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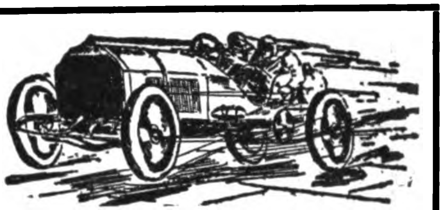

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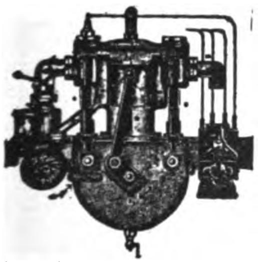

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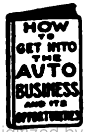

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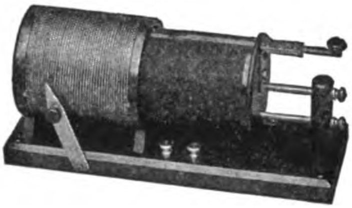

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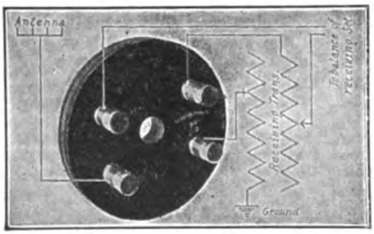

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ELECTRICIAN & MECHANIC

VOLUME XXVI JUNE, 1913 NUMBER 6

MAKING A JAPANESE PERGOLA

GEORGE F. RHEAD

The pergola shown in our illustration, Fig. 1, would be suitable for either a town or country garden. It is such as an amateur worker with even the most rudimentary knowledge of joinery could construct, for outside woodwork does not call for the absolute exactness of indoor work, while the method of jointing chosen is of the simplest, and will be clearly understood from our diagrams.

The measurements for a small-size pergola are given in the half front and side elevations, Figs. 2 and 3, and although for practical purposes the size of the structure could not be reduced to any extent, it could be very easily enlarged in scale to suit one's requirements.

In Fig. 4 is shown the preliminary framework; the four posts are of 3½ in. square wood and measure 7 ft. 6 in. in length. The carcass being 6 ft. wide, and 4 ft. 6 in. from back to front, four rails are prepared, two of each measurement, but with an allowance of at least 3 in. added for the tenons. The rails at the top measure 5 ft. in length, for the joint is cut to extend the whole thickness of the wood at first, a portion being later cut away to fit the front-board of roof (see Fig. 4). The best joint to employ at the top would be the dovetail tenon shown in Fig. 5*a*, which is really quite an easy joint to make, providing it is marked out carefully at the beginning, and when finally a couple of nails 1 in. board 6 ft. 9 in. in length and 3½ in. wide, and is inserted through slots cut in the posts at a distance of 6 ft. from the ground, small slots being cut in the rail where it projects from the posts on the outside, for inserting wedges, Fig. 6, which will allow the uprights to be adjusted to a perfectly vertical position

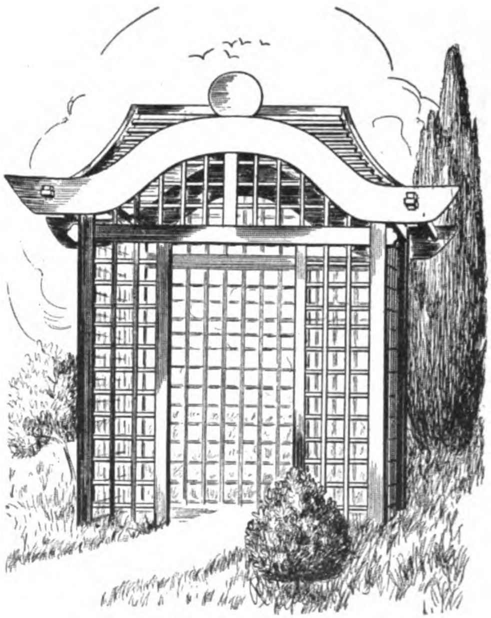


Fig. 1

at will. In fixing, employ a waterproof glue at all the joints, and, of course, use waterproof glue or dowels for jointing. The upper board, it will be observed in Fig. 8, need only measure 4 ft. 6 in. in length, and the lower 8 ft. 6 in., and the curve is shown marked out in our sketch. Cut away the waste with a keyhole saw, fixing the work in a bench-screw if possible, as shown in Fig. 9, or if the worker is not the lucky possessor of one, a couple of screws inserted through the waste portion of the wood into an old kitchen table, or bench, will afford a fair substitute. Two of these curved pieces will be required; they are jointed together by means of struts, which are halved and inserted through slots cut near their ends and wedged on the other side; the joint in, Fig. 11, *A* and *B*. Both joints are secured with spike nails. Narrow strips are now nailed upon each side of the raking pieces to form an attachment for the laths of roof, which are then put in.

The upper and lower parts of structure may now be put together, the upper portion being jointed to the posts which are halved at the top by two 4 in. screws through each. The upper portion is also further screwed by the center-board of front, which is tenoned into the lintel and curved roof, the latter being for safety fixed to a strut marked *A* in Fig. 3, which will prevent the possibility of its movement during a high wind.

Fig 2

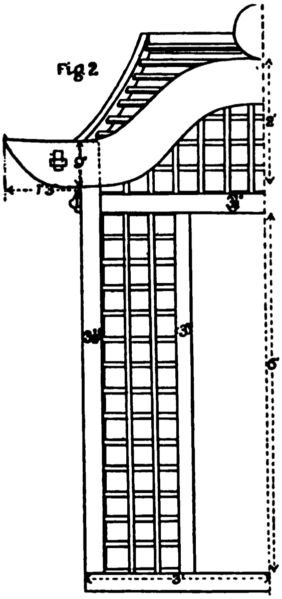
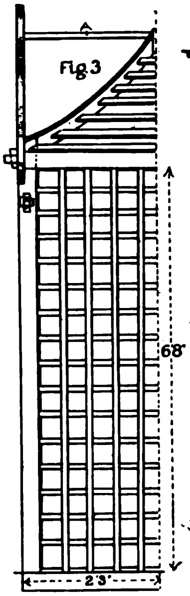


Fig.3



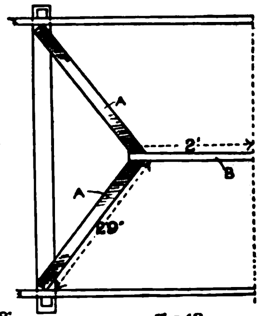


Fig.12

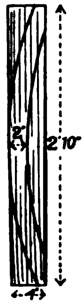


Fig.10

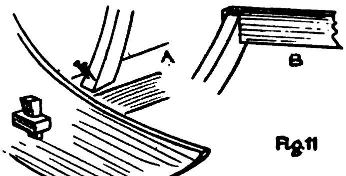


Fig.11

being made clear by a glance at our perspective view, Fig. 1.

The making of the curved pitch roof requires a little care, but with patience the initial difficulties may be easily surmounted. The curved raking pieces marked *A* in the plan, Fig. 12, are cut from a board measuring 2 ft. 10 in. x 4 in. x 1½ in., the width of the curved piece when cut being 2 in., Fig. 10. These pieces are notched at their upper ends at an angle, which can be easily found

There is now to be added the circular piece at the top of arch, which measures 12 in. in diameter. A little of the bottom of this is cut away so that it may fit the curve of arch, to which it is secured with dowels.

The pergola is now quite complete, with the exception of the lattice-work panels, which are made separately. The most inexpensive and convenient material to employ for these are plasterers' laths, which are procurable in bundles

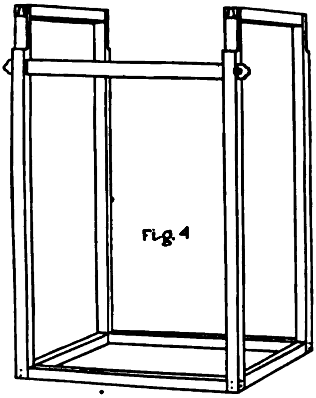


Fig. 4

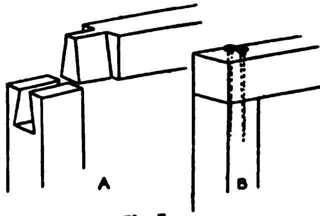


Fig 5

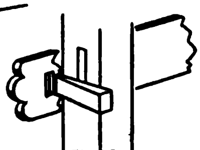


Fig 6

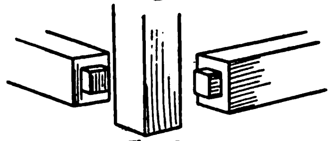


Fig. 7

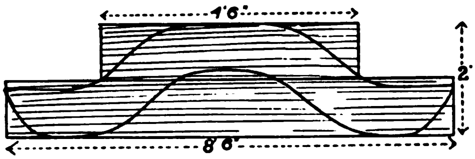


Fig. 8

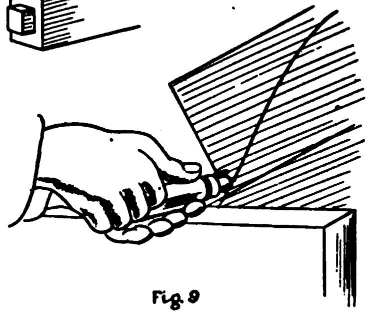


Fig. 9

will also save the necessity of marking out the position of each lath. This is made the same width as the distance between the laths—in the present case 4 in.—and the grooves, which are the width and depth of a lath, are set apart the same distance.

A series of laths are laid in the grooves, and the board is then tenoned with the grooves downwards. It then forms a guide for nailing on the upper laths, it being moved along one, as each lath is applied, and thus not only saves measuring the positions, but keeps the lower laths in position during the nailing.

The trellis panels are attached to strips nailed round the openings where they are applied.

When completed, at least two coats of paint should be given, and this matter should also not be neglected at subsequent intervals.

WORKING OF THE NEW LAW

Secretary of Commerce Redfield is in receipt of a statement from the Bureau of Navigation, showing that during the first four months of the operation of the act to regulate radio communication, which took effect on December 13, 1912, the Department of Commerce, through the Bureau of Navigation, has issued 3,407 licenses to wireless operators and stations in the United States. The first grade commercial operator's licenses number 1,279, second grade 186, while 1,185 amateurs have been licensed, although work with the latter class has been delayed to push the licensing of commercial stations and operators. Eight operators' licenses of the experiment and instruction grade have been issued.

The Bureau of Standards has designed special testing instruments for the purpose of measuring wave-length, decrement, etc., to reduce interference and insure the orderly use of radio-communication, and these instruments are now being put into the hands of the ten inspectors in the field, who will be fully equipped by the end of the month. Thus far forty-six American ship stations and eighteen coast stations have been licensed, and this branch of the work will now proceed more rapidly. Six hundred eighty-five amateur stations have been licensed. The inspections already made have considerably increased the efficacy of wireless apparatus on ship and coast stations. The wireless apparatus on ocean passenger steamers has been inspected before about 1,500 sailings from the United States during the four months.

AN X-RAY SET FOR STUDENTS

EDWARD H. KURTH

A great many experimenters and students have wished to own an X-ray outfit of moderate power, but due to the great expense if purchased, have been unable to procure one. An effort will be made to show how at small expense an outfit can be made, by which different sections of the body and small animals can be photographed by means of the X-ray.

THE TRANSFORMER

The transformer rightly comes first, because on this depends the power of the outfit. The type used is the closed core magnetic leakage ¼ k.w. transformer. As a very suitable one of this style was described in the August and September, 1912, issues of this magazine no more space will be given to this part of the outfit.

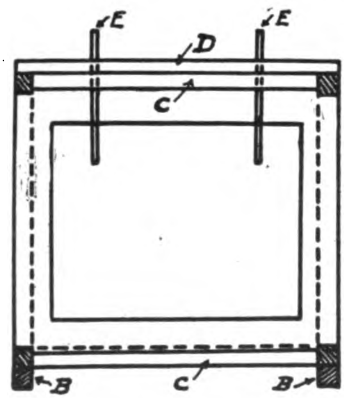
THE CONDENSER

The condenser consists of 20 glass plates 8 x 10 in. covered on both sides with heavy tin-foil 6 x 8 in. placed 1 in. apart in the frame. It is made of maple, stained and polished. The plates are connected as shown in Fig. 2 in the drawing.

THE TESLA COIL

The secondary is wound in one layer of No. 30 enameled wire, spaced about the width of the wire apart. The tube is made of cardboard, and is 4 in. in diameter and 20 in. long. The primary is wound on the frame, made as shown in the drawing, and consists of six turns of No. 4

Fig. 1.



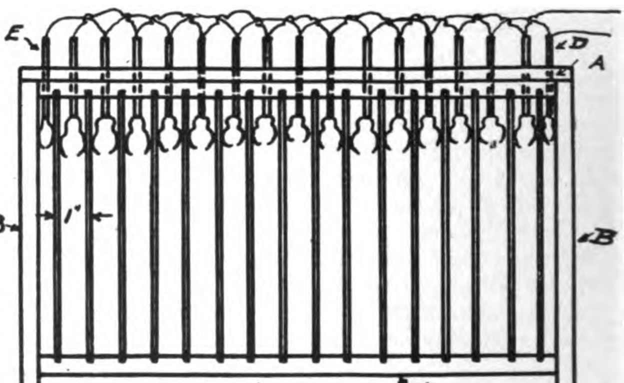


Fig. 2

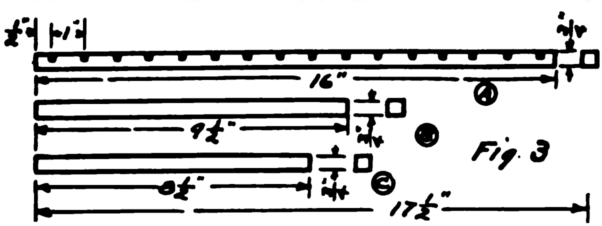


Fig. 3

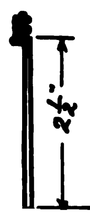


Fig. 4

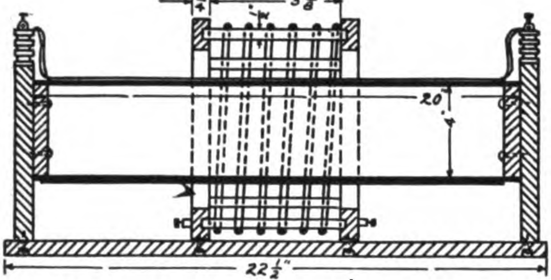


Fig. 1

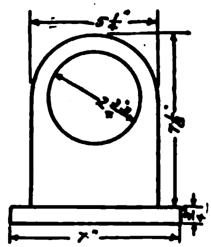


Fig. 2

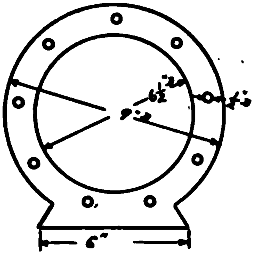


Fig. 3

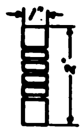
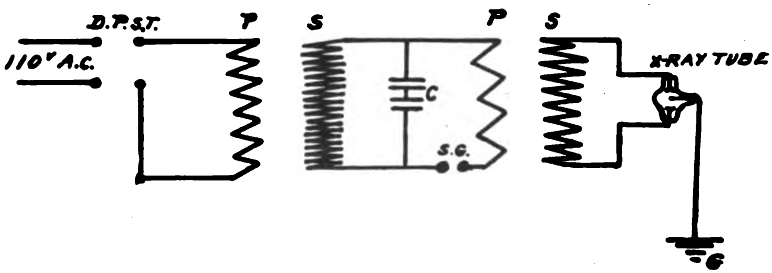


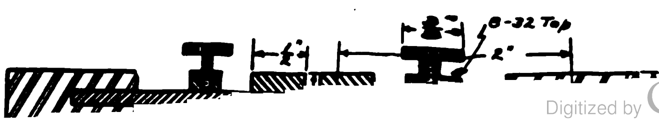
Fig. 4

B.&S. brass wire. The whole is then mounted on the base, as shown in the drawing, and each end of the secondary connected by means of a small copper strip to the binding-posts mounted on the rubber posts. The ends of the primary wire are connected to binding-posts on the rings.

THE SPARK GAP

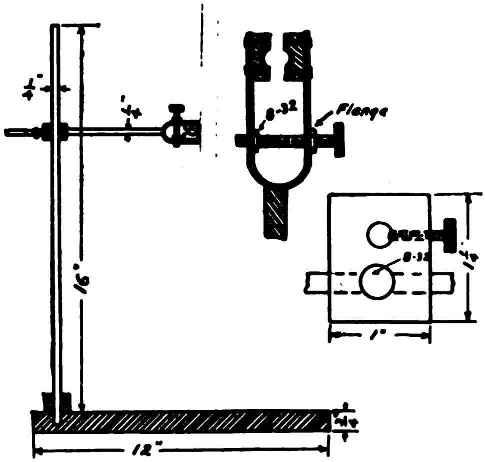
The spark gap is next to be considered. It is of the common wireless type and consists of 2½ in. zinc electrodes screwed on the ends of 2 in. lengths of ⅛ in. brass wire. The standards are 5/16 in. brass rod and mounted on a ½ in. rubber base. Details may be had from the drawing.





THE TUBE HOLDER

The tube supporter consists of a ¼ in. or 5/16 in. brass rod 16 in. long. In this



slides the adjusting block; a small block of brass shown enlarged in the drawing. The taps are 8-32 thread. The horizontal arm is made of ¼ in. brass rod, on the end of which is the tube clamp, which consists of a small bow of brass with felt-lined jaws and a tightening screw. The whole is mounted on a 12 in. square maple base, which forms a rest for the object to be radiographed and the plate holder.

The tube used to secure the best results should be of the double focus style and extra fast plates should be used. The connections aré shown in the drawing. It is not absolutely necessary to ground the center terminal of the tube, but sometimes better results are obtained in this way. The time for exposure to the rays can be determined only by experiment.

KNURLS

Please give me some information about using knurls. I bought a set containing eighteen assorted patterns with a holder, and thought all there was to do was to put your work in a lathe, hold the knurl against it while it was revolving very fast and transfer the pattern to the work, but it does not work at all. The most I can get is a poor job of ordinary milling, like that on a coin. In making tools for my own use I wanted to have a nice finish on them, same as on the ones we buy. A brief description of how to do it will be highly appreciated. Also please tell how the finish resembling engine turning is put on screw-driver handles and such things; it looks as if it might have been done by milling with a knurling tool and my set contains several with that kind of pattern.

The way to use a knurl is to run the lathe *slowly*, and apply the knurl to the work with *heavy pressure*. You have been doing just the opposite, which is the reason you have not been successful. Let us remind you that the heavy pressure which must be used, makes it necessary to mount the work very solidly in the lathe. For instance, if you are making a screw with a brass head, such as a binding-screw, to have a knurled or milled edge, you must not attempt to knurl the head after you have fastened it to the screw, because the pressure of knurling will bend or break the screw, or spoil the threads where held in the chuck. The knurling should be done before cutting the piece off of the rod of stock, so that the knurled diameter is not much greater than the metal which connects it with the stock, so as to avoid all risk of bending or breaking off the knurled part, which can afterward be separated from the stock by turning or sawing. If the knurling is to be done on a disc which has been sawed from flat metal, the disc should be centered and drilled and held on a strong arbor chuck; or, if drilling is not permissible, it can be soft-soldered to a brass plug-chuck, or if not of large size or width, to a short cement-brass, or even to a thick piece of brass rod held in a split-chuck. It sometimes is advisable to support the free end of the work with the tailstock.

The kind of knurling which you describe as sometimes seen on screw-driver handles, like a continuous engine-turned surface, is made by a special machine in which a number of knurls are fastened to a revolving head, on sliding bars which are pressed toward a common center, which, of course, is also the axis of the rod which is being knurled. This kind of operation would be impracticable unless very large quantities of work are to be produced.—*The Keystone.*

A HOME-MADE ACETYLENE GENERATOR

CHARLES I. REID

A reliable and very cheap acetylene generator may be made from an ordinary Mason fruit jar, a one-quart size being large enough for two one-foot (48 candle power) burners, or a proportionate amount of other sizes. If more burners are desired, use a two-quart jar. Having secured the jar, procure about two feet of copper tubing with an inside diameter of ⅛ in., also a supply of rubber tubing (in the absence of gas tubing, nursery tubing will do). Knock the porcelain out of the cap for the jar, and drill two holes through the zinc, one in the middle and one near the side, just large enough to pass the copper tubing through. Cut a piece of the copper tubing long enough to reach about half way to the bottom of the jar; solder this tube in the hole in the middle of the cap. Also cut a piece of the tubing about two inches in length and solder it in the side hole to let the gas out of the generator. Both tubes should be soldered air-tight; but zinc is treacherous metal for soldering, and a tinsmith's help may be useful. Attach

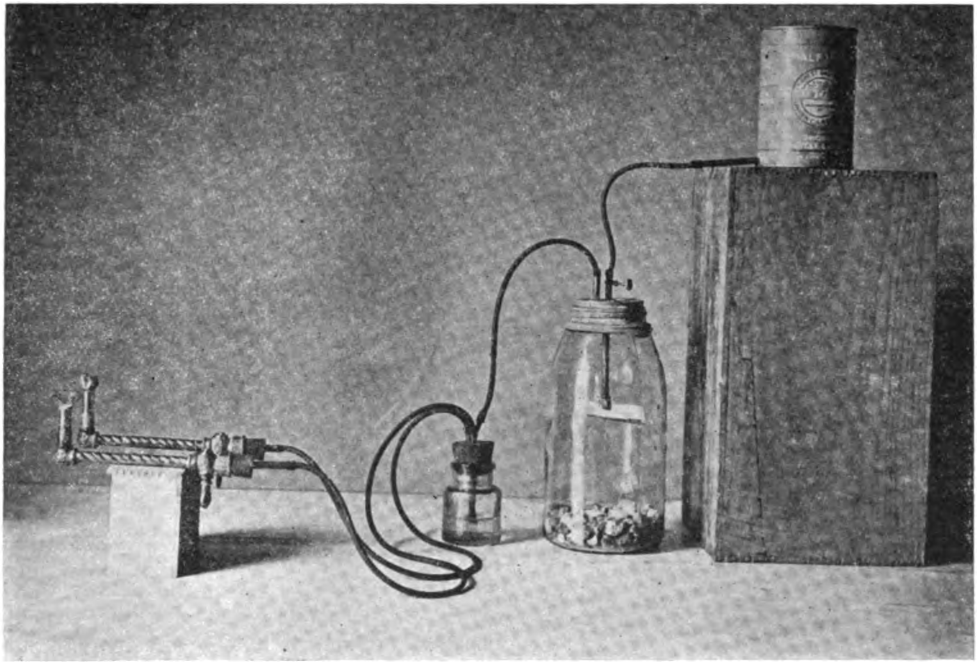
giving a more steady light. Attach some kind of a spigot to the top of the long tube to control the water, one with a needle point being the best.

The water can be supplied from an ordinary tin fruit or carbide can by punching a hole in the side near the bottom and soldering in a piece of tubing, making connections between the can and the generator by means of a piece of rubber tubing.

This completes the generator, which is now ready for use by simply filling about one-fourth full of carbide. The cover should be screwed on tightly, and it is advisable to use two or three rubber gaskets to prevent possibility of any gas escaping.

After connecting the burners by means of a piece of rubber tubing, turn on the water just a little, and after waiting a few seconds, light the burners. If the flame is scattered, do not let the water drip so fast; but if the flame is not full size, turn on a little more water.

A safety device is advisable, as this



with a piece of sharpened copper tubing. Now, cut two pieces of copper tubing, one about one inch and one three inches in length, and pass them through the holes in the cork. Fill the bottle about one-fourth full of water and insert the cork, making sure that the long tube passes into the water. Connect a piece of the rubber tubing to the generator with one end and to the long tube of the safety bottle with the other end. Connect another short piece of the tubing to the burner and to the other tube of the safety bottle. If more than one burner with this device is desired, make an extra hole in the cork of the safety bottle for each additional burner and insert long pieces of the copper tubing.

The luminosity of acetylene can be greatly increased by adding hydrogen peroxide to the water used in the generator. One and a half ounces of twenty-volume peroxide in ten ounces of water increases the light seventy per cent.

A SELF-RECORDING DICTOGRAPH

A self-recording dictograph, which could not only overhear a conversation in a room where its presence was not suspected, but could make a full record of the conversation, whispers and all, on a phonographic cylinder located some distance away, is being exhibited in New York by K. M. Turner, the inventor. The secret of how to build such a self-recording dictograph has been sought diligently ever since the instrument that made Detective Burns famous was placed upon the market eight years ago. In his cases in court Burns has been forced up to the present to submit stenographic notes, the authenticity of which he has had to prove.

For eight years Mr. Turner worked on the invention. For seven and a half of them he sought to connect the diaphragm of the dictograph directly to the needle of a phonographic roll, but got no results. Four weeks ago he began experimenting with an air cushion between the diaphragm and the needle, instead of a direct connection, and at once obtained a full and natural reproduction of the voice.

Mr. Turner explained that the new invention, as applied to business, means that it is now possible for a business man to sit at his desk and dictate his letters in his ordinary tone of voice, and have them taken down on phonographic rolls

sisted, was that now recognized in the transmission of conversations by telephone.

"There's a chance here," said Mr. Turner, "for newspapers to eliminate the time loss between big convention halls and their offices. It could manufacture in the office over this wire phonographic rolls of the speeches just as they were made. Type-setters, working from these rolls, could pass the matter almost directly from the speaker to the printing presses."

In detective work, Mr. Turner said that the absence of the self-recording feature had proved an almost insurmountable difficulty. It had been necessary to make the instruments so that two detectives instead of one could listen to what was being repeated by the dictograph. In some court cases the dictograph's evidence had been thrown out, because a single detective's transcription of the record was thought to be hardly reliable enough for a conviction. "But now the judge can listen to the phonograph in the courtroom," said Mr. Turner, "and he can tell each man's natural voice. The dictograph will identify each man who has spoken in a room where it has been at work."

In detective work, the dictograph would be equipped both with listening

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

WORKING DRAWINGS AND ASSEMBLIES

When a piece of machinery is to be designed, a rough *lay-out* of the machine is first made, and then the dimensions and proportions of the various parts are calculated. In Fig. 1 is shown the *lay-out* of a cam arrangement consisting of a plate cam and a cylindrical cam. The cylindrical cam oscillates a disc through an angle of 90 degrees. In the periphery of the disc are two ¾ in. holes 90 degrees apart. The plate cam raises and lowers a lever arm to which is attached a plunger, and at certain intervals this plunger drops into one of the two holes. The relative motion of the two cams is such that when the plunger is entering or leaving one of the holes, the disc remains stationary, while when the disc is moving

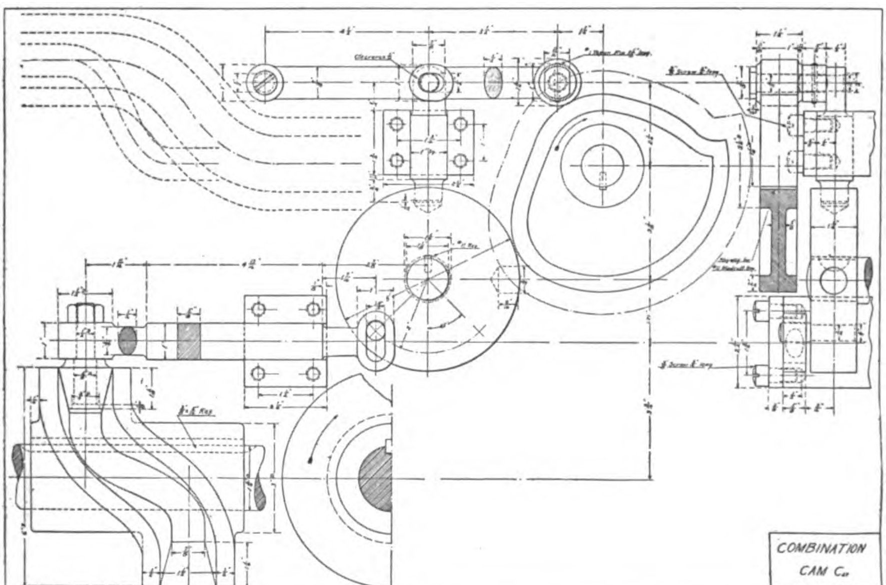


Fig. 1

necessary in such a drawing to show sections or indicate dimensions, as such a *lay-out* is usually made to a definite scale, and the dimensions may be scaled off directly from the drawing.

One of the chief purposes of a *lay-out* is to insure the proper arrangement of the various parts so that there may be no overlapping of any kind or any interference of one part with another. It is not usually necessary to show as complete a drawing as this one, and as a rule only the outlines are shown. Where one portion of the mechanism travels a considerable distance during its cycle of operation, it is best to show with full lines one of the extreme positions of the mechanism, and to indicate with dotted checking up the proportions and operations of the various parts, the drawings are next passed on to a draftsman who draws out to scale the various parts of the mechanism. Such a draftsman is known as a *detailer*. His duty is to make separate drawings of each individual part, giving full dimensions and instructions on the drawing, so that the pattern-maker or the machinist may work entirely from these drawings without any verbal instructions from the designing room. *Detail drawings* and sketches were shown in the April issue of the ELECTRICIAN AND MECHANIC. These drawings were made from actual machines, but where a new machine is being designed exactly similar drawings

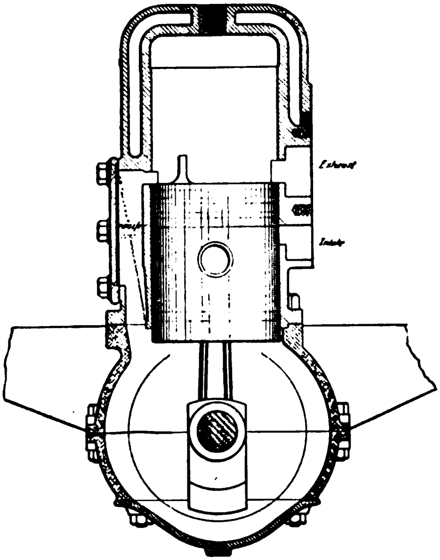


Fig. 2

are made from the *lay-out*, and these are the ones which the pattern-maker and the machinist receive.

After the detail drawings have been completed, an *assembly* drawing is made information which is necessary to clearly define both the shape and arrangement of every part of each piece of the mechanism. Frequently, however, these three views are not sufficient to give complete information regarding the construction and arrangement of the parts, and in such cases, it is necessary to make a representation of the object as it would appear if cut by a plane, or in some cases a detailed view of one or more parts must be given. Where a section is taken through the object, the cross-hatching of the section indicates both the materials used and where the different pieces of the same material are in contact. The principle of sectioning was carefully treated in a previous article and the U.S. Standard style of sectioning was given. When possible an *assembly drawing* should be made full size, but where this is either impossible or impractical, the drawing should be made so many inches to the foot and the scale used indicated on the drawing in the following manner: namely, 3 in. = 1 ft., or one-quarter size. The title of the *assembly* is always placed in the lower right-hand corner of the drawing and inside of the margin line. It includes the name of the machine or mechanism; the name of the special part which the *assembly* shows; the scale to which the drawing is made; the date of completion of the drawing; and the draftsman's name or initials. With *assemblies* as with other drawings, the inking of the drawing should never be begun until the penciling is completed. Usually, however, the penciling is done on ordinary detail paper and the tracing is made from the pencil drawing. Copies of the drawing may then be made by the ordinary blueprint process and the tracing need not leave the drawing room, where it is filed away for reference.

If it is desired to make but one view [illegible] machine, it is often found hatching indicates the material of which the different parts are made, and as the drawing is made to scale, no dimensions are shown. It should be noticed that when taking a section through such a piece of machinery, the section is taken through a diameter, and a cylindrical surface within may be cut by the section or not, at the discretion of the draftsman. Where several similar parts are united in one *assembly*, a section taken through one of these parts may cut all interior mechanism, a section taken through another of these parts may cut but a portion of the object, while the remaining parts may be shown in full. This is exemplified in Fig. 3.

which covers the cam-shaft is removed. The drawing shows one of the valves lifted to its maximum height and the other valve seated. The fourth cylinder and its valve mechanism are shown complete. The scale of the original drawing was 6 in. = 1 ft., but as the drawing had to be reduced before reproduction, the scale was omitted.

Blueprints of the *assembly* drawing are sent to the assembling department and are used as a guide in erecting the machine. They are often used by salesmen or in catalogs to describe and explain the workings and construction of the machine.

Assembly drawings are usually the last things treated under the title of Mechanical Drawing. It was the original intention of the authors to include Gear Design, Cam Design and Perspective in this course, but as the work progressed it was realized that these subjects were worthy of separate attention and it was not considered advisable to include them. As a last word to the student in Mechanical Drawing we would say that the only way to learn drawing is by doing original work. The making of tracings is but a poor substitute for original work, and is not worthy of the attention which it is usually given. Anyone with ordinary intelligence and some slight experience

(*Continued on page* 392)

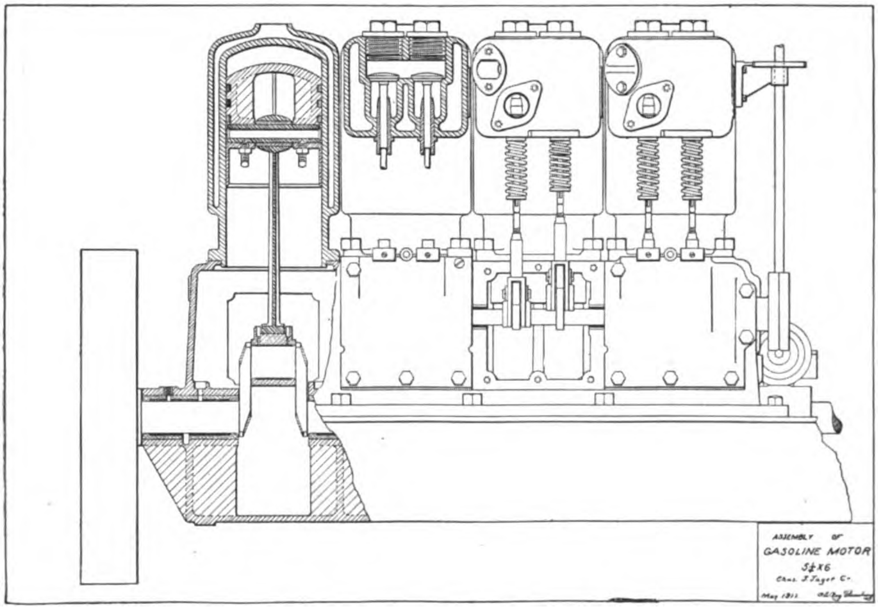


Fig. 3

Fig. 3 is the assembly of a gasoline motor set up ready to run. The first cylinder and a portion of the crank-case are cut by a section-plane. This plane passes directly through the piston, piston-rings, piston-rods and crank-shaft, and therefore clearly shows the various materials used. It should be noticed that the section is so taken that the entire valve mechanism for this cylinder is eliminated from the drawing. The valve mechanism for the second cylinder is cut by a section-plane, and the valve rods and springs are not shown. This section shows the valves and the interior of the valve-chamber. The third cylinder is not cut by a section, but the plate

METALLIC TUNGSTEN AND SOME OF ITS APPLICATIONS*

Tungsten does not occur as such in nature; but in the form of compounds it is pretty well distributed. The most important ores are sheelite, or calcium tungstate, and wolframite, or iron-manganese tungstate. The principal source of the ore at this time in this country is Boulder County, Col.

From the ore it is a simple matter to get the yellow oxide (trioxide) of tungsten. And the trioxide may be reduced in various ways, as with hydrogen, zinc, and carbon, to metallic tungsten. The product so obtained is in the shape of a powder, ranging in color from gray to black, depending upon the fineness of its state of subdivision.

Owing to its very high melting-point, it was for a long time impossible to get the pure powdered metal into the form of a dense coherent homogeneous mass. Two Austrians, Messrs. Just and Hanaman, working in Vienna, finally succeeded, however, in producing the pure metal in this condition and in a filamentary form, and by using it as an incandescent filament became the inventors of the tungsten lamp.

PHYSICAL PROPERTIES

Wrought tungsten is a bright, steel-colored metal, having the same density as gold—19.3. (This varies somewhat with the amount of mechanical working which the specimen has had.) The strength and pliability both increase with the amount of mechanical working. The fracture may be very coarsely crystalline, or it may resemble that of a very fine-grained tool-steel, or it may be fibrous and silky in appearance, or it may lie anywhere between these extremes, the appearance in each case depending upon the chemical purity and upon the preceding thermal and mechanical treatment and quenching. Similarly, tungsten containing carbon is not appreciably affected by quenching. The hardness imparted by working may be entirely removed by carrying the metal to white heat. The ductility is extreme, as is shown by the fact that wire only 0.0006 in. (0.0152 mm.) in diameter is now produced in large quantity. Tungsten is non-magnetic. The electrical resistivity at 25 degrees C., expressed in microhms per centimeter cube, is 6.2 for the hard-drawn wire and 5.0 for the same annealed. The corresponding data for annealed copper and annealed platinum are 1.87 and 11.1 respectively. The temperature coefficient of electrical resistivity per degree between 0 degree and 170 degrees C., is 0.0051. Assuming the Franz-Wiedemann law to hold for the relation of heat to electrical conductivity, we may calculate the heat conductivity of annealed wrought tungsten to be 0.37 times that of copper and 2.2 times that of platinum. The coefficient of heat expansion per degree, from 20 degrees to 100 degrees C., is 336 x 10^{8}8, which is about 0.26 that of platinum.

CHEMICAL PROPERITIES

Wrought tungsten does not tarnish upon standing in the air. Upon heating it to a temperature of 300 or 400 degrees, however, it oxidizes superficially and turns blue just as steel does. At bright red heat the oxide volatilizes, and the metal wastes away more or less rapidly, depending upon the temperature. It is quite resistant to the action of most acids, being entirely unaffected at room temperature by either dilute or concentrated hydrofluoric, hydrochloric, nitric, and sulphuric acids. With aqua regia at room temperature the action is very slight. At a higher temperature, 110 of sulphuric and chromic acids, but the metal dissolves rapidly in a mixture of hydrofluoric and nitric acids. An aqueous solution of caustic potash has no effect on wrought tungsten, but the fused salt does attack the metal slowly. In aqueous solutions of sodium or potassium carbonate or mixtures of the two, tungsten dissolves slowly, the action being considerably hastened by the addition of potassium nitrate.

ELECTRICAL CONTACTS OF WROUGHT TUNGSTEN

Under the conditions pertaining in many electrical make-and-break devices, as in magnetos, spark-coils, voltage regulators, railway signal relays, telegraph and telephone relays, telegraph sending keys, etc., wrought tungsten has proved to be far superior to platinum or platinum-iridium for the contact points.

This was not in any sense an obvious application, for tungsten is not like platinum, a difficultly oxidizable metal. It might well have been assumed that under the heat of the minute arcs which form when the contacts are separated, the tungsten would oxidize at the points where arcing has taken place, and that non-conducting layers would thus be formed which would produce a high and variable contact resistance. In fact, our first experiments bore out this theory. But subsequent work showed that the difficulty in these early experiments came from the fact that, at the time, we were unable to make a good thermal and electrical joint between the tungsten and the contact-carrying members. With the attainment of a good conducting joint, our results changed completely. The contacts no longer rose to the same high temperature, and the oxidization decreased to little or nothing. Moreover, in case there was any oxidization, it was to the lower and electrically conducting oxides.

Tungsten contacts wear longer than those of platinum or platinum-iridium. This is doubtless largely to the lower vapor pressure. At temperatures at which platinum volatilizes badly, tungsten has a very low vapor pressure. Besides this, the heat conductivity of tungsten is more than twice that of platinum, and as a result, the contact faces do not rise to the same high temperature. (In comparison with platinum-iridium alloys, the ratio of heat conductivities is still more favorable to tungsten.) In connection with the life of contacts, another important consideration is that of hardness. Tungsten is so hard that it does not batter down at all under the continual hammering which the contacts get in service.

Tungsten contacts show less tendency to stick than do contacts of platinum or platinum-iridium. This is to be attributed in part to the higher melting-point of tungsten. There seems to be another factor here, however, for while we are able, by proper manipulation, securely to weld together two pieces of platinum at a temperature considerably below the melting-point, it has not as yet been possible, except by actual fusion, to produce anything more than a very weak adhesion between two pieces of tungsten.

One minor and unexpected advantage connected with the use of tungsten contacts consists in the fact that they seem less sensitive to the accidental presence of oil than do platinum contacts.

Allusion has already been made to the difficulty at first experienced in producing satisfactory thermal contact between tungsten and the metal comprising the contact-carrying member. This was due to the fact that tungsten can not be satisfactorily soldered by any of the ordinary processes. This difficulty has been overcome in the following way: The little disc of tungsten, which is to serve as contact-point, is attached by means of copper to the head of an iron tack. Copper does not alloy with tungsten; but, under suitable conditions, it wets it, and then adheres firmly. This gives a joint of high thermal and electrical conductivity between the tungsten and the head of the iron tack. The shank of the tack is then either pressed in, or brazed, or riveted to the contact-carrying member.

WROUGHT TUNGSTEN IN X-RAY TUBE

This has proved to be, both from the scientific and practical points of view, an exceptionally interesting application.

Until recently platinum has been almost universally regarded as the best target material, and it has so long held undisputed sway in this field that the Roentgen-ray worker has come to look upon its limitations as inherent in the Roentgen tube.

With the advent of dense, forged pieces of pure malleable tungsten, the possibilities of the Roentgen tube are greatly extended.

The desiderata in a material to be used as the anticathode or target are the following:

1. High specific gravity.
2. High melting point.
3. High heat conductivity.
4. Low vapor pressure at high temperature.

The reasons why the above qualities are desirable follow readily from a brief consideration of the theory of Roentgen ray production.

From the concave cathode, electrically-charged particles—the electrons—are shot out at high velocity in a direction normal to the surface. The paths of these particles converge, and the target is placed at or near the point of strongest convergence—the focus point. When the electron meets an obstruction, as the target, its velocity is reduced, and the denser the target the more rapid is the deceleration. The more rapid the deceleration, the greater is the amplitude of the electromagnetic pulse—the Roentgen-ray—sent out. Here, then, is a need for high specific gravity: that of forged tungsten is but little less than that of platinum.

In modern Roentgen-ray practice, powerful apparatus, running sometimes to a capacity of 10, and even 15 kw., is used to excite the tube. A considerable part (perhaps as much as one-third) of the energy delivered to the tube is transformed into heat at the point where the cathode rays bombard the target. Where platinum is used it has been found necessary, to prevent melting, to place the target tube has been increased by water-cooling the platinum or by using as a target a large mass of copper having a very thin platinum face. But the limit, although raised by these artifices, has still been the melting-point of the platinum.

Tungsten has a much higher melting-point (3,000 degrees C., as against 1,755 degrees for platinum), and so, even with sharp focusing of the cathode rays on the target, permits the use of more energy than has hitherto been possible, for the high temperature to which it can run enables it to radiate more heat, and its better heat conductivity permits a more rapid flow of heat from the focus-spot to the surrounding metal.

Stability of vacuum in a Roentgen tube is of the utmost importance, as the character of the rays is so largely determined by the vacuum. Metal, which, under the influence of the high temperature, vaporizes from the target, condenses on the glass in finely-divided form and absorbs relatively large amounts of gas, thus changing the vacuum. At high temperatures tungsten vaporizes least of all the metals.

Two distinct types of tungsten targets are being tried out experimentally in competition with one another.

The first of these consists of a heavy copper block with a disc of wrought tungsten attached to the face. This is similar to the platinum targets which have been in use for some years. The function of the copper is simply to conduct heat away from the tungsten and to act as a heat storage reservoir. In this latter capacity it is much more effective than would at first seem possible, owing to the fact that while the rate of energy input is high, the time is correspondingly short, a single excitation of the tube lasting for perhaps only half a second. [illegible] that it would

ELECTRICITY AND PURE DRINKING WATER IN THE CITIES

FELIX J. KOCH

Water-works engineers, as well as students of municipal sanitation, the world over, are watching with no little interest the development of a remarkable application of electricity, obtained without cost, to the municipal filtration system of what Lincoln Steffens termed the "worst-governed city in America"; materially reducing the cost of such filtration and thus making it by so much within the reach of poorer municipalities.

In the winter-time, in order to insure the purity of the water, chloride of lime is used. A solution is really made, consisting as a rule of six-one-hundredths of a millionth part in the bulk. At present this chloride of lime, for one day's consumption, costs about $10; multiplying this by the number of days of the year, and keeping in mind, too, that with the natural growth of popula-

sum, the engineers have now found a way of using the electricity generated here—as at most filter-plants—by the water, in flowing from the settling-basins to the coagulating basins. This means that they will practically get their electricity free.

In utilizing it they have a special "battery"—as it is called—into which salted-water flows. The electrical current is then passed through that salt water so as to produce all the chlorine that need be used to sterilize the city's drinking-water.

While to date there have been made only large-size laboratory tests on the subject, the city is now to build a new house devoted to this end, where it will practically cost Cincinnati nothing to make her chlorine, except for the salt in the water.

HALL STAND

The design for a Hall Stand, shown at Fig. 1, is very simple in construction, yet artistic in appearance. There are no difficult joints to be made, and anyone with only a little knowledge of woodworking tools should be able to make a satisfactory piece of work.

The side and front elevation is given at Figs. 2 and 3, and it will be seen that the widest part is 3 ft. 2 in., the height 6 ft. 3 in., and the depth or amount of projection from the wall, 10⅛ in. There are six hooks, four screwed underneath the top, and two in front. A beveled edge mirror is fitted in front and a box, 10¾ x 9⅛ x 5⅜ in. inside measurements, divides the space for umbrellas, etc. Tin trays are fitted in the bottom board.

It will be as well to make a commencement with the sides, as shown at Fig. 2, but it will be necessary first of all to cut up the wood in the most economical manner.

We have four 10 ft. lengths, and this gives us a little over in the event of a mishap, one length should be divided up as shown at Fig. 5. This will give us two 6 ft. 3¾ in. lengths, two 3 ft. 9 in. lengths, and leave sufficient to make the sides, base, etc., of box. Two more lengths should be cut up into lengths of 6 ft. 3¾ in. and 3 ft. 2 in., the longer lengths forming the sides, as shown at Fig. 6, and waste portion providing lengths of 3 in. wood for rails, as shown, the shorter lengths form top and bottom boards. The remaining length, shown at Fig. 7, provides the two middle rails with waste portions, which may be used up as required.

It will be seen at Fig. 2, that the sides are cut out to 2 in. wide for a considerable portion of the length, the widest part being 9¾ in. Plane up both pieces to this width, and ⅝ in. thick, and then mark out the curves to a radius of 7¾ in. If a compass or bow-saw is at hand saw to the curves; if not bore a series of holes close together, and then use a handsaw on the straight part. As the sides are sloping when in position, it will be necessary when spokeshaving the curves smooth, to allow for this, so that the front corners are horizontal when in position.

The back, Fig. 4, should now be made. *A* and *B* are 6 ft. 3¾ in. long, *C* and *D* 3 ft. 9 in., *E* 3 ft. 2¼ in., *F* 3 ft. 1¾ in., *G* 2 ft. 9½ in., *H* 2 ft. 4 in., all 3 in. wide by ⅝ in. thick, with the exception of *F*, which is 6 in. wide. The joints, without exception, are the ordinary lapped halving shown at Fig. 8, those at *K* being shown at Fig. 9. To avoid showing the end of the joint an alternative joint is shown at Fig. 10, this taking a little more time, but is not at all difficult. When the back is jointed up, glue all the joints and screw them from the back with ½ in. screws, two in each joint, placed diagonally. The sides may now be screwed on with 1⅜ in. screws, as shown by the letter *S* at Fig. 2; the top also may be screwed in position, countersinking the heads to avoid having a projection.

We have now to fix in the shaped front *M*, shown at Fig. 7; this should be carefully fitted, and screwed in from the sides, as shown. The bottom front rail may also be fitted in and screwed in position. The sides of the box may be fitted, and can be nailed with oval brads from front and back, the bottom being fitted and nailed in on all sides.

The top of the box should be 13 in. long and 8½ in. wide, with two 2½ x ⅝ in. lengths of wood screwed on underneath, as shown at Fig. 11. It should be hinged with 1¼ in. brass butts to a 1¾ in. wide length, and the top beveled off, as shown at the enlarged detail, Fig. 12. The bottom board may be fitted in, and screwed or nailed from the top, previously cutting out a hole at each end 1½ in. away from edges, and 11 in. long.

The mirror should be fitted in space, 15 in. x 6 in., with a rebate formed by beading made as shown at Fig. 13, and fixed on the edges, as shown at Fig. 14. A thin backing should be tacked in to prevent damage to the back of mirror.

The trays, Fig. 15, may be easily made of ordinary tinned iron, cut out at the corners, as shown at Fig. 16. The inside dotted oblong should be 11 x 7 in. the next dotted line should be 1 in. outside, and the outside the same distance outside again. A small portion is allowed for overlapping, and the outside inch border is mitered. The corners

IDEAL HOUSE FURNITURE.

I.—HALL STAND.

1. Completed Stand.
2 and 3. Elevation.
4. Back.
5, 6, and 7. Method of planning out timber.
8 and 9. Lapped joints.
10. Alternative form of joint.
11. Lid of box.
12. Detail of corner of lid
13. Bead.
14. Section through mirror.
15. Tray.
16. Method of setting out corners of tray.

Materials Required.

Four 10-ft. lengths of 10 in. by ¾ in. wood.
One piece of bevelled-edge mirror, 15 in. by 6 in.
One pair of 1½ in. brass butt hinges.
Two coat and hat hooks.
Four wardrobe hooks.
One piece of tinned iron. No. 22 S.W.G., 18 in. by 15 in.
Screws, nails, stain, &c.

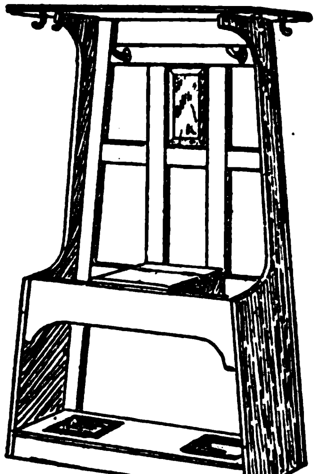


FIG. 1.

FIG. 5.

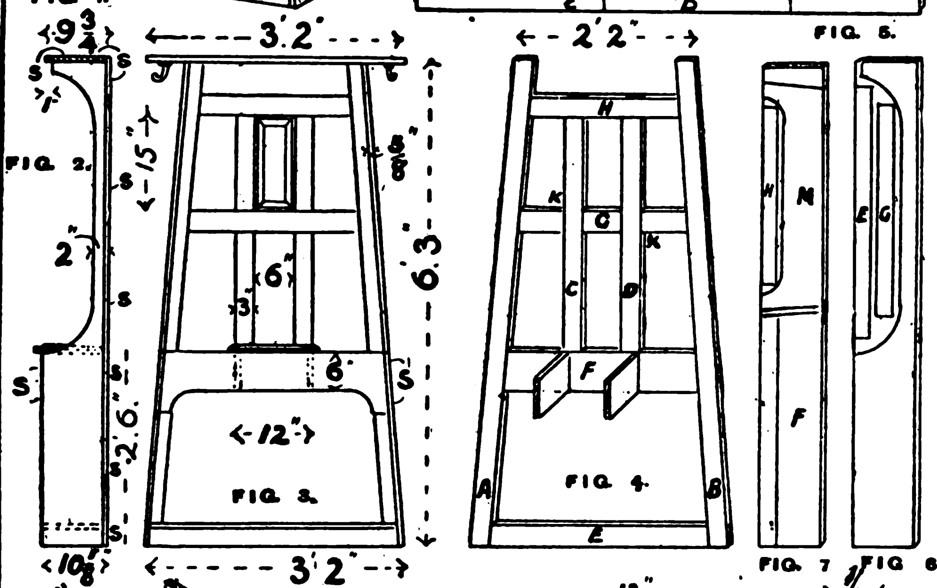


FIG. 2. FIG. 3. FIG. 4. FIG. 7 FIG. 6.

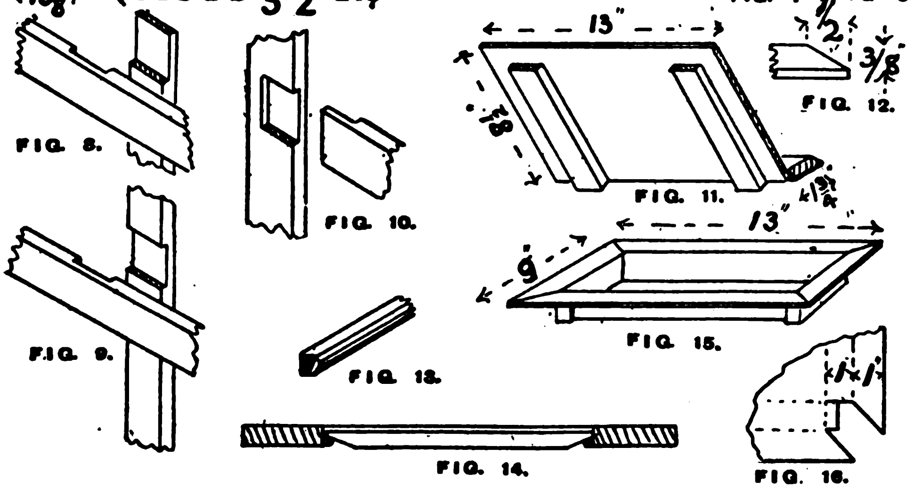


FIG. 8. FIG. 9. FIG. 10. FIG. 11. FIG. 12. FIG. 13. FIG. 14. FIG. 15. FIG. 16.

may be beaten up with a mallet on the flat face of an iron, and if just flushed with solder, they will be quite water-tight.

All holes should be filled in with stopping made of sawdust and glue before finishing off, and a good surface given with glasspaper before staining.

There are several methods of staining suitable, either water stain, size and varnish: Spirit stain and varnish combined; or a good walnut, "egg-shell," finish may be imparted by coating with turpentine, darkened by means of Brunswick black.—*Hobbies*.

WIRELESS FOR HOURS, LONGITUDE AND LATITUDE

DR. LEONARD KEENE HIRSHBERG A.B., M.A., M.D. (JOHNS HOPKINS)

Mr. E. A. Fath of the Smith Astronomical Observatory, Beloit College, Beloit, Wisconsin, endorses the use of radio-telegraphic signals as an accurate mode of transmitting seconds, minutes, hours, and the determinations of longitude. Although Dr. Fath's suggestion is by no means new, the weight of an astronomer's confirmation of this idea, which has been in use on the Eiffel Tower station in Paris and other stations such as the Norddeutch Station in Germany, will hasten the general adoption of the scheme.

Shipping in the North Sea, the English Channel, the Atlantic Ocean and elsewhere, will be made much more valuable if this plan is extended. In America the radio-telegraphic time service is about to be established for the first time as an accurate means of setting the time by electric waves. The plan suggested by Professor C. A. Culver, of the department of physics of Beloit college, is the one that meets with serious approval. He and Dr. Fath went over the ground with great detail and weighed the various plans before selecting the system they propose.

A standard time clock is connected in the office with a system of relays by wire. These relays are connected with the wireless apparatus, a radio-transmitting equipment with an induction coil at the left which was used as an open core transformer of the high tension type. The ordinary alternating current from an electric lighting circuit was used; it had a frequency of sixty cycles and the usual voltage of 110. The transformer changed this voltage to about 30,000, which charged a high tension condenser on the right side of the apparatus.

This condenser discharged through the customary spark gap and the helix in the center, which should be an oscillation transformer. This last device changed the frequency from sixty to several hundred thousand per second. The aerial arrangements, from which the electric waves were radiated into space, were 400 feet high and of course connected up with the oscillation transformer.

Thus, the standard time clock in an office or elsewhere can be made to control the current which actuates the high tension transformer and therefore the electric waves which are shot out. With every tick of the clock, a series of electric waves is shot forth into the circumambient atmosphere, and each train of waves is received as a single dot at the imparting station. Dr. Fath sends out each day these signals. "At 2.55 p.m. the clock is switched into the circuit and each beat sends out into space a group of ether waves. The 59th beat each minute is omitted up to 2.59:50. There is then an interval of ten seconds followed by a single beat. This beat marks 3.00:00 p.m. and may be considered the essential signal."

All of this is so simple that any schoolboy who is in the habit of using a wireless outfit may put it easily into practice.

Bubbles will last for hours and may be blown to exceed 2 ft. in diameter with the following solution: 1 part oleate of soda, 50 parts distilled or rain water (parts by weight). Mix thoroughly and leave one day to clear, using only the clear solution. The tenacity of the film is much increased by adding pure glycerine, not exceeding 2 parts glycerine to 3 parts clear solution.

EDISON TELLS HOW HIS MOTION PICTURES TALK

Thomas A. Edison, whose inventions have, for more than a third of a century, held the world breathless and made the "Tales of the Arabian Knights" seem commonplace by comparison, has passed his own wonder record of electric light, phonograph, fluoroscope, kinetescope and countless other marvels by his latest magical invention—the kinetephone.

Youngest of all the wonderful children of that wonderful brain, but requiring the most of mechanical ingenuity, the most of long sustained and determined effort, it seems destined most of all to preserve for him his title of "The Wizard of Menlo Park."

What is a kinetephone anyhow? That was the question that bothered your correspondent, hearing vague rumors of this new Edison wonder. He knew it had something to do with "making the movies talk," but he had seen of recent years many pitiable failures of phonographic and vocal accessories striving to accomplish this for these same "movies." He had seen the shot fired and the girl fall, heard a belated phonograph crack like a pistol and let out a feminine shriek. He had seen—

But this kinetephone? This was Edison—and that was different.

So straightway he betook himself to Mr. Edison for first-hand information. He found the inventor not the abstracted, intellectual giant, with head in distant clouds, as pictured in popular fancy. The intellectual giant was there—but so far from being in the distant clouds, he was a most pleasant and hospitable human being. His genial countenance, with the smile of humor ever poised to spring rippling forth, reminded one much of Oliver Wendell Holmes, in his best "Breakfast Table" mood. His greeting was most cordial.

"Oh, yes; I've plenty of time to see you," was his cheery reply to a request for information. "What is it you wish to know?"

"About this new invention of yours, the kinetephone," replied the visitor.

"Come along with me," was the wizard's hospitable interruption. And leaving his 200 assistants busily delving in all manner of scientific problems, he led the way to a large building adjacent, in one corner of which was a spacious chamber, proof against both sound and light.

"This is my experimental theatre," he explained, as he switched on the electric lights. It was much like the type of motion-picture theatre known to every person in the land who is old enough to walk—about 40 ft. wide and twice as long. At the far end was the broad white screen; in the rear was the motion-picture machine. Folding chairs took the place of ordinary seats; for in his numberless experiments Mr. Edison must have plenty of room.

NOT METALLIC

"But what is the kernel of the invention?" queried the visitor, too curious to await developments.

"It is the absolute synchronization of the movements in the motion pictures with the appropriate sounds," replied the wizard, as the lights went out, "and that, whether it be the human voice or—

Just then there burst upon the ear the opening strains of "Il Trovatore." Not in the harsh metallic timbre of the phonograph, but clean, clear and resonant, as from an orchestra, many toned and perfectly balanced. The next instant there flashed upon the screen the opening scene of the great opera. From the crowded stage came the full-throated voices of the singers, blended in perfect harmony with the orchestra.

Rising, swelling and sinking in cadence, all in faultless rhythm with every motion and gesture of those picture singers, the mingled music of voice and orchestra floated forth from that picture stage in an illusion that held the visitor spellbound. Not a false or harsh note! Not a single ill-timed movement, nor a belated gesture from a single one of all that lifelike throng, gathered there on the phantom stage; but all in perfect keeping—perfect beyond perfection—with the strains of voices and instruments.

"Marvelous?" whispered the visitor to himself. "I'll have to get something stronger than that weak word to tell this tale."

What struck him as strangest as he sat there trying to collect his scattered wits while the great opera proceeded to its tragic end, was the magical modulation of the sounds. The absence of any rasping, phonographic metalism was wonderful enough. The perfect coincidence of gesture, with the appropriate words, was marvelous, indeed. But by what magic was it that the voices of the singers were trained so deliciously as to be in keeping with every position they took, whether up—or down—stage; whether with backs or faces to the front?

The modulation of melody and harmony, of voices and orchestra, so different from the screeching of some phonographs, with their dull, flat monotony of timbre, were reproduced with an exactness and reality worthy of a finished opera troupe.

THE ALERT INVENTOR

Yes, the illusion was perfect; the visitor was not listening to a phonograph; he was not looking at a "movie." He was hearing and seeing the greatest of emotional operas, rendered by the living flesh and blood of singers and musicians and not some subtle combination of dead metal and celluloid and dull wax, galvanized by electricity into phantom life.

Leonora and Manrico were there alive, agonizingly alive, sobbing out their woes in exquisite melody, buoyed by the harmonies of an orchestra of artists. The writer's breath came short, as does that of any music lover in such case, his fingers clutched the arms of his chair. And then—

And then, from the tail of his eye he caught a glimpse of Mr. Edison and was back to earth in an instant! The great inventor was not watching the stage at all. His gaze was fixed upon his visitor, observing his every movement, his every expression of interest and astonishment—truly, the man of practical science, noting

far back, remember—the quavering tone of Manrico, with its piteous "Ah che la morte," distant, soft, almost a whispering sigh of melody.

Then, as the tone swelled, the hearer could see, in his mind's eye, the unfortunate lover, groping his way through the darkness toward the sound of Leonora's voice. Louder, nearer it grew until, as his face appeared at the grating of the dungeon, it rang forth in all its volume and filled the theatre with its despairing farewell—and just then it stopped and the lights flashed up, and there was nothing but an innocent white screen, which none the less seemed to wear a very human expression of humor on its blank surface as the visitor caught his breath with an ejaculatory "Oh!"

It was like being jerked headlong into another world, this sudden transition from the company of the fourteenth century "troubador" to a seat beside a twentieth century scientist in one of his experimental departments!

"Well I declare!" exclaimed the visitor; it was all he could think to say. "It's the most wonderful thing I——"

A SIMPLE DEMONSTRATION

"Ladies and gentlemen," interrupted a smooth, trained voice as the lights blinked out. The visitor turned his gaze from Mr. Edison to see what newcomer had broken in upon his rhapsody. There, on the stage, stood a man in evening dress, pointing to a machine set upon a table beside him.

"I desire to explain briefly to you the mechanism of the kinetephone," continued the man on the stage—well, on the screen then, but it looked just like a lecture stage. Again the visitor gasped at the perfect realism of it all. The opera had been something wonderful; but then [illegible] real. illusory, There was something uncanny about this everyday human being, so real, and yet so unreal; not even a painting, but just a fleeting will-o'-the-wisp of an image. Farther over the visitor leaned, rapt—and then he caught a glimpse of his wizard host, watching him with that subtle, quizzical smile—the smile of the "Autocrat of the Breakfast Table" playing about his lips and sparkling in his eyes.

As he turned again to the stage, the lecturer dropped a china plate. "Crash!" it struck the stage and the fragments clattered merrily as they danced across the floor! The visitor jumped. He couldn't help it; he'd broken plates himself!

Then followed the blowing of horns and whistles, together with piano, violin and vocal solos, all in perfect coincidence of movement and sound.

Last of all two collie dogs romped on the stage and set up a most lugubrious howling. An hour before these dogs would have set that visitor's heart tripping in excited amazement. But he was beyond that now; he had exhausted all his stock of astonishment.

"Bring on Michael and his archangel!" he sighed to himself. "I'm ready for anything now!"

RUN BY A BOY

But here the lights flashed up again and the marvelous show was over. The visitor drew a long breath. He looked at the dead appliances that had produced such astounding results. He was beyond rhapsody now.

"It must take a most accomplished and experienced scientist to operate this kinetephone," he remarked to Mr. Edison, coming back with relief to the commonplace after his breathless journey into wonderland.

The smile rippled full-tide over the features of the wizard.

"Here, Bobbie!" he called to a boy standing by the motion-picture machine. The boy came up.

"This boy, just turned 16, who is but a two-weeks' apprentice at the work," remarked Mr. Edison, "operated the kinetephone throughout the entire exhibition you just witnessed. Anyone who can operate an ordinary motion-picture machine can operate the kinetephone."

"But, tell me this, please, Mr. Edison," explained the visitor, the pent-up question now bubbling to the surface as they gained the open air. "How do you make the phonograph sound so unscreeching and life-like? And how do you make it coincide so exactly with the motions and gestures of the persons as they talk and move in the motion pictures? And how do you modulate the tones so perfectly? And how do you ever manage to get a phonograph that would take in a whole opera cast like that, when everyone knows that when folks sing or talk into a phonograph, they crowd close around the receiving horn as if they were all looking into a hole? And how——"

"Come into my office," said the wizard, good-naturedly, "and I'll explain it all to you. Oh, yes, I've plenty of time."

"I've been working on the kinetephone for twenty-five years," he resumed, when they were comfortably seated in his private office. "At least, I began to do some desultory work upon it that long ago. For six years I have been at it, day and night. It was my aim, from the beginning so to perfect motion pictures—not 'moving' pictures, by the way, for the picture stays in the same spot, only the objects within it move—so to perfect motion pictures that they would exactly simulate the stage and indeed real life, in words and sounds as well as action.

"I did not bring out the motion picture until I was able to show perfectly all that took place on the stage. I decided then to give the public the benefit of what I had accomplished. That I was right in doing so is evidenced by statistics, which show that 12,000,000 persons visit the motion pictures daily.

MECHANISM SIMPLE

"I continued, however, to work on my original problem until I reached my goal—which I have now done. When not only the actor's movements, but also his words can be reproduced, I believe the popularity of motion pictures will increase still more. No, there is no complicated mechanism added to the present motion-picture machine to create the kinetephone. It is merely a perfect combination of that machine with the perfected phonograph.

"Now, there were several great difficulties confronting the perfection of the kinetephone. First, to synchronize both motion-picture machine and phonograph so that each word spoken by the actor on the screen should be exactly contemporaneous with his appropriate action. This presented several difficulties; ordinarily the speaker must talk right into the horn of the recording phonograph. But I found that I must have a recording medium of sufficient sensitiveness to make an accurate record at a distance of 40 ft.; otherwise, the recording phonograph would show in the motion picture.

"After a number of experiments, I perfected a cylinder which would make such record. It was of wax; soft wax; so soft that the slightest sound would make an impression upon it. It was almost as soft as butter. Then I placed the motion-picture machine and the phonograph with the wax cylinder side by side, and connected the moving parts to the same gearing with identically the same gearing. This, you see, insured absolute synchronism of voice or sound, with the appropriate action.

"When the actors move and talk upon the stage both machines record what occurs both as to movement and sound, at identically the same instant. A notch at the starting point of both the recording film and the wax cylinder shows the beginning of both records.

"Why, that seems very simple, now!" exclaimed the visitor. Then he paused: "Columbus and the egg!" he murmured to himself.

CATCHES FAINTEST SOUNDS

"And then," continued the wizard. "I found I had to face a still more difficult problem. That arose from the fact that the volume of sound, as recorded by a phonograph, vastly increases or diminishes with the proximity or distance of the speaker from the recording instrument. In playing their parts actors

extreme softness of the wax-recording cylinder enabled me to catch the faintest sounds. In order to diminsh the sound, when the actors were speaking nearer the phonograph, I had the horn attached to the recording phonograph so made that its size could be increased or diminished by the operator. Of course, you know that the larger the flaring sides of the horn the greater the number of sound waves it will receive, and consequently transmit for record on the phonograph; on the other hand, the smaller the horn, the less sound it receives.

"How did I get a horn that could be made big or little at will? Why, by making the sides open or close by the simple movement of a lever. Here is one." And Mr. Edison exhibited this novel adjunct to his success. It was constructed much on the lines of the old-fashioned accordion, once much affected by rural serenaders; its sides opened out and closed in the same manner.

"Well, I declare," exclaimed the visitor, "that's simple, isn't it! Columbus and the egg again!" he added.

"Next," went on the wizard, "I realized that in order to perfectly simulate the human voice, or, indeed, any sound—it must be reproduced without the harsh, metallic rasping of the ordinary phonograph. This is an entirely separate invention, but I was stimulated to it by my desire to perfect the kinetephone.

NEW STYLE NEEDLE

"The metallic sound was wholly eliminated by the use of a diamond-shaped needle; this, you see," and here Mr. Edison held a needle for inspection, "is broad at its base, tapering gradually down to a point. Of course, the greater the volume of sound the farther the needle was pushed into the wax cylinder, and hence the broader the impression made. With this style of needle it is the breadth of tions of depth in the wax, and not, as with the old needle, with those of the breadth. This, I find, does away entirely with the metallic rasping, as you yourself have lately witnessed.

"I will mention here that I made a vast number of experiments before I succeeded in getting a wax cylinder that was perfectly satisfactory. The most difficult sound to catch and reproduce seemed to be the 'sh' sound, as in the word 'sugar.' I spent eighteen days standing before phonographs containing wax cylinders of various formulas, gazing into them, and only saying 'Sugar!' At last I succeeded in getting a perfect cylinder that would reproduce it properly, but I was so tired of the word that it was a month before I enjoyed anything with sugar in it again!"

"And that reminds me," continued Mr. Edison, in most charming digression, "that people think it strange that I take no interest in my perfected inventions. The incident of 'sugar' will explain why. While engaged in an invention I work at it so hard and constantly that by the time it is perfected I am so tired of it that it is a relief to get away from it. After I put the motion-pictures before the public I fairly hated the sight of them, and felt as though I never wanted to see one again. I wanted to go at something else!"

"Alexander, sighing for more worlds to conquer," thought the visitor.

CYLONITE CYLINDERS

"To return to our kinetephone motions," Mr. Edison resumed, "after the temporary record is made in the soft wax cylinder, it is then transferred to a cylinder made of cylonite. What is cylonite?" He smiled that quizzical smile. "That is a secret of our laboratory. Enough to say that it will make a record clearly, and is practically indestructible. Here is one. Observe this." He took up a cylinder looking much like the ordinary hard rubber cylinder of the phonograph, and dashed it down with all his force to the floor. It was absolutely uninjured.

"These cylonite cylinders," he continued, "are infinitely superior to the rubber ones in every respect.

"In transferring from the wax to the cylonite cylinder," he explained, "two phonographs, one containing the record-bearing wax, the other the blank cylonite cylinder, are set facing each other, about two feet apart. Both are geared to the same shaft, insuring absolute identity in speed. The machines are set going, and the cylonite cylinder receives the record from the wax one. Later it is hardened, thus making it ready for practical use."

"And that's simple too," exclaimed the visitor. "Columbus again."

"One more difficulty I found I had to overcome," said Mr. Edison. "That was to do away with the echo. You see, the wax cylinder had to be made so impressionable that it would record the slightest sound. Now, as the recording phonograph was sometimes quite a distance from the voices or sounds to be recorded, the result was that it recorded the echoes of these sounds against the walls of the studio also! They annoyed me greatly."

"And how did you get around that?" asked the visitor eagerly.

"Simply by using a tent of soft, flexible material. Yes, it was simple, but I was sorely annoyed before I bethought myself of that device."

"Simple, indeed!" inwardly ejaculated the visitor, "but, shades of America's discoverer, who but Edison would have thought of it!"

"Thus, I overcame my difficulties in the perfection of the kinetephone," he said. "The practical operation of the invention is very simple. The perfected phonograph with the necessary record in it is placed behind the motion-picture screen. It is then geared to the motion-picture machine containing the appropriate film, so both picture machine and phonograph will run absolutely synchronously or contemporaneously. That is all."

WILL BE POPULAR

That the kinetephone will become immensely popular Mr. Edison feels assured. "Heretofore grand opera as sung by the renowned singers of the world has been only for the wealthy classes," he said. "The poor man has not two to five dollars to expend on an evening's entertainment, no matter how excellent it may be. Soon for 5 cents he may hear music as well sung, or rather just as it is sung, by the most noted singers.

The motion-picture patrons will see and hear them as though upon the stage, living, breathing personalities."

And here, with his whimsical smile, Mr. Edison dropped into a paraphrase of Anecreon's ode, thus:

"And here is one substantial advantage that the kinetephone will have over the modern stage," he continued. "There will be real houses, real dogs, real trees, real greensward, real everything, in fact, instead of the *papier mache* substitutes of the stage. Scenes can be reproduced from appropriate surroundings, unhampered by the limitations of today's dramas."

Nor is all this a utopian dream of a visionary. These kinetephone productions will be placed before the public in a very short time. Their first appearance will be as a novelty in vaudeville houses, a large promoter in that line having obtained the right for a limited period. Eight motion-picture houses are now being fitted up in New York for their production.

A little later the kinetephone will be placed in all motion-picture theaters. As the ordinary motion-picture machine may be readily fitted at small expense with a kinetephone, plays will soon be as cheap as the ordinary motion-picture plays are now.

The great inventor declares that he will not sell the rights to make kinetephone pictures to other motion-picture concerns, but will retain them solely for his own company. With his announced policy of making only high-grade productions, he thinks their influence will be elevating and that they will generally supplant certain low-priced vaudeville that at present is more or less objectionable.

Millions have been refused by Thomas E. Edison for his new talking pictures and two other late inventions, which bring are a diamond-tipped reproducing needle that will wear forever, and a process for making phonograph records of an unbreakable material called "condensite." These inventions were lately heard officially at a public demonstration of the talking pictures in New York. The Cleveland and Chicago capitalists will endeavor to buy the patents.

Rumor that a wealthy Chicago man and several Cleveland financiers were after the talking-picture rights or an interest in them revealed that an actual offer had been made and refused.

Mr. Brady would not say who his clients were. It was learned, however, that he, in company with at least one of them, recently visited Mr. Edison primarily to investigate the adaptability of the famous Edison storage battery as motive power for railroad locomotives and interurban trolley cars.

An incidental demonstration of the talking pictures by Mr. Edison himself led to the offer for the invention. The matter of the storage battery is still pending.

Mr. Brady, after a hurried trip west, returned to Orange with the certified check, only to have it pleasantly refused. Mr. Edison, it was learned, hoped to control and operate the invention himself, and with this in view is training twelve young men at the factory.

"I not only offered him a million dollars merely as an evidence of good faith of the larger offer to come, but made a proposition for large royalties on every reel," said Mr. Brady. "He doesn't want money."—*Industrial Advocate*.

Electricity and Pure Drinking Water in the Cities

(*Continued from page* 349)

of reverse currents. The electricity, ... *through*, rather than

GEAR WHEELS AND GEARING SIMPLY EXPLAINED—Part IV

ALFRED W. MARSHALL, M.I.MECH.E., A.M.I.E.E.

A kind of gear which is frequently adopted when the driven wheel is required to give a much lower number of revolutions in a given interval of time than the driver is shown by the sketch, Fig. 40. The arrangement is called worm gear. The driving wheel is a screw *S*, and is called the worm. The driven wheel *W* is provided with teeth, and is called a worm wheel. Imagine the

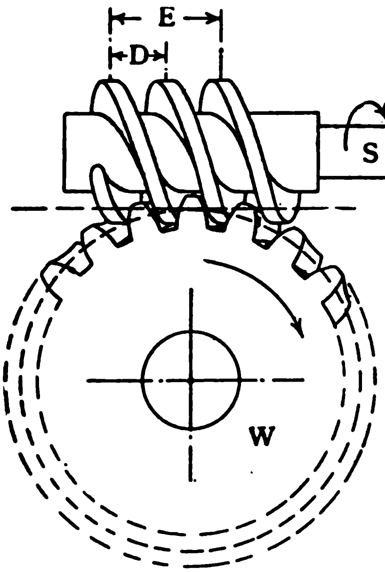


FIG. 40.

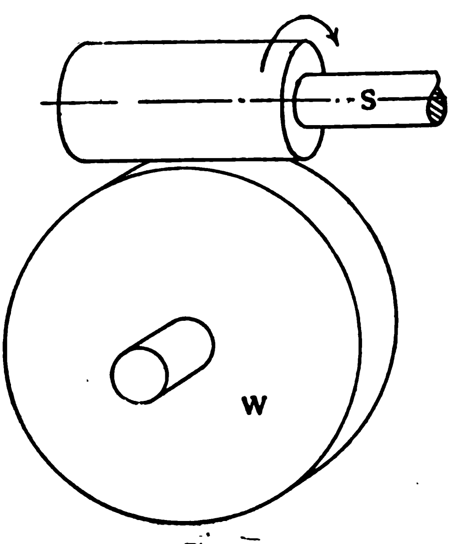


Fig. 41

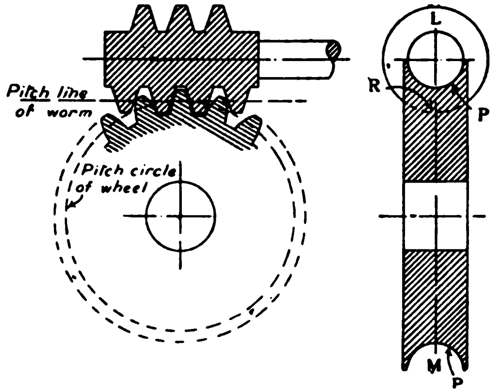


Fig. 42

wheel *W* to be fixed so that it cannot rotate. If the worm *S* is rotated, and can move also in a direction along the line of its axis, it will act as if *W* was a nut through which it was being screwed, because the thread of the worm is engaging with the teeth of the wheel. It will therefore move in a forward or backward direction, depending upon the direction in which it was being rotated. If, on the contrary, the shaft of the worm is held between thrust bearings so that it cannot move in an end direction, and the wheel *W* is free to rotate, it will do so if the worm is rotated. As the worm is unable to screw itself past the wheel, the latter will rotate, due to the sliding action of the worm thread upon the wheel teeth. The rotation of the shaft *S* will be thus transmitted to the shaft upon which *W* is fixed.

This kind of gearing, though equivalent to a pair of spur wheels in its action, differs to some extent. Either wheel of a pair of spur wheels may be made to drive the other, but though the worm can always be made to be the driver, the wheel cannot be made to drive the worm under all circumstances of design. As in the case of spur wheels, the gear is planned by pitch lines and surfaces. There is this difference, however—the pitch surfaces of spur wheels roll together, and, as already explained, one would drive the other by contact friction if the load upon the driven wheel is not in excess of the grip obtained between the surfaces. The pitch surface of the worm gear, Fig. 40, is represented by the sketch, Fig. 41; obviously, if *S* is rotated, its effort will be expended entirely in a line parallel to the shaft of *W*, and will not produce any rotating effects at all on *W*. The surfaces will merely grind together without producing any turning effort upon *W*. Similarly if *W* is rotated, the effort will be expended entirely in a line with the shaft of *S*, and no rotating effect will be produced. Any rotary effort can therefore only be produced by providing *S* and *W* with teeth which are placed at an angle to the axes of the shafts and can slide against one another. This is effected in practice by means of a screw thread upon *S* and teeth upon *W*, which are placed at an angle to correspond with the inclination of the screw, so that the two will engage in gear. The amount of rotation which will be given to *W* for each complete

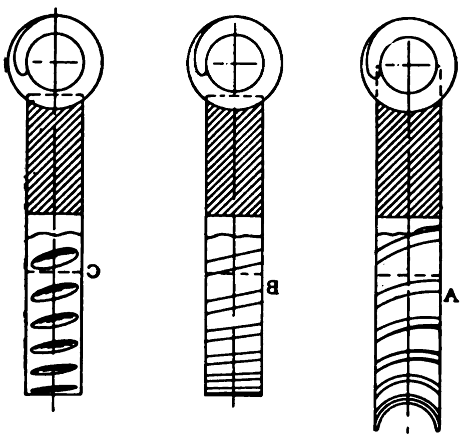


Fig. 43

revolution of *S* will therefore depend upon the pitch of the screw thread. This pitch divided into the circumference of the pitch circle of the worm wheel gives the number of revolutions which the worm will make to produce one complete revolution of the wheel.

pitch of a screw is the distance through which the thread advances whilst making one complete turn round its axis, *S* must make twenty complete revolutions to drive *W* through one complete revolution. If the screw thread is made to have a pitch of 2 in., the wheel *W* would then be made to have ten teeth of 2 in. circular pitch. The screw would now make ten revolutions to drive *W* through one complete revolution. So far, the number of teeth on *W* has been made proportional to the ratio of the gear, that is, we have halved the number of teeth whilst obtaining half the number of revolutions of *S* required to obtain one complete revolution of *W*. But we need not have reduced the number of teeth on *W*. We could have allowed the screw to gear into alternate teeth, half of the number of teeth thus being unused. The arrangement would effect the desired result, as the screw would move the circumference of *W* through twice the distance each revolution which it made, than when its pitch was 1 in. It would thus give one revolution to *W* when its own shaft had made ten instead of twenty turns. But it would not be a good arrangement to permit half of the number of teeth to be idle. The whole twenty teeth can be utilized by providing a second thread upon *S*, interspaced with the first thread, so that it gears with the idle teeth. Each thread will then take a share in driving the wheel, and the pressure and wear will be distributed over double the amount of contact surface. It would be necessary to re-shape the teeth, so they properly gear with the altered curve of the screw due to increasing the pitch. The wheel *W* thus retains its previous number of teeth, namely, twenty, and yet makes one revolution for ten instead of twenty revolutions of the screw. Similarly, the screw may be made to have three or more threads.

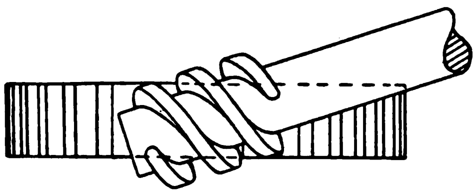


Fig. 44

worm thread in its action with the wheel. Referring to Fig. 40, if the worm has a single thread, its pitch will be the distance *D*, and this will be equal to the circular pitch of the teeth on *W*. But if the worm has a double thread its pitch will be the distance *E*; this will be twice the length of the circular pitch of the teeth on *W*.

When preparing the worm blank and wheel blank for cutting, allowance must be made for the distance beyond the pitch line by which both the thread of the worm and teeth of the wheel will project. If a section be taken through the center-line of the worm, the teeth of the wheel and thread of the worm can be regarded as a pinion and rack at that line, the screw thread representing the rack, and may be designed upon the method used for determining the shapes of the teeth of a pinion and rack. They may be curved upon the cycloidal or involute principle. If the former method be used, the teeth and screw thread will both have curved sides; if the involute method be adopted, the sides of the screw thread will be straight lines, as explained in an earlier part of these articles. The involute principle is usually adopted, because it is easier to cut the worm thread if it has straight sides. Fig. 42 is a sketch showing such a section of a worm gear through the center line *LM*.

If the teeth of the wheel accurately fit the spaces between the thread of the worm throughout the entire breadth of the wheel following the true curve of the screw, the shape will alter in section, according as the distance from the center line *LM* is increased. A section of any tooth taken on any line but *LM* will show a different shape from that taken on line *LM*. In addition to this, the circumference of the wheel must be hollowed to fit the worm at the points of the teeth and bottoms of the spaces between the teeth, the curves being arcs of circles of two different radii, as indicated by *PR*, Fig. 42. On this account shaping and cutting the teeth of a worm wheel correctly is a difficult matter. The method adopted in practice, especially for wheels of small or comparatively small sizes, is to shape them by means of a cutter which is a fac-simile of the screw intended to gear with the wheel. This cutter is called a "hob," and consists of a steel worm of the exact shape of the worm which is to gear with the wheel; it is provided with cutting edges and hardened. The teeth of the wheel are first cut nearly to size by means of an ordinary circular cutter; the hob is then geared with the wheel, and the two are run together until the hob has cut the teeth to the true shape. Obviously, if the hob is a correct representation of the worm it will remove all irregular places from the teeth and leave them a perfect fit to the actual worm. It is sufficient, therefore, to plan the thread and teeth upon a single section *LM* through the center line of the worm and wheel.

A correctly shaped worm wheel will then have the appearance of *A*, Fig. 43. On account of the expense of making a hob, worm gears are frequently made to a compromise. The circumference of the wheel is not hollowed at all, but straight, as in the case of an ordinary flat spur wheel. The teeth are cut upon the slant, as indicated by *B*, Fig. 43, at an angle to correspond to the inclination of the worm thread. Another method is to make the circumference of the

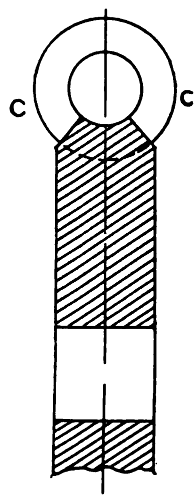


Fig. 45

wheel straight and cut teeth by causing the edge of a circular milling cutter to dip down into it, as indicated by *C*, Fig. 43, technically called "gashing" it. If the axis of the worm need not be at a right angle to that of the wheel, an ordinary flat spur wheel can be used by slanting the worm until its thread meshes with the teeth of the wheel, as indicated by Fig. 44. Any one of these methods, Figs. 43 and 44, may be used successfully, and for transmission of very small amount of power or purposes of mechanical adjustment only the worm can be an ordinary Whitworth or similar screw thread. In practice the edges of the wheel are usually beveled off, as indicated at *C*, Fig. 45, except in the

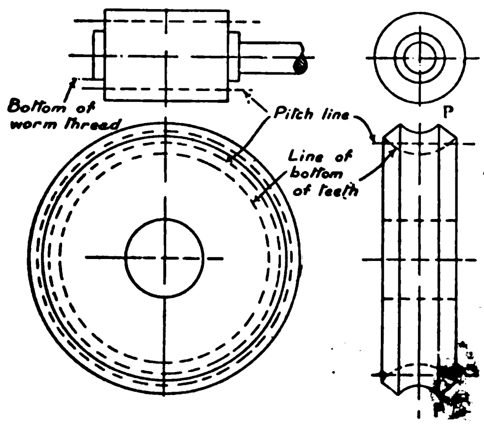


Fig. 46

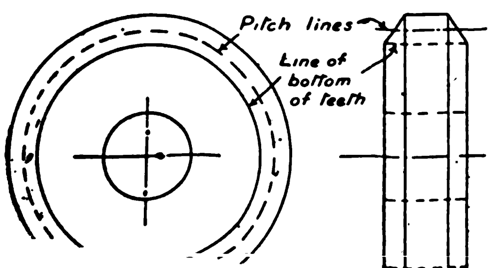
case of wheels like *C*, Fig. 43. This diminishes the inaccurate portion of the teeth and removes the weak corners. A blank worm and wheel ready for cutting a gear such as Fig. 40 would have the appearance indicated by Fig. 46 if the eeth were to be of perfect form and shaped by means of a hob. The dotted lines show the pitch lines and the allowance of metal to give the part of teeth

Fig. 47 shows a blank wheel similar to Fig. 46, but which is to be cut with straight-through teeth, as *B*, Fig. 43. The throat *P* is now made straight, and not curved, as in Fig. 46.

The diameter of the worm has no influence upon the ratio of the gear. As already explained, this is determined by the lead of the worm thread, and the circumference (and therefore the diameter) of the wheel. If the distance between the shaft centers of worm and wheel is fixed, you must select a lead for the worm thread which will give you the ratio desired. The diameter of the worm can be made greater or less, to accommodate the size of wheel found to be suitable in the particular instance. For example, suppose the distance between the centers will admit a wheel having a circumference of 10 in.; the pitch circle for this will have a diameter of 3 3-16 in. If the worm thread is made with a lead of one turn in ½ in. (½ in. pitch), the ratio of the gear will be 1 to 20, because each revolution of the worm will rotate the wheel by ½ in. As there are twenty half inches in the circumference of the wheel, twenty revolutions of the worm will be required to rotate the wheel through a distance of 10 in. If a ratio of 1 to 10 be required, it can be obtained by making the worm thread with a lead of one turn in 1 in. Ten revolutions of the worm will then produce one revolution of the wheel. If a greater ratio than 1 to 20 be required it can be obtained by decreasing the lead of the worm thread. For example, if the lead is one turn in ¼ in., the ratio of the above gear will be 1 to 40, as there are forty quarter inches in a circumference of 10 in.; therefore, forty revolutions of the worm will be required to produce one revolution of the wheel, and so on. If the worm thread is made to have a lead of 1-10 in., the ratio of the gear ... The lead may be one ... to 5.

be advisable to cut four or five threads. The wheel would then have twenty or twenty-five teeth respectively. Should the circumference of the wheel pitch circle, as first determined, prove to be inconvenient to the number of teeth, it may be increased or decreased to a limited extent and the diameter of the worm altered to accommodate the difference. When the centers are not fixed, the wheel size is limited only by convenience of construction. It is advisable to have at least thirty teeth in the wheel, if convenient. When a smaller number must be used, the top edges of the worm thread do not properly clear the wheel teeth. This interference can be avoided by a slight rounding off towards the tops of the thread or by increasing the diameter of the wheel so that the teeth project almost entirely outside the pitch circle. Messrs. Brown and Sharpe, in their treatise on gearing, give the following rule for this increase of diameter. The pitch diameters to be multiplied by .937; add to the product four times the addendum, that is, the part which in the ordinary way would be outside the pitch circle. The sum gives the diameter of the blank at the throat *P*, Fig. 46. The whole diameter of the wheel is obtained by making a drawing to this rule and measuring off the dimension. They say, however, that it is not practical to finish wheels sized by this rule with a hob when they have twelve to eighteen teeth unless the wheel is driven by separate mechanism; the hob must not be relied upon to drive the wheel.

Professor Unwin gives the following proportions for worm gearing, *P* being the circumferential pitch of the wheel teeth. Thickness of tooth on pitch line, .48 *p*; height outside pitch line, .3 *p*;



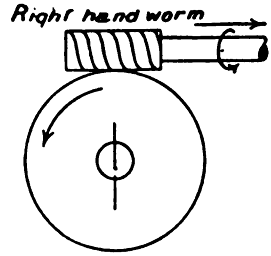


Fig. 48

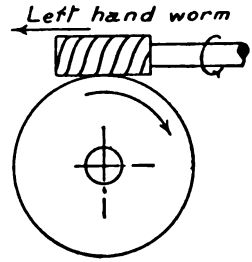


Fig. 49

depth below pitch line, .4 *p*; length of worm, 3 to 6 *p* (usually 4 *p*); width of wheel face, 1.5 to 2.5 *p*. The worm is frequently made of some different metal from that used for the wheel. For example, a steel worm and gun-metal wheel, a hardened steel worm and a phosphor-bronze wheel, give good results, a wrought iron or steel worm and cast-iron wheel are also used; a cast-iron worm can be used with a cast-iron wheel. When the gear is used for continual running and transmitting power for driving purposes, the shape and materials used are of much greater importance than when the gear serves for adjustment purposes and occasional use. A hardened steel worm and phosphor-bronze wheel is a very good combination for transmitting power, but efficient lubrication of the surfaces in contact is the most important factor. The gear should run in an oil bath, if possible. Worm gear was at one time regarded as a very inefficient means of transmitting power, but during recent years it has come into extensive use for this purpose, and, if well designed and run in oil, is found to have high efficiency. The loss of power due to friction between the worm thread and wheel teeth decreases with increase of the inclination of the thread, that is, multiple threads thus give a higher efficiency than single-threaded worms, and a small diameter worm gives a higher efficiency than one of corresponding lead, but larger diameter. In addition to the friction at the worm thread, there is friction set up by the end thread of the worm shaft. This is also of importance, and some form of thrust bearing is required if high efficiency is to be maintained; a ball thrust bearing is very good. As previously explained, the worm must be prevented from moving end-wise, if it is to exert pressure upon the wheel teeth and rotate the wheel; therefore, the wheel teeth will press against the worm thread with a force proportional to the load which the wheel has to drive. The teeth therefore thrust the worm shaft against the bearing in which it runs. The direction in which the wheel rotates for a given direction of rotation of the worm depends upon whether the worm thread is

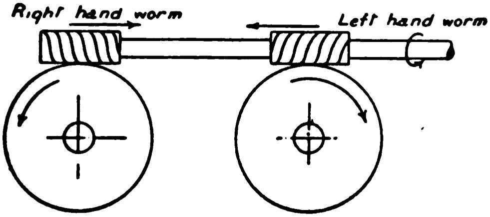


Fig. 50

right- or left-hand. It is possible on this account to combine two worm gears so that end thrusts of the worms oppose each other, and no thrust comes upon the bearings. Fig. 48 is a diagram of a worm and wheel, in which the thread is right-hand, and Fig. 49 is a similar design, in which the thread is left-hand. The arrows indicate the direction of rotation and thrust. The worm shaft rotates in the same direction in each instance, but the wheels rotate in opposite directions, and the direction of thrust exerted upon the thread of the worm, and worms. The driving force of the wheels can be combined and transmitted to a single shaft by means of spur wheels.

A distinctive feature of worm gearing is that it is not always reciprocal—that is, the worm will always drive the wheel, but the wheel may not drive the worm. If the lead of the worm is small, and therefore its angle small, the friction between the surfaces in contact will be so great that the worm cannot be rotated by the wheel. The critical lead of thread at which the wheel can drive the worm will depend upon the friction between the surfaces in any particular instance. Generally speaking, single-thread worms cannot be driven by the wheel, but if the lead required is sufficiently great to necessitate a multiple thread, the wheel may drive the worm; the greater the lead, the more likely is the gear to be reciprocal.—*The Model Engineer and Electrician.*

All About Permanent Magnets

The British Journal of the Institution of Electrical Engineers contains the lecture on permanent magnets which Professor Silvanus P. Thompson delivered at the meeting of the institution at Glasgow last year. It occupies more than sixty pages, gives a complete account of present-day knowledge on the subject and points out directions in which further research is necessary. The author shows that the most powerful and permanent magnets are made of steels with about 6 per cent. of tungsten and 0.5 per cent. of carbon, and have the ratio of length to breadth large. After forging at as low a temperature as possible the magnets should be heated to 900 degree C, cooled to 750 degrees C, kept at that for a time, and then cooled off. Hardening is a repetition of this process down to 700 degrees C, at which temperature the magnets are to be plunged into brine at 20 degrees C. Maturing is done by boiling the magnets for ten or twelve

BOOK RACKS AND DESK TOPS

Variety of Designs—Single and Combination Affairs—Details of Construction—Best Woods for the Purpose

GEORGE E. WALSH

Book racks, desk tops and ornamental tops for old book-cases make suitable presents for friends as well as desirable articles for one's own use. There is considerable variety in such useful articles, and one may use ingenuity in designing them to fit any special need. Sometimes it is an old desk with merely a flat top which could be greatly improved by designing an ornamental book rack with pigeon-holes on the side for papers, or it may be an entirely new top is needed. Such a new top was designed and made for an old desk after the pattern in Fig. 1. The legs and sides of the desk were in good condition, but the top had been split and badly used, and it never was very pretty or ornamental.

The dimensions of the top of the desk were taken and the design drawn to fit snugly on it. When finished sufficient room was left between the side book-racks for writing purposes and two small desk drawers were provided for pens and papers. The lid of the old desk lifted up, but this was screwed down, and a drawer fitted in front to take the place of the old space. No space was lost by this operation, and much was gained in the way of an ornamental article of furniture. The book spaces on either side of the desk top were found to be of invaluable aid, for in them were kept all books needed for ready reference.

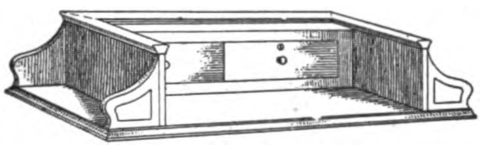


Fig. 1—One Style of Desk Top

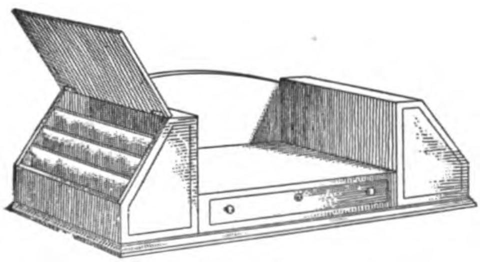


Fig. 2—A Book Rack and Letter File

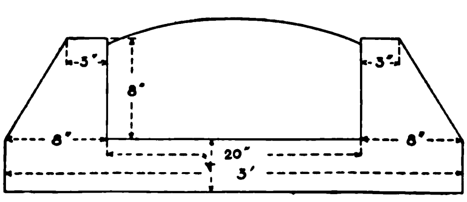


Fig. 3—Dimension Diagram for Book Rack and Letter File

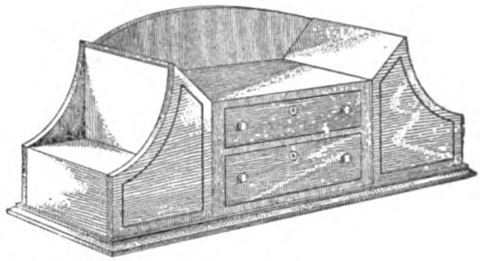


Fig. 4—Another Style of Combination Book Rack and Letter File

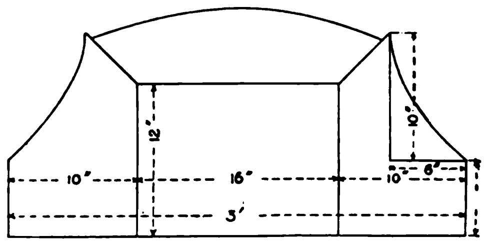


Fig. 5—Dimension Diagram for Previous Figure

Combination book racks, drawers and letter files are among the most useful of ornaments for topping off book-cases, desks and mantel-pieces or side tables. If artistic in design and execution they will finish off many old pieces of furniture better than can be accomplished in any other way. The two designs shown in Figs. 2 and 4 will clearly indicate their purpose. In one we have either side of the article finished off with small letter file arrangements, with lids to cover them and a center space for books, magazines or other articles. The shallow drawer furnishes room for small articles such as paper, pens, letters and envelopes. Placed on top of an old book-case, it occupies a conspicuous place and adds greatly to the ornament of the room. In Fig. 4 rather more space is given to books, which are placed on either side

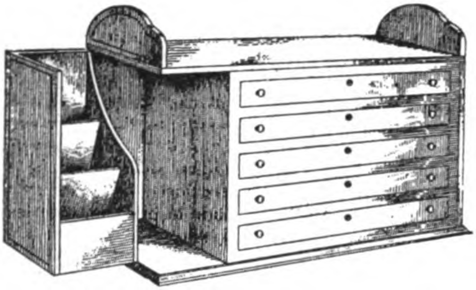


Fig. 6—A Combination of Drawers and a Book Case

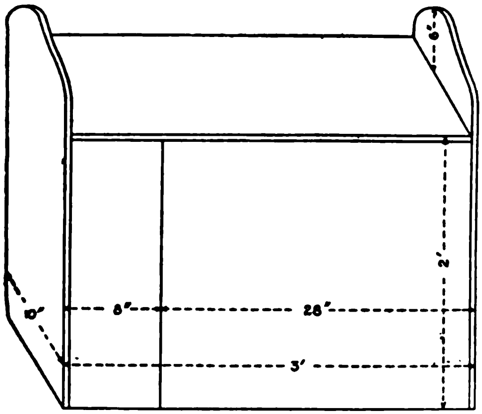


Fig. 7—Dimension Diagram for Article Shown in Previous Figure

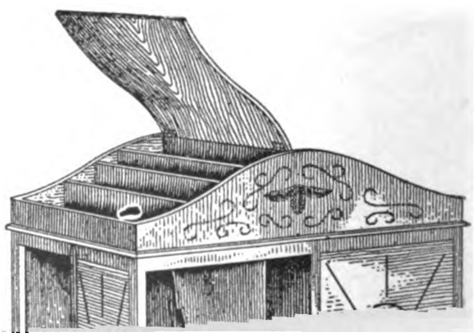
and in the center, but two drawers are provided for small articles.

In Fig. 6 an attempt is made to build up a series of shallow drawers, with a side space for bills and letters that opens and closes on hinges, and the top space finished off as an ordinary book rack. Such a generally useful article may be made in almost any suitable height desired for special purposes. If to fit on the top of a desk, table, book-case or mantel-piece it should not exceed 2 ft. from the base to the book rest on top. In that case the number of drawers should be cut down to about three. A tier of five is more suitable for a case 3 or 4 ft. high and designed to rest on some low article. This combination

In Fig. 8 we have another combination book-rack and a letter file. The top of the case is devoted entirely to spaces for letters and papers, divided off in compartments as one desires. Some of these spaces are quite shallow and others quite deep. The doors swing on hinges from the top center and fall down snugly on the sides to finish off the top. If one found it difficult to make doors with curves in them, the top could be made flat or sloping with a peak at the top. That is merely a matter of individual taste and capacity. The designs are intended more as a guide than to follow absolutely in every particular. The lower part of the case is made entirely for books which are placed in the four compartments.

The design can be made on the plan of the ordinary revolving book-case, or with the compartments simply divided by upright posts at the corners. In the illustration the design has every alternate space panelled, which can be done in any way desirable. A design may be burnt on the panel or it can be finished off with strips of wood, following some simple drawing.

The wood for making any of these ornamental tops should preferably be birch or maple. There is no better wood for the work than birch. It should be obtained from the mill in two thicknesses—one-quarter of an inch and three-quarters.



The thin boards are used for making the partitions between letter compartments, filing arrangements, pigeon-holes and shallow drawers. The thick boards are for the rest of the work. The thin pieces of wood finished off in the natural colors of the wood will contrast beautifully with a mahogany stain given to the outside part.

If the articles are to be decorated by burning, the best wood to select is good basswood. This is nearly grainless and does not split easily for a soft wood, and it takes pyrographic work better than almost any other. Most soft woods when cut as thin as a quarter of an inch are too fragile to be of much use and a very slight pressure will split them. But good basswood is not so easily ruined. All inside partitions should be glued in position and not nailed. If one is deft enough with tools to fit them together with groove and tongue all the better, but it is easier to glue the small pieces in. Only the best furniture glue should be used for this purpose, and that means it must be prepared for the purpose. Self-prepared glues are hardly strong enough. Get a pot of glue and keep it hot while working, and when a piece is glued in position it must be kept there under pressure for at least 24 hours.

All the designs, with the exception of the book-case with a curved top, are made in simple straight lines, and any one who can saw out and fit a square box together accurately should be able to make any or all of these useful ornaments. A scroll saw may be necessary for cutting out some of the pieces to advantage, but they can all be made without it. Besides the lumber mentioned above a few feet of molding should be purchased at the mill. This is to finish off the base of each article. The sides and upper part can be decorated with a few strips of beaded mill-work, which can be bought at a mill or carpenter's shop

After the different parts have been cut out and put together, the edges should all be sandpapered down to a very smooth finish. Then the surface should be rubbed with some good filler so that all the open grain and pores can absorb it.

When the filler has dried properly the stain should be applied, rubbing it in and wiping it off carefully. This in turn must dry before oil or varnish is applied.—*The Building Age*.

New Southern Pacific Ferryboats with Double Power Plants

W. ZACHERT

All of the public service corporations in and around San Francisco are making great preparations for the enormous increase in travel and the large activity in trade that is expected when the Panama Pacific Exposition is opened in 1915.

In line with this, the Southern Pacific Company has just placed an order with the New Jersey Shipbuilding Works for a large steel ferryboat to run between San Francisco and the Oakland Mole. It is stated that the hull alone will cost $98,000.

The name of this new vessel will be the *Santa Clara*, and it will be a duplicate of the *Alameda*, which is now under construction at the West Oakland Shipyards.

Both of the above ferryboats will be built of steel throughout, and will be provided with longitudinal water-tight bulkheads. They will be of the side-wheel type, and each wheel will be independently operated by its own engine of 2,800 h.p. These boats will be twice as powerful as any of those now in the service of the Southern Pacific Company on San Francisco Bay. Each vessel will have two smokestacks and Babcock & Wilcox water-tube boilers; in fact, on each side of the boat there will be a complete and independent power plant. The cabins will be of mahogany finish. Each boat is to have seating capacity for 2,600 passengers; this is 900 more than that of the Ferryboat *Berkeley*, which is at present the largest Southern Pacific vessel crossing the Bay.

The time required for making each trip between San Francisco and Oakland is 20 minutes, but when these swift new steamers are placed in commission, the time will be cut down to 12 minutes; thus travel across the Bay will become quicker and more frequent.

Another contract will soon be let for a third boat, which will be called the *San Mateo*. It will be exactly similar in every particular to the two mentioned above. The *Alameda* will be completed and placed on the run in about six months. All three of these ferryboats will be in full operation by January, 1915, in time to handle the immense traffic in connection with the opening of the Exposition.

A SIMPLIFIED POTENTIOMETER

H. S. MANISTY

As probably most of our readers already know, with a potentiometer and its accessories many things can be done. For example:

Small and also very large voltages can be measured, though in the present case the range will only be from 0 to about 30 volts, reading to about .1 per cent. Small resistances, such as armature coils and also large ones, can also be accurately measured. An ammeter is necessary for this, as a piece of extra apparatus. Small and large currents also come within its range with great accuracy. It is specially useful for graduating volt and ammeters.

I will now try to make clear the principle of this apparatus. It is based on Ohm's law, which shows that the fall in potential down a uniform wire carrying a current varies directly as the length of the wire, and also that when two equal and opposite potentials are present in a circuit no current flows in that circuit.

The instrument consists of five parallel wires of No. 30 S.W.G. manganin, and 1 meter long, connected at their ends to heavy brass bars, slit, as seen in the plan, Fig. 1. These bars are considered to have no resistance compared to the wires, and the arrangement is virtually one wire 5 meters long. A constant current is passed through this (about 1/8 amp.) from two accumulator cells. This current is regulated (by cutting out more or less of the last two wires with a piece of thick flexible wire) till the drop down 1 meter length is exactly 1 volt, then the drop down the 3 meters is 3 volts. The so-called setting is done by comparison with a standard cell.

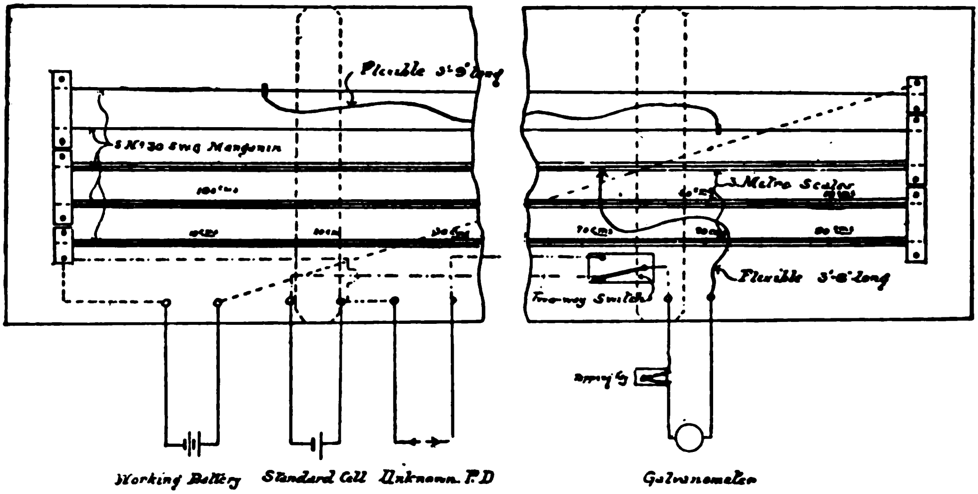


Fig. 1. Plan of Potentiometer, showing Connections (Scale 2¼ in. to 1 ft.).

The first thing to describe will be the potentiometer proper. The base is a board 3 ft. 9 in. long and 10 in. broad, cut from well-dried ½ in. pine. It has three stiffening pieces at the back, 1½ x ½ in. This must be of dry wood, planed smooth, and then it is given a couple of coats of shellac varnish and allowed to dry while the other parts are being got ready. The wires, as mentioned, are No. 30 S.W.G. manganin; five pieces 41 in. long will be wanted. Cut off two pieces of strip brass ½ x 3-32 in., or a little thicker; draw-file this all over. Drill six countersunk holes for ½ in. brass screws in the position shown on plan. On the underside scratch five shallow slots to fit the wires; these are to be spaced as drawn. Fix the two strips down temporarily on a board, their inside edges exactly 1 meter apart (1 meter = 39.3708 in., or about 3 ft. 3⅜ in.). Solder the ends of the wires carefully to the brass strips for the full length of the brass, and then

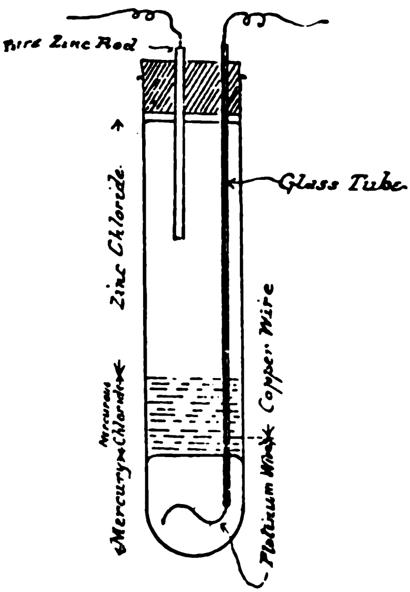


Fig. 2. A Calomel Cell

carefully stretch and solder the other five ends, so that each wire has 1 meter free length and all are stretched alike. Trim off the odd ends and unscrew from the board, and screw down right side up to the final base, still keeping the brass exactly 1 meter apart. Three paper scales 1 meter long and divided into centimeters are to be fixed under the first three wires; it would be safer to fix these scales before the brass, as they should have a coat of varnish, and the wires must be left clean. Six terminals are to be fixed, spaced evenly in pairs along one side. The connections can be easily followed from the plan.

A standard cell is the next thing to make. For all work not requiring very great accuracy a calomel cell is the best, as its variation with temperature is very slight; but for more accurate work a Clark Standard should be used, made up to Board of Trade specification, as described in S. P. Thompson's "Electricity and Magnetism." In this case the temperature must be taken into account. I will here describe the calomel cell. All chemicals must be bought as "pure."

The cell (Fig. 2) is set up in a wide test tube about 1 in. diameter and 4½ to 5 in. long. In the bottom of the test tube is poured about 1 in. of mercury, and dipping into this is a fine platinum wire, enclosed till it reaches the mercury in a fine glass tube. The tube is drawn out to a blunt point and the wire passed through. The tube is then heated till the glass flows round the wire and seals it in. A short length of platinum wire, say 2 in., need only be used, and a thicker copper wire soldered to the end, which also forms one terminal. Above the mercury is ¾ in. to 1 in. of mercurous chloride.

On top of this again is poured a saturated solution of zinc chloride. A cork is fitted, and passing through this is a small rod of pure zinc; this forms the other terminal. The cork is sealed with paraffin wax, and the whole arranged in some form of stand to keep it upright. This cell gives a voltage of very nearly 1 volt; to be exactly 1 volt, the specific gravity of the zinc chloride must be 1.38. Two or three cells should be made up, so that they can be checked against each other.

A galvanometer is essential, but I will not describe one here, as nearly every amateur has one, and if not, very good descriptions will be found in back numbers. The galvanometer must be sensitive and also have a high resistance; if not, some high resistance must be

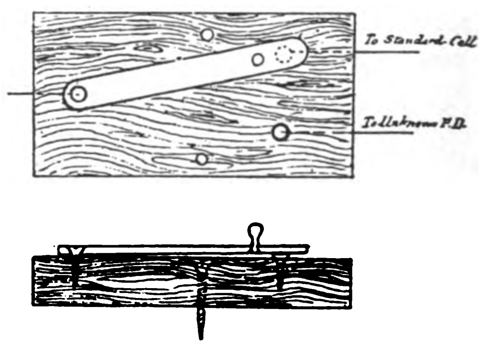


Fig. 3.—Two-way Switch.

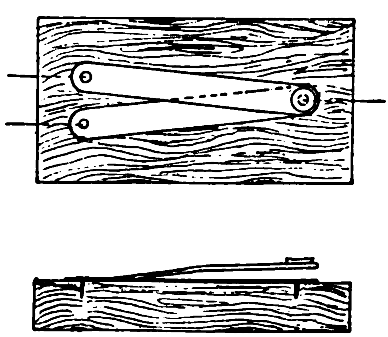


Fig. 4.—Tapping Key.

inserted in its circuit. The accuracy of the results depend largely on the sensitiveness of the galvanometer and the correctness of the standard cell. There is one other small thing to be made before any readings can be taken, that is, a flexible connection to cut-out part of the last two wires.

Cut out from springy copper or brass four pieces, 1 x ¼ x 1-32 in.; file one edge of each to a slight bevel. Turn bevels inwards and solder the opposite edge, and also solder one end of a piece of flexible to each pair, so as to form a clip. Now each end can nip the fine wire at any part, and so vary the resistance. This will give a variation of about 12 ohms.

Two switches will be needed—one a two-way switch to switch from the standard cell to the unknown *PD*, and a small tapping key to connect up the galvanometer. The two-way switch (Fig. 3) consists of a base of well-dried and varnished wood, 2½ in. long by 1¼ in. wide, of about ⅜ in. or ½ in. wood. A strip of springy brass 2 in. long and of a section ¼ x 1-16 in. This must have a hole drilled at one end and a small knob at the other, so that one end can be screwed down and still free to move sideways. Two brass screws are screwed in, as shown, and their heads left about 1-16 in. above the level of the base. To these the wires from "Standard Cell" and "Unknown Potential Difference" are fixed on the under side, and the galvanometer wire to the fixed end of the brass strip. The general idea will be seen from the drawing. The strip must have a downward set, so as to make good contact. The tapping key (Fig. 4) is made by fixing two pieces of brass strips (2 x ¼ x 1-32 in.) to a small base (2¼ x 1¼ in.), so that when the top one is pressed down it makes contact on the one beneath. This can be seen in the drawing...

time it was re-charged. Connect up the battery and put the two-way switch to standard cell. Take the wire from the galvanometer marked "flexible," and touch the manganin wire at one meter; with the other hand depress the galvanometer tapping key, and if there is any deflection alter the double-ended flexible connection till there is no deflection. Be careful that the standard cell and battery Potential Difference oppose each other, or they cannot be balanced. Then the instrument is said to be "set," because the drop down 1 meter=1 volt; therefore, the drop down the 3 meters = 3 volts. Of course, if a Clark cell is being used, the manganin wire must be touched at 1.434, the voltage of a Clark at 15 degree C. Now put over the two-way switch to unknown Potential Difference, and find the point on the manganin wire, where, when it is touched with the galvanometer flexible, there is no deflection on depressing the tapping key. This shows that the drop Potential Difference and the unknown Potential Difference are balanced, so read the distance, say 1.421 meters, and this corresponds to 1.421 volts, the Potential Difference of the cell. Again switch back to standard Potential Difference, and check the setting of the instrument. This, of course, should not have altered; but if it has, the trial must be repeated. For higher Potential Differences up to, say, 30 volts, a voltbox must be used. This consists of two coils of high resistance, and the smaller coil has a resistance of one-tenth the total, so that the Potential Difference across the smaller is one-tenth the total Potential Difference.

Make a bobbin 4 in. long between the cheeks, 2 in. diameter, and ¾ in. core, of hardwood (see Fig. 5), and fix between the cheeks and a flange, so as to divide the two parts in the ratio of 10 to 1. Boil the whole in paraffin wax, and wind ...

the chief thing is to have one nine times as great as the other. For the final adjustment of length, apply a Potential Difference of from 2½ to 3 volts over the two, and measure on the potentiometer the Potential Difference across the whole and also across the smaller one. Then the first must equal ten times the second. To use this the unknown Potential Difference is applied across the two coils in series and the Potential Difference across the smaller measured; then total = 10 times this amount. It would make a better job, but more expensive, if the coils were wound with cotton-covered resistance wire, such as iron or manganin of about No. 36 gauge.

The next step will be the measurement of currents, and for this some extra resistances must be made. A standard ohm coil must be bought or made to start with. There is no trouble in the making, provided there is something to compare it with, as it must be accurate. The checking can be done with the potentiometer if the reader has a reliable ammeter reading to about 2 amps. Pass a current of about 2 amps. through the ammeter and coil, and simultaneously read the potential drop across the coil and the ammeter; then the resistance $= \frac{v}{c}$. This must be adjusted to 1 ohm. On the whole it would be better, if possible, to buy a standard coil, or at least get the loan of one for comparison.

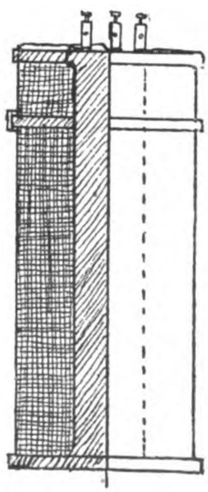


Fig. 5. A Bobbin

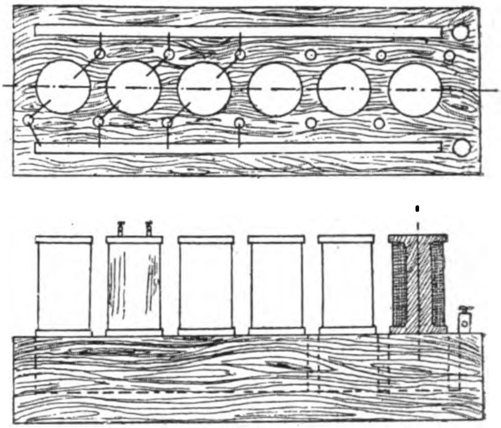


Fig. 6.—Resistance Coils and Stand. (*One-third full size.*)

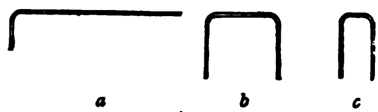


Fig. 7.—Connectors. (*One-third full size.*)

The reader will now need six such coils, made of iron or, far better, of manganin of No. 20 S.W.G. These will enable him to read currents up to 15 amperes. If he requires a larger range, more resistances will be needed. For small currents a resistance-box will do away with all this trouble. For a 1-ohm coil 10 ft. of manganin will be needed—No. 20 S.W.G. cotton-covered. Turn up six bobbins 1½ in. long between cheeks, and the core ½ in. diameter, and cheeks 1 in. diameter, and boil in paraffin wax. Double the wire, and start winding by putting the doubled end through a hole in one cheek; wind on the whole length double, and fix the two ends to two terminals. Now bare a short length of the doubled end, and twist this up till the resistance is exactly 1 by comparison with the standard; solder up this end and tuck it away. Definite lengths cannot be given, as manganin varies in composition and resistance; but the resistance of a length, say 10 ft., can be measured, as will be described, and this will give a good base to calculate from. To each terminal of each coil must be soldered a stout piece of copper wire (No. 12 or 14) bent into an *L*, so that each coil can be connected with a mercury cup.

A stand must be made for these coils,

so that they can be connected in series or parallel, or any other combination, at will, and have a negligible resistance at the contacts. Cut out from a board 1½ in. thick a piece 8 x 3 in., and drill in this twelve clean holes ¼ in. diameter and 1 in. deep; the positions are marked on the drawing (Fig. 6). Cut also a slot 6½ x ¼ x 1 in., as shown. Then boil the whole in paraffin wax. Cut from No. 14 copper wire six pieces as *a* in the drawing, six as *b*, and six as *c*, Fig. 7. With these any combination of the six coils can be made. For example—for a resistance of ⅓ ohm to carry a current of 9 amperes, connect up as is done in the drawing of stand for resistance.

Now the measurement of any current from 0 to 15 can be made. Suppose the reader wants to graduate or check an ammeter, divided into tenths, from 0 to 5. Connect up all the resistance coils in series, and connect the set and the ammeter in series, and pass a current through the whole of about 1-10th amp.; connect the resistance coils by fine wires to the unknown Potential Difference, and read the Potential Difference, then the actual current flowing = $\frac{v}{r} = \frac{v}{6}$. Gradually increase the current till about .4 is reached, taking reading at intervals of both unknown Potential Difference and ammeter scale. At .4 cut out one coil of resistance then current = $\frac{v}{5}$. Keep on in this way, altering the coils so as to keep the Potential Difference reading about 2 volts to 2¼ volts, and never having more than 2½ amps. to any one resistance coil. For example—at 5 amps. two coils must be in parallel. From this, I think, the reader will follow the method of manipulating the resistance coils.

Measurements of resistances can be done in two ways—by direct comparison, or by absolute measurement; this second ...d necessitates the use of an accurate an ammeter is series with the coil, and pass 5 amps. or 10 amps.—if the armature will stand it—through the two. Measure with the potentiometer the Potential Difference across the armature, and read the current passing; then the resistance $= \frac{v}{c}$, if the Potential Difference = .794 and the current = 9.6, resistance $= \frac{.794}{9.6} = .083$.

To measure the resistance by comparison. Connect five resistance coils in parallel; this gives .2 watt to pass about the same current as before through both, but there is no need to know the actual current. Measure first the Potential Difference across the known resistances, and then across the unknown; if the Potential Difference across known resistance = 2.014 volts, and that across unknown = .836 volt, then resistance = $\frac{.836 \times .2}{2.014} = .083$. I think this will show the great usefulness of this simple apparatus, and the reader will very soon find how very accurate it is. What always strikes me is the very large range and at the same time great accuracy over that range.—*The Model Engineer and Electrician.*

Hot Galvanizing Again

A new hot galvanizing process has recently been patented by Professor Charles F. Burgess differing from other previous processes in that it covers the use of an alloy of zinc and iron for coating iron or steel. The alloy is composed of about 92 per cent. of zinc and 8 per cent. of iron and is prepared in a powdered or granulated form. The alloy is applied to the iron and steel in a similar manner to the well-known process of sherardizing.

Arthur D. Little, Inc., of Boston, who touch upon this matter in their report as official chemists to the American Institute of Metals, say that it

DANGERS OF THE SEA

LIEUT. ALEC MC NAB

It seems strange that in this wondrous age of shipbuilding many methods are employed for the safety and guidance of a ship that were in vogue hundreds of years ago. The steady advance in shipbuilding and engineering has produced remarkable changes and luxuries in ocean travel, combined with great protection to the traveling public, still many additional changes must be made to approach anything like absolute safety. Too much time and money are spent on interior decorations and fittings, and too little on appliances which mean much for the safety of the vessel.

Shortly after the recent *Titanic* disaster the United States House of Representatives, and the British Parliament sent up a shout and demanded boats for all, but it is a sad but true fact, that, although boats for all have been supplied on many of our ocean liners, the means for lowering boats for all has been sadly neglected. A landsman, to look at the boat deck of one of the ocean liners today, would feel that the steamship companies have done all in their power to assure the safety of the traveling public by the three tiers of boats which extend forward and aft on the port and starboard sides of the boat deck—but what has been the outcome? Previous to the *Titanic* disaster the boats were placed in such a position that should disaster befall the vessel, and it was necessary to lower the boats, the sailors could, with ease, get at the falls and guys and swing out the davits for lowering away. After the *Titanic* disaster, as I have stated, the cry went up for boats for all—but what have they done? They have congested the original boats so much with the placing of other boats on the boat deck, with life rafts under the original boats, that it is impossible for the sailors to get at the boats they formerly could. Furthermore, lowering purposes under present conditions, and, although there are boats for all, the danger is not lessened.

Furthermore, where are the sailors to man the boats? It was bad enough to man the scant number of boats on the ill-fated *Titanic*, to say nothing of the far greater number of boats placed on ocean liners since that disaster. Stewards, cooks, and firemen cannot handle an oar the same as a sailor can; therefore, if any sea is running, and the boats cannot be handled properly, they will "broach to" in the sea and most assuredly capsize. Personally, I think that the oars for the manipulation and handling of the life boats are way behind the great advance in shipbuilding; as far behind, in fact, as the ancient galley was of the present-day ocean liner. In my opinion, the time is not far off when the oar-propelled life-boat will be a thing of the past and will be superseded by the installation of the internal combustion engine.

It may seem strange for me to state that many of our present-day so-called "sailors" are unable proficiently to handle a boat's oar. The sailors of today are not like the good old "shell-back" of fifty years ago. Because of the great strides made in shipbuilding, ships today can be likened unto a great machine. The sailors are more mechanical than otherwise. The days of splicing ropes, bending sails, holy-stoning the wooden decks and keeping the ship in trim are past. Today, owing to the many mechanical appliances on board ship, the sailor's training is not to be compared to that which he used to receive. The old sailors are dying out, and while occasionally we come across them on board ship, their number is becoming smaller and smaller. I believe that the time will come when a sailor will practically be an engineer, owing to the many mechanical appliances or battleship when approaching shoal water. The quartermaster is instructed to cast the lead. This crude way of informing the captain of his approach to shoal water is not in keeping with the general makeup of the up-to-date equipment on board ship. The lead consists of a weight fastened to a heaving line, with pieces of bunting reeved through the line at each and every fathom—similar to a flexible scale. Very few sailors are proficient in the casting of the lead, and it usually is the quartermaster's duty to do this. As the vessel is approaching shoal water, under reduced speed, the quartermaster stands on a grating which overhangs the side of the vessel, and casts this lead from time to time—informing the captain of the depth of water during the progress of the vessel. Now, on our modern battleship, trans-Atlantic liners, and other vessels, this would appear, even to the landsman, to be a very crude method of determining a ship's approach to coast—especially in a dense fog. Captain Noah, when he sailed the Ark, could have tied a brick to a piece of grass rope and obtained exactly the same results as with the method employed today.

Another feature which also goes back to the time of Captain Noah is that, until of late, the only way in which the captain or officer could obtain the absolute draft of the ship was by going to the forward end of the vessel to see how far the water came up to his mark at that point, then go aft to the stern of the ship and see how far the water came up to his marks at that point also. Now, this was the only method by which Noah could tell how far his Ark was submerged.

In loading a vessel today the cargo is handled by machinery which places the cargo on board at such a rate that it is utterly impossible under the existing circumstances for a shipmaster or officer to have accurate knowledge of this most important matter—actual draft of his vessel. Furthermore, even under the best of conditions, the method at present employed is crude, as the agitation at the surface of the water prevents an accurate reading's being obtained in this manner. Should disaster befall the ship, the captain must necessarily command one or compartments and ascertain the amount of water the vessel is making. This information relative to the various internal compartments of the ship keeps him advised of the rate at which his vessel is being submerged. Now, it would appear, even to a landsman, that an accurate instrument placed in front of the captain to show him the actual draft of the vessel at all points, as well as informing him of the rate of submersion, should disaster occur, would be of invaluable assistance to him—as he could see at a glance the rate at which his vessel was being submerged because of damage incurred in collision or accident of any sort, and suppose he was making two feet or more of water per hour, he could then figure his time to the nearest point of land—knowing his running distances—and reach land before the vessel was in such precarious shape as to demand abandonment. Many ships have been abandoned at sea and later picked up. Why? Because the information given to the captain and other officers was false and terrifying. Many ships, again, have been abandoned when the rate of submersion did not warrant abandonment.

Another crude method in vogue prior to the *Titanic* disaster was that of determining the proximity of ice at sea. During the vessel's progress a sailor was commanded by the officer to take sea temperature. The method in which this was done was as follows: The sailor would pick up a leather temperature bucket, with a piece of line attached, dip it overboard, get it full of surface water and insert a thermometer (similar to the ordinary household thermometer) in the water contained in the bucket. He would hold the thermometer there for about two minutes, take it out, and shout the temperature to the officer on the bridge: this temperature being entered in the log book as the sea temperature taken at that time. This is repeated once or twice every four hours.

The temperature of the surface water is not the temperature of the sea, as water on the surface will show a temperature between the atmospheric temperature and the temperature of the sea itself. Owing to the difference in specific gravity, surrounding atmosphere—floats like a blanket over the surface of the ocean. During the time that ice drifts down from the Arctic into the path of trans-Atlantic liners, the atmosphere is of a far higher temperature. This temperature causes the icebergs to break away from the glaciers and drift down towards the path of the ocean steamships. The iceberg, during its southerly progress, creates at a considerable distance below the surface an enormous body of cold water which drifts with the iceberg. The warmer water is on the surface and stays there, owing to the difference in specific gravity. The temperature of this surface water is what is taken on board ship, and, instead of being a help, is very misleading. Still, for years they continued in this way until the loss of the *Titanic*, which, I may state, prompted me to think about the Frigidometer.

Regarding sea temperatures, I can plainly show you how crude and misleading the present method of taking sea temperatures is. In the first instance, the bucket which is dropped overboard is of the temperature of the atmosphere—owing to its exposure on deck. The water which is picked up in this bucket absorbs heat from the bucket itself. The mercury in the thermometer which is used for taking this temperature, owing to its previous exposure to the atmosphere, is considerably higher than the temperature of the water contained in the bucket, and the sailor, not being very careful as a rule in taking the temperature, submerges it only for a couple of minutes, which will not under any circumstances give it time to descend to the actual temperature of the water obtained therein. I have known cases myself where supposedly accurate readings have been given me that were "taken" with a broken thermometer.

It is now time that such crude methods for a ship's guidance in the path of ice should be eliminated. The only way in which such information can be of assistance to the navigating officer of the vessel is:

1.—Human fallibility must be entirely eliminated.

3.—The sea temperature should not be taken from the surface, but at a considerable distance below the surface.

4.—The atmospheric conditions and changes, when encountered, should also be automatically transmitted to the officer in charge.

It is a well-known fact that sailors can smell ice. The sailors in the crow's-nest of the *Titanic* knew that they were in the vicinity of ice, and they even had a very great drop in the sea temperature prior to the vessel's collision with the berg, but, owing to the temperature being taken from the surface, sudden drop was encountered too late to avert the sad catastrophe.

Having knowledge of the method in which temperatures were taken aboard ship, immediately after the loss of the *Titanic* I set my mind on a method that would accurately determine temperatures and transmit same to the officer in charge. Therefore, thirty-six hours after the loss of the *Titanic* I paid a visit to Mr. F. W. Smith's office, in this city, with the plans and drawings of my Frigidometer, and instructed him to push it with all speed through the patent offices in Washington and the various European countries.

My first installation of this apparatus was made on the *Mauretania* in July of last year, just about eleven weeks after the occurrence of the disaster previously mentioned. My wife and self went over on the *Mauretania* to England. On the way across every temperature encountered, both atmospheric and sea, was faithfully recorded and transmitted to the captain on the bridge.

My apparatus was also the means of pointing out to me another aid in the navigation of the ship, apart from its valuable assistance in locating icebergs at sea. During the voyage of the *Mauretania*, we found that on approach to shoal water the difference in sea temperature was so great from that at considerable depth that it informed the captain the moment he was off the Banks of Newfoundland, the moment he entered and left the Arctic current, the moment he entered and left the Gulf Stream, the

the *Mauretania* leaving Liverpool on the following Saturday. The *Adriatic* sighted an iceberg one day at noon in a certain latitude and longitude. Knowing that the *Mauretania* was coming up astern of her at the rate of twenty-five knots per hour, the captain of the *Adriatic* flashed a Marconigram advising Captain Turner, of the *Mauretania*, that he had passed a huge iceberg, giving the latitude and longitude. This Marconigram was received by the captain of the *Mauretania* and acknowledged by wireless—thanking the captain of the *Adriatic*. In the early hours of the next morning the *Mauretania* was under reduced speed, as they were drawing near the vicinity of the iceberg. The captain of the *Mauretania* bore to the south'ard to avoid the berg. The berg was also bearing south'ard as it seemed to meet the *Mauretania*. During the time the *Mauretania* was under reduced speed, about 2.00 a.m., they encountered a dense white fog. The officers knew that they were in the vicinity of ice, owing to this dense fog due to the condensation of the surrounding atmosphere. Suddenly, and without warning, the Frigidometer pealed forth an announcement and flashed a red signal that a sudden change had been encountered in the temperature of the sea at 36 ft. below the surface. No sooner had the Frigidometer been placed at a lower degree, than the atmospheric alarm gave warning of a decided drop in temperature. From time to time changes in temperature occurred, indicating that they had crossed the well defined line between warm and cold water which was influenced by the enormous mass of ice. The captain starboarded his helm and found that in this direction he got a greater and more rapid decrease. He ported and got an increase, which showed him plainly that he was getting away from the berg. The *Mauretania* still continued under very slow speed, and, shortly after the course had

tically the first voyage after its installation. I was in London at that time, and, when the papers arrived in that country, informing me that my Frigidometer had detected ice at a distance of fifteen miles from the ship, I would not believe it. On the next arrival of the *Mauretania*, I went to Liverpool, from London, and interviewed the captain, who informed me that it was absolutely true, and that the ship was at least fifteen miles from the berg when he had his first alarms. Since then I have received numerous letters from the captain of the *Mauretania* advising that the Frigidometer is doing all we claim for it and that it is a valuable aid to safe navigation.

Recently I had the installation placed, at the request of the White Star Line, on their *Baltic*, and also have many other installations to make on trans-Atlantic liners on my return to Europe in the course of a week or two.

Another important feature has been neglected in up-to-date ships, and practically the same methods are employed today as in the days of Fulton and his *Clermont*. When steam was first introduced for the propulsion of vessels, the accurate transmission of signals between the captain on the bridge and the engineer below in the engine room was carried out by means of a cow bell and gong. Today, the same methods are employed in our coastwise passenger vessels. For the safe and efficient handling of vessels, the engineer and captain must be kept in such close touch with all information transmitted from one to the other that the present method is not in keeping with the steady advance in engineering. The captain may give a correct signal to the engineer to reverse his engines, and the engineer, at times, through error, will put his engines ahead. The captain hears the vibrations of the engines started below, but has nothing to show him the direction until the

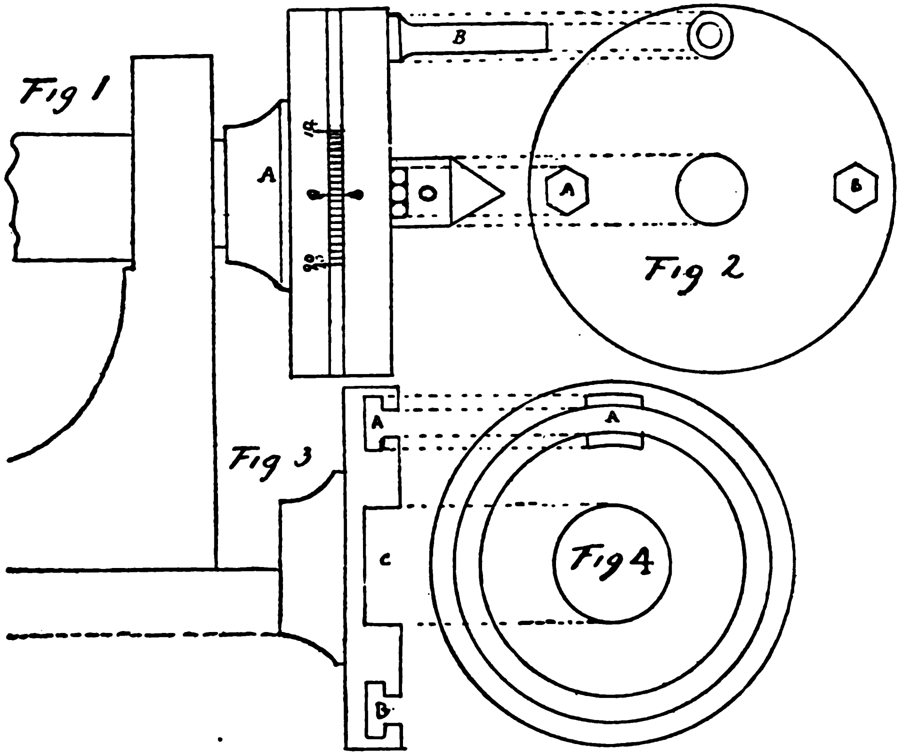
CUTTING MULTIPLE THREADS

J. H. EVANS

The original mode, and one still pursued by some, is to divide the wheel on the mandrel into the desired number in accordance with the threads required. To effect this is not a difficult matter, but is has its drawbacks. Suppose it is desired to produce a screw with four threads, the wheel, whatever it may be that is attached to the mandrel, is divided into four and distinctly marked. The first thread having been cut, the radial arm is released and the wheel turned one quadrant and gently lowered to gear with that from which it was removed, the same having been marked to insure the accuracy of the regearing. This means will, as I say, effect the purpose; but I do not think it is used, except in very remote parts, and may be considered obsolete.

The dividing chuck is now generally adopted. We will take first the center dividing chuck most generally used for engineering purposes. It we study Figs. 1 and 2 it will be at once seen that this chuck is made in two parts, the base *A* being well bedded home to the mandrel face and turned all over perfectly true. The material selected may be either gun metal or cast iron; I think the first is preferable.

Having the body thus turned, a *T*-shaped groove must be turned in the front as shown in *AB*, Fig. 3, and a recess turned in the front *C*, to receive the conducting fitting of the front plate. These fittings must be as perfect as it is possible to make them, as the corresponding accurate movement of the front plate depends entirely upon this fitting.



I have shown these parts in section as well, to illustrate more clearly the internal fittings.

The back plate must now have a recess cut out in the groove, as shown in *A*, Fig. 4, to admit the two steel fittings to hold the clamping-screws *A* and *B*, Fig. 2, which secure the two parts together. The readiest manner of getting this out will be to drill a few small holes through the part that is to be cut away, then break them one into the other with the point of a round file, and finish them off to the side of the tee-groove with a

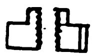


Fig. 5

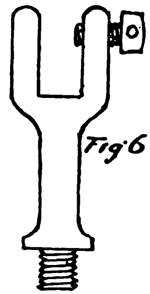
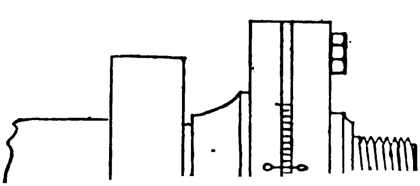


Fig. 6

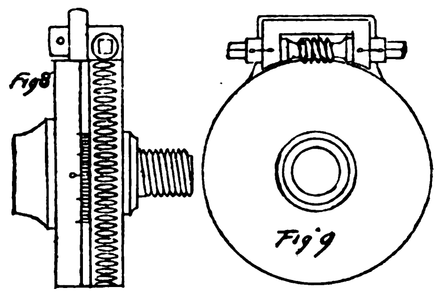
series of other and smaller files. This may take a little time, but it is the most handy in many cases. Another way, if preferred, will be to have a small rose drill fitted to a drill-spindle, and adjust it on the slide-rest to the required position, and move the plate backwards and forwards as far each way as the size of the recess necessitates. It is not important that the ends of the recess be squared; they can be left as formed by the diameter of the drill. The steel block that moves round in the recess only requires to pass into the groove. As shown in Fig. 5, these fittings are tapped right through, and the clamping bolts have a plain fitting through the front plate, so that when they are in their places and are released the plate will move round to the desired position, when the bolts are again set up to secure the two together. The back plate is thus divided into a series of equal divisions, and the zero distinctly marked, a corresponding reading line being marked on the front plate, as shown in Fig. 1.

The center is screwed on to the front plate, and can be replaced by a female center, if required for any special purpose. The length of the chuck necessitated by its construction prevents the use of the centre as fitted to the front of the mandrel nose. This, however, is found to be not the least detrimental, as when



carefully and correctly made, the axial truth is quite as accurately maintained.

Another very useful addition will be found in a second driver to replace *B*, Fig. 1. This is illustrated in Fig. 6, and will be seen to have the extremity forked, or open, which enables the carrier upon the work to be passed into it, and secured by the fixing-screw; this obviates the care otherwise required to keep the carrier in contact with the driver when starting a fresh cut. The chuck made in this way can be continually employed; but I think it preferable to keep it strictly for its intended purpose—that of cutting screws requiring multiple threads, using the ordinary one for general purposes.



We have two other methods to adopt in fitting up this particular type of chuck. It is very often required to cut a series of threads up a piece of work that is already held in a cup chuck or on a soldering plate. This being the case, it is essential to have a second chuck made, as illustrated in Fig. 5. This, it will be observed, is precisely the same construction as that previously described, the only difference being the replacing of the running center by a screwed nose to correspond with that on the mandrel. This is more especially useful in the case of amateurs, and has been found a considerable advantage, and dispenses with the necessity for removing and recentering the work in hand, and thus saves much valuable time.

We may go still further in the perfection of this addition to the lathe when required for special purposes. I received instructions in one instance to make one

one for their own use. It will be seen that as shown it is provided with a worm-wheel adjustment, for the purpose of further insuring the accuracy of the numerous settings required, when about to cut a screw with a greater number of separate threads, a multiple of something like ten or more for the work in hand being required. Any number can, of course, be obtained from the foregoing chucks already detailed, but that shown in Fig. 8 affords greater facilities for what in the case referred to became necessary—the greatest accuracy obtainable. It will be seen that the fixing-screws *A* and *B*, Fig. 2, are now dispensed with, the front worm-wheel being retained in its bearing and close contact with the face of back plate, in the same manner as the usual spiral dividing chuck—viz., a screw fitted to the back of the wheel.

In order that the bearing surfaces of the two plates may be more substantial, they are made to cover throughout the entire diameter as seen in Fig. 8, the back plate being divided, and a small reader fixed on the worm-wheel. The plate may be divided in any number preferred, in Fig. 1 one hundred divisions are engraved, while in Fig. 8, a worm-wheel of ninety-six teeth, ten to the inch, is, I think, quite all that is necessary, being divided at each thread, and the tangent screws each divided into four, the initial or reading lines both in accurate agreement when the indicator on the wheel points to 0 in the back plate—*vide* Fig. 8.—*English Mechanic and World of Science.*

THE SELECTION OF EXPLOSIVES

The United States Bureau of Mines has just published Bulletin 48, "The Selection of Explosives used in Engineering and Mining Operations," by Clarence Hall and Spencer P. Howell. It deals with the characteristic features of the principal explosives used in engineering and mining operations, and especially with the tests that show the suitability of different classes of explosives for various kinds of work. The bulletin is published as one of a series dealing with tests of explosives and methods of reducing the risks involved in the use of explosives in mining work.

In large engineering projects and in mining operations requiring the use of explosives the selection of a suitable explosive from the many varieties offered for sale is of fundamental importance. The various considerations involved in the selection of the proper class of explosive for the blasting to be done are given. Many explosives suitable for quarry work have been proved unsuitable for use in deep mines or in close workings. In metal mining and in driving tunnels, the character of the gases evolved by the explosive on detonation is an important consideration. An explosive for use in gaseous or dusty coal mines must be formulated and compounded so that its flame temperature and the height and duration of its flame are reduced enough to permit its being used with comparative safety. In wet workings or in submarine blasting, explosives impervious to moisture are requisite. In extremely cold climates, explosives that do not require thawing are desirable, provided they are equally good in other respects. An essential requirement of all explosives, especially of those for use in tropical countries, is that they shall remain stable without change in chemical or physical characteristics.

Because of the varying conditions in the different projects on which explosives are used, the fact is emphasized that some characteristics of explosives are of much importance in certain classes of work and of little or no importance in others. As practically every class and every grade of commercial explosive is used in open-air work to meet varying conditions, the authors indicate the method of manufacture, give typical composition of, and state the use to which each of the following explosives is best adapted: black blasting powder, granulated nitroglycerin powder, "straight" nitroglycerin dynamite, low-freezing dynamite, ammonia dynamite, and gelatin dynamite.

Black blasting powder is stated to be best suited for work in which a gradual pushing or heaving effect is desired, such as excavating cuts, quarrying soft rock or stone, and especially in quarries where large blocks of building stone are sought, and in order to obtain the maximum efficiency the charge must be well confined by suitable stemming. Granulated nitroglycerin powder is more effective and gives better results than black blasting powder in soft and seamy rock or in material that does not sufficiently confine the gases evolved. "Straight" nitroglycerin dynamites, as a class, develop greater disruptive force than any of the other commercial classes of explosives tested, and for this reason they should be used for producing shattering effects or for blasting very tough or hard materials whenever the conditions permit. If the "straight" nitroglycerin dynamites are found to be too violent for certain classes of work, the low-freezing dynamites or the ammonia dynamites, which have lower rates of detonation and hence less disruptive effect, are recommended. The low-freezing dynamites have the advantage of not freezing until exposed to a temperature of 35 degrees *F* or less, but, like all nitroglycerin explosives, after they become frozen they must be thawed before use in order to insure the most effective results. As the ammonium nitrate used in ammonia dynamite is deliquescent, this class of explosive absorbs moisture more readily than other dynamites, therefore it is emphasized that care should be observed when storing this class of explosives in wet or damp places. The gelatin dynamites have been used to a large extent in wet blasting, such as in the removal of obstacles to navigation and in deep workings, and, as a general rule, they are best suited for these purposes.

The products of combustion of explosives used in closed work is said to be of vast importance, because in such work large quantities of explosives are generally used and they may produce [illegible] gases on detonation will result in its being commercially manufactured.

This special gelatin dynamite was tested at the Pittsburgh testing station of the bureau, in a limestone mine at West Winfield, Pa., and in a zinc mine at Franklin Furnace, N.J., the detailed results of which are reported in bulletin 48.

The bulletin points out dangers arising from the burning of high explosives by showing the great increase in the percentage of poisonous gases evolved.

The authors describe the method of blasting followed at Lock No. 1, Monongahela river, as an example of submarine operations, giving the difficulties encountered, showing the causes of misfires, and the methods used for overcoming these difficulties. The tests incident thereto, showed that variation in the cross-sectional area of the bridge of an electric detonator was an important factor in its failure to explode when in series with other electric detonators.

The bulletin closes with a table showing for nine explosives of different classes and grades the relative potential energy, disruptive effect, which bears a close relation to the percussive or shattering force of explosives, and propulsive effect, which corresponds to the pushing or heaving force.

Copies of this bulletin may be obtained by applying to the Director, Bureau of Mines, Washington, D.C.

Cast Iron Brazing

Nearly everyone has had at one time or another a broken piece of cast iron to repair, which, owing to its shape, etc., required either arduous patching, or had to be sent to one of the companies who make a specialty of this kind of work. By using the following brazing process considerable expense and delay can be avoided. The pieces of iron are first [illegible] if they were steel

ELECTRO-DEPOSITION OF PLATINUM

Use of Platinum in the Arts Rapidly Increasing. Platinum Plating a New and Interesting Operation

The present extensive use of platinum in jewelry has given rise to a demand for platinum plating. This demand has also been in existence in other lines in which platinum is employed, and it is believed that many useful and economical goods can be made by its service.

Platinum plating is not a difficult operation, particularly if carried out on a small scale, as it usually is. The solution must be used hot, which is, of course, an objection to large installations, but is not in the case of small ones. The solution employed is an acid one, and for this reason must be used in a porcelain or glass vessel. This feature, too, is not objectionable, as gold is deposited every day under the same conditions.

There are a number of solutions for the electro-deposition of platinum, but the best is that first proposed by Roseleur, the celebrated electro-metallurgist of Paris. This solution has been found to give excellent results and is not difficult to work or to make up. With a little chemical knowledge and experience in electroplating, an operator will have no difficulty, but will be able to turn out a good job of plating right along.

This solution has the advantage over the others proposed (whether they are in commercial use or not cannot be ascertained) in that the platinum has no tendency to separate out as the bath is standing idle. In the other solution, this is an objection, and the platinum has a tendency to separate spontaneously, and thus in time render the solution useless.

The solution about to be given, and which was first used by Roseleur, has been slightly modified. Phosphate of ammonia as recommended by him as one of the ingredients has been left out, as it is difficult to obtain. The same result, however, is obtained by using phosphoric acid and then adding ammonia.

To make the platinum solution for the electro-deposition of platinum, proceed as follows:

strong nitric acid. The amounts are fluid ounces. The platinum should be as pure as possible and free from iridium, as the latter metal not only causes the platinum to dissolve with great difficulty, but the iridium chloride interferes. The pure platinum chloride may be purchased and the amount made from 1 ounce of platinum or that containing 1 ounce of platinum should be used. (2 oz. 14 dr. 16 gr. avoirdupois of crystallized platinum chloride are the chemical equivalent of 1 Troy ounce of metallic platinum. Three ounces of the salt is a sufficiently close approximation in practice.—*Eds. Electrician and Mechanic.*)

The platinum is placed in a porcelain dish and heated gently with the aqua regia until it is dissolved. When this is done, heat the dish gently for some time until the platinum chloride that has now been produced becomes thick and syrupy. The object of this evaporation is to remove the excess of acid, but the platinum chloride should not be evaporated until dry, as it is then partially destroyed. When it is thick and syrupy, the right condition has been obtained. There is now obtained pure platinum chloride, free from an excess of acid.

When cool, dissolve this platinum chloride in 3 qts. of water (or 3 liters) and to it add 15 ounces (fluid) of a 50 per cent. phosphoric acid (or 450 c.c.). Next add ammonia until the solution smells rather strongly of it, when a yellow precipitate of the double phosphate of platinum and ammonia will be thrown down. This precipitate should *not* be filtered out, but is allowed to remain in the solution.

Now dissolve 50 ounces (or 1,500 grams) of sodium phosphate in 3 quarts of hot water (or 3 liters). Now pour it with constant stirring into the platinum solution containing the ammonia. The mixture is now boiled for a short time until no more smell of ammonia is given and the solution, which was previously alkaline, turns blue litmus paper red.

yellow liquid also becomes nearly colorless as this reaction takes place. The solution is now ready for use. The amount should be about 1½ gallons, or about 6 liters. If desired, the amounts can, of course, be reduced in order to make a less quantity. It will be seen that the solution is rather rich in platinum, but this is necessary in order to obtain good results.

The solution when used for platinum plating should be heated to about 150–180 degrees F. The hotter it is, the better it seems to work. A cold solution will not work.

As an anode a piece of platinum is preferable, although not entirely necessary. Carbon may be used if desired. If a platinum anode is used, however, there is no action on it and the solution cannot be fed from it. To replenish the solution, fresh platinum chloride must be introduced. The platinum anode is never attacked, and may be used indefinitely without injury.

A high current density is necessary and the voltage should be maintained at 5 or 6. At a less votage the electro-deposition does not take place.

The platinum cannot be deposited upon iron or steel direct, but they will have to be coppered, nickeled or silvered before it is done, when no difficulty will be experienced. The electro-deposition on brass, copper, silver, nickel, bronze or gold takes place readily. It is useless to coat the articles with a slight film of mercury in a "quick-dip," as this seems to do no good. The deposit is put on the metal direct, but it is needless to say that extra care should be taken to produce a clean surface before the electro-deposition of the platinum.

The deposit forms immediately and in a few seconds a bright deposit is obtained if the metal underneath is highly buffed. The platinum deposit takes the nature of the metal underneath and upon highly long deposition. The deposit seems to come dense under such circumstances.

The deposit of platinum is quite hard and of the regular platinum color. It is so hard that it cannot be scratch-brushed by a brass scratch-brush, but one of steel must be used. Even then, it seems to remove particles of steel, but these can be taken from the surface by muriatic acid (equal parts of acid and water). The platinum deposit cannot be burnished, as it is too hard. It must be buffed, and the same compositions used for hard nickel employed. Vienna lime is good for this purpose. The best results, however, seem to be obtained by highly buffing the base metal and then depositing the platinum upon it as a light coating. It will then be sufficiently bright and will not need buffing.—*The Brass World.*

Dangers of the Sea

(*Continued from page* 376)

just as soon as the captain rings a bell and the engines start, the controlling levers are on the bridge, but, should a vessel pick up and gain momentum in the wrong direction, it is impossible to slam on brakes and stop the vessel. With her great body she must go and there is no stopping until something "harder than the ship" comes in contact with her.

Such thoughts inspired me with the idea of the now well-known McNab Direction Indicators. This instrument was invented by me three years ago, and today it is hard to find a corner of the earth, under any flag, where the McNab Indicator is not doing its duty: informing the captain of every engine movement, speed at which the engines are turning, and should the engines start in the wrong direction, before the vessel can gain momentum the error is rectified.

I have had letters from many stating

A SMALL FAN MOTOR

LEON BURGOYNE

This article describes the construction of a double-acting small electric fan motor, there being two armatures and flywheels. It is a machine which will look very pretty if carefully made and finished, and has the great advantage of not requiring any special castings, being easily made by an amateur with the aid of a few tools. We will take first the field magnets. Procure 1 doz. hardwood bell bobbins (unwound), 1¼ in. outside length, ¾ in. flange, ¼ in. hole; also 1 doz. soft iron cores for same. These can be bought ready made, and will be found to have one end screwed for fitting bell magnet frames. These screwed ends are cut off the length of the screw, and carefully filed perfectly flat till the length of core is 1⅜ in. Now carefully drive the cores through the bobbin holes, which will leave 1-16 in. projecting from each end. If the cores are a trifle too large for the holes, file a little. On no account use too much force in driving, or the bobbins will probably split. The bobbins should now be carefully wound with No. 20 silk- or cotton-covered wire. Well soak the wire in melted paraffin before commencing, and cover each layer as wound with thin paper, leaving about 2 in. over at each end of the wire for connections. Finally, when all the bobbins are wound, give them a coat of shellac varnish and set aside to dry thoroughly. Now to deal with the motor frame. This consists of two pieces of 3-64 in. sheet brass cut to the shape and dimensions shown, Fig. 1. The circular part must be divided into twelve even parts exactly, and where the dividing lines cut the inner circle (see dotted circle Fig. 1) ¼ in. holes must be carefully bored (see Fig. 1), also ⅛ in. holes at all the points marked on the edge of outer circle. As the thorough efficiency of the motor depends on the accuracy of dividing the circle, to save spoiling the brass plates by corrections in case of error the best plan would be to cut out a circular piece of note-paper 2⅜ in. radius, and describe a circle 1⅝ in. radius, and divide as required. Paste the paper firmly on the circular part of one of the plates, place the other plate underneath the latter and clamp together; carefully drill all the holes ¼ in. and ⅛ in. as marked right through. These should be neatly done, seeing that the edges are not burred, or else when putting together there will

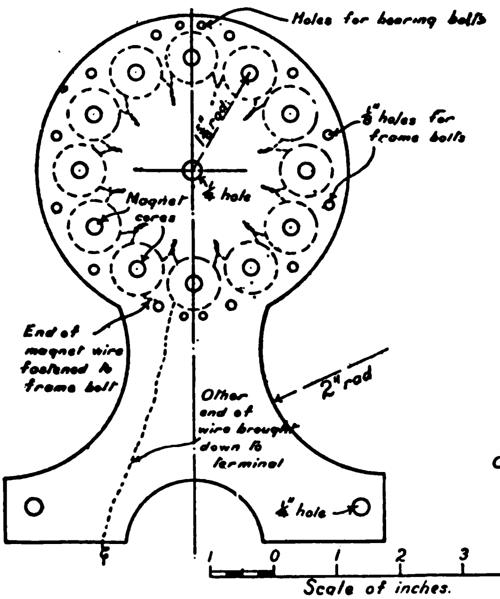


Fig. 1. Side View

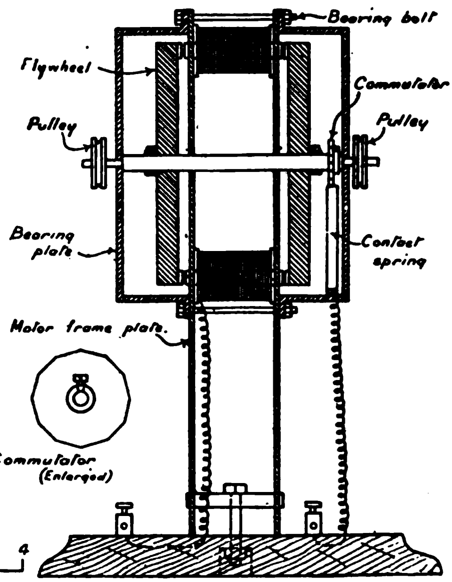


Fig. 2. Section

A Small Electric Fan Motor

be trouble. Hammer the brass with a wooden mallet till dead flat; then thoroughly clean, polish and lacquer both sides, and lay by to dry. When dry, lay one of the plates flat on a clean surface, and place each of the bobbins upright (either end up) with one end of each core resting in one of the 1/4 in. holes. The magnets will then be in a circle (see small dotted circles, Fig. 1). Now join the ends of wires as shown—it does not matter in what order—by baring them and twisting together, and after cutting off any superfluous wire bend inwardly in such a way as not to touch either of the plates when clamped together, which latter must now be done by placing the other plate on top of the bobbins with cores in the holes, as before, and passing 1½ in. bolts through the outer holes, and tightening all up with nuts, one of the wire ends being securely fastened after being bared, to one of the lower bolts. In screwing up the nuts, care should be taken not to do it too tightly, which would have a tendency to make the plates bulge slightly in the middle.

We now come to the armatures and fly-wheels. Two of these will be required—one for each end of the field magnets. For the fly-wheels get two light-weight brass wheels 3½ in. diameter, with center hole 3-16 in. For the armature the easiest plan will be to get a few cogging laminations with 12 cogs and 3½ in. diameter, or the same could be cut out of thin, soft sheet iron. These armatures are then soldered at the tips of the cogs to the fly-wheels. The bearings should next be made of ½ x 1/8 in. strip brass, to shape shown Fig. 2. The shaft holes being 1/8 in., these bearings must be drilled at each end to take two 1/8 in. bolts, which pass through both plates. The bolt holes in the bearings should be made somewhat larger than is or commutator. This consists of a circular piece of 1/8 in. brass or copper, ¾ in. diameter, divided into twelve parts (see detail sketch), and a 3-16 in. hole bored in the center; a short piece of brass tube with hole 3-16 in. being soldered to one side and drilled and tapped to take a small setscrew for adjusting the commutator on the spindle. The hub of each fly-wheel should be drilled and tapped for a small setscrew for securing to the shaft; if the hub is not deep enough for screwing a short piece of tubing (3-16 in. hole) may be soldered on and screw fitted, as shown at Fig. 2. Now place the spindle through the center holes in plates; place, the left-hand fly-wheel on, then the right-hand one, and the commutator, and finally put on the bearings and secure to the frame by means of bolts and nuts. Now push each fly-wheel up to the magnet cores till the armatures touch them. If some project a little too much they must be carefully filed down. If they touch all one side of each armature, but not the other, the bearings must be slightly shifted so as to bring the faces of the armatures perfectly parallel with the magnet cores. This part of the fitting will probably require a little patience, but is necessary to the efficient working of the motor. When you have succeeded in getting the cores and armatures perfectly adjusted so that they practically touch each other at all points, screw up the bearings tight. Now draw back the armatures just enough to clear the cores when revolving; the closer, they are, of course, the better will the motor work. The setscrews will secure the armatures to the shaft. A contact spring of thin brass for the commutator is made and fitted on the lower part of the bearing, from which it must be insulated in the usual way. The stand for the motor is a polished block of wood of suitable size fitted with two terminals, the frame other terminal; but take care that there is no electrical contact between either wires or the motor frame, as this would be fatal to its working. A fan can best be made out of a single piece of thin sheet brass having a small bit of tube with setscrew soldered to its center for securing to the shaft. The pieces for the vanes are cut and then twisted at a slight angle so as to strike the air when revolving. The motor will take an intermittent current of about 1 amp. or less at 2 volts. Not more than 4 volts should be used, or the insulation might be destroyed.—*The Model Engineer and Electrician.*

A METHOD OF SECURING CRANK-PINS, ETC.

CLIVE NICHOLSON

The following is a modification of a well-known method of fixing crank-pins, axles, etc., which I find very useful. The drawings are self-explanatory, the shape of the component pieces being clearly shown. The threads on the reduced portion of *A* and on the outside of *B* may be cut with Whitworth standard dies, though *A* need not be so much reduced if a gas thread is used on *B*, and a stronger job results. In putting together, *B* is first screwed into *C* as far as it will go; the threaded shank of *A* is then screwed into *B* till the collar (or cone) is fairly home; *B* is then turned back so as to screw it *out* of *C*. The result is that as *B*, owing to its coarser thread, tends to leave *C* faster than it pushes *A* away from itself, *A* is drawn on to its seating by an amount due to the difference in the pitches of the two threads. When tightened up, everything is very firmly locked. The usual method of making such a joint is to put the fine thread on *B* and the coarse thread on the reduced portion of *A*, and the joint is tightened by screwing *B* into *C* instead of out of it. Besides the obvious advantage of having the fine thread on the smaller part of the work, bringing in standard taps and dies, the very awkward calculation is avoided with reference to the length of the screw threads required on *A* and *B* to bring everything into position when tightened up.

Fig. 2 shows a method of making the joint with a head on the pin and everything else flush. Though not so strong a job as that shown in Fig. 1, it has its advantages.

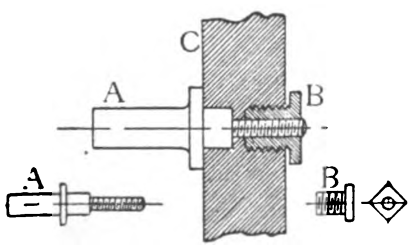


FIG 1.

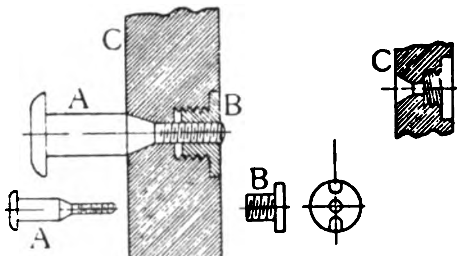


Fig. 2

Important Wireless Work

FRENCH AND AMERICAN EXCHANGE OFFICERS TO ESTABLISH EXACT DIFFERENCE IN LONGITUDE

With the arrival at Washington, March 17, of four French officers prominent in the army and navy of France and in European scientific circles, experiments are to be undertaken through the medium of the powerful navy wireless station at Arlington, Va., and the station of the Eiffel Tower in Paris, to establish the exact longitude between the two countries. The work is of great importance, for when similar data is obtained by other nations, the information will permit for the first time the drawing of a true map of the world. The French officers are Lieutenant Ludovic Driencort and Lieutenant Charles de Vaisseau of the navy, and Colonel Gustav Ferrie and Captain Paul Levesque of the army. They have brought with them a number of highly sensitive instruments, similar to those which will be used in Paris so that the work at both ends will be synchronous. The naval observatory will join in the tests and exact time here will be flashed at intervals to Paris as part of the program. While here the French officers will be the guests of the Government. They have been quartered at the Army and Navy Club, and a number of entertainments already have been arranged for them.

WHAT ELECTROCHEMISTRY IS ACCOMPLISHING*

JOSEPH W. RICHARDS
(*Professor of Metallurgy, Lehigh Univ.*)

My theme is to depict for you, as clearly as I may be able, the part which electrochemistry is playing in modern industrial processes. I have no exhaustive catalogue of electrochemical processes to present, nor columns of statistics of these industries; but my object will be to classify the various activities of electrochemists and to analyze the scope of the electrochemical industries.

SCOPE OF ELECTROCHEMISTRY AND ELECTROMETALLURGY

Chemistry is the science which investigates the composition of substances and studies changes of composition and reactions of substances upon each other. As an applied science, it deals chiefly with the working over of crude natural material, and its conversion into more valuable and more useful substances.

Some common examples, to illustrate this statement, are the conversion of native sulphur into sulphuric acid, the manufacture of soda and hydrochloric acid from common salt, the conversion of phosphate rock into superphosphate fertilizer, etc. Several pages would not suffice merely to catalogue the great variety of chemical industries; immense amounts of capital are invested in them and they are some of the most fundamental industries in their relation to supplying the needs of a rapidly advancing civilization.

Metallurgy is the art of extracting metals from their ores, and of purifying or refining them to the quality required by the metal-working industries. It is a branch of applied chemistry. The metallurgical industries form a highly important part of our national resources; on them we depend for iron, steel, copper, brass, gold, silv[illegible]

agency in accomplishing chemical operations, and it has not only succeeded in facilitating many of the most difficult and costly of chemical reactions, but it has in many cases supplanted them by quick, simple and direct methods; it has even, in many cases, developed new reactions and produced new materials which are not otherwise capable of being made. A few examples will illustrate these points: Caustic soda and bleaching powder are made from common salt by a series of operations, but the electrical method does this neatly and cheaply in practically one operation; lime and carbon do not react by ordinary chemical processes, but in the electric furnace they react at once to form the valuable and familiar calcium carbide; carbon stays carbon except when the intense heat of the electric furnace converts it into artificial graphite. The list of such operations is a long one, and it may be said that the chemist has become a much more highly efficient and accomplished chemist since he became an electrochemist, and he is becoming more of an electrochemist daily.

Electrometallurgy applies electric energy to facilitating the solution of the problems confronting the metallurgist. Its birth is but recent, yet it has rendered invaluable service; it has made easy some of the most difficult extractions, has produced several of the metals at a small fraction of their former cost, and has put at our disposal in commercial quantities and at practicable prices metals which were formerly unknown or else mere chemical curiosities. It has, further, refined many metals to a degree of purity not previously known. The metallurgist is rapidly appreciating the possi- [illegible] and metallurgy, and is rapidly increasing in importance. It is a new art; people are really only beginning to understand its principles and to appreciate its possibilities; it is an art pursued by the most energetic and enterprising chemists, with the assistance of the most skilled electricians. Some of its most prominent exponents are electrical engineers who have been attracted by the vast possibilities opened up by these applications of electricity. The chemists have worked with electricity like children with a new toy, or a boy with a new machine; they have had the novel experience of seeing what wonders their newly applied agency could accomplish, and it is no exaggeration to say that they have astonished the world—and themselves.

THE AGENTS OF ELECTROCHEMISTRY

The operating agent in electrochemistry is, of course, electric energy, which may be used in three classes of apparatus, *viz.*:

I. Electrolytic apparatus.
II. Electric arcs and discharges in gases.
III. Electric furnaces.

I

Electrolytic apparatus and processes use or utilize the separating or decomposing power of the electric current. Whenever an electric current is sent through a liquid material which is compound in its nature, *i.e.*, a chemical compound, the current tends to decompose the compound into two constituents, appearing respectively at the two points of contact of the electric-conducting circuit with the liquid in question, *i.e.*, at the surface or face of contact of the undecomposable conducting part of the circuit with the decomposable part. If the current has a definite direction the constituents appear at definite electrodes. The action is simply the result of the current passing being regarded only as a tendency or a determining cause which practically results in the reactions actually taking place.

This agency is an extremely vigorous and potent force for producing chemical transformations. It enables us, for instance, to split up some of the strongest chemical compounds into their elementary constituents, to convert cheap materials into much more valuable derivatives, to purify impure materials, in short, to perform easily some very difficult chemical operations and in some cases to perform chemical operations otherwise impossible. A description of all these various processes would take a volume, but a short explanation of a few of them will make the principles clear and suffice for my present purpose.

Electrolysis of water.—As a raw material, water may be said to cost nothing. Apply an electric current to it in the proper way, and it is resolved into its constituent gases, hydrogen and oxygen, as cleanly and perfectly as anyone could desire. These gases have many and various uses, and are valued each at several cents per pound. A whole industry has thus grown up, based on the simple electrolysis of water, to supply these two gases for various industrial uses. Europe possesses many of these plants; there are a few in the United States. The speaker has translated from the German a small treatise on this industry.

Electrolysis of salt.—Common salt, sodium chloride, is one of the cheapest of natural chemicals. It has some uses of its own, but centuries ago chemists and even alchemists devised chemical processes for transforming it into other sodium salts, such as caustic soda or soda lye for use in soap, soda ash or carbonate, for washing or glassmaking, and into chlorine bleaching materials. Chemical works operating these rather complifighting for their existence. As for the electrolytic process, the salt is simply dissolved in water and by the action of the current converted into caustic soda at one electrode and chlorine gas at the other. By some special devices these are kept separate and collected by themselves, and the work is done. The principles involved are simplicity itself as compared with the older chemical processes, the only agent consumed is electric energy, and the products are clean and pure.

Chlorates.—These are salts used on matches and in gunpowder. Chlorate of potassium is a valuable salt with important uses. It is made from common cheap potassium chloride, in solution in water, by simply electrolyzing the solution without trying to separate the products forming at the electrodes. It is a simpler operation than the production of electrolytic alkali. Chlorate thus forms in the warm solution, and is obtained by letting the solution cool and the chlorate crystallize out. The ordinary chemical manufacture of this salt was tedious and dangerous; the electrolytic method has practically entirely superseded it.

Perchlorates.—These salts have more limited uses, but are made by expensive chemical methods. The electrolysis of a chlorate solution at a low temperature, without separating the products formed at the two electrodes, results in the direct and easy production of perchlorates. I cite this more to illustrate what I might call the versatility of the electrochemical methods, rather than because of its commercial importance.

Metallic sodium.—The caustic soda produced from salt can itself be electrolytically decomposed; this is the easiest way of producing metallic sodium. Sir Humphrey Davy discovered sodium by electrolyzing melted caustic soda, and at this moment several large works are working his method on an immense scale. The caustic contains sodium, hydrogen

Magnesium.—This is a wonderfully light metal, whose chief use is in flash-light powders. Its compounds are abundant in nature, but its manufacture by any other than the electrolytic method is almost impracticable. The operation consists in simply passing the decomposing current through a fused magnesium salt—a chloride of magnesium and potassium found in abundance in Germany.

Aluminium.—The most useful of the light metals; an element more abundant in nature than iron, yet which costs by chemical methods at least $1.00 per pound to produce; electrochemistry enables the makers to sell it at a profit at $0.25 per pound. This is probably the most useful metal given to the world by electrochemistry. Although the French chemist Deville obtained it by an electrolytic method in 1855, yet he had only the battery as a source of electric current, and the process was too costly. This very city of Pittsburgh was the real cradle of the electrolytic manufacture of aluminium, when in 1889 Mr. Charles M. Hall, with the financial assistance of the Mellons and the business assistance of Capt. A. E. Hunt, commenced to work his process up at Thirty-third Street on the West Side. The principle of the process is here again one of beautiful simplicity—when it is once made known. Aluminium oxide, abundant in nature, is infusible in ordinary furnaces, but easily melts and dissolves, like sugar in water, in certain very stable and liquid fused salts—double fluorides of aluminium and the alkali metals. On passing the electric current through this bath, the dissolved aluminium oxide is decomposed, appearing at the two electrodes as aluminium and oxygen, respectively. When all the oxide is thus broken up, more is added, and the operation continues. One of the most difficult problems of ordinary chemistry is thus simply, neatly and effectively solved by electrochemistry. The lower burgh district. Many other factors besides cost of power bear on the question—cost of labor, abundance of labor, cost of carbon, coal for heating, various supplies, railroad freights, nearness to the consumers, and many other considerations must be taken into account. Aluminium is certainly destined to become the most important metal next to iron and steel, and, as far as one can now foresee, will always be produced electrochemically. To have accomplished the establishment of this one single industry would of itself have proved the usefulness of electrical methods and their importance to chemistry and metallurgy.

Refining of metals.—Unless metals are of high purity they are usually of very little usefulness. Electrolytic methods enable almost perfect purity to be easily attained, and in addition permit the separation at the same time of the valuable gold and silver contained in small amounts in the baser metals. Over $100,000,000 worth of copper is electrically refined every year in the United States; the metal produced is purer than can be otherwise obtained, giving the electrical engineer the highest grade of conducting metal, while several million dollars' worth of gold and silver are recovered which would otherwise have to be allowed to remain in the copper. Again, the method is so simple that but a few words are necessary to set it forth in principle. The impure copper is used as one electrode—the anode—in a solution of copper sulphate containing some sulphuric acid; the receiving electrode—the cathode—is a thin sheet of pure copper, or of lead, greased. The electric action causes pure copper only to deposit upon the cathode, if a properly regulated current is used, while a corresponding amount of metal is dissolved from the anode. Silver, gold and platinum are undissolved, and remain as mud or sediment in the bottom of the bath; other impurities may go into the solution, but are not deposited on the cathode if the current is kept low. The cost of this operation is small, and the results are so highly satisfactory that 90 per cent. of all the copper produced is thus refined. Similar methods are in use for refining other metals; silver, gold, and lead are thus refined on a large scale; antimony, bismuth, tin, platinum, zinc, and even iron can be thus refined; the field is very inviting to the experimenter and to the technologist, and is rapidly increasing in industrial importance.

Metal plating.—All electroplating is done by the use of electrolytic methods similar to those just described. If we imagine the impure metal anode replaced by pure metal, and the receiving cathode to be the object to be electroplated, we have before us the electroplating bath ready for action. Everybody knows the value and use of gold, silver, and nickel plating; less well known are platinum, cadmium, chromium, zinc, brass, and bronze plating. These are among the oldest of the electrochemical industries. Electrotyping is only a variation of this work; also the electrolytic reproduction of medals, engravings, cuts, etc., and even the production of metallic articles of various and complicated forms, such as tubes, needles, mirrors, vases, statues, etc. The speaker has translated from the German a monograph concerning these last-named uses of the electric current. There is hardly opportunity here more than to catalogue these various branches of electrometallurgical activity. Pittsburgh people will be interested, however, in knowing that many of the newer buildings in this city contain thousands of feet of electrical conduits zinc-plated in a splendid fashion by electrolysis, at a works within a few miles of this city. At McKeesport tubes are coated on an immense scale, by dipping into melted zinc, but the electrolytic method is gaining a foothold, and we may live to see all galvanizing in reality practiced as it is spelled. The removing of metallic tin from waste tin scrap is also accomplished on a large scale by the application of similar principles. It is being operated at a distance from Pittsburgh, but your open-hearth furnaces use up annually thousands of tons of the scrap steel thus cleaned and saved for remanufacture into useful shape.

Without having mentioned or described more than a fraction of the electrolytic methods in actual industrial use, I hope that I have made clear the importance and extent of this kind of electrochemical processes. Assuming this, we will pass to the consideration of another entirely different and yet important class of apparatus and processes.

II

Electric arcs and high-tension discharges through gases are capable of producing some chemical compositions and decompositions which are very useful and profitable to operate. This is a branch of electrochemistry which has not been as thoroughly studied as some others, its phenomena are not as thoroughly under control as electrolysis and electrothermal reactions, and its possibilities are not as thoroughly understood or utilized.

Ozone is being made from air by the silent discharge of high-tension electric current. The apparatus is so far simplified as to be made in small units suitable for household use, ready to attach to a low-tension alternating current supply. The uses for the ozone thus produced are particularly for purifying water and air. It makes very impure water perfectly safe to drink and purifies the air of assembly halls and sick rooms, acting as an antiseptic. According to all appearances, this electrochemical doubling up of oxygen into a more efficient oxidizing form is developing into a simple and highly efficient aid to healthy living.

Nitric acid is an expensive acid made from the natural alkaline nitrate salts, such as Chili saltpeter. These nitrates are the salvation of the agriculturist, for they furnish the ground with the necessary nitrogen which plants can assimilate. The Chili "nitrate kings" have gained many millions of dollars, even hundreds of millions, in thus supplying the world's demand for fertilizer. But electrochemistry has another solution to this problem, which is rapidly rendering every country which adopts it independent of the foreign fertilizer. The air we breathe contains uncombined nitrogen and oxygen gases, which, if combined and brought into contact with water, furnish the exact constituents of nitric acid. The way to do this has been laboriously worked out, and the electric arc is the agent which does it. Air is simply blown into the electric arc, where it for an instant partakes of the enormous temperature, and on leaving the arc is cooled as quickly as possible. In the arc the combination of nitrogen and oxygen is effected to a certain extent, and the mixture is cooled so suddenly that it does not find time to disunite. The nitrogen oxides thus obtained are drawn through water, and this solution of nitric acid is run upon soda to produce sodium nitrate or on lime to produce calcium nitrate, the latter called nitrolime or "Norwegian saltpeter." These salts entirely replace the South American natural salt.

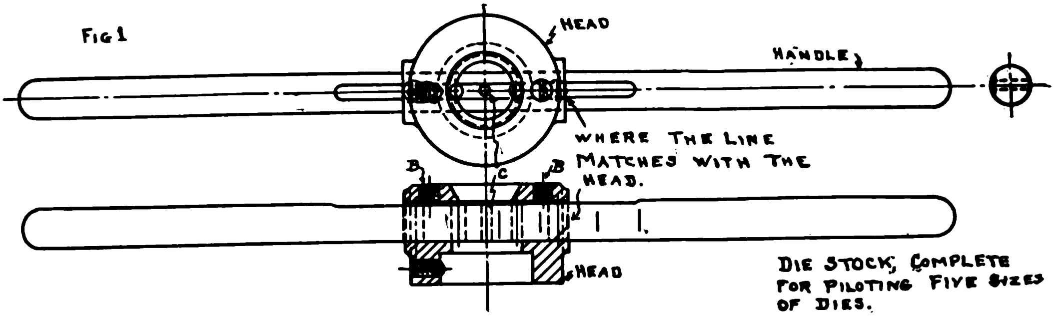
The materials used in this industry are air and lime, and to these is added electrical energy. Air is universal, lime cheap almost everywhere, and electrical energy is cheapest where water powers are most abundant. In Norway water power can be developed and electrical energy supplied from it at a total cost of $4.00 to $8.00 per horse-power year. Some other countries can do nearly as well. Under these conditions, almost every country can afford to make its own nitrates and so be independent of other countries for the fertilizer needed in peace and the gunpowder used in war. Norway felicitates itself already on being thus independent. Nearly 200,000 h.p. is being utilized there by a $15,000,000 syndicate, and the industry is spreading rapidly over Europe. The study of this problem, its solution, and the rapid development of this vigorous industry, is one of the most remarkable chapters in the history of recent industrial development. In this accomplishment electrochemistry has signally aided the agriculturist and demonstrably multiplied the food supply resources of all civilized and highly populated countries.

Boron is an element which has until recently defied the best efforts of chemists to isolate in a pure state. It is an element which may have important application in the manufacture of a high-class special steel—boron steel. Dr. Weintraub, one of our fellow members, has recently solved the problem of its production by an adaptation of the "oxygen-nitrogen" arc apparatus and utilizing the same principle of introducing the material into the arc and very rapidly cooling the products obtained. We mention this not because of its great commercial importance at present, but because it shows how the "arc method" may be of wide application in solving other difficult chemical problems. It has opened before us a new method in chemical science, and may give birth to many and various new chemical industries.

(*To be continued*)

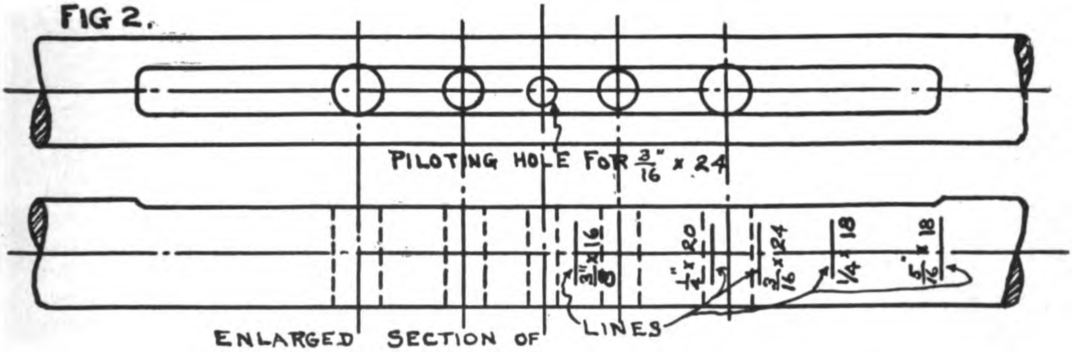
SOME SCREW-CUTTING TOOLS

FRANK H. MAYOH



Cutting screw threads with a die is a job which most all mechanics are familiar with, and have had more or less trouble getting a true thread.

Although there has been quite a number of die stocks designed to pilot and hold the die, the accompanying sketches show two styles of die stocks which I believe will be new to most readers.



ENLARGED SECTION OF HANDLE IN DIE STOCK, FIG 1

Fig. 1 shows what might be called a jobbers' complete die stock, as the handle has any number of holes desired, drilled through it to pilot the die while cutting various sizes of threads. Fig. 2 is a section of the handle used in this die stock and shows more clearly how it is used. For example, say, it is required to cut a 5/16 in. x 24 P.I. thread, the die is placed in position, and held in place by the screw *A*, next loosen screws *B*, Fig. 1, and slide the handle through the head until the line marked 5/16 in. x 24, Fig. 2, is in line with the end of the head, Fig. 1; now tighten the screws *B* and the die is ready for use. When using, the hole *C*, Fig. 1, is slipped over the piece to be threaded and acts as a pilot.

Fig. 3 shows a die stock designed for use in a lathe and carries a center hole for that purpose. When using, the die

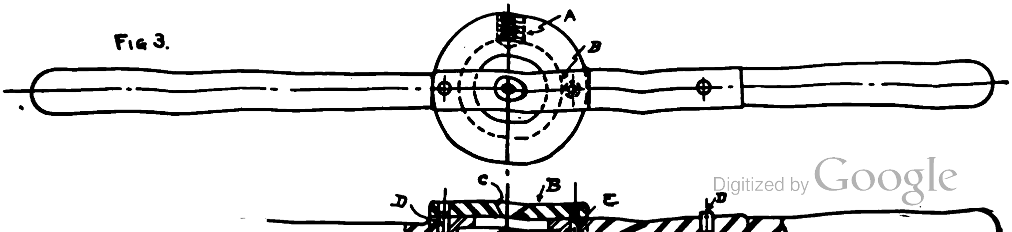
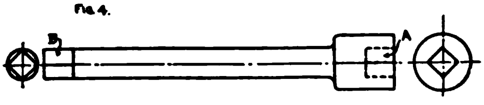


FIG. 4.



EXTENSION ROD FOR TAPPING

is held in place by the screw *A*, the loose piece *B* is in the position shown, the piece to be threaded is held by a chuck in the lathe, there is an ordinary 60-degree pointed center in the lathe tailstock, which has been used to support the work while turning; now instead of taking this tailstock center out and putting a pad in, the center hole *C* in the die stock is placed on the pointed center, which brings the die in line with the piece to be threaded, and the result is a true thread. If it is desired to thread a piece longer than the thickness of the die it can be done by swinging the loose piece *B* out of the way after the die has been started true and it will continue to cut a true thread. The two pins D are provided to keep this loose piece in the correct location, either when centralizing or when the piece has been swung out of the way, while the stud *E* is the pivot about which the loose piece swings.

Fig. 4 shows an extension rod for tapping holes in awkward places, where it is impracticable to use a tap wrench. The end *A* is slipped over the square head of the tap, and the tap wrench placed on the end *B*, and the hole is tapped as usual.

"VOLTITE" A SUCCESS

A particularly interesting invention is that of "Voltite" by Mr. Arthur T. Firth of New Zealand, which in brief is a method for the electro-plating of one metal on another by frictional precipitation. "The electro-plating of metals has grown rapidly to an industry of great importance," says Mr. Carl F. Woods, Secretary of Arthur D. Little, Inc., the well-known chemists and engineers of Boston, "but up to the present time there has been a great deal of economic waste, owing to the practical difficulties in the way of replacing the electro-deposited metal which is lost by the friction of constant use. A number of attempts have been made to solve this problem and several patents have been issued, but in most instances the coating possible of application to the metal by this process is so thin as to be of little value.

"A recent patent was issued for the deposition of nickel and other metals by friction which created considerable discussion in the electro-metallurgical world, but after a series of careful experiments it was found that the energy used in the process was so great in proportion to the results that the process possessed more theoretical than practical value.

"The process invented by Mr. Firth is electrolytic like other electroplating operations but very much simplified and it is claimed for the invention that anyone of ordinary intelligence can operate the process successfully. The compound itself, water and the slight friction used in applying it form a voltaic action, the metallic powder forming the anode, and the article on which it is to be deposited the cathode; hydrogen is developed which reduces the salt to a metallic state upon the article itself. The operation is applicable to gold, silver, nickel, copper, tin, and brass, and one of the most interesting applications is that of silver direct to steel. Perhaps the biggest field for its application lies in household use. The constant cleaning of silverware results in the removal of the deposited metal, whereas the use of 'Voltite' is claimed to increase the thickness of the metal instead of decreasing it and at the same time to preserve the desired appearance of the article."

Mechanical Drawing

(*Continued from page* 345)

in the use of instruments can trace another man's work, but the man with the ability to visualize and to put his ideas into such shape that they can be understood by the mechanic is the man who reaches the top of this profession.

(*Concluded*)

A TABLE WITHOUT JOINTS

In attempting to make furniture, even of a simple kind, many boys come to grief over the mortise and tenon, housing and other joints which have to be encountered if the article is going to stand the ordinary wear and tear of everyday use. Here, then, is an opportunity for making a useful table so designed that, while none of the joints mentioned are required, it will be neat, strong, lasting and serviceable.

The table is made of plain wood and is held together by means of small metal brackets, which can be purchased from any ironmonger.

The sizes shown in our sketch are as follows: The top is 22 x 17 x ½ in. The legs are 27½ in. long by 1 in. square (the total height of table thus being 28 in.). The legs are each set in 2½ in. from the edge of top, and thus the width over legs is 17 x 12 in. The shelf is 16½ x 11½ in. (½ in. less than width over legs), and from floor to upper face of shelf is 16 in.

These sizes may be varied as required. The table may be a little larger or a little smaller every way, but the proportion here suggested is good. In any case it would be unwise to make a much larger table on the present lines.

For the top, the best plan is to buy a ready-made drawing-board—a deal one

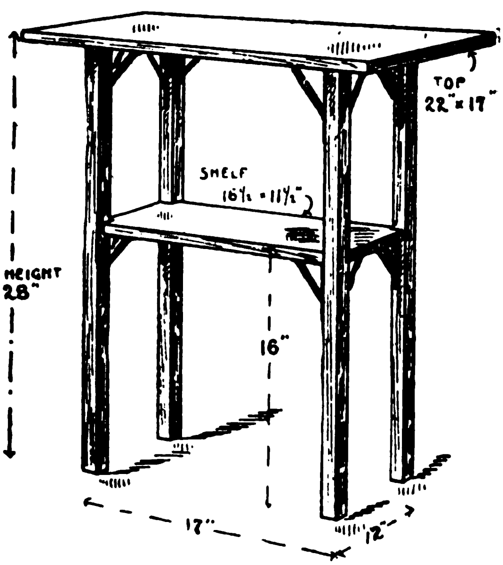
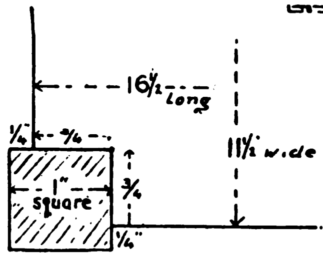


Fig. 1—The Finished Table



[Fig. 2—Corner of Shelf

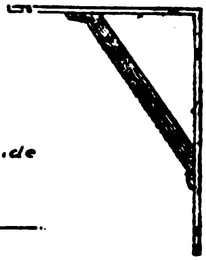


Fig. 3—Bracket

with clamped ends; 22 x 17 in. is a standard size. Pieces for the legs may also be bought, cut to 27½ in. long, and planed to finish 1 in. square. The shelf (½ in. thick) is cut at each corner, as in Fig. 2, in order to fit against the legs, the cut-away part being ¾ x ¾ in. It will thus be seen from Fig. 2 that the edges of shelf stand back ¼ in. from the face of legs.

Sixteen brackets, as illustrated at Fig. 3, are next required, two for each leg at the top and two for each at the shelf. Ordinary iron angle brackets must not be used; they are too ugly for such a table. The japanned-black stamped metal ones, as shown, should be asked for. A size approximately about 4 x 5 in. is suitable, and it will probably be found that each bracket is provided with five or six screw holes.

The positions of the brackets will easily be understood from Fig. 1. They are screwed to the two inner faces of each leg, special care being taken that the horizontal edges of each set of eight brackets are flush. If the shelf is ½ in. thick, the top edges of the lower eight brackets should be 15½ in. from foot of leg. These lower brackets, too, should be placed rather towards the inner corner of the leg, this because of the shelf being set in ¼ in., as shown at Fig. 2. Of course it is well not to fix all screws tightly until the top and shelf are placed in position.

The legs, with their brackets, are then placed in position in relation to top and shelf, and the latter screwed on. For the legs, ¾ in. screws may be used, but for the top or shelf only ⅝ in. ones are necessary. When it is seen that everything is square and true, all screws may be driven in tightly. Should the table not stand steadily at first, it is easy to saw a shaving off the end of the faulty leg.

If the table is to be used for a lady's work the top will look best if covered with some dark green cloth material. If this is done the reader should first take the extra precaution to drive four 1½ in. screws through the top into the legs, taking care that the screw heads are filed off flush. The cloth is then stretched over the top, carefully brought over the edges, and tacked down underneath. If the shelf is to be similarly covered, this should be done before it is fixed on.

If the legs are stained, say walnut, and afterwards varnished, the table is one that can be used in any room. It is perhaps well to add that the writer is not merely describing an idea which has occurred to him. He has made several tables of the sort and has found them not only simple to construct, but of very great service.—*Handicrafts for Boys.*

Building a City to Order

"Not the least interesting thing in our trip down the Fraser," says Frederick Foster, writing in February *Canada Monthly*, "is the way some of the new British Columbia towns are being constructed ready for a population that hasn't yet arrived, and steel that is still some dozens of miles to the eastward. As Ed. and I canoed down the Fraser we saw one of these new towns in the making; with transit, chain and level, a score of engineers were laying out the town of Willow River with scientific precision.

"The novelty of seeing a 'town being made to order' appealed so strongly that I sought the Chief Engineer.

"'You are standing on the corner of the two principal streets of the future town,' he told me. 'The stake on which you just knocked the ashes from your pipe marks a lot which will be worth several thousand dollars a year or so from now.'

"Then with a blue-print spread before us he launched into the subject.

"'Here, at the crossing of these two streets, is where we are standing,' he explained. 'Four blocks down this way,' tracing the blue-print with his finger, 'will be the railway station and yards. This portion we are now surveying is the business portion only. When our work is finished, the plans must be registered at the government office, then the town is thrown open to settlement, or a better word is occupancy. For town building in Western Canada is much like skyscraper building in New York—everything made ready for the tenants to move in. As it is the wish of the railway company to make this one of the leading towns of Central British Columbia, the completion of our work is being looked forward to by merchants, manufacturers, home-builders and investors, who are anxious to get in at the beginning.'

"'Then you think that some day here will stand a city?' I asked.

"'Yes, there are many reasons why a city should rise here. There are seven billion feet of timber in the immediate vicinity waiting to be manufactured into lumber. The Willow River is an ideal logging stream and the boats on the Fraser can distribute the lumber manufactured here throughout central British Columbia, while the railway will carry it to the prairies. One of the largest coal deposits in the world lies a short way southeast; the Peace River country of the unlimited agricultural opportunities spreads to the north, and here at our door is an unlimited water power supply. So there you have it—manufacturing, mining, agricultural—a combination which puts cities on the map.'"—*Industrial Advocate.*

Time Signals from the Arlington, Va., Station

Since the tests of the Arlington, Va., station have been completed, that station is sending out the time signals twice each day. The signals are sent on a 2,500 meter wave, and are sent at noon and 10 p.m. Following the evening signal is sent a report of derelicts and other information useful for navigation. In addition to this the baseball scores are sent. These time signals are sent Sundays and holidays. This latter fact is very important, because until this time the coast naval stations have not sent the time on such days. As this station can be heard over the entire Atlantic coast and for a long distance at sea, it is proving very useful to navigation.

QUESTIONS AND ANSWERS

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

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

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

2015. **Transformer.** L. L. W., Toronto, Canada, asks: (1) Will you please tell me through *Electrician and Mechanic* the design of a transformer to operate on a 110 volt, 25 cycle supply and in the secondary to give 2, 4, 6, 8, 10 volts? (2) The amount of wire in pounds for same? (3) Is an iron core as good as anything else? Ans.—(1 and 2) Your request makes no mention of the size of transformer desired, so we cannot propose any explicit dimensions. We have published several articles on the construction of such for use on 60-cycle circuits; and the same general directions will hold for 25 cycles, except that you need about 25 per cent. greater section of the iron and 25 per cent. more turns of wire. After you have found out how many turns are required for the main winding that receives the 110 volts, you can easily determine how many turns are required for the other voltages for they will be directly proportional. This estimate, however, does not allow for voltage lost in the resistance of the coils, and you would need to admit perhaps 10 per cent. leeway. (3) Transformers for all purposes, except for certain wireless telegraph or kindred applications, require an iron core, and this should be well laminated as well as free from bolts and rivets.

2016. **Induction Coil.** Mr. W. F. M., Rochester, N.Y., asks: I have on hand ten coils of 35 s.c.c. wire of the following dimensions; Width 5-16 in., diameter of hole in center 1¾ in., wound to 2400 turns. I can obtain as many as twenty if necessary to make a good coil. I would like to wind a primary and make a core for same, so that it may be used on either 110 volts a.c. or 110 volts of batteries. (1) Could you please give me an idea of what the primary and core should be, also, the insulation for same? (2) What would be the spark length of this coil with 110 volts a.c.? This coil is to be used for X-Ray and wireless purposes. (3) What size condenser must I use across the interrupter? Ans.—It is quite problematical to state what the construction or output of the coil should be. So much depends upon the details of workmanship and materials that with the same weights of wire two constructors bundle of fine iron wires about 1 in. in diameter in a fiber tube 1-16 in. thick. Over this wind two layers of No. 16 wire, then slip on a hard rubber or glass tube to fill the space between primary and secondary. Such a winding will be adapted for 10 to 12 volts direct current, and secondary may produce sparks 3 in. to 6 in. in length. Across interrupter contacts a condenser should be connected consisting of 100 sheets of tin-foil about 7 x 9 in. in size. If you desire to use the 110-volt supply, you will require finer primary wire, but the only sure method will be to try several different windings.

2017. **Selenium.** W. F. G., of San Francisco, Cal., asks: I would like to get information on selenium. (1) Are there any manufacturers of selenium in the United States? (2) Please give names and addresses also (3) where can I buy selenium in wire or ribbon, and are their any books on the above subject; please give names and publishers. Ans.—(1) Selenium is very brittle, and usually is sold in the form of pencils, of about the size of caustic soda sticks. (2) You can get it from Eimer & Amend, 205–211 Third Ave., New York, N.Y.

2018. **Potentiometer Trouble.** J. W. H. M., Coatesville, Pa., asks: I have not been successful in using a potentiometer with my detectors. I use perikon. When attempting to use potentiometer I cannot hear anything. It is wound non-inductively and has about 400 ohms resistance. I use a small flashlight cell. Can you give me connections that will work with the phones in series with detector. Phones are 2,000 ohms. Ans.—You are certainly using a very poor connection. Remove the phones from where they are now and place them in series with the variable slider on the potentiometer and the detector. Entirely remove the variable condenser you now have across the phones and go directly back to the tuner. You already have one stoppage condenser, which is quite sufficient.

2019. **Armature Winding.** B. B. B., Racine, Wis., says: Could you tell me where I can get information on how to figure the size and amount of wire to be used in winding an armature? I would be very useful. Ans.—The comparison for direct-current cases is not difficult, for the number of turns of wire must be directly proportional to the voltage. For instance, if you had a 110-volt motor and desired to rewind it or a similar one for 220 volts, all you would have to do is to use the same weight of wire of half the cross section, *i.e.*, three numbers finer in the wire gauge, thereby getting on twice as many turns. Obviously the winding will be good for only half as much current. For the alternating-current case, the additional factors of self-induction and frequency come in, and no such simple rules can be given. If you have a 133-cycle 50-volt fan motor, and desire one for operation on a 110-volt 60-cycle circuit, you had better purchase a new one, for the old one cannot be fitted to operate at all economically. If only a matter of voltage is concerned, you can effect the change by putting about 25 per cent. to 40 per cent. more turns on the higher voltage machine. You ought also to increase the quantity of iron, but of course this cannot be done in the case of a motor already constructed. We do not know any book that will be so helpful for such small motors as these few simple directions coupled with your own experience. Of course in any specific case we may be able to offer more helpful suggestions.

2020. **Nib of a Saw.** L. X. S., Reno, Nev., asks: On the back of an ordinary carpenter's saw, about 3 or 4 in. from the end farthest from the handle is a kind of little knob. (1) Is it an ornament or not? (2) If it has a special use what is it? Ans.—If you talk with workmen you will get various ingenious explanations of the function of this feature, but the following extract from Henry Disston & Sons catalog seems entirely definite: "The 'nib' near the end of a hand saw has no practical use whatever; it merely serves to break the straight line of the back of blade, and is an ornamentation only."

2021. **Electrical Education.** J. E. T., Plessisville, P.Q., Can., asks if we have any books that will be helpful to him in becoming an electrical operator. An electrical sub-station is being equipped in his village, to which energy at 10,000 volts will be delivered by a power company. From this the current is to be distributed at about 110 volts pressure. He thinks there may be some chance for employment in caring for the apparatus. Ans.—You may be assured that the proper care of such electrical apparatus requires skilled attention, and the person entrusted with it will have had considerable training at the works of the manufacturing company. If the equipment was made in Canada, most likely it was from the works

direct current 110 volt. I want considerable force to stroke and rapidity coupled with extended use and small space occupied 6 in. or 8 in. Plunger or vibrating hammer, according to which is more powerful in striking. Ans.—Possibly Underhill's book on the Electromagnet will be helpful, but you must recognize the insulation-puncturing power of the counter electromotive force of self-induction exhibited at every break of the circuit. "Discharge" resistances, or their substitute, must be provided.

2023. **Education as Draughtsman.** E. C. S., Chicago, Ill., asks: What are the salaries which an auto repairer or overhauler receives? I am going to graduate from a technical high school in June and there have had some mechanical drawing. How long does it take to start at the bottom and work your way up to be a draughtsman? What is the average pay of a common draughtsman? Have also had machine and electric shop practice. Which trade has the most opportunities? Ans.—Quite a number of manufacturing concerns have courses definitely arranged for training young men for various engineering or administrative positions. A high school graduate should be able to take a course that will bring him a compensation of from 10 to 20 cents per hour, and at the end of three years land him in the drafting room. We would advise you to write to several of the automobile manufacturers in your vicinity or in Detroit, enquiring what opportunities they could offer.

2024. **Storage Battery.** W. W. B., of San Francisco, Cal., asks: Please tell me how I can charge the storage battery you mention on page 189 of the March number by James P. Lewis. Is there any way I can charge it from a 110 volt direct current circuit? Ans.—As the little battery has a capacity of only about ½ ampere, you can readily charge it by inserting it in the cord circuit of some regular incandescent lamp. The lamp will burn to less than full candle-power, but if the lamp is one ordinarily used in some corridor, its diminution in light will not be of much consequence. You will thereby get the charging for practically nothing. Be sure always to connect the same terminals, else you will reverse the polarity of cell, which ordinarily means loss and possibly ruin.

2025. **Photophone.** H. C. B., Grantsburg, Wis., asks: I desire to make for experimental purposes a working model of Bell's Photophone, in which he used transmitter, mirrors, selenium cell and lens for transmitting speech by beam of light tion as to some later description you will be successful. We do not find advertisements of the parts in any of the scientific catalogs at our disposal.

2026. **Dry Cells.** J. F., of Paterson, N.J., asks: (1) What is the exciting paste in the Columbia dry cell? Please tell the proportions. (2) How can calcium chromate be made? (3) Is there any book on up-to-date makes of dry cells, and where can it be obtained? Ans.—Different manufacturers have different formulas, but these ingredients and proportions are not all the factors concerned in the operation of a successful battery. The method of assembling is of great importance. The preparation for a standard make of cells is: Oxide of zinc, by weight, 1 part; sal ammoniac, 1 part; plaster of Paris, 3 parts; chloride of zinc, 1 part; water, 2 parts. (2) Calcium chromate can be made by dissolving commercial chromium trioxide (chromic acid) *cautiously* in water and neutralizing with precipitated chalk or slaked lime. This will give an impure substance which would do for technical work, but if the pure salt is wanted it could be bought quite cheaply. (3) We can furnish you with a book on the subject by Norman H. Schneider for 25 cents.

2027. **Rectifiers—Transformers—Arc Lamps.** A. F. D., Whitman, Mass., asks: (1) Will you kindly explain to me the theory of the mercury arc rectifier. (2) The difference between a core type and shell type transformer. (3) Why is it that although they are all in series, that street lights, when broken or unscrewed from the base, do not break the circuit and put out the other lights? Ans.—(1) The complete theory is rather abstruse, and perhaps you are not asking for more than a popular description. Whatever be the theory, the mercury vapor possesses the peculiar property of permitting current to flow through it in one direction only. In other words, the vapor acts like a check-valve, permitting passage in one direction and not in the other. At one instant an impulse drives current in at one upper terminal and out of the bottom one, where the pool of liquid mercury is located. At the next instant the current being in the opposite direction, comes in at the other terminal, and also passes out at the bottom. The action is as if the pool were bombarded with current first from one electrode then the other. In order to tide over the instant when there is current passing in neither direction, there is a "sustaining" coil inserted in the direct-current circuit. In this circuit, the current is not entirely uniform, but is noticeably pulsating. (2) In the core type, illustrated by the familiar appearance of an electromagnet, the wire is mostly on the outside, and when you look at such a one, you see mostly wire. In this construction, the magnetic circuit is rather long, and subject to a certain amount of magnetic leakage, but the wire being on the exterior, has a good chance to keep cool. In the shell type, the wire is largely buried in the mass of sheet iron, and while giving much better magnetic conditions, shields the iron from the desired circulating air currents. The latest types of transformers gotten out by several of the manufacturing companies are attempts to utilize the good qualities of both constructions, the style made by the General Electric Company being denoted as the "Improved Type H." (3) Back of the ordinary screw portion of the lamp socket is another socket of the "pull" sort, between the two prongs of which is ordinarily an insulating bit of thin paper. When rupture of the circuit takes place, due to the breaking of a lamp filament, the sudden rise of voltage punctures this film and permits the prongs to come together. The act of withdrawing the whole socket permits the two strips with which the prongs make contact to come together, so the circuit is even then not broken. A new lamp is screwed into the socket, a fresh bit of paper placed between the prongs, and the new lamp readily and safely inserted in the circuit.

2028. **Magneto.** E. H. A., Sulphur Springs, Tex., says, or writes: I have a four-magnet, telephone-ringing magneto, practically new. (1) How should I wind a transformer to give from 50 to 75 volts from this little machine? (2) Should a three-prong armature motor, to be run on dry cells, have a three- or six-section commutator? (3) What effect does the size of the wire on field and armature windings of a small battery motor have? Ans.—(1) Such a machine when driven at an ordinary speed by means of the hand crank regularly gives about 75 volts, so you do not need to introduce a transformer. Please recognize that these machines are not adapted for continuous working, for the bearings are altogether too inadequate to give acceptable results for other applications. Then, too, the armature core is not always laminated, hence continuous use would result in considerable heat. (2) Three segments are all that this sort of winding permits. (3) The finer the wire, the slower the motor will rotate when operated at a certain voltage, or for the same speed, the higher voltage will the motor withstand. Of course, you will recognize that the finer the wire the smaller will be the permissible current, so for securing a given amount of work with a certain definite current, the voltage must be made sufficiently high.

2029. **Generator Winding.** H. D. P., of Watson, Ind., asks: I have a generator of the following dimensions which I wish to wind compound to give 7 volts. (1) What size and how much wire must be used? (2) Must it be double cotton-covered? (3) How many amperes will it give? Two poles 1¾ in. x 2¼ in., length 1 in., may be wound to a depth of ¾ in. Armature smooth-faced drum type 2¼ in. long, 1¾ in. diameter; commutator 11 segments. Ans.—In the absence of a sketch that would give sufficient dimensions for basing a calculation, we can only give a rough guess. Let armature have two layers of No. 20 wire—one layer for each half-winding. This even total number permits easily placed coils. If, however, you are familiar with such work, you may with good advantage place on three layers, but the odd number requires some skill. For the series portion of field winding, use one layer on each core of No. 16 wire, and fill the remainder of the space with No. 23.

2030. **Electromagnet.** E. E., Oakland, Cal., asks: Can you tell me how to make a magnet to operate a brake something like the sort used on the Otis elevator, to pull only one way, and about a 6 in. to work on 220 volts direct current. Ans.—Before we could propose anything definite we would require more explicit specifications. Perhaps you will find Underhill's book on the "Electromagnet" of considerable value.

2031. **Motor Winding.** E. M., Cincinnati, O., asks for information as to correct sizes of wire for winding motor for operating a model electric car that fits a 7 in. gauge track. Field magnet is of cast iron, in one piece, one coil only being used. Armature core is laminated, 2 in. in diameter and 2 in. long, with 12 round holes, each 9-32 in. in diameter. Speeds between 1,200 and 2,000 revolutions per minute are desired, and the winding should be adapted for about 3.5 amperes at a pressure of 25 to 30 volts. Ans.—Explicit dimensions for the field magnet were not supplied, and in the design of a dynamo most of the calculations are based on that part of the machine. In consequence of the railway application, you should adopt a series winding, and the armature can have No. 21 wire and the field No. 18—all you can get on. Your suggestion that you prefer a wave winding is rather inappropriate, for this designation refers to windings for multipolar field magnets. In case of a two-pole field magnet you have no choice, and the winding is just as much "lap" as it is "wave."

2032. **Induction Motor.** W. D. S., Waterloo, Ia., asks: Enclosed you will find 15 cents for which please send me your March, 1913, back number, as I am very anxious to get Part I on "Induction Motors," as I consider it is the best treatise on that subject I have seen in some time. There is one part I wish you would explain in a letter to me, and that is the working of the ring on a single split phase-motor. The ring is attached to the rotor, opening and closing the aux. circuit. I do not know what ails mine; it will not start alone. I also have a flaming arc (no name on it), but made in Germany, which persists in feeding the carbon clear to the end and will not burn. Can you explain that to me, too? Ans.—From your description of the motor we should judge it was one of the Westinghouse Company's make, following the "Heyland" principle. If there is a name plate on it you will surely learn the identity of the maker, and then can do no better than to write to headquarters for information. If you have access to *Electrical World* for several years back, you should be able to locate the particular make of arc lamp from comparison with the various illustrations. If you succeed in this, it is a simple matter to write to the New York representative.

2033. **Connections for a Radio Station.** G. A. S., Laurium, Mich., asks: I would like to know (1) the best way to connect a wireless set, both transmitting and receiving. I have an electrolytic detector; fixed condenser; one 1,000 ohm Murdock receiver, and a 3-slide tuner. The transmitting set is composed of a spark gap; a 1 in. spark coil and vibrator; a helix, two pint Leyden jars; dry batteries 8 (or more if needed): a telegraph key. Aerial about 35 ft. high and 65 ft. long (4 wire), seven-strand No. 21 copper [illegible] a D.P.D.T. switch. (2) How far [illegible]

side of the switch connect end and one slider of the tuning coil. Connect one of the other sliders to one side of the condenser, and from the other side of the condenser go to the detector, and from the detector go to the remaining slider on the coil. The phones go directly across the condenser. On the other side of the switch connect the bottom of the helix and one clip going to a point near the top of the helix. Put the Leyden jars in parallel and directly across the spark coil. Also from one side of the Leyden jars go to the spark gap and from the other side of the spark gap connect to a clip on the helix. Connect the other side of the Leyden jars to the third clip on the helix. (2) We can positively give you no authentic data on the subject. (3) The total capacity is equal to the sum of the separate capacities of the jars.

2034. **Wavemeter Inductance.** F. W. L., New York City, asks: I am constructing a wavemeter and wish to know the inductance in centimeters of the following coil to be used in conjunction with a Blitzen variable condenser; ten turns of No. 18 d.c.c. annunciator wire, wound on coil 6 in diameter. I have tried to figure it out according to the formula, but was unable to do so. Please advise as soon as possible the charges of this calculation and the desired payment will be sent. Ans.—You have not given us enough data to calculate the inductance of your coil. We have assumed that it has been wound in the form of a single layer solenoid. In that case the inductance would be 28,000 centimeters. Since you are to use this with a wavemeter, you should have your wavemeter calibrated or your inductance measured. The Bureau of Standards will measure your inductance for a small sum. If you are near an electrical laboratory, one of the assistants would probably measure it for you for a small charge.

2035. **Spark Coil.** F. H. R., Cleveland, O., asks: (1) Are the data for a ½ in. spark coil in Volume 23, page 213 of the *Electrician and Mechanic* correct? I have started to make a 1 in. coil and it is much smaller than the one detailed above. (2) Will you please give me the formula for resilvering mirrors? Ans.—The construction of spark coils is a very uncertain thing, and what one maker considers good another might completely reject. The data you refer to appear to be nearer a 2 in. coil rather than a ½ in. Perhaps a mistake was made in reading or setting up the title. If you have the data for a certain size of coil and have reason to believe that the data are correct do not be disturbed because another person gives different data for the same thing. (2) Unless you have a laboratory where you can work, it is very hard to do good work in silvering mirrors. You will find that the "reduction," which is the so-called cold process, to be the most convenient. In volume XVI of the Encyclopedia Britannica you will find a complete description of this process. There are several other processes given there also, but you will find the one suggested to give the best results in the hands of an amateur. Do not neglect to remove all [illegible]

If a condenser is used please tell number of sheets of tin-foil, etc. (2) Please describe a Tesla coil to use with above transformer, and what would voltage be of the Tesla coil? (3) Would a shock from the Tesla coil endanger the receiver's life? Ans.—(1) Connect two 2 m.f. telephone condensers in series directly across the line supplying your transformer. Ground the middle point of this pair of condensers and place a small spark gap across the terminals of each. These spark gaps should be set at 1/16 in. It would be far cheaper to buy the condensers than to make them. Such condensers if kept small, such as telephone condensers, would contain about 1,000 sheets of tin-foil each. These condensers can be purchased for about $1.50 each. The makers of your Blitzen transformer will furnish you with a complete protective device including line fuses for $5.00. (2) See article in the May, 1913, *Electrician and Mechanic*. (3) No.

2037. **Storage Batteries.** C. V. E., Divernon, Ill., says: I have a storage battery of 16 cells, 4 negative plates, 3 positive plates per cell, 120 ampere-hours capacity. The negative plates are Faure process, and the positive plates are Planté process. This battery was in use about 18 months, and plates were taken out of acid partly charged and boxed up after being washed. After being idle for eight months the battery was reassembled. The negative plates had sulphated badly in spots, and some of the positive plates had a sprinkling of sulphate, while some appeared all right. I have kept specific gravity down to 1.210 by drawing off acid and adding distilled water. I have been working this battery for about three months and have attempted to remove sulphate by giving repeated overcharges and keeping specific gravity down, but have only partly succeeded. I am not able to get over 40 ampere-hours out of battery. The active material in the negative plates seems too hard. How can I remove this sulphate and increase capacity? Ans.—It is commonly accepted that plates that are badly sulphated, especially if the sulphate is between the paste and the grid, are ruined, and that the cost of removing is more than that for new plates. Of the two methods ordinarily adopted for trying to remove the sulphate, you have evidently given one a thorough trial but without success. The other consists in temporarily reversing the battery. When discharged to a low degree, run out what little charge remains, and immediately begin charging in the reverse direction, whereby the negatives will be somewhat changed into positives, and as peroxide of lead is porous, this condition will be introduced into the "petrified" negatives. Use only a slow charging rate, else the outer plates will buckle. Even if they are somewhat distorted by the process, you can easily straighten them by pressing them between boards. A third method which has been recommended, but not yet demonstrated by us, is to remove the entire sets of plates from the acid solution, wash them and then assemble them in a weak solution of caustic soda, say of about 5 per cent. strength. Charge them at a slow rate. When the whiteness has disappeared, remove plates from the caustic solution, wash thoroughly, and transfer to the regular electrolyte. Perhaps you might try the process on a sample cell. If you do, please let us know the results.

2038. **Motor Winding.** O. W., Hartland, Me., sends a sketch showing a 7-prong rotor for a 4-pole motor, and asks for data for the winding. The rotor is 4¼ in. in diameter, and 1 in. long, axially; 15 volts are desired. Ans.—This is the most unusual design we ever saw, and we confess ignorance as how to proceed with it. Perhaps you have made some error in the sketch or the designer was not acquainted with the essentials of dynamo design. You did not state whether the rotor was laminated or if it was of solid iron. In case the latter supposition is true, there is no doubt that the structure is some crudity that can well be thrown into the scrap heap. Our magazine has regularly supplied designs for making dynamos of high order and economical working, and you do not need to content yourself with anything poorer.

2039. **Length of Sidereal Year.** F. F., Brooklyn, N.Y., desires to know the exact time required for the earth to make a complete revolution around the sun, and also desires to know the exact position of the earth in relation to the sun and the fixed stars as viewed from a point above the North Pole. Ans.—The length of the year varies slightly in accordance with the fixed point which is taken as reference. The tropical year, *i.e.*, from equinox to equinox, is 365.2421988 days. The sidereal year, or the absolute revolution, is 365.2563604 days. The anomalistic year, from perihelion to perihelion, is 365.2596413 days. It is probable that the second value is the one which you would desire for your calculations, and you can probably make these more easily with the length of the year expressed as a decimal fraction than if it were reduced to hours, minutes and seconds. In regard to the position of the earth in relation to the sun—the diagram you have sent does not show the actual state of facts, because the earth's axis is not perpendicular to its path around the sun, but inclined to it at an angle which is diminished annually by about ½ second of arc. The exact expression for the obliquity of the ecliptic is 23 degrees, 27 minutes, 8.26 seconds — 0.4684 seconds (t — 1900). In this expression "t" represents the date expressed in years and decimal fractions. For instance, April 1, 1913 would be approximately 1913.25, though three months is not exactly a quarter of a year. This obliquity of the ecliptic is what causes our seasons, and the North Pole of the earth is nearest to the sun at the summer solstice, which in 1913 is June 21st at 8.01 p.m., Washington mean time. So far as the position of the earth in regard to the fixed stars is concerned, the solar system occupies a position which may roughly be regarded as the center of an infinite number of stars fairly regularly distributed in every direction. The sun and its accompanying planets are moving rapidly through space in a direction of which you may find information in any standard text-book of astronomy.

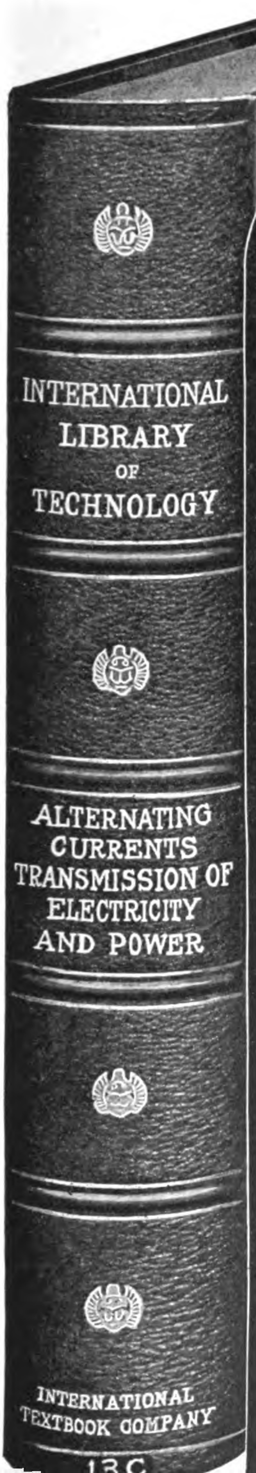
2040. **Voltmeter.** A. F., Union Hill, N.J., says: (1) Will you kindly tell me how much resistance a d'Arsonval type voltmeter switchboard size requires outside instrument to give a reading up to 125 volts? (2) What size wire to use and should winding be non-inductive? (3) What kind of metal and what size to use for the shunt in ammeter, same type, center zero, to give a scale reading to 30 amperes each way.

Ans.—(1) We cannot give you any information without knowing more about the meter. The resistance of the meter and the volts necessary for full scale deflection must be known. If you have an instrument that you want to calibrate for a definite voltage, the best way to do is to try it out experimentally. For direct currents it is not necessary, but preferable, to have the winding non-inductive. (2) The wire would be about No. 34 copper. (3) The same applies to the ammeter; we must know the resistance of the instrument. The shunt should be of a metal that has a small change of resistance with temperature changes. There are various metals on the market for such purposes. If you have a standard instrument you can probably obtain the information you desire by writing to the makers. Be sure to send them the number of the instrument.

2041. **Electromagnet.** W. G., Klondyke, Can., asks: How can I construct an electromagnet to lift (for about a minute) 100 lbs. What weight of iron and what size and weight of copper wire are necessary? I can use 110 volts from the mains or any number of bichromate cells of large size which may be required. Can A.C. be used? Ans.—The problem cannot be solved without further specifications. The shape of the thing to be lifted must be stated, and also the space, if any, between the magnet and the other part. That is, what is the length of the air-gap? 100 lbs. is not a large amount for a magnet to "hold," but to start a weight when actual separation exists is quite another matter. Perhaps you will find helpful ideas and data in Underhill's book entitled "The Electromagnet."

2042. **Kick-backs.** E. H. S., Columbus, O., asks: I would be pleased to know if there are any on the market or whether it is possible to make a kick-back preventer that is absolutely reliable every time. What causes a kick-back? The power company claims that changing length of service wires on their system would cause it. Please give information if possible that will be satisfactory to the power company, as the success of the Club depends on putting in a transmitting outfit. Ans.—The Clapp-Eastham Co., Cambridge, Mass., supply a very effective protective device for kick-backs at a cost of $5.00. Since the success of your club depends on such a device we would advise you to write to them at once. It is possible that changing the length of the service wires would cause or prevent breakdowns, as such surges caused by the induced potentials are dependent on the length of the line.

2043. **Motor Construction.** G. E. M., Detroit, Mich., asks: I have built a motor as described in your September, 1911, issue. It has not the speed I think it should have. It also has very small power. I have carried out directions in every detail, but have designed a case for it. I have connected the windings in groups of six coils and reversed the current in alternate utterly discouraged with the outcome of my work. The mechanical part is all right, but the wiring or coils is absolutely rotten. Why, that motor hasn't as much power as a 1/8 h.p., let alone 1/2 h.p., as was stated in article. I am building this motor at Central High School, and intended using it to run a lathe we are making, but it would not run a sewing machine as it is. The starting coil described to go with it does not start it any better than you can by hand. It will not start it from a stand-still. I would like to hear from you as soon as possible so I can repair it before school closes this June. I would like a diagram of connections for these coils or a diagram of a new set giving number of turns and placement of coils to produce about 1,800 revolutions per minute. I also would like a drawing and description of a good starting coil or device. Ans.—Several of our readers have become confused in the construction of this motor, and we confess the diagrams were by no means clear. We advise you to rewind it, using "concentric" rather than "formed" coils. Such follow the famous "Heyland" motor, and if you can find some description of it you will be helped. As for a diagram you can most advantageously make it yourself. Number the slots consecutively from 1 to 24. Draw a coil occupying slots 1 and 6, but passing just outside of the intervening slots. Make a similar one between slots 7 and 12; also 13 and 18; finally 19 and 24. Then use No. 18 d.c.c. wire, pieces of curved 1/2 in. board being clamped over the intervening slots so as to prevent the wires from interfering with them. Wind the coils all alike, getting in as many turns as possible, and after winding them, bind cotton, not rubber, tape around them. Now wind a coil of the same size of wire in slots 3 and 4, and without cutting the wire continue it into slots 2 and 5. Wind similar coils in slots 9 and 10; 8 and 11. Similarly wind 15–16 and 14–17; finally, 21–22 and 20–23. Tape these groups. The four single coils first wound are the "starting," the rest the "running." Now in the former, connect the inner ends of coils 1 and 2, then the outer ends of coils 2 and 3, then inner ends of coils 3 and 4, finally leaving outer ends of 1 and 4 to be led to the binding-posts. Similarly, with the running coils, connect inner ends of groups 1 and 2, then outer ends of 2 and 3, inner of 3 and 4, with outer of 1 and 4 led to other binding-posts. Proof of the proper sequence of poles can be made with a direct current, and if this test is correct, the motor should run when using either winding alone, a start being, however, needed by hand, and only about half as much voltage used upon the starting winding as upon the running. After you have demonstrated this, you can put an extra inductance in the running winding, thereby increasing its already considerable lag in current, and putting ohmic resistance in the starting winding, thereby reducing its already less lag, whereby sufficient difference of phases may be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BOOK REVIEWS

Examples in Applied Electricity. By C. G. Lamb, M.A., B.Sc., A.M.I.E.E. Cambridge, at the University Press, 1912. New York, G. P. Putnam's Sons. Price, 70 cents net.

This is an excellent collection of problems in the mathematics of electricity taken from examination papers set to students in Cambridge University, in electrical and mechanical sciences. They are arranged in the form of thirty examination papers, each of eight questions, arranged in order of gradually increasing difficulty. Both electrical students and teachers will find this collection of problems of great value in practical study.

Practical Geometry and Graphics. A text-book for students in technical and trade schools, evening classes, and for engineers, artisans, draughtsmen, architects, builders, surveyors, etc. By Edw. L. Bates and Frederick Charlesworth. Contains a large number of practical exercises and answers, and about 600 illustrations. New York, 1912, D. Van Nostrand Co. Price, $2.00 net.

This book covers in a simple and practical manner the essentials of practical geometry and graphic, and is especially strong in its application of the principles of these mathematical sciences to the solution of problems often met in practical work. The book covers material which is intended for a two or three years' course of instruction, according to the capacity of the student; and the treatment is such that the pupil who is away from his teacher will be able by himself to get full benefit from the book. The instruction on plane geometry includes a good deal of mensuration and calculations relating to this extremely practical application of this science, and other chapters of practical treatment, especially on conic sections, much in excess of what is usually found in books on practical geometry. The chapters on graphics and descriptive geometry are also of the most practical nature; and while they go to the bottom of the pure mathematics, yet the applications are carefully worked out, and very complete.

American Telegraph Practice. A complete technical course in modern telegraphy, including simultaneous telegraphy and telephony. By Donald McNicol. New York, 1913, McGraw-Hill Book Co. Price, $4.00 net.

This beautifully printed volume of over 500 pages is a complete text-book to the modern practice of telegraphy in the United States, including all its applications and ramifications. There is no portion of the technical part of the subject which is not thoroughly covered in the most modern method, and a great deal of impr—

Steel. Its selection, annealing, hardening and tempering. This work was formerly known as "The American Steel Worker." It is the standard work on hardening, tempering and annealing steel of all kinds, being comprehensive and giving specific instructions as well as illustrations of the methods of hardening a large number of tools. All kinds of annealing muffle furnaces, blast ovens, open flames and the use of the lead and cyanide baths are fully described. Case hardening and pack hardening are treated in a comprehensive manner. A practical book for the machinist, tool maker, blacksmith, tool hardener or superintendent. By E. R. Markham. 4th edition. Fully illustrated. New York, 1913, The Norman W. Henley Publishing Co. Price, $2.50.

This new edition of a well-known book has been thoroughly revised, especially to cover the treatment of the various alloyed steels so much used at the present time in the manufacture of automobiles, gas engines and other modern apparatus. While many of the methods of handling these alloyed steels are held secret by the manufacturers, enough has been discovered about them to enable a valuable and thorough treatment of the subject in this book.

Practical Handbook of Gas, Oil and Steam Engines. Stationary, Marine, Traction Gas Burners, Oil Burners, etc. Farm, Traction, Automobile, Locomotive. A simple, practical and comprehensive book on the construction, operation and repair of all kinds of engines. Dealing with the various parts in detail, and the various types of engines, and also the use of different kinds of fuel. By John B. Rathbun. Chicago, 1913, Charles C. Thompson Co. Price: leather, $1.50; cloth, $1.00.

This very excellent and well-printed treatise fully lives up to the description contained on the title page, and is a complete and thorough handbook to the use of all kinds of engines in use at the present day.

NOTE

Mr. L. T. Hill, of Brookline, Mass., was the first amateur arrested under the "New Wireless Laws" in the New England District.

Radio Inspector H. C. Gawler filed a complaint with Commissioner Hayes, Department of Justice, Boston, Mass., wherein he stated Mr. Hill was operating an unlicensed radio station, and further complained Mr. Hill was not licensed as an operator of any radio station. Mr. Hill was requested to call at the Commissioner's office to answer the complaint and did so. He pleaded innocence of any intent to interfere, and was released on his personal bond to appear for a hearing [illegible]

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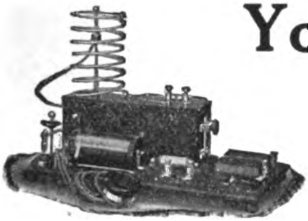

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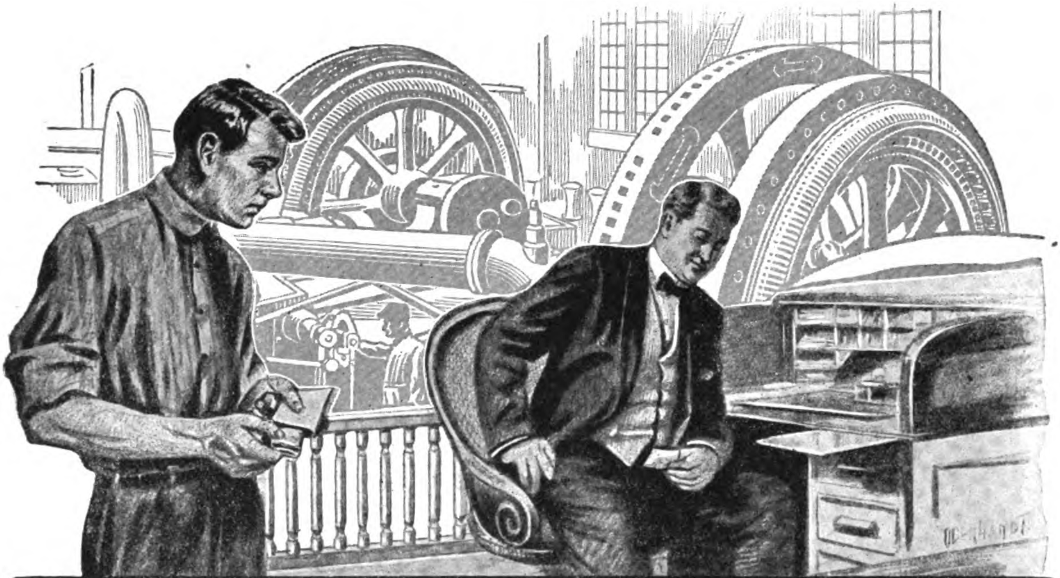

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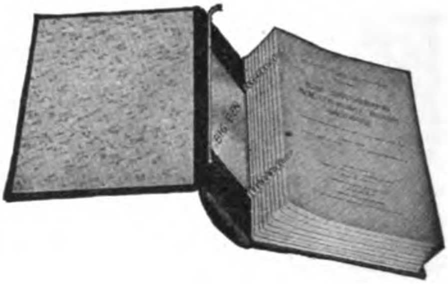

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PIERCE, GEO. W., Asst. Professor of Physics in Harvard University.
Principles of Wireless Telegraphy.—Just reprinted with corrections. The treatment of wireless telegraphy in this volume is strictly scientific. The book takes up the subject from the historical standpoint and develops each section of the art from its beginning to the present stage of knowledge. It shows fully why the earlier forms of apparatus in each instance have been discarded, and thereby enables the student to discover the merits which enabled present forms to survive. The chapters on detectors of all kinds are especially full and practical. While the book is not quite as full as Fleming's great manual, it covers all the points which the average specialist desires to know, and is an adequate presentation of the present state of the art. 1912.............. 3.00

ROBINSON, Lieut. Com. S. S.
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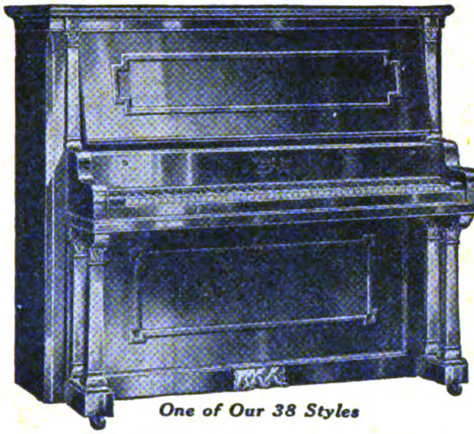

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