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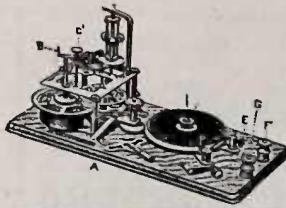
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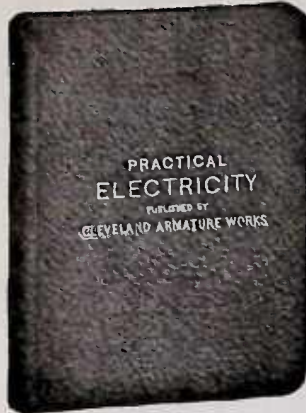


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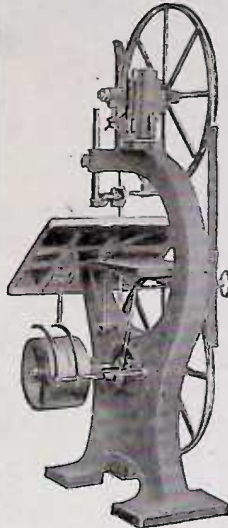
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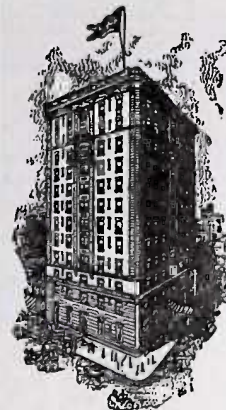
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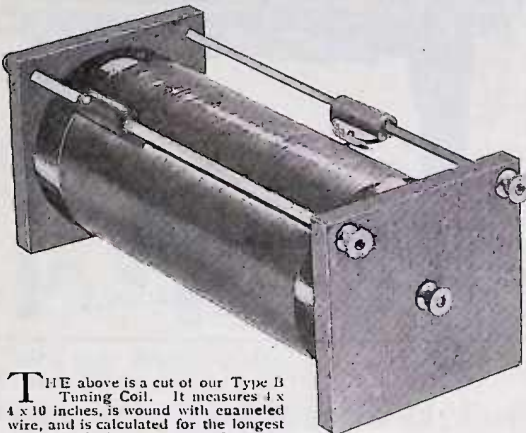
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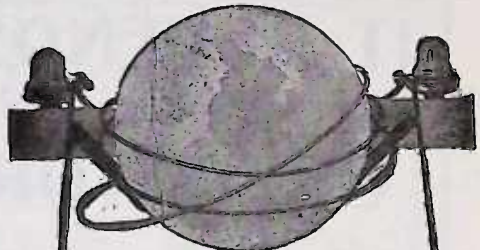
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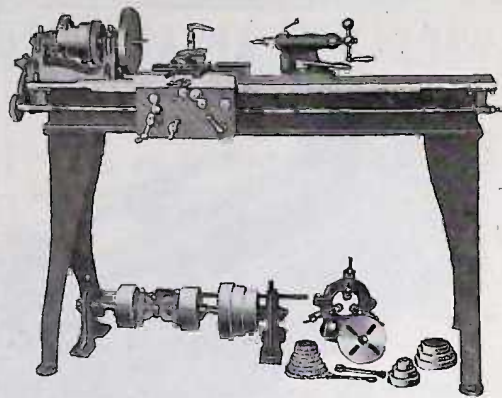
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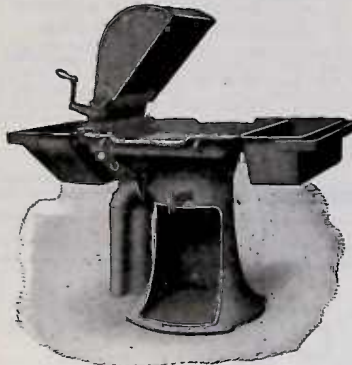
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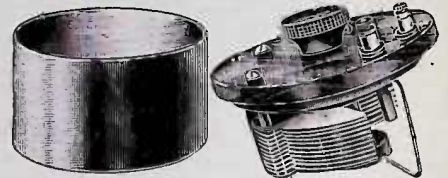
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AUGUST, 1909

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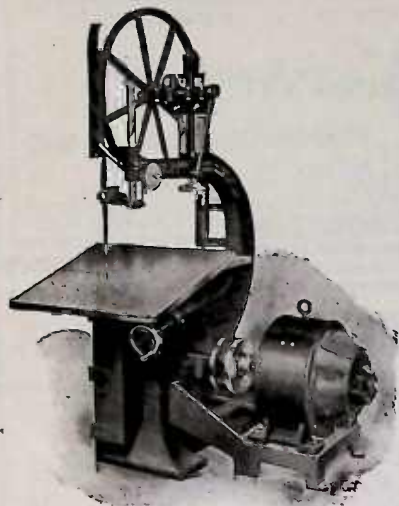
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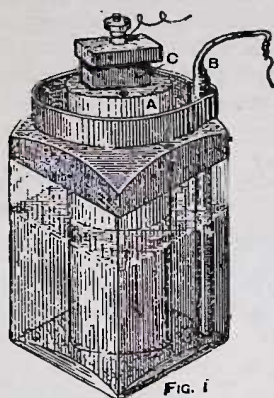
AUGUST, 1909

NUMBER 2

FITTING ELECTRIC BELLS

CLARENCE BIGGS

The task of fitting a simple electric bell system in a house, whether it be as an ordinary door bell or for signalling in case of burglars or fire, is one which any inexperienced person can easily



undertake and when once the principle which underlies the action of the electric current is clearly understood, it becomes possible for even an elaborate installation to be undertaken. In ordinary houses where the bell is operated by means of a push from the front door, we have what is perhaps the simplest electric bell system possible. This consists of (1) a battery cell, (2) a vibrating bell, and (3) a push, and when these are connected up with a metal wire in a well-known and recognized manner then, when the push is pressed, the electric circuit is "closed" and the bell starts ringing.

TYPE OF BATTERIES

There are many types of batteries which will answer the purpose of ringing electric bells, but the one universally adopted is that known as the Leclanché (named after the inventor) a single quart cell of which being sufficient to operate a small bell when the distance traversed by the wire is not very long. An illustration of a Leclanché cell is given in Fig. 1 and it consists, as shown,

of an outer glass jar—usually square, containing an inner porous cup, A, and a zinc rod, B. The porous cup contains a carbon plate, C, with a leaden cap and around the plate is tightly packed a mixture of equal parts of crushed carbon and peroxide of manganese—without dust—whilst the outer cell contains a sal ammoniac solution. With a cell thus made, chemical action takes place when the carbon plate and zinc rod are joined by a wire, setting up an electric current, and this is the force which is of such use in the electric bell systems of the present day.

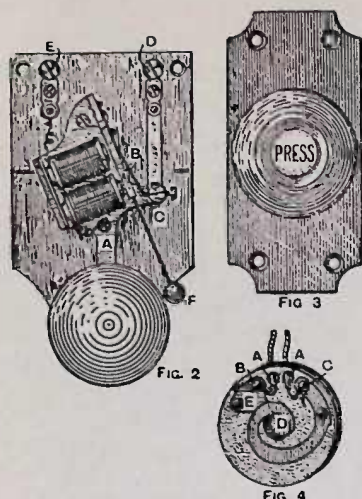
The reason why this type of battery (two or more cells usually being spoken as a battery) is so extensively used, is on account of it giving the least trouble, and further, the cheapness of its maintenance.

Another type of battery, which is useful in giving an intermittent current such as required for electric bells, is the so-called dry battery, and this kind is undoubtedly best when the battery is liable to much vibration, or in warm climates; they are not, however, so suitable for heavy work or continuous action.

THE BELL

The type of bell required is so well-known that little description is necessary, but few ordinary people seem familiar with its action, and as this knowledge is necessary, should slight adjustments or repairs be needed, the mechanism of the ordinary vibrating bell is shown in Fig. 2. This consists of a polished wooden back—usually of teak or walnut—upon which is mounted a cast iron frame, A, carrying the bobbins covered with No. 26 B.W.G. silk-covered wire. An armature of soft iron, B, is fixed to a steel spring, one end of which touches a platinum point, C, and this point is the end of a screw which works in a short pillar connected by means of a metal arm or wire to a terminal, D. The second terminal,

E, is connected to one of the loose wires of the bobbin—either direct or through a metal plate—whilst the other end of



the bobbin wire is either directly connected to the armature spring, or to the metal base plate, as shown.

The action of the bell is as follows: When the circuit is closed, a current of electricity is generated from the battery and flows through the wire in at terminal, E, from thence it flows through the wire round the bobbins, and in doing so the soft iron cores inside the bobbins become magnetized and attract the armature, B, causing the hammer, F, to strike the gong a smart tap. When this occurs, the spring on the armature ceases to make contact with the platinum point, C, thus breaking the circuit and allowing the armature to fall back again. The circuit is again closed, another tap occurs, and thus a continuation of these taps causes the vibrating sound of the bell we hear. The usual sources of weakness in cheap bells are the springs and contacts; the springs should be of tempered steel and plated to resist rust, and the contacts should be of platinum.

The push is used for closing the electric circuit, and when the connections of the battery and bell are in order, the act of depressing the central stud should cause the bell hammer to vibrate. A common form of street door push is illustrated in Fig. 3, with the back or working part shown separately in Fig. 4, which latter is made of a non-conducting material, such as vulcanite, etc., and is

screwed in the central part of the frame from the back. The two wires—one from the bell and one from the battery—are passed through the holes, A, and the bared ends wound round the screws, B and C, which are then screwed down tight. When the stud is depressed, the top part of the spring, D, is pressed on to the bottom part, E, and thus the ends of the two wires are metallically connected together through the two springs, D and E.

Having thus explained the chief features in a simple electric bell system, we will now consider how an electric bell, to be operated by a simple push, is fitted up, and for convenience the case will be taken where the push is fitted to the front door.

THE POSITION

The first thing to decide is the best position of the bell and the battery. As previously explained, the Leclanché battery requires such little attention it can be put right out of the way, and the place usually selected is on a shelf in the cupboard under the stairs. It matters little, however, wherever it is placed, so long as it is dry and cool, warm or damp places lessening or preventing the action of the cells. For a short distance one quart cell will be sufficient, costing about 60c without the solution, which should be mixed in the proportion of 2 oz. sal ammoniac to 1 pint of water, and the outer cell two-thirds filled. It must be a saturated solution.

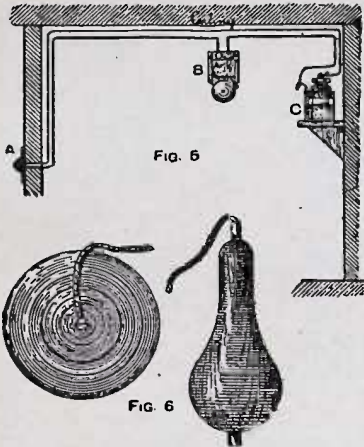
The bell should, of course, be put where it is best heard under all conditions, and if it is the only bell in the house, then the hall is usually the best place. The wires necessary for connecting up are made of copper and covered with some non-conducting material and should be placed in such a position that they can be hardly noticed, consequently on the wall under the ceiling or along the skirting boards of a room may be generally regarded as best positions.

It must be remembered that there are two wires running from the street door push, and for convenience these wires are run together side by side as far as possible, as being thoroughly covered with non-conducting material such as double cotton soaked in paraffin wax, silk, or even india rubber, risk of connection be-

tween the wires (called short circuiting) is avoided. A little wire more or less matters little in the action of the bell, yet it is not advisable to make the path of the wires too long, as they possess a certain amount of resistance to the electric current and obviously the longer the wires the more the resistance.

HOW THE WIRES WILL BE PLACED

There will be two wires running from the street door, one of which goes to the battery and one to the bell, whilst a short length will also run from the bell to the battery. These connections may be better understood by reference to the diagram (Fig. 5), where A is the street door push, B the bell, and C the battery, the black lines indicating the wires. In measuring up the wire before purchasing,



paper, and the wires passed through the holes, A, Fig. 4, the bare ends being wound round underneath the screwheads, as shown. Screw on the outer case and temporarily fix to the woodwork by one screw, carefully pushing the wire through frame.

The wires must be run along the wall where convenient, bearing in mind the best positions, as previously stated. One wire must be conveyed to the screwed terminal on the top of the carbon plate of the battery cell, whilst the other must be taken to a terminal of the bell. The bell and battery must now be joined together by a short length of wire. Reference to Fig. 5 should make this quite clear. In connecting the wires to the terminals, the same procedure must be adopted as in fitting to the push, viz., the ends must be bared for at least an inch, cleaned with emery, and then wound round the screw of the terminal and tightly screwed down. This is important, as with bad connections, weakness of the circuit or even failure, is almost bound to occur. When all is connected up, test the bell by depressing the push, and if the wires have been joined up correctly the bell should ring. The front door push can now be screwed up and the wires put straight in position.

In fixing the wires to the wall and woodwork, staples should be used, but great care should be taken so as not to injure the covering, because the staple being made of metal will close the circuit (short circuiting the current), and thus spoil the system.

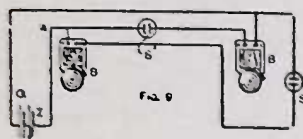
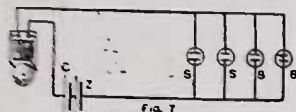
In new houses it becomes possible to shorten the length of the wiring by running wires down behind the door frame below the flooring and underneath oat of way; this, however, is not always advisable as in case of repair the trouble to get at the wires is increased. When wires are run in walls or behind fixed framework, insulating tubing may be used to take the hidden wires, the ends of the tubing being rounded off to prevent damage to the insulation.

Once the worker has mastered the proper manner of connecting up the wiring, the installation of more complex systems becomes fairly easy, and only needs a little study with pencil and paper to devise some intricate signalling by electric bells.

allow an inch extra for fitting to each terminal and about 2 in. for each wire for connecting to the push. The size of wire used for electric bells is that known as No. 18 B.&S., although No. 20 is often used, but mostly for short lines. The prices vary from 1c per yard, according to the nature of the insulation—silk being much higher.

The next step is to mark the position of the push, and this should be about 4 ft. from the ground on the door frame. Bore two small holes through the door frame a little distance apart to take the wires, leaving, say, a couple of inches protruding in front. A larger hole can be used to take both wires, if great care is taken not to damage the insulated covering. The ends of each wire must be stripped of their covering for a distance of about 1 in.; then cleaned with emery

Before considering more intricate wiring, it may be here remarked that there are various types of pushes besides the one shown, but all work on the same principle as previously described. There is the cheap kind of wooden push, which can be bought for a few cents, the pear-shaped push (see Fig. 6), which is connected to a rosette of wood or other material fixed to the wall. These are useful for operating from the study table, or from the bedside in the case of invalids. There are other means of making contact which are useful in the warning of burglars, or in time of fire, and these will be explained later. All that is necessary in devising an electric bell system is to be able to trace a circuit along a metal wire without a break through the battery and bell when contact is made by means of a push or other device. Take the case of Fig. 7, for example, and it may be remarked that here the battery is indicated by the thick and thin lines marked C and Z, there being two cells shown in this diagram. This



is the conventional manner of representing a battery by practical men, and will be adopted in future sketches.

In Fig. 7 the bell can be operated by either of the four switches or pushes, S, and when any one is pressed a complete circuit can be traced from push to battery, battery to bell, and from bell back to switch. In fitting up such a system, supposing that the pushes are in separate rooms of a house, the best place after putting the bell and battery in position is to take the wires from them up to the farthest room, and in so doing run

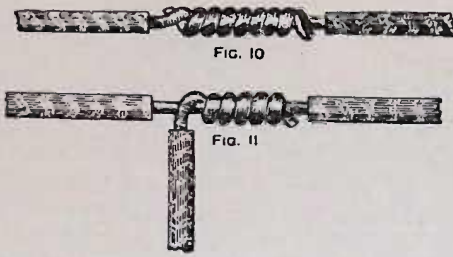
as near to the other rooms as possible, then joining the other wires to them as indicated. As the length of the circuit may be reasonably supposed to be a long one, two cells properly joined together must be employed. The best method of connecting together branch wires will be presently explained. In connecting two or more cells together, a wire must be run from the carbon of one cell to the zinc of the next.

Fig. 8 shows the manner of wiring up so as to ring two bells from one push, and in this case each bell takes half the current. The method of joining up the bells in this case is known as being "connected in parallel," on account of their similar terminals being in direct communication with the same terminal of battery.

In Fig. 9 we have a method of signaling in two directions. When the push, S, is pressed, the bell, B, will sound. This may seem complicated to follow, but in reality it is not so. Suppose for example the push, S, is pressed, the current flows from the carbon of the battery right round to the push, S, and through this push to the bell, B, then through the bell to the line, A, and thence round to zinc of battery. In a similar manner when S¹ is pressed, bell B¹ will ring.

In wiring for electric bells, it becomes possible to join wires together so as the current will continue to flow, despite the fact that the wires are broken, and this is especially useful in connecting branch wires, as indicated in Figs. 7, 8 and 9. To connect up the ends of two wires in one straight line, strip off the insulation on each wire for a distance of 1 in., and clean the bare wires with emery cloth, afterwards binding together tightly. The best plan is to cross the wires in the form of a letter X, twisting one wire to the right, and one to the left until a good joint is made. The bare wires should now be covered with a damp proof insulation, to prevent the copper corroding, which would increase the resistance. The best plan is to solder together, using resin as a flux. Fig. 10 shows two wires connected together in a straight line, and Fig. 11 two at right angles.

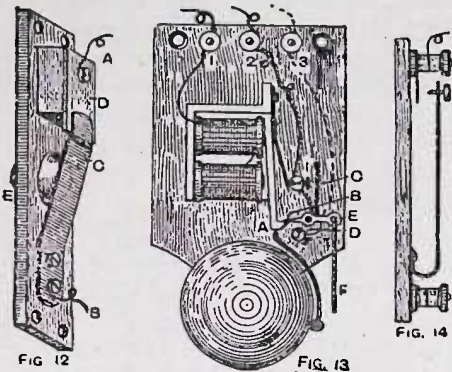
With the examples previously explained (see Figs. 7, 8, and 9), it should become quite possible for almost anyone



with a little thought to devise many other systems, the method in which the circuit is closed so as to operate the bell being immaterial so long as a good contact is made.

Fig. 12, for example, illustrates a burglar alarm contact, and in this the electric circuit is closed when the wires, A and B, are in direct metallic communication, and this only occurs when the top of the spring, C, is touching the metal topped ebonite block, D.

This device is fitted to the bottom of the window sash, and sunk level with the woodwork so that the end of the marble at E projects slightly as indicated. When the window frame is in position the marble is forced back, and the top of spring, C, kept away from the metal surface of D, thus at night should the window be raised the marble is forced slightly outward, allowing the spring to close the circuit, and thus start the bell ringing.

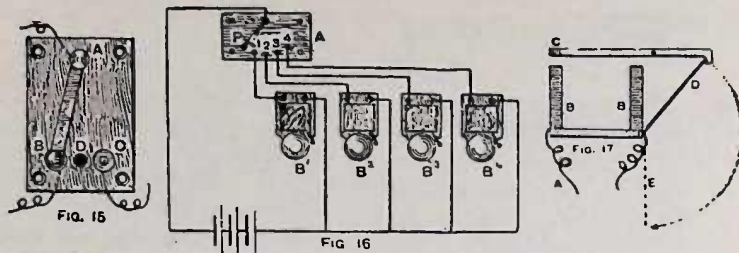


In connection with burglar alarms, it is far better to employ a continuous ringing bell, so that when once the circuit has been completed, i.e., when the window sash has been raised, the bell will continue to ring, even when the circuit is again broken by closing the window, thus notifying the fact that the window has been once raised. The mechanism

of this kind of bell (see Fig. 13) is somewhat similar to the ordinary vibrating kind, but it has three terminals, 1, 2, and 3. The armature is slightly longer than in the vibrating bell, and at its lower end, A, carries a catch which engages a trigger, B. When the circuit is closed, the current passes through the terminals, 1 and 2, and also the coils; thus the cores are magnetized, the armature is attracted, and the trigger released. The spring, C, pulls up one side of the trigger, the other end falls down, makes contact with D, and another circuit is closed; but this time through terminals 2 and 3—see dotted lines—which entirely excludes the alarm contact, and thus the bell continues to ring until the trigger is restored to its former position by pulling a cord attached at E. This type of bell is also useful for fire alarms when it is necessary that the bell should continue to ring until attention is attracted.

Many types of electrical fire alarms have also been adopted, and the majority of those at present all depend for their efficiency on the fact that heat makes most substances expand, and so cause contact to be made. Others operate by means of a platinum wire being inserted in a thermometer, so that the mercury makes contact with the wire when the temperature rises. Fig. 14 shows one example of an electric fire alarm, and needs but little description. All that is necessary is to fix up the circuit, immerse the device in water at the desired temperature, and regulate the small side screw until the bell rings. Remove from the water, and then it will be noticed that as the metal contracts, the circuit is broken, and thus requires the heat of the room to be at the required temperature, in order for the bell to ring again.

It is often necessary to break an electrical circuit, such as for example in burglar or door alarms, during the day time, so that the opening and closing of windows or doors will then not operate the bell. In such cases, switches are used, and a simple two-way switch is shown in Fig. 15. One of the wires from the battery connected to the terminal, A, whilst the other line wires to the studs, B, and so that when the handle is switched over to either stud the particular circuit is closed, and the bell can ring when con-



tact is made either by push window contact, etc. When the handle is on the central pin, D, then communication is broken.

Switches can thus be made to connect up various bells. For example, suppose we have a four-way switch, as indicated at A in Fig. 16, then by connecting up the terminals to the battery, as shown, and the studs 1, 2, 3 and 4 to bells B¹, B², and B³, then by switching handle over to these studs the various bells can be rung. As shown in the sketch, the circuit is broken, there being no connection between P and either 1, 2, 3 or 4.

When fitting up an electric bell system, the use of an indicator is often necessary, showing from what part of the building the bell has been rung. These are somewhat complex in detail, but, as a rule, their principle is exceedingly simple, their action depending upon the current magnetizing two coils. Fig. 17 is a diagram, and will serve to illustrate the principle upon which indicators act. The current enters from A and round coils to B, and in so doing magnetizes them, which attracts one end of an armature, C. The other end of C therefore rises, releases the arm D, which, therefore, falls to the position, E, and can thus indicate through which set of wires the current passed.

Should the bell wiring and fitting have been properly executed in the first place, the usual cause of a bell not ringing can be traced to a defective battery. In the first place the solution may be exhausted, in which case the best thing is to take out the porous cup and wash the glass cell. Put in 3 or 4 oz. of sal ammoniac, and about half fill with water. Look to the zinc rod, and if crystals have formed on it scrape them off. Return the porous cup and connect up. The liquid in the outer jar should not be more than two-thirds full when the porous cup is in position, or else the sal

ammoniac will "creep" over the outer jar. Should this at any time occur, it must be removed, and the top—inside and out—well greased. Sometimes the porous cup gets choked, and prevents the efficient action of the cell, and in such a case the cup should be stood in boiling water for a little time, and then cooled. Should the wires run through a damp place, damp proof wiring should be employed.

It is always best in fitting up an electric bell system to buy the bell and push, but the handy man can make the battery cell quite easy. First, take a quart jam jar to serve for outer cell, and for the porous cup canvas can be used bent in circular form, and provided with a piece for the bottom, coated with melted paraffin wax, and also dip $\frac{3}{4}$ in. of the top into resin and hot pitch. The outer cell should be coated with brunswick black at the top. Insert the carbon plate, put in the mixture, adding the zinc and solution; then fit on the terminal. The manganese, carbon, zinc, terminal and solution can be bought for a few cents. In a future article the subject of fitting up electric light for amateurs will be considered.

When wiring with twin wire do not connect on to the battery until last thing. Should the ends of the wires come in contact, the battery would soon run down. When economy of wire is desired and a gas or water pipe connection is pretty handy at each end, it is possible to make the pipe serve as one conductor, using only a single wire as the other. Solder a wire to the pipe at each end and lead them to the battery, bell or push, as the case may be.

Watches were made in Nuremburg as early as 1417.

FORGING FOR AMATEURS—Part IX

F. W. PUTNAM, B. S.

CEMENTATION PROCESS

This is by far the most important method of producing steel for cutting instruments, i.e., steels of hard temper. As previously noted, when iron is heated in contact with carbon, carbon monoxide, or compounds of carbon and hydrogen (hydrocarbons), to a high temperature, carbon is taken up by the iron. This is the basis of the process by which all the best qualities of steel for cutlery, springs, etc., are produced. The superiority of the method is due to the fact that practically pure iron is employed for the purpose. Swedish bar iron, made in the Swedish Lancashire hearth under charcoal, from charcoal pig, is the material usually operated on, so that such steels practically consist solely of iron and carbon. The bars employed are about 10 ft. long, 3 in. wide and $\frac{5}{8}$ in. thick. Hammered bars are preferred. Basic steel bars are also sometimes employed.

The converting furnace proper consists of a rectangular arched chamber of fire-brick. This communicates by the chimneys, three on each side, with the hovel about 40 ft. high, which serves as a chimney and diminishes the loss of heat by radiation. It gives the furnace the appearance of an ordinary glass furnace. A narrow fireplace, 12 to 15 in. in width, runs down the middle, with a firing door at either end. On each side of the fireplace is a trough or pot for the reception of the bars of iron. They are made of firestones, open at the top, and rest on the benches on brick bearers, which divide the space below the pots into a number of flues. These are continued up the sides and ends of the pot; the space above the fire is similarly divided, so that the boxes may be heated as uniformly as possible.

The pots are from 10 to 15 ft. long, $3\frac{1}{2}$ to 4 ft. wide and deep. In the end of each is a small opening, known as the tap-hole. This is opposite a similar opening in the outer wall, and through it the tap or trial bars are withdrawn, from the appearance of the

fracture of which, the progress of the operation is judged. A manhole is provided for the purpose of charging and discharging the pots, and is closely bricked up during the conversion.

The pots are charged by first spreading a layer of charcoal nubs (about as large as peas or beans) over the bottom. On this a layer of bars, about half an inch apart, is placed. A second layer of charcoal, followed by bars, is then put in, and so on, until the pots are full, finishing off with charcoal. The charge is covered with "Wheelswarf."

This is the refuse from under the grindstones, and consists of particles of oxidized (rusted) iron and sand. At the high temperature of the furnace, this frits and forms a rough glass, which hermetically seals the pots and excludes air.

The manhole is bricked up and carefully luted, as also is the space around the trial-bars. A coal fire is then made, and the temperature gradually raised. In about twenty-four hours the pots are at a dull red heat, and in about fifty hours, or more, the bright red or yellow heat (1,100 to 1,200 degrees C) required for conversion is attained. This is steadily maintained for a period of from four to eight or ten days, depending on the degree of carburization required. For springs, saws, etc., four or five days suffice.

For shear steel, 5 or 6 days; double shear, 7 to 8 days; and tool steel, 10 days or more. The progress is judged by the appearance of the fracture of the trial bars, a crystalline layer of steel of greater or less depth is formed, enclosing a "sap" of unaltered iron, but there is no sharp line of demarcation. When judged complete, the fires are allowed to burn out, and the furnace to cool very gradually. This occupies about a week, and the pots are then discharged. The bars present a blistered or warty appearance and a laminated structure, and are hence known as *blister steel*.

These blisters are evidently formed by the efforts of gas to escape from the interior of the bar while in a pasty

state. The gas is formed by the action of the carbon on particles of slag, containing oxide of iron, enclosed in the iron.

The bars are brittle, and are sorted out by breaking with a hand hammer on a block, and examining the fracture. "Spring temper" shows a comparatively thin skin of steel enveloping unaltered iron. In "double shear heat," the proportions of steel and iron are about equal. In "melting heat," the "sap" has disappeared and the conversion has extended through the bar. The carburization is probably due to the decomposition, by the iron, of carbon monoxide produced from the oxygen in the small amount of air retained in the pot and in the pores of the carbon. As before noted, iron at redness is easily permeated by gases, and thus carbon is carried into the interior of the bar. The amount of carbon taken up varies with the time and temperature up to 1.5%.

Blister Steel is brittle, largely crystalline, and lacks homogeneity. For most purposes it is either tilted or melted.

Shear Steel. The blister is cut into lengths, faggoted, reheated, and welded, and then either drawn out under the hammer or rolled, in a manner resembling the treatment of iron. By this means greater uniformity of composition is obtained. The metal sometimes undergoes a second piling and reheating. By this treatment the percentage of carbon is very slightly reduced by oxidation, and only the milder tempers with less than 1.125% of carbon can be satisfactorily welded. The pile is frequently coated with clay wash and borax, to protect it from oxidation and facilitate welding. Tilted steel has lost the laminated appearance of blister steel and is more uniform in character.

CAST CRUCIBLE STEEL

Steel produced as above must necessarily be far from homogeneous. In 1740, Huntsman introduced the practice of melting down the blister steel in crucibles, pouring it into ingot moulds, and working the ingots into bars, etc. The fusion ensures uniformity of character and composition, hence the term *homogeneous* metal or steel applied

to it. Its commoner designation is *crucible cast steel*.

The steel-melting holes or fires are simply wind furnaces of oval section, lined with ganister. They are placed below the floor level for convenience of handling the pots. Each fire has a separate flue, which is continued down behind the furnace, and opens into the ash-pit. The draught is regulated by the insertion or removal of a brick in this opening. The crucibles, which are dried on shelves round the melting-house, are from 16 to 19 inches high and 6 to 8 inches in diameter at the mouth. Each fire takes two pots. Before placing them in the furnaces, they are annealed in a stove or oven, mouth downwards, for some hours, gradually attaining a dull red heat. The blister steel is cropped up into small pieces, and the charge is introduced into the heated crucibles by means of an iron funnel. The pots generally last about three melts, the weight of the charge being less each time. Thus a first charge of 50 lbs. will be followed by charges of 45 and 40 lbs., respectively, for the second and third.

The charge having been introduced, the lid is put on, the fire is made up with hard, free-burning coke and the furnace closed. This first fire burns off in about forty-five minutes, and is followed by a second and third firing. The amount of fuel added in the third fire is judged from the amount of metal remaining unmelted, to ascertain which, the workman pokes an iron bar into the pots and gives directions accordingly, in order that all the crucibles may be ready at one time. The crucibles are lifted from the fires, for teeming, by grasping them round the belly with tongs having bent jaws, which encircle the pots. The first melt occupies from 4 to 5 hours.

Small ingots are run from a single pot. For larger ones the pots are doubled, that is, the contents of two pots are transferred to one before teeming, while for still larger ones the metal from the crucibles is transferred to a ladle, or arrangements must be made to keep up a constant stream of metal into the mould.

The ingot moulds are of cast iron,

and made in two parts. While casting, they are held together by an iron ring. The moulds are warmed and reaked, that is, coated with lamp-black, by smoking them with the flame of burning tar. Sometimes a wash of clay is applied. This treatment prevents the ingots from sticking. In pouring, the hot stream of metal should not touch the sides.

The pots, if in good condition, are returned, after detaching clinker, etc., to the fires, ready for the next charge. If allowed to cool, they cannot be reheated without cracking. In melting blister steel, it is usual to add a small quantity of black oxide of manganese, which is partly reduced, and manganese passes into the metal. The slag is removed before teeming by moving a knob of slag (mop), attached to an iron bar, over the surface of the metal, by which means the slag is cooled, collects on the mop, and is removed.

DIRECT CAST CRUCIBLE STEEL

In casting large ingots of crucible steel, bar iron or puddled steel is employed, instead of blister steel, charcoal, spiegel and ferro-manganese being added to carburize the metal to the desired degree. Ingots 40 tons in weight have been cast.

A regenerative crucible furnace for steel melting takes from 8 to 24 pots in a double line. The roof is in several sections, which can be removed as required for charging or teeming purposes. Some furnaces of this type are provided with a movable bottom, which can be elevated, by a hydraulic ram, to the floor level, with all the pots standing on it.

PRODUCTION OF STEEL FROM PIG IRON WITHOUT PREVIOUS CONVERSION INTO MALLEABLE IRON

These processes involve the removal from the pig of the silicon, sulphur and phosphorus, and the reduction of the amount of carbon to the quantity required to convert the metal into steel. It is found more satisfactory, however, to completely remove carbon as well, and recarburize by the addition of carbon in some form or other, generally as spiegeleisen or ferro-manganese; but gas carbon and other sub-

stances are also employed (Darby process).

BESSEMER PROCESS

In the Bessemer process the impurities are burnt out of the pig by blowing air through the molten metal. All the impurities, except sulphur, will practically be oxidized before the iron, so that by stopping the blast at the right moment, and adding a quantity of spiegeleisen or other carbon-bearing material sufficient carbon may be introduced to produce steel of the desired temper.

The process is generally conducted in a vessel or converter. It consists of a boiler-plate casing $\frac{3}{4}$ in. thick, carried on a cast-iron ring, provided with trunnion arms, upon which it is carried in bearings on standards or other supports. Upon one of the trunnions is keyed a toothed wheel, which gears with a rack attached to a hydraulic ram, by the movement of which the converter can be rotated on its bearings through 180 to 300 degrees. The other trunnion is hollow, and connects by a pipe with a blast-box at the bottom of the converter. This is a compartment into which the blast is led through the hollow trunnion, and and forced through the metal by means of clay tuyeres passing through the upper or guard-plate of the blast-box and the lining of the vessel. The vessel is lined with about 9 to 12 in. of ganister on the sides, and 18 to 20 in. on the bottom. The tuyeres are slightly conical in form, and are about 22 in. long. They are made of fire-clay, and contain from 10 to 12 $\frac{3}{8}$ in. holes, running in the direction of the length, by which the air passes from the blast-box to the vessel. They pass up through holes in the guard-plate, against which they are pressed by suitable stops, and are embedded in the ganister, lining the bottom. They only stand out slightly from the surface.

If a tuyere proves faulty in work, it can be removed and replaced, by taking off the bottom plate, knocking it out, and pushing up a new one in its place, a little slurry of ganister being run round from the inside to make the joint secure. After drying and heating, the converter is again ready.

Converters with detachable duplicated bottoms are now commonly employed, so that little delay is occasioned by the removal of a worn-out or faulty one, and the substitution of a newly prepared bottom. The vessel itself is also made in sections, and duplicate parts are kept in stock.

METHOD OF CONDUCTING THE PROCESS

The pig iron to be treated is melted in cupolas, or is taken direct from the blast furnace, after mixing to ensure uniformity. The converter, previously heated, is turned on its side, and the metal run in. The full charge lies below the level of the tuyeres when in this position. The blast, at a pressure of from 20 to 25 lbs., is then turned on, and afterwards the vessel is rotated into a vertical position. The metal now flows over the bottom, and the air passes up through it, the high pressure preventing its running into the blast-box. At first, only a short, yellowish-red flame is seen at the mouth of the converter, accompanied by sparks. During this period, the temperature rapidly rises. The silicon is being rapidly oxidized to silica (SiO_2), which, combining with oxides of iron and manganese, forms silicates. The flame gradually becomes larger and more luminous, and is accompanied by showers of brilliant sparks, consisting of slag and particles of iron. This corresponds to the "boiling stage" of the puddling process, and is known as the *boil*. The violence of the disturbance of the metal is due to the rapid oxidation of the carbon with the production of carbon monoxide, which escapes. During this part of the process, the pressure of the blast is reduced. The luminosity and volume of the flame gradually diminish, and in the third or "fining" stage, during which the remainder of the carbon and manganese are being removed, it fades to a pale amethyst tint, and is nearly transparent. There are also fewer showers of sparks. In from fifteen to twenty minutes from the commencement of the blow, the flame suddenly shortens or "drops." This marks the almost complete removal of the carbon, and if the blast is further continued, great loss from oxidation takes place, and the quality

of the metal is rendered much inferior. The vessel is accordingly turned down, and the blast shut off. A weighed quantity of spiegeleisen, previously melted in a cupola, is added to the metal, as it lies in the converter, from a ladle. This addition is attended by a violent outburst of flame and considerable agitation of the metal. The spiegel imparts to the iron the requisite amount of carbon to produce steel of the desired temper, and also sufficient manganese to restore the malleability, which, as before noted, is always lost when malleable iron in a molten state is subject to oxidizing influences. For steel of very low temper, ferro-manganese is employed, in order to introduce the necessary amount of manganese without adding too much carbon. This is added solid. After standing a few minutes to allow the slag and metal to separate, the converter is turned down and the steel run from its mouth into the ladle. Enough slag to cover the metal and keep it hot is also allowed to flow into the ladle. The converter is then turned completely over, and the slag allowed to run out. All the movements of the vessel, as also the blast, are regulated by a workman situated on an elevated platform at some distance from the converter, the progress of the operation being judged from the appearance of the flame.

The ladle, to which the metal is transferred, is mounted on a hydraulic crane, in the centre of the casting pit, which is circular. The converters are situated on the side of the pit. The ladle can be raised and lowered, can be made to travel round the pit, to and from the centre, and also turned over to empty slag. It is lined with ganister, and heated by a fire made in it before receiving the metal. The teeming is effected from the bottom, through a hole closed by a fire-clay stopper, which is raised and lowered by an iron rod protected with fire-clay tubes and connected with a suitable lever.

The process described above is commonly known as the *acid* process, from the siliceous nature of the ganister lining. The slag is a basic silicate of iron and manganese. As already shown, iron containing phosphorus cannot be treated under these circum-

stances. By substituting a lining of basic material, phosphorus, as well as other impurities, may be removed.

THE BASIC BESSEMER PROCESS

This process is conducted in a vessel similar to that already described, but generally with a straight neck, so that the metal can be poured from either side, and the converter can be completely rotated by worm and wheel gearing, actuated by hydraulic engines attached to the standards.

The converters are made in sections, which can be readily secured together by pins and cotters, so that if the lining of any portion gives way, another similar part can be substituted without delay; an overhead travelling crane which commands the converters, and hydraulic tables under each converter, being provided for raising and lowering the parts.

The lining employed consists of calcined dolomite or magnesite, and is about 14 to 16 in. thick on the sides, and 24 in. on the bottom. Loose tuyeres are sometimes employed, but generally they are formed by ramming the lining material round steel spikes, which are withdrawn when the bottom is rammed up, and thus form free passages for the air. The process differs somewhat from the ordinary *acid* process. Before running in the iron, a quantity of lime, equal to about 15% of the charge, is introduced, with a little coke, into the hot converter, and blown hot. The charge is then run in, in the usual manner, and the blow proceeds as before up to the point at which the flame drops. Instead of stopping the process here, the blast is continued for some two or three minutes longer to eliminate the phosphorus. The vessel is then turned down, and a sample taken with a spoon, hammered out, cooled and broken. From the fracture and malleability, the workman judges how long the blow must be continued to complete the elimination of phosphorus. A crystalline fracture indicates that the phosphorus is not completely removed, and the vessel is turned up, and the blowing continued until the metal is dephosphorized. A second sampling may be necessary.

The slag is then run off, to prevent precipitation of phosphorus into the metal by reduction from the slag when the carbon is added. Spiegel and ferro are then added in the usual manner, and the charge transferred to the ladle, and thence to the moulds. In some cases, where hard metal is required, the carburization is effected by grey pig iron free from phosphorus, added in a molten state to the metal in the ladle, ferro-manganese being afterwards added.

The oxidation of impurities during the blow, up to the dropping of the flame, proceeds as in the acid process, but, owing to the nature of the lining and the basic character of the slag, some phosphorus is also removed. In the after-blow, all of the phosphorus is oxidized, and, combining with lime, forms calcium phosphate, and passes into the slag. This frequently contains as much as 30% of phosphates of lime and magnesia, together with 8 to 10% oxide of iron, sulphur, and some oxide of manganese. It amounts to about 20% of the charge, and on account of the phosphates present is ground up and used as manure.

OPEN-HEARTH PROCESSES

Under this heading are included processes conducted in regenerative gas furnaces of the Siemens type, the bed of which may be composed of silica sand (acid), or of magnesite, dolomite or chromite (basic).

Siemens' Regenerative Furnace is a double-ended, reverberatory, gas-fired furnace. The furnace chamber communicates at either end with the chambers by means of the ports and flues. The chambers are filled with chequer brickwork, built up of bricks 2 in. square. The chequers are alternately heated by the passage of the hot gases from the furnace descending through them on their way to the chimney stack, and the heat retained is subsequently given up to the cold air and gas passing upwards through them on their way to the furnace. The chambers are worked in pairs, the gas and air being heated in separate chambers. One pair of chambers is being heated up while air and gas are passing through the other pair. The smaller chambers

are the gas chequers. The direction of the air and gas are reversed every half-hour. In this way the chequers are kept at a high temperature, and the gas and air coming to the furnace develop a much higher temperature than if supplied cold.

THE SIEMENS PROCESS

This process is analogous to the "pig-boiling" puddling process, the decarburization of the metal being effected by pure oxidized iron ores added to the fused metal in the bath of the furnace. On this account it is sometimes described as the "pig and ore" process.

The pig iron, to the extent of 5 to 40 tons, is introduced on the bed of the furnace and melted. After fusion, additions of red hematite, roasted pottery mine, or other pure oxidized ores are made from time to time, which effect the oxidization and removal of the silicon, carbon and manganese in the pig in the same manner as in puddling.

At the high temperature attainable in these furnaces, however, the metal remains molten, even after decarburization is complete, and its conversion into steel is effected by the addition of spiegel and ferro, as in the Bessemer and basic Bessemer processes. The time occupied is, however, much longer, extending sometimes to 10 or 14 hours with large charges. This permits of more perfect control over the composition of the steel produced, as samples can be taken from time to time, and the character and carbon contents of the metal rapidly determined. When the carbon has been reduced below .1%, spiegel is added, the tap-hole is broken open, and the metal run into the ladle. Some ferro-manganese, broken into small pieces, is generally added in the ladle, as the metal flows out, to replace that lost by oxidation in the furnace, and to make up the amount necessary to restore the malleability and carburize the iron.

In the decarburizing stage, the metal boils violently, and is thus brought into contact with the oxidizing slags and the atmosphere of the furnace, but becomes quiet towards the end of the operation. The addition of the spiegel causes it to again become lively, and the metal is tapped on the boil.

The yield is some two or three per cent in excess of the pig iron charged, owing to the reduction of the ore added to decarburize it. A cutting oxidizing flame is employed in the earlier stages.

SIEMENS-MARTIN PROCESS

In this process the percentage of carbon to be removed from the metal is diminished by melting the pig iron with scrap wrought iron or steel introduced into the furnace at the same time, or previously heated and charged into the bath of molten pig iron. Scrap to the extent of 8 to 10 times the weight of pig is frequently employed. The charge, after fusion, contains less than 1% of carbon. The amount of scrap added depends on the greyness of the pig. No ore is added, and the decarburization is effected by the oxide formed on the scrap during melting, and the atmosphere of the furnace, which is oxidizing. The bath is sampled from time to time, and, when the carbon has been sufficiently reduced, spiegel and ferro-manganese are added as before. The loss amounts to about 7 or 8% of the metal charged.

A combination of the two processes is commonly used in this country, pig iron, scrap, and ore forming the furnace charge. It affords a convenient method to utilize scrap.

BASIC OPEN-HEARTH PROCESSES

In furnaces with sand bottoms, the pig iron employed must be of Bessemer quality but with basic bottoms phosphoretted pig can be treated. As in the basic Bessemer process, lime is charged in the furnace, and samples are taken from time to time and tested.

As the phosphorus is not required as a heat-producer, the less there is present the better. Pig containing about 1.5 to 2% is satisfactorily treated, the presence of manganese up to 2 or 3% is also desirable, as it prolongs the fining stage and permits of the elimination of the phosphorus without undue oxidation of the iron. In dephosphorizing, it is sometimes necessary to make small additions of ferro-manganese and pig to prevent this. The metal obtained by any of these processes is dealt with as in the Bessemer process.

CASTING

Formerly the casting-pits were rectangular, and the ladle, mounted on a carriage, travelled on rails over the top of ingot moulds.

Circular or semicircular casting-pits with hydraulic central cranes are being introduced.

Attempts have been made to combine the rapidity of the Bessemer process with the certainty of the results obtained in the open-hearth processes.

A combination of the two processes is followed by blowing the metal in a converter till the carbon is sufficiently reduced, and then teeming it into a heated Siemens' furnace, and completing the decarburization in the ordinary manner.

Hollow rabbles introduced into the molten metal on the hearth, by which air or steam can be blown through it, are in use to a limited extent. Clay-covered iron tubes are employed. At Ruhort, 3 such tubes, each containing 3 holes, are employed. The blast is continued for from 10 to 20 minutes, and the temperature rises higher than in the ordinary open-hearth process.

The steel produced by the Bessemer, Siemens and analogous processes is generally of a mild character, containing less than .5% of carbon, and is employed for rails (.3 to .4% of carbon); boiler-, bridge-, and ship-plates, .2 to .25% of carbon; rivet-iron, .1 to .15% of carbon; armor-plates, guns, and other purposes, where metal of high ductility, elasticity, uniformity and strength are required, and also for castings.

TREATMENT OF INGOTS

The ingot moulds, after the solidification of the metal, are lifted by cranes situated at the side of the casting-pit, and the ingots allowed to cool; or, in the newer works, removed immediately to "soaking-pits," in which they are kept hot till required for rolling.

These soaking-pits consist of a series of vertical chambers of fire-brick below the ground-level, arranged in a double line, each capable of holding an ingot, and covered with a tile and commanded by cranes. The ingots are removed to them immediately they have solidified.

The interior of the ingot when stripped

is much too hot to permit of it being rolled at once, and the excess of heat gradually soaks out and distributes itself uniformly through the mass. They can be kept hot for some time, and removed for rolling as required. Little heat is lost and reheating of the ingots is avoided. Oxidation is prevented by the gases exuding from the metal, which are of a reducing character.

The difficulty of keeping up a supply of ingots to keep the pits hot has led to the use of "soaking-furnaces," the several cells or pits of the furnaces communicating with each other, a fireplace or gas-producer being provided at one end of the system.

The rolling of mild steel is effected in a manner similar to that followed for malleable iron.

USE OF SPIEGEL AND FERRO-MANGANESE

In carburizing Bessemer or open-hearth steel, the richness in manganese of the alloy used is mainly determined by the amount of carbon desired in the resulting steel. If a steel very low in carbon is required, an alloy (ferro-manganese) containing much manganese is employed, to introduce the needful amount of that element, without at the same time adding an excess of carbon. For higher carbon steel, spiegel and ferro containing less manganese are employed. Steels containing a higher percentage of carbon than .5% may be made, as in the Darby process, by carburizing with gas carbon, anthracite, etc. The molten metal is run into a ladle containing the carburizing material, which it dissolves. An undue proportion of manganese is thus avoided.

In connection with the Austrian governmental establishment for the preparation of uranium products there has been built in Joachimsthal, Bohemia, a laboratory for working up radio-active substances found in the tailings and by-products of the uranium minerals. There will also be erected a bathing establishment, where the radio-active mine water will be used for healing purposes.

Greasy stoves may be cleaned with a strong solution of lye or soda.

GEAR CONSTRUCTION

EARLE W. REED

The subject of gear construction is one that is usually considered hard to master, and this may to some extent account for the comparatively few draftsmen that are able to make drawings without the use of the odontograph, but suppose a man wishes to draw a set of gears that cannot be drawn with the odontograph, he finds it necessary to have in mind the theoretical construction. The odontograph may be correct for the gears that it is intended to construct, but it cannot be applied to some gears.

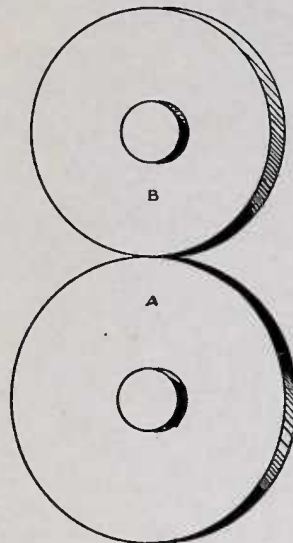


Fig. 1

The theoretical drawing of gears is very simple. Let us imagine two cylinders rotating with their faces in contact; then when A (Fig. 1) turns on its bearings it will cause B to turn on account of the friction between the two surfaces. However, in practical gears, we put teeth on these cylinders to prevent any loss of motion. These teeth are made up of two parts, the addenda and dedenda, as indicated in Fig. 2.

There are three kinds of curves used in the construction of gear teeth, involute, epicycloidal and hypocycloidal. The involute curve is the path of a point in a cord unwinding from a cylinder. The path of a point on a circle rolling

on the cylinder on which we are to construct the teeth, forms the epicycloidal and hypocycloidal curves that are used in gear construction.

We find the following names adopted by draftsmen for the different parts of gears:

The pitch circle (on which the teeth are constructed) is the original circumference of the cylinder.

The circular pitch is the distance on the pitch circle between the centre of one tooth and the centre of the next. As will be seen, the circular pitch is equal to one tooth and one space.

The diametral pitch is the ratio of the number of the teeth to the diameter of the pitch circle.

The pitch point is the point on the pitch circle where the two engaging teeth meet.

The addendum is the part of the tooth which is outside of the pitch circle.

The addendum circle is a circle drawn tangent to the addenda.

The dedendum is the space between the teeth inside of the pitch circle.

The dedendum circle is a circle drawn tangent to the dedenda.

The base circle is a circle drawn tangent to the line of action and is the circle on which the involute curve is drawn.

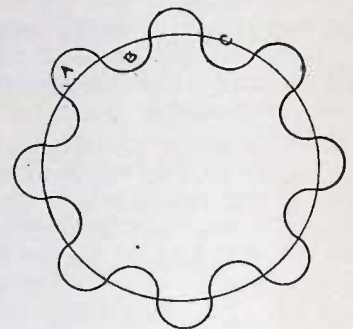


Fig. 2'

A, addendum, B, dedendum, C, pitch circle

The clearance is a small space left at the bottom of the dedenda for easing the working of the gears. This would be unnecessary in theoretical gears, but in practical gears it is necessary.

The back lash is a small space left between the teeth to prevent excessive friction.

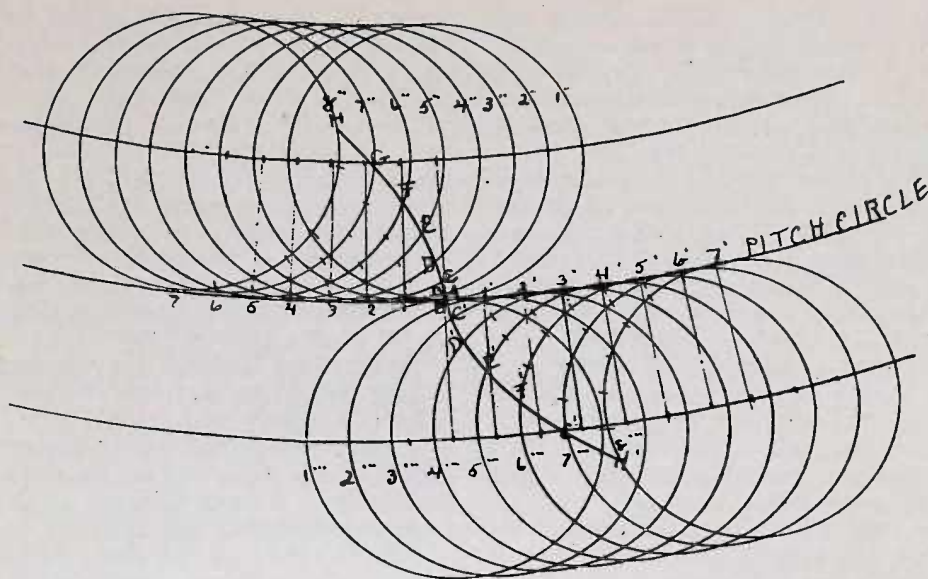


Fig. 3

The face of the tooth is the part between the pitch circle and the addendum circle.

The flank of the tooth is the part between the pitch circle and the dedendum circle.

The angle of action is the angle through which the gear turns while one of its teeth is engaged with the corresponding tooth on the other gear.

The arc of action is the arc of the angle of action and is found on the pitch circle. The arc of action must be equal to or greater than the circular pitch. If it is greater than this, the second tooth of the gear will be engaged with the corresponding tooth on the other gear, and if the arc is sufficiently large, the contacts will in a large gear be distributed over several teeth.

The following are some of the formulas necessary, in which A=Circular pitch, B=Diametral pitch, C=Thickness of the tooth, D=Clearance, E=Diameter of the pitch circle, F=Number of teeth, G=Addendum, H=Dedendum.

Formula No. 1. Addendum (G) = $1 \text{ in.} \div B$ or $A \div 3$.

Formula No. 2. Dedendum (H) = G or $1 \text{ in.} \div B$ or $A \div 3$.

Formula No. 3. Thickness (C) = $A \div 2$ or $3.1416 \div 2B$.

Formula No. 4. Clearance (D) = $A \div 20$ or $3.1416 \div 20B$.

Formula No. 5. Circular pitch (A) = $3.1416 \div B$ or $3.1416E \div F$.

Formula No. 6. Diametral pitch (B) = $F \div E$ or $3.1416 \times 1 \text{ in.} \div A$ or $AB = 3.1416$.

With these formulas and definitions, we are now ready for the drawing of the cycloidal curve.

In Fig. 3, we first draw a pitch circle, then from any point on the pitch circle, as A, draw the epicycloidal and hypocloidal curves. These curves represent the path of any point on a circle called the generating circle rolling on the pitch circle. To draw them, we take any convenient radius, as $1\frac{1}{2}$ in. for the generating circle. Draw circles with diameters $1\frac{1}{2}$ in. greater and less than the pitch circle, then take any point, as A, on the pitch circle and from that point lay off short equidistant spaces (1, 2, 3, 4, 5, 7) on each side of A. From these points, draw radii intersecting the circles just drawn. With the points made by these radii as centres, describe circles tangent internally and externally to the pitch circle, and letter them, starting with the one whose radius passes through A as in Fig. 4.

Suppose now that we consider that circles 1'' and 1''' are rolling until they coincide with 2'' and 2''', and we find that in doing so the point A

risers to B. Now consider circles $2''$ and $2'''$ rolling to coincide with $3''$ and $3'''$, the point then rises from B to C, and in like manner the other points are found and curves drawn through these points. The curves are drawn by taking the distance A1 as a unit of measure, and from 1 measure off on the circles $1''$ and $1'''$ a distance equal to A1, making the points B and B'. On circles $2''$ and $2'''$, with 2 as a starting point, measure off a distance equal to A1 making a point C. We continue in this way, taking A1 on each of the circles as many times as is indicated by the number at the point of tangency to the pitch circle. This completes the epicycloidal and hypocyloidal curves AH' and AH.

Now that we have these curves, we can find the centre line of our tooth and take points corresponding to those on the constructed curves, thus completing the cycloidal tooth.

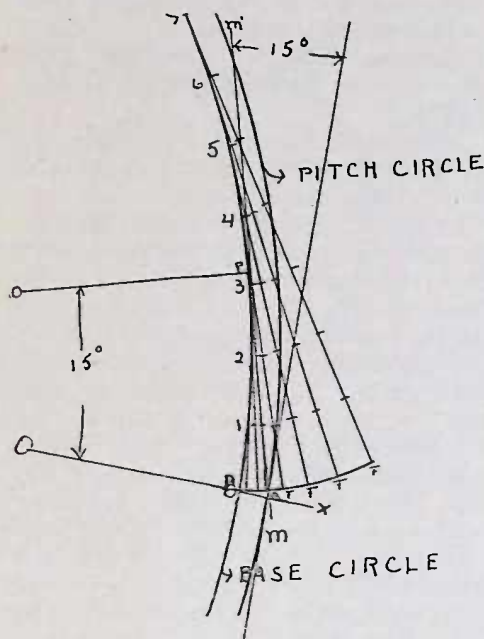


Fig. 4

We now have the involute curve to construct (Fig. 4). Draw the pitch circle and the centre line of teeth OX, cutting the pitch circle at A. If we take the angle of action to be 15° , we measure off 15° from a line perpendicular to OX at the point A, and we have a line of action in the line M'M. Now taking an angle of 15° at O, the

centre of the pitch circle, we have a perpendicular OP to the line of action, which is also the radius of the base circle. Now on this base circle, lay off equal distances on one side of B as 1, 2, 3, 4, etc. From these points, draw tangents 7F, 6F, 5F, etc., and on these tangents measure off the distance 1B as many times as is indicated by the numbers at the point of tangency, and connecting these points, we have the involute curve required in the drawing of gear teeth.

A practical method for the drawing of the tangents is to draw the radii from O to each of the points as 1, 2, 3, 4, etc., and at the points where these radii cut the base circle, we draw perpendiculars, for the tangent to a circle is perpendicular to the radius.

For the part of the flank below the base circle, we have a line drawn from the centre O to the base circle, thus completing the involute tooth. A centre line is now found and points taken off, corresponding to the points on the curve already constructed with the dividers.

We are now ready to make drawings of gears, and to do this, we must have certain data given us.

Let us take the following: circular pitch, 2 in.; number of teeth in gear, 20; number of teeth in pinion, 16; angle of action, 15° ; using the involute curve.

From these, we will draw a set of gears that will fulfil all the requirements by substituting these in the formulas.

First, we must find the circumference of our pitch circle, and since we must have 20 teeth 2 in. apart, we must have a circumference of 20×2 in. or 40 in. Now divide this 40 in. by 3.1416, and we have 12.73 in. as the diameter of the pitch circle on our gear. In the same way the circumference of the pinion is found to be 16 (number of teeth on pinion) $\times 2$ in. = 32 in., 32 in. divided by 3.1416 gives us 10.18 in. as the diameter of the pinion. Draw the pitch circle of the gear with the diameter 12.73 in. Through the centre of the pitch circle of the gear, draw a straight line called the line of centres, and where this line cuts the circle at A, Fig. 5, draw the pitch circle of the pinion tangent to the pitch circle of the gear and with its centre on the line of centres.

Since we are to draw an involute

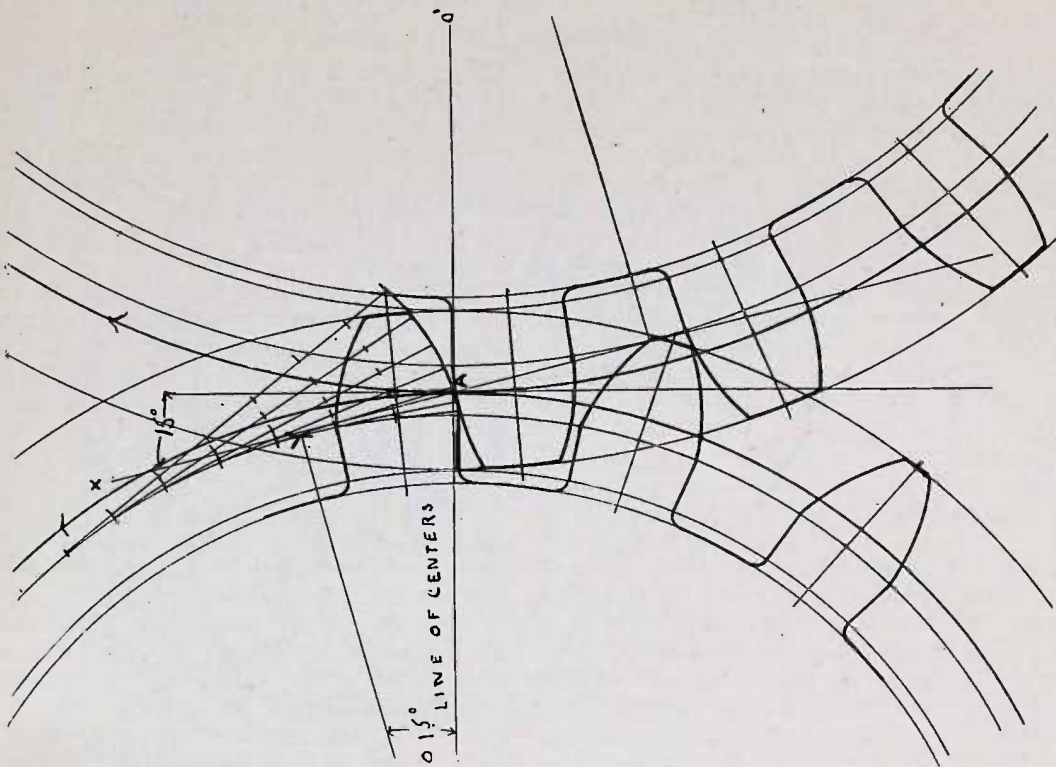


Fig. 5

gear, we now erect a perpendicular to the line of centres from the point A and draw AX, making an angle of 15° (our angle of action) with this.

Draw a line OY perpendicular to AX, passing through the centre of the pitch circle, making the angle AOY = 15° . Now with radius OY, we draw a circle which is called the base circle, on which our curves are constructed. Starting at the point A, draw the involute curve as already directed. Now we take our circular pitch (2 in.), and mark off points 2 in. apart on the pitch circle, and from these points, draw radii to the centre of the circle. These lines from the centre are centre lines on which the teeth are drawn.

Having done this with the gear, we do the same with the pinion or the smaller gear, drawing our involute curve on the pinion, so that it will make perfect contact with the corresponding tooth on the gear at the point A.

Now take formula No. 1 addendum = $A \div 3$ or $2 \text{ in.} \div 3$. Draw circles from OO' as centres $\frac{2}{3}$ in. greater and less than the pitch circles.

Take formula No. 3 thickness of tooth = $A \div 2$ or $2 \text{ in.} \div 2$ or 1 in. This 1 in. is taken as the space between each one of the teeth, but the teeth themselves must be smaller with allowance for backlash. In small gears this does not need to exceed $\frac{1}{32}$ or $\frac{1}{16}$ of an inch, and in larger gears the amount depends on the kind of work to be done by the gears. We will allow $\frac{1}{16}$ in. for our construction, therefore we take $\frac{1}{32}$ in. from each tooth ($\frac{1}{64}$ in. from each side of the centre of the teeth), and when engaged this gives us a backlash of $\frac{1}{16}$ in. Now we draw the clearance circle, using formula No. 4, clearance = $A \div 20$ or $2 \text{ in.} \div 20$ or $\frac{1}{10}$ in. less than the dedendum circles.

To complete the flank of the involute tooth, we draw straight lines from the base circle to the dedendum and passing through the centre of the pitch circle. Now we draw fillet curves from these lines to the clearance circle with a radius of $\frac{1}{10}$ in. This completes the construction of the involute gear.

In drawing the cycloidal gear, we use the construction of the curves, as

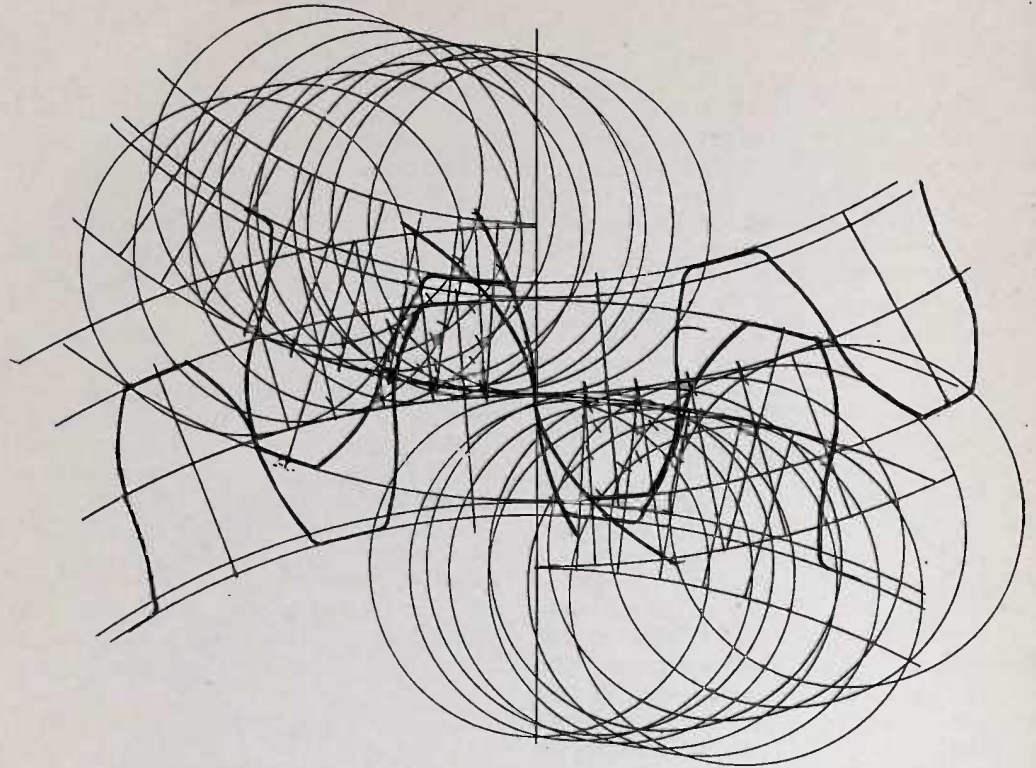


Fig. 6

already described, and with the same clearance, thickness of tooth, backlash, addendum and dedendum, as were used in the involute gears just drawn.

In all gears designed to run together, we must have the same size generating circle. We need no base circle or angle of action, as these are taken care of by the curves themselves. We draw the addendum, dedendum, and clearance circles, and then find the centre line of teeth and draw in the curves as already described. Find the centre line of this tooth, and complete the outline of the tooth by taking corresponding points from the centre line. Measure off the circular pitch on the pitch circle, and draw centre lines to the centres of the pitch circles and on these construct teeth equal to the ones already drawn.

As in the involute tooth, the thickness is $3\frac{1}{32}$ in., and the space between the teeth is 1 in., leaving, when the two teeth are in contact, $\frac{1}{16}$ in. as backlash.

This completes the drawing of the two kinds of gears, the involute and the cycloidal. As can be seen, the construction of the involute gear is much

simpler than the cycloidal, and it is used a great deal more in practical machinery.

There are different ways to true a grindstone, but the following method is very satisfactory and easy: Large threads are cut on a 6 in. steel bar, which has a bearing turned on each end. Use six threads to the inch or larger. Two L-shaped bearings are fastened to an iron plate, and this plate has two long slots cut in it, one on each side. Lag screws put through the slots and turned into the frame of the grindstone hold the plate and roller close to the face of the grindstone. A sharp blow of a hammer will push the plate and roll up to the grindstone for a second or third cut or as many cuts as are necessary to make the stone true. The steel roll should be a little longer than the width of the grindstone.

We spend too much time in searching after what we have lost, and not enough in taking care of what we still possess.

THE SAW AND HOW TO USE IT ON WOOD AND METAL

M. COLE

The oldest form of saw was a jagged-edged flint, set in a handle of bone or wood. Those of a later date were of bronze, and in use before iron was used for industrial purposes, being too scarce and valuable for other purposes than weapons. In the middle ages, when steel was still very dear, the saws and many other tools were made from iron and case-hardened, a method in practice until a comparatively recent date. Saws of these classes were, however, little more than narrow files. They did not make a clean cut, but scraped away the wood, etc., in fragments. The modern saw consists of a number of small knives, each having a properly sharpened cutting edge (terminating in a point), each of which makes a clean cut. One result of the low quality of the old saws was that they had to be used to cut in the pull stroke, instead of in the push stroke as modern ones do. Some of those now in use, cut with both strokes, but these are used only for rough coarse work. The teeth of these old saws were consequently in the opposite direction to those we use, and this style of saw is still used by many eastern nations. A low quality metal will stand the pull stroke, but would break on attempting to cut by pushing it. Those narrow saws that are strained in a frame, such as fret saws, sweep saws, etc., are used in this way to cut while pulled towards the worker. If used the other way, they soon break, often at the first attempt. Hack saws for cutting metal are among the reversed ones.

Saws in general use are of the following classes: hand saws (so called to distinguish them from the two-handed pit saws, etc.), consisting of a flat blade and pierced handle.

1—Ripping saw or rip saw with coarse teeth, used for cutting soft wood in the direction of the grain. These cut rapidly, and the widely spaced teeth do not clog so soon as those of a finer saw would. They are, however, of little use with hard wood or for cutting across the grain.

2—Cross-cut saw, or more generally called hand saw, and if with fine

teeth, panel saw. This is the shape that does most of the cutting in joiners' or cabinet makers' workshops.

Key hole saw, a smaller form of the hand saw, terminating in a point, so as to enter in a hole made with a centre-bit. A variety of this is the pad saw, having a round handle with hole through it lengthwise, into which the blade fits when not in use. When used, the blade is held by two screws in the ferrule of the handle. Both of these saws are of very soft steel, so that they bend when one of ordinary temper of the same section would break. It would be an advantage if these saws were made to cut in the pull instead of the push stroke.

Backed Saws. In cutting fine work, in order to get a very narrow saw-cut, a saw with a thin blade must be used. If not in some way supported, these would be too weak for the purpose, and also liable to bend in using. They are, therefore, strengthened by a rib of brass or iron, having a groove in its length into which one edge of the blade fits. These must be used with care to avoid buckling or bending the blade. They are made in many sizes, from 8 to 24 in. long for various requirements of cabinet makers, picture framers, etc., others much smaller, 3 to 6 in. long, with blades little thicker than note paper. Those most used are:

1—Tenon or dove-tail saw, 8 to 16 in. long, having from 8 to 16 tooth points to the inch, and backed with brass or iron. The smaller sizes have open handles, the larger ones closed.

2—Straight-handled back saws, a smaller form of dove-tail saw, with round handle, very thin blade and small teeth, suitable for delicate work.

3—Metal cutting backed saw or ward saw, much used by locksmiths, etc., in preference to the hack saws in frames, as it is less liable to breakage, though slower and dearer than the thin saw.

Tension saws, consisting of a narrow blade strained in a frame by a spring, screw, or twisted cord.

1—Sweep or bow saws. The blade, sometimes less than $\frac{1}{4}$ of an in. in

width, is strained in a wooden frame. Its narrowness enables it to cut in a curve. It is much used with broader blades on the continent instead of the hand saw; also for rough work, such as cutting up logs of firewood, for which purpose it has large teeth far apart, so as not to clog. Some are so arranged that the blade can be swivelled, so as to cut sideways to the frame.

2—Fret saws for cutting very thin wood, and strained by the spring of the frame itself.

3—Hack saws for cutting metal are a modification of the fret saw, using blades about $\frac{1}{2}$ in. wide and the teeth fine and slightly set. These are useful for fine wood-cutting. This refers to the American hack saw, the old English shape, being thick blade, coarse teeth and very little set, was slow cutting and heavy to work.

Special saws, for instance, a long narrow saw, similar to the keyholesaw, but having half the edge of the blade at right angles to the remainder—a very useful tool for cutting a square hole. Starting with a centre-bit hole, the end of the saw cut as far as was required, then the second part came into use, starting a cut at right angle to the first one, which could then be extended by using the point part again. Others are ripping and log cutting saws, having large and specially shaped teeth, and many others.

Machine saws of many kinds—circular and gang saws, band saws, veneering and other kinds—cannot be treated in this article.

Saw Teeth. If the teeth of a good saw are examined, it will be seen that each is a knife, ground at one side like a joiner's chisel, which leaves the top of the tool pointed, and it will also be seen that each tooth is bent away from the central line of the blade. In some saws, each tooth is sharpened at both its edges (not at both sides of one edge), so that it cuts in the push or pull stroke. These teeth differ a little in shape from the other teeth, having only one cutting edge. The shapes of saw teeth vary with the work they have to do. While all the smaller saws cut in one direction only, rip saws and two-handed saws, also American pattern log saws, cut in both directions.

How to choose a saw. A fair outfit for a wood-worker would be: rip saw, 28 in. long, 4 points to the in.; hand saw, 26 in. long, 6 to 7 points to the in.; tenon backed saw, 14 in. long, 10 to 12 points to the in.; dovetail backed saw, 10 in. long, 14 to 18 points to the in.

Also pad saw, sweep saw for curves, and hack saw for metal. In all saws, it is important that the handle should be comfortable and fit the hand well, and the saw well balanced, *i.e.* in a hand saw or rip saw, when held in the cutting position, it appears to weigh less than if held in any other position. It should also be thinner at the back than at the cutting edge, apart from the set of the teeth. The blade must be capable of being bent into $\frac{3}{4}$ of a circle without taking a permanent set. Some of the more expensive saws have smaller teeth for a few inches near the end to make a start easily in the work. In all saws, the thinner the blade is, the easier it is to work and good quality saws are always thinner than common ones of the same size and class. Look also at the finish, good saws are not sent out dull and old looking, they have a bright, highly finished appearance. For picture frames and other small work, a saw with very small teeth should be used, as it leaves the work nearly smooth. Don't buy a second-hand saw, unless it is from someone who thoroughly understands a saw and can guarantee it to be a good one. New saws sold at second-hand shops are always bad, but good old saws can often be bought cheaply. Small size hand saws are made for amateurs' tool chests, which are usually too small to hold a full-sized saw. These do not give scope for the whole arm to work. A full-sized man requires a full-sized saw to exert his strength, with a small one, there is much waste of energy. For odd jobs, however, the 18 in. chest saw (a small hand saw) is a very useful tool. Backed saws in particular are liable to be twisted or buckled, so should be examined before buying.

USING THE SAW ON WOOD

Always mark the work before cutting; it does not take long and saves a lot of trimming up afterwards. For rough

work a pencil mark will do, but for any exact work the mark must be made with a metal point or sharp edge, especially if cutting dovetails. In marking, allow for a shaving being taken off afterwards with the plane, and use a square to get a square cut. If merely dividing a bit of wood, it is enough to cut along the line, but if the work has to fit another piece, cut so as to leave the line or pencil mark.

Work must be fastened down any way so long as it does not move. Large work will keep steady on the sawing tressle by putting the knee on it, and should be about the height of an ordinary chair, a couple of boxes are often used instead. Smaller work can be held in the bench vice, or cramped down with screw clamp or carvers screw, or even nailed to the bench. A bench sawing stop is very easily made and just the thing for small jobs. It is usually cut out of the solid, but one can be knocked together out of odd bits in a few minutes. Take a bit of board 12 in. long, $\frac{1}{2}$ in. thick, 4 in. wide, at one end nail on a bit, 1 in. thick, 4 by 2, nail a similar bit at the other end, but not on the same side of the large piece. See that one of these pieces is nailed or screwed near its ends only, and at half its length make a saw-cut in it so that it becomes two bits, each 2 by 2 by 1 in. thick, side by side, and separated by a narrow slot that will just allow the saw blade to enter. The work to be cut rests against these two blocks, the other block catches the edge of the bench and prevents the whole affair moving when using the saw. It also protects the surface of the bench from saw-cuts. Grease the saw as often as required. Tallow does well, or thick oil, common butter is about the best for all wood-cutting tools. Rest the side of the saw against the thumb to guide it in making a start, make the first few cuts very slowly to ensure correct entrance of the saw. With all saws, stand so that you look down the whole length of the saw, not one side only. Cut slowly. Those who know nothing about saws always use them quickest, while a good sawyer cuts with a steady slow stroke, but continues to cut long after the quick one has got tired. It is not necessary

to press the saw on the work; if sharp, it will grip well enough if merely moved up and down, if not it requires to be sharpened. In making a long cut, the parts already cut are apt to close and bind the saw. To remedy this, wedges should be inserted to keep the cut open. In cutting a long piece of thick wood, it is well to cut a few inches each side alternately, there is then less risk of cutting crooked. Cutting with a backed saw is much easier, as the work is closer to the eyes, and being on a bench, much easier to work. This also should be used slowly, and never on any account cut without the work being held or fastened to the bench, or the saw will get buckled.

METAL SAWING

Metal sawing is done with a hack saw, a narrow blade strained in a frame. Those now mostly used are of American make, very thin in the blade and having fine teeth slightly set. They cut rapidly, remove very little metal, and are so cheap that they are never resharpened. The older styles were twice as thick in the blade, coarser teeth, and being more expensive were filed up as many times as required. To do this, it was necessary to leave the blade softer than the later form, so they had not so much cutting power. Another form of metal saw is the screw head saw or ward saw—still a favorite with locksmiths, blacksmiths, and jobbing mechanics on account of its power of standing rough usage. It is similar to the dovetail backed saw. Even with these rough workers, it is rapidly being replaced by the American saw.

In cutting metal, the saw must be used slowly and kept well greased, and great care used to prevent twisting, as what would cause other saws to buckle, would break one of these. Frames are arranged to take the saw blade in four positions, often a great convenience to the worker. When sawing steel, it is annealed first. Some special saws, similar to fret saws, are made for cutting metal. There are also some about double the width of a fret saw. A good quality dovetail saw with fine teeth will cut brass, and is often used for the purpose. Plumbers' lead saws are the ordinary keyhole saw, which has very little set on it.

HOW TO SHARPEN AND SET A SAW

The filing of the teeth must be done before setting them. The saw must be fixed firmly, either in a special filing vice, or between two slips of wood pinched in the bench vice, or by other means.

Topping is the first operation. To bring the top of the teeth quite level, a file without handle is laid on them lengthwise, and rubbed down from the handle to the end of the saw, repeating as often as required to bring them level. Any teeth below the line do not do their share of cutting, but there will always be some such, and broken teeth cannot always be avoided. This is of less consequence than a few teeth being higher than the bulk. The file used is the three cornered one and is single cut, files for ordinary purposes being double cut. An ordinary flat smooth file may be kept for topping.

Filing the teeth. The position of the file on the teeth depends on the shape of the teeth, and the angle of the cutting surface required. A safe and easy rule is "Put a new surface at exactly the same angle it had before." If it is intended to alter the shape or cutting angle of the teeth, the job should be given to a saw cutler, while to follow the old lines is easy and requires only a steady hand. Push the file with a slow and steady stroke, so as to use the whole length of the file. On the return stroke, either lift it clear or allow to rest very lightly on the saw. Two strokes are usually enough for each tooth of a hand saw, while small tooth backed saws are usually done with one stroke. Don't use an old file full of dirt, and if a new one is bought, keep it clean and well oiled.

See that the toothed edge of the saw is very little above the level of the vice top, only enough for the file to clear it. Start at the end nearest the handle, and file each alternate tooth, then reverse the saw, and file the remainder. While the file is cutting the slanting edge of one tooth, see that it does not at the same time touch the adjoining edge of the next tooth.

Setting the teeth. The correct way of doing this is with a single stroke of a special hammer on each tooth. The saw-edge rests on a sort of anvil,

part of the edge with the teeth overhanging. This, however, requires a good deal of practice to do it evenly. The easy way is with a tool called a "saw-set" of which there are several shapes. The plate shape having several notches to fit various thicknesses of saw plate is an old but useful form. The tooth to be set is inserted in a notch, and bent by using the handle as a lever. Other forms are capable of adjustment, so that there is no danger of uneven bending. Some work by pressing a lever, others by a stroke of a hammer on the head of a punch, the lower end of which presses on the tooth to be set. The amount of set varies with the work to be done by the saw. The rip saw, and those for cutting damp wood, must have more set than a dovetail saw used only on very dry wood. Setting a saw is quite as important an operation as sharpening it, but a saw need not be set every time it is sharpened. Too much set is as bad as too little, in the former case a larger quantity of wood has to be reduced to sawdust, while with too little set the saw will bind or touch the sides of the cut, and cause extra labor by the friction. The setting must be done near the point of the tooth. Teeth are usually broken by attempting to get the bend too low down. The tooth does not always break at the time of setting, but cracks, breaking off while cutting.

Re-toothing a saw. A good saw having many teeth broken is well worth a new set of teeth. This has to be done by a saw cutler, who cuts off a strip at the edge with all the old teeth, and punches new ones in the new edge. It is quite possible to do this by hand, but it is a very tedious job, though in all early saws the teeth were always filed out, the punching press being of comparatively modern introduction.

The triangular (or 3-square) file does for all saws in ordinary use by hand, but large circular and other large-toothed saws are filed with a flat file specially made for the purpose, and after a certain amount of wear these require gumming or gulletting, that is, the space between the teeth deepened.

Protecting teeth of saws. All small saws kept with other tools or carried about should be protected by a bit of

wood the length of the saw by about $\frac{1}{2}$ in. square, having a saw-cut lengthwise $\frac{1}{4}$ in. deep, which may be tied on with string. It saves sharpening and prevents accidents.

Cutting ivory and bone. Use a saw having very thin blade, fine teeth, and little set; an American hack saw does well for this. Cut slowly, use no oil or grease, or it will disfigure the ivory, but either dry or with plenty of water which will wash the dust out, while a little water will make a paste of it that will remain in the cut. Ebomite is cut with a saw suitable for brass.

Band saws. The blades for these are sent out by the makers in very long lengths. The required length having been broken off, the ends must be brazed together to get an endless band. From the nature of the saw and its work, it is important that the joint should be no thicker than the remainder of the saw. If carefully done, it will be so. There are several ways of heating the joint, many workers using the gas blow-pipe. This should never be used for the purpose, as however carefully used, the sulphur in the gas makes the steel at or near the joint brittle. The right way is with hot tongs. In any case the parts must be held in position by a suitable vice which will prevent any movement while the job is being done, yet allowing the tongs or gas flame to get on the joint. File away enough from each end of the saw to bevel it for a length of three teeth. Put between the surfaces some borax powder and some fine grain spelter (brazing spelter, not zinc, which is often called spelter) mixed with a little water to a paste. Arrange the parts so that the teeth of the scarfed parts just fit on each other, then (if for gas) tie up with some soft iron wire to hold in position, and apply the flame of the blow-pipe to joint till the spelter melts. At once grip the joint with a pair of tongs made hot, and hold together till it cools. In order to economize gas, a reflector should be made of asbestos sheet $\frac{1}{4}$ in. thick, which will form a kind of hood covering the joint above and below, and keep the flame on the work. A better way is to use a pair of tongs having very heavy ends, also a pair of light ones having thin

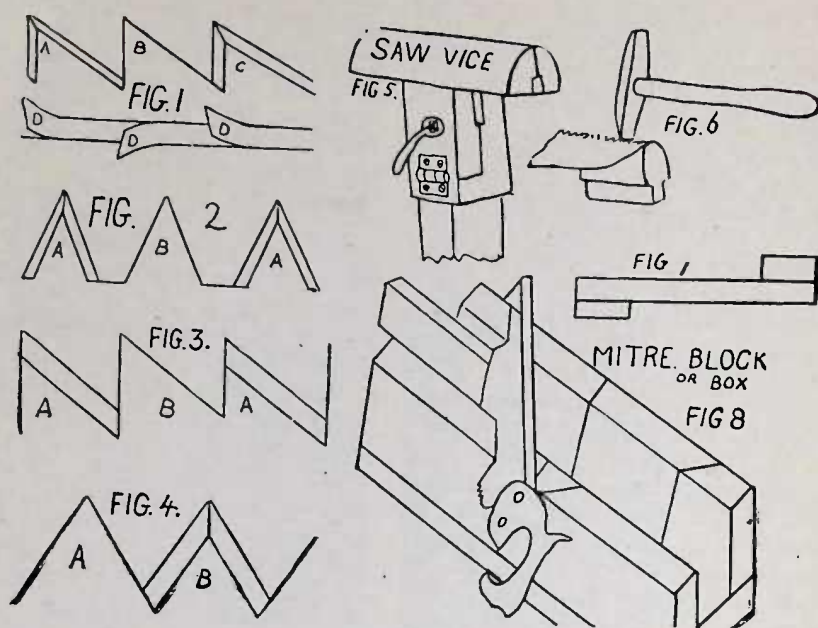
ends. The light ones being heated are put so as to grasp the joint, the heavy ones are heated almost to white heat and put so as to grasp the joint over the light tongs. The heat of the heavy tongs is great enough to melt the spelter, and they can then be removed, the light pair being kept in place until the joint is well set, to prevent the parts opening. A fork or block of iron at end of a long handle, and having a slot in it, can be used instead of the heavy tongs, but should fit easily over the light ones.

Silver solder should be used for all band saw joints. It melts at a much lower heat than spelter, and only a small quantity is used. It is in thin sheet, cut off enough to go inside the joint, use with wet borax, and there will be scarcely any file work to do, while if spelter is used there is a lot of dressing up of the joint to get it same thickness as the remainder of the saw. Band saws after being several times joined up are, though still very serviceable, almost always thrown away at the saw mills. A length should be got to practice on, either brazing or sharpening and setting the teeth.

Cutting nails. Before commencing to cut old wood, nails must be carefully looked for along the line to be cut. Even the smallest tack will spoil the sharpness of a saw. Nails that cannot be pulled out must be forced through with a punch, even then the rust left in the hole is bad for the saw. At public saw mills, a fine is charged for every nail the saw cuts into. The sound given by the saw when it touches a nail is easily recognized and must be taken as a warning not to proceed until the nail is removed.

Rebate saw, for cutting a rebate such as in picture frame moulding, is easily made from a bit of old saw, screwed or cramped to a block of wood. A little of the wood is cut away behind the saw, forming a guide, so as to make an even saw-cut along the length of the wood beading. This method is much quicker than the rebate plane.

Depth guide for saw is made by cramping a strip of wood one or both sides of a backed saw, at such distance from the edge as the depth of the cut requires.



DIMENSIONS OF SAWS

	Without Backs	Length	Points to 1 in.
Rip saw		28	4
Hand or Cross Cut		26	6 to 7
Panel		20 to 24	10 to 11
Keyhole or Com-			
pass saw		14 to 18	9 to 12
Backed Saws.			
Tenon		10 to 14	10
Dovetail		8 to 10	14 to 18
Straight handle		3 to 6	18 to 40

In measuring saw teeth, reckon the number of points to the inch, not the teeth.

Fig. 1 shows the teeth of ordinary handsaw. A and C show the sharpened sides of the teeth, B shows the side not filed, which is bent away from the other two, which are bent point outwards. In this case, the front of the teeth is filed. It is doubtful if there is any advantage in this, but many workers do it though it weakens the point of the tooth. D shows the amount of the set. It will be seen that a line drawn lengthwise will be overlapped by the heels of all the teeth, thus preventing a ridge forming between them.

Fig. 2 shows a quick-cutting form of tooth for two-handed cross cut saws, or for pit saws. It cuts equally well in either direction, but requires a thick blade or the teeth break off.

Fig. 3 shows the form of tooth most

in use for hand and backed saws, also for band saws. The teeth are filed on the slope only.

Fig. 4. Rip saw for soft wood, the teeth cutting both ways. This shape of tooth, being set closer, is stronger than at Fig. 2.

Fig. 5. A good form of screw-vice and easily made. If the leg is long, and two pegs are at back of the jaws to rest against a wall, this form makes a good portable vice.

Fig. 6 shows how the saw-teeth are set with a small hammer on anvil block.

Fig. 7. Bench stop for sawing small work.

Fig. 8. Mitre box, with length of work being cut by backed saw. If the back of the box is omitted, it becomes a mitre block, but this form is not so good a guide for the saw as the box.

When a telephone line is electrostatically charged, the telephone acts as a condenser. The winding serves as one plate of the condenser, the frame of the receiver as the dielectric, and the person who is holding the receiver to his ear as the other plate of the condenser. In order to prevent this condenser from discharging through the person, a German inventor provides a grounded metallic cover for the receiver, the capacity of which is somewhat greater than that of the body.

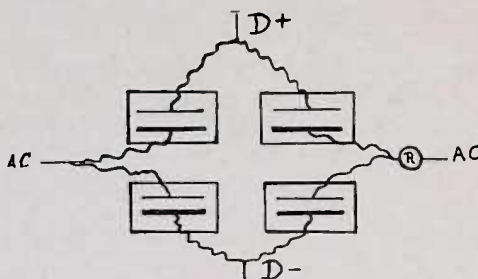
HOW TO CONSTRUCT AN EFFICIENT ELECTROLYTIC RECTIFIER FOR ONE DOLLAR

H. T. HEWLETT

It does not seem to be generally known by amateur workers, who wish to use direct current, that the alternating "juice" supplied in many of our smaller towns, can be readily and cheaply converted by an electrolytic rectifier. Such an apparatus, sometimes called also a current reorganizer or a nodon valve, is not as efficient as the mercury arc, nor can it well be used on currents of over 220 volts; but it is much cheaper and simpler to construct, and the amateur seldom has occasion to use higher than 110 volt currents. In explaining the rectifier's action, we may liken the alternating current to a series of rising and receding waves of water; the apparatus acts as a check valve, allowing all of the waves to pass, but when they start to recede, the valve closes and prevents them. Thus the current is not changed into a truly continuous, but into an unidirectional pulsating one. It is similar to that supplied by a dynamo fitted with the old Siemens H armature and a two piece commutator. In its simplest form such a converter consists of an aluminum and a lead plate, immersed in an oxidizing solution. The current passes freely in one direction; but when its direction changes, the metal becomes coated with oxide, thus causing so great a resistance that the flow ceases.

In actual practice, however, it has been found that a single cell is not sufficient and for the apparatus here described we use four. Procure, therefore, four battery jars and the same number of lead and aluminum plates, as large as will just fit nicely in the jars. The lead should be not less than 3-32 of an inch in thickness and the aluminum as pure as possible. Fasten the plates to a small piece of wood in a manner similar to the elements of a primary battery, attaching a short piece of copper wire to each. For this purpose binding posts from exhausted dry cells are good, as it is difficult to solder aluminum.

Connect up the plates as shown in the cut, the light lines representing the aluminum plates and the dark ones the lead. Fill up the jars with a saturated solution



of ammonium phosphate. Take the direct current from terminals D+ and D-, while the alternating current is fed in at Ac¹, and Ac², using a plug to connect with a lamp socket. It is also necessary to place some resistance at R. For this purpose a lamp board is a great convenience, but by having a 16, a 32, a 50 and a 100 candle power bulb, sufficient flexibility can be obtained for most occasions. Use lamps designed for 20 volts lower than the supply circuit of 110 and higher voltages, to allow for a drop due to the internal resistance of the cells. In order to obtain the best results it is necessary to observe care on several points.

Use only distilled or rain water and add more water occasionally to make up for loss due to evaporation. In case of excessive heating or foaming use larger plates. Both plates slowly oxidize and it is well to scrape the aluminum plate once in a while. The liquid in the jars slowly decomposes, and if not renewed the "valve" no longer closes and prevents the receding current from passing. Its life may be greatly prolonged by pouring a small quantity of blue litmus solution into each jar and frequently adding enough phosphoric acid to turn the solution pink. This is often done when performing experiments of long duration and which cannot be interrupted. But it cannot be continued indefinitely, because excessive waste products finally collect. The total cost of this apparatus does not exceed one dollar.

By using a different electrolyte, the rectifier can be employed on a large range of voltages. For currents of less than 20 volts use dilute sulphuric acid; while for the usual 110 volt current, a

saturated solution of ordinary baking soda (sodium bicarbonate), sodium or potassium phosphate or the ammonium phosphate, used above, seem equally good, but for 220 volts use the ammonium phosphate.

The apparatus will pass as high as 7 amperes and may be put to a great variety of uses, replacing about 20 bichromate cells. It has been successfully used for experiments in electrolysis, for charging storage batteries, to run a Ruhmkorff coil, and for many similar

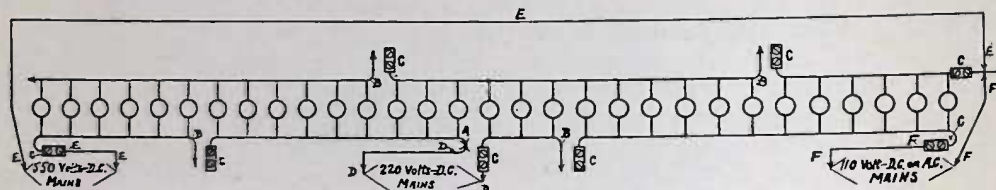
purposes too numerous to mention. In a certain few cases, such as experiments in wireless telephony and telegraphy, the pulsating current may be objectionable and it sometimes causes small motors to give off a hum. These drawbacks may be overcome by using small storage batteries or ordinary dry cells in the circuit. Thus, when the current starts to drop between the pulsations, the batteries begin to feed in, and the current is made continuous.

A CASE OF MULTIPLE SERIES

WALTER S. ROCKWELL

The accompanying drawing shows a simple but practical way to use 110 v. multiple wiring on 550 or 220 v. D.C. mains without changing lamps or destroying wiring.

To connect to 550 v. mains, connect E's to C's, C's at A; disconnect C's at B's, D's from C's and F's from C's; but be careful and balance the c.p. of your lamps for good results.



Traveling electricians with carnival and street fair companies often find it impossible to get the desired voltage, as some cities use the 220-v. D.C. system for lighting. Then you might be placed out in the suburbs, where the only current available would be 550 v. D.C. from the street car company's trolley wire.

Then again in using the A.C. the transformer goes up and it is impossible to replace it for a day or two, and you can get another current handy which might be 550 or 220 v. D.C. In such cases the drawing will prove a great benefit.

The illustration shows arrangement for 30 lights, but the principle will work with any number that will divide by 5 for 550 v. or divide by 2 for 220 v. A string of 30 lights like the above can be changed to one of the 3 different voltage currents in 5 minutes.

To connect to 110 v. mains, connect F's to C's, B's to C's, A to C; disconnect E's, from C's, D's from C's.

To connect to 220 v. mains, connect D's to C's at A, C's at B's; disconnect E's from C's, F's from C's.

Uncle Harris was a carpenter, and had a shop in the country. One day he went into the barn where Dick and Joe were playing with two tame pigeons.

"Boys," he said, "my workshop ought to be swept up every evening. Which of you will undertake to do it? I am willing to pay a cent for each sweeping."

"Only a cent?" said Dick. "Who would work for a cent?"

"I will," said Joe.

So every day, when Uncle Harris was done working in the shop, Joe would take an old broom and sweep it.

One day Uncle Harris took Dick and Joe to town. While he went to buy some lumber, they went to a toy shop.

"What fine kites!" said Dick. "I wish that I could buy one."

"Only ten cents," said the man.

"I haven't a cent," said Dick.

"I have fifty cents," said Joe.

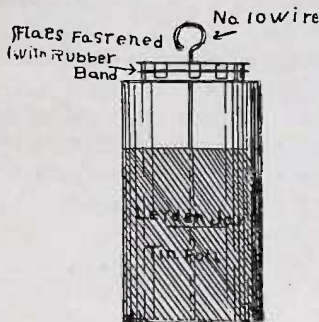
"How did you get fifty cents?" asked Dick. "By sweeping the shop," answered Joe.—*Sunday Afternoon.*

THE CONSTRUCTION OF A HIGH FREQUENCY RESONATOR

K. B. SHELDON

Of late, many articles have been written in regard to high frequency currents at great tension. Such currents are used by physicians for the relief and cure of certain diseases, particularly in treating cases of arterio sclerosis (hardening of the arteries), which occurs most frequently in persons of advanced age.

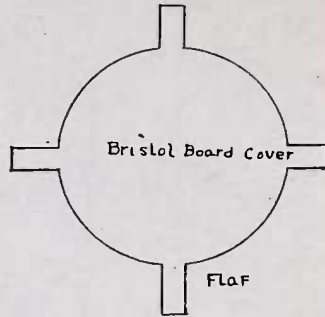
D'Arsonval of Paris discovered that currents having a period of oscillation from 100,000 to 5 million cycles per second, were harmless in their effects upon living organisms; no sensation being perceptible when the electrodes were applied to tissues except a little heat. Dr. Oudin, also of Paris, in 1892, improved upon D'Arsonval's resonator, and constructed one for therapeutic purposes. Their respective designs are shown in diagram. A high frequency resonator may be said to consist essentially of an induction coil or its equivalent, oscillator, spark gap, capacity resistance and inductance. The principle upon which a resonator produces high frequency currents is



based upon the phenomena, that when a Leyden jar or spark coil is discharged through a circuit possessing resistance, inductance and electrostatic capacity, the current alternates from a few thousand to several million times a second, according to the coefficients of the system.

Those who would like to construct a resonator may do so by following the few simple directions. The inductance is made by winding 40 turns No. 16 B. & S. bare copper wire upon a fibre or bristol board cylinder, as per diagram. This is for the D'Arsonval resonator;

for the Oudin arrangement, make another helix the same as the first. For the necessary capacity, make six Leyden jar condensers by pasting tin foil on the inside and outside of quart fruit

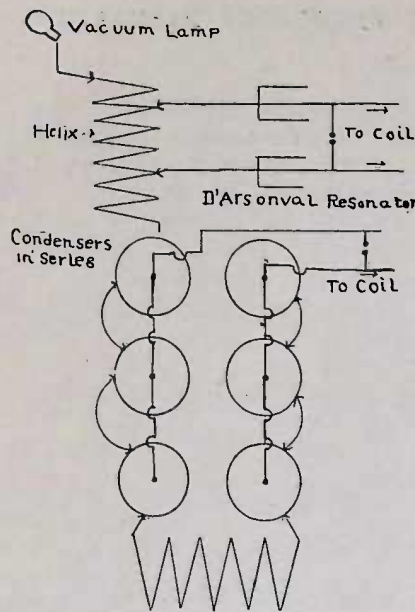


or battery jars, within a third of the top; the foil may easily be fastened to the jar with shellac. The inner coating may be connected with No. 12 bare copper wire instead of tin foil; the inner coating may be water, in which is dissolved a teaspoonful of common salt. The covers to the condenser should be of well-varnished wood or bristol board, as shown in diagram. The condensers are connected in series, as high potential is desirable.

The spark balls should be at least 1 in. in diameter, and kept well polished, as the quickness of discharge depends upon the condition of the surface of the oscillator.

With a coil of suitable size, the resonator will be found to have a very strong alternating electro-static field surrounding it. When a Tesla lamp or Geissler tube is brought within its influence, the lamps will instantly begin to glow; also when the hand is presented to the field, beautiful violet sparks may be drawn. Again, if one terminal is grounded, a pretty brush discharge will be observed in the dark, issuing from the other terminal; this wire must be sharply pointed. These effects, of course, depend upon the size of the induction coil; no results worthy of name will be secured, if less than a 2 in. coil is used.

To obtain resonance, cut in or out a certain number of turns on the helix. The longest spark that can be drawn



with the hand or discharging tongs from the helix, or when a Geissler tube glows most brilliantly, is an easy way to ascertain that resonance has been obtained; of course, a better and more accurate way is to insert a hot-wire ammeter in one of the wires from condenser to helix.

For coils over 12 in., the dimensions of the above system should be doubled to get the best results.

The writer used a set as above described with a 2-in. coil and obtained very good results. An electrolytic interrupter greatly increases the effects.

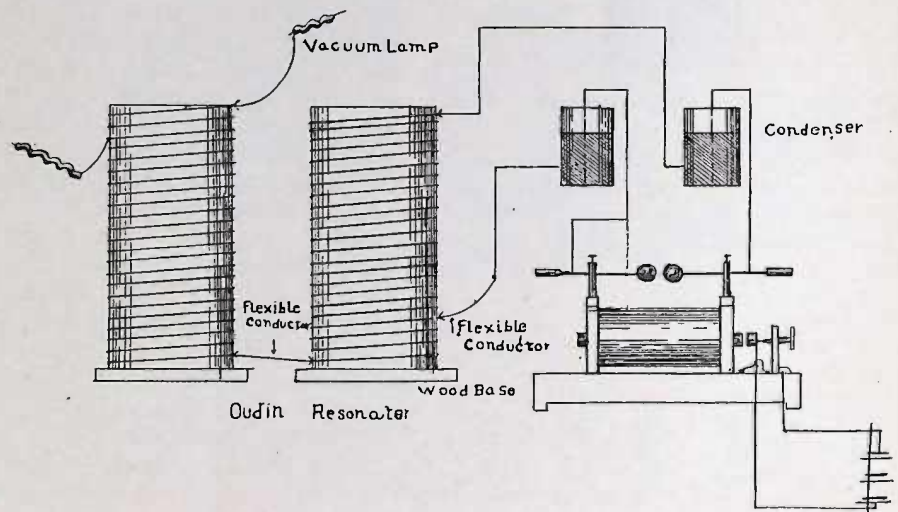
The highest voltage is found at the terminal wires, by virtue of the electro-

static capacity and inductance of the helix. It is, therefore, apparent that the Oudin arrangement will give the higher voltage.

The amateur should be cautioned against connecting the condensers in parallel, as this connection slows down the frequency to such a degree, that uncomfortable, and even dangerous shocks might result, if any part of the body should come in contact with the resonator.

A writer in the *Scientific American* says: The true action of a cutting tool or edge is not fully understood by the common machinist, I have noticed. It is not realized that it does not cut, as the word is usually understood, but tears the material apart. No matter how fine the edge, the tool tears the fibres, but the finer the edge, the fewer fibres it tears. To divide the material without tearing, a cutting edge of absolutely no thickness would be required, but this is an impossibility. On microscopic examination, the edge of the finest razor is shown to be composed of irregular saw teeth, while the edge of an ordinary lathe tool is very rough and blunt.

The man who goes ahead and does things and says but little about it, is worth two of the man who is always telling about what he can do or what somebody else has done that is superior to what is being done around him at the present time.



A LOG BOX AND HOW TO MAKE IT

A log box, unlike a coal box, is not necessarily a piece of furniture for the dining- or drawing-room. To suit the purpose, it is intended for, it is bound to be roomy, or would be useless, so that a log box pure and simple is no ornament to a room. The idea we have in view is to combine the advantages of a log box with those of a hall stool or seat, and this we show in the illustrations 1 and 2. It should, if possible, be made of oak, or failing that, American whitewood can be stained oak color, and makes a very good substitute. There is nothing intricate in the construction; it wants to be strong, of course, and no joints should be obtrusive. In order to accomplish this end, the front and back are let into grooves.

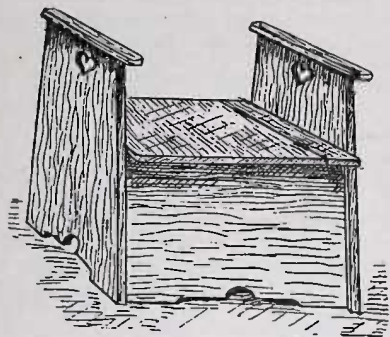


FIG. 1.—GENERAL VIEW.

Fig. 3 shows one of the sides. The height is 2 ft. 3 in., width at bottom 15 in., and at top 12 in., made out of $\frac{3}{4}$ -in. wood, or not less than $\frac{5}{8}$ in. Fig. 4 shows the front (or back piece, as they are both alike), with the ends cut in the form of a shoulder or rebate, to let into the grooves in the sides. It measures 18 in. square, not including the rebates. The grooves for the bottom of the box come 3 in. from the floor line, and instead of cutting a shoulder in the bottom board, bevel the edges down on both sides to fit. If $\frac{3}{4}$ in. wood is used, the grooves should be $\frac{1}{2}$ in. wide and nearly $\frac{1}{2}$ in. deep; and if thinner wood is used, they must be proportionately less. The width necessitates a joint in each part, a glued joint is strong enough, providing the edges to be joined are "shot" quite true, not too much glue used,

and that well rubbed out by working the two boards together, then securely clamping until quite set. The hollows at the bottom are cut out with a frame saw, and the heart-shape holes with a keyhole saw, having first prepared an opening with a twist bit.

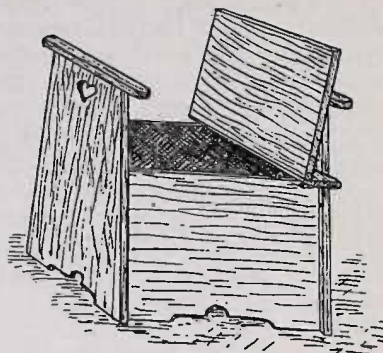


FIG. 2.—SHOWING LID OPEN.

To put the parts together, lay one side on the floor face downwards, glue in the front and back, slide the bottom in (gluing it also), and then fix the other side on, seeing there is no twist in the box before the glue sets, and finally binding it tightly round with strong cord.

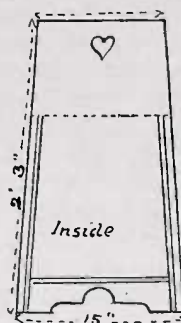


FIG. 3.—VIEW OF END.

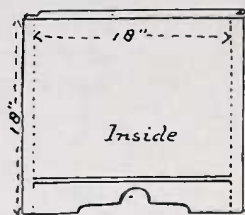


FIG. 4.—FRONT OR BACK.

When set, fix a 2 in. malleable iron bracket (one that has no stay) to each corner inside, and underneath the bottom glue several small blocks of wood.

The seat is 15 in. wide, with the grain of the wood running at right angles to the front; the flap or lid is 15 in. long, and the fixed part 3 in., the lid being hung with a pair of 2 in. brass butt hinges.

To fix the 3 in. part of the seat, drill a $\frac{3}{8}$ in. hole with a twist-bit

through it into the front and back of the box, then fit and glue in wooden pegs of the same material, and also glue two or three small wood blocks underneath to the side of the box. The arm-rests or caps for the sides are 14 in. long and 1½ in. wide, grooved underneath, and then glued on.

If the box is made of oak, as a finish rub in some raw linseed oil, and repeat the process two or three times until the oil is well rubbed in; but if made of whitewood, get some oak water-stain (not varnish stain) and apply it with a piece of sponge, allowing one coat to dry well before putting on a second, the number of applications depending upon the shade required; then rub in the oil as directed above, and the result will be infinitely better than varnish.—*The Woodworker*.

A Warning about Telephones

Amateurs ordering high wound telephones should always be sure to get a guarantee that there is no German silver wire used in them. Already, too many innocent young men have received telephones which easily test up to the specified number of ohms, only to discover that they were wound with German silver wire, and therefore no better than 75 ohm telephones. The value of a telephone depends on the number of times the wire goes around the magnet and not in the least upon its resistance. Often, the outside layers are wound with copper, and the inner layers with German silver. These it is impossible to discover without unwinding the bobbins. The only safe way is to buy telephones of a standard electrical supply house, and get a guarantee with them.

Iron and steel pipe may be readily distinguished by a flattening test, according to statements made at the meeting of the American Society of Heating and Ventilating Engineers. Soft steel pipe, cut in very short lengths or rings, flattens smoothly and evenly without breaking, while wrought iron pipe usually fractures at two or more places when flattened.

Improved Method of Melting Magnesium

Owing to the fact that the melting point of magnesium is low and it oxidizes rapidly when melted, the loss on melting, when carried out in the usual manner, is large. Paul Rakowicz, of the Chemische Fabrik Griesheim Electron of Frankfort on the Main, Germany, has patented a method of melting magnesium which, it is said, minimizes the loss. The method is intended more particularly for melting magnesium in the process of alloying it with other metals.

The method used is simple. The magnesium is placed in a graphite or clay crucible and allowed to arrive at a temperature beyond that of a pasty mass. If it does go beyond, more magnesium is added. When the whole of the magnesium in the crucible has become pasty, the crucible is removed and the magnesium allowed to melt by the heat transmitted from the walls of the crucible itself. In this manner, overheating the magnesium is avoided. It is well known that as soon as magnesium becomes slightly hotter than its actual melting point it combines with the oxygen and nitrogen of the air and wastes. If it can be prevented from rising to this excessive temperature, the oxidation is prevented.

After the magnesium has been melted in the manner previously mentioned, the other metals, with which it is to be alloyed, may be added. In this manner of melting, the inventor says, no flux is necessary.

In chemical properties tantalum approximates to gold and platinum. Boiling hydrochloric, nitric or sulphuric acid or *aqua regia* are without action on it, as also are aqueous solutions of the alkalies. It is attacked, however, by fused alkali or hydrofluoric acid; the latter acts slowly under normal conditions, but if the metal is in contact with platinum, the action is rapid. Tantalum does not amalgamate with mercury. At a low red heat it rapidly absorbs nitrogen and hydrogen, forming compounds having a metallic appearance. It also combines readily with carbon.

QUESTIONS AND ANSWERS

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

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

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

1062. **Miniature Multipolar Dynamos.** F. R. F., Philadelphia, Pa., asks if a 3 in. dia. 15-slot armature core is too small for a four-pole field magnet, and if there is a limit to the smallness for such multipolar machines? Ans.—If you intend to use the minimum standard voltage of ordinary lighting circuits,—110 volts,—two poles are all you should have for any size under 1 h.p., and the best makers would prefer the 2 h.p. mark. For 500 volts a 5 h.p. size is a safe limit, though some four-pole motors might be found in as small as 3 h.p. size. The principal consideration is to have enough segments in the commutator between one brush and the next to permit sparkless running. 20 volts between adjacent segments is a good limit in small machines, 10 volts in large sizes. Thus 24 segments would be a proper minimum for a 110-volt two-pole machine, or 48 segments for four poles. 32 and 64 would be better numbers. Some two-pole 500-volt motors have been made with as few as 32 segments, but twice that number is none too many. A 4-pole 10 h.p. motor for this voltage should have 112 or more. A standard 500-volt railway motor has 117,—the odd number being required by the series character of the winding. Your proposed machine would certainly be limited to 50 volts, but more properly to 10.

1063. **Rectifier.** H. N. S., Howell, Mich., asks for directions for making and operating an electrolytic rectifier. Ans.—We gave an excellent article in the last November issue of this magazine, another this month.

1064. **Dynamo Design.** W. F. S., Galt, Ont., gives specifications for a small dynamo, as follows, and asks if they are good? Field magnet, four poles, faces being $2\frac{1}{2}$ in. square, with air gap of $\frac{3}{8}$ in.; winding of 4 lbs. of No. 25 S.W.G. d.c.c. wire. Armature, $4\frac{1}{2}$ in. in dia. and $2\frac{1}{2}$ in. long, 24 slots $\frac{3}{8}$ in. x $\frac{3}{4}$ in., 24 coils, having in all 864 turns of No. 20 wire. Speed 1,200 rev. What output could be obtained? Ans.—The corresponding numbers in the B. & S. wire gauge are 24 and 19, respectively. 4 lbs. of the former will give a resistance of about 80 ohms, and this size being good, in case of a field winding, for about half an ampere, the machine will be limited to 40 volts for regular running, but for short periods 50 volts could be impressed. To produce 40

volts, however, you will need to drive the armature at about 2,000 rev. per min., but this speed is quite allowable. If you wish to adhere to the 1,200 limit, you can put the field spools two in series, and the two groups in parallel with each other, run armature at 1,000 to 1,200 rev. and get 20 to 25 volts. Ampere capacity of armature, supposing the multiple winding, will be about 12.

1065. **Potentiometer.** H. H. G., Worcester, Mass., asks if a potentiometer of 500 ohms resistance can be made by winding German silver wire around a wooden stick, 1 in. in dia. and 8 in. long? What size of wire would be necessary? Ans.—Wood is not good material for such purposes; though the winding be well spaced and tight in the first place, inevitable shrinking will relax the tension, and that along with the pushing of the contact piece, will bring the turns into confusion. If you could turn a fine thread in the wood and wind the wire in the grooves thus formed, it would prevent this trouble, but such cutting is not easily done. We would recommend hard rubber or fibre, 1 in. or a little larger in dia., 8 in. or so in length, in which a V-thread, 32 to the inch, can be cut, and wind in it No. 26 German silver wire of the 30% grade. This will give in the neighborhood of the required resistance. Even with the smooth stick you might wind coarse linen thread between the turns of wire, and bake the whole in shellac.

1066. **Dynamo Design.** G. C., New York city, sends a sketch of a fan motor having a smooth core drum armature divided into 11 spaces, and an iron-clad field magnet. The former is about $1\frac{1}{2}$ in. in dia. and $2\frac{1}{4}$ in. long; field bore is $2\frac{3}{4}$ in., cores for the winding being $1\frac{1}{4}$ in. x $2\frac{1}{4}$ in. and $1\frac{1}{2}$ in. long. He asks what winding would suffice for simple experimental use as generator, also for running as a motor from batteries? Ans.—This design is quite like that of the "Watson" 1 h.p. machine, and of about one-half the dimensions. You can make a serviceable machine out of it, but until you have acquired some facility in winding, we would recommend you to adopt a relatively low voltage. On the field you can use No. 23 s.c.c. wire, about 34 turns per layer and 16 layers, requiring about 2 lbs. in all, and having a resistance of 18 ohms. For some purposes you could

put the two spools in parallel with each other instead of the regular connection in series. In series, a potential of 10 to 12 volts could be impressed; in parallel, half that value. On the armature you could wind two layers of No. 20 d.c.c. wire,—one layer for each half winding, after the manner explained in the last November magazine, in our article on Armature Winding. There would be this difference from that given in the cut, in that your odd number of spaces would not permit an exact diametrical spacing, but this feature is not important. You should get 10 wires between the pegs, and thus 220 wires in all on the core. For 10 volts drive at full speed, say 3,000 rev. per min., having spools in series; for half voltage put spools in parallel, and drive at half speed. In either case the capacity of armature will be about 5 amperes. Of course the field is connected as a shunt.

1067. Gasoline Engine. E. S. K., Rushville, Ind., asks for reference to some publication giving directions for making a $1\frac{1}{2}$ h.p. size. Ans.—We are unable to find one of this particular specification. Perhaps some of our readers can assist us.

1068. Induction Coil. C. R. LeC., Newport, Ky., has made an induction coil of apparently large output, yet it fails to give sparks longer than $\frac{1}{4}$ in. He asks what is likely to be the fault? Ans.—Although you have made the coils in a large number of sections, there is opportunity for short circuits within the winding, in the connections between these successive sections. Unless you have taken special precautions, the wire from the bottom layer of one section passes directly across the entire adjoining section in order to connect with the next end. There is great danger of breakdown in these close places. Sections should be wound in pairs, whereby ends would always come on the outside. Perhaps you do not have the right capacity of condenser. The actual size cannot be predicted, for there are so many unknown quantities in the problem. You must needs experiment with different sizes. It is certain that your amount of wire and battery ought to give sparks 6 in. long. Our experience leads us to favor the construction of induction coils wound in relatively few and wide sections, and immersed in paraffin oil. A coil of this sort wound with bare wire, paper insulation, in two sections each about 4 in. in length, and 5 in. outside diam., readily gives sparks 5 in. long. See a helpful article on *The Electrical World*, July 1, 1909, pp. 26-30.

1069. Wimshurst Plates. F. W. H., Brooklyn, N.Y., asks if such plates could be covered with cellulose acetate, as is employed on so-called "enamelled" wire, and thereby well protect the plates against moisture. Ans.—We think this is rather impracticable. Shellac baked on, that is, dried at a temperature at which the melting point is just passed, is the ordinary method, and one that possesses no particular difficulties.

1070. Alternating Current Rectifier. M. A., Milford, O., describes a four-coil armature winding connected to four commutator

segments and to two collector rings, which being used in a four-pole field magnet ought to transform from direct to alternating currents, or vice versa. He asks if this will be the result? Ans.—Yes, but the device has serious defects in that the sparking is serious, for at every change of connections there is a dead short circuit at the brushes. An ordinary rotary converter does not have this defect, for in consequence of there being a large number of commutator segments, reversal takes place at any given instant in only a small portion of the winding. In your proposal the conditions of an ordinary Siemens' shuttle armature are imitated, in which reversal of the entire winding is introduced at every exchange of segments.

1071. Small Motor Design. E. D., New York City, asks: (1) What rules to follow in such design, for both series and shunt field cases? (2) How to calculate the best winding for an enclosed fan motor, having an armature core $2\frac{1}{8}$ in. in diam., $2\frac{1}{2}$ in. long, with 12 slots of $\frac{1}{4}$ in. diam.? Field magnet is made in 2 identical parts, fitted together. (3) How far apart should the plates of a bichromate battery be? Ans.—(1) To give an adequate explanation of even simple motor design would require more space than these columns afford, but your second question allows a definite illustration. You will also find many good ideas on the subject given in Watson's book on the "Design of a 1 k.w. Dynamo." Many of the rules pertain to a machine size. (2) As you do not state for what voltage or speed you desire the winding, we will have to assume some values. Suppose you intend primary batteries, such as your third question seems to indicate, and that a speed of 1,800 rev. is wanted. Though your sketches are incomplete, it would appear that a polar face is about 4 sq. in. area, and should allow a useful flux of 80,000 lines. For a practicable value of the counter e.m.f. of 10 volts, you will then need about 400 conductors on the armature, or 32 per slot. Allowing room for oiled muslin insulation, you can probably get in this number, if you use No. 24 d.c.c. wire. Since the winding will be of the closed circuit sort, giving the effect of two wires in parallel, the capacity of armature will be about 3 to 4 amperes. Weight of wire, about $\frac{1}{4}$ lb.; resistance of armature, as wound, 1 ohm, therefore wasting 3 to 4 volts at full load, and requiring an applied e.m.f. of 13 to 14 volts. Field winding, if shunt, must therefore be designed to withstand that voltage, or if series, to be capable of passing full current with a loss not exceeding 3 or 4 volts, —preferably less. As you did not give the length of space for this winding, we cannot compute the size, but the method should be to fill all the available space, using, probably, No. 27 wire for shunt, or No. 20 for series. (3) About $\frac{1}{4}$ in.

1072. Small Motor Design. W. A., Wilmerding, Pa., sends a sketch of a machine of about the same proportions as above, except that armature is only $1\frac{1}{4}$ in. long. Latter is wound with 384 turns of No. 25 wire, connected to a 6-seg. commutator.

He asks how many turns of No. 20 wire should be placed on fields to allow an output of 40 to 60 watts, at a pressure of 12 to 15 volts? Ans.—There is a radical error in your armature winding, in that the turns are placed in slots distant from each other by only $\frac{1}{4}$ of a circumference, while the field, being of the bipolar order, demands that the winding enter slots opposite each other. You will have to rewind the armature. See our article on "Armature Windings" in the Nov., 1908, magazine. Your No. 20 wire suggests a series winding. A shunt of finer wire is rather more serviceable for most experimental purposes.

1073. **Synchronizing.** A. O. D., Tampa, Fla., asks what would be the result if 2 opposite impulses of electricity should collide on the same conductor? Ans.—With the additional specification that they shall be equal as well as opposite, we have the exact conditions desired and accomplished when properly starting an alternating current synchronous motor, or in connecting an alternating current generator in parallel with others. It gives the proper instant to accomplish the connections without shock or injury. See Chapter XV of the Engineering Series, in the Sept., 1907, magazine.

1074. **Wireless Telegraph Transformer.** A. D., Buffalo, N.Y., asks: (1) for directions for making one for 20,000 volts, and requiring about one electrical h.p. to operate it. (2) Could a single phase alternating current synchronous motor be started on a 3-phase circuit by connecting to rings tapped to the 120° points of winding, then when at synchronism, to switch over to single phase, using 5 rings in all? Ans.—Doubtless you have already found the article on a $\frac{1}{4}$ k.w. transformer in the July issue appropriate to your needs. By making the dimensions of core and coils about $\frac{1}{2}$ larger, but with same sizes of wire, you will accomplish what you want. (2) Yes, but the same result can be obtained with only 4 rings, for one could be the same for both cases. You can do it simpler still, for with only 3 rings, and started on a 3-phase circuit, you can merely disconnect one of the 3 wires, when the motor will continue to run, but now as a single phase motor, with a capacity of about one half the full rating. In this respect, however, the power is fully what any other single phase connections would give. This is a common method of operation. A service may often be of the single phase variety, but a standard 3-phase motor may be procured, then by use of a resistance in one branch and an inductance in a second, the third being a common return to the other main, starting may be secured, provided load is sufficiently light; and then, as soon as full speed is secured, disconnect the wire to the inductance. You will understand that a 2-pole machine is not well adapted for this purpose, for the synchronous speed at 60 cycles is 3,600 rev. per minute.

1075. **Amateur Transformer Experimenting.** E. J. H., Chicago, Ill., asks for diagrams and directions for connecting an ammeter, voltmeter, and rheostat for use

with a 110-volt circuit operating a transformer, also stating what size of rheostat, and at what supply house can the apparatus be secured? Ans.—These ideas are so elementary, and given in any high school book on physics, that we think you will have no difficulty in getting the right ideas. Put the ammeter directly in the circuit, that is, in one of the wires leading to the experimental transformer. Connect the voltmeter to the main binding posts of this transformer, or to the secondary posts, dependent on whether you wish to measure the 110 volt primary, or the lower voltage secondary. Recognize that the voltmeter always represents a steal of electricity,—that it always is a shunt circuit. In order to minimize this loss, and to protect the instrument from being burned out, its resistance must be high. See Chapter XIX and XX, in the Jan. and Feb., 1908, magazines. Ordinarily you should not have a rheostat in the circuit, but a reactive resistance. In any case it would be connected as if it were an ammeter,—directly in the line. See The Central Electric Co., 264-270 Fifth Ave., in your city.

1076. **Transformer.** F. W. K., St. Louis, Mo., asks if we can give directions for building a transformer that will economically cut down a 110-volt circuit to 40 to 50 volts for a 50-ampere moving picture lamp, and could an ordinary mechanic make the device from stove-pipe iron? Ans.—Yes, we could design one and you could build it, but we think at greater expense to you and with less economy in running, than if you procured a stock article on the market. Instead of a regular transformer, with separate primary and secondary coils, we would advise the use of an "auto-transformer," sometimes also called a "compensator," or "balance-coil." Please address the Wagner Elec. Mfg. Co., of your city, or the local office of the General Elec. Co., in the Wainwright Bldg., or the Westinghouse Elec. & Mfg. Co., in the Bank of Commerce Bldg.

1077. **Measuring Instruments.** W. E., LaGrande, Ore., asks: (1) Will the instruments designed for alternating currents be accurate for direct? (2) What would be a good size of transformer to reduce 110 volts to 6 volts, and allow a secondary current of 4 amperes? Ans.—(1) There is such a variety of measuring instruments, operating under quite different principles, as to preclude a general answer. Some will operate with very small errors on either circuit; others will operate on one only, some would be ruined if attached to the wrong circuit. We think you will find a good deal of information in Chapters XIX and XX of the Engineering Series. You will find that the permanent magnet type, or "Weston," is adapted for direct current only; it will not be injured, but the pointer will merely tremble near the zero mark, when put on alternating current circuits. The induction type of instruments will operate on alternating currents only, the ammeter receiving no harm, but the voltmeter being burned out, if placed on direct currents. The dynamometer style will read correctly for either direct or alternating,

while the soft-core form involves no dangers, but considerable errors, in the two cases. The recording instruments have the greatest errors. (2) Perhaps the first answer in the July magazine will be serviceable to you.

1078. **Transformer.** N. C. P., Wallingford, Conn., asks for data for making a transformer for use on a 60-cycle 110-volt circuit, that will give 10 volts and 5 amperes or 5 volts and 10 amperes in the secondary? Ans.—We can do no better than refer you to the first answer in the July magazine.

1079. **Small Dynamo.** A. F., —, asks for the design of a small machine that will generate 10 volts and 10 amperes? Ans.—You will find an excellent design for such a machine in Watson's "How to Build a $\frac{1}{4}$ h.p. Dynamo," for sale by us or at any bookstore. By reducing the dimensions about one-quarter, you will have a size for the desired output. 12-slot armature punchings $2\frac{1}{2}$ in. in dia., excellent for the purpose, can be secured from the W. & S. Mfg. Co., Worcester, Mass. Let the core be $2\frac{1}{4}$ in. long, axially,—the full length described in the pamphlet,—and, of course, let the field be the same. Use No. 17 wire on armature, No. 20 on shunt field.

1080. **Dynamo Castings.** M. F., Montevideo, Uruguay, asks if the armature and field winding of Watson's $\frac{1}{4}$ h.p. dynamo will be the same for four poles as for the two that the description involves, and can castings for this machine be obtained? Ans.—The same weight of wire can be employed for 4 as for 2 poles, but that is about all that could be said. The armature wound to fit a 2-pole field will not operate at all under the influence of 4 poles. To make good proportions, the armature core for the latter case should be made of a larger diameter and shorter axial length than for the simpler case. The one described in the book you have is 3 in. in dia. and $2\frac{1}{4}$ in. in length. For the 4-pole field the armature core could well be $3\frac{3}{4}$ in. in dia. and $1\frac{1}{8}$ in. in length. Form wound coils, such as were described in the Nov., 1908, magazine, would be the most practicable to put on such a core, but for the 2-pole case, hand winding would be best. Castings for the standard machine, as given in the book, can be obtained from A. E. Watson, 30 Congdon St., Providence, R.I.

1081. **Synchronizer.** C. O. S., Los Angeles, Cal., asks: (1) Which form is most commonly employed? (2) How do central stations balance a 3-phase system? (3) What is meant by a "harmonic" electromotive force? (4) What kind of motor is best adapted for elevator service? Ans.—(1) The "Lincoln" synchronizer is a most ingenious and effective dial device for gauging the operation of paralleling alternators. Although the inventor's name is not always seen on the dial, the construction is his. Incandescent lamps are usually employed, but as an addition to the dial indicator,—not as a substitute for it. (2) By transferring circuits or individual transformers from one side of the system to another. Some predetermination of the conditions is desirable, else the transference of such wires may make matters worse than at first. (3) A "sine"

curve is the simplest illustration of harmonic motion, and if the electromotive force varies in its values so as to be correctly represented by such a curve, it can be graphically denoted as "harmonic." (4) If directly connected to the elevator mechanism, so as to start and stop, as actuated by the attendant, the motor should have series wound field magnets. If motor is belted to elevator mechanism, and kept running all the time, the motion of the car being controlled by moving clutches or belt shippers, the fields should be shunt wound. The series motor gives the more economical control, and allows more powerful starting torque and greater capacity for overloads, while the shunt motor is required when other machinery is operated from the same source.

1082. **Caloric Engine.** J. T., Pittsburg, Pa., asks: (1) Is it possible to build a caloric engine of sufficient power to drive a 37-watt dynamo? (2) Has a description appeared in the Electrician and Mechanic for building a $\frac{1}{4}$ h.p. gasoline engine? (3) What is the action of the ammonia refrigerating machine? Ans.—(1) Yes, but for so small a machine we think you will find foot or hand power more practical. You might study the Ericson and Rider engines. A prominent feature connected with all hot-air engines is their large size and high first cost for relatively small output. (2) Yes, in the numbers from Nov., 1906, to Apr., 1907, inclusive. (3) Dry ammonia gas compressed under 110 to 150 lbs. pressure per sq. in. becomes liquified. Allowing this liquid to evaporate again within a vacuous chamber or system of pipes so absorbs heat as to produce refrigerating effects. You might address the Penn. Iron Works Co., 50th St., Philadelphia, or the Vilter Mfg. Co., 901 Clinton Ave., Milwaukee, Wis., for commercial data.

1083. **Wire.** A. W. B., Sapperton, B.C., sends 3 samples of copper wire, and A. W., Wilburton, Okla., sends 6, and asks what sizes they are? Ans.—The first lot measures No. 26, 28, and 32; the second, 13, 23, 26, 28, 31, and 36.

1084. **Small "Prime Mover."** W. H. M., New York City, asks: what kind of engine, steam, gas or gasoline, is best suited for driving a 40-watt dynamo? Ans.—An ideal device for producing small driving powers is not found outside of an electric motor. If you have access to the city service, you can find nothing cleaner, more reliable, or cheaper. If you do not have this service, its substitute will have almost all the opposite conditions. No matter how small a steam engine is used, the boiler requires almost incessant attention, and with gas engines there is an objectionable noise. With gasoline engines, there is the rather rigid prohibition from the insurance companies. Hot air engines are safe, but expensive, and except for the single purpose of pumping water, the difficulties of keeping the pistons and valves lubricated, limit their usefulness.

1085. **Theatrical Lamps.** H. F. A., Rochester, N.Y., asks: (1) Who makes the "Bogue" theatrical lamp and the "Campbell"

spot light? (2) What current do such devices take, and can they be operated from a circuit suitable for a stereopticon? (3) How can humming be eliminated from an alternating current lamp? Ans.—(1) For the first the address is Chas. J. Bogue, 209 Center St., New York City; we fail to find a direct clew to the second, but think the one mentioned makes about all the desired forms of projection lamps. A spot lamp is merely one that is in the focus of a parabolic mirror, and sends the light in so nearly parallel rays as to light little more than a spot, but by spot would ordinarily be meant an area as large as the human body. (3) The cause of the noise cannot be removed, for it lies in the alternate heating and cooling of the air in the region of the arc. Some of the annoyance can be removed by using the lamp in an asbestos lined case, or by mounting the lamp in an adjoining room, and letting the light come through a hole in the wall.

1086. **Ampere Hours.** W. L. G., Clarkston, Wash., asks: (1) Explain the exact meaning of "ampere hours," as used in expressing the output of Edison Primary Batteries. (2) What voltage would a 150 ampere hour battery give? Also a 100 ampere hour (Edison Primaries)? (3) To what resistance should a relay be wound to work good on a short distance wireless telegraph, say—up to 5 miles? Where can one get a high resistance relay with a magnetized core? Ans.—(1) The capacity of an Edison battery in ampere hours refers to the service that can be obtained from it when operated at the normal discharge rate. If a battery has a capacity of 100 ampere hours, it means that it will carry 1 ampere 100 hours, 2 amperes 50 hours, or any other combination which will give the same number of ampere hours. (2) The electromotive force of a battery is entirely independent of its size; the Edison cell has an initial e.m.f. of .95 volt, which drops to .7 volt when the circuit is closed. By placing different numbers of such cells in series, any multiple of this e.m.f. may be obtained. (3) 100 or 150 ohms. (4) The A.B.C. Wireless Specialty Co., 111 Broadway, New York City, or any dealer in telegraph apparatus, sell polarized relays.

1087. **Wireless Distances.** H. Z., Pleasant Hill, Mo., asks: (1) How far should I be able to receive with the following instruments: 50 ft. aerial, silicon detector, tuning coil, battery, potentiometer, condenser, and a pair of 1,500 ohms resistance? (2) Could I increase the distance by using an electrolytic detector? (3) How much spark will this induction coil give: core 10 in., 1 lb. No. 18 wire primary, 2 lbs. No. 33 wire in secondary, wound in coils $\frac{1}{4}$ in. thick? Ans.—(1) You should receive about 500 miles under good conditions. Receivers wound to 5,600 ohms are recommended for use with silicon detector. (2) Yes. (3) You should receive about $1\frac{1}{2}$ in. spark.

1088. **Wireless Distances.** J. S. H., Pittsburg, Pa., asks: (1) Could I receive 100 miles with the following outfit: carborundum detector, tuning coil, condenser, aerial 35 ft. high, cylinder type? If not,

how should I fix it to receive this distance?

(2) I have a watch case receiver, double pole, sold by Manhattan Elec. Supply Co. The number is 1,403. Could I use it in connection with the outfit above, after having it rewound? Where could I have this done, and cost? (3) Please give a list of instruments for use on a tuned circuit sending station. Ans.—(1) Your aerial should be at least 60 ft., for distances of 100 miles. (2) The receiver you mention is a telephone receiver, and will not give the best results for wireless, but may work 100 miles under good conditions, if rewound to 1,000 ohms. The A. B. C. Wireless Specialty Co., 111 Broadway, New York City, make a specialty of receivers, and will rewind it for \$1.00. (3) Coil or transformer, Leyden jars, helix, wireless key, spark gap and hot wire milammeter. Sizes range according to sending distance.

1089. **Transformer.** C. E. G., St. Johnsbury, Vt., asks: (1) I have some transformer iron in pieces 6 in. x $1\frac{1}{2}$ in., and 10 in. x $1\frac{1}{2}$ in. What size and amount of wire shall I use to make an efficient transformer for wireless telegraphy? (2) How much insulation should be used and what should it be? (3) Where can Climax resistance wire be obtained? To answer this question properly, will take up considerable space. Best to send for blueprint which will give full data, otherwise he will be asking continuously.

1090. **Wireless Distances.** H. E. L., Hutchinson, Kan., asks: (1) How far can I receive with the following outfit: Carborundum detector, 1,000 ohm receiver, variable condenser, tuning coil and foundry batteries? My aerial is made of 3 strands of telephone wire 2 ft. apart and 75 ft. long, and is 30 ft. above my instruments. (2) Do trees have any effect on the receiving distance if your aerial is not above their tops? Ans.—(1) You should receive up to 500 miles under good conditions. (2) Trees will effect aeriels somewhat if in the vicinity.

1091. **Ground and Aerial.** N. E. S., Norwich, Conn., asks: (1) How deep in the ground should the wire be for a wireless? (2) What harm would lightning do if it struck an aerial? Ans.—(1) Ground wire should be run to permanently moist ground, so that frost will have no effect as to freezing the ground. (2) Should lightning strike the aerial, it will destroy instruments, and may set fire to same, but if grounded, lightning will not hit it.

1092. **Wireless Distance.** F. S., Lexington, Mass., asks: If I have an aerial 50 ft. high, of 30 ft. of No. 16 copper wire, a 75 ohm receiver and electrolytic detector, how far can I receive? Ans.—With this outfit, you will receive but a few miles. For good results, you should erect a 60 ft. high aerial, and no shorter than 50 ft. in length, and 4 strands, and use a pair of 1,500 ohm receivers, potentiometer, tuning coil and condensers.

1093. **Wireless Distances.** O. C., Gloucester, Mass., asks: (1) How many miles can I receive with the following set: tuning coil made of 100 ft. copper wire (like sample)

wound on a mailing tube 17 in. x $2\frac{1}{2}$ in. in dia., a potentiometer made of German silver wire (like sample) wound on a mailing tube 9 in. x $1\frac{1}{2}$ in. in dia., 52 ft. of wire being used, one 1,200 ohm head receiver with a gold diaphragm, a condenser of 0.1 of a micrafarad, an electrolytic and silicon detector, the aerial being 15 ft. from the D.P.D.T. switch, containing 70 ft. of 14 copper wire? (2) Please tell sizes of wire sent? Ans.—(1) This outfit should work up to 500 miles or more, under good conditions, if you have an aerial about 60 ft. high, and no shorter than 50 ft. in length, of 4 strands. (2) Copper wire is No. 20, German silver is No. 28.

1094. **Rebuilding Dry Batteries.** C. W. L. Watsonville, Cal., says, (1) In your magazine of Feb., 1909, page 346, you give a formula for "rebuilding dry batteries," but do not state whether the parts are by weight or measure as some of the parts are dry and some liquid. Ans.—In the formula, all parts should be by weight.

1095. **Tuning Coil.** A. H. P., Arlington Heights, Mass., asks: In making the tuning coil for the wireless receiver in the June, 1908, issue shall I put the binding posts as follows: one at beginning of winding, one at end of winding, one at the end of each rod? And is it the same in the potentiometer, except that you put one on each end of the rod? (2) Is it necessary to have the tuning coil wound with No. 22 bare copper magnet wire? Is not the enclosed wire magnet wire? Why do I have to use magnet wire? Could I use ordinary copper wire? If not, why? (3) Where in Boston can the copperites and zincites be procured, and what is the price of each? For the wireless receiver, described in the April issue of *Popular Mechanics*, is the part taken from Amateur Mechanics on page 385, and also what is the entire cost of the instrument which has the copperites and zincites in it? Ans.—(1) The potentiometer has a binding post at each end of the winding, but only one slide rod. See July, 1908, issue for full description. (2) Answering the several questions, advise that the submitted sample is magnet wire and is satisfactory. Magnet wire is different in alloy and ductility from other grades of copper wire, being particularly adapted for winding purposes. (3) These minerals might be purchased of a mineralogist. The detector using these is known as the Perikon detector, and many irresponsible firms now selling above minerals for use in making same will be prosecuted by owners of patents.

1096. **Detector.** H. H. G., Worcester, Mass., asks: (1) Could I make a detector for my receiving set as follows: battery carbon $1\frac{1}{2}$ in. x 1 in. x $\frac{1}{2}$ in. Hole drilled in middle $\frac{3}{8}$ in. dia., and $\frac{1}{4}$ in. deep, filled with 1 part nitric acid and 3 parts water. Diagram enclosed. (2) Could I make a potentiometer, by taking a wooden rod 1 in. in dia. and 8 in. long, wound German silver wire for 500 ohms? Please state size wire needed, and how much? Diagram enclosed. Ans.—(1) Yes, the detector could be made, though it would be inefficient. (2) Get

4 oz. of No. 28 Enameled German silver wire. This may be obtained from the Wireless Equipment Co., West Arlington, Md. (3) The sliding contact is to regulate the potential or voltage of the current.

1097. **Wireless Telegraphy.** M. H., Seattle, Wash., asks: (1) Are these connections right? I have followed the directions of Mr. E. E. Getz, but find I can't make things work. I have a 40 ft., 4-wire antenna. (2) Why is there a faint hum in my receiver instead of short buzzes. (3) Is an oil engine better for running small dynamos than a gasoline engine? Ans.—(1) You should use a high resistance receiver. No results can be obtained with a low resistance type. Otherwise your circuits are O.K. (2) This is due to above cause, and too much battery flowing through detector. (3) It altogether depends on type and efficiency of the respective engines. One is probably as good as the other for maintenance and running, if they are of equal power.

1097. **Resistance.** G. T. C., Chelsea, Mass., asks: Please tell me resistance of 300 ft. German silver wire (No. 24 gauge)? This cannot be answered on account of not receiving your full name and address with the question. Advise, and query will have our attention.

1098. **Rheostat,—Steam Engine.** E. J. vD., Canajoharie, N.Y., asks: (1) Will you please give me instructions for making a rheostat; also for making a dynamo-motor which runs as a motor will furnish about $\frac{1}{2}$ horse power? How much electricity would it take to run the motor? How many revolutions per minute would the dynamo need to make, how much h.p. would it take to run it, and about how much electricity should it generate? (2) I would also like to make a steam engine as cheaply as possible. Could I make one that would work if the body was made of concrete, made of cement mixed with fine sand, smoothed up with lead, and with the piston made of lead or brass? Would lead or brass be the best material for a piston, and how do I make the piston? Ans.—(1) Instructions for making electrical apparatus such as you desire may be found in *Electrical Designs*, published by the McGraw Publishing Co., New York (1901). (2) Regarding the concrete engine cylinder I should not recommend your building one. The amount of time taken to bore out your cylinder, after the lead was in place, together with the shrinkage of the lead, would immediately cause me to say that you had better buy a cylinder and steam chest casting and then make a cast iron piston. If you wish to do this, state what size engine you wish to build and we will tell you where castings can be purchased.

1099. **Wireless.** G. B., North Hanson, Mass., asks: (1) What is the apparatus needed for a wireless station to operate 5 miles, and where may I obtain the apparatus? (2) About how much would it cost? (3) What would be height of aerial required? Ans.—Apply to A.B.C. Wireless Specialty Co., 111 Broadway, New York City. Make a very good outfit, and will give you full data.

TRADE NOTES

On June first, The Hoyt Electrical Instrument Works, of Penacook, N.H., removed their New York office to 136 Liberty St., where, with greatly increased space and facilities, they are in a better position than ever to give their rapidly growing business the best possible attention.

* * *

The fact that the manufacture of automobiles in the United States is not quite such a new industry as we are accustomed to think is brought vividly to mind by the illustration sent us by the Holtzer-Cabot Electric Co., of Brookline, Mass., of the first electric automobile manufactured in the United States. This was made by them in 1891, and was a perfectly finished and practical vehicle. Those who are interested in the history of the industry may obtain a copy of this illustration on request from the firm.

* * *

The New York Electrical School is sending out a pamphlet entitled "11 volts." Possibly you never heard of such a tension, so send for the book and find out about it. The address is 39 West 17th St., New York, N.Y. Everyone interested in electricity should certainly become acquainted with the school.

* * *

Kendrick & Davis, Lebanon, N.H., are now mailing their 1909 catalogue of electrical goods No. 9. This firm makes a specialty of small motors, dynamos, rheostats, coils, measuring instruments, and other electrical devices, built with the same precision as is used in the manufacture of fine firearms. Beside a list of their goods and prices, the book contains a table of the sizes, weight and resistance of copper wire, an elementary treatise on electricity, and other useful information. It will be sent on request to any one of our readers.

* * *

The L. S. Starrett Co. have just added to their list of tools, a number of useful pieces, including a universal bevel protractor with vernier, No. 362, similar to 360, described in their catalogue, except that it reads to $\frac{1}{2}$ of a degree. Other new tools are three types of toolmaker's calipers and dividers for inside and outside calibration and measuring, and sighting attachments to be used on an iron level for levelling at long range.

* * *

The Crescent Machine Co., of Leetonia, Ohio, send us their 1909 catalogue of wood-working machinery. In addition to the machines formerly built, the following new tools are added: No. 5 sliding top saw-table, a new 26 in. planer, with top and lower rolls driven, and a variety woodworker, which

may be used as a joiner, borer, saw-table, pole-rounder, shaper, and emery grinder. These new machines are up to the well-known Crescent standard and are guaranteed to give absolute satisfaction. Motor drives and motors for all machines are listed. The catalogue will be sent to any one interested, on request.

* * *

From the Crescent Co., 106 South Clinton St., Chicago, Ill., comes catalogue No. 10 of electrical specialties for electric lighting.

* * *

The General Electric Company has just issued bulletin No 4,662 covering Thomson Recording Wattmeters for switchboard service. This bulletin illustrates and describes the various types of wattmeters and their parts, and in addition gives dimensions and connection drawings.

These instruments are designed to retain accuracy for a long period and without depreciation in value. They are essentially high torque devices, and friction has been reduced to its lowest practical value, so that the ratio of "torque to friction" is a maximum, insuring long life with accuracy.

The various types of meters and their ranges in capacities are as follows:

Direct current astatic Type CS is manufactured in capacities of from 50 to 100 amperes, inclusive, for 2-wire and 3-wire circuits, and for potentials of 100 to 600 volts. Direct current astatic Type G-2 are designed for capacities of from 2,000 to 10,000 amperes, for 2-wire and 3-wire circuits, and potentials from 100 to 600 volts. Single-phase meters, Type IS-2 and IS-3, for capacities ranging from 5 amperes to 150 amperes. They are designed for operation on single-phase primary circuits, 60 to 133 cycles, and potentials of from 1,000 to 2,300 volts. Other recent issues are No. 4,161 and 4,163 on lightning arresters, and No. 4,669 Curtis steam turbines.

* * *

The Hess Warming and Ventilating Co., 908 Tacoma Bldg., Chicago, have just issued a new edition of their handsome booklet "Modern Furnace Heating," which, in completeness and in high quality of printer's work, excels anything ever published by this company.

The booklet forms a complete handbook of furnace heating, and contains much information of value to every house builder or owner. It covers forty-eight pages, beautifully printed in two colors, on fine enameled paper. The cover is handsomely embossed in two colors; and the booklet, as a whole, is most attractive and well worthy of preservation. The Hess Company, whose advertisement appears on another page, are large manufacturers of steel furnaces, selling directly to consumers, and not through dealers.

They invite correspondence from all who

contemplate using hot air furnaces, and offer most unusual terms of trial, besides a lower price on furnaces and fittings than any dealer can afford to quote. The new booklet is free on application; and a copy will be sent to every one requesting it.

* * *

Not long since, we received the 1909 catalogue of Henry Disston & Sons, and expressed our appreciation of its fine typography and execution. We now receive from the same firm, copies of its pocket size catalogue, gotten out similarly to the larger edition, but with pages of reduced size, suitable for pocket use. In illustrations, stock, and printing, this catalogue is the same as the larger one. For convenience, it is divided into two parts, one of which covers everything needed for saw mills, and the other carpenters' and other smaller tools. A copy will be sent to any of our readers on request.

* * *

BOOK REVIEWS

The Design and Construction of Induction Coils. By A. Frederick Collins. New York, Munn & Co., 1909. Price \$3.00 net.

The author of this large and well printed volume has produced what did not previously exist, a book giving full and explicit directions for the actual construction of modern induction coils, of all capacities from $\frac{1}{2}$ in. to 12 in. spark. The author writes from the ground of practical experience in the building of coils, and apparently with due caution in the matter of prescribing rigid dimensions. Realizing that the modern induction coil is an empirically constructed machine, he leaves some latitude for individual choice in the matter of dimensions, but yet gives explicit directions for producing coils suitable for average demands. The various sizes of coils are treated in three groups, each with a slightly different construction, but all having a family resemblance. The book is embellished with numerous illustrations, covering every part of the design, and completed by tables of cost of the necessary materials, and other essential data.

* * *

Harper's Machinery Book for Boys. By Joseph H. Adams. New York, Harper & Bros., 1909. Price \$1.75

We have previously reviewed several of the books in this series, and this one is not behind its predecessors in interest and completeness. It takes up the principles of mechanics, the means of generating and transmitting power, the various kinds of machines used in the various kinds of mechanical work, and finally describes the automobile, the motor boat, and the gas engine. From this book a boy will learn the operation and use of almost any machine which he may find, and also learn how to make a number of useful and simple machines for home use or experimenting.

Lessons in Telegraphy. By C. H. Sewall. New York, D. VanNostrand Co., 1909. Price \$1.00 net.

This book is intended for use as a text book, both in schools and for individual learners. Being thus designed, the author has laid great stress, not only on the instructions necessary to learn telegraphy, but on the avoidance of faults. This is a very important point, as it is far easier not to learn faults, than it is to unlearn them afterwards. The book contains numerous practice lessons, and is thoroughly practical.

* * *

Questions and Answers about Electrical Apparatus. By W. B. Clayton and Jas. W. Craig. West Lynn, Mass., Clayton & Craig, 1909. Price \$1.00.

This is the second edition of this very useful little book intended for those who already know something about electricity, and designed to be a catechism of all the various forms of electrical machines and instruments in use in modern practice. The book covers many of the questions which come up repeatedly in our query department, and is to be commended to every electrical student.

* * *

How to use Slide Rules. By D. Petri-Palmedo. New York, Kolesch & Co., 1909. Price 50c.

This is the second and revised edition of this very complete and useful little book on the use of the various types of slide rules. It has been revised and amplified, and is a useful pocket companion for every student and calculator.

* * *

Internal Combustion Engines. By Wm. M. Hogle, B.S. New York, McGraw Pub. Co., 1909. Price \$3.00 net.

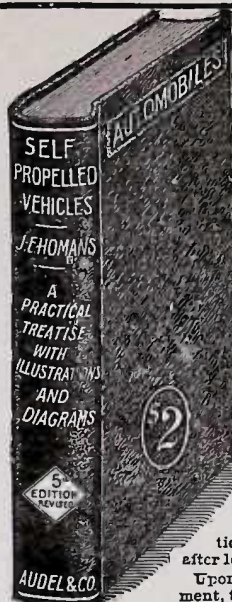
This book is intended to be a reference book of the modern gas engine. It describes the present commercial types of machines, theoretically, but practically, complete and in detail, giving attention to each of the various types. The principles of operation are carefully explained, and the student who becomes familiar with the book should be able to cope with the ordinary difficulties which are likely to occur. The book is free from mathematics, being intended for practical handlers and users of such machines.

* * *

Human Nature in Selling Goods. By James H. Collins. Philadelphia, Henry Altamus Co., 1909. Price 50c.

This little book, consisting of articles reprinted from *The Saturday Evening Post*, should be both interesting and valuable to every person who either buys or sells. This would include about 10,000,000 of the inhabitants of the United States, including probably the most of our readers.

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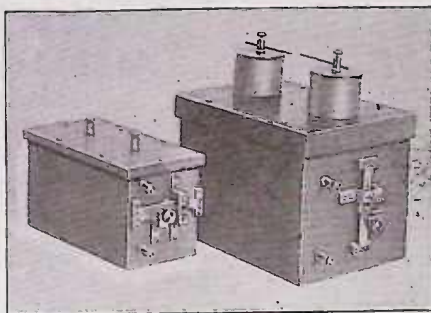
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Mr. Parker on November 1, 1903, after having been a member of the Examining Corps of the U.S. Patent Office for over five years, resigned his position as examiner to take up the practice of patent law.
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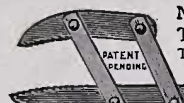
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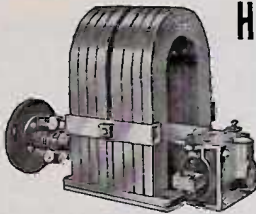
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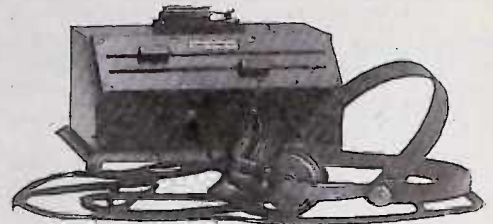


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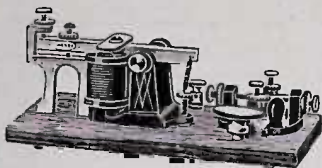
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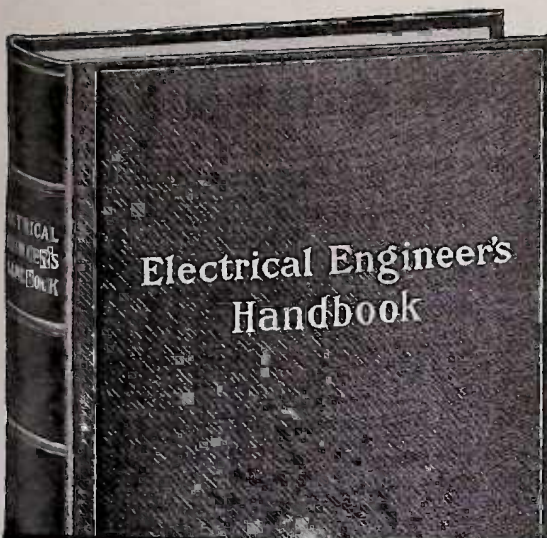


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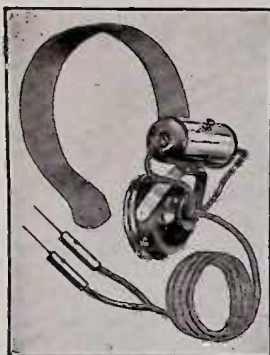
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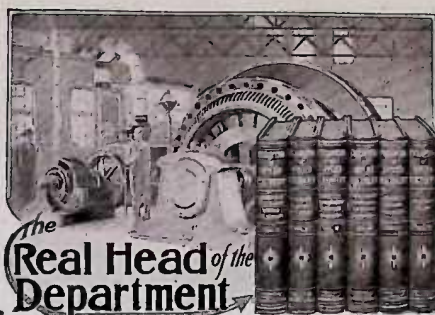
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Owing to the large number of inquiries we are constantly receiving from inventors, we have established a bureau for the convenience of our readers, through which they will be enabled to secure patents on their inventions at the lowest cost consistent with the work performed. We have retained a firm of skilful patent attorneys of Washington, D. C., with a branch office in Boston, who will have charge of this bureau, and who will pay special attention to the legality of patents secured.

If you have made an invention and contemplate applying for a patent, the first step is to learn whether your idea is patentable. Do not depend on the fact that you or your friends have never seen anything of the kind.

Send us a pencilled sketch, showing plainly your invention, and write out a brief description of its construction and operation as well as you can. If you have a model send this also, express prepaid. We will give you our opinion as to the patentability of your invention based on years of experience, and you will get honest advice as to the probable value of your invention.

By having our report as to the patentability of your invention, you will have documentary evidence that at the date of such report you were in possession of the invention referred to therein, and thus be assisted in establishing invention should it ever be necessary to prove that you were the prior inventor.

With the report of reputable and experienced patent attorneys showing that your ideas are new and practicable, you may be able to interest capital in your invention, and thus provide for expenses incidental to the patent, etc.

If you have been working on an invention that is not new, or for which there is no demand, we will so inform you, and you can drop it without further trouble or expense.

DON'T DELAY

Procrastination has cost inventors more money and resulted in the loss of more patents to bona-fide inventors than all other causes combined.

An inventor, in order to protect his ideas, should not postpone applying for a patent.

Fill out the coupon below and forward, together with the description, sketch and model if you have one, as above directed, to this bureau and our attorneys will immediately take up the case.

Inventor (Name in full).....

Residence (Street and No.).....

City or Town.....

Attach above to description of patent and forward by mail to address as follows:—

Electrician and Mechanic Patent Bureau

6 BEACON STREET

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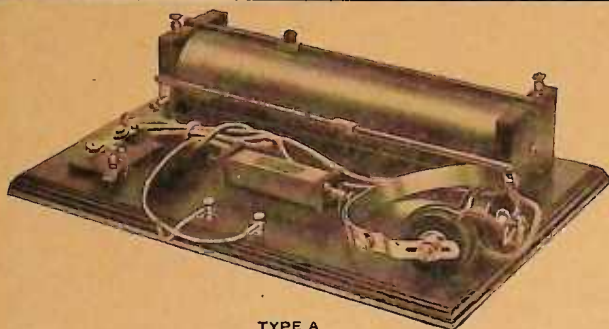
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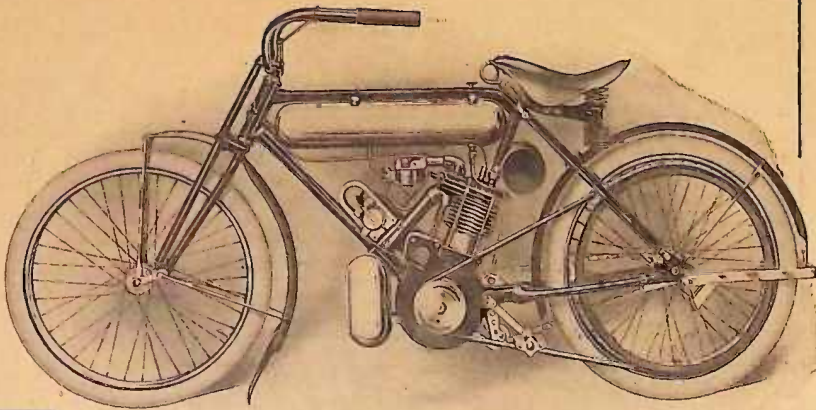
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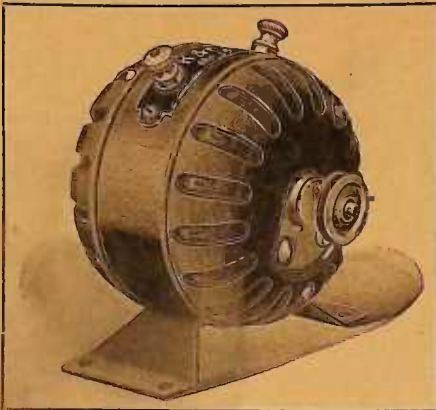
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The commutator has hard copper segments, carefully **insulated with mica**; the component parts of the commutator being rigidly clamped together. Such commutators are found in small motors of our manufacture **only**.

K. & D. self-adjusting resilient-tension brushes. The machine is perfectly ventilated. Fields and base finished in black **enamel**—not paint.

For its weight, the most powerful motor manufactured.

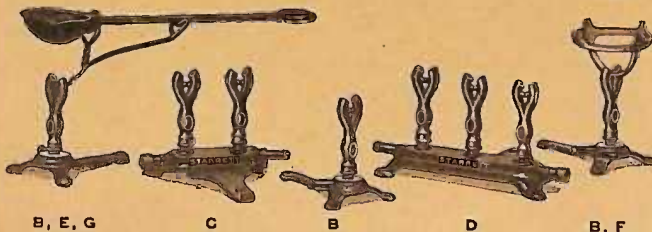
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