Cents May, 1908

ELECTRICIAN
AND
MECHANIC

INCORPORATING AMATEUR WORK

CONTENTS

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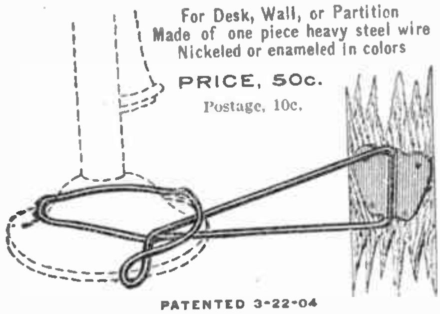

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ELECTRICAL ENGINEERING—Chapter XXIII

STORAGE BATTERIES. PART II

Switchboard Arrangements

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

WITH the positive and negative plates duly assembled in order in the jars or tanks,—the positive of one set being attached to the negative of the next,—the solution may be poured in, but not unless it is fully cooled. All the cells should be filled without unnecessary delay, for the act of plates standing uncharged in the solution, as already stated, tends to the formation of undesired sulphate. In consequence of some inevitable action of the acid upon the materials, it is likely that some sizzling will take place, but this is not injurious.

All connections to the switchboard terminals having also been made, the charging should be started immediately after filling the last cell. In Fig. 120 is shown a diagram that represents the essential connections, and while succeeding diagrams illustrate further details and additions, it is to be inferred that these elements, too, are included as a matter of course. In this, a shunt-wound dynamo is represented with its main terminals attached to the lower contacts of a double-pole single-throw switch, with a rheostat in the field circuit, whereby, within the scope of the machine, the voltage may be adjusted to any desired value. Between the upper contacts of the switch the storage cells are connected, with an ammeter of the permanent magnet type included in any convenient place. A small double-pole double-throw switch is shown under the voltmeter,—also of the permanent magnet sort,—the hinges being connected to the instrument, the upper terminals to the upper ones of the main switch, the lower contacts similarly to the lower ones of the larger. By this it is seen that when the main switch is open, the act of closing the small switch in the under position, as shown, will attach the battery to the voltmeter and the pressure may be read. By closing

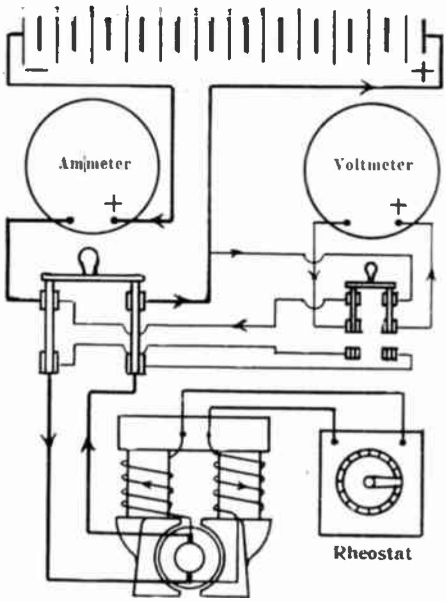


Fig. 120. Simple Diagram of Connections for Storage Battery Charging

the switch in its down position the voltage of the dynamo may be read. It will be noticed that the right hand of the two terminals of each instrument is marked +; this is the regular construction of the Weston voltmeters and ammeters, and in the diagram care has been taken to represent consistent directions. Since the battery has a definite polarity of its own, it is highly important to have instruments of the sort that will respond to the particular polarity. In charging, the positive pole of dynamo must be connected to the positive of battery, and the voltmeter is relied upon to reveal the poles, and the ammeter to indicate whether current is going into the battery or coming out of it.

If the plates are in such a completely discharged condition that when first set up they give no deflection at all upon the voltmeter, the circuit must be traced from the set of plates that is properly to be positive to the right hand terminal of voltmeter, the dynamo set for a low voltage, and the charging current rather cautiously brought to its normal strength. About 20 to 25 square inches superficial area of positive plates is to be allowed per ampere,—this general statement being modified by the directions ordinarily sent out with batteries from the various manufacturers. Assuming that the battery does at first, as certainly it will on subsequent use, show a definite potential, this particular value is to be noted, and then the voltmeter switch is to be turned to its lower position, and the field rheostat of dynamo adjusted until the voltage from this source is equal to that of battery. It may happen that with all the connections as shown,—except that main switch must of course be as yet unclosed,—the dynamo polarity may be such as to deflect the voltmeter needle the wrong way. This shows that the polarity of dynamo needs reversal, and the truthful prediction of this condition is one of the valuable qualifications of this type of instrument.

To remedy such a contingency as the wrong polarity of machine, it is not necessary to change the wiring or switch connections; while such means would be effective, they would be, especially in case of large conductors, decidedly inconvenient. The magnetism itself can be readily shifted. To do this, in case of a bipolar dynamo as shown in the diagram, remove the brushes belonging to one set, then close the main switch. Current will then flow from the batteries around the shunt field winding in the direction to give the right polarity. If machine is multipolar, having several sets of brushes, it may be more convenient to remove a main connection from the switch, or from the terminal board on the dynamo itself. After thus letting the current flow for a moment, open the main switch rather slowly, so as to allow the self-inductive electromotive force to dissipate itself gradually, then replace the brushes or other connection, and the voltmeter should unfailingly indicate the correct polarity.

Set the dynamo voltage the same or slightly higher than that of the battery, close the main switch, and then raise the voltage of dynamo until the proper current is indicated by the ammeter. Say, in a given case, there were thirty cells, each consisting of four positives and five negatives, each 6 x 8 inches. The area of one side of a plate will be about 50 square inches, giving, for both sides, 100 square inches, and consequently 400 for the set. Allowing 20 to 25 square inches per ampere, the normal charging current can economically be between 16 and 20 amperes. When the battery is in ordinary good condition, but awaiting charge, the total voltage may be slightly below 60; it should not be allowed to get below 55, or 1.8 volts per cell. The dynamo should be set for about 60 volts, but directly after closing the main switch there may flow only a small current. Within a short time 2.2 volts per cell will be needed to overcome the natural counter electromotive force of the cell, and about .3 volt more to overcome the ohmic resistance. With a new battery the charging is supposed to continue with as few interruptions as possible, until the voltage, after shutting off the charging current, is 2.6 per cell, and the gravity of solution is 1.21. Succeeding charges may stop with the value of 2.5 per cell. This voltage must be read immediately after opening the main switch, for after a little wait, the excess of hydrogen bubbles in the solution pass off, and the potential falls to 2.2. After a slight current has been drawn off, the voltage still further falls to its normal value of 2 per cell.

In stopping the charge, operations just the reverse of those in beginning the charge should be taken. The main switch should not be abruptly opened, for this unnecessarily burns the contacts, and in case of large currents, may produce a blinding flash. It is orderly and simple to turn resistance into the field rheostat until the ammeter indicates no current, and then open the switch. It will be recognized that the operation of connecting a dynamo for charging a battery, or of disconnecting it, is exactly like that of

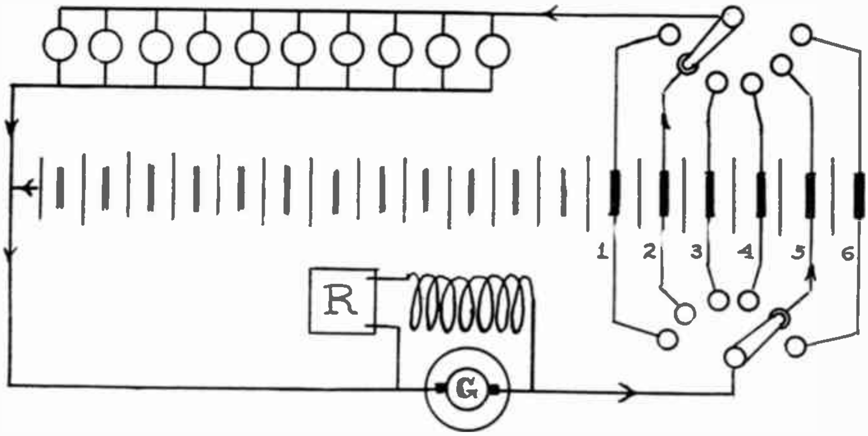


Fig. 121. Diagram of Connections for Storage Batteries with End-cell Switch Method of Control

operating a dynamo in parallel with other dynamos.

In case the dynamo potential is made lower than that of the battery it is normally charging, current will run backwards into the machine; but in case the field has a plain shunt winding, as shown in all these diagrams, no harm will result, for the armature will merely continue to turn in the same direction, though now as a motor. For this reason it is well to let the ammeter have its zero mark in the middle of the scale, then plainly, charging currents will deflect the needle to the right, and discharging currents to the left. Of course this action needlessly runs out the battery, so a common device to include in the main line is an underload circuit breaker. The construction closely imitates that of the ordinary overload circuit breaker,—which may also be included in the outfit,—but with the functions reversed, so that a current anything below a predetermined minimum will release an armature and open the line.

A series dynamo is quite unfitted for charging a battery. As just explained, the voltage of the machine must be adjusted to a particular value before closing the main switch, yet confessedly the series machine must have its circuit closed before it can generate at all. Of course a temporary artificial load could be arranged, until the voltage was correct, then the battery connected in parallel with this, and then the artificial load disconnected. Even then the means for further adjusting the voltage would not be apparent, and if for an instant did the dynamo voltage get below that of battery, the current would flow out of battery around the field magnet in the direction to reverse its polarity, when generator and battery would at once be connected in series on a ruinous short circuit.

If a compound-wound dynamo is used for such charging,—and occasionally it may be possible to find such,—there is the ever present danger that the current will flow in the wrong direction in the series portion, reverse the polarity, and cause serious damage to the armature or the switchboard apparatus. The experience of central stations in this respect is conclusive, that shunt-wound generators are alone practicable. Though thus compelling hand regulation of the field rheostat, the fact that a battery load is fairly constant renders the actual amount of attention required as infrequent. Many stations have changed their compound windings to shunt, and some of the very largest generators built have only these simple field coils,—a notable resort to the type first adopted and for years tenaciously adhered to by Edison in his central station equipments.

In the diagram and manipulations just explained, no mention has been made of the uses to which the batteries were to be put. The act of charging them is not of course the final object, but, at will, to get the current out. Without further appliances the installation would be quite helpless to maintain the particular service desired. For an experimental laboratory, it might be sufficient merely to lead wires from the various connections between the cells, thereby allowing any desired number to be connected to the apparatus at hand.

For central and sub stations, and even

small plants, the device known as the "end-cell" method of control is largely used, and gives great flexibility to the system to which it is connected. A graphical representation of its peculiarities is given in Fig. 121. The system is supposed to consist of a load of lamps or other devices, operating at a fixed normal voltage, yet the battery charging, so that for certain hours, later, it may assist the generator to carry the maximum load, and then at another time, when the load is small enough, the engine may be shut down altogether, and the battery do the work alone.

All these desirable conditions are readily filled by the arrangements shown. Assume the practical case of a country residence, a hotel, or apartment house desiring an isolated electric lighting plant. The lights should be available at any hour of the day or night, but for reasons of economy the engine should not be run after midnight. If 110-volt lamps are to be used, and the minimum voltage of 1.8 per cell is admitted, the number of cells required will be sixty-one. To charge the battery an allowance of 2.5 volts per cell must be provided, or the dynamo must be able to generate 155 volts. This is far in excess of what the lamps could directly stand, yet during the charging, the 110 volts only must be supplied to the lamp circuit. Taps must be led from a certain number of cells near the end of the series, and connected to a double switch, in the order shown, and by proper manipulation of the contact arms, the desired regulation may be secured. In the case taken, the excess voltage would be 45, and at the charging value of 2.5 volts per cell, this would mean that eighteen cells should be thus connected. The diagram shows only six, but the principle is obvious. As the end cells are less in circuit during the discharge than the main set, they are more quickly charged, and so can soon be removed from circuit, and the voltage of generator proportionately reduced. The charging of these end cells is further accelerated by the necessity, as will be noticed, of the current for the entire lamp load in addition to the regular charging current, passing through whatever cells are included between the two movable contact arms.

When the arms rest on similarly numbered contacts, the battery may discharge in parallel with the dynamo, and then, when the latter is disconnected, the battery alone carries the load, additional cells being occasionally cut into circuit, as a watchman may see fit from observation of the voltmeter.

In making an end cell switch, precaution must be taken to have the end of the arm narrower than the space between contacts. In case considerable current is flowing, this necessitates an objectionable flash, but the alternative case would be worse, for at the instant when the arm simultaneously touched two contacts, the cell between them would be on a short circuit, with the result that the contacts might melt and stick together, and also injure the cell. To avoid both flashings and short circuits, it is common, in case of large installations, to make the contact arm double, the two arms insulated from each other, and then connected through a suitable resistance. During the transition from one position to the next this resistance momentarily carries the main current and also a local current from the cell concerned, but the flash is avoided, the lamps experience no wink, and the cell is not quite short-circuited. For very large installations carbon blocks serve as excellent resistances for this momentary interposition.

There is another method of arranging cells for a private or small installation, somewhat resembling the one just described, with which it might readily be confused, yet having some essential differences. It is called the "counter-cell" arrangement. In this there would be a full set of cells, numbering, for an analogous case, sixty-one, as before, and a second set of eighteen cells, connected in opposition to the main set. A contact switch with eighteen points would be connected so as to include more or less of these. The dynamo is supposed to be directly connected with the main set, while the lighting circuit is attached to one end of main battery and to the hinge of the contact switch. By this means, whatever current is used for the lamps has ordinarily to pass through some of the counter cells, always in the direction to charge them. This represents some expenditure of energy, and an original expense for the extra cells. The only excuse for prescribing such an installation would be where the demands were small, and the apparatus was intrusted to unskilled hands. All the main cells would be charged alike and used alike, while the other cells, though used variably, would always be passing current in the charging direction.

The extension of the end-cell method of control for an ordinary two-wire system to

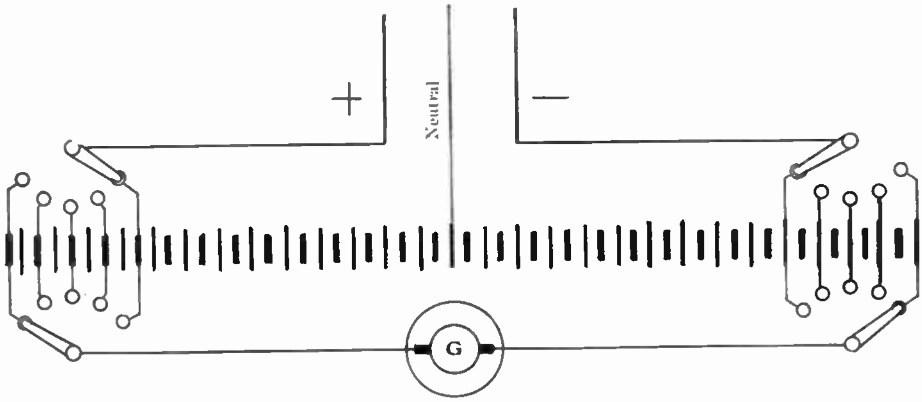


Fig. 122. Diagram showing Double Set of Storage Cells for Operating Three-wire System
61 Cells Charging under Pressure of 150 Volts

the extensively used three-wire system is readily accomplished. Indeed, it may be said that the storage battery adjunct to a central station has really encouraged the development of this system. The serious objection to the former necessity of always having to run the dynamos in pairs is eliminated by tapping off the "neutral" from the middle point of the battery, and charging the entire set with a single generator of double the usual potential. Double end-cell switches must be used at both ends of the battery. Figure 122 clearly shows the arrangement, the positions selected for the switches being those for allowing all the cells to charge, and yet impressing the minimum possible voltage on the line. Sometimes additional end-cell switches are connected in parallel with the others, so that by independent shifting of the arms different voltages may be impressed upon different feeders.

A good illustration of this particular method of operating a three-wire system is that of the Edison Electric Illuminating Company, of Boston, in their Atlantic Avenue station, where six 300-volt generators, of 1600 k.w. capacity each, are in regular operation, connected to local loads and to various storage battery sub-stations in different places in the city.

A tolerable, but uneconomical arrangement of a battery to be charged from a circuit of fixed potential, yet to discharge at that same value and supply the lights when the engine is not running, is offered by having the cells in two equal groups,—say for 110 volts, two sets of thirty-one cells, and connecting them in parallel for charging and in series for discharging. A rheostat would need to be included in the circuit under both conditions. Such a method of operating has been adopted for small apartment houses or for pleasure yachts, in which the dynamo ordinarily supplies the load, but for a very few lights in the latter part of the night the battery can be called upon. Occasional adjustment of the rheostat by the watchman usually suffices to give all the regulation needed.

For larger installations, in which the dynamo ordinarily carries the day load, and for part of the night, and the battery is to finish out the service unaided, or the battery is to assist in carrying the "peak" of the load, the most convenient and economical method of control is that by the aid of "boosters." A booster is a dynamo of apparently distorted proportions. It is considerably smaller than the main generators, but its armature windings, or bars, may be equal in size to those on the largest machines, and the commutator may be designed to pass fully as much current. While the booster may be directly driven by a steam-engine, as are the main machines, it is not common to do so, but to drive it by an electric motor. Convenience in position and ease of starting and stopping are thereby secured, and in addition allows the engines to be of large size only. Central station managers dislike the use of small engines,—ordinarily of low economy. Electric motors are of high efficiency.

The main generator, G, in Fig. 123, is supposedly operating at the normal voltage and supplying the demands of the customers, as typified by the 110-volt load. A circuit tapped from the "bus" bars is led through the armature of the booster, B, to the set of

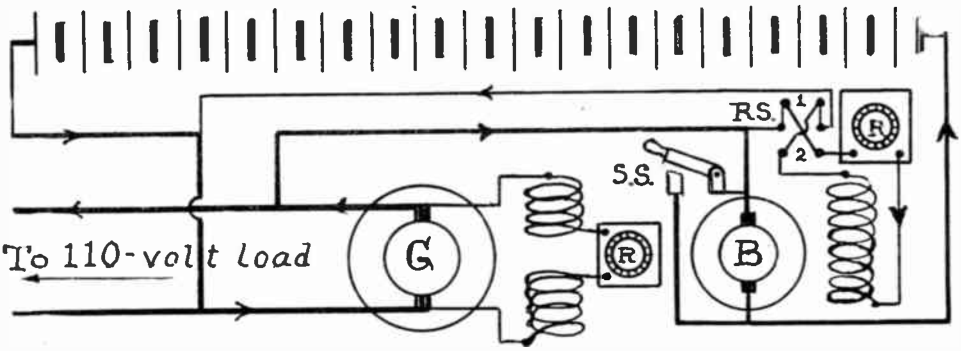


Fig. 123. Operation of Batteries under "Booster" Method of Control

storage cells to be charged. If, however, the booster is not desired, its armature can be cut out by use of the short-circuiting switch, SS. To put booster into use, this switch is opened, and the motor started. The field-magnet of booster is separately excited from the same main circuit. It will be observed that in this field circuit a rheostat and reversing switch are included. With this switch in one position, say the upper, current will flow around the field to make the voltage generated by the booster added to that of the main generator; in the other position, the voltage of booster may be reversed. The rheostat may be varied to adjust the voltage to any desired extent.

In case storage batteries are added to an existing installation in which dynamos alone had previously been used, the booster method of control is usually imperative, for otherwise the voltage would fall considerably short of that required for economical charging. The scheme is preferable, too, for many original plants, for thereby the main generators are enabled to operate under fixed loads and normal voltage, while the variable portion of the requirements is entirely transferred to the booster.

The ability to reverse the polarity of the booster is of value for facilitating the discharge of the battery, for in case of an accident to the generator, or of sudden overload, when time was lacking to start an additional machine, the battery could be compelled to come to the rescue, and for a short time deliver a relatively large share of the current.

The arrangement shown in Fig. 123 would be classed under the manually controlled sort. It has valuable and sufficient qualifications for following the demands of an electric lighting plant, but for classes of service in which the fluctuations of load are sudden, frequent, and severe, as in railroad circuits, automatic control of the functions of the booster would be desirable. Such results have actually been secured and regulate the system to a degree almost marvelous. For this purpose, the booster is furnished with a series winding on its field-magnet, through which the entire current to the particular circuit to be controlled passes, but in the opposite direction to the current in the other or separately supplied winding. The result is a differential winding. When there is no demand at all in the exterior circuit, this series coil is inert, and the excitation derived from the main winding prevails so as to give the booster its highest electromotive force, and the battery charges at the maximum rate. When current is demanded, it flows around the field of booster, with the result of somewhat reducing the strength of field magnetism, whereby less current is driven through battery, but allowing proper share to go to line. If a larger demand for current exists, the field of booster may be entirely annulled, whereby battery may be rendered inert,—neither receiving or giving. When an extra heavy demand comes, the series coil preponderates, reverses the polarity of booster, and thereby helps the battery to discharge, and to that extent relieves the generator. By proper adjustment of the series winding and of the field rheostat, the points at which the charge and discharge take place is quite under control, as desired; but with the adjustments once made, aside from following the degree of charge of the battery, no further attention need be paid to the apparatus.

A view of a booster arranged for work of this sort was given in Fig. 85, in the chapter on "Current Reorganizers," in the December, 1907, magazine.

Sometimes other special windings are employed on machines of this sort to accom-

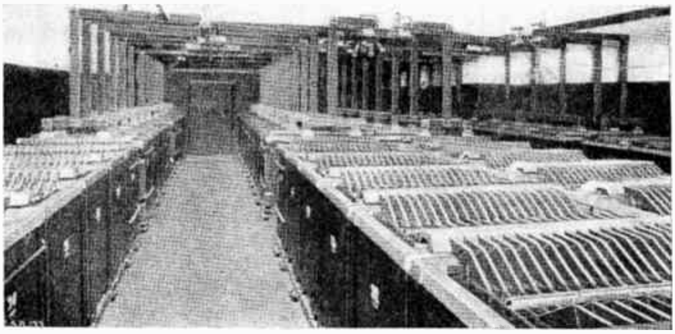


Fig. 125. View in Battery Room in Large Central Station, with End Cells in Distance

plish particular ends, the case being a confirmation of the point already emphasized, that electrical engineering represents a highly specialized collection of machinery, each doing a certain kind of work, but quite unfitted for doing any other of equal value. The adjustment of means to particular ends is one of the conspicuous marvels of the art. To show in a graphical manner what are the demands upon an ordinary city electric lighting station, and just how a storage battery assists in preparing for that demand, and then in supplying it, a curve of the station output for a single day may be given, as in Fig. 124. The readings were taken from one midnight to the next, in early winter. In consequence of the drain on the battery from the preceding evening's use, and with recognition of the principle that it should not, for even an hour, remain empty, the charging began at once. In the particular case illustrated, the current was kept at about 2500 amperes until the proper voltage and specific gravity was reached, necessitating the continuance until about 5 o'clock in the morning. Since the demand for current for other purposes was a minimum during that time of the night, it represented the most favorable opportunity for charging.

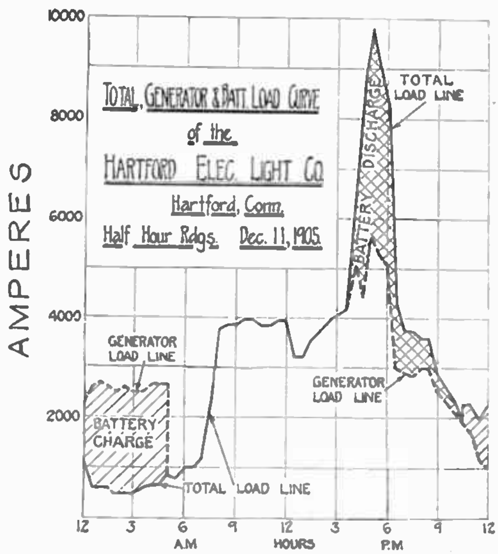


Fig. 124. Typical Load Curve for an Electric Lighting Station with Storage Battery Adjunct

From the diagram it appears that from this time until nearly 7 o'clock there was only a very small output from the station, the time being probably improved to shut down most of the apparatus for examination and preparation for the day's run. At 7 o'clock the starting of motors and lights in shops made a sharp rise in the load, continuing to rise until 8 o'clock, when the full load was on, and this remained fairly constant until noon. There was a marked cessation at this hour, and the load restored rather tardily, but shortly after 3 o'clock the rise was not only rapid, but extreme, — quite beyond the ability of the generators to supply. The battery had been idle until this time, but now came to the support of the generators, and indeed carried fully as much load. All the available generators were probably started, supplying in all about 5000 amperes, but the demand was for a total of nearly 10,000, an amount properly designated as the "peak" of the load.

After 6 o'clock in the afternoon the load fell off rapidly, and some of the generators were shut down, the battery continuing to supply some of the demand, until about 10.30, when the charging process again began at something over 2000 amperes. Of course rather more energy has had to be put into the battery than was returned, for only about eighty per cent is recoverable, and the relative areas of the charge and the discharge portions of the diagram truthfully testify the fact.

Were it not for the storage battery, sufficient power in engines, boilers, and dynamos would have to be kept on hand, ready for this peak load, then after a short run, be shut down again, and remain a source of expense without earning revenue until the few hours offered on the next day. With the added opportunity of having batteries located not alone at the central station, but at various sub-stations within well-defined centers of distribution, far better regulation of voltage can be maintained than when the system is supplied directly from the generators.

Such cells as are used in large stations are heavy and expensive. Glass jars are not practicable in these sizes, hence recourse is had to wooden tanks, lined with sheet lead, with plates of glass standing edgewise to support the weight of the lead plates and to prevent them from coming in contact with the lining. The cells are usually located in basements, where sufficient foundation for the great weight is afforded. A view of a battery room in a New York station is given in Fig. 125. A portion of the main body of cells is in the foreground, and the numerous vertical copper bars seen in the distance are recognized as furnishing the double sets of end-cell connections belonging to the three-wire system typified in Fig. 122.

MISSION FURNITURE CONSTRUCTION

IV.—LIBRARY TABLE

WILL B. HUNT, 2D

It is a demonstrated fact that the real beauty of a room lies, not in the elegance of its appointments, but in its simplicity and tasteful arrangement.

Time was when it was considered the correct thing to have heavy black walnut furniture, gloomy in appearance, and the bane of the housewife's existence, owing to its numerous carvings, in which dust and germs held high carnival in spite of all efforts to keep the crevices free from dirt.

At another period we were delighted with frail white and gold articles, the spindle legs of whose chairs defied one to sit down with any degree of security, — pretty and dainty things, to be sure, but for actual use, of but little value.

In these present days, however, we have come to combine the beautiful with common sense, and now the straight lines and solid appearance of the Mission style is recognized as the most artistic and economical of all designs.

A comparatively plain room may be made attractive by means of cartridge wall paper, a plate rail and the judicious arrangement of a few pictures, ornaments, and several pieces of Mission furniture rightly placed.

This type of furniture is invariably stained some dark shade, which, if left to itself, would be dull and severe, but as nearly every piece calls for some ornamentation, such as a cushion, or, in case of a table, a cover or a fancy lamp, the darkness of the woodwork serves as an excellent foil for the richness of the coloring in the accessory.

For instance, on the Mission library table here described a book in a bright red binding will enliven the whole room. This may not seem possible, but try it and see the result.

A window seat or a cozy corner provided with a few cushions of vivid hue will give "tone" to an otherwise commonplace room. It must be distinctly understood that this does not mean an indiscriminate jumble of pillows and books and vases, — such a medley reminds one of a department store. A plate rail overloaded with bric-a-brac is not pleasing to the eye, but exactly the reverse, and the artistic effect is obtained by a few good ornaments placed with a thought to symmetry, not only in themselves, but with regard to other articles in close proximity.

We are showing this month a substantial table suitable for a library, with a broad top and a shelf underneath. This table is extremely simple, this very simplicity giving it distinction. Its greatest beauty, aside from the form of its lines, lies in its careful planing and finishing. To get the best results it should be treated after the manner described in the April Electrician and Mechanic.

To make this table requires 21 feet 1-inch oak, and 10 feet 3 x 3 oak joist for legs.

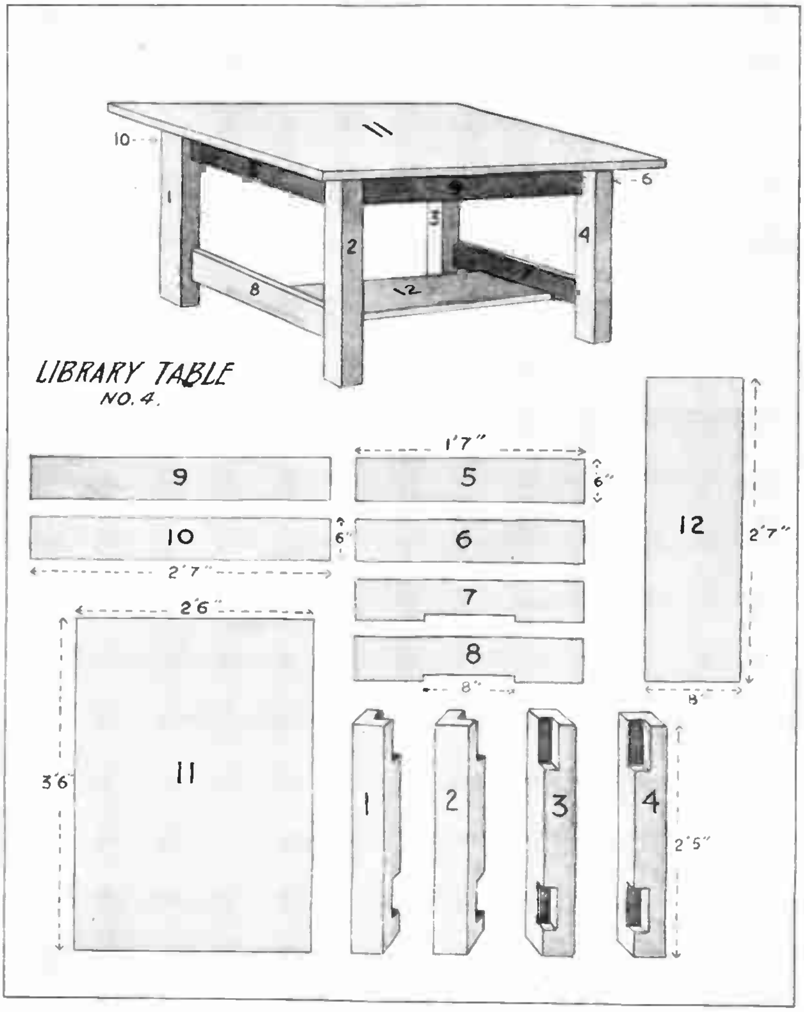
Nos. 1, 2, 3, and 4 are the legs; 5 and 6 the upper ends; 9 and 10 the sides; 7 and 8 the lower ends; 11 the top; 12 the shelf.

The legs are 2 feet 5 inches high and 3 inches square, or larger if you wish. Cut out places 1½ inches deep, thickness of the board for 5, 6, 9, and 10 to fasten to, making sure the legs are all the same length.

Prepare 5, 6, 9, 10, glue and screw into place.

MISSION FURNITURE

DRAWINGS · AND · TEXT · BY
Will · B · Hunt 2nd



Prepare 7 and 8, glue and screw into place.

Prepare 12, glue and screw into place.

The table is now ready for the top, which is to be fastened by sections of ½-inch dowling inserted to the depth of 2 inches, the sections to be 8 inches apart.

Plane and sandpaper, and stain to suit taste.

POLISHING WOODWORK

It is probable that many of our readers, especially those who are following our serial articles upon cabinet making, will desire to be able to finish their work by means of French polishing, and as an assistance to those interested in the matter — and what worker in wood is not? — we are presenting this brief, yet nevertheless practical article, for their benefit.

It is assumed that the surfaces have been properly finished by plane and scraper before polishing is attempted.

The process of polishing may be divided into three parts, — viz., filling in the grain, bodying-in with polish, and finishing the surface. If common wood has to be made to represent better stuff, staining will have to be resorted to, and the worker will find it far better to obtain his stains ready made than to put himself to the trouble of mixing his own. Those stains which have spirit as a vehicle are the best, as spirit is very volatile, and consequently the surface of the wood being treated is the more quickly dried, thus rendering the grain less liable to swell. If the stains, as purchased, are too deep, they can be easily let down by the addition to them of water or spirit, according to which variety they belong.

Filling in the Grain

In order that the actual polishing may the more quickly be executed and that the quantity of liquid used may be economized, the surface of the wood should be treated with one or other of the grain-fillers in use. There are two or three ready-made fillers to be obtained, and for these is often claimed some special advantage, but the filler in most common use, in the trade, at least, is one made of *fine* plaster of Paris and water. For light-colored wood the plaster may be used as it is, but for dark-colored stuff the filler will have to be stained with dry colors, those used in connection with the woods named being Venetian red for mahogany, yellow ochre for oak, satin walnut, etc., umber for walnut, Venetian red and gas-black for rosewood, and gas-black alone for ebonized work. The pigments are mixed with the plaster of Paris, but the powder and water are not mixed together, a piece of rag being first dipped in the water and then in the plaster, and then applied to the surface of the wood across the grain. After the pores of the wood are stopped, the surplus filler is cleaned off, — a piece of canvas answers the purpose very well, — and when the wood is dry it is lightly glass-papered.

In order to enrich the figure of the wood, the surface may be gone over with raw linseed oil, the work being then set aside for a time to become dry.

Bodying-in with Polish

Amateur workers are rather given to look upon French polish as a sort of mystic mixture, but the general basis of this compound is shellac dissolved in spirit. The worker can make his own polish by adding 5 ounces of flake or orange shellac to 1 pint of methylated spirit. When the shellac has dissolved the mixture should be strained through fine muslin, when it is ready for use. Far better results are obtainable with polish made in this way than with stuff of doubtful quality purchased from an oil and colorman.

In bodying-in the work, much will depend upon the nature of the wood. An open-grained material will require more polish than a close-grained one, so that hard-and-fast rules cannot be laid down in this direction. Some polishers body-in with a loosely made wadding rubber, which must, of course, have a rag covering; others use a brush called a gilder's mop; but the writer prefers to use a piece of old flannel, without a rag covering. Rubbers and brushes may be kept soft when not in use by placing them in a tin having a tight-fitting lid. A few drops of denatured alcohol may be sprinkled on the bottom of the tin.

A little of the polish should be placed in a saucer, or rather china receptacle, and into this the rubber should be dipped. Then the polish is applied across the grain of the wood with a quick motion. Care must be taken that too much polish is not put on at a time, otherwise the film is likely to be picked up. At no time during the process of polishing should one part of the work be dwelt upon too long, as the shellac is certain to become soft and the surface will be injured as a result. Quite a number of coats will have to be put on, sufficient time being allowed between them, to admit of hardening. Working the rubber across the grain should be varied with strokes taken in its direction, and during the bodying-in process oil had better not be used. These first applications of polish form a somewhat rough-surfaced film on the wood which, when quite dry and hard, should be smoothed down with fine glass-paper, upon the surface of which a few spots of linseed oil have been sprinkled.

Working up the Surface

In this part of the work there are one or two details which the would-be polisher will do well to bear in mind. In the first place, if the rubber is excessively charged with polish, too much will be put upon the work at a time; secondly, the pressure exerted on the rubber must be a light and even one, and last, but by no means least, the use of too much oil must be rigidly avoided, as, although some oil is necessary in order to prevent the rubber sticking, it forms no part of the polish and, in fact, has to be worked out before the final finish can be got.

The rubber with which the polish is applied in the smoothing stage is made of a piece of wadding or cotton-wool which has to be formed into a shape resembling half a pear. This is covered with a piece of soft rag, the ends being twisted round on the top of the rubber. The sole of the rubber should be quite free from creases, etc., and the charging with polish should be done from a bottle having a cork with a slit cut on one side, thus allowing the liquid to be sprinkled on the sole of the rubber. In charging the rubber the rag covering should always be removed, and care should be taken that at no time is the rag or wadding allowed to become hard. Softness of the rubber should be maintained by working it about with the fingers after charging.

The rubber being ready, and a spot of linseed oil having been put upon the rag covering, it is worked in a circular direction over the surface of the wood. This operation has to be continued, the rubber being recharged as it becomes dry, and a spot of linseed oil being put upon it from time to time with the tip of the finger. The whole surface of the work has to be gone over again and again, care being taken that the film is not picked up. Rather than run the risk of damaging the polish by reason of the rubber being worked upon it while it is too wet, it is better to let the work stand to harden. The common error of using oil whenever the rubber inclines to stick on the surface should be avoided, otherwise failure to bring up a good finish will result. As a bright súrface is obtained, the polish should be thinned down with denatured alcohol, as this eases the rubber and assists in flattening down and brightening the surface of the polish.

No rubber marks, and only a few oil smears being present on the work, the polish rubber can be discarded — or rather put away in a tin for future use — and a fresh one, made of wadding or cotton-wool, upon which a few drops of denatured alcohol are sprinkled, the whole being covered with three of four thicknesses of soft rag, is used to go over the work. At first the pressure should be light, but as the spirit dries out more energy can be exerted, the rag coverings being removed one by one as they become dry.

If the reader follows the foregoing instructions carefully, and does not mind exercising patience on his task, he should, with quite a moderate amount of practice, be able to produce polishing which will, to say the least, do him credit. — *Hobbies.*

A COMPACT TESLA COIL

F. T. WEBB

I think this apparatus will be admitted to be as interesting a piece of mechanism as an electrical enthusiast can have as an accessory to a spark coil. I have made several varieties from the excellent instructions given in the *Model Engineer;* but the Leyden jar I found very liable to get broken, and the oil had a nasty way of leaking out of the wood box, if it was not very carefully made, so I substituted a condenser of Franklin's panes instead of a Leyden jar, a glass jar replaced the wood box, and I generally rearranged the construction in a more compact manner, as shown in photograph and description. This, when tested, proved so satisfactory that I give a description: —

The Primary Coil. — Glue three strips of tape on a 1-pound thick glass jam jar, and wind twelve turns of india-rubber-coated bell wire (about No. 22 gauge). Fold the ends of

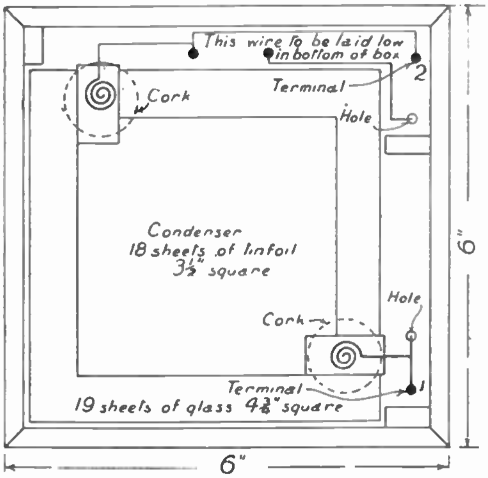


FIG. 1.—PLAN OF CONDENSER.

the tape over the wire and glue down securely, as shown in photograph, also cementing the jar into the base with thick shellac varnish.

THE SECONDARY COIL. — Select a suitable piece of wood, and, after drying in the oven all night, soak immediately in melted paraffin wax to exclude moisture, turn to shape, and bore a hole in center for wire (india-rubber-coated bell wire). French-polish and wind close with No. 38 s.c.c. wire, which, I think, will be better if soaked in melted paraffin wax before winding, as it helps to space the wire slightly farther apart. Solder the ends of the wire to the two screws shown in Fig. 2.

THE CONDENSER. — This consists of a series of Franklin's panes (old half-plate negative glass cut to size with the sharp point of a broken file). The tin-foil is placed on one side of the glass only, and is stuck on with flour paste, also strips for connection. When the condenser is placed in position in base, the spirals forming the connections are pressed down by the two corks when screwing down the baseboard by the three screws (Fig. 3). The coil is now finished, except placing the secondary coil in jar, and nearly filling with boiled linseed oil and cementing up with thick shellac varnish or paraffin wax.

The coil, when completed, and started to work, at first was not satisfactory; but the next day, when the oil had settled down to business, the coil worked splendidly, lighting

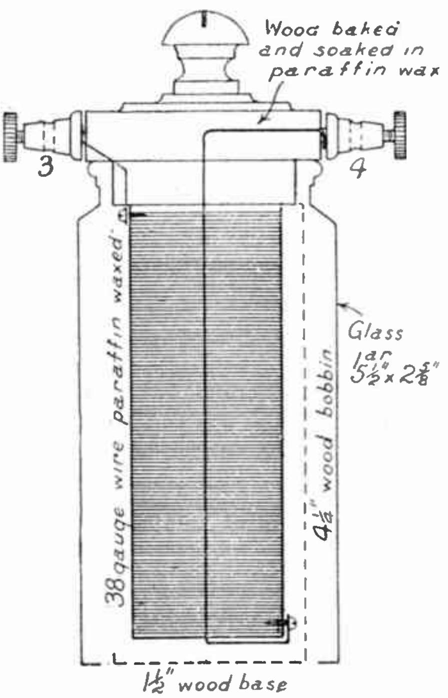


Fig. 2. Secondary Coil

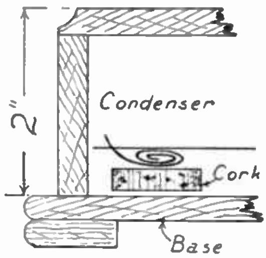


FIG. 3.

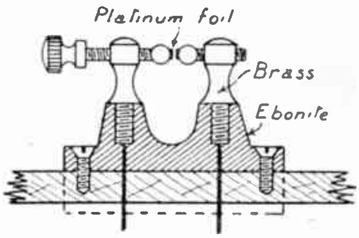


FIG. 4. SPARK GAP.

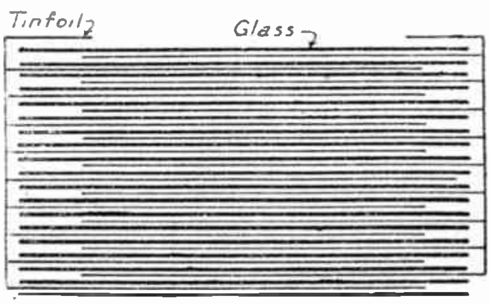


FIG. 5.—CONDENSER.

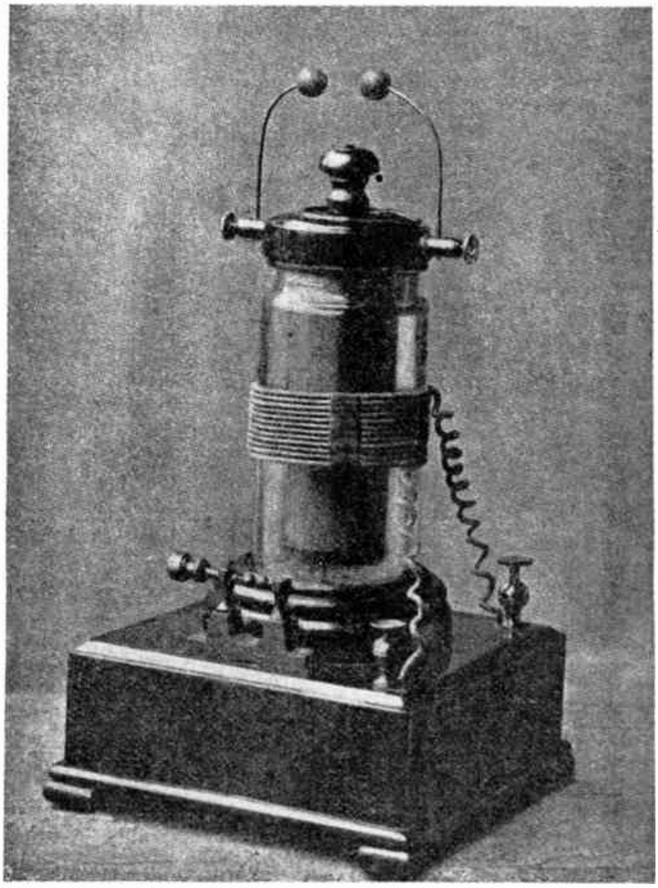


Fig. 6. The Coil Complete

up a 6-inch vacuum tube brilliantly with a ¼-inch spark. If the terminals 1 or 2 are connected to 3 or 4, a more brilliant effect is obtained, and a 6-volt burnt-out lamp, hanging on only one wire, is illuminated with a pale blue glow when attached to terminal 3 or 4. Sparks can be drawn from the fingers; vacuum tubes lighted up by just holding to terminal 3 or 4, and no shock is felt. — *The Model Engineer.*

HOW TO BUILD A SIXTEEN-FOOT LAUNCH

VI.—INSTALLING THE ENGINE

CARL H. CLARK

In the choice of an engine there are several points to be considered. In the first place is the question of the power of the engine; for ordinary speed an engine of about 1½ to 2 h. p. will answer nicely and give good speed of about six miles per hour. If more speed is desired, a double cylinder engine of 4 to 6 h. p. may be used. In any case a medium or light weight engine should be used, as a heavy weight in the bow is not desirable.

As to quality, it should be the best that the means at hand will allow, as a cheap engine is quite likely to give some trouble and to be short lived.

Many cheap engines are of such small dimensions as to be deficient in power; the price also is sometimes quoted for the bare engine, and the accessories must be purchased in addition, which brings the price nearly up to that of a moderately good engine. The entire equipment, with the possible exception of the piping, should be included.

It will, however, be necessary to order an extra long shaft, as the shaft usually furnished will not be long enough. This extra long shaft will, of course, cost something extra over the regular price.

If the engine bed has not already been built, it can be done as soon as the dimensions of the engine base are known, following the directions given in the fourth chapter.

The engine is set in place upon the bed and the shaft passed through the shaft hole and inserted into the engine coupling. The stern stuffing-box, which fastens on the back of the stern-post, should now be slipped on to the shaft and fitted in place. The shaft is adjusted so as to be in the center of the hole. When this is done the stuffing-box may be fastened in place on the stern-post. Care must be taken to so adjust the stuffing-box that it does not cramp the shaft and pre-

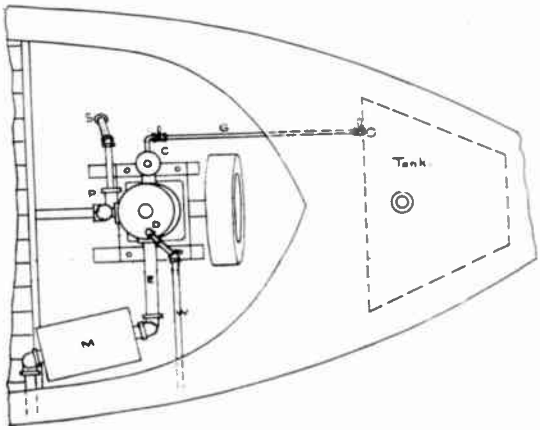


Fig. 13. Piping for Engine

vent its turning. The engine is now adjusted on the bed until the shaft fits readily into the coupling without any tendency to bend. The engine is now fastened in place with the lag screws, taking care not to move the engine during the work. When all is in place, the whole should turn readily, without friction. As the propeller is usually fitted to the shaft by the engine builder, any excess length is cut off the engine end. The amount to be cut off can be found by measuring. After this is done, the shaft may be put in place and the set screws in the coupling tightened up. A thread of packing should be inserted in the stuffing-box and the latter tightened up. There may be a tendency for the shaft to sag somewhat, owing to the length from the engine to the deadwood; this may be remedied by cutting a groove in a block of hard wood, to just fit the shaft, and fastening it under the shaft in such a position as to just take the weight of the shaft. This block should be well filled with graphite and grease, and will finally wear down to make a good bearing.

While it is not feasible to sketch all possible arrangements of piping, Fig. 13 may be taken as a fairly representative arrangement.

The exhaust piping E, being the heaviest in the outfit, should be fitted first. The muffler M is fitted in a convenient place and the exhaust pipe connected to it. The size of the pipe should be the same as the threaded outlet from the cylinder. From the muffler the pipe should lead out through the side of the boat a few inches above the water line. The muffler should be placed at least as high as the outlet, to avoid the possibility of its being filled with water which might run in through the open pipe. Where the angle between the pipes to be joined is not a right angle, as where these pipes join the muffler, the angle may be made with a pair of 45° or 90° ells, as shown. Where the exhaust pipe passes through the side of the boat, the pipe should be threaded and a lock-nut placed both inside and outside. A block should be fitted between frames so that the cutting of the hole will not weaken the plank. The exhaust piping should be as direct and free as possible, as bends and turns reduce the power of the engine.

The piping for the cooling water is next to be fitted. The suction S passes through the bottom of the boat in some convenient place. A special fitting is usually provided for this purpose; it has a pair of lock-nuts for the inside and outside of the plank and a strainer outside. It is carefully fitted to make the joint water-tight. Piping is then fitted between this fitting and the suction of the pump. Rubber hose is well suited for this purpose, as it is easy to fit and takes up the vibration readily.

The overflow from the cylinder jacket is at D, from which point the pipe w is run through the side of the boat, with a lock-nut each side of the plank.

The gasoline piping G is of lead about ¼ inch inside diameter. As far as possible all joints in this pipe should be soldered, as any leakage of gasoline is extremely dangerous. A stop-cock should be fitted at the carburettor and also at the tank.

In setting up the exhaust and water piping the threads should be smeared with red lead before screwing together, to make the joints tight. The joints in the gasoline pipe which cannot be soldered should be made up with shellac or soap.

Every engine will not, of course, have exactly the arrangement of piping here shown, but all of these pipes will be found in some position or other, and must be arranged in the most convenient manner according to the circumstances.

The gasoline tank may be usually purchased from the engine builders at a reasonable figure. The tank is often made tapering to fit in the bow of the boat, as shown. It is supported on cross braces and should be well fastened in place. The cylindrical galvanized iron tanks are very satisfactory and very strong. The capacity may be from 8 to 10 gallons. The filling pipe should extend above the deck so that any overflow will drain overboard.

It must not be forgotten to provide some very small air vent to avoid the possibility of a partial vacuum being formed in the tank by the draining out of the gasoline.

After the engine is installed and the piping fitted, a floor may be laid around the engine, preferably somewhat lower than the cockpit floor.

A shelf may be arranged in the extreme bow, to support a box, in which the batteries may be placed. Two sets of batteries of about six cells each should be used, in order that one set may be used while the other is building up. Great care must be taken that the batteries are always kept dry, as any moisture rapidly runs them down. The coil should be placed near the engine if the jump spark is used, in order to have the secondary wiring as short as possible. A very good idea is to enclose both batteries and coil in a covered box, which may be placed in a convenient place near the engine and at night may be taken ashore and kept in a dry place. If this scheme is followed out, little trouble will be had with the ignition outfit. Directions for the wiring of the engine will vary somewhat, according to the engine, and detailed directions can usually be gotten from the builder.

A heavy canvas cover should be made to slip over the engine as an additional protection from the weather.

In starting the engine, it is well at first to secure the help of some one who is used to handling them, as there are some small points which cannot be covered by written directions. After a few trials no difficulty should be had in running the engine, and good service should be had if the above directions have been followed.

After the boat has been in the water two or three months she should be hauled out and sandpapered thoroughly and given a coat of paint and varnish. Great care must be taken the first season to keep all varnished parts well covered while they are "setting" into place. This will, to a large degree, avoid the checking which is apt to occur.

With reasonable care this boat should last almost indefinitely and be very safe and satisfactory.

A DESIGN FOR A SMALL MODEL UNDERTYPE ENGINE

VIII.—THE BOILER

HENRY GREENLY

ALTHOUGH a reference will have to be made to the engine portion again, several readers having expressed an opinion that they would prefer to build a two-cylinder $\frac{5}{8}$ x $1\frac{1}{4}$-inch high pressure engine instead of the compound arrangement, the last chapter completed the description of the moving mechanisms, and we can therefore now pass on to the boiler.

As shown in the general arrangement drawing included with the first article, the generator is of the well-known water tube, as brought up to date by the addition of the improved design of downcomer. This kind of boiler is comparatively easy to make (if we leave out the question of silver-soldering), and, once made, gives practically no trouble. The strength of a water-tube boiler when made out of solid drawn tube, properly silver-soldered or brazed, is far superior to any other type, and the cylindrical form remains practically undisturbed. The ends may be considered the weakest part, the bursting pressure, the shell of the boiler used in this model being approximately 1200 pounds per square inch. But with thick cast flanged ends, pinned and then silver-soldered, the factor of safety is still very large, after allowing for any weakening of the material due to the temperature

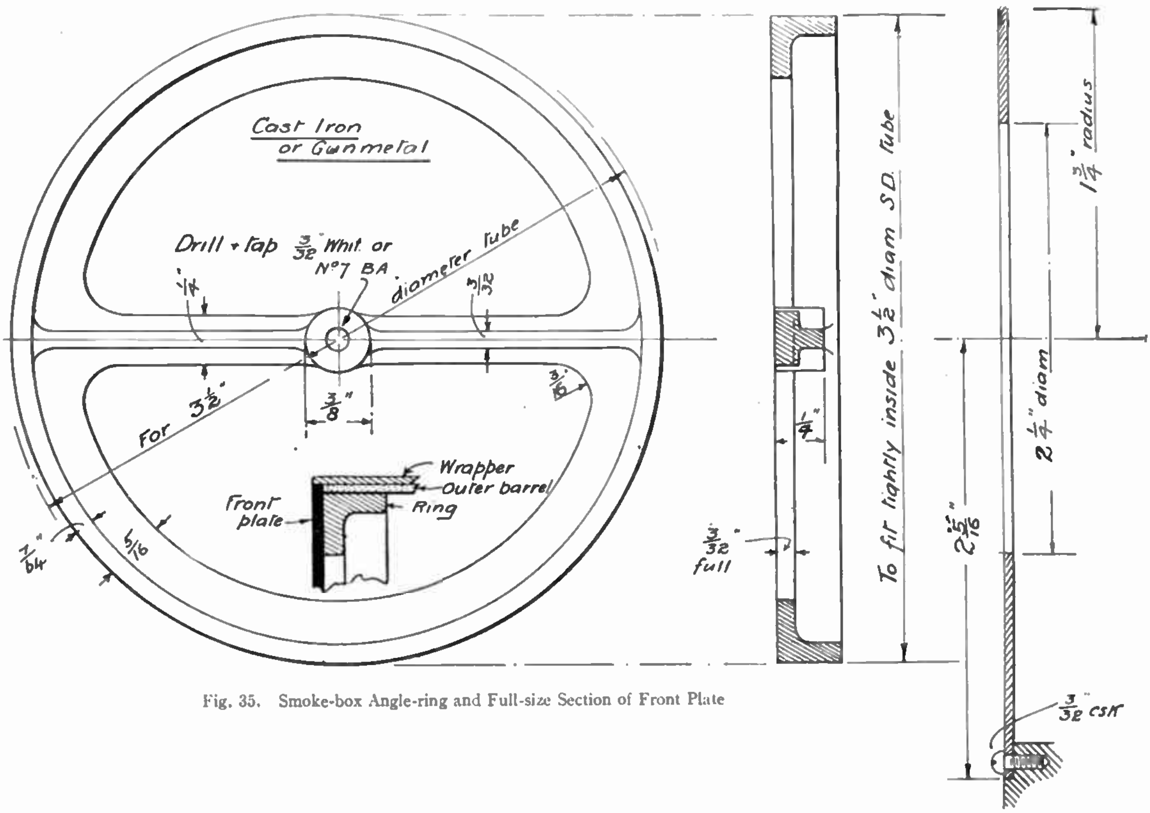


Fig. 35. Smoke-box Angle-ring and Full-size Section of Front Plate

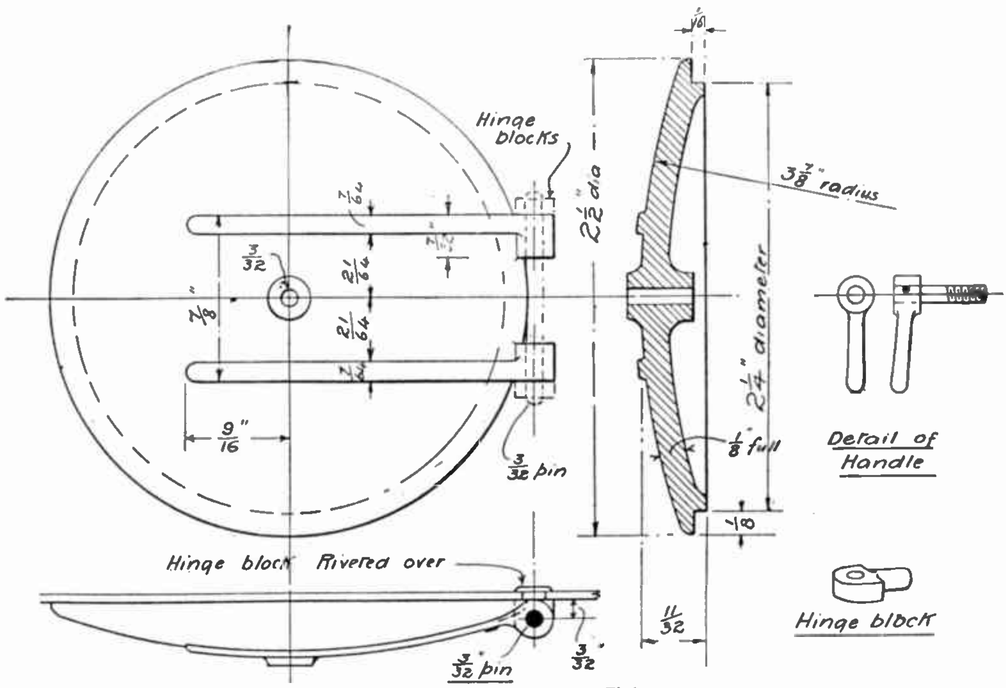


Fig. 38. Smoke-box Door and Fittings

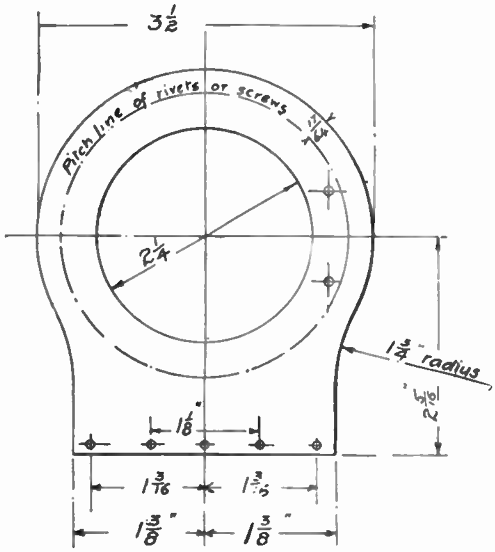


Fig. 36. Smoke-box Front Plate (HALF FULL SIZE)

of the metal when the boiler is steaming, and for the holes made in the shell for fittings and water tubes.

For the complete boiler the raw materials required, not reckoning castings and steel plate, include: —

10 inches of solid drawn (seamless) copper tube, 2½ inches diameter outside, and not more than 1-16th inch thick, for the inner barrel.

13 inches of common brass tube, 3½ inches diameter outside, $\frac{1}{16}$ inch thick for the outer shell.

5 feet of ¼ inch outside diameter solid drawn copper tube (light) for water tubes and blast pipe.

2 feet of 5-16ths inch outside diameter solid drawn copper tube for the superheater.

2 feet of 3-16ths inch outside diameter solid drawn copper tube for steam connections. If a pump is intended, then sufficient tube (say another foot) may be obtained for the connection to the check-valve.

Before describing the construction of the inner barrel, the fittings, which involve pattern making, may as well be commented upon, more especially as the writer understands that the firms who are supplying castings are anxious to finish the complete set. Therefore drawings will be found herewith of the smoke-box fittings, chimney, and safety-valve casing, besides the working parts which accompany these fittings.

The smoke-box is of the ordinary pattern, with straight sides, and fits directly on the top of the cylinders without the intervention of a saddle casting. Instead of making this out of the piece of tube used for the outer shell, by sawing the tube transversely and then splitting it longitudinally for a depth

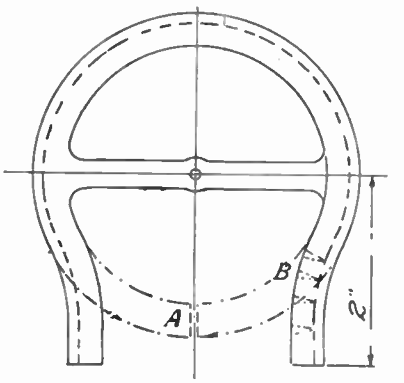


Fig. 37. Sketch of Smoke-box Angle-ring altered for Plain Smoke-box

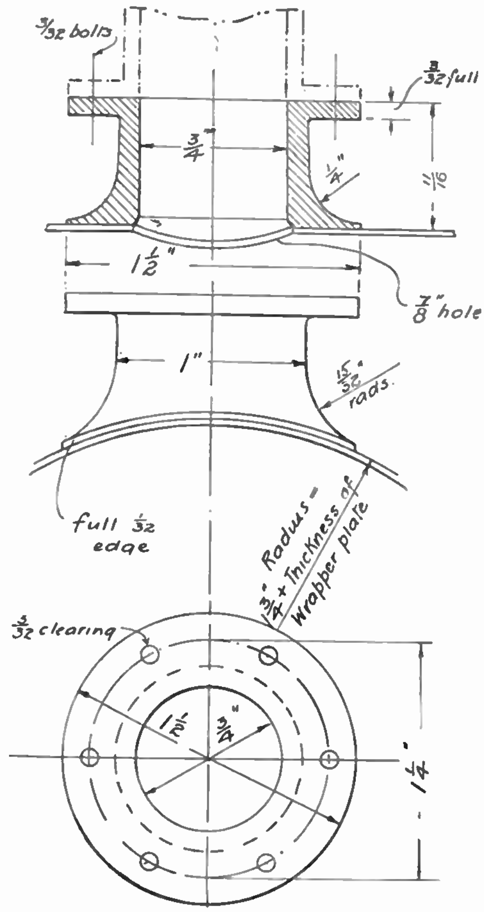


Fig. 39. Chimney Base

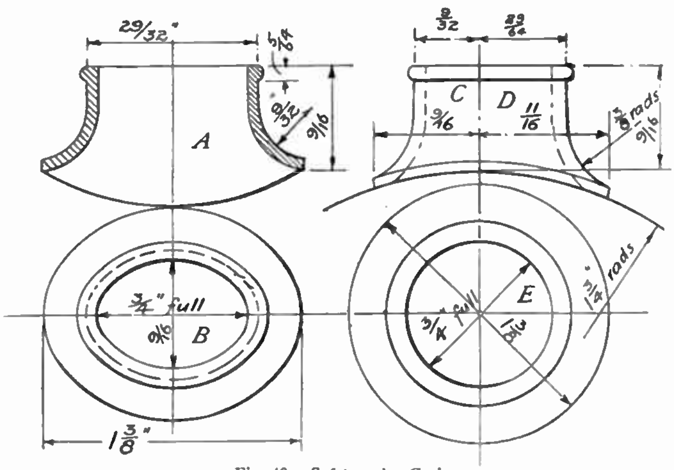


Fig. 40. Safety-valve Casing

to dispense with the extra wrapper plate, a common brass casting may be obtained, and after turning and facing the angle, the bottom portion may be sawn through (on the vertical center line, as indicated at Fig. A), and the angle bent to the shape of the wrapper, as shown. Should any difficulty arise in the bending of the ring to the profile, saw cuts (B) may be made in the front flange to facilitate the operation of shaping the angle to the wrapper plate.

equal to the length of the smoke-box, spreading the sides out to fit the cylinders, the outer tube of the boiler retains its circular shape right to the smoke-box front plate. A wrapper plate made of planished steel is then folded round the tube, as shown on the general arrangement drawings. This method of making the smoke-box, in addition to the better appearance provided by the raised wrapper plate and the excellent finish afforded by the planished steel itself, has the advantage of preventing any water (condensed steam and other drippings) which may fall from the blast pipe from lying in the top of the cylinders and absorbing heat from the steam contained therein. Then again the cast angle-ring, which is used to attach the planished steel front plate, provides a very good method of fitting. The ring can be turned the correct size to fit the boiler tube, the front plate fitting inside the smoke-box wrapper plate in such a way that the job looks clean and nice, and an air-tight smoke-box obtained. At the same time, also, the front may be readily removable by taking out the four rounded screws at the bottom (those which screw into the flange of the cylinder casting) and, say, a couple of small screws at the top of the smoke-box (one either side of the chimney flange).

The angle-ring may be of cast iron — gunmetal, which was originally intended, having risen so high in price lately that if used too lavishly, soon runs up the cost of a model to a prohibitive figure. Therefore, cast iron, which can be now obtained in very soft qualities, is recommended in the present case, as it can be turned quite as easily as brass. Should, however, any reader wish

When the writer prepared the general arrangement drawing, he intended to make the cross-bar separate from the angle-ring, but, especially where an iron casting is used, there is no reason why it

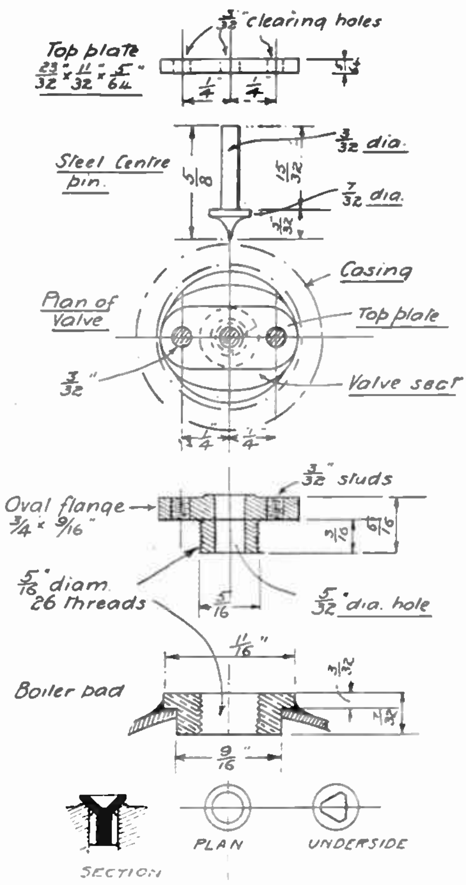


Fig. 41. Details of Safety-valve

should not be made solid with the ring, as shown in Fig. 35. This method will, of course, save the trouble of fitting a separate cross plate, and the smoke-box front, being so easily removed, no difficulty should arise in getting at the pipes and unions.

The wrapper plate should be 1 13-16th inch wide, and when it is flat, it will measure approximately 10½ inches long. The thickness of this plate should be about 1-20th inch (say No. 18 I. S. W. G.), and to secure it in place it should be attached to the boiler tube with a row of small rivets or small round-headed screws, just at the point where the wrapper leaves the circular boiler shell. The wrapper should extend over the boiler barrel to an amount *almost equal* to the thickness of the smoke-box front plate.

In the general arrangement drawing, a plain turned smoke-box door, without hinges, fitting only with center screw, was intended. As many builders like accuracy in such details, the writer shows in the detail drawings herewith a more complete door with hinges cast on and hinge strips. The door may preferably be cast in soft iron, so that when the hinge strips are polished the effect of steel used for these fitments in actual practice is obtained. The hinge blocks on the front plate may be filed out of the solid, and when drilled, may be riveted on. The holes for the hinge-pin should be made slightly smaller than the correct size at the outset, and be afterwards broached out with an "English broach" when fixed in place.

The chimney may be in brass or cast iron. The top flange should be at least 7-64ths inch (finished) if iron is used, and the pattern should allow for this. The top flange should be drilled for six (or eight) 3-32ds inch bolts, which will be used to attach the flanged extension piece to the chimney, shown in chain dotted lines in the drawings.

The safety-valve casing was originally intended to be oval in plan (as at B, Fig. 40), but the maker who is building the model for the writer has anticipated matters, and working from the general arrangement drawing, has made the safety-valve casing quite circular. This, however, is not a matter of great importance, as the circular shape renders it possible to finish the casing in the lathe, whereas the oval would necessitate handwork entirely. In Fig. 40, A is a longitudinal section of the casing (oval or circular), B and E are plans of the two

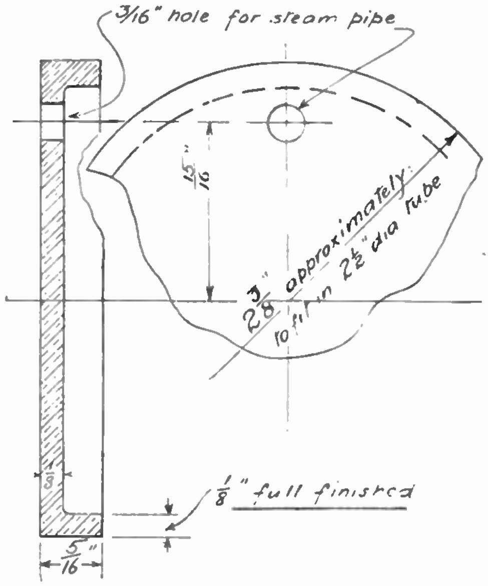
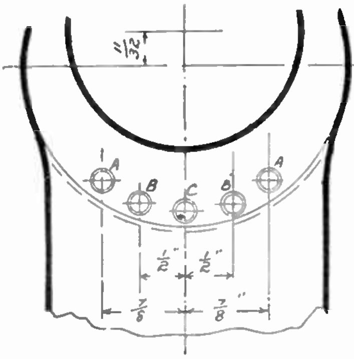


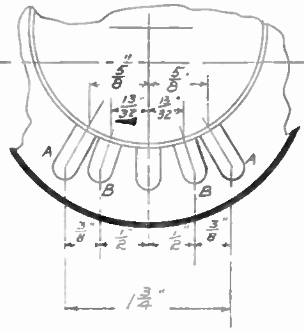
Fig. 42. Flanged End for Inner Boiler Tube

types of casings, and C and D are respectively half end-views of the oval and circular pattern casings. The safety-valve is of the well-known pillar type, direct spring loaded, full details except the spiral being shown in the accompanying drawing, Fig. 41.

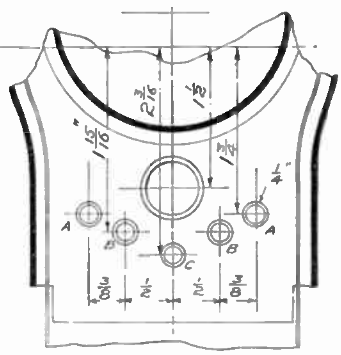
The center spring which holds the spring and communicates the pressure to the valve is best made out of the solid, and if a running down cutter is not available, one should be made for the job, as it is certain to prove useful, sooner or later, for making screws, bolts, and similar articles. This "steel center pin" may, to employ an Irishism, be made of German silver if the builder thinks it desirable to eliminate corrosive materials. This also applies to the studs, which, by the way, should be made 3-32d inch diameter and 13-16ths inch long. The spring may be of hard brass or German silver, although a steel spring will generally last a considerable time and has more "life." The spring should be 3-16ths inch outside diameter, and ⅜ inch long unloaded, the diameter of the wire being 21-inch or 22-inch gauge. The flange of the piece forming the valve seating may be oval, especially where an oval casing is used, and should screw into the boiler pad, which, by the way, must be silver-soldered to the barrel, so that the inner barrel may be put into place. The flange should be drilled and tapped for the pillar studs, and when finally



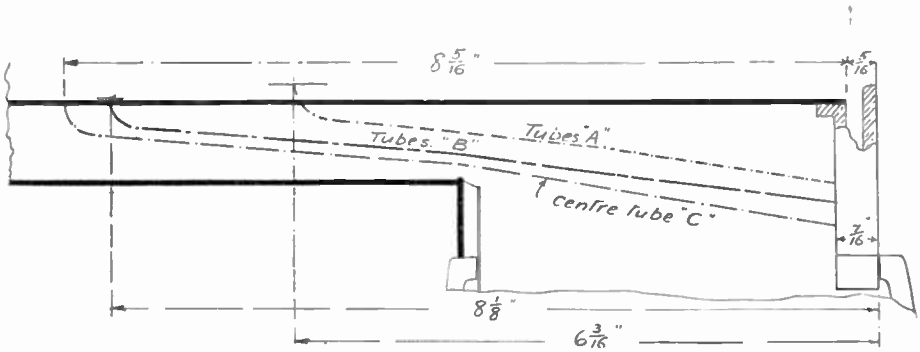
Cross-section at Throat-plate



Cross-section at Front of Boiler



Cross-section at Downcomer



Longitudinal Section, showing Inclination and Bending of Water-tubes
Fig. 43. Setting-out of Water-tubes

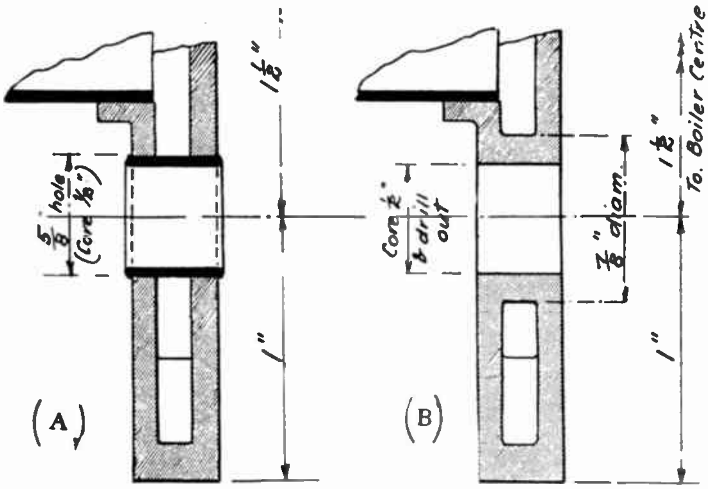
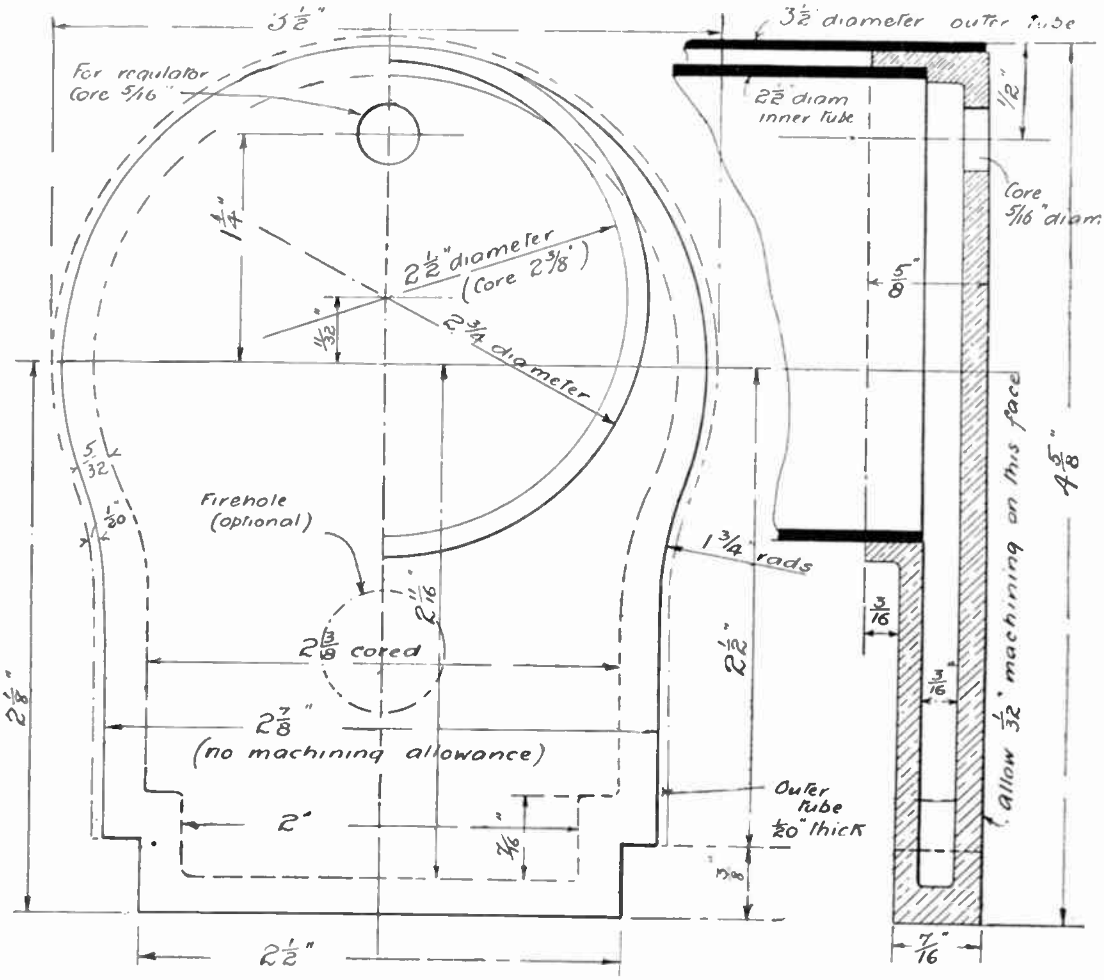


Fig. 45. Alternative Arrangements of Fire-hole in Downcomer



Half Elevation of Outer Face

Half Elevation of Inner Face

Section with Inner and Outer Barrels Fixed

Fig. 44. IMPROVED DOWNCOMER AND BACK PLATE

fitted, these studs may be soldered in and any projections on the under side filed away, so that a steam-tight joint may be obtained with the boiler pad.

To ensure ready action in opening and closing, the valve should be made as shown in the sectional sketch, with a deep sinking in the top. A knife-edge seat, as described in a recent issue of the *Model Engineer*, and used in many commercial fittings, may be employed in place of the conical seating shown. However, in either case the *point of contact with center spring pin must be below the level of the valve seating*. The top plate may be of brass, the adjustment nuts being of the same material.

The inner barrel, as already mentioned, should be made from 10 inches of solid drawn copper tube. The thickness of the tube should not be more than necessary for the working pressure. Reckoning 100 pounds as the working pressure and a factor of safety of 10, which is amply sufficient to cover all contingencies, the plate thickness should be:—

$$PT = \frac{D \times WP \times F}{S \times 2}$$

Where PT = plate thickness.
WP = working pressure.
F = factor of safety.
S = strength of copper plate (say 25,000 pounds per square inch).

There is no riveting allowance to make, therefore the "R," which is usually employed in this formula, is eliminated.

Therefore:—

$$PT = \frac{2\frac{1}{2} \times 100 \times 10}{25,000 \times 2} = \frac{1}{20} \text{ in.}$$

and the recommendation that tube should not be more than 1-16th inch thick is well within safe limits. If the tube is too thick the boiler will not steam quite so freely, and also it will be needlessly heavy. With mistaken ideas of the strength required, the writer has seen even ⅛-inch tube used for such a boiler as the one at present being dealt with; but this sort of thing is sheer waste of good copper.

The tube should be trued up on a wooden mandrel, and the inside of one end and the outside of the other cleaned for silver-soldering. The positions of the tubes should also be marked, as shown in Fig. 43, and the center lines also drawn in for the safety-valve. The front end of the inner boiler should be a sound brass casting, and if there is any tendency in the casting to be porous, it should be hammered before turning the flange to fit inside the boiler. The thickness of the casting should not be more than ⅛ inch all over when finished. For those who intend to do their own pattern making, Fig. 42 gives the proportions of this particular portion, and shows the position of the main steam-pipe.

The downcomer is of the improved pattern, which does away with the separate end used in the earlier forms of this type of boiler, and is a standard size for model locomotives with 3½-inch and 2½-inch tubes. The outer face of the downcomer casting should be cleaned up on the lathe, and when this is done it may be reversed and fixed on the face plate eccentrically, and bored to take the 2½-inch tube.

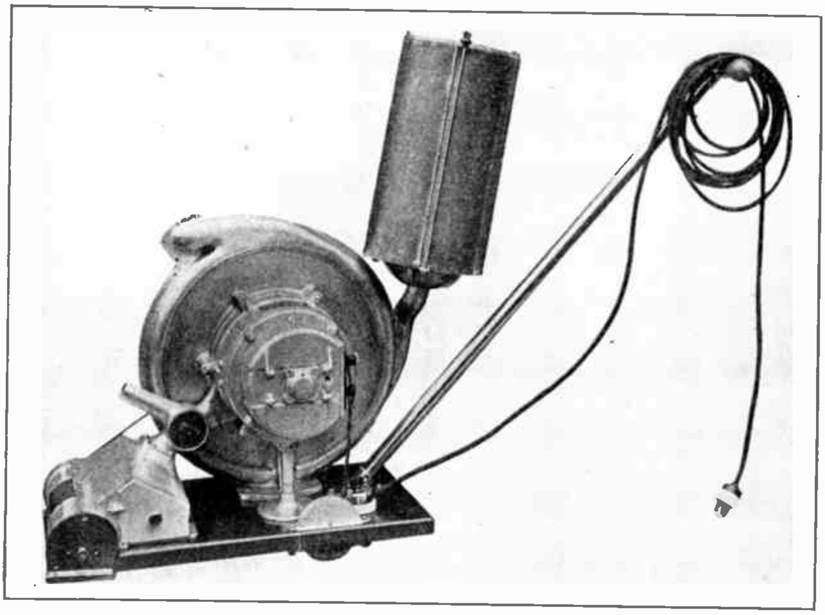
Where a standard casting is obtained, no provision will be found for the fire-hole (see opening marked "air tube" in the general arrangement drawing). If this is desired, then the downcomer should have a ¾-inch hole drilled in it as shown. Where new patterns are to be prepared this hole may be cored right through, not as at A, Fig. 45, but as at B. This will help the molder to provide a better casting, as the writer understands this particular design of downcomer is a little troublesome in the foundry. The long, thin core, unsupported at the end, causes a considerable number of "wasters" to be produced, and although the second method of arranging the fire-hole (Fig. 45, B) is all right as far as it goes — it saves the subsequent fitting of the piece of tube — it weakens, rather than strengthens the core. The writer, therefore, suggests the method A as the better of the two. When the flange for the 2½-inch tube is being bored, the portion of the downcomer from which the water tubes start may also be cleaned up. Of course, this is not so essential, as in the case of the outer face, to which the boiler fittings have to be affixed, but while the casting is on the face plate it may as well be done.

In the matter of silver-soldering the front end downcomer, the pad for the safety-valve, and the water tubes, little can be said which will be of very great value to the builders of the model. It is here that skill and experience tells. However, it is important that the work should be clean. The downcomer and flanged end should be service-riveted on to the shell, or screwed with two or three brass pins or screws round its diameter to prevent the movement of the parts. The work should be built round with asbestos or broken fire-bricks to retain the heat, and the heaviest parts should receive the greatest attention of flame so that the work is thereby evenly heated throughout. Furthermore, the "slicker" the work is done, the better. Several bites at the cherry will tend to produce a rough, dirty job. Borax should be used as flux, and the silver solder may be held in a pair of tweezers or an old pin vice and applied to the joint when the work reaches the proper temperature. To clean off the borax, dip the work in a pickle of diluted sulphuric acid (about 1 to 20) when the boiler is nearly cold. — *The Model Engineer.*

A LAMP which has burned eight hundred hours and not reduced much in candle power nor increased much in power requirements, has done well enough and is usually at the point where it would be economical to replace it with a new one, even though it will still burn. Though this policy is expensive, it would be more expensive in most cases to burn the old lamps, as the cost of the excess power consumed and the inferior quality of light because of reduced candle power would more than offset the cost of new lamps. This argument does not apply so forcibly where tenants are paying for their light by meter according to the amount of current consumed, but where it is being supplied at a flat rate or included in the rent, it is well worth looking into. There is no sure way of telling just when a lamp has reach the limit of its usefulness except by test. — *American Inventor.*

ELECTRIC HOUSE-CLEANING APPARATUS

FRANK C. PERKINS



THE accompanying illustration shows a most interesting and novel electric apparatus for labor saving in housework. The home is cleaned by electric power, paper, matches, and coarse material being picked up from the carpet without having to resort to broom and dust-pan, the cleaning being thoroughly done by a single passing of the machine over the rug.

It is as easily moved as a carpet sweeper, and it becomes an electric household necessity, its uses are so many. For instance, by means of this electric renovator, with its several attachments, one is not only enabled to clean the floor covering, but the cushions, mattresses, lounges, and all of the crevices, corners, and close places from floor to ceiling.

By means of one attachment, the walls, ceiling, ornaments, and decorations are cleaned to perfection without danger of damage, and by using this apparatus the lace curtains and other hangings do not gather the dust as in ordinary sweeping, and these delicate fabrics may be cleaned by another electric attachment at any time, making them look fresh as new without any labor to speak of.

The apparatus consists of a small electric motor for driving the renovator, a brush revolving with great rapidity, and adjusted to suit the carpet or material cleaned. A double fan is also provided, which draws the dust into the renovator, a great volume of air being produced, but no dirt can escape from the machine. All of the dust is discharged into the separator, which is easily removed and the dirt and dust burned or otherwise disposed of.

No long line of hose is required, a simple flexible cord being connected to any electrolier, lamp socket, or chandelier in any part of the house. It is maintained that not only the mattresses but the bedding can be easily cleaned by the electric labor-saving device.

It is now no longer necessary for outside help to be called in with great heavy machinery connected with hose from the street, but by this electric device the same cleaning can be accomplished by the housewife or maid with little effort and the same effectiveness.

IN Montana there is practically no merchantable native hard wood, unless cottonwood and poplar be so classed. Such as is used comes from the South or East, and is sold by the pound, a practice which would seem to discourage thorough drying.

ICELAND will have a system of land telegraphy this fall.

A SMALL SINGLE-PHASE INDUCTION MOTOR

C. H. BELL (CANADA)

THE following notes on a small single-phase induction motor, without auxiliary phase, which the writer has just completed, may be of interest to some of our readers, says the *Model Engineer*. The problem to be solved was the construction of a motor large enough to drive a sewing machine or very light lathe, to be supplied with 110-volt alternating current from lighting circuit, and to consume, if possible, no more current than a 16 c. p. lamp. In designing, it had to be borne in mind that, with the exception of insulated wire, no special materials could be obtained.

The principle of an induction motor is quite different from that of a commutator motor. The winding of the armature, or "rotor," has no connection with the outside circuit, but current is induced in it by the action of the alternating current supplied to the winding of the field-magnet, or "stator." Neither commutator nor slip rings, therefore, are required, and all sparking is avoided. Unfortunately, this little machine is not self-starting, but a light pull on the belt just as current is turned on is all that is needed and the motor rapidly gathers speed provided no load is put on until it is in step with the alternations of the supply. It then runs at constant speed whether given much or little current, but stops if overloaded for more than a few seconds. As the pulleys on the machinery to be driven, in the writer's case, have V grooves, a loose pulley is not admissible and recourse must be had to a jockey pulley to tighten the belt after the motor has run up to speed.

The stator has four poles and is built up of pieces of the sheet iron used in this country for stove pipes, running about 35 to the inch (see Fig. 1). All the pieces are alike, and each layer of four is placed with the pointed ends alternately to the right and left so as to break joint (see Fig. 2). The laminations were carefully built up on a stout board into which heavy wires had been driven to keep them in place until all were in position and the whole could be clamped down. Holes were then drilled and the bolts put in and tightened up, large holes being cut through the wood to enable this to be done. The armature tunnel was then carefully filed out and all taken apart again so that the rough edges could be scraped off and the laminations given a thin coat of shellac varnish on one side. After assembling a second time, the bolts were coated with shellac and put into place for good. The rivets at the corners were also varnished before being closed.

This peculiar construction was adopted because proper stampings were not available, and as every bit of sheet iron had to be cut with a small pair of "tinman's snips," it was important to have a very simple outline for the pieces. They are not particularly accurate as it is, and when some of them got out of their proper order while being varnished, an awkward "jog" occurred in the magnet which was never entirely corrected. No doubt, too, some energy, is lost through the large number of joints, all representing breaks in the magnetic circuit, but as the laminations are tightly held together and the circuit is about as compact as it could possibly be, probably the loss is not as great as would appear at first sight.

The rotor is made of laminations cut from sheet iron (Fig. 3), which were varnished lightly on one side and clamped on the shaft between two nuts in the usual way. A very light cut was taken in the lathe afterwards to true the circumference. The shaft was turned from ½-inch wrought iron, no steel being obtainable (see Fig. 4). The bearings were cast of Babbitt metal in a wooden mold and bored to size with a twist drill in the lathe (see Fig. 5). They are fitted with ordinary wick lubricators. Figures 6 and 7 are sections showing general arrangement of the machine.

The stator is wound full with No. 22 D.C.C., about 2½ pounds being used, and the connections are such as to produce alternate poles — that is, the end of the first coil is joined to the end of the second, the beginning of the second to the beginning of the third, and the end of the third to the end of the fourth, while the beginnings of the first and fourth coils connect with the supply.

The rotor is wound with No. 24 D. C. C., each limb being filled with about 200 turns, and all wound in the same direction. The four commencing ends are connected together on one side of the rotor, and the four finishing ends are soldered together on the other. All winding spaces were carefully covered with two layers of cambric soaked in shellac, and as each layer of wire was wound it was well saturated with varnish before the next was put on.

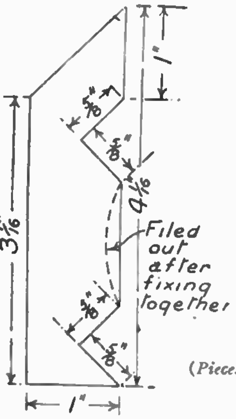


Fig. 1. Showing Construction of Stator

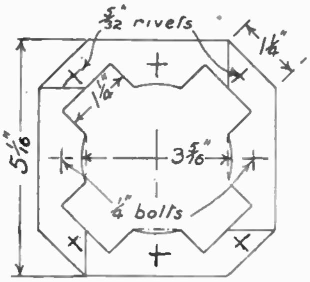


FIG. 2.

(*Pieces in Next Layer to Point in Opposite Direction*)

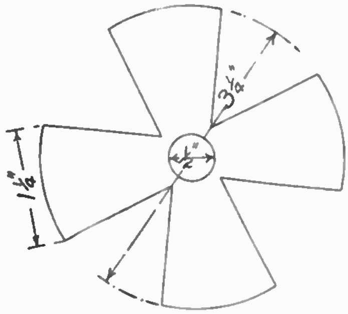


Fig. 3. Laminations, half size

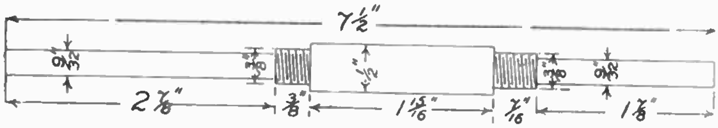


FIG. 4.—SPINDLE. (*Half size.*)

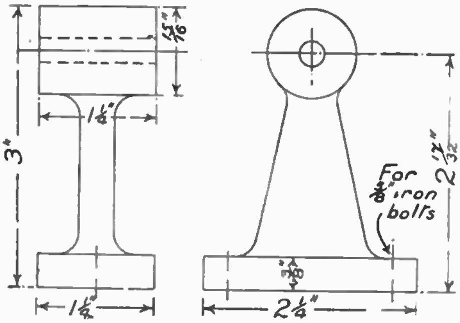


Fig. 5. Bearings, half size

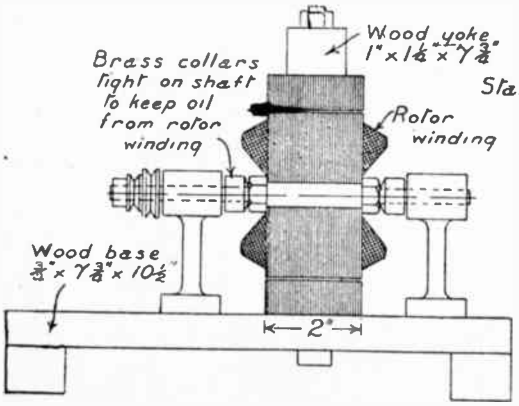


Fig. 6. Longitudinal Section

(Scale ½ full size)

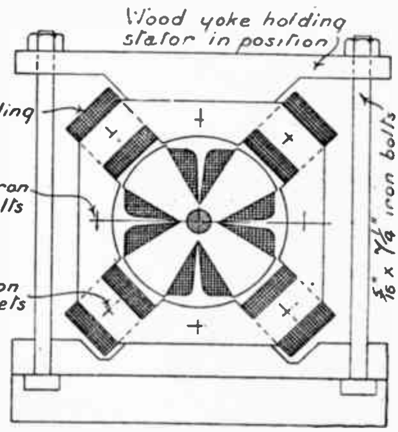


Fig. 7. Cross-section through Center of Stator

This type of motor has drawbacks, as before stated, but if regular stampings were obtained for the laminations it would be very simple to build, having no commutator or brushes, and would not easily get out of order. No starting resistance is needed, and as the motor runs at constant speed, depending on the number of alternations per second of the supply, a regulating resistance is unnecessary. Experience, however, suggests the following modifications in the design. The bed ought to be of metal, as wood is liable to shrink and warp; the bearings should be of the self-oiling type, as those now used throw the oil about a good deal; and eight bolts through the stator would keep it in shape better than the four shown in the drawings, as the thin laminations tend to spring outwards at the ends when tightly clamped in the middle.

As a meter is not at hand, the consumption of current cannot be stated, but the machine runs from an ordinary lamp socket and does not blow the fuses with which the 16 c. p. lamps are fitted, so it must take less than 1 ampere. The coils become only comfortably warm to the hand while running.

Probably by enlarging the spaces for windings in the stator and adding auxiliary coils, with a choking coil in series fixed to the base, the motor could be made self-starting, but with so small a machine this complication would hardly be worth the trouble of going about.

THREE-PHASE TO TWO-PHASE TRANSFORMATION WITH SPECIAL REFERENCE TO CORE TYPE TRANSFORMERS

W. J. WOOLDRIDGE

ATTEMPTS have at times been made to operate regular single-phase core-type transformers on three-phase primary two-phase secondary circuits, and as these attempts are often not successful, it seems advisable to point out as briefly as possible the reasons for such failures, with the hope that a clearer understanding of the conditions in the windings may prevent the trouble, sure to result from wrong practice in this particular.

In the transformation of power by means of the T connection there arise certain peculiar current and voltage relations which at first sight are liable to escape ordinary observation, but if disregarded are sure to result in serious unbalancing. The relation between the currents on the two sides of the primary winding of the main transformer make it absolutely necessary, if this distortion is to be avoided, to "balance" each half of the winding on the legs.

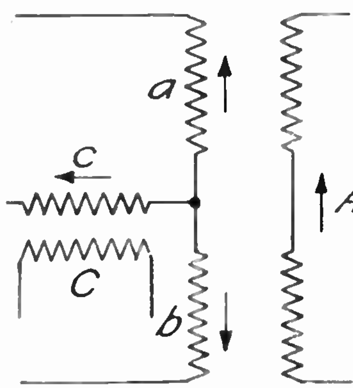
In the accompanying figure, a, b, A, are the primary and secondary of the main transformer in the T connection, and c, C, corresponding coils of the teazer transformer. Considering current I_s amperes drawn from the secondary A of the main transformer, an equivalent current must then flow through the primary a, b. With current I_s taken from the secondary C of the teazer transformer, the equivalent primary current must be

$$\frac{2}{\sqrt{3}} I_s$$

which is 90° out of phase with the current in the main transformer. This teazer current divides into two parts; one half,

$$\frac{I}{\sqrt{3}}$$

flowing in main b, and the other half in main a. Since this current flows in opposite directions in the two halves, and, as above stated,



is 90° out of phase with the main current, it lags 90° behind the main current in one coil and leads by 90° in the other.

These extra currents have no equivalent secondary current in the main coil, since they are equal and flow in opposite directions in a and b, and therefore neutralize each other as far as magnetizing effect is concerned.

Hence the coils a and b may be considered, with relation to the teazer current which flows in them, as a single-phase transformer, one coil being the primary and the other coil the secondary.

In any core-type single-phase transformer, the secondary is never wound all on one leg and the primary all on the other leg, because such an arrangement would introduce a large leakage flux, the effect of which is to increase the reactance of the transformer. The primary and secondary coils are always placed as near together as good insulation permits, in order to reduce to a minimum the flux which does not link both coils.

If these same precautions are not taken in connection with the main coil of the T transformer, a large reactance drop will result. This reactance drop is 90° ahead of the teazer current, and since the teazer current in the main coils lags 90° behind the main current in one core, and is 90° ahead of the main current in the other core, with a non-inductive load the reactance drop in one coil is in phase with the electromotive force across the coil, and opposite in phase to the electromotive force across the other coil. Therefore the reactance drop increases the voltage across one side and decreases it across the other side of the main coil.

The necessity of reducing the reactance between the two sides, by balancing each side of the main coil on each leg, to prevent this distortion, is easily understood with the above facts in mind.—*General Electric Review.*

DRILLING SQUARE HOLES

"SREGOR"

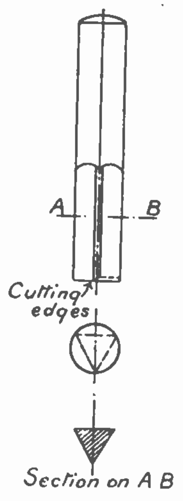


FIG. 1.

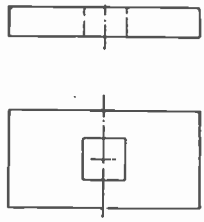


FIG. 2.

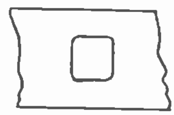


FIG. 5.

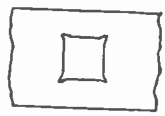


FIG. 4.

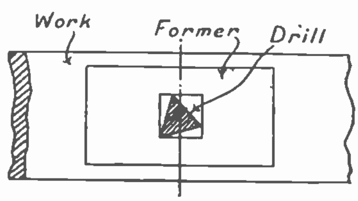


FIG. 3.

To drill a square hole with an ordinary drilling machine will at first appear an impossible task, but it can be accomplished with a very simple arrangement consisting of a special form of drill, shown in Fig. 1, and a guide, or former, shown in Fig. 2.

The drill is made from a piece of round steel and filed to the triangular shape, as shown by the section, Fig. 1. The size of the triangle is, of course, decided by the required size of the square hole to be made. That is, the sides of the triangle must equal the length of the side of the square holes, as shown in Fig. 3, which is a plan of the former and tool in position, with the work to be operated upon under the former.

The former is made from a piece of flat steel of convenient size, and hardened, and secured in position on the piece of work to be operated upon by any convenient method. To ensure a good result the sides of the former must be filed out to a perfectly square corner; better still if the corners are filed in slightly, as shown in Fig. 4 exaggerated. A little practice will soon show the necessary amount to produce the best result. When the sides of the tool are shorter than the sides of the former a radius is left in the corners of the work, as shown in Fig. 5. This is convenient on some classes of work, such as a box wrench, when the radius left in will considerably strengthen the tool. To assist the work of the special tool, Fig. 1, an ordinary drill can be put through the work so as to remove the bulk of the metal, leaving only the square outline for the special tool to machine.

The action of this drill will more clearly be understood if the reader will shape a piece of metal or wood the shape of drill and insert this into a square hole cut in a piece of cardboard (or other suitable material), and then revolve the piece which represents the drill; and it will be observed that as this revolves, the three edges of the tool follow the square outline of the cardboard. At the same time the cardboard itself moves, and thus allows the edges of the tool to follow the square outline of the former. As mentioned above, the former is secured to the piece of work to be operated upon, and the cutting, or lower edge of tool removes the metal, and the square hole is attained. The length of the triangular portion of the drill is determined by the depth of the hole required. The edges must be parallel, as shown in Fig. 1, otherwise the tendency of the drill would be to produce a hole of varying sizes as it cuts its way through the metal. For producing small holes, say up to ½ inch square, the fixed drill which revolves on its axis, and the former and work moving, is successful providing the piece of work is not too heavy; but when it is, obviously it is best to provide the drill holder with a floating head, which allows the drill to conform to the outline of the former. — *The Model Engineer.*

EARLY HISTORY OF ELECTRICITY

THE history of electricity reads more like a romance than science. The name goes back twenty-five centuries and is derived from the Greek word "electron," meaning amber. This amber was brought by voyagers from the north Baltic shores and was prized for its color and luster. Thales, one of the oldest of the Greek philosophers, one day discovered that this amber, when rubbed, exhibited the property of attracting light bodies. This was the first known discovery of electricity; but Thales could not explain it, except by ascribing to this yellow jewel a soul. He supposed it contained the hidden principle of life.

Rome fell heir to Greek learning, and we find Pliny the elder writing of this mysterious property of amber. He concludes that this animated stone was rubbed into life by his fingers. The Romans, however, with all their arts and learning, never got any farther than this. They could not associate this inexplicable phenomenon with the lightning in the sky, nor did they know that the secret of the rubbed amber was that of Jove's thunderbolt. This same energy showed itself as strange lights, flashing along the metal helmets and spears of the Roman legions marching at night, and the great Cæsar records the terror and awe that it brought to him. The ancient mind did not have a strong scientific bent. Nature was little comprehended and her manifestations were held as attributes of the gods and only brought terror to these children in science.

Roman civilization passed away and the Dark Ages succeeded, but this knowledge that Thales had given to the world was not lost. The seventeenth century saw science struggling into life. Gilbert, an Englishman, studied the properties of electron and the magnet, and his book, "De Magnete," was the beginning of a new science of electricity. The facts that Gilbert announced did not far exceed what Thales had known, but they were followed up by the scientific spirit of the new age. Soon Guericke, a Prussian, invented the electrical machine, which consisted of a cylinder of sulphur on an axle, and as this turned, a cloth was held to it, which produced friction and generated electricity. Now experiments began in earnest. Many properties of this mysterious force were discovered; the weather was found to affect it; dampness dissipated it; it developed strange tricks, attracting and then repelling light bodies. The century passed away, however, and not even the mind of a Newton had penetrated the secret of this new, intangible force.

In the next century the scientists were again working at the problem and discoveries soon followed which filled the Europeans with astonishment. The glass electrical machine was invented, and in France Du Faye transmitted a spark through a cord thirteen hundred feet long. In conjunction with Abbe Nolet, Du Faye suspended himself by a silken cord and was then charged with electricity. When he was approached by his fellow-worker a long spark passed between them, to their extreme surprise and consternation. Shortly after, Musschenbrock, in trying to store the electric current, unknowingly invented the Leyden jar and received a shock which so impressed him that he declared the whole kingdom of France could not induce him to take another.

The Leyden jar was now investigated by all experimenters, and it brought alarm and terror to all who felt its power. Even Louis XV, at Versailles, was induced to hold audience with this scientific instrument and receive its potent message, which alarmed and mystified him greatly.

Electricity at this period owed its greatest advancement to our own Franklin. With his imported electrical machine he began a series of experiments which proclaimed him the greatest scientist of the age. He constructed a battery of Leyden jars whose terrific shock killed animals and was not unlike the thunderbolt itself. From this clew, probably, Franklin announced the identity of the electricity in the bottle with the electricity in the sky, and showed how pointed iron, by attracting it, might serve as a protection against lightning. His theories were at first received with ridicule by European scientists. Franklin then determined to prove his assertions and the story of the kite is familiar to all. His experiments were repeated in Europe, and this provincial philosopher, this Thales of the New World, was honored as the greatest scientist of his age.

Up to this time static electricity alone was known. It was generated by friction, which is very different from our induction machine of to-day, with its numerous plates and powerful discharges. We now come to a discovery of a new kind of electricity, which was very different in its manifestations from the electricity which Franklin drew from the clouds or generated with his sulphur cylinder. Galvani, professor of anatomy at Bologna, in 1790, was experimenting with an electrical machine. As it happened there were lying on the table, near the machine, some frog legs ordered by a physician for Galvani's sick wife. By chance a spark jumped to one of the frog legs and Galvani noted with surprise that it contracted and showed the appearance of life. He followed up the experiment, with the thought that he was about to discover the hidden principle of life. By another accident he found that the frog legs would contract when in contact with two different metals, and he thought that the electrical action was generated by the muscles and nerves. It remained for Volta to show that Galvani had created a cell with his two metals. So Volta constructed his "voltaic pile," composed of alternate sheets of zinc and copper separated by a cloth moistened with an acetic solution.

The scientific thought of that time now centered upon the voltaic pile, as it had upon the frictional electrical machine of the previous decade. The body was thought to be a voltaic pile, and life a manifestation of electrical energy. Personality and human power were spoken of in electrical terms and for a time became the cult of the scientific world. Powerful apparatus was made and it was noted that there was not produced the sharp spark of the friction machine, but a silent, continuous current whose power was not less alarming. When its poles were grasped it seemed to develop the strength of a giant and shook the victim with terrifying convulsions. By its action water was decomposed and the diamond melted; chemistry was revolutionized and year by year there was added valuable knowledge to the arts and sciences. Following Galvani and Volta there appeared a coterie of brilliant men, and the names of Oersted, Ampère, Davy, and Wollaston became known throughout the world.

In 1820 Oersted discovered the relation between magnetism and electricity. By his experiment it was found that the galvanic current deflected the magnetic needle. After this principle we are able to measure the amperage and voltage of the constant current.

In 1831 Faraday discovered the principle of voltaic induction, which gave rise to the faradic, or alternating current. Then followed the dynamo, based upon this same principle, and electricity began to assume great commercial importance. The telegraph, the telephone, electricity as a source of power, the arc and incandescent light, the electric motor cars, the X-ray and many important discoveries have followed. What the future of this unique energy is to be is difficult to predict; but the possibilities are unlimited. — *The Industrial Magazine.*

A VERY simple and efficient plate-washer can be made of two boards the width of the negatives. A ledge ¼ inch high is fastened along each side of both. One end of one is hung just below the tap and the water allowed to run down it in a gentle stream. The upper end of the second is placed just below the lower end of the first, so that the water which runs away from the sink as it descends the first runs back into the sink as it descends the second. The arrangement is like a V laid on its side with the point supported. The plates are laid along the board.

PHOTOGRAPHIC DEPARTMENT

This department is conducted for the benefit of our readers. If any reader has a photographic question, it will be answered here, and pictures will be criticized in this column. A monthly prize of $1 in cash or one year's subscription to ELECTRICIAN AND MECHANIC will be given for the best photograph submitted. The rules are as follows: Any reader may compete and send in as many prints as desired, mounted or unmounted, and made by any process except blue-prints. Prints must be received before the first day of the month to be considered for the number of the following month. Prints will not be returned unless sufficient stamps are enclosed when sent. Prints will be criticized if requested. We prefer prints of mechanical subjects. Prizes will be awarded for photographic excellence and interest of subject.

My Laboratory — Frank P. Rohrer

PRIZE PHOTOGRAPH

THE interest in our photographic department seems to be increasing, and we are glad to note that while many of our readers and subscribers are active electricians or mechanics, they are enjoying and using extensively their cameras as a pastime or hobby.

The prize picture this month is a flashlight, taken by Frank P. Rohrer, and was the maker's first attempt in this line of photographic art. Arthur J. Walton sends in an example of good work, and we give honorable mention to the same.

Many of our contributors, failing to receive a prize or honorable mention, need not feel discouraged. Perhaps the next time trying will bring the desired reward. There is nothing like keeping everlastingly at it to bring success in anything. This is especially so in photography.

Good results have been shown us by a beginner after only one week's work, with an outfit costing, complete, but $3.

Picture Criticism

G. C. W. — "Bashful." A print of a boy taken outdoors, in sunlight. Very good photographically. The portrait might be more interesting if the little fellow could be made to look up. Try him again, if possible, and be sure the background will be interesting.

A. D. B. — One of our contributors sends a little print of a dog with a pipe in its mouth. The dog is no doubt a pet, and well trained. The photographer speaks very enthusiastically of his pleasure in taking all kinds of photographs, and informs us that he has only a dollar Brownie camera, and has derived unlimited pleasure from it. Interest in photography would be increased if more would avail themselves of such an outfit. We hope to see other examples of this young man's work.

C. J. K. — "Around the Camp." This print is very good, considering the circum-

Companions Arthur J. Walton

stances of grouping and lighting. Possibly it would have been better had the exposure been longer. Print was taken with a No. 2 Flexo Eastman Kodak, and is a flash-light.

A. E. W. — "A Great Entertainer." A very good print, showing a large phonograph in the corner of a room. The wall paper, which has a flowery design, is perhaps too conspicuous, and the instrument, which is the subject in question, is less in evidence than it should be.

H. E. Y. — "The Diving Sea Lion" is a record photograph, and, considering the cost of the camera, is exceptionally well done. To stop rapid motion with an ordinary shutter is a difficult feat, but you have succeeded very well.

A. E. G. — Three prints are submitted for criticism. "The Five O'clock Train" is interesting as an instantaneous exposure, and, strangely, shows signs of over-exposure. Your other prints show correct exposure, but are not very interesting as subjects.

Photographing Machinery

A. EDWARD RHODES

It is generally conceded by photographers that one of the most difficult objects to make a satisfactory photograph of, is a piece of machinery. The reason for this is quite evident upon a little consideration, and lies in the fact that machinery almost always consists of parts which are unfinished, and painted a dark color, while other parts are brightly finished, and often polished, and therefore reflect nearly all the light which falls upon them. The result is, that when a negative is exposed long enough to bring out the dark parts of the machine distinctly, the exposure is too long for the finished parts; and if, on the other hand, the exposure is timed for the bright parts, the darker portions are usually represented by black patches which show absolutely nothing of form or construction.

I have made many experiments to overcome this difficulty, among others, that of using lamps with reflectors placed so as to illuminate the dark portions. This makes the machine look about right to the eye; but since no artificial light, except electric light, has any noticeable effect upon a photographic negative (under these conditions), the results were not satisfactory.

Somewhere I saw a plan which has never failed to give good results. It is as follows: Paint the machine all over, using for the finished parts a paint mixed with any oil which will not readily harden or dry out, so that after the exposure is made the paint may readily be wiped off. By this method all parts of the machine can be made to reflect light equally.

It is a good idea, also, to have several different shades of this paint, and after the first exposure, any parts which do not come out sufficiently may be painted lighter, while those which are too light may be painted darker, and thus, by a few experiments, a perfectly satisfactory negative may be obtained.

This is a matter of considerable importance to many manufacturers and mechanics, whether they take photographs to send to prospective customers or whether they are taken for engravers to work from. — *The Industrial Magazine.*

Measuring the Focus of a Lens

THE problem of measuring the focus of a lens is one for which there are innumerable solutions, but one of the simplest, which was devised by Grubb, is nothing like so well known as it deserves to be. It can be done, too, with very considerable accuracy, and with no calculation whatsoever. To carry it out, we take a table and place it preferably out of doors in such a position that a camera placed on it can be focused on some distant, distinct, and small object, such as a chimney or a distant spire. The surface of the table is covered with a smooth sheet of paper (a newspaper will do very well), and this paper should be fastened to the table with drawing pins, as neither table nor paper must be moved during the operation. On the ground glass of the camera two marks are made, about half an inch from the two vertical sides of the ground glass. Sharply focusing the distant object, the camera, placed flat on the table, is twisted round until its image comes exactly on one of the marks of the ground glass. Then holding the camera firmly, and using one side of its baseboard as a ruler, a line is drawn on the newspaper to show the position of that edge of the baseboard. The camera is then twisted until the image of the selected object comes exactly on the second mark. Then, holding the camera steady again, and using the same side of the baseboard as a guide, a second line is drawn. It is quite easy to arrange that these two lines shall meet at one end, giving us a V-shaped mark on the paper. We now have to find the position in this V where we can draw a cross-bar to it, so as to make it the shape of the letter A, the two ends of the cross-bar of the A falling on the two legs of the V equidistant from the point, and the cross-bar itself exactly the same length as the distance between the two marks of the ground glass. When we have done this, the distance from the center of the cross-bar to the point of the A is the focus of the lens. This may seem complicated if read over hurriedly, but any one who sits down to do it will be surprised at the ease and quickness with which it can be done. — *Photography.*

Lenses Stuck Fast

A FEW months ago we were using a particularly fine whole-plate anastigmat, of the type which allows one of its combinations to be employed by itself, and wished to use the back lens, but found it immovably fast in the mount. All the devices which have been recommended for dealing with such things were tried, but all were without avail, and after having taken the skin off our hands in futile efforts, it was given up in despair. At that very moment a friend appeared whose professional pursuits have rendered him an adept at extractions (generally of a painful kind). We entrusted the stubborn tool to him, and apparently without effort, he did what was required. The whole secret of unscrewing a thing of that sort which was stuck fast, he explained, was to press it in at the same time as the attempt to turn it was made. It seemed too simple to be true, but a few days ago we were with a photographer to whom precisely the same thing occurred. Taking the lens from him, we pressed as suggested, that is to say, the lens we were trying to unscrew was pressed towards the diaphragm, and then trying to turn it, it yielded at once. We should advise any one in a similar difficulty to deal with it in the same way. — *Photography.*

The Accuracy of the View Finder

No view finder can be always accurate, and a rough approximation to the view on the screen is all the photographer is likely to get in his finder. But this is not to suggest that there is any excuse for the finder not being as accurate as it can. The center of the subject on the plate, with objects more than five or six feet away, for example, should appear in the center of the view finder. If this is so, and if the finder includes at least as wide an angle as the camera itself, it is not hard to adjust the latter to give a reasonably accurate view of what is to be got on the plate.

Electrician and Mechanic

Incorporating
BUBIER'S POPULAR ELECTRICIAN
Established 1890
AMATEUR WORK
Established 1901

PUBLISHED MONTHLY BY
SAMPSON PUBLISHING CO.
BOSTON, MASS.

A. E. WATSON, M. O. SAMPSON, F. R. FRAPIE — *Editors*

SUBSCRIPTION, IN ADVANCE, $1.00 PER YEAR

In the United States and dependencies, and Mexico. In the Boston Postal District and Canada, $1.25. Other countries, $1.50.

Subscribers wishing to have their addresses changed must give both old and new addresses. Notice of change of address must reach us by the 15th of the month to affect the number for the month following.

SINGLE COPY, 10 CENTS

Advertising Rates on Application

Forms close on the 10th of the month preceding date of publication.

Contributions on any branch of electrical or mechanical science, especially practical working directions with drawings or photographs, solicited, and if accepted, paid for on publication. No manuscripts returned unless postage is enclosed.

All communications should be addressed

SAMPSON PUBLISHING COMPANY

6 Beacon Street, Boston, Mass.

ELECTRICIAN AND MECHANIC may be obtained from all newsdealers and branches of the American News Co.

CHICAGO REPRESENTATIVE — Gordon Boyd, Suite 309, 253 La Salle Street.

FOREIGN AGENTS — Arthur F. Bird, 22 Bedford Street, Strand, London.
The Argosy Co., Ltd., Georgetown, British Guiana.

Entered as Second-Class Matter July 13, 1906, at the Post Office at Boston, Mass., under the Act of Congress of March 3, 1879.

VOL. XVIII. MAY, 1908 NO. 11

EDITORIALS

IN our April issue we published a short paragraph, requesting our readers to send in suggestions as to the bettering of our magazine, and announced that we would give five subscriptions as prizes for the best letters or the most helpful suggestions. We have received a number of communications on this subject, but not as many as we desired, and therefore will hold this offer open for another month, doubling the number of prizes if a sufficient number of letters to justify it is received. From a study of the letters which have already come in, we have not been led to discover anything in our policy which appeals to many of our readers as a very weak point; in other words, what one man dislikes, several others like, and there is no point on which more than one or two readers seem to have the same idea. In a general way, each one of the readers who has sent us a letter has some particular interest which is uppermost in his mind and on which he would like to see more information, and we have received several suggestions which will be turned into helpful articles as soon as we are able to get satisfactory experts to write upon the subjects.

Some of these suggestions have been under advisement and some of them present new ideas to us, but all will receive consideration and will be met as soon as it is possible to do so. On many of the points, however, on which information is sought, the statement is made that nothing can be found in other magazines or in books on the subject. This should lead the inquirer to reflect that at the present day when no satisfactory information on a subject can be found in print, it is going to be rather difficult for any magazine to give satisfactory articles on the subject. In some cases the state of the art is such that no definite information can be had. In wireless telephony, for instance, the whole subject is in an evolutionary state and those who are working at the subject are breaking new ground. Under these circumstances, it is not to be supposed that they will put the results of their work into print until they have protected it by patent or brought it to such a state of perfection that it becomes feasible to give definite information to the world. If it is not patentable, naturally information of commercial value will not be given away.

Some of the other subjects suggested to us are of very limited interest; for instance, one reader desires a series of articles on all the various possibilities in the way of wiring for electric bells, alarms, and annunciators, and a comprehensive series of articles on the various forms of primary batteries. We published not long since an article on bell wiring, the second which we have published on this subject within two years. Either of these articles gives all of the general information necessary to successfully wire any sort of a bell system. The other details must be planned for each installation separately, and any standard book on wiring diagrams will give enough examples to enable the architect or constructor to plan out his installation for himself. No general article can cover this field properly; and if it did, it would be of interest to but a comparatively few readers.

In regard to primary batteries, there is nothing new to be said on this subject. The various forms of primary batteries have been described so many times and full information about them can be found in so many books, that it seems hardly worth while to publish a new series of articles on this subject. Practically all the necessary information about primary batteries can be found in the twenty-five-cent book retailed by our publishers, entitled "Modern Primary Batteries."

Readers who desire this particular information may say that they do not want to buy the book. They want to get in the magazine the information on the subjects they desire. We can only answer that our policy is to work for the greatest good of the greatest number, and it does not seem advisable to give too much information which is already public property, in the form of magazine articles. There are many subjects which are treated in books only in a disjointed and unconnected way and have not received a large amount of publicity, and such subjects we feel come within our scope; but we feel that there must be some originality in the articles which we publish, and therefore cannot consider a series of articles on as worn out subjects as primary batteries.

* * *

The suggestion is made that we publish more articles on how to make various pieces of machinery. We are always glad to consider these articles and continually try to get them. If some of our readers who have made practical pieces of apparatus would write to us on the subject, they might find a market for their articles. As a general rule, however, we find that the man who knows a mechanical subject thoroughly and is competent to write upon it for the instruction of beginners, is too busy to give his time to it or is not sufficiently trained in literary work to be willing to attempt it. We can supply the literary training. In other words, we can polish up any practical article, no matter how badly it may be expressed, but we cannot furnish time to the practical expert. We have, however, a number of practical constructive articles in consideration and will take pleasure in printing them as fast as they are ready for us.

* * *

Considerable interest is expressed in wireless telegraphy and we shall continue to have practical articles on this subject, expounding some of the newer systems. We shall also give considerably more attention to tool work, both in wood and metal, in the future than we have in the past, and expect to develop our magazine as strongly as possible along these lines.

The suggestion is made that we increase the size of the magazine. This we shall be very glad to do as soon as financial considerations warrant it. With the present high prices of white paper, any increase in the size of the magazine means a very material increase in the cost. If each one of our present subscribers would obtain a new subscriber for us, we could soon enlarge the magazine, and we extend a cordial invitation to every present subscriber to consider himself a committee of one for the purpose of increasing our subscription list. We do not ask you to do this out of gratitude, as we are prepared to pay a liberal commission on every subscription which you can obtain for us.

* * *

We again call the attention of our readers to the fact that we offer at least five annual subscriptions to ELECTRICIAN AND MECHANIC, and if the number of letters received warrants it, ten subscriptions, as prizes for the best letters sent in, giving hints or suggestions for the improvement or betterment of this magazine in any way. Do not hesitate to write. The simplest thing which you want may be something which is wanted by hundreds of others and may win you the prize. We want every reader of ELECTRICIAN AND MECHANIC, without an exception, to write us on this subject, telling what he would like to have in the magazine if it were written entirely to suit him. Only by finding out what the majority of our readers want, can we satisfy them, and only by satisfying our readers can we hope to grow.

* * *

The suggestion is made that a club or society of readers interested in wireless telegraphy be formed for the purpose of exchanging information and of bringing together readers who are interested in this subject. If a sufficient number of readers approve of this idea, we shall be very glad to assist in the organization of such a society and give it space in our columns for the exchange of ideas. All readers, therefore, who are interested in wireless telegraphy and would like to join such a society, if formed, are requested to communicate with us to this effect.

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. Neither do we guarantee that the answers will be satisfactory for any special use or purpose required.

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.

580. **Motor.** R. B. P., Cooperstown, Ill., has tried to make a motor, but has failed. The field magnet has two limbs, ½ inch thick, 2 inches wide, and 2½ inches long, wound with No. 16 wire. Armature is 1¾ inches in diameter and 2½ inches long, has 12 slots, each containing twenty-four No. 18 wires. What is the trouble? Ans. — We have inquiries of this sort so often that a perusal of these columns ought to show what sort of investigations might be made. Remove the armature, and send a good battery current through the field winding. This will show whether the spools are connected properly, and if there are any grounds. If unlike poles are produced at the extremities, insert the armature, but do not put on the brushes. Excite the field with the batteries, and drive the armature at as high a speed as possible. If much power is required, or if much heat is produced, you can suspect some error in the armature winding or connections. If everything is cool, place on the brushes, and with the batteries still connected, move the brushes to the most effective position, — if indeed there is any such. When you find it, connect the armature in the battery circuit too, and see if the machine will run as a motor; if it will not do that, it is no use to try to make it generate a current. Nos. 18 and 21 wires would have been rather better sizes of wire to use for such a small machine.

581. **Medical Coil.** C. S. J., Monroeville, Ind., asks if there is any substitute for the induction coil, as used for medical purposes, and if so, is it patented? Ans. — A telephone magneto generator may be utilized to produce most of the effects. In this case you would have to provide mechanical means for driving the armature. For occasional use this machine would answer, but since the bearings are too small and lack means for proper lubrication, you will find a generator of the igniter type for gas engines more durable. There are no patents involved, but for some purposes you might find the two devices operating somewhat differently; the induction coil supplies a much stronger electromotive force in one direction than in the other, while the dynamo has both alternations of equal strength.

582. **Telephone Condenser.** C. C. B., Sharon, Ohio, asks how to make one. Ans. — Two pounds of the thinnest tin foil, 1 pound for each strip, about 7½ inches wide, and thin paraffined bond paper, 8½ inches wide, and in about the same length are to be procured. A piece of copper wire is attached crosswise the end of each strip, and the three strips then wound closely around a central piece of cardboard, until the finished structure is a flat coil, with the two wires extending out from the vicinity of the two opposite edges of the center. The overall dimensions may then be 4½ x 8½ x ¾ inches. The condenser should be enclosed between sheets of cardboard and sealed in a tin case, the wires protruding through holes well protected from entrance of moisture by use of paraffin.

583. **Small Dynamo.** R. W., Roswell, New Mexico, proposes to make a dynamo, using for the exterior of the field frame a piece of 10-inch pipe coupling, measuring 10½ inches inside diameter, 4 inches long, and ¾ inch thick. He asks some general directions so as to allow for a 300-watt machine, speed to be 1500 revolutions per minute. Ans. — You can get a good-looking and well-operating machine by use of four poles, and a toothed drum armature. Let the cores of the field be of wrought iron, 2½ inches in diameter, fitted with cast iron pole faces large enough to embrace three-fourths of the armature. Latter can have a core 5 inches in diameter and 2¾ inches long, with 32 slots ¼ x ½ inch, or 7-32 x ⅝ inch. With multiple wound coils, requiring brushes at all four places on the commutator, you will need about 64 wires per slot; insulation need not be over .03 inch, and with use of oiled muslin it can be considerably less, — and you should be able to use not smaller than No. 19 wire, thus allowing an output of about 5 or 6 amperes at 110 volts. Field wire can be of No. 23 wire, somewhat over 3 pounds per spool. Air gap between armature core and polar faces, 1-16 inch.

584. **Dynamo Troubles — Storage Battery Construction.** F. P. H., Baltimore, Md., asks (1) What is the matter with his ⅛-h. p. dynamo? It will not generate, although it has a plenty of residual magnetism, and will run at a terrific speed as a motor. (2) If battery plates are made by burning together at the edges two sheets of perforated lead, with paste filling between, will it be a good construction, and if so, how many ampere hours capacity will a cell have with two positives and three negatives, 3½ x 4½ inches? Ans. — (1) It looks as if you had the two field coils connected in opposition to each other, with the result that both extremities are of the same polarity, while the base is of the other. If both spools are wound alike, both inside ends should be connected together, and the outer ends be led to the connection board. You can easily

prove the connections by testing the poles with a compass. The high speed as a motor is suggestive of a weak field, — that is, if connected as a shunt. (2) This is a good construction, being practically that now adopted by one of the largest manufacturers, and known as the "box" form of plate. You will not need the third plate in the interior, but it will be an advantage if you suspend the plates from the upper edges of jars rather than let them stand on the bottom. About 12 ampere hours.

585. **Electrolytic Rectifiers.** O. J. H., Fergus Falls, Minn., asks (1) for directions for making the electrolytic rectifier mentioned in the May, 1907, magazine. (2) How is an electrolytic interrupter made? (3) What should be the construction of a transformer to change 110 volts to 10 volts? Ans. — (1) As this is a very inefficient device, it has never been reduced to practical shape. The mercury arc rectifier, though poor, is much better. (2) A tip of platinum faces a sheet of lead immersed in dilute sulphuric acid. By varying the separation, adjustment may be given to the frequency of the interruptions. About 110 volts are necessary, and the device is objectionable from the rapidity with which it fouls the liquid and the danger it introduces of breaking down the insulation of the induction coil. (3) See answer No. 543 in the March, 1908, issue. You did not state how many amperes the secondary should supply.

586. **Alternating Current Phraseology.** A. G., Telluride, Col., asks what is meant by "frequency," "cycles," etc.? Ans. — See Chapter XIII, of the Electrical Engineering series, in the July, 1907, issue.

587. **Dynamo and Transformer.** A. E. N., Butte, Iowa, sends sketches and data for a small dynamo of the bipolar enclosed type, with 12-slot armature. He asks (1) What will be the voltage at 40 cycles. (2) If the current be led to the coarser winding of a 2 to 1 transformer, what voltage will be generated in the other winding? Ans. — (1) Your description is that of a direct current dynamo, but your expectations seem to be based on the operation of an alternator. For alternating currents at 40 cycles, you should have a 4-pole field magnet, a single circuit armature winding, terminating in two collector rings. (2) If you apply direct current to a transformer, you will either burn out its primary winding or the armature of the generator, — the secondary will yield nothing.

588. **Armature Winding.** G. O., New York, N. Y., (1) has an 11-slot armature core and a commutator to fit; he asks directions for winding and connecting. (2) Why will a 2-ampere current fail to magnetize an iron core wound with No. 18 wire? Ans. — (1) Start the winding in slot 1, and put on sufficient turns to occupy one-half the space in it and slot 5; twist a loop in the wire, to be connected later to segment 2; wind the same number of turns in slots 2 and 6; leave a loop beside slot 3 for the third segment; wind slots 3 and 7, and then bring out a third loop; similarly, slots 4 and 8, and then 5 and 9; since slot 5 was already half filled, these additional turns will completely fill it. Thus the winding is to proceed on top the existing wire, as if it was not there, the pairs of slots being respectively, 6-10, 7-11, 8-1, 9-2, 10-3, and 11-4; the very end of the wire is then to be twisted to the beginning and thus provide the double connection for the first segment, similar to those for the others. (2) If you are sure that the current is really there, and that the winding is not short-circuited, or the several coils not connected in wrong order, the iron must be magnetized.

589. **Incandescent Circuit.** F. C., Helena, Mont., asks (1) What current flows through a circuit of five incandescent lamps in series, as on a street car? (2) What will be the electromotive force between the terminals of any one of the five lamps? (3) Why are wires of a telephone or power transmission line transposed? Ans. — (1) About ½ ampere. (2) With no other wires attached, the voltage will be about 110, but if you attach other wires to draw off some current, even though the circuit be only a high resistance voltmeter, the additional path lowers the resistance, and more current will flow. The maximum will be that resulting when you short-circuit the lamp, perhaps ⅝ ampere, but this current is ruinous to the remaining lamps. (3) To lessen or eliminate the troublesome effects of induction between the different currents.

590. **Rectifier.** G. B. M., Nashville, Tenn., asks (1) Where he can get a mercury arc rectifier, and at what price? (2) What is the size and material of the sample of wire sent? (3) Can Nos. 34 and 40, and some intermediate sizes of wire be connected to be suitable for winding the secondary of an induction coil? Ans. — (1) From the General Electric Company, Schenectady, N. Y., or the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., but we do not know the price. There is an unexpected lot of auxiliary apparatus in connection with one of these devices, and we think you would find a motor-generator set of greater value and flexibility. (2) Without making a chemical analysis, we should say that it was platinoid wire; it has certain dissimilarities from constantan, manganin, and German silver. The size is No. 16. (3) Yes, but joints are objectionable, they are likely to make bunches in the winding. If you use acid for a soldering flux, be sure to wash it off thoroughly, and to smear the joint with shellac. The different sections may readily be of different sizes of wire, using the coarser ones for the central sections.

591. **Storage Battery Operation.** C. W. A., Buffalo, N. Y., says (1) that he is trying to charge a 15-ampere-hour storage cell from a 6-volt, 6-ampere dynamo, without use of regulating rheostat or measuring devices, but the charging seems to be very slow. Should a rheostat be used? (2) Can a small heating pad be energized from four storage cells, and what size and quantity of wire to use? (3) What are the addresses of firms making small dynamos? Ans. — (1) We think you are bordering on disaster when you try to operate storage cells without adequate appliances. For all you know, you may be running your machine as a motor, exhausting the battery, instead of charging it. (2) Your specifications are too indefinite, but you may be sure that storage cells would be insufficient and expensive. (3) See our advertising columns.

592. **Magneto Dynamo.** D. D. D., Vacaville, Cal., has made the small dynamo described in the March, 1907, issue, and finds that while the machine will generate a good voltage on open

circuit, the greatest current is only a fraction of an ampere. What is the reason? Ans. — You did not state what size of wire was put upon the armature, but if it is very fine, the reason is clear. The resistance is too high, and it is quite likely that a fraction of an ampere is all the wire can safely carry. If you use coarser wire you can get more current, but the voltage will be correspondingly reduced.

593. **Electric Heater.** F. P. P., Westminster, Md., asks (1) How much and what size of nickel wire will suffice for making a flat top heater about 6 inches in diameter and suitable for use on a 110-volt circuit? (2) What size of German silver wire will carry 1.7 amperes without overheating? (3) Why will not a 6-volt 1.7 ampere "Midget" motor run on a 110-volt circuit, in series with a 16-c.p. lamp? Ans. — (1) It is quite impossible for a person to foretell by this data. The shape and weight of the containing structure need to be considered, and the operation is quite different when something is being heated from the case when it would be clear. The only way is to try various sizes and see what the results are. Experiment has been the only guide in electric heating devices. (2) If wound in open coils, with plenty of opportunity for circulation of air, No. 20 will suffice. (3) The lamp passes only about .5 ampere and you will need to have about three lamps in parallel to give the desired working current.

594. **Calibrating Instruments.** J. M. asks (1) How to determine the graduations of an ammeter and voltmeter? (2) Where can he obtain an "H" armature for a 3-bar telephone magneto? (3) It is proposed to make an induction coil having a bundle of wires ¾ inch diameter and 7½ inches long, wound with two layers of No. 12 wire and 2½ pounds of No. 36 wire. Are these proportions good? Ans. — (1) See Chapter XIX of the electrical engineering series in the January, 1908, issue. (2) Some of our advertisers deal in such goods, or you might address one of the manufacturing companies, say the Dean Electric Co., Elyria, Ohio. You ought to be able to purchase a second-hand generator complete cheaper than any one part. (3) Yes.

595. **75-watt Dynamo.** J. S., Merrick, Okla., asks (1) What size of field magnet, and what quantity of No. 23 wire for winding it, would be adapted for a 12-slot 3-inch armature wound with No. 20 wire? Voltage is to be 40 to 50. (2) Can gravity cells be used for charging a few small storage cells? Ans. — (1) You do not state what the axial length of armature core is. If it is also 3 inches, the air gap can be 1-16 inch or less, the polar arc sufficient to cover about ¾ of the armature, and the cross-section of iron of field 2 square inches, or a little over. About 6 pounds of field wire will be needed.

596. **Spark Coil.** Q. E. C., Chicago, Ill., asks (1) What size of spark is used for ignition in a gasoline engine? (2) What would be good dimensions for coil? (3) What would be diagram of connections? (4) What is the size of wire sent? Ans. — (1) For ordinary stationary engines the flash resulting from a single break in the electric circuit is sufficient. For higher speeds, such as are common on automobiles, the jump spark is more reliable, and draws less heavily on the batteries. (2) A bundle of iron wires, 7 inches long and ¾ inch in diameter, wound with 6 layers of No. 14 wire. A good method is to make a thin wooden spool, wind the copper wire on it, and thrust the iron wires into it. (3) These columns do admit making diagrams, and for such an extremely simple device as a make-and-break contact a printed diagram is hardly necessary. (4) No. 31.

597. **Plumbing.** F. D. J., Stoneham, Mass., asks (1) How to "tin" a soldering copper? (2) How to solder two lead pipes together? (3) How to "wipe" a lead joint? Ans. — (1) A small cavity excavated in a brick makes a good preparation, and then with the copper suitably heated, file the surfaces of the tip until all oxide is removed; then melt some ordinary solder into the cavity in the brick; pour in a few drops of soldering acid, and rub vigorously. Repeat the filing and rubbing, with addition of solder and acid, if necessary, until the entire end of copper is tinned, and the melted metal will hang on in drops. In use, do not let the copper get red hot, for that temperature burns off all the tinning. (2) Enlarge the hole in one piece, and whittle down the end of other, until one will enter the other a short distance. Stand pipes in a vertical position, so that the larger end is at the bottom. With solder and resin you ought to be able to make a good joint. (3) To do this is quite an art, and only watching others and personally trying it will give the necessary instruction. A special grade of solder is needed, one that melts rather more easily than the ordinary quality, and plumber's "candle" for a flux. In melting the lead, caution must be used not to get it too hot, for it is important to have the solder midway between the liquid and the solidifying state. Before the wiping begins, considerable solder is poured over the parts to be joined, apparently to waste, but really to warm the lead ends to the point at which adhesion takes place.

598. **Voltmeter and Ammeter Scales.** H. G. D., Brooklyn, N.Y., ask (1) What resistance can be put in series with a 10-volt instrument to allow its scale to read to 50 volts? What shunt to use with a 25-ampere instrument to bring it down to 5 amperes? (2) A fan motor is wound for 115 volts; what sizes of wire to use for changing it into a 15-volt 6-ampere generator? Ans. — (1) You need to know the present resistance, and then add enough more resistance wire to make the total just five times as much. If your ammeter is an electromagnetic instrument, wound with coarse wire, the shunt will be inappropriate, and you will have to rewind with smaller wire to get five times as many turns in the space as at present. The divisions should then be checked in comparison with some known standard. (2) Ascertain what the present sizes of wire are, then rewind armature with wire nine sizes larger, and for shunt field 12 sizes larger than that now on armature. Possibly the present field winding, which is of the series sort as far as the fan motor is concerned, may be right to be taken as a shunt for your new purposes. At any rate, try it.

599. **Telephone Repeating Coil.** H. N. J., Havelock, Neb., sends a diagram consisting of a metallic telephone circuit connected to a grounded line through the medium of a repeating coil, and asks (1) if diagram is correct, (2) what size of coil to use, and where can it be bought? Ans.—(1) No, for one end of coil should be attached to ground, other to line. The telephone, too,

has one terminal grounded, as specified, thereby completing the circuit. (2) A common size has a bundle of No. 24 iron wires about ¾ inch in diameter, enclosing two coils of No. 31 wire, each of about 200 ohms resistance. The word "enclosed" is used advisedly, for the iron wires are made long enough to be bent back over the winding, thereby improving the magnetic circuit. The Dean Electric Co., Elyria, Ohio, make them.

600. **Ohm's Law.** S. C. W., Chicago, Ill., asks how this law fits the case of a welding circuit, in which the generator may supply energy at 300 volts, while the welder may pass 25,000 amperes? Ans.—In order that this voltage may send so large a current, the resistance outside the dynamo would have to be as low as .012 ohm; for then, since $C = E \div R$, $R = E \div C$. But this amount of current could not readily be transmitted from the generator to the welder, so use is made of alternating currents, and the welder itself is really the secondary, consisting of only one turn. This is a copper casting, of large section, and with the bars to be welded jammed tightly together, the entire resistance of this secondary circuit is very low, for the difference of potential across the clamps is not over half a volt, and yet the enormous current flows. The actual resistance must be $.5 \div 25{,}000$, or .00002 ohm.

601. **Small Engine and Boiler.** J. C., Louisville, Ky., has an engine with cylinder 1 7-16 inches diameter and stroke 2 1-16 inches long, made from a piece of brass pipe with steam chest of Babbitt metal. He asks (1) What power will the engine develop, and will it be of any actual use for running a dynamo? (2) Can a suitable boiler be made from a galvanized iron water tank, such as is used in kitchens? (3) Would pole pieces for a dynamo 3 3-16 inches diameter and 2⅞ inches long, axially, be right for a dynamo to be driven by the engine? Ans.—(1) We do not think the engine good for else than instruction in valve motion; the soft metal could not be sufficiently well lubricated to withstand much wear. Anything more than a small pressure might spring the walls of the chest. You might rate the engine at ¼ h. p., but even if well made, you would lack sufficient means for closely regulating the speed to allow for practical operation of a dynamo. (2) Such would be unsafe, and its operation in violation of municipal ordinances. While you personally might be able to manage it safely, some day, in your absence, a bad accident might happen. Experimental boilers made of mercury flasks, joined together at top and bottom with piping, make strong and servicable structures. (3) This is altogether too meager data. Castings for excellent designs of dynamos can be purchased for less than for what you can make patterns, and you ought to make only good machines.

602. **Dynamo Construction.** G. McK., Belle Valley, Ohio, sends a sketch of a small dynamo with iron-clad type of field magnet. Armature is 2 inches diameter and 2 inches long, field cores 1½ inches in diameter and length. Outer frame is 2 inches wide and ⅝ inch thick, with internal spaces of 3 inches and 5½ inches. He asks if these proportions are good, and what should be winding for ten volts? Ans.—With the exception that the 3-inch dimension should be increased to about 3½ inches, it is in good shape. Use a 12-slot armature, with No. 20 wire, and all you can get on of No. 22 on the field.

603. **Rheostat.** H. C. McE., Ada, Ohio, asks (1) What would be a good motor voltage for the experimental machine described in the March, 1907, issue? (2) How can a 10-point rheostat be constructed having 25 feet of No. 29 German silver wire per step? Ans.—(1) The 10-volt, 4-ampere winding would be as good as any for operation from batteries. Of course you must use large batteries to get that current. (2) Your data seems to answer the question. If it is the arrangement about which you are in doubt, we would suggest that you use strips of slate, such as might be cut from roofing material, or from school slates; make saw cuts close together in two opposite edges, and wind the bare wire in flat coils. These slabs can then be slipped into grooves in the iron box, and the terminals led through holes in the slate front to the ten contacts. Let No 1 coil connect to contacts 1 and 2, No. 2 coil to 2 and 3, No. 3 to 3 and 4, etc., the final end of No. 10 leading to a binding post, while the hinge of the arm connects to the other post. Round buttons ¼ inch in diameter make sufficient size of contacts.

604. **Range of Wireless Telegraph.** R. M., Hooperston, Ill., asks (1) How far will a 2100-ohm relay catch a message sent from a 4-inch spark coil from a 40-foot aerial? (2) What is the nearest wireless station to Danville, Ill.? (3) Can a 2-inch spark coil be made from cotton-covered wire if well paraffined paper is placed between the layers? Ans.—(1) This is outside our information, for the factors concerned in such a prediction are numerous. The real range is not so much the length of spark and height of aerial, as how much energy you can dissipate at the spark gap. Perhaps some of our readers can speak from personal experience. (2) We shall be glad if any resident in that vicinity will let us know. (3) Yes, and even bare wire is very successfully used for this purpose, notably by the Varley Duplex Magnet Co.

605. **Lightning and Aerials.** E. W. C., Brooklyn, N. Y., asks if the pole supporting an aerial is in danger of being struck by lightning, and also what is the best way to string the wire? Ans.—Yes, all projecting metallic bodies afford extra opportunity for the pranks of lightning. However, for cities the presence of numerous wires on poles, and the use of iron columns in tall buildings so dissipates atmospheric charges as to make the actual risk very small. Lone objects far out in the country make a much more obvious mark. A double wire of copper, attached to a cross arm on the top of the pole, makes a simple and effective arrangement.

606. **Foundry Supplies.** G. C. W., Boston, Mass., asks (1) Where can such be obtained? (2) Can an electric motor be made by casting lead or Babbitt metal around an iron core? Ans.—(1) For small parts, such as you seem to desire, Chandler and Farquhar, 34 Federal Street, in your city. (2) No.

607. **Telephones.** A. C. H., Seymour, Mo., asks (1) What causes the whistling sound when a telephone receiver is placed close to the transmitter? (2) What resistance induction coil is best adapted for rural telephone lines, and why? (3) Where can static electric apparatus be obtained? (4) What is the formula for making

artificial ivory from potatoes, as was mentioned in the *Technical World?* Ans.—(1) Sometimes this whistling almost amounts to a screech, and its occurrence must be ascribed to the fact that a telephone is an extremely sensitive device, receiving not alone whispers of the voice, but sounds proceeding from any other source. When the space is wholly or partly enclosed in the manner you state, there exists a chamber of air that can reverberate with a frequency consonant with some audible sounds, and by a cumulative process reach the stage you mention. In some cases you might find considerable variation in the sound, dependent upon the size of the air space enclosed. (2) High resistance, for these run down the batteries less rapidly; while three or four dry cells may be needed to operate them as compared with the two only as required for the ordinary transmitters, the first cost of the batteries is small as compared with that of renewing them over widely scattered areas. (3) The Central Scientific Co., 14 Michigan Ave., Chicago, Ill. (4) This is of course secret, but we assume that the substance is essentially celluloid, such as is used for piano keys.

608. **Coherer, Electrolytic Detector.** A. K. A., Orange, N. J., asks (1) What is the construction of the self-restoring coherer? (2) What proportion of acid to use in an electrolytic detector? (3) What length of spark will a coil give if made like that described in the July, 1907, paper, if wound with No. 32 instead of No. 36 wire? (4) Will glass serve as well as hard rubber for the tube that covers the primary? Ans.—(1) The tube contains three plugs, the central one being of iron while the others are of carbon. Globules of mercury are placed in the two intervening spaces. (2) No exact strength of solution is required, it merely being necessary to polarize the solution by action of the local battery. Experiment alone will bring out the most sensitive conditions. (3) This will depend largely upon the battery. It ought to operate ½-inch sparks of considerable power. (4) As far as insulating qualities are concerned, yes, but danger of breakage is not to be ignored.

609. **Radium.** R. B., Spokane, Wash., asks (1) Does radium evaporate? (2) In making photographs will it take the place of a Nernst lamp? (3) What does B. & S. and B. W. G. mean? (4) A certain telephone magneto does not generate. What is the reason? Ans.—(1) It undergoes gradual change, forming various substances called rays and emanations. All these changes will not be effected in case of a given sample until the lapse of perhaps two thousand years, so if you have some of the element on hand, you need not worry about its disappearing before you are through with it. (2) Its photographic qualities are limited to scientific curiosity rather than adapted to practical work. (3) Brown & Sharpe (American) gauge, and Birmingham Wire Gauge (British). (4) The wire must be broken or short-circuited.

610. **Transformer.** S. H. B., Huntington, Ind., asks (1) What should be the size of the ground plate for a 300-foot transmission of wireless messages? (2) Where can battery carbons be obtained? (3) Where can a 10-inch or 12-inch metal turning lathe be obtained? Ans.—(1) For such a short distance, almost any connection will do. Attaching to the lightning rods or to a pipe in a well would be good. (2) The National Carbon Co., Cleveland, Ohio. (3) Consult our advertising and exchange columns.

611. **Transformers.** J. M., Denver, Col., asks (1) If the voltage in an electric circuit can be changed by anything except a transformer? (2) What book can be procured that treats on transformer designs? (3) How many ohms must be inserted in a direct current circuit of 110 volts and 46 amperes that will reduce the current to 3 amperes? Ans.—(1) See the article on "Current Reorganizers" in the December, 1907, magazine. (2) Perhaps the best books for your purposes would be some of the publications by the correspondence schools. See our advertising columns. (3) Applying Ohm's law, if there is a current of 46 amperes established by a pressure of 110 volts, the resistance must be 2.4 ohms; for a current of 3 amperes, the resistance must be 36.7 ohms, therefore you must have 34.3 ohms more. We should hardly think you were mature enough to consider the design of transformers if such a simple problem as this stalls you.

612. **Magneto.** C. H. B., Colora, Md., asks if a magneto generator that will ring a bell through 100,000 ohms resistance would be suitable for exploding dynamite? Ans.—No, the fine wire with which such a machine is wound is so fine as to allow only a shadow of a current to flow, and would be quite insufficient to heat the detonator. You should use a relatively low resistance machine. A Siemen's shuttle armature, made of cast iron, 2 inches in diameter and 4 inches long, wound with No. 18 wire, and a series field magnet wound with No. 14 wire ought to do the work.

613. **Fan Motor for a Generator.** A. S. O., Louisville, Ky., asks if the armature of a 110-volt fan motor can be used for a gas engine igniter? Ans.—The armature as now wound has altogether too fine wire, and you will have to rewind it. Examine the size employed on the present series field, and use three sizes larger than that for the new armature winding. Connect the present field as a shunt, and you may be able to avoid the necessity of making permanent magnets. You can use batteries for starting, and when full speed has been reached, and the field magnet has become excited, switch the sparker to the dynamo.

614. **"Kid" Dynamo.** E. M. H., Independence, Mo., sends a sketch of a small dynamo with Edison form of field magnet, cores being 9-16 inch diameter and 1½ inches long; pole pieces are bored 1½ inches in diameter and 1½ inches in length. Armature has six round slots, each 5-16 inch in diameter. He asks what should be the winding for 6 volts, and what will the output be in amperes? Ans.—The pole pieces are rather overgrown to fit the rest of the dimensions, for they could well have been bored out to 2 inches in diameter. The output will be too small to calculate with any exactness. If you put No. 27 wire on armature, and No. 24 on series field, and drive machine at a lively speed, you might get the desired voltage and about an ampere. Better make a larger machine.

615. **Induction Coil.** C. U., New Albany, Ind., asks (1) If it would be proper to finish out with No. 34 wire in making an induc-

tion coil, if there was an insufficient quantity of the desired No. 36? Of what does the electrolyte consist in an electrolytic detector of wireless messages? (3) What is the resistance of a 104-volt 16-c.p. incandescent lamp, and can one be used in circuit with a low-range voltmeter to increase the scope? Ans.—(1) Yes, put the coarse wire in the inner sections, for the less turns will reduce the disruptive force, leaving the end sections with their larger number of turns and accumulated insulation to withstand the greater electromotive force. (2) Dilute nitric acid. (3) About 400 ohms when cold, and nearly 250 when hot. For this very reason that carbon largely reduces its resistance with increase of current, it is quite inappropriate for such purposes as you propose. You must use alloys that have a "zero" temperature coefficient. See the article on "Measuring Instruments" in the January, 1908, magazine.

616. **Subterranean Battery.** H. D. B., Oaklawn, R. I., says that he has read of an electric battery, used in England, made by burying a zinc and copper plate, separated with coke, in a hole 9 feet deep. Such a device is supposed to operate an electric clock for several years. He asks if a battery made in this manner would be suitable for operating small electric lamps or motors? Ans.—The only use of burying the elements is to get them into something permanently moist. It would seem easier to put them in a jar of water, and pour on a layer of paraffin oil than to dig a hole 9 feet deep. One dry cell ought to run a clock, but it would be quite insufficient for more serious work.

617. **Spot Lights.** E. P., Somerset, Pa., asks (1) Where a resistance coil can be obtained to burn carbons on a 52-volt alternating current, and what size carbons are to be used? (2) What kind of a lens is used in a theatrical spot light, and where can one be obtained about 1 inch in diameter? Ans.—(1) German silver and various other metals are used to make resistances, the makers usually keeping their methods to themselves. Resistances can be obtained from any dealer in moving picture supplies. Carbons from any electrical house. If your local current is 52 volts, you can get the carbons from the electric company. (2) Spot lights have 5-inch or 6-inch condensers. One 1 inch in diameter would be of no value.

618. **Induction Coil Construction.** M. H. T., Dowagiac, Mich., wishes to build a spark coil on plan published last month, for wireless telegraphy. He is going to use No. 33 s.c.c. wire for secondary. (1) Would there be any changes needed in rest of coil? (2) Using No. 33, is it not true that the spark would not be as long, but would be fatter and good for a longer distance in wireless telegraphy? (3) Could an electrolytic interrupter be used? Ans. — (1) No. 33 wire has approximately half the diameter and half the resistance of No. 36. A secondary built of the same weight of No. 33 instead of No. 36 would give only about half the spark discharge. (2) The spark would be better for wireless work because of its thickness and life. (3) An electrolytic interrupter may be used with such a coil in connection with a source of house current, 104 or 110 volts, alternating or direct.

619. **Silicon Detector.** S. K. B., Arlington, Mass., asks (1) Where can I buy some silicon crystals for a wireless receiver? (2) Where can I find the best way to make a silicon detector? (3) Is it best to have the wires of an antenna separated and insulated at the top? Ans. — (1) The Carborundum Co., Niagara Falls, N. Y., manufacture carborundum and silicon crystals. (2) A description of a silicon detector is in preparation and will shortly be published. (3) It is not necessary. Spread the receiving wires out in a fan or cage shape to cover as much area as possible.

620. **Series and Bridging Ringers.** E. T., Troupsburg, N. Y., asks (1) How to finish mission furniture? (2) What is the difference between a series ringer and a bridging ringer for a telephone, and could both be used on one line? Ans.—(1) An article on the subject is published in this issue. (2) A series ringer is connected in series with the line. Users of the telephone talk through the bell coils as well as ring through them. The resistance is usually 80 ohms. Bridging ringers are bridged across the line, like the rungs of a ladder. The resistance is usually 1000 ohms, though they are made 500, 2000, and higher. The resistance offered by the bell coils to the transmitted current sends it practically all through the line, and the ringers are not in the talking circuit. It is not advisable to combine series and bridging instruments on one line, except for experimental purposes. The transmission would be imperfect and ringing unreliable.

621. **Wireless Telegraphy.** R. F., Natick, Mass., asks (1) How may I protect my wireless telegraph station from electrical storms? (2) What is the use of a choking coil? (3) Would a magneto when changed into a direct current dynamo give sufficient current to operate a 1-inch induction coil for wireless telegraphy for a distance of about 5 to 8 miles? Ans. — (1) The easiest way to protect wireless apparatus from an electrical storm is to arrange a simple but substantial throw-switch by which your aerial wires may be connected with the earth, OUTSIDE of the premises, as soon as a storm approaches. Any arrester or device for automatically directing atmospheric discharges from the aerial into the earth without affecting the apparatus would be rendered constantly inoperative by the high potential discharges upon which the successful operation of all wireless sending stations is dependent. In the way suggested, the aerial wires would be grounded, except when the outfit was in use, and it is not advisable to operate in a violent storm, except in case of emergency. (2) Choking coils were used in series with the relay and coherer and battery of the earlier coherer systems, for the purpose of diverting any atmospheric impulses which might pass through the sensitive relay, were they not used. It was desired that the full vigor of the Hertzian waves should operate on the filings of the coherer, and not enter such by-paths as a bridged relay and battery circuit offered. (3) The ordinary telephone magneto when rewound with coarser wire on the armature will give from 6 to 10 volts, but the current output is very small, and not sufficient to operate a standard 1-inch coil suitable for wireless telegraphy. By winding the armature full of No. 24 or 26, sufficient current could be generated to operate a gas-ignition coil of about ½-inch discharge.

BOOK REVIEWS

STORAGE BATTERIES, — THEIR THEORY, CONSTRUCTION, AND USE. By A. E. Watson, E.E., Ph.D. Lynn, Mass., Bubier Publishing Co., 1908. Price, $1.50.

To those who are interested in storage batteries, and desire a more complete account of them than is given in the two articles on the subject appearing in this and the previous number of ELECTRICIAN AND MECHANIC, we would commend the new book on the subject, by A. E. Watson, one of the editors of this magazine. The book is a thorough and up-to-date discussion of all modern types of the lead storage battery, and gives all the information necessary for a thorough understanding of its principles, construction, and uses. As the lead battery is at present the only one which is commercially practicable, but little attention has been given to other types. The book is a valuable addition to the literature of the subject.

TELEPHONE CONSTRUCTION, INSTALLATION, WIRING, OPERATION, AND MAINTENANCE. By W. H. Radcliffe, E.E., and H. C. Cushing, Jr., E.E. Contains one hundred and twenty-five illustrations, showing apparatus, circuits, and systems. New York, The Norman W. Henley Publishing Co., 1908. Price, $1.

This book in no way conflicts with the purposes of other publications on telephony, either of encyclopedic character or of less pretentious scope. It is intended for the amateur, the wireman, or the engineer who desires to establish a means of telephonic communication between the rooms of his home, office, or shop; between his house and shop; between his home and the homes of his friends; or between his shop and some distant building. It is also for the contractor who desires to do this work for others, or who wishes to build small exchanges in factories, mills, or small towns.

The reader is assumed to know absolutely nothing of telephony, and no intricate mathematics are used, nor is mention made of any apparatus, circuits, or systems which are not thoroughly illustrated and described with respect to their construction, installation, wiring, operation, and maintenance.

The equipments and the methods of wiring presented have been selected with great care from those which have been in use for a sufficient length of time by the Bell and independent companies, to have proved their practical value and become thoroughly standardized. No partiality is shown the equipments and methods of either organization, except in so far as they are superior electrically, magnetically, or mechanically, or in illustrating the points to be impressed upon the reader.

TINPLATE WORK. With numerous engravings and diagrams. Edited by Paul N. Hasluck. Philadelphia, David McKay, 1908. Price, 50 cents.

This handbook is the latest issue in the well-known Handicraft Series. It is a very practical treatise on the manufacture of all kinds of articles from tin plate, and gives not only general instruction as to the use of various tools required, but a very large number of patterns for almost every possible article which can be made of this material, from the simplest to the most complex.

HOW TO USE SLIDE RULES. By D. Petri-Palmedo. Kolesch and Co., New York, 1908. Price, 50 cents.

Everybody who has any great amount of calculation to do and who does not use a slide rule is giving himself a large amount of labor which is absolutely unnecessary. For multiplication, division, involution, and evolution, and all trigonometrical calculations, the slide rule enables one to get instantaneous results instead of laborious calculations. For all practical engineering purposes, it is fully accurate enough. The very name of slide rule, however, often deters students, as an impression exists that it is used with great difficulty. This is not the case, and this little booklet gives the necessary instructions for its use in the most simple manner.

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1908. Containing a collection of electrical engineering notes, rules, tables, and data. Manchester, Emmott and Company, Ltd. Price, 25 cents.

THE MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1908. Containing a collection of useful engineering notes, rules, tables, and data. Manchester, Emmott and Company, Ltd. Price, 25 cents.

These two pocket books, although they are published at such an amazingly low price, contain an enormous amount of the most valuable information in the way of formulas and tables for the use of electrical and mechanical readers. They are especially designed for the use of steam engineers and power station attendants, and are thoroughly practical. Some of the data are of course based on English requirements, but most of the information is just as valuable in this country as in England.

PRACTICAL HINTS ON JOINT WIPING FOR BEGINNERS IN PLUMBING. With an appendix giving a selection of practical letters and articles compiled from *The Metal Worker, Plumber, and Steam Fitter*. Enlarged edition. New York, David Williams Co. Price, 25 cents.

Joint wiping is one of the essentials of the plumber's trade, and while it is an art which must be learned by experience, as far as it is possible to give instruction by a book, it is to be found in this manual. The written description is helped out by a large number of valuable photographs, and the book gives all the information on the subject which can be obtained from a printed record.

HOUSE CHIMNEYS. A series of articles and letters on chimney troubles and their remedies. Reprinted from *The Metal Worker, Plumber, and Steam Fitter*. Third Edition. New York, David Williams Co., 1908. Price, 25 cents.

This little book contains a large number of practical drawings and instructions on the construction of good chimneys and the bettering of imperfect ones. It is thoroughly practical and contains many useful hints.

DOMESTIC ELECTRICAL WORK. Illustrated with twenty-two diagrams. By William A. Wittbecker. New York, David Williams Co., 1906. Price, 25 cents.

This book is designed to give sufficient instructions to enable any one who knows nothing of electricity to do any kind of wiring anywhere around the house, excepting the wiring for incandescent lights. It treats of various simple and complex wirings for bells, fire and burglar alarms, and electric gas lighting.

AMATEUR MECHANICS. A book for old and young who like to make things. Written so you can understand it. Reprinted from *Popular Mechanics*. Chicago, Popular Mechanics. Price, 25 cents.

This interesting booklet consists of pages reprinted from *Popular Mechanics*, and contains a very large number of practical directions for making all sorts of useful articles from telescopes to telephones.

MEN WHO SELL THINGS. Observations and experiences of over twenty years as traveling salesman, European buyer, sales manager, employer. By Walter D. Moody. Chicago, A. C. McClurg and Co., 1907. Price, $1.

This is a book for those who are, or want to be, salesmen. It is written by a man who has spent his life in this profession, and contains a very large amount of very practical advice, given in short, pithy sentences and chapters.

TRADE LITERATURE

YANKEE TOOL BOOK, 1908. Describing, with illustrations, some up-to-date labor-saving tools, more especially: Ratchet Screw Drivers, Spiral Screw Drivers, Automatic or Hand Drills, etc., made by North Bros. Mfg. Co., Philadelphia, Pa. This is one of the handsomest catalogues of small tools which has come to our desk for some time, and by far the most attractive catalogue ever gotten out by its makers. It fully describes their line, and is illustrated with numerous photographs. After reading it, any man who loves tools will certainly feel obliged to buy some Yankee tools at once. It is free for the asking.

STOCK SIZES HYATT STANDARD BUSHINGS. This is Bulletin No. 31 of the Hyatt Roller Bearing Co., Newark, N. J. This firm now announces that it has standardized its line of roller bearings in such a way that it can furnish bearings of any size and nature in small quantities at extremely low prices. These bearings are now obtainable for all conditions of speed and load, and are well worth investigation by every user of machinery.

SHORT STORIES ABOUT STEEL. — 1. Early History of Iron Making in England; Kinds of Steel used in Modern Drop Forgings. 2. Dud Dudley and the Invention of Smelting with Coal; Common Elements found in Steel. These two interesting pamphlets are published for free distribution by the Park Drop Forge Co., Cleveland, Ohio.

THE YACHT MODEL EMPORIUM ALBUM OF DESIGNS. Catalogue of designs and working specifications for boats of every kind, size, and description, all for sale at very low prices by Yacht Model Emporium, Liverpool Road, Syracuse, N. Y.

NOMENCLATURE OF MURRAY CORLISS ENGINES. — This valuable book, published for free distribution by the Murray Iron Works Co., Burlington, Iowa, contains a large number of outline drawings of steam engines, with every part named.

CATALOGUE OF ELECTRICAL NOVELTIES, EXPERIMENTAL APPARATUS, DYNAMOS, MOTORS, AND GAS ENGINES. The Carlisle and Finch Co., Cincinnati, Ohio.

AUTOMOBILING AS A PROFESSION. Catalogue of the New York School of Automobile Engineers, 146 W. 56th Street, New York City.

CRESCENT COMBINATION AND LINEMAN'S PLIERS. — Catalogue of a very complete line. Crescent Tool Co., Jamestown, N. Y.

IN looking over the literature which the various manufacturers and dealers supplying photographic goods have prepared for free distribution, we have been strongly impressed by the enormous amount of valuable information which is to be had for the asking. There is hardly a question which perplexes the amateur which does not find an answer in one or another of these books and catalogues. We have prepared a partial list of the literature now ready for this season's distribution, which we print below. Every firm mentioned will be very glad to furnish any of its literature on request, if you cannot obtain it from your dealer. In writing for these booklets, kindly say that you saw them mentioned in ELECTRICIAN AND MECHANIC.

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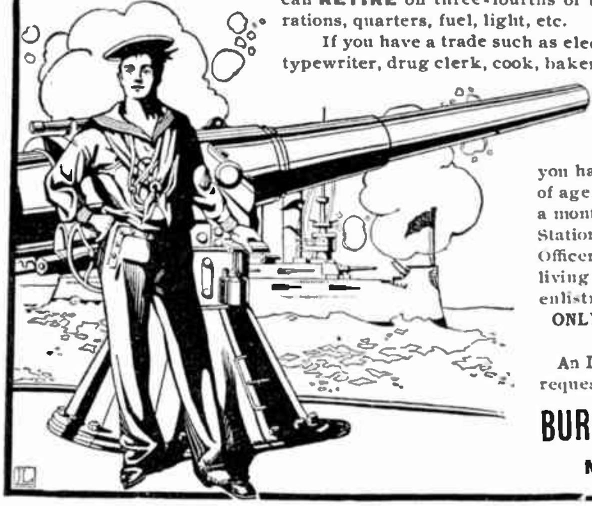

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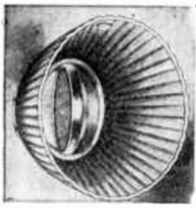

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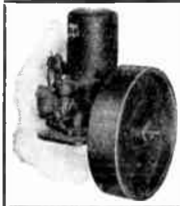

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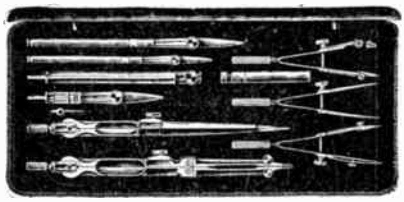

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