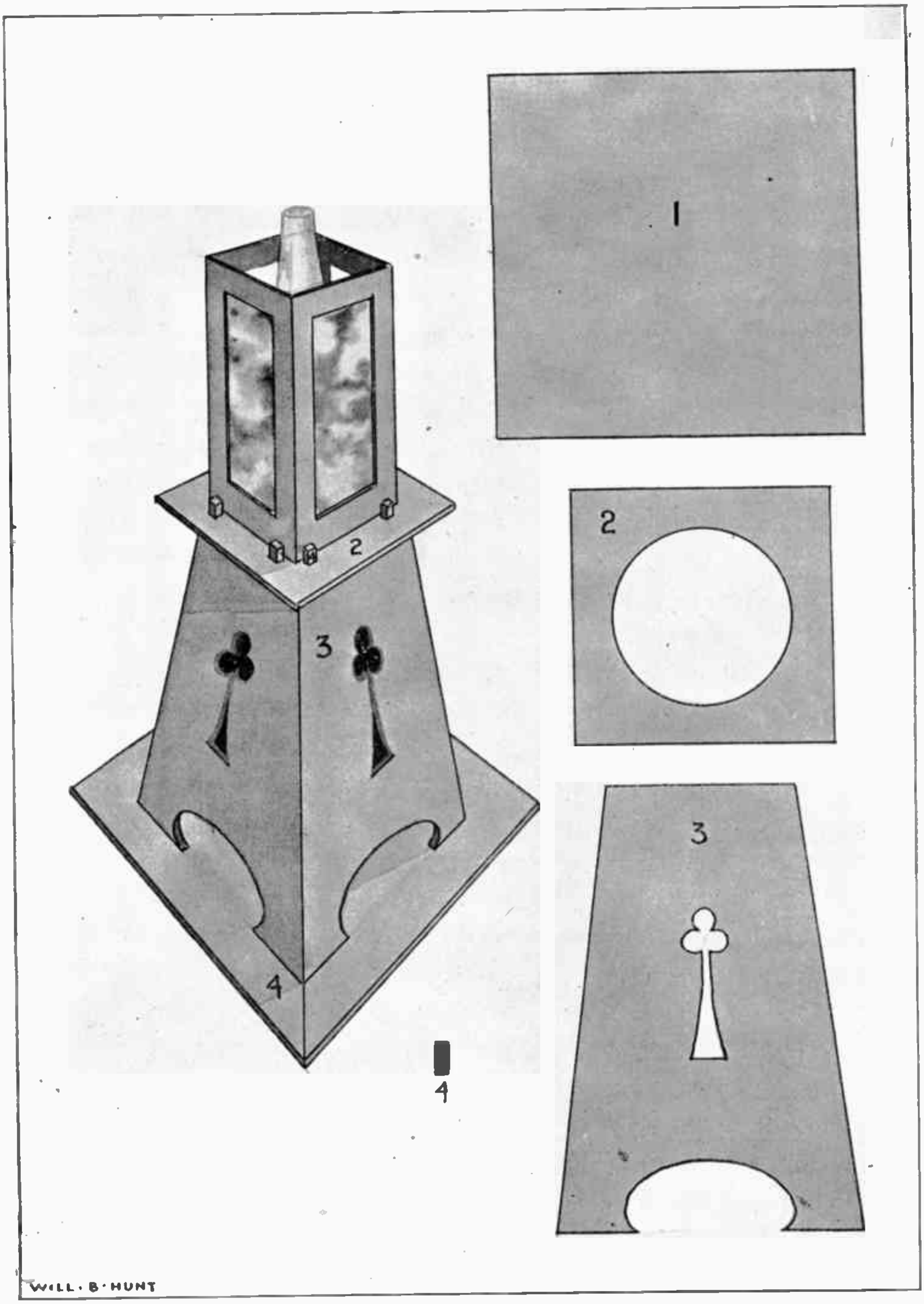
If one is fortunate enough tô possess one of the old blue and white spreads, so much the better, as it will harmonize nicely with the wall tones.

The draperies for the windows of this room should be of one piece, and hang straight down from the rod, with little or no fulness, — the style known as the Bonne Femme curtain. Rugs, blue and white.

A passe-partout picture, representing a sunset scene in rich red tones, will give character to this room.

It is a good plan to provide a utility box to stand at the foot of each bed, and, owing to the vogue of the one-piece dress, the original shirt-waist box would better be displaced by one as long as the width of the bed, 12 inches wide and 16 inches high. This should be covered with upholstery like that on the walls of the room it is to occupy. Not only will this be found useful to hold clothing, but it will also serve as a seat, so that one chair instead of two may be used.

On each dresser should be placed a china pin-tray and a rack for receiving the mail of the occupant, also a jar for odds and ends.



MISSION TABLE LAMP

It is a good idea to screw a bracket lamp to the wall at the side of each dressing case, for, in the absence of electricity and gas, it is necessary to have some way of throwing a good light on to the mirror. And don't forget the match safes, — two in each room, one fastened beneath the lamp, the other at the head of the bed, on a little candle shelf.

We are showing design for Mission candlestick, simple and in keeping with the cottage. For the yellow and blue rooms, smooth wood treated with black oak finish and provided with white and gold candles is suggested. For the other room, green stain rubbed off before it is quite dry and fitted with a pink candle is suitable.

During the day these candles may be kept in a row in the living room, the idea being for each one on retiring to select his own, and carry it, lighted, into the room reserved for him, thus avoiding any inconvenience which may be attendant on entering a dark room, especially if it be unfamiliar to him.

WIRELESS TELEGRAPHING TO A BALLOON

NORBERT CAROLIN

A WIRELESS telegraph receiving station could be easily installed in a balloon. A transmitting station, however, would be too heavy and the spark might ignite the gas. A telegraph station would be better than a telephone, for it could receive messages from greater distances.

The antenna might be insulated, stranded, copper wire braided into the valve rope its full length, without interfering in the least with the operation of the valve. The same length of wire could be braided into the guide rope as "ground." The length of the wave used should be twice the total length of the two wires. Where the two wires meet in the basket there should be inserted a variable inductance in series with a detector of the barretter type; as the electrolytic type might freeze, the coherer will not stand jarring, and the magnetic is too heavy. Shunting the detector, there should be a variable mica condenser and a high-inductance telephone receiver, supplied with headgear, in series with a few dry cells.

The total weight would be less than 25 pounds and the cost less than $20.

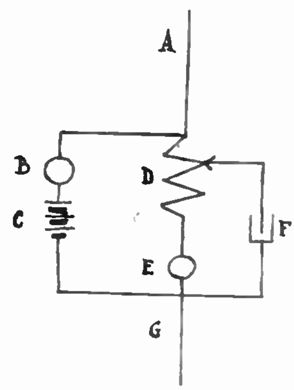
The shortness of the wave length, occasioned by the short distance between the basket and the valve, would not make much difference, as there would be no obstructions for the waves to encounter.

A transmitting station already established would probably consent to send the messages.

It might be better to use aluminum throughout, instead of copper, because, weight for weight, it is more conductive, but takes up more space.

A wireless outfit might be dangerous in a thunder storm.

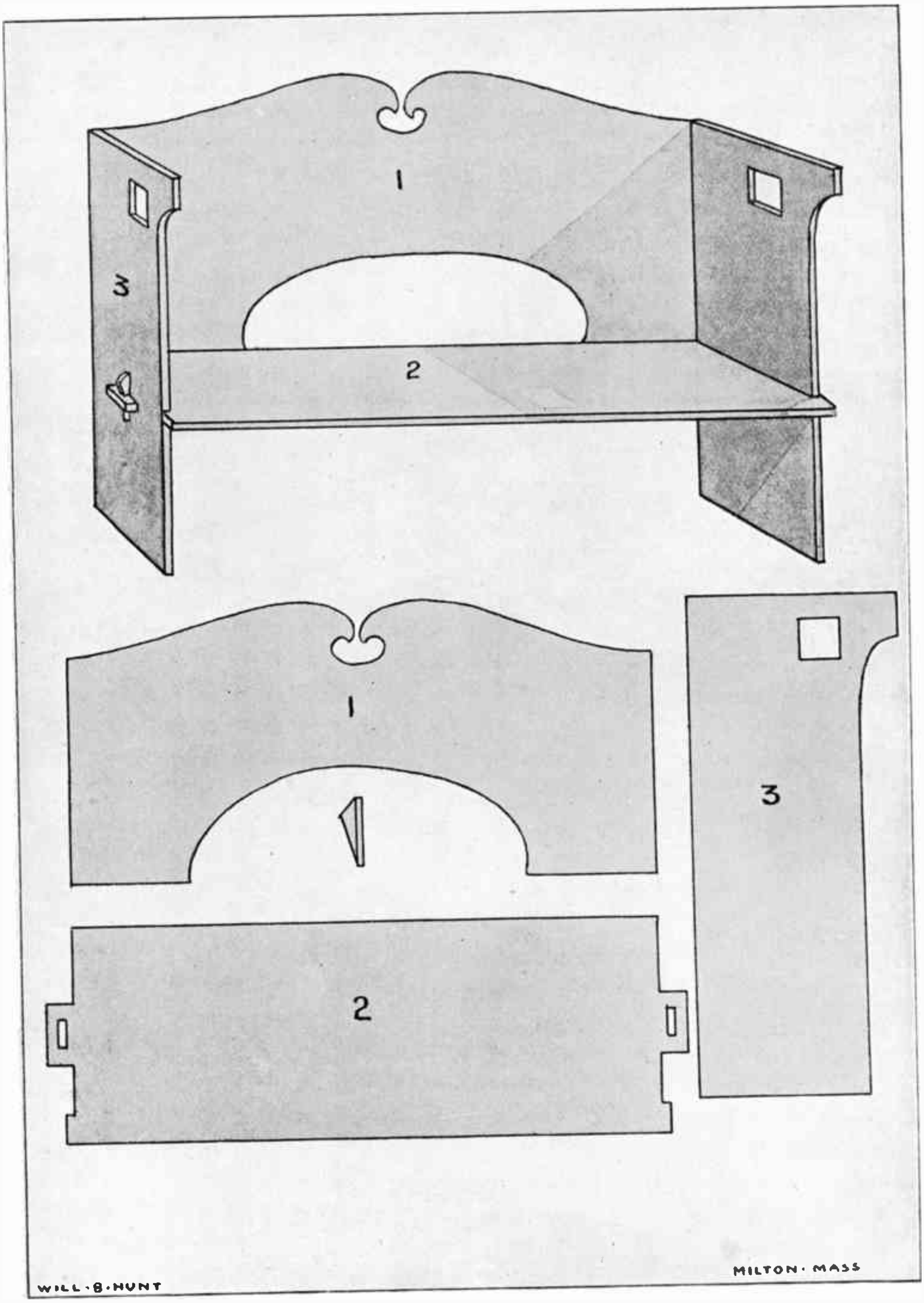
DIAGRAM OF CIRCUIT



A = antenna
B = receiver
C = battery
D = variable inductance
E = barreter
F = variable condenser
G = "ground"

Wireless waves might be used to control balloons or airships containing no passengers, in the same manner that torpedoes are now controlled.

One of the first dirigibles was propelled by electricity, and now that the storage battery has been reduced to less than 70 pounds h. p. per hour, it might be worth while trying again with a specially designed motor. — *Aeronautics.*



PIAZZA SETTLE

GASOLINE ENGINE TROUBLES CLASSIFIED

HOWARD W. RILEY

THERE frequently come times when the gas engine bucks and we are at the moment unable to remember just the particular rule that applies, and so fail to get the engine to start. At such times we all of us feel the need of a classified list of gasoline engine troubles, both great and small.

The purpose of this article, then, is not to furnish anything new in regard to gasoline engine difficulties, says *Gas Review*, nor to supply detailed information as to the exact nature of any specific cause of difficulty, but simply to gather together a list of the different causes of trouble and to properly classify them under the various symptoms which they may produce in the engine.

Just a word of warning, however, before we go farther. Always study and follow the directions sent out by the manufacturers with their engines. Remember that the makers know their engines better than any one else, that they know the troubles to which they are most subject, that they are vitally interested in having their engines give satisfaction, and that they therefore take special care to have their directions correct. If, however, these directions do not give the information required, then turn to the following list: —

SYMPTOMS OF TROUBLE

I. Difficult starting.
II. Lack of power.
III. Pounding.
IV. Poor speed regulation.
V. Excessive fuel consumption.
VI. Back-firing.
VII. Heavy explosions at exhaust.
VIII. Smoke.

CAUSES OF TROUBLE

I. DIFFICULT STARTING.

1. Lack of fuel.
    - *a.* Main valve or carburetor needle valve closed.
    - *b.* Supply tank empty.
    - *c.* Supply pipes or carburetor openings clogged.
    - *d.* Gasoline pump out of order.
    - *e.* Gasoline suction pipe leaking or too long.
    - *f.* Gasoline check valve reversed.
2. Defective ignition.
    - *a.* Main switch not closed.
    - *b.* Engine switch or timer not making good contact.
    - *c.* Wire disconnected, loose at binding post, or broken.
    - *d.* Batteries too weak.
    - *e.* Wiring or coil terminals short-circuited.
    - *f.* Wiring incorrect.

    Make-and-break System.
    - *g.* Sparking points not making contact because of dirt.
    - *h.* Sparking points not making contact because engine sparking mechanism out of adjustment.
    - *i.* Sparking points short-circuited by dirt.
    - *j.* Arm of moving point loose on shaft.
    - *k.* Speed of break too slow.
    - *l.* Coil defective.

    Jump Spark System.
    - *m.* Spark plug points more than 1-32d inch apart.
    - *n.* Spark plug points short-circuited.
    - *o.* Vibrator of induction coil out of adjustment.
    - *p.* Vibrator terminals not making contact.
    - *q.* Coil defective.
3. Cold engine and gasoline.
    - *a.* Air intake pipe too cold.
    - *b.* Jacket water turned on too soon or too freely.
    - *c.* Gasoline for first charges too cold.
4. Incorrect mixture.
    - *a.* Engine cylinder or air intake not primed.
    - *b.* Engine cylinder or air intake primed too freely.
    - *c.* Mixture too weak, causing snapping at carburetor, back firing (VI, 1 *a*) and muffler explosions (VII, 1).
    - *d.* Mixture too rich, causing black smoke at exhaust (VIII, 1, *a*).

5. Water in gasoline or cylinder.
   a. Gasoline carelessly handled and unstrained.
   b. Cylinder gaskets blown out or leaky.
   c. Cylinder or cylinder head castings defective.
6. Incorrect setting of engine mechanism.
   a. Spark out of time.
   b. Make and break spark points not touching.
   c. Exhaust valve out of time.
   d. Exhaust valve not allowed to close.
   e. Exhaust valve not fully opened.
   f. Governor mechanism out of adjustment.

II. Lack of Power.

1. Lack of fuel.
   See I, 1.
2. Defective ignition.
   a. See I, 2.
   b. Cells really worn out but strong at starting.
3. Incorrect mixture.
   See I, 4, *c* and *d*.
4. Overheating and friction of engine parts.
   a. Insufficient cooling water.
   b. Insufficient lubrication.
   c. Lubricants of poor quality.
   d. Bearings bolted up too tightly.
   e. Piston heated by pre-ignition.
   f. Piston heated by escaping gases. See II, 5, *b-e*.
5. Leaks in compression chamber.
   a. Valves not seating.
   b. Piston rings not coated sufficiently with oil.
   c. Piston rings sticking in grooves.
   d. Piston rings set with all breaks in line.
   e. Piston rings not truly circular.
   f. Valve stems worn, bent, or binding.
   g. Valve springs weak, loosened, or broken.
   h. Valve cages not properly packed or ground into place.
   i. Igniter mechanism leaking.
   j. Cylinder gaskets defective.
   k. Sand holes in piston.
6. Constricted valve openings and air passages.
   a. Carburetor clogged by dust and dirt.
   b. Air passages clogged by dust and dirt.
   c. Valve stems or operating levers bent, binding, or loose.
   d. Exhaust pipe too long, too small, or with too many turns.
   e. Carburetor clogged by frost.
   f. Admission valve spring too strong.
   g. Original design at fault.
7. Overload on engine.
   a. Overheating and friction of working parts. See II, 4.
   b. Outside load too great.

III. Pounding.

1. Pre-ignition.
   a. Spark too early.
   b. Cylinder and piston overheated. See II, 4.
   c. Glowing carbon or metal points in cylinder.
   d. Ignition uncertain. See I, 2, *c* and *j*.
2. Leaks in compression chamber.
   See II, 5, *a-g*.
3. Looseness in some parts of engine.
   a. Connecting-rod bearings loose.
   b. Main shaft bearings loose.
   c. Fly-wheel loose on shaft.
   d. Fly-wheel cracked in hub, spoke, or rim.
   e. Lost motion in any other part.
4. Moving parts of engine striking some obstruction.
   a. Must be determined by inspection.

IV. Poor Speed Regulation.

1. Defective ignition.
   See I, 2.

2. Governor out of adjustment.
   - *a.* Lost motion in moving parts.
   - *b.* Detent lever with too much clearance.
   - *c.* Moving parts gummed and binding.
   - *d.* Lack of lubrication.
3. Incorrect mixture.
   See I, 4, *c* and *d*.

V. EXCESSIVE FUEL CONSUMPTION.

1. Leaks in gasoline tank or piping.
2. Incorrect mixture.
   See I, 4, *c* and *d*.
3. Defective ignition.
   See I, 2.
4. Leaks in compression chamber.
   See II, 5.
5. Engine run too cold.
6. Engine run too fast at light loads.
7. Fuel of poor quality.
8. Engine parts heating and binding.

VI. BACK FIRING.

1. Delayed burning of previous charge.
   - *a.* Mixture too weak.
   - *b.* Spark too late.
2. Glowing points in compression chamber.
   - *a.* Carbon.
   - *b.* Metal.

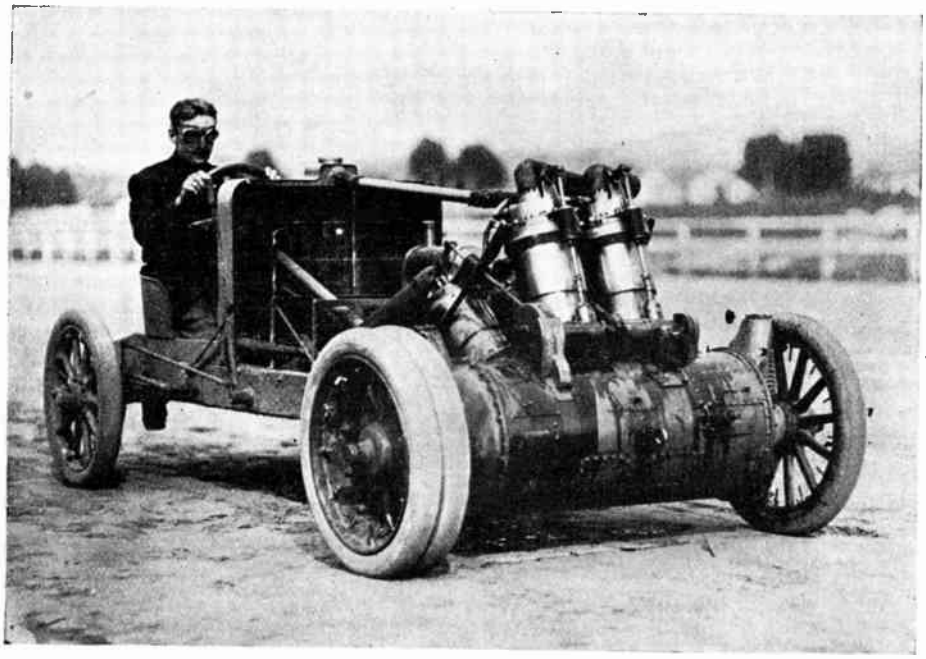
VII. HEAVY EXPLOSIONS AT END OF EXHAUST PIPE.

1. Defective ignition.
   See I, 2.
2. Mixture too weak.

VIII. SMOKE.

1. At end of exhaust pipe.
   - *a.* Mixture too rich, gives black smoke.
   - *b.* Excessive cylinder lubrication gives blue smoke.
2. At open end of cylinder.
   - *a.* Leak past piston rings.
     See II, 5, *b-e*.
   - *b.* Sand hole in piston.

—*Gas Review.*



FREAK AUTOMOBILE

The fastest thing in the automobile line ever built is capable of traveling at a rate of 2 miles per minute on a straight-away track. It is the invention of Mr. Walter Christy, wealthy New Yorker, who has spent years developing the "freak automobile," as it is known. Unlike any other automobile this machine develops all its power over the front axle, where all the mechanism is located and the power applied. The horse power of this machine is estimated at 130 and it is built for racing exclusively. Mr. Christy races this machine for pleasure and recreation. He has nothing for sale and does not advertise anything.

HOME-MADE JEWELRY

CHARLES B. DYER

In the very start the workers must fix this fact well in mind: Without a proper sense of fitness and a feeling for good design, no jeweler can produce good work. The design is the first and most important part, and should, therefore, be given great care and thought. Some have the mistaken idea that the more elaborate the design, the better it is, when in fact the simple straight-line designs are infinitely better and more pleasing. A good design may be easily spoiled by over-elaboration. Well-wrought simplicity is the most enduring and admirable.

Although there are as many bad as good designs in old work, it can be taken as a rule that the best inspiration may be received from old work. A careful study of the great variety of results obtained by simple means, a personal interpretation, and expression of individuality are bound to produce fresh and satisfactory work. It must be remembered that art is not a mere copy of nature either, as nature is not art. It is only when nature is interpreted by the artist that it becomes art. A slavish copy of nature is mechanical, not artistic. The worker must keep these facts in mind when starting his design, and if he desires to represent nature, let him do so, but by translating it, remembering at all times the limitations of his materials and color schemes.

For the first piece of work, we will undertake a small bar pin, such as ladies wear for collar or belt pin. This piece will teach the use of the saw and some of the tools most often used. Design some piece with straight lines, and make a drawing on tracing paper the exact size and shape desired. Take a piece of silver or copper large enough to receive the design and heavy enough to be substantial after the pin is done. Be sure and do not try to make small pins of light metal, as they bend too easily. Gauge 18 to 16 are best for small pieces.

After the design has been drawn on tracing paper just as you want it, use a piece of carbon paper, and transfer it to the metal. Go over the design now on the metal with the steel pencil, and straighten it up, marking just deep enough to prevent its being rubbed off during the process of work.

In the designs shown in Fig. 2, the shaded places may be either cut through (and show as holes in the metal) or they may be depressed and show dark when oxidized.

If you wish to saw through, take a small pointed punch, and put a good deep punch mark in the middle of each dark place. This should be done by resting the metal on the steel block, to prevent its bending under the stroke. Now, with the pump drill, put holes through all the punch marks. Do not rest the metal on the steel block during this operation, however.

The pump drill will need to be experimented with for a while to get the right swing. After the cord has been tied to each end of the cross bar and run through the end of the drill shaft, the cross bar should come down almost to the balance or fly-wheel. The drill of the proper size having been adjusted, grasp the cross bar with the fingers on top, with two on each side of the drill shaft. Turn the fly-wheel with the thumb until the cord winds clear up around the shaft. When wound tight, press down on the bar with the finger, but release the pressure in time to allow the cord to rewind on the continued swing. Continue this pumping motion rapidly, but evenly, until the drill goes through the metal.

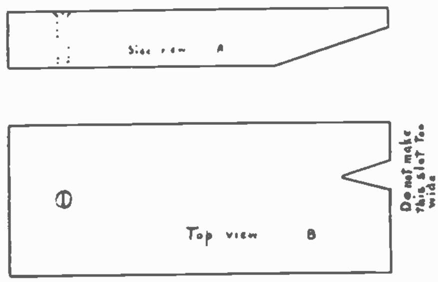


Fig. 1

A saw block should now be made for the bench. Take a piece of hard wood, 2 inches wide by 5 inches long, and cut it like Fig. 1, a and b. Screw it to the bench, with about 3 inches protruding. The V-shaped slot allows you to run the saw and still have the material well back on the block. Adjust the saw frame to the length of the saw. Rest the top of the saw frame against the front of the saw block and the handle against the breast. Put in the saw, with the teeth on the top side pointing toward the body. Tighten up the top screw first. Press slightly on the handle while tightening the lower screw, so that the frame, when released, will spring enough to make the saw tight. Use No. 1 saws for all but very heavy or very light and close work. If the design is to be cut out inside, it is best to do that part first, as the large piece of metal is more easily held.

Do not grip either the saw handle or the metal too tightly, as this is unnecessary and will be very tiring.

Run the saw straight up and down slowly until you learn its use. Never try to force the saw along or bear heavily upon it, and, if caught, never twist it to get it loose, but work it up and down carefully.

Be sure to keep the saw straight up and down, as a slant in either direction will leave the edges of the metal with an objectionable bevel.

Having fastened in the saw through one of the drilled holes (with the design on top, of course), place the metal on the block. Saw as closely to the line as possible, being careful not to go over the line on the side to be preserved. Of course, as a rule, the line may be straightened up with a file, but that is extra work, and the worker should learn to saw right to the line just as soon as possible.

Remember that the saw is wider than it is thick, so you cannot turn sharp corners or short curves by simply turning the saw. Saw along the line clear up to the corner to be turned; then pulling the saw back a short ways, make the cut a little wider by sawing a little more off the side away from the design. Make this widened place large enough to allow the saw to turn readily, and then continue along the new line.

After all the inside holes have been cut as desired, saw around the outline of the pin. If necessary, clean and straighten the lines with a fine file.

If you desire to give the surface the appearance of having been hammered, take a piece of emery and clean off all the steel pencil marks, and make the face as smooth as possible. Place the piece on the polished steel block, and hold it with the little finger of the left hand. Grasp a rather large round-faced punch with the thumb and first finger of the left hand, holding the punch just a little off the metal. Strike it with the hammer. Do not strike it too hard until you see the effect you have produced, and then regulate your stroke to obtain the desired depth of mark.

By moving the punch over the entire surface and leaving no smooth places between the marks, the work will assume the hammered effect.

This same effect may be obtained by striking the surface with a round-faced hammer, and this is the best process on large pieces, but on small work the punch may be more easily managed.

We are now ready to solder on the catch and joint to make the pin. Joints and catches may be secured from your jobber. Be sure to get the kind for hard solder, and in the German silver. The soft solder ones may be used if the patches are cut off.

Make a thick cream of borax by rubbing your borax (having added a little water) in borax block. Turn the pin upside down on the charcoal. Cut your solder into small squares about twice the size of a pinhead. Heat the work just a little, and then, having wet the joint and catch with the borax, place them in the position desired, — the joint on the right end and the catch on the left. Have the open side of the catch toward you. Wet pieces of solder with the borax, and put them at the base of the joint and catch.

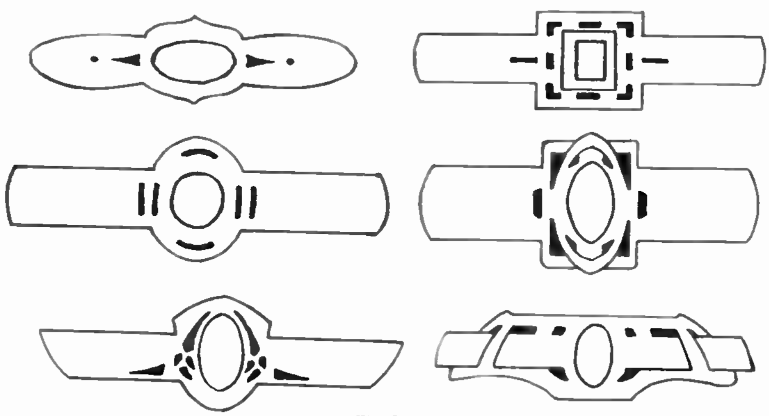


Fig. 2

The use of the blow-pipe will take some time to master, but the worker should practice its use on a scrap piece of material before he starts to solder. Remember the blue flame is the hot one, and the yellow only blackens the work and cannot be made to solder. In practice, move the blow-pipe back and forth through the flame, until you find how to make the blue flame and how to make the yellow flame. Do not blow from the lungs or cheeks, and do not try to blow a steady blast. Blow with even, intermittent blasts from the throat, breathing through the nose.

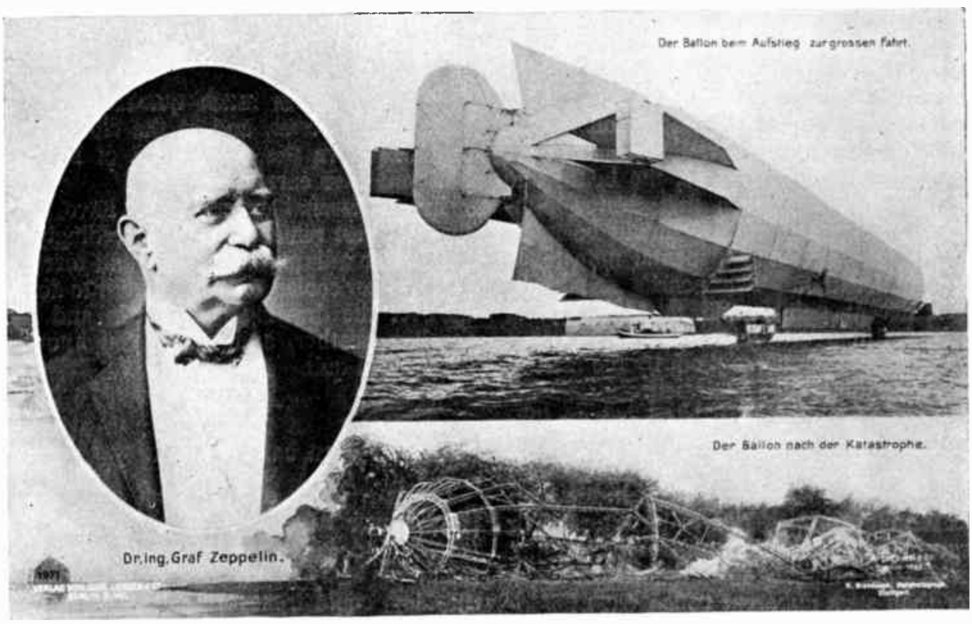
No difference what the size of the piece you are soldering, the whole piece must be heated almost red hot first. After the whole piece has been heated, direct the flames to the place to be heated, until the solder flows and you can see a clean, bright streak. A blue needle-point flame is large enough to flow the solder if the whole piece has been well heated first.

Now, either drop the piece in pickle while it is hot, or, with a small copper pan, boil it in pickle and wash in soda (common cooking soda). Remember and do not put steel tweezers in the pickle.

Cut the pin tongue the right length, and sharpen it. Polish the point well with fine emery, and burnish to keep it from catching in the cloth. File a piece of German silver wire to a long taper point. Put the pin tongue head into the joint, and insert the tapered piece from right to left. Run it up on the taper as far as it will go, and then cut off the wire close up on each side of the joint. With the steel block and hammer, rivet down the left side. You put the rivet in from right to left, because that is the rule in the trade, so if the pin should break and another worker should want to put in a new pin, he would know how to remove the old rivet with the least trouble.

Oxidize the piece by either dipping or painting with a soft brush. Rub off with soda or pumicestone to the shade desired. Wash with clean water, dry in sawdust, and the piece is done.

Use the soda or pumice on the ball of the thumb, so you will rub the oxidizing from the high lights only.



The picture above gives a view of the great Zeppelin airship rising from the waters of Lake Constance for its last great flight. Below is a photograph of its ruins as they lay in the field at Echterdiugen. On the left is a portrait of the builder, Count Zeppelin, who is now building a fleet of aerial warships for Germany, one of which is almost ready to fly, and four more of which will be delivered next year.

A FEW DRAFTING ROOM NOTES

I. G. B.

A MAGAZINE recently published an article, covering no less than two pages, giving an account of an unfortunate young man, who had evidently gained the displeasure of the writer by marching all around the drafting room to find an oil can with which to oil his instruments.

He was at last quietly shown the simple, well-known manner of using a soft lead pencil instead.

I labored through the article to find out what was in it, and came to the end with no other reward than the above information, and when, in the course of a few weeks, I saw the same article copied by other magazines, I thought, if the readers can be burdened in this manner, there is no reason why the public should not do the same by me.

As a matter of fact, this young man, whoever he may be, was perfectly right in choosing an oil can in preference to the untidy practice of rubbing a soft lead pencil across the pen screw or any other screw belonging to a draftsman's kit; his only trouble seems to have been that he had not one of his own. Without being a dude, or girlish in his manner, it is a draftsman's duty to be neat in his appearance and his work. A slovenly kept table, instruments, and person usually go together.

On arriving at the office, the board and surroundings should be first dusted thoroughly. A general survey should be made of the tools, etc., and a mental note taken of their location. The pencils should be given decent points, and the memoranda books be in a convenient place, in case a sudden call is made for them by the man in charge or the manager himself.

I have seen draftsmen hand out an ink-eraser when a pencil rubber had been called for, and a pair of spacing dividers with the business ends more like pin heads than needle points, which had to be returned in disgust, and certainly mistrust. Nothing can be more annoying to an industrious manager than such apparent trifles.

Much-used tables or data sheets should be mounted on cards, and hung upon the walls in a handy location for quick service. Occasionally wash the dirt off the scales, and see how much better the graduations can be read.

Be obliging, and covet tact as you would success.

If the manager comes into the office with another man, see that each has a stool offered to him, if they are likely to remain at your board.

Attend strictly to all that is said, and be ready at a moment's notice to hand out what is called for, or answer any questions regarding the work.

Many a man has gotten himself into favor by being able to supply information foreign to his particular work, such as the accurate time, the latest time tables of the various railroads, and other information of a general character.

How often have I seen a whole office of men unable to supply a two-cent stamp or a postal card.

Unless there happen to be a lady typewriter in the offices, I question very much if a man could get a needle, much less some thread, should he unfortunately lose a trouser button.

In conclusion, be persevering and conscientious. Commence work on time, and quit on time, and work straight through the day, wet or shine.

Time will pass much quicker, you will learn much better, and at the close of the day will have the satisfaction of knowing that you have earned your pay.

From personal experience, I have found that the best remedy for an exceedingly hot day is not walking backwards and forwards to the water cooler, or ice filter, but to double up over the drawing board, grin and bear the hot weather, and before you know it, it's time to quit.

Can carry an Army

GERMAN army officers seem greatly perturbed over the possibilities of the "Lusitania" and her sister ship, the "Mauretania," as army transports. The two ships, they say, could transport an army of 20,000 men from England to the continent in very short order, if the necessity should arise. The officers and crews are members of the British naval reserves, and the vessels could be turned over to the admiralty with but very little preparation.

AN IMPROVED METHOD OF MAKING SPIRAL COILS

"NOLEGE"

The following method of making spiral coils for springs or resistances has several advantages over the usual method of coiling the wire, which is kept under tension on a long, circular rod. The chief are — the length of the coil is unlimited, the pitch or number of turns per inch can be made to suit, and the internal diameter of the coil constant.

Figure 1 is the mandrel. This is best made of silver steel; the amount of taper depends on amount of spring in the wire — the greater the spring the greater the amount of taper, which should be recorded for reference when making other size mandrels.

Fig. 1.

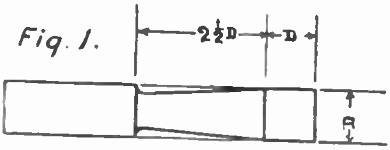


Fig. 2.

Fig. 2a

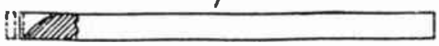


Figure 2 is the spacing and forming tool, which is made of mild steel. The spacing of the holes is equal to the required pitch of the coils, which are drilled 4-1000ths or 5-1000ths inch larger than the diameter of the wire to be used. The dotted portion is then cut away, leaving half the holes, which act as guides for the coils. The first hole should be given a good lead for the wire (Fig 2 *a*).

Figure 3 shows a coil in the making. A start is made by putting a few turns on by hand, which are placed in the recesses of the former. The former is then pressed fairly tight up to the mandrel, and all is ready for turning off the desired coil.— *Model Engineer and Electrician.*

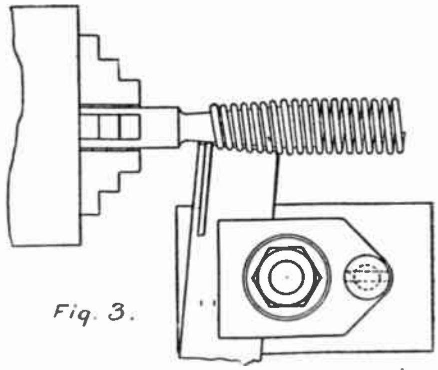


Fig. 3.

Some Details of the Proposed Equitable Building

Some idea of the magnitude of the proposed 62-story structure which the Equitable Life Assurance Society is to erect upon the present site of the old structure at Broadway, Nassau, Pine, and Cedar streets, Borough of Manhattan, N. Y., at a cost of approximately $10,000,000, may be gathered from the statement that the building will contain all told 40 acres of floor space, 5200 windows, 4800 radiators, 25,000 electric lights, 38 electric elevators, about 3600 offices accommodating between 20,000 and 21,000 people, two acres of eight-inch thick granite, and 1,750,000,000 brick, making 4,375,000 tons, or 8,750,000,000 pounds of brick.

The two 22-story terminal buildings of the Hudson and Manhattan Railroad, in Church Street (taken together), the largest office building in the world, occupy 70,000 square feet of ground. The cubic area is 14,500,000 feet above ground and 3,650,000 cubic feet below ground, comprising a total of 18,150,000 cubic feet. There are 5200 doors, 5000 windows, 120,000 square feet of glass, and 39 elevators in the two buildings.

The City Investing Building, 33 stories high and immediately adjoining the Singer Building, contains 12 acres of rentable space 11,000,000 cubic feet, 500,000 square feet of floor space, 21 elevators, 2260 radiators, represents an outlay of $10,000,000, and accommodates 10,000 tenants. — *Carpentry and Building.*

Electrician and Mechanic

Incorporating

Bubier's Popular Electrician......*Established* 1890
Amateur Work..................*Established* 1901
Building Craft..................*Established* 1908
The American Inventor..........*Established* 1892

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VOL. XIX. NOVEMBER, 1908 No. 5

EDITORIALS

WE have in preparation, and will be ready to mail to our readers within the next month, a premium list containing a description of a number of most valuable electrical and mechanical premiums which we are prepared to give to those of our readers who are willing to obtain one or more new subscribers to ELECTRICIAN AND MECHANIC. This list will not contain any cheap or second-class articles, but tools and electrical goods manufactured by the foremost manufacturers in the United States, and in every case their best products. We shall be glad to forward this list when it is ready to any of our readers who are interested.

We also have in preparation a list of clubbing offers on magazines. We shall be able to offer you subscriptions to all of the important mechanical and popular magazines, either alone or in conjunction with ELECTRICIAN AND MECHANIC, which will be well worth waiting for. In the meantime, if any of our readers have made up their minds what magazines they would like to take next year and will send us the list, we will name them a price which will be as low as any price which they can get from any other subscription agency or news dealer. Send in your name at once for these two lists when they are issued.

* * *

ON recent trips on Atlantic steamers, during which we had good opportunities for inspecting the Marconi installations, we were surprised to find how inefficient was the service on Atlantic steamers of the first class. Although these vessels are fitted with very large induction coils and should theoretically be able to communicate up to two hundred miles with little difficulty, this seems to be exceptional, and it is rather the exception than the rule that the smaller steamers can get into communication with vessels in their vicinity. The station at Cape Race, which is officially designated by the Marconi Company as ultra-potent, and which has a sending capacity of at least a thousand miles, sends news messages every night, which are supposed to be taken by all ships in the eastern half of the Atlantic Ocean. As a matter of fact, however, on the writer's trip from England this message was received on only one occasion, and communication was established with only a half-dozen steamers, although by the Marconi October communication chart we should have been in touch with nearly fifty. Either the Marconi apparatus on most Atlantic steamers is extremely inefficient or the operators are incompetent.

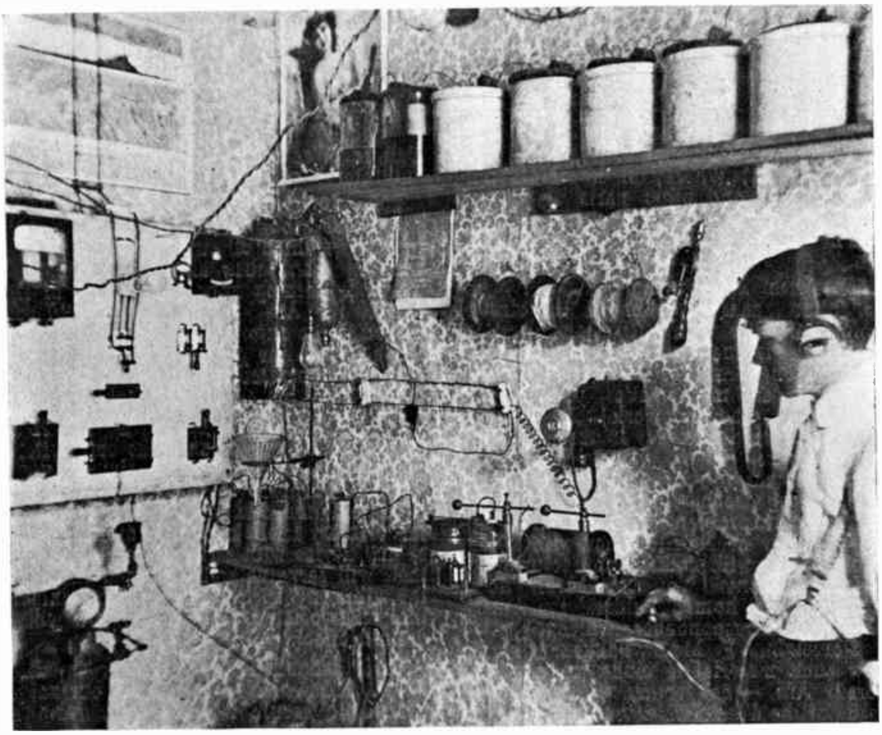
* * *

THE U. S. Civil Service Commission announces an examination on November 23, 24, 25, to fill position of Electrical Engineer and Draftsman in the office of the Supervising Architect Treasury Department, Washington, D. C., at $1200 per annum.

For full information apply at once, either to U. S. Civil Service Commission, Washington, D. C., or to the Secretary of the Board of Examiners, at cities where examinations are to be held.

WIRELESS CLUB

This department is devoted to the Club members and those interested in Wireless Telegraphy. We will publish experiences, discoveries, and suggestions, which may be helpful to all interested.



Wireless Station of P. E. W.

We give above a picture of a station constructed by one of our readers, which is being very satisfactorily operated in the South. We hope to receive other pictures of stations and workshops for publication.

We would like to hear from all our Wireless members, and ask that the call numbers of stations be sent at once. Also any information which might be of interest to us in making further plans for our Club. If any local Clubs have been formed, would also like to be advised.

Sampson Publishing Co.:—

We have equipped, since April of this year, the following boats with our system: The "Pennsylvania," "Yucatan," "Northwestern," "Santa Clara," "Victoria," "Chicago," "Bertha," "Portland," "Chippewa," "Iroquois," "Hilonian," "Enterprise," "Buckman," "Watson," "Porter," "Barge 95," "Col. E. S. Drake," all working every day.

We also have in operation and *working every day* the following land stations: San Diego, Los Angeles, San Francisco, and Eureka, Cal.; Astoria and Portland, Ore.; Seattle, Tacoma, Westport, Aberdeen, Wash.; North Vancouver, B. C.; Katalla and Cordova, Alaska, and our station at Victoria, B. C., is now being installed and will be in operation before you receive this letter. We have also signed contracts for the installation of a station at Vancouver, B. C., in a hotel, and at Bellingham, Wash., in a hotel. The Dominion Government on this coast have already installed and working every day in British Columbia five Shoemaker sets, which, as you know, are now our patents.—United Wireless Telegraph Company.

QUESTIONS AND ANSWERS

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

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for the 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.

804. **D'Arsonval Galvanometer.** E. S., Clinton, Iowa, asks (1) Where can he obtain mirrors, suspensions, and other parts of such a galvanometer, also standard resistance coils? Ans. — The Leeds and Northup Co., Philadelphia, Pa.

805. **Electrical Engineering.** J. L. T., Annandale, Minn., asks (1) What is the size of the sample of wire sent? (2) Can electrical engineering be learned at home? Ans. — (1) No. 36. (2) The branches involved in electrical engineering are mathematics, physics, mechanics, drawing, and shopwork. By as much as you can acquire proficiency in these lines, at home or otherwise, you are well on the road to the professional career you have in mind. Help from experienced teachers and opportunity to work out specific problems with electrical apparatus are surely needed, together with a year or two of service with some manufacturing or engineering company. You can surely do a part of the work at home. Address the American School of Correspondence, Chicago.

806. **Porcelain.** P. M. E., Salisbury, N. C., asks how such material is made for electrical insulators? Ans. — See article in the March, 1908, issue of the *General Electrical Review*, published in Schenectady, N. Y., price, 20 cents per copy.

807. **Induction Coil.** J. A. C., Seattle, Wash., asks (1) Is it practical to use a 115-volt 60-cycle alternating current on an ordinary induction coil, the usual interrupter being retained? (2) Can the current be also used for electroplating, by inserting a rectifier? Ans. — (1) You will find it rather unsatisfactory and uneconomical. Use considerable resistance in circuit, either by use of a bank of incandescent lamps, or by reactive coils. (2) The rectifiers are expensive, not readily under control for variable currents, and few men are acquainted with methods of repairing them. We would advise you to use a motor-generator set for both purposes.

808. **Water-wheel.** W. R. E., New Orleans, La., asks various questions about the power available from an impulse wheel 12 inches in diameter under the action of water at 40 pounds pressure from various sizes of nozzles. Ans. — Power for anything other than momentary use is altogether too expensive from the source you have in mind. For 1 h. p. you will need about 3000 gallons of water per hour. If you will send to the Pelton Water Wheel Co., San Francisco, Cal., for a catalogue, you will get some reliable and interesting data.

809. **Lubricator.** A. E. W., New York City, asks what method of suspension is used for the weighted oil cup often seen on the overhanging crank disk of a large steam-engine? There is nothing opposite the end of the shaft to hold it. Ans. — A sufficiently stiff rod is attached to the outer end of the crank-pin, and extends to the line of the axis. Sometimes valve rods are operated from a similarly arranged device, only the end is set slightly off center.

810. **Induction Coil.** A. H. W., New York City, asks how to arrange the connections so as to get what is called the primary current for medical purposes? Ans. — All that is meant is the reaction due to the makes and breaks of the primary itself, and an ordinary electric bell, or any device with a rapid make-and-break contact, will serve as well. Attach the handles to the vibrating spring and to the contact screw that is associated with it and you will get the desired effect.

811. **Induction Coil.** R. P. G., Ellenville, N. Y., asks what voltage and current will be needed to secure 2-inch sparks from a properly made coil? Ans. — The volume of the discharge enters the consideration, for a large coil actuated by considerable battery power may be cut down to sparks of that length. We should advise you to count on using not less than 8 volts and 4 or 5 amperes.

812. **Rewinding Dynamo.** J. H., Sterling, Col., has burned out his 1902 Midget dynamo, and asks what sizes of wire to use to adapt it for 10 volts, with a shunt field? Ans. — You should have given some of the dimensions of the machine, and sizes of wire originally employed. You cannot expect us to have samples of all the makes of dynamos in stock for determination of such details. We think No. 21 wire on armature and No. 24 on field, — all you can get on, — will give good results.

813. **Model Electric Boats.** V. G., Willowdale, Ont., asks (1) Is there any book treating on this subject? (2) Are Fuller batteries good for charging small storage cells? (3) Will a 4-volt battery run two 4-volt lamps, or should more cells be used? Ans. — (1) We do not know of any. (2) Not so good as gravity cells permanently connected to the accumulators. (3) Use 6 volts with some sort of slide wire resistance in circuit.

814. **Condenser.** A. B., asks (1) In wireless telegraphy is it necessary to have the plate glass condenser in addition to the one belonging to the primary breakpiece? (2) What is the best way to step down the 110-volt direct current to fit the 2-inch spark coil? (3) If a Wehnelt interrupter was used, will the regular vibrator be disconnected? Ans.—(1) Yes. (2) For occasional use a rheostat consisting of metal plates in a wooden pail filled with salt water will suffice. For regular use a motor-generator set would be more economical. (3) Yes, the electrolytic interrupter is sufficient,—in fact, usually too vigorous for most coils.

815. **Induction Coil Troubles.** A. F. M., New Decateur, Ala., has disastrous experiences with his coil when operating it on alternating currents, and asks how he can improve matters? Ans. — We are afraid you will not meet with gratifying success with such current. Some improvement can be made by making one or more choke coils, resembling primaries of induction coils; control will be secured by varying the position of the iron cores within the winding.

816. **Chemical Rectifiers.** S. V. T., New Westminster, B. C., asks for the addresses of manufacturers of such. Ans. — We fail to find that these devices are regarded as satisfactory. We think a motor-generator set is the only recourse.

817. **Water Power.** C. M. R., Blissfield, Mich., refers to the answer No. 670, in the July issue, and asks where the 650 comes from? Ans.—The formula is a common one found in books on mechanics, the one we often use being Molesworth's "Pocket Book." The statement is found on page 136, although we stated to divide by 650 instead of multiplying by :0015, — its equivalent.

818. **Armature Winding.** A. H., Amana, Iowa, has made an electric motor after the description given in *Scientific American* Supplement, No. 641, winding the sheet iron field with No. 16 wire. The motor will run out without any appreciable power, and he wishes now to make a cast iron six-pronged armature, in the hopes that by thus reducing the air-gap the power will be increased. He has used as many as 20 batteries. Ans. —While the large air-gap involved in the original design does seriously limit the power of the motor, perhaps you have overestimated the strength of the batteries. What sort did you use? Dry cells would not be suitable. You need 8 to 10 amperes, and only large plunge batteries, or those of the storage sort will supply such a large current. The cast iron armature you propose will be so productive of eddy currents as to be no improvement over the present one. If you do make it, wind one of the six limbs full of wire, twist a loop, wind the next one, twist a second loop, and so on until there are five in all, when by joining the end with the beginning, a sixth loop will be secured. A six-segment commutator will then be needed. No. 18 wire will be a good size. You will get the most power by use of a sheet iron armature with not less than 16 slots, — 24 will be better, and wound as an ordinary drum, such as is described in Watson's "How to Make a $\frac{1}{4}$ h. p. Dynamo."

819. **Steam Boiler and Engine.** F. P. H., Baltimore, Md., has made a model steam-engine with cylinder $1\frac{5}{8}$ inch bore and $1\frac{3}{4}$ inch stroke. The boiler is made, as we suggested, from a 5 x 12 inch mercury flask, and is heated by two gas burners. The engine runs only when there is a very high boiler pressure, and then runs at a terrific speed, but quickly stops, though there is still a good pressure of steam. On starting, a good deal of water comes out of the exhaust. Can this be prevented, and what is the trouble in general? Ans. — The boiler seems to be all right, but we think your engine has altogether too much friction. You ought to be able to turn it with ease, and that it ought to make several revolutions when given a single impulse by hand. It ought to move by blowing into the pipe. If the stuffing-box is too tight, loosen it and tolerate a little leakage there. Perhaps the stuffing-box is not axial with the cylinder. How far is the engine from boiler? It ought to be close, but if some distance is imperative, use a good size of pipe, say $\frac{3}{8}$ inch, and cover it with long strips of paper, wound on spirally. You should have cocks at both ends of cylinder for "blowing off," previous to starting. This procedure allows the iron to get well warmed, and prevents accident to the engine. Perhaps, too, you have used insufficiently large ports into the cylinder.

820. **Underwriters' Rules.** M. D. G., W. Medford, Mass., asks where a copy of the latest edition can be obtained? Consult your local insurance agent, or address The Factory Mutual Insurance Companies, 31 Milk Street, Boston.

821. **Battery Cells.** V. B., Indianapolis, Ind., states: In "Questions and Answers," No. 742, question No. 3, about "improved Fuller battery cells," I have tried every way to learn what kind of cells they are, as I have a battery cell planned, and before I go to any expense, I wish to know whether or not they are alike. Just give a short answer as to what it is made of and its output in volts and amperes, as I can tell from that what I want to know. Ans. — In the improved Fuller battery a clay porous cup and Daniel zinc goes inside of the carbon cup. The solution for this cell can be either bichromate of potash or bichromate of soda. It is claimed that the advantage of this cell over any other type lies in the fact that the cell requires absolutely no attention on open-circuit work in from two to four months. The output in volts and amperes is unknown to us. The cell can be purchased for $1.50 from J. H. Bunnell & Co., New York City.

822. **Aeronautics.** K. M., Everett, Mass., asks: (1) How many pounds will 1 cubic foot of hydrogen gas, with a specific gravity of .005, lift in air? (2) How many pounds will that quantity of hydrogen make as light as air, — that is, float in the air? (3) Is it best to have only two blades in the air propeller? Ans. — (1) Air is 14.4 times as heavy as hydrogen, under same conditions of temperature and pressure, so with hydrogen weighing .0055 pound per cubic foot, the weight of an equal volume of air will be .079 pound. The lifting power will be the difference between these two weights, or .073 pound, or a little over an ounce. (2) We really cannot com-

prehend what you mean. Perhaps you wish to know with what particular weights equilibrium will be attained, and the balloon have no further tendency to rise. This will depend upon your particular construction, for if the envelope is not completely filled, the rising will continue until the expansion of the gas within the envelope will be balanced in space by the weight of the displaced air of reduced density. During ascent the hydrogen will expand and displace more air: and though the air is of continually lessening density, it allows the same lifting power. Just as soon as the envelope prevents further expansion of gas, the tendency to rise begins to lessen. (3) The two blades allow the greatest strength with lightest weight.

823. **Potentiometer.** C. H. P., Ridgewood, N. J., asks: (1) What is bisulphide of mercury used for? (2) Is there any substitute for the potentiometer described in the July issue? (3) What is the size and composition of the sample of wire sent? Ans. — (1) We are in doubt as to where you found the "bi" part of the name, for the common compound of mercury and sulphur is cinnabar or vermilion, and denoted by the symbol HgS. This is a familiar pigment for coloring. Formerly it was very fashionable to put it in shellac, for use in covering wire on electrical apparatus. The substance is rather expensive, and for such purposes entirely needless. (2) This is merely a rheostat with a large number of contacts; you are at liberty to vary the method of construction so long as you retain this qualification. (3) The size is No. 23, and we think the material is German silver; anyway, if you have plenty of it, use it for the resistance. If you can send a longer piece, we will measure the resistance, so you will know how much to wind on the coil.

824. **Ignite Generators.** E. S., Wilmington, Del., asks: (1) Are such machines for direct or alternating currents? (2) A 6 h. p. motor-cycle engine is on hand. Will this be suitable for driving an alternating current dynamo, for wireless telegraph use? (3) Using the transformer system, what would be the range of such a set? Ans. — (1) Although the machines have permanent magnets, and therefore resemble the familiar alternating current telephone magnetos, they really have drum armatures and commutators, and give direct currents. (2) Yes, rather more than you need. Watson's 1 kilowatt design of alternator will be of interest to you. (3) Several hundred miles. We think batteries will be all you need to cover the distance you have in mind.

825. **Wireless Telegraphy.** E. R. P., Roxbury, Mass., states he is making a spark coil that is intended to give a 1½-inch spark, and has wound the secondary in five sections with ½ pound of No. 30 D.C.C. wire, one each section. The primary is composed of four layers of No. 14 S.C.C. wire wound over a bundle of soft iron wire ¾ inch in diameter and 11 inches long. The condenser is composed of forty sheets of tin-foil 4 x 6, placed between paraffin paper. The interrupter is the ordinary vibrating type. Fifteen dry cells are used and a spark about ⅛ inch jump across the gap. The insulation seems all right. Ans. — See if you have not a section reversed or "bucking" the rest of the coil. This will cut down the efficiency considerably. Test each section for open circuit, as this is also liable to cause trouble. You have your sections too big. Each section should not be over ¼ inch thick. It is better to have a number of thin sections, rather than a few thick ones. Make up another primary condenser, one half the size of the one you have, and see if it makes any improvement in the operation.

826. **Wireless Telegraphy.** V. C., San Francisco, Cal., asks: (1) How far should I be able to receive with the following instruments: Sixty-five-foot aerial on house supported by 10-foot poles, electrolytic and silicon detectors, one 1000-ohm watch-case receiver, tuning coil, potentiometer, and four dry cells? (2) Are the receivers used on the ordinary telephones good to use with a wireless set? Ans. — (1) Under favorable conditions you should be able to receive up to 500 miles with the above-mentioned outfit, if connected properly. See diagram in July issue, for best form of connecting. (2) No, ordinary telephone receivers are not sensitive enough, unless rewound to a high resistance by an expert. When properly rewound, they are usually very good for experimental purposes. See July Classified Advertising Column for advertiser who makes specialty of rewinding receivers.

827. **Wireless Telegraphy.** J. A. M. K., Newport, R. I., states as follows: (1) I have an aerial brought from the two chimneys of our house, about 50 feet high. I have a pair of 75-ohm receivers, a silicon detector, tuning coil, variable condenser, and a potentiometer, which cuts down a cell of battery. How far should I be able to receive under most favorable circumstances with a powerful tuned station on the sending end? (2) If I should substitute an electrolytic detector for the silicon, raise my aerial about 10 or 15 feet, and use 1000-ohm receivers, how far should I then be able to receive from same sending station? (3) How far should I be able to send with a transformer as described on pages 55–57 of ELECTRICIAN AND MECHANIC with a tuning coil and condenser? Ans. — (1) Under favorable conditions, 70 miles. If you get a pair of 1500-ohm head receivers, the distance may be increased to 500 miles. (2) About 550 to 600 miles, using 1500-ohm receivers. (3) About 90 miles.

828. **Wireless Telegraphy.** R. McC., San Francisco, Cal., asks following questions: (1) Please state the capacity in watts, size of spark, and sending distance of the coil described below, the stations using tuned circuits and electrolytic detectors: —

Core — a bundle of annealed iron wire 1 inch diameter and 6 inches long. Primary — Three layers No. 16 B. & S. S.C.C. Secondary — Three pounds No. 30 B. & S. D.C.C., sections wound in paraffin. (2) Please give data on an open core transformer, such as described in the August, 1908, issue, by V. W. Delves-Broughton, that would be capable of transmitting 220 miles overland, tuned circuits and electrolytic detectors being used. (3) How many watts capacity would the coil in question No. 2 be, or a coil of how many watts would be required to send the above distance? Ans. — (1) It is impossible to accurately estimate the watts, spark length, etc., of your coil. It should be about 140 watts, have a 1½-inch spark, and transmitting distance with a 50-foot aerial be about 30 miles. (2) Data is given in that article. See also Series "D" drawings of W. C. Getz, which thoroughly treat of coil design for wireless work. (3) For a distance of 220 miles, a 750 kilowatt or 750 watt coil should be used.

829. **Wireless Telegraphy.** W. C. B., Brighton, Mass., asks: (1) How is wireless telegraphy carried on in a balloon? (2) Where does the ground connection come in? Ans. — (1) By having a wire net on the bottom of the balloon for the artificial "ground," and a suspended vertical wire, insulated from the net, for the aerial. (2) The wire net takes place of ground.

830. **Wireless Telegraphy.** G. L., Detroit, Mich., asks: (1) What kind of steel do they use on the telegraphone for records? Is it the same as used for making wire nails? (2) Where can this steel be gotten in thin sheets? Ans. — (1 and 2) Cannot find any data on this.

831. **Wireless Telegraphy.** O. W. H., Denver, Col., asks to have explained the method of calculating the wave length when given the height of the aerial and power for transmitting. Ans. — In direct connected type of antenna, the wave length is very nearly four times the length of the antenna. This is only approximate, but will serve all practical purposes.

832. **Wireless Telegraphy.** J. A., Brooklyn, N. Y., states he has a 15-foot pole on the top of the house, which is about 50 feet high. About 20 yards to the west a depressed electric railway runs, and to the north and south respectively there are trolley lines two and three city blocks away. The country is flat and is covered with frame houses. He has an auto-coherer with carbon grain and a 1500 ohm telephone receiver. (1) How far ought my receiving radius to be? (2) Would a silicon or electrolytic receiver increase this? (3) Is there any formula for computing the capacity of a condenser in microfarads and the inductance of a coil in millihenrys? (4) Would No. 18 B. & S. wire do instead of 22 in Mr. Getz's tuning coil? Ans. — (1) Your receiving radius should be about 10 miles. (2) Yes, a silicon or electrolytic receiver would greatly increase this radius. (3) See Collins's "Wireless Telegraphy" for the information. (4) Yes, No. 18 B. & S. wire would do as well.

833. **Wireless Telegraphy.** G. B. M., Nashville, Tenn. If two poles 30 feet long were erected 20 feet apart, and wires strung across 10 inches apart, putting up, say, ten wires, horizontally, would this antenna have more or less receiving radius than a single pole, say, 80 feet high? If not as great, give dimensions for a horizontal antenna with as great, if not greater, radius than an 80-foot single pole. Ans. — A horizontal antenna cannot be made that will give a greater wave length than a vertical antenna of equal or greater height. While the efficiency of a vertical antenna may be sometimes increased by converting it into an inverted "L" shaped aerial, the fact that the capacity decreases directly as the square of the distance of the antenna from the earth, makes it impossible for a horizontal antenna of a given length to have the same efficiency of a vertical one of the same length. To get a horizontal antenna equal to a vertical one of 80 feet, it would be necessary to have about two 80-foot poles.

834. **Wireless Telegraphy.** E. E. H., New York City. (1) Are there any laws governing the erection of a wireless telegraph station by amateurs? (2) How far will a 2-inch spark coil transmit messages, with other instruments properly connected? (3) According to diagram by W. C. Getz in the July issue, there is only one wire leading from D. P. D. T. switch; is this correct? (4) Does it increase the receiving radius to use more than one tuning coil? Ans. — (1) At present there is no law governing wireless, but it is a generally understood form of wireless etiquette for government and commercial wireless stations to always take precedence over the amateur stations. (2) With a tuned circuit system, and a 40-foot mast, the antenna having about a 100-foot span, the transmitting distance should be about 150 miles. (3) For receiving, the antenna is used as one straight wire, only one end being used on the instruments. In sending, the two ends of the antenna are short-circuited, and are thus used as a conductor of double the surface area, but one half the distance. (4) Not unless some balanced tuned system is used, such as the De Forest with the Hertzian loop antenna.

835. **Wireless Telegraphy.** E. M. V., Chicago, Ill. (1) What size is the enclosed wire? (2) Could I use it on a receiving tuning coil? (3) Would a coil work well if it had twelve sections of No. 31 B. & S. and ten sections of No. 28 B. & S. in the secondary? Ans. — (1) No. 22. (2) Yes, it can be used on a receiving tuning coil. (3) No, it would not work well.

836. **Wireless Telegraphy.** A. W., Gates, N. Y. I have never yet seen an article telling how many volts and amperes must be sent through primary of induction coil for wireless distances. (1) For example, 100 miles. Will the coil described by Mr. Delves-Broughton in August number of ELECTRICIAN AND MECHANIC work 100 miles with 40-foot mast? (2) Will you give primary winding for battery? (3) Could not this coil be built in sections without materially increasing its size and thus secure better insulation? Ans. — (1) Would refer you to article on "Wireless Telegraph Distances" in the November, 1907, issue of this publication. (2) Kindly make your question clearer. (3) Yes; it is not necessary to do so, however. The insulation as described is sufficient.

837. **Wireless Telegraphy.** A. S. T., East Orange, N. J. (1) Will the transformer described by V. W. Delves-Broughton lose any of its efficiency in not being connected to a "sending coil" as described in the article by O. Kerro Luscomb? (2) Would not the above transformer work with satisfactory results as per Fig. 1 in article by W. C. Getz? De Forest system. (3) On page 68 about opposite Fig. 1, would the transformer or induction coil hinted at as possible in a later article be any more powerful than the above, 500 watts or ½ kilowatt? Ans. — (1) Yes, to a certain extent, although it is not necessary to use such a coil. The usual helix can be used in place of this coil and good results be got from it. (2) Yes. (3) We do not think so.

TRADE NOTES

ALTHOUGH the little motor just out by Kendrick & Davis carries for its number 13, it is no hoodoo, but is up to the usual high standards of this well-known concern. We are sure many of our readers will be interested in this product, and will order at once, as the price is very reasonable.

THE firm of Smith & Frisbee, Patent Attorneys and Corporation Organizers, have issued a pamphlet entitled "Letter of Instructions," for the organization of Massachusetts corporations. This pamphlet gives practical suggestions to incorporators, and the advantage obtained by incorporating under Massachusetts laws, together with information for treasurers of Maine and other foreign corporations. This firm is also about to issue a special circular for inventors, called "Inventor's Protective Certificate," giving information how to protect their inventions before filing caveats or application for letters patent. The above are of value to any one or any firm contemplating the organization of a corporation or the procuring of or purchase of any interest in any patents.

Charles F. A. Smith and Franklin S. Frisbee, the members of this firm, are both men of long experience in the procuring of United States and foreign patents and trade-marks, and in the organization of corporations under the laws of Massachusetts and other States.

Copies of either the pamphlet or certificate will be mailed free upon request, addressed to the firm at 49 Federal Street Boston, Mass.

WE have received from W. C. Getz of Baltimore, Md., copies of his blue-print wireless diagrams, series A to G, and we can cordially recommend these as of the greatest practical value to every student and experimenter who is interested in this art. We have not space for a complete description of these various series of drawings, but can say that they cover all of the practical details of construction of tuned circuit wireless telegraph instruments in a most workmanlike and thorough manner. There is no portion of the construction or connection of a wireless set which is not covered by some one of these drawings. The prices, we understand, are moderate and will be furnished on application by Mr. Getz, whose address will be found in our advertising pages.

OUR readers who are interested in telephones may be interested to know that *Telephony* has just purchased the *American Telephone Journal*, and is now the strongest telephone magazine published in the United States. *Telephony* is a weekly, and the price is $3 per year. If any of our readers, however, desire to subscribe before the first of next January, we shall be glad to accept subscriptions at the special price of $2 or $2.75 for *Telephony* and ELECTRICIAN AND MECHANIC together. We may mention here that we are preparing a list of magazines which we can offer at reduced prices. We can save you money on all your magazines. Write us at once.

BOOK REVIEWS

HEATING AND VENTILATION. By Charles L. Hubbard, B. S., M. E. Illustrated. Chicago American School of Correspondence, 1909. Price, $1.50.

A working manual of approved practice in the heating and ventilating of dwellings and other buildings, with complete practical instruction in the mechanical details, operation, and care of modern heating and ventilating plants.

This volume is the latest of the series of practical working guides issued by the American School of Correspondence. It is comprised of a complete course of instruction to the man on the work, in modern heating and ventilation. It appeals not only to the technically trained expert, who may use it to great advantage as a reference, but also to the beginner and self-taught practical man. The text is clear and concise, and technical terms and the formulas of higher mathematics are avoided where possible, without materially decreasing the worth of the work. The student, the architect, the draftsman, the heating man, the engineer, and the contractor should own and read this book.

REINFORCED CONCRETE. A manual of practice by Ernest McCullough, M. W. S. E. Illustrated, 1908. The Myron C. Clark Publishing Co., New York and Chicago. Price, $1.50.

This book, the latest addition to the ranks of authorities on reinforced concrete, attacks the problem from the right standpoint. It is a manual of practice, a handy book for the draftsman and the man on the job. It leaves higher mathematics very severely alone, yet gets at the root of the question surely and quickly.

It treats of strength of beams, formulas, definitions, stone and cinder concrete, floor slabs, loads on beams, dead and live load, deflection, shear, concentrated and distributed loads, free, tied, and cantilever beams, columns formula, strength, and stiffness, walls, tanks, and footings, design and cost, forms, the conduct of the work, and tools. The practical value of this work is very great, as it is taken largely from the author's own experience, combined with the observations of other practicing engineers.

FOUNDRY WORK. By Stimson. American School of Correspondence, Chicago, Ill., 1908. Price, $1.

This subject is an interesting one to very many working men particularly, and the author has developed the practical side of the subject in a very satisfactory manner. The illustrations, for the most part, are excellent, and it is to be regretted that some of the simplest drawings are so crudely done as to detract from the otherwise general excellence of the book. The subject "Shop Management" deserves a more thorough treatment than the author has given, but what is presented on this subject is good. A chapter on "Casting in Aluminum" would also have been a valuable addition to this book.

Taken as a whole, this book is fully up to the high standard, and deserves a large sale.

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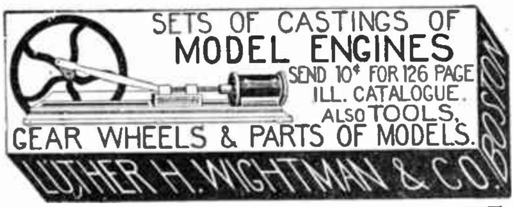

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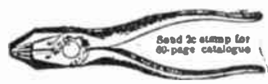

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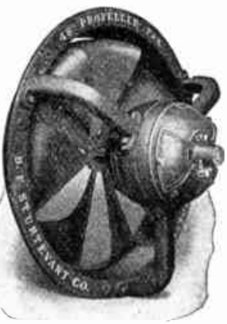

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