ELECTRICIAN & MECHANIC

VOLUME XXIV APRIL, 1912 NUMBER 4

LATHE WORK: MILLING ATTACHMENTS—Part IV

"SIGMA"

The writer feels that an apology is due those readers who may have been interested in my former articles, for the unreasonably long wait for this installment, but personal affairs have not the sooner allowed me the time necessary to their continuance.

It will be remembered that the former installments on milling attachments which appeared in the March and April issues of *Electrician and Mechanic*, Vol. XXII, described a simple milling spindle that was intended to be bolted to the tool rest and driven from an "overhead," such as described in the April issue referred to above; also reference was made to two other types of milling attachments, viz.: the vertical slide or elevating spindle and the elevating milling slide rest. This installment describes the construction of the elevating spindle type.

The design submitted is original, so far as the author is concerned or as far as such things can be original, and embodies all the features and ideas gained by a couple years' experiment with several different designs.

The great fault of many appliances of this kind is their lack of material where strength is essential; that is, they are perhaps strong enough structurally, but too often no provision in the way of excess material is made to keep the deflections within reasonable limits; as, for instance, consider a boring bar that is required to stand a tool pressure of 50 lbs. at 10 in. from the point of support. The bar would be sufficiently strong, considered merely as a cantilever beam, if made 1⁵⁄₁₆ in. diameter, but if an accuracy in its boring of ±.001 in. was required it would have to be made 2³⁄₁₆ in. diameter, because the smaller bar would have so great a deflection at the assumed tool pressure as to be unable to turn out work with an accuracy greater than ±.006 in.

I merely make this digression to answer the criticisms of any who may object to the apparently liberal use of material in the design, and before leaving this discussion I wish to point out that the weak point in many small lathes is their tool rest or saddle design, which are too often poorly designed, thus limiting the use of the lathe and any appliances that may be attached thereto. Though this attachment was originally designed for my own 10 in. lathe, it is as strong relatively as the slide rest of many 13 to 15 in. lathes; and while an attachment of smaller dimensions would be advisable, nevertheless it can be used in a limited way on 9 in. lathes.

SPECIFICATIONS

Spindle No. 1 Morse taper socket, ⁵⁄₁₆ in. hole clear through, is ¾ in. by 5½ in. in ball bearings and will take every tool and cutter made with this taper, while No. 1 taper shank arbors with blank ends (¹¹⁄₁₆ in. diameter by 1⅛ in. long) can be obtained and turned down to fit the various small milling cutters having holes to ⅝ in. diameter. Vertical movement of spindle 4 in. The attachment is back-geared and by the use of eight gears a total speed ratio of 16 to 1 can be obtained relative to any one speed of driving belt, which, together with the various speeds that may be applied to the back-gear shaft through the driving belt, gives a wide range of available speeds for the spindle. The gears required are one 1 in., one 1½ in., one 2 in., two 2½ in., one 3 in., one 3½ in., and one 4 in., costing 30, 38, 60, 65, 70, 80 and 90 cents each, total $4.98. These gears are all 16 pitch with ½ in. hole by ½ in. face and give speed ratios of 1:4, 1:2½, 1:1½, 1:1 and in inverse ratio to 4:1.

CONSTRUCTION

The Knee.—Have the slide of the knee casting planed or milled to the dimensions given and also have the under side of the holding-down foot planed exactly at right angles to the face of the slide, leaving only the hole for the holding-down bolt to be drilled to suit the tool rest of your lathe and the drilling of the hole for the feed screw, which should be located exactly half way between the two edges of the slide and 5/16 in. from the face of the slide. To drill this hole correctly, place blocking on the lathe bed until its top surface is exactly 5/16 in. below lathe centers, lay the slide on this, entering a ⅜ in. drill in the center hole of the boss, line up the casting and feed to the drill with the tail center, thus completing this part.

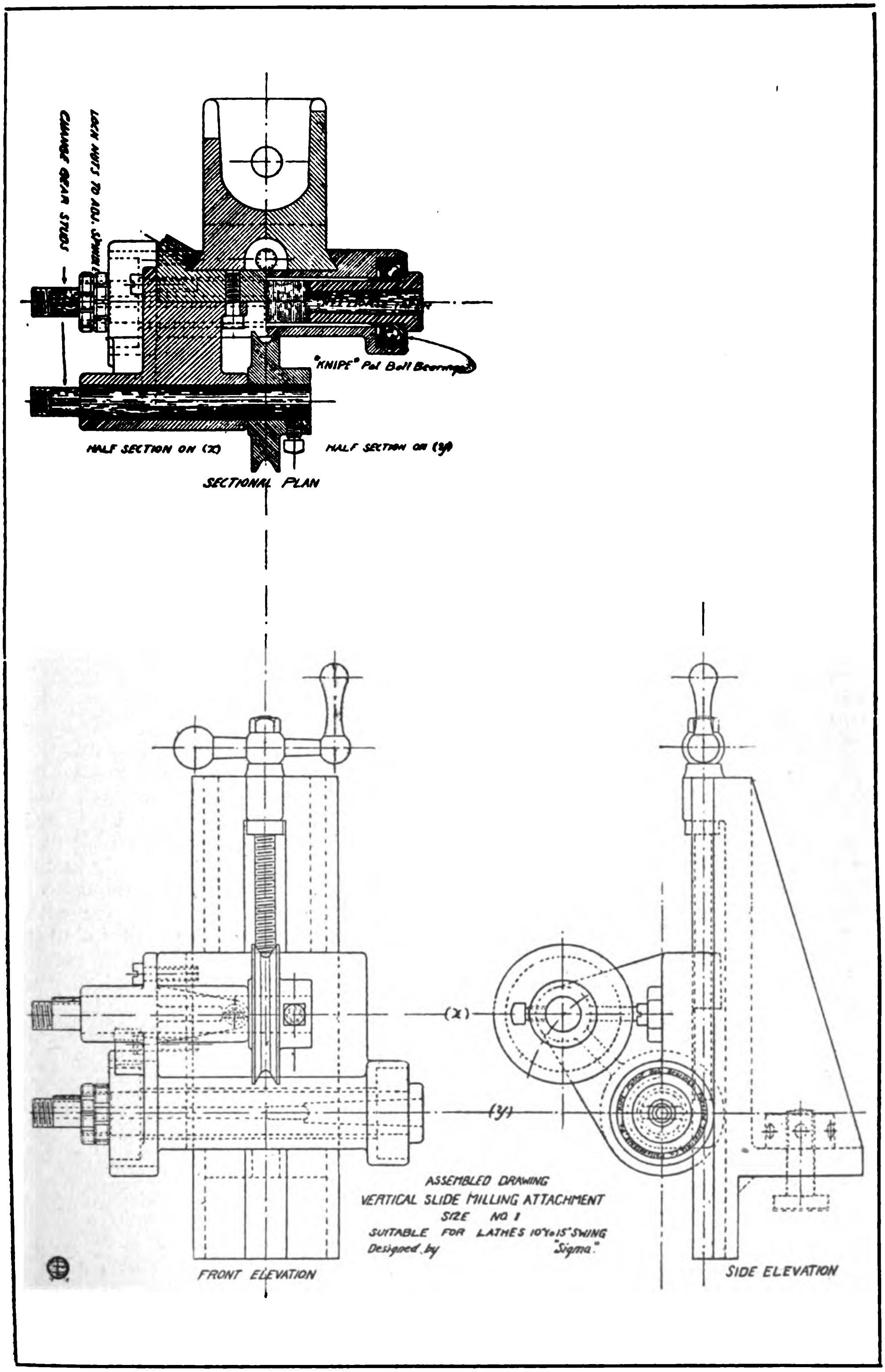
Spindle Slide.—This is shown in Figs. 27 *a*, *b*, *c*. Secure this casting with the slide planed to the given dimensions and I might add that the hole for the bearings and the spindle should be cored out. Lay out and center drill the tap-hole for the feed screw and block up on the lathe bed just as was done for the knee, but have the blocking 5/16 in. *above* the lathe centers; and after lining up carefully, drill out the boss with a 19/64 in. drill, tapping the hole ⅜ x 16 in. Now make a holding-down bolt to fit your lathe and a capstan nut, like Fig. 26, and bolt the knee to the tool rest with the spindle slide assembled and fit a piece of ⅛ in. steel for a gib, as shown in section in the assembled drawing. This done remove and drill the holes for the gib screws with a No. 26 drill tapping 3/16 x 32 in., and it might be explained here that the angular boss for the bottom screw is provided in order to clear the hub of the back-gear bracket. Replace the slide on the knee put the gib in place and spot through the holes in the slide so the points of the gib screws, Fig. 28, will enter and hold it in place.

Feed Screw.—Put a centered piece of ⅝ in. cold rolled or machinery steel in the lathe and turn down all over with the exception of the shoulder to ⅜ in. diameter, after which the feed screw can be threaded ⅜ in. x 16, and lastly the ¼ in. end can be turned down and threaded ¼ x 20 in., and a standard hexagon nut fitted. The ball handle can either be made to the dimensions shown in Fig. 32, or purchased from any machinery supply house. It is prevented from turning on the feed screw by a round key, Fig. 25a, let half way into both the feed screw and the handle, the key-way being made with a ⅛ in. drill, the handle being held in place.

You are now ready to bore out the bosses to receive the roller bearings. Provide a ¾ in. boring bar for this job, and one round nose tool and a square nosed tool cranked to the right and one cranked to the left.

Bolt the knee to the lathe, assemble the feed screw run on a ⅜ in. nut and assemble the slide. Now get the knee parallel to the axis of the lathe, and with the feed screws of both the lathe and milling slides, center the bearing hubs; and with the boring bar in place, bore out both hubs with the round nose tool, after which bore out the fillet left by the round nose tool and face off the bearing seats with the right and left tools. For fear the bearings might vary somewhat from the dimensions given, it would be best to check them up before taking the finishing cuts. These bearings are called the "Knipe" pat. ball bearing, and are 1⅝ in. diameter by 9/16 in. thick, and are listed at 50 cents each. In boring the hubs, see that the lathe gibs are tight and also tigthen up the milling slide gibs securely and run down the nut on the feed screw referred to in order to make the job as stiff as possible and prevent chattering. Assemble the bearings, and a couple of ⅛ in. pointed grub screws should be put through each boss and let into the soft steel outer casing of the bearings to prevent them from turning. Now drive a hard wood plug in each bearing hole and carefully center, place in the lathe and driving with a stud from the face-plate turn down the bearing hub over which is slipped the back-gear bracket, as shown in the assembled drawings.

Spindle.—The spindle is made from a No. 1 Morse taper socket, catalog No. 100. These are regularly made with the socket and knock-out slot finished, and the socket end turned down to about ¾ in. diameter, for a distance of 3⅛ in., the balance of


LOCK NUTS TO ADJ. SPINDLE
CHANGE GEAR STUDS
"KNIPE" Pat Ball Bearings
HALF SECTION ON (X)
HALF SECTION ON (Y)
SECTIONAL PLAN
(X)
(Y)
ASSEMBLED DRAWING
VERTICAL SLIDE MILLING ATTACHMENT
SIZE NO 1
SUITABLE FOR LATHES 10" to 15" SWING
Designed by "Sigma."
FRONT ELEVATION
SIDE ELEVATION

the length (3⅞ in.) being left blank and 1⅛ in. diameter. The shoulder will have to be brazed or shrunk on—I turned down the end slightly and turned up a ring about the right size for the shoulder and bored it out for a shrink fit and when it was shrunk on, it was turned up to finished dimensions, making a good job. I might add that a plug for the socket end is furnished for turning up the socket, both the plug and the blank end being centered. Drill out this ring with a 11/16 in. drill and very slightly bevel off the edge of one end of the hole to guide the spindle in entering. Turn down the end of the spindle for a distance of ¼ in., leaving a square shoulder, and to such a diameter that it won't quite drive into the ring, then heat the ring to a dull red and try your fit. If the spindle won't drive in put it back in the lathe and rub down slightly with a file, and try again; and when a fit is secured quench in water at once. This cut and try method presumes the absence of a micrometer caliper, in which case a fit might be tried with the spindle .01 in. larger than the hole in the ring. The ring can also be brazed on if care is used in doing it, but in either case the ring must be trued up after attaching.

The knock-out slot is hardly necessary, but it is regularly furnished and might be useful sometime in case a shank should become stuck in the socket and could not be removed by way of the regular 5/16 in. hole, provided for this purpose. The other end of the spindle is threaded ¾ x 20 in., as shown in Fig. 30, and two lock-nuts ¼ in. thick fitted as shown in the assembled drawings. These are for the purpose of taking up any slackness and maintaining a light pressure on the bearings. The end of the stud for the change gears is threaded ½ x 13 in. threads, and a slot cut and a ⅛ in. diameter x ½ in. long key let in. The 5/16 in. through hole will have to be drilled in from each end, thus completing the spindle.

Back Gear Shaft Bracket Bearing.—This is shown in detail in Figs. 24 a and b. Hold the large ring in the chuck with the short hub of the bearing next the faceplate and bore out to 1⅞ in. Next lay out and drill the three ¼ in. holes for the cap screws, Fig. 29, and fit to the slide. Spot the slide through these holes, run a 3/16 in. drill through and tap ¼ in. x 20 thread and put the screws home. Now assemble on the lathe again and with both feed screws center (at a radius of 2½ in. *exactly* from the center of the spindle), the bearing and drill with a ⅝ in. drill, following the work up with the tail center. A ⅛ in. oil hole completes the part.

Back Gear Shaft.—Fig. 31 is made from a piece of cold rolled shafting turned to the dimensions shown. The stud for the change gears is exactly similar to that of the spindle.

Drive Wheel.—Fig. 33 is turned up from a simple casting, and though easily made one might be bought. This completes the device with the exception of splining the gear wheels for the ⅛ in. round keys. This is best accomplished by drilling a ⅛ in. hole in the end of a centered piece of round steel, say ¾ in. diameter, and at a distance of exactly ¼ in. from the center, then by turning this down so that one-half the hole is exposed, or in other words to ½ in. diameter, a counterpart of the groove in the studs will be obtained. Make this end dead hard if of steel tool, or case harden if made of soft steel, by bringing to a red heat and sprinkling well with yellow prussiate of potash (potassium ferrocyanide), when this has fused, re-heat and sprinkle again, doing this several times (only the groove need be hardened), and after the last fusing, heat and quench in water, when it ought to resist a file. Now chip a nick in the edge of the hole in the gears, slip them on this stud so the nick is opposite the groove and drill out the groove with a ⅛ in. drill, letting the drill follow the groove in the stud. You will get nice straight holes in this way, and they will register with those in the studs. Your attachment is now complete and it is hoped that it will prove most serviceable.

A small drill chuck fitted with a taper shank makes a useful adjunct, and for some operations a necessary one, and when a full set of tools and cutters are acquired you will be pleasurably surprised at the variety of operations that are possible with it. I might add that by replacing the spindle slide with a milling vise slide you can also have an elevating milling slide, thus making two tools of one and thereby further increasing its utility. I will describe the construction of such a vise in the near future.

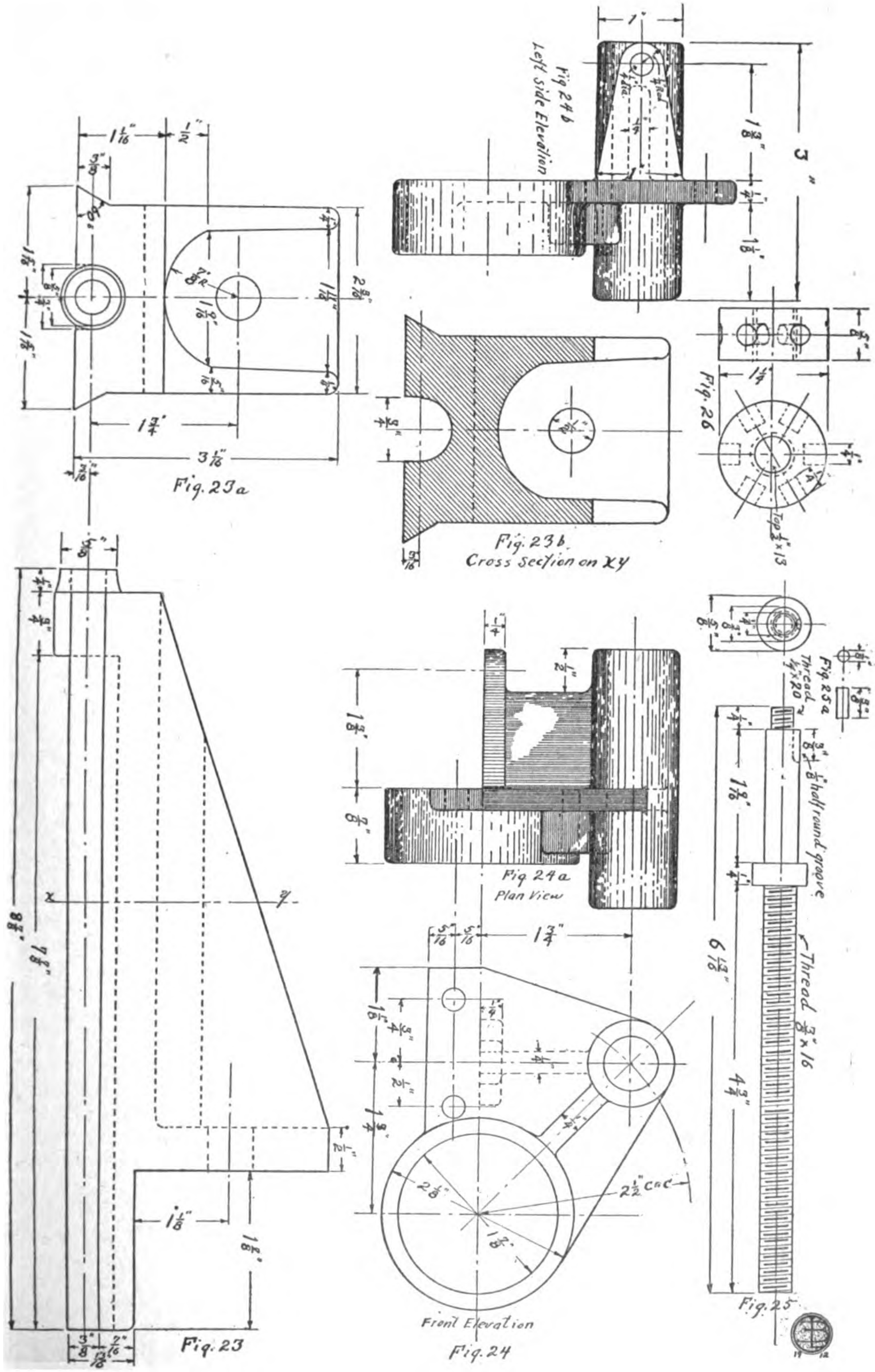


Fig. 23a

Fig. 23b Cross Section on XY

Fig. 24b Left Side Elevation

Fig. 26

Fig. 25a

Fig. 24a Plan View

Fig. 24 Front Elevation

Fig. 25

Fig. 23

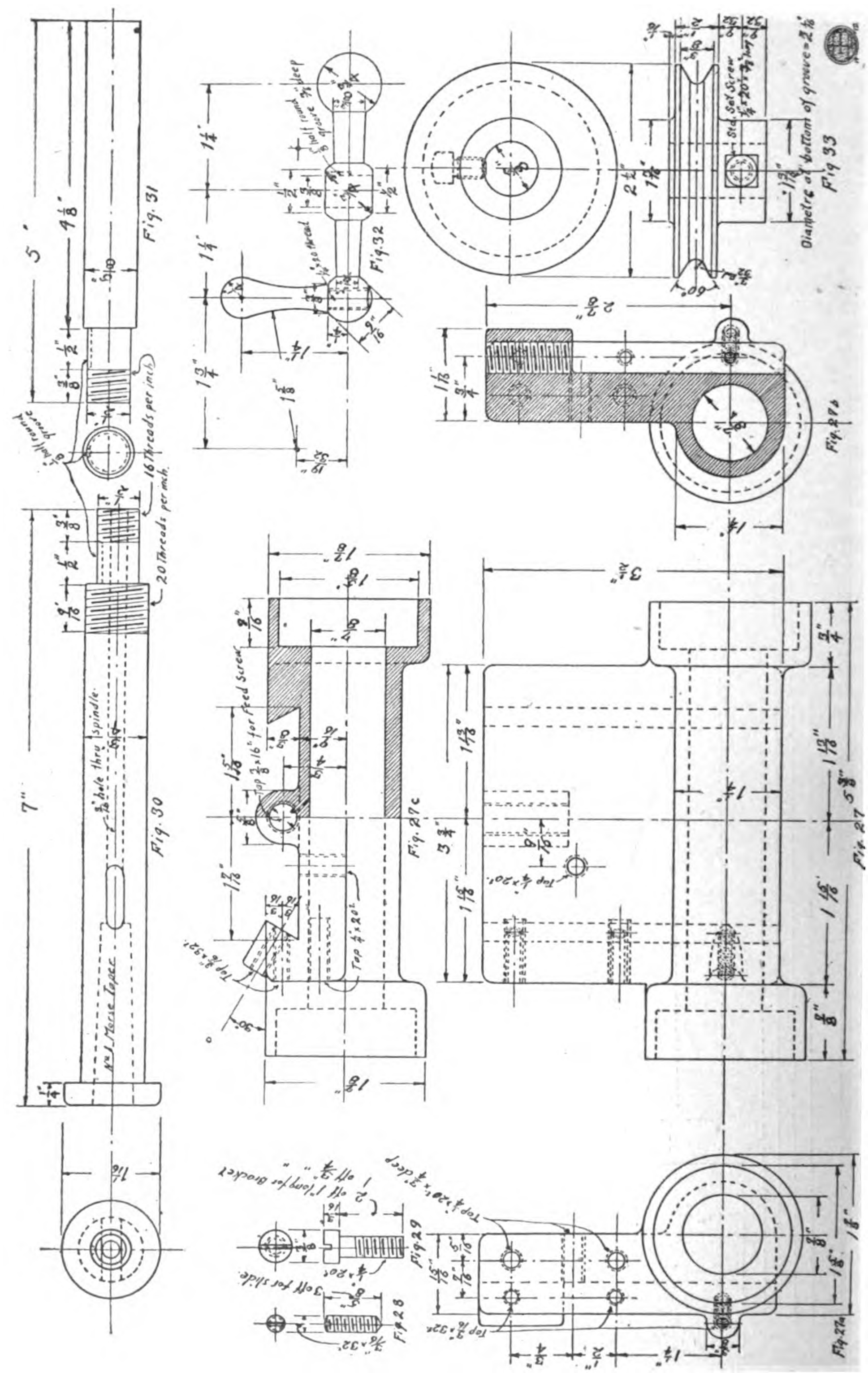


Fig. 27
Fig. 27a
Fig. 27b
Fig. 27c
Fig. 28
Fig. 29
Fig. 30
Fig. 31
Fig. 32
Fig. 33
No. 1 Morse Taper
16 Threads per inch
20 Threads per inch
Diameter at bottom of groove = 2 1/8"
Std. Set Screw
3 off for slide
2 off 1" long for Bracket
1 off 3/4" "

THE BURGESS-WRIGHT BIPLANE AND HYDROPLANE

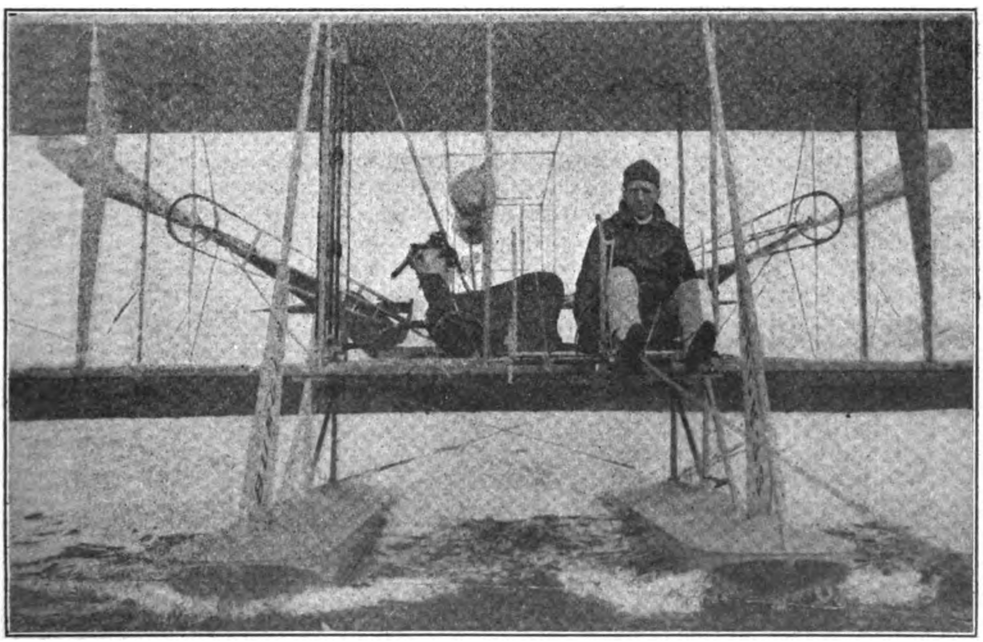
AUSTIN C. LESCARBOURA
Member of the Aeronautical Society

The pioneer experiments of the Wright brothers, combined with the years of technical experience possessed by the famous yacht builder, Mr. W. Starling Burgess, have produced America's most successful aeroplane.

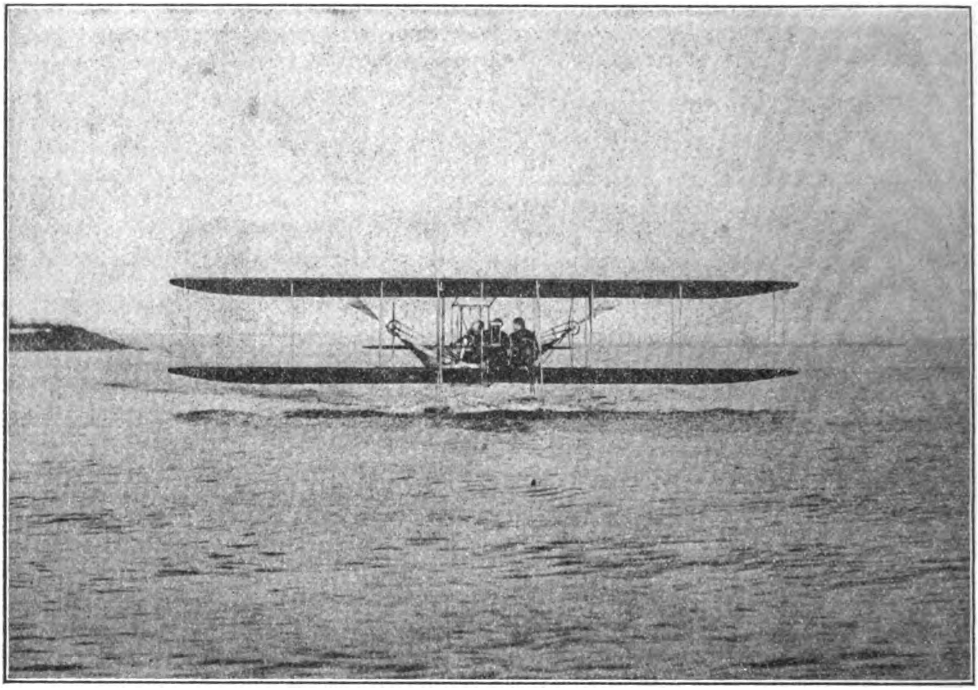
The Burgess-Wright biplane is built at Marblehead, Mass., and differs from the standard Wright biplane only in the minor construction details It is licensed under the Wright patents. For instance: the spruce wood used for many of the parts in the Wright biplane has been replaced with ash; heavier control wires replace those of smaller size and strength; turn-buckles are employed throughout in place of wires of the exact length; and, in short, many other details have been improved, which render this type the realization of a reliable and efficient biplane.

The biplane is of the headless Wright type, which made its debut at the Asbury Park, N.J., aviation meet during the middle part of 1910. Two seats are arranged on the front edge of the lower plane, while the motor is placed next to the seats. The motor drives two wooden propellers in opposite directions through chain drives. Above the motor are placed the radiator and gasoline tank.

From the two main planes, four main beams are trussed so as to form a boxed structure which extends to the elevating plane and rudders, placed at several feet to the rear of the main planes. The elevating plane is connected with one of the controlling levers by wires. Two vertical planes are connected so as to move in unison, and are controlled by wires leading to another lever. These rudders enable the steering of the machine to the right or to the left. Heavy ash skids extend from the rear edge of the main planes to several feet in front of them, and are joined by two wooden struts extending to the leading edge of the upper plane. A small surface has been placed between the skid and the strut, in order to eliminate the tendency of the biplane to skid sideways when negotiating a sharp turn. On the skids are mounted pairs of heavy rubber-tired wheels with shock absorbers. All the surfaces are double coated, so that the ribs of the planes are entirely covered. The rear edge of the



Howard W. Gill Driving a Burgess-Wright Hydro-aeroplane



Phillips W. Page Driving a Burgess-Wright Hydro-aeroplane and Taking Motion Pictures

two main planes can be pulled down, or warped, by means of control wires leading to one of the control levers. This enables the biplane to retain its stability when turning curves or when assailed by brisk winds.

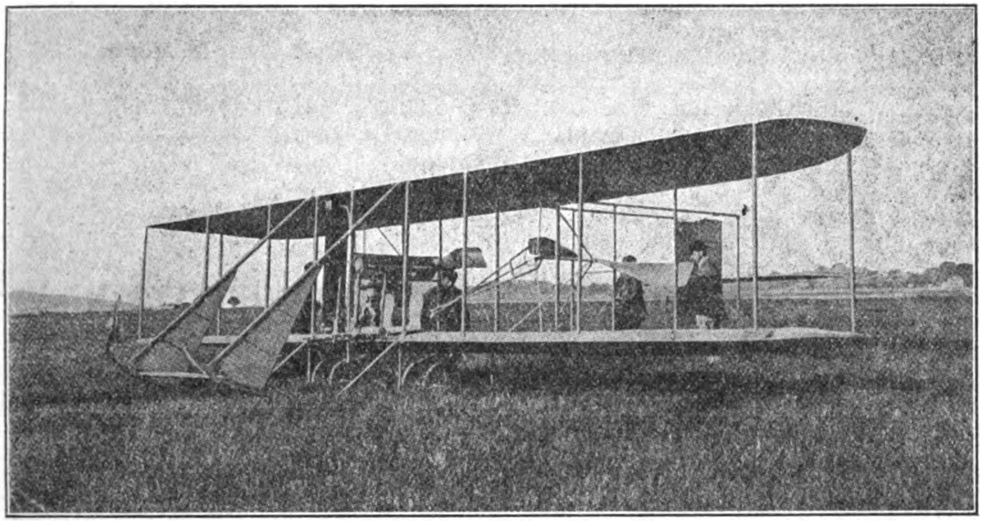
The motor is of the standard Wright type, 30–35 h.p., 4 cylinder, and weighs 180 lbs. The body of the motor is cast aluminum, while the cylinders are individually cast of iron. The crank shaft is nickel steel, cut and machined from a block, as is likewise the cam shaft operating the exhaust valves. The cylinders are lubricated by a pump, and the intake valves are automatic in action. Gasoline is taken directly into a mixing chamber without passing through a carburetor, by means of a gear pump and injector. A centrifugal pump circulates the water through the aluminum water jackets of the cylinders, and the ignition is furnished by a high tension magneto. Many of the Burgess-Wright biplanes are being equipped with the Gnome rotary motor and prove speedier and more reliable.

The control is effected by two levers; but, by having an additional lever, which is a duplicate of one of the two necessary levers, it is possible for either passenger or aviator to drive the biplane while in flight. One of these levers controls the rear elevating plane, so that the biplane may be guided upwards or earthwards. The other lever is arranged with a movable handle, so that the rudder planes can be moved; either side of the main planes warped, or both operations performed together by one movement. The independent movement of the handle and lever enables these separate operations. The combined warping of the planes and the turning of the vertical rudders in one operation, is the basis of an important Wright patent.

The principal dimensions of the Burgess-Wright biplane are:

Spread over wings	39 ft. 6 in.
Length over all	30 ft. 0 in.
Height on wheels	8 ft. 0 in.
Depth of wings	6 ft. 3 in.
Elevator	15 x 3 ft.
Dimensions for transporting	39 x 8 x 8 ft.

Of the many important flights made with the Burgess-Wright type of biplane, those made by Harry N. Atwood are the most remarkable and noteworthy. His



Standard Burgess-Wright Biplane

flights from Boston to Washington; from St. Louis to New York; and from Boston to the mountains of New Hampshire with a passenger, have placed American aviation progress on par with the accomplishments of the European aviators.

By replacing the skids and wheels with two metal boat-shaped, air-tight pontoons, the Burgess-Wright biplane has been converted into a hydroplane of no less a success. The hydroplane parts of the machine have been designed by Mr. Burgess, and may be seen in the accompanying illustrations. By having the wheels and pontoons on the biplane, it is possible for the aviator to start and alight on either the water or land.

Harry N. Atwood recently made a 126-mile flight along the New England coast, while Phillips W. Page, and Howard W. Gill are also making interesting hydroplane flights in similar machines. Page has made flights with a motion-picture camera mounted on his hydroplane and arranged so as to operate by the motor, and thus require no attention for turning the crank. Meanwhile New York city has had another novelty in the witnessing of the remarkable flights of Coffin, the Wright pilot using a standard Wright hydro-aeroplane. A motion-picture camera has also been mounted on his machine for taking pictures of New York harbor.

From the recent activity in hydroplaning by several of the American aviators, little doubt remains but that it will become the sport of yachtsmen. Many sportsmen who would not risk aeroplaning are turning their attention to the hydroplane, which offers the same excitement and pleasure, but with the danger practically eliminated.

TELEPHONE vs. TELEGRAPH

Some people entertain the erroneous idea that the telephone will supplant the telegraph. It is, however, evident that the transmission of articulate speech between two distant points by any means whatsoever is a problem involving difficulties far greater than those of telegraphy, where transmission of single waves or impulses following each other in the proper succession is all that is required. A telegraph circuit only requires one wire, and in quadruplex telegraphy four circuits may be obtained from the one wire, two operators sending and two receiving. In order to obtain absolute quiet on a telephone circuit, a metallic circuit of two wires is required. In telephonic transmission, not only must the constantly varying rate and amplitude of vibration be faithfully reproduced at the receiving end of the line, but the fundamental tone and all overtones must be reproduced, giving each its proper value and without altering the phase relations between them.

PICTURES OF LIGHTNING

Three years ago the Smithsonian Institution received a letter inquiring for a publication. Framed in a foreign hand upon a scrap of paper and expressed in quaint English, it incidentally mentioned some curious experiments which the author had made in odd moments. With a small camera which he held in his hand and revolved from side to side, he had taken some photographs of lightning. He enclosed a print in his letter and wanted to know if his results had any scientific value. The idea of photographing lightning with a moving camera was a novel one to the Smithsonian experts, and, after an investigation, these officials decided that such experiments were worthy of assistance. A grant was therefore voluntarily made to enable the continuance of this photographing with more accurate apparatus.

In letters which followed it was learned that Mr. Alex Larsen, for such was the author's name, was a Danish immigrant, educated in physics, chemistry and electrical engineering at a night school, and that all his experiments were performed for the pure enjoyment of doing something new.

With the aid of the Smithsonian grant Mr. Larsen constructed special apparatus for his work. Upon a revolving table turned by a timed motor were placed cameras in such a position that they would not miss a flash when one occurred. To secure the photographs desired, the table-top was then revolved at a certain speed.

The results are interesting. Where the flash appeared perpendicular, the negatives show naturally a broad sheet for a mere streak of lightning. By calculating from the speed of the camera's motion and measuring the width of the sheet, the time of the flash is easily determinable. But the photographs showed at the very start that a single flash is not one big vibration. It is made up of very many minor flashes, or rushes, following usually in the same channel as the first, and herein lies the special value of the work. In the best of the negatives there are easily counted as many as forty separate rushes which, as the whole flash lasted little over half a second, followed each other in marvelously rapid succession. By measurements and by subsequent calculations, Mr. Larsen determined the actual time between each rush; the figures, as may well be imagined, are almost inconceivably small, varying from the largest, three one-hundredths of a second, to the smallest, as low as two one-thousandths of a second.

There appear many peculiarities of these separate rushes which might bear scientific investigation, but the most salient feature over which meteorologists and electrical engineers may puzzle is recorded on some of the plates among all the bright oscillations, as a marked black rush of lightning. The idea of lightning producing the extreme of darkness is repugnant to the actual name of "lightning." Yet the black rush is plainly visible. Mr. Larsen, after refuting a number of suggestions that might be made to account for it, ventures his own theory to solve the puzzle. In discussing the record of a particular flash in which the mark of the black rush is very distinct, he concludes: "The flash must have given out light of a wave length much shorter than the wave lengths of visible light and with a power sufficient to render the portion of the plate struck by it non-sensitive to ordinary light." "Such a flash," he says, "would appear black on a partially illuminated background, or be invisible."

Invisible lightning, therefore, seems to be a term perfectly proper in view of the results recorded in some of these photographs. At the suggestion of the Institution officials, and with their help, Mr. Larsen carried his researches still further into the actual makeup of lightning. Photographs and studies of the light spectrum of electric flashes in the air were compared with sparks produced by a static machine. The conclusions, in line with the century-old observations of Benjamin Franklin, show that there is little perceptible difference.

The latest ideas outlined by Mr. Larsen to the Smithsonian Institution are no less remarkable than the first. He proposes to photograph electric sparks reflected in a rapidly revolving mirror, and thereby secure records, a study of which may add materially to our knowledge of electric action.—*Boston Transcript*.

NEW METALLIC FILAMENT LAMPS*

G. S. MERRILL

The author deals with the lamps themselves rather than with their applications in commercial service, and discusses the following physical properties of the materials: Electrical resistance, vapor tension and melting point, emissivity, selectivity, mechanical strength.

The following figures are given for the effect of 1 percent increase in voltage of lamps operating at normal efficiency:

	Increases Wattage Percent	Increases c.p. Percent
Tungsten	1.59	3.73
Tantalum	1.72	4.27
Metallized carbon	1.77	4.90
Treated carbon	2.07	5.69
Untreated carbon	2.32	7.10

The filament of an incandescent lamp must not only meet certain requirements of an electric conductor, but it must also possess certain characteristics as a luminous radiator. The latter condition greatly limits the number of materials which can be used as filaments of incandescent lamps. The light of incandescent lamps is produced by temperature radiation as distinguished from luminescence or fluorescence. It is therefore desirable to operate the incandescent filament at as high a temperature as possible in order that the proportion of the energy radiated within the visible spectrum, and hence the efficiency of light production, may be high. The maximum temperature at which it is possible commercially to operate a certain material in the high vacuum of an incandescent lamp bulb is determined by its rate of disintegration if the vapor tension is high, and by its melting point if the vapor tension is low. The high vapor tension of the carbon filament, which is shown by its tendency to evaporate at temperatures far below its melting point, makes it impossible commercially to operate carbon filaments at the normal working temperature of the tungsten filament.

Not only do the various filament materials differ in their ability to withstand high operating temperatures, but they differ also in their radiating properties. The emissivity or mere ability to radiate energy does not affect the luminous efficiency, but it plays an important part in determining the lengths and diameters of filaments in commercial lamps.

The metal osmium has been shown to possess the property of selective radiation in the visible spectrum to a high degree, but the difficulty of working it and its relatively low melting point have made its commercial use impracticable. Tungsten, while not quite as selective as osmium, is more plentiful, and, moreover, it can be operated commercially at a higher temperature and efficiency, so that it is a more desirable filament material than osmium, in spite of the greater selectivity of the latter substance.

The greatest problem in the production of metal filament incandescent lamps has been to produce the filament material in a high state of purity and in the proper physical form, and the ingenuity of the manufacturer has been taxed to the utmost in devising means by which this can be accomplished. It is difficult to secure a high degree of purity in tungsten metal, principally because its atomic weight is high and, in consequence thereof, a very little carbon (which is the most common impurity) is sufficient to form a considerable amount of tungsten carbide. The Paper contains a number of micro-photographs which illustrate the changes during the various processes of manufacture and during the subsequent burning. Microscopic inspection of the longitudinal surface of tungsten filaments after various periods of operation shows that a gradual wrinkling or breaking up of the surface takes place. Apparently the effect is confined almost entirely to the surface material, the filament itself suffers no serious distortion and no marked difference in appearance is produced by burning on alternating current. The appearance of the tantalum filament after burning on direct current is not very different from that of a tungsten filament, but on alternating current a gradual breaking up of the tantalum filament takes place. This can hardly be ascribed to vibration due to rapid heating and cooling, because tungsten filaments, operated under similar conditions, do not show this tendency.

* Abstract of a Paper read before the Franklin Institute.

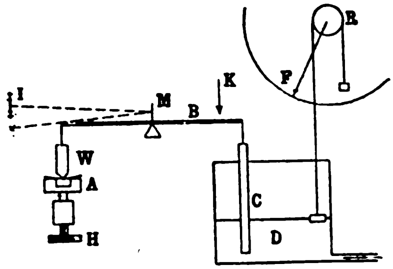


FIG. 1 —FILAMENT TESTING MACHINE.

The study of the change in appearance of filaments throughout their life naturally leads to a consideration of the effect of burning on the strength of the filament. In order to investigate the relative strength of lamps of different types, various methods of testing them have been devised. Strength tests are made with the filaments cold, because when they are heated it is practically impossible to break them, the most serious damage that can then result from shocks and blows being a twisting together of one or more loops.

One method of testing strength consists of mounting the lamp rigidly on a block which can be bumped by a second block allowed to swing as a pendulum. The impact is regulated by the arc through which the pendulum is allowed to swing, and is increased by small increments until the filament is ruptured. The method has been modified by one investigator so that the impact is obtained through a ball rolling down an inclined plane. Another method requires the lamp to be mounted on a block which can be dropped from gradually increasing heights, the apparatus resembling somewhat a miniature pile-driver. Other tests have been made by packing lamps in boxes as for shipment, and dropping the boxes from increasing heights, the lamps being frequently inspected. These methods have the advantage of breaking the lamps under conditions at least approximated in service, and, moreover, give some indication as to the value of the method used in supporting the filament. The results obtained are at best somewhat erratic, and a large number of lamps must be averaged in order to obtain a proper appreciation of relative strengths.

In order to obtain some idea as to the strength of the filament itself, considered apart from its supporting structure, several methods of testing have been commonly used. One method consists in laying the filament on a pad of paper, smooth but not rigid, and allowing a small metal cylinder to roll lengthwise along it. Rollers of increasing weights are used until the filament breaks. In another device the filament is drawn by a hook at the center between two converging guides until it breaks; the distance which it was drawn into the "V" before breaking gives an arbitrary measure of its elasticity. This method has been varied in another device so as to draw the filament through a spiral guide, thus giving the sample a greater and greater curvature until it breaks.

The number of ways in which filament strengths can be measured with precision is somewhat limited by the physical nature of the filaments and by their extremely small diameter. The filaments readily lend themselves to cross-bending tests, and in order to carry out certain investigations a device for making such tests with some degree of accuracy was constructed. Short pieces of filaments were supported at points 0.5 cm. apart and a load slowly applied at the middle until the filament broke, the load and deflection both being measured. By taking short pieces of filament it was possible to test from 10 to 20 samples from a given lamp, and the average load and deflection shown by these 10 or 20 samples gives a very good measure of the filament strength in that particular lamp. In addition to determining the breaking strength, the deflection under various loads could be measured and deflection load diagrams could thus be obtained.

The machine, which it is believed involves a new principle, consists essentially of a horizontal beam balanced on a knife edge (see Fig. 1), supporting at one end a cylindrical plunger *C* and at the other end a cylindrical weight *W*, of the shape shown. The weight *W* at one end of the beam hangs with its lower edge midway between the points of support of the filament which is laid horizontally across an opening 0.5 cm. long. The block *A* carrying the filament can be raised through measured distances by means of a micrometer screw.

A small concave mirror *M* on the beam reflects light from the source to form an image at I. By keeping this image on a certain point, the beam may be kept horizontal and the deflection of the filament may be read from the micrometer screw.

The plunger at the other end of the beam hangs within a vessel which may be filled slowly with water. The plunger is buoyed up by the water as the latter rises and a load proportional to the weight of water displaced by the plunger is thrown upon the filament. As the plunger is uniform in section, the volume of water displaced can be most easily measured by its height upon the plunger. In testing, the beam has been kept balanced with a small part of the plunger submerged, and consequently the load upon the filament is determined by a difference in water levels. To enable the water level to be read with accuracy, a carefully balanced float rides upon the surface of the water in vessel D, and by means of a silk thread passing over the small pulley R, its motion is magnified by the long pointer F traveling over an arbitrary scale. The water level readings can be reduced to the equivalent load in grammes on the filament by means of a calibration curve.

After putting the filament in place, and taking the initial reading of the pointer F and the micrometer head H, water is allowed to flow into the vessel D. As this throws a load on the filament and produces a deflection, the operator raises the filament with the micrometer screw, in order to keep the image I at a fixed point. The loading continues until the filament breaks, at which instant the water supply is automatically cut off by electrical contact of the unbalanced beam with the point K. The pointer F indicates the water level at breaking. The deflection of breaking is indicated by the difference between the initial and final readings of the micrometer head.

In order to compare strengths and deflections of filaments of varying size, it was necessary to express the results in terms of some unit length and diameter. Consequently all measurements of strength and deflection have been reduced to the equivalent load in grammes and deflection in centimeters of a filament 0.5 cm. long and 0.005 cm. in diameter. In some cases filaments were found to be slightly elliptical in cross section rather

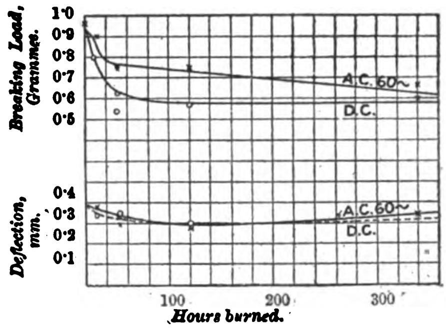


Fig. 2

than circular. (The difference between the maximum and minimum diameter, however, rarely exceeded 10 percent). In reducing the results of the cross-bending tests to a common basis, the diameter of the filament was therefore taken as the mean of two diameters at right angles in order to reduce the error due to possible deviation from a circular section.

Some of the most interesting tests made with the device have reference to the change in strength of the filament during its life. Three lots of 40-watt 110-volt tungsten filament lamps representing modifications in manufacturing processes were run through such comparative test. Each lot was divided into two parts, one of which was burned on 60-cycle alternating current and the other on direct current. All lamps were burned at 1.23 watts per candle-power. At certain intervals lamps of each lot were removed from the burning racks and the strength of the filaments tested. Fig. 2 shows the results of the tests for one lot, the general tendency of the curves being the same in each case.

Each point on the curves is the average of 10 determinations of strength of the filament from a single lamp. The deflection at breaking indicates that the flexibility of the filaments does not change very much with burning, especially after the first few hours.

The decrease in strength with burning could be most easily shown by either some change in the structure of the filament or by some change in the effective cross section. Although the results have all been reduced to terms of a uniform gross diameter, a microscopic inspection of the filament shows that there is a tendency for the surface to become wrinkled with burning, which would, in all probability tend to reduce the effective diameter as far as strength is concerned. In general, the surface, which was originally smooth, gradually becomes rough during the first 100 hours' burning. Beyond this point the changes are not so marked. The strength curves indicate in a general way that the greatest reduction in strength occurs during the first 100 hours of inspection, and thereafter the change is less marked. This seems to point to the possibility that the strength is dependent at least to some extent upon the surface roughening. It might be noted that during the period covered by the test the gross diameter of the filaments of the several lots remains practically constant, *i.e.*, no marked reduction in diameter with burning could be noted.

In regard to changes in structure, there is a tendency for the crystalline structure to become somewhat coarser with burning. This change would naturally tend to weaken the filament, due to the greater ease with which the fracture could follow the larger crystalline surfaces. A compact small-grained crystalline structure is apparently the more desirable from the standpoint of strength. The investigation, however, should be carried further before any definite conclusions are reached.

In order to give the relative idea of the strength and stiffness of a tungsten filament and a glass thread, a glass rod was drawn down to a diameter approximately equal to that of the filaments and a number of samples were tested. The ultimate strength of the threads of glass was almost three times that of the filament, but the flexibility of the glass was considerably less, giving about 60 percent as great a deflection as a tungsten filament under the same load.

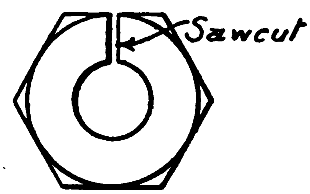
NEW USE FOR ELECTRICITY

Electricity as an agency to destroy the codling moth is the latest innovation of modern apple-orcharding in the Spokane valley, where W. M. Frost, inventor of the device, and J. C. Lawrence, a practical grower of Spokane, made what is declared to be the first demonstration of its kind in the world the evening of August 18. The test was made in a six years' old orchard at Opportunity, Wash., where a score of second-brood moths and hundreds of green aphis were killed in a few minutes. The apparatus consists of a storage battery to charge incandescent light globes of 6 c.p., which are netted with fine steel wires, coated with copper and tin, alternately. Attracted by the bright light in the tree, to which the globe is strung by a covered wire, the moth flies against the net work, completes the electric circuit and is instantly killed, the body dropping into a receptacle beneath the globe. Mr. Frost thinks that one battery to an acre of trees will keep the moths under control, thus eliminating spraying and saving many dollars for equipment and fluid. If electric light wires are extended to the orchard tracts, as they are in the Spokane valley, the expense of batteries may be saved by making direct connection and using the commercial current. The cost of covering the globes with wire nets is a small item and any electrician can do the work. Growers in various parts of eastern Washington are preparing to equip their orchards with the new pest destroyers the coming season.

Repairing A Stripped Thread

A. G. D. C.

The thread on one of the studs holding down the cylinder of a petrol motor had partially stripped, and as to replace the stud meant taking the engine down it was necessary to make a temporary repair. It was not possible, owing to the position,



to cut another thread on the stud, but the job was done as follows: The nut was taken and a saw-cut made in one face as shown, the nut was then pinched up in the vise till the saw-cut was closed. On threading the nut on the bolt it was found to grip the remaining scraps of thread quite tightly and made a satisfactory temporary repair.

ENGINEERING LABORATORY PRACTICE—Part V

The Determination of the Percentage of Moisture in Steam

P. LE ROY FLANSBURG

When steam is delivered to an engine or pump it may be in any one of three conditions, and it is highly important that the engineer should know in which of these conditions the steam is when admitted. The three possible conditions are: 1st—wet saturated steam; 2d—dry saturated steam; and 3d—superheated steam. If the steam is perfectly free from water it is called dry saturated steam. Provided the boiler from which the steam is taken has a sufficiently large steam space and is making steam slowly, it is possible that the steam may be entirely free from moisture; but under ordinary conditions it is much more common to find a certain percentage of moisture in the steam. Steam containing moisture is known as wet steam, and it is then important to know the exact percentage of moisture which is present. The third condition is obtained by taking the steam as it comes from the boiler and then heating it to a higher temperature than it was at in the boiler. Steam which is so treated contains no moisture and is known as superheated steam.

In engineering work it has been found convenient to speak of the amount of steam which is present in each pound of wet steam, as the quality of the steam or the dryness factor. This factor is ordinarily represented by the symbol x.

There are several methods of determining the quality of steam, but the best modern practice favors the use of one of four types of calorimeters. These four types are called "throttling" calorimeters, "superheating" calorimeters, "separating" calorimeters, and the "Thomas Electric" calorimeter.

In its simplest form the throttling calorimeter can be readily made up from pipe fittings and a throttling valve. The steam is led from the steam mains through a throttling valve into a small cylinder which is well-covered with a material such as hair felt or some other non-conductor of heat. The steam then exhausts from this cylinder, and where there is no valve on the exhaust the back pressure is practically atmospheric. A thermometer is placed inside of the cylinder and by means of it the temperature of the steam inside of the cylinder may be read. Where accurate work is desired, an improved form of the throttling calorimeter is used. One of the improved forms of instrument is the Carpenter Throttling Calorimeter, and another the Peabody Throttling Calorimeter. The Carpenter type of instrument is very similar to the instrument which has just been described, the only real difference being that a "manometer" (a device for measuring pressures) is attached to the body of the calorimeter. By means of the "manometer" it is possible to determine the pressure of the steam which is inside the calorimeter.

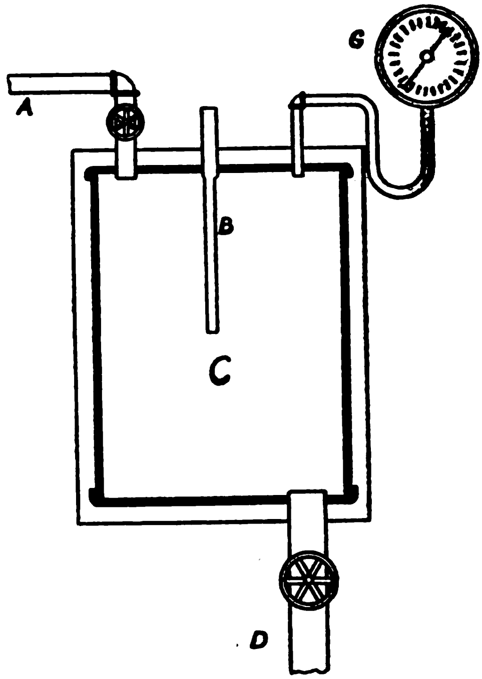


Fig. 1

The Peabody Throttling Calorimeter is shown in Fig. 1. It consists of a chamber or reservoir C into which the

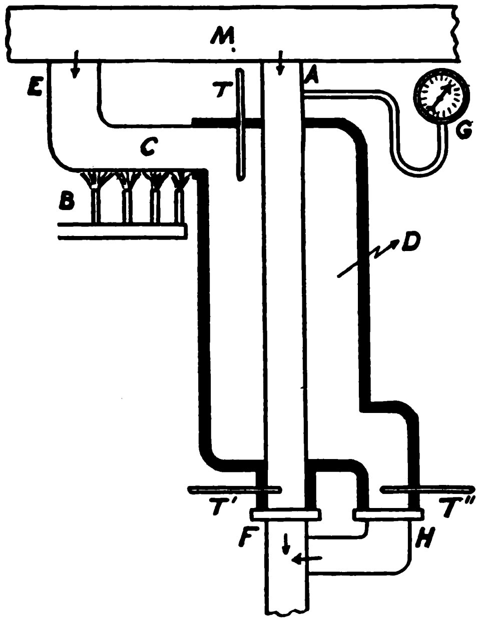


Fig. 2

steam is admitted through a throttling valve, and from which it is exhausted through a pipe D. The pipe A is connected directly to the mains where it is desired to know the quality of the steam. Pipe A is a ½ in. pipe, while pipe D is a 1 in. pipe. The pressure in the mains is read with a guage. Due to the large diameter of the exhaust pipe D, the pressure in the reservoir C (given by the gauge G) is far lower than the pressure in the mains. The total heat of saturated steam increases with increase of pressure, so when the saturated steam is expanded through the valve and has its pressure decreased, the excess heat is liberated and will evaporate any moisture present in the steam. Provided the amount of moisture is not excessive, the dry steam will then be superheated.

As the calorimeter is carefully protected by a covering of hair felt (which is a good non-conductor of heat), there will be no loss of heat during the test. Therefore, the total heat of the steam in the mains is equal to the total heat of the calorimeter steam, pound for pound. Stating this same thing in another way: during an expansion where there is no heat lost, the specific heat of moist steam remains constant. At the higher pressure the specific heat is not sufficient to vaporize all of the water, but at the lower pressure it is sufficient not only to do this but perhaps to even superheat the steam. This type of calorimeter cannot be used unless there is sufficient excess heat liberated to superheat the steam.

Let the boiler pressure or pressure in the mains equal p. Look up r, the latent heat, and q, the heat of the liquid at this pressure. Let p' equal the pressure inside of the calorimeter; r', the heat of vaporization; q', the heat of the liquid; and t, the temperature of saturated steam at that pressure. By means of the thermometer B, read the temperature t_s of the superheated steam within the calorimeter. Now call x the quality of the steam. Then $xr+q$=total heat at entrance.

$r' + q' + C_p(t_s - t)$ = total heat at exit (where C_p = the specific heat of steam). Now equating the total heat at entrance to the total heat at exit, you obtain

$$x = \frac{r' + q' + C_p(t_s - t) - q}{r}$$

The throttling calorimeter is by far the simplest calorimeter to install and operate.

The Superheating Calorimeter is shown in Fig. 2. In this type of calorimeter the steam to be tested is allowed to enter the calorimeter through A, and after flowing down the tube leaves it through an orifice F of cross-section a. Just before the steam passes through F, its temperature is measured at T'. Surrounding the tube A is a jacket D which is filled with superheated steam. The superheated steam is obtained in the following manner. At E, steam from the mains enters a pipe C and is superheated in this pipe, by means of Bunsen burners, to an amount which is determined by the thermometer T. The superheated steam then flows through the jacket D and leaves the jacket through an orifice H of cross-section a. Just before passing through H the temperature of the superheated steam is taken by a thermometer T''. The pressure in the calorimeter is measured by the gauge G.

Since the area of the two exit orifices is the same and the pressures are the same, if we neglect the differences of volume due to exit temperatures, then equal weights of steam pass out in a given interval of time. In passing through the jacket, the superheated steam loses some of its heat by radiation, and if we run the apparatus admitting steam only to the jacket, this radiation factor can be obtained. The difference in temperature at entrance and at exit of the jacket shows the amount of heat which is lost in passing through the jacket. If from this is subtracted the loss in heat due to radiation, you can at once find the amount of heat given up to the sample during any interval of time. From this data the quality of the sample of steam may be calculated.

When there is more than 3 percent moisture in the steam, a separator is used which will remove all of the moisture from the sample of steam by some mechanical process of separation. To find the percentage of moisture in the steam use the formula:

$$1-x=\frac{W-R}{W+w}$$

where:—

W = water drawn from separator.

R = water thrown down during run, by radiation.

w = weight of dry steam discharged at exit orifice.

One of the best forms of Separating Calorimeters is the type designed by Prof. Carpenter.

The Thomas Electric type of calorimeter is shown in Fig. 3. Although somewhat similar to the superheating type, the Thomas Electric type would probably be preferred, owing to its ease of operation and the fact that the determination of the quality of the steam is easily computed.

The steam is allowed to enter the cylindrical vessel or chamber from the mains through the pipe G. It then passes up and over a heating coil C, which is supplied with electrical energy either from batteries or from electric mains. It is possible to govern the amount of energy put into the coil by means of a rheostat or other electrical resistance connected in the circuit as shown in the drawing. The actual watts input is measured by means of an ammeter and a voltmeter. After passing over the heating coils the steam is superheated and the number of degrees of superheat is measured by a thermometer T. The steam then passes through D, and, by inserting a glass tube E, you have a means of observing the

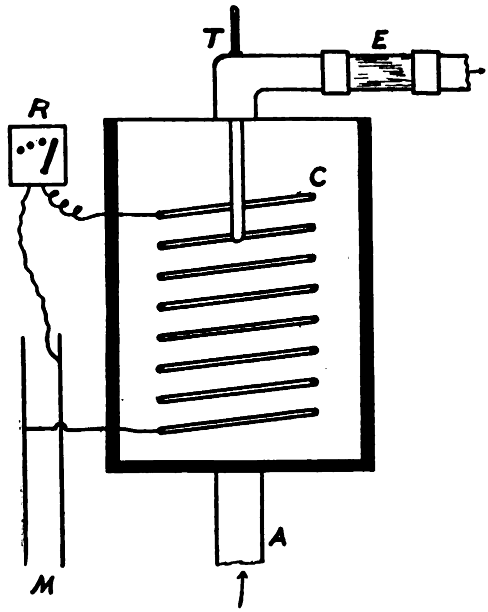


Fig. 3

condition of the exit steam. For instance, if the steam is wet the glass will become moist, while if the steam is dry, no moisture will be present to fog the glass. Now, knowing the heat added to make the steam dry saturated and the amount of steam flowing through, you can compute the quality of the steam.

Let E_1 = the number of watts needed to dry the steam.

E_2 = the number of watts increase which are needed to superheat the steam to some such temperature as 30 degrees Centigrade.

W = weight of steam flowing per hour under first conditions.

S = amount of electric energy needed to superheat 1 lb. of steam from saturation at various pressures to 30 degrees Centigrade.

Heat required to dry one pound of steam = H,

$$H=K\frac{E_1}{E_2}B.t.u.$$

In finding the quality of the steam, use the formula

$$x=\frac{r-H}{r}$$

r = the heat of vaporization at the pressure used.

K = a constant, and is obtained for all pressures from a plot supplied with the calorimeter.

The following test is one made by the author with a Peabody Throttling Calorimeter.

TEST MADE WITH A
PEABODY THROTTLING CALORIMETER

Barometer—30.41 in.

Boiler pressure in lbs. gauge	Calorimeter press. in inches gauge	Temperature of Calorimeter
41.8 lbs.	2.55 in.	120.0°
41.8	2.60	120.0
41.7	2.55	120.5
41.7	2.45	120.0
41.7	2.55	120.5
41.7	2.55	120.0
41.73 lbs.	2.54 in.	120.16°C = 248.4°F

Calorimeter pressure = (30.41 + 2.54) x .491 = 16.2 lbs. abs.

Boiler pressure = 41.73 + (30.41 x .491) = 56.6 lbs. abs.

T = 217°F = temp. caused by pressure in cal.

$C_p(T_s - T) = (248.4 - 217)\ .463 = 14.8$ B.t.u.

185.6
966.2
———
1151.8

1151.8 + 14.8 = 1166.6 B.t.u.

$q + xr = H = 1166.6$

$258.6 + 917x = 1166.6$

$917x = 908$

$x = .99$ = Ans.

1166.6
258.6
———
908.0

Readings taken at 3-minute intervals.

Alcohol as Fuel

A process of burning alcohol as a fuel under conditions similar to those obtaining with the use of gasoline (petrol) has recently been developed, in which the alcohol is used in combination with acetylene gas. In a recent demonstration in New York, use was made of a single cylinder de Dion Bouton motor of 3½ h.p., coupled direct to a dynamo having a separately excited field. A bank of incandescent lamps was used as resistance.

An ordinary carburetor was employed, the mixture being formed of alcohol, acetylene gas and air in about equal quantities. Acetylene gas alone burns too quickly and alcohol too slowly for direct use in gasoline motors, but the combination is said to have given practically the same results as would have been obtained by the use of gasoline. The process is a method of producing the gas for power purposes, in which a spray of atomized diluted alcohol is brought into contact with calcium carbide, resulting in the formation of an explosive vapor.

The apparatus is constructed to carry the atomized alcohol, on its way to the motor, through a chamber having a bed of calcium carbide. The resulting product, consisting of the three gaseous substances, has been called "Alkoethine." This is passed by suction into the engine cylinder to be exploded. The power developed is said to be about equal to that from gasoline, and to be produced at a small cost. In addition is the ability to start a motor while cold, which it is impossible to do with alcohol under ordinary conditions. Denatured alcohol contains about 10 percent of water, which would be a deterrent where alcohol only was used. In the new process, however, it is a decided advantage, because not only is this water utilized, but still more is required in order to produce the chemical effect of forming acetylene gas from the carbide. In this connection it is said that up to a certain point the more water added the greater is the power obtained. The new process when fully developed will doubtless have a very wide field of operation.—*The Engineer.*

Testing Oils for Household Use

Petroleum for use in lamps, stoves, etc., should be white or light yellow in color with a blue reflection; clear yellow indicates imperfect purification or adulteration with inferior oil. The odor should be faint and not disagreeable. The specific gravity at 60 degrees Fahrenheit ought not to be below 0.795 nor above 0.84. When mixed with an equal volume of sulphuric acid, of the density of 1.53, the color should not become darker, but, if anything, lighter. A grade of oil that will stand these tests and possesses the proper flashing point may be safely used. It is of great importance to know that this oil is pure and safe for home use, as loss of life and property has been caused many times by the use of inferior grades.

Earnest effort increases your employer's business; you should not talk too much during business hours nor close up shop too soon when the day's work is done.

ELECTRO-CHEMISTRY

Electricity and Electrical Conduction

ERNEST C. CROCKER

STATIC ELECTRICITY

Through experiments with static electricity which were carried out by Benjamin Franklin and others over a century ago, it was seen that there were two distinct kinds of electrical charges. These two kinds were named "positive" and "negative" charges, for convenience. From the way in which charges of electricity could be conveyed from one body to another, and from the presence of visible sparks accompanying such transferences, it was considered that electricity must be material and a fluid or fluids. By "fluid" was meant "fluid" in its larger sense, which means anything which flows, as water or air.

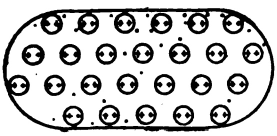


Fig. 1
Relative positions of atoms and electrons in an uncharged (neutral) conductor.
Circles containing + signs are atoms; small dots electrons. An atom is represented as having a charge equivalent to that of two electrons. This representation will be the same in all the figures.
Note.—Atoms are stationary, hence cannot form current. Electrons are free to move, and can form current.

The two different kinds of electrical charges suggested two things: electricity is a one fluid substance, or electricity is composed of two different fluids. In the first case, a body is neutral if just the normal amount of fluid is present, positive if the fluid is in excess, and negative if deficient. In the second case, neutral if the same amount of each fluid is present, positive if positive is in excess, and negative if negative is in excess.

Recent work points out that each theory is right in part: there are two kinds of electricity, but one is a "solid"

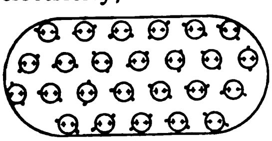


Fig. 2
Relative position of atoms and electrons in an uncharged (neutral) non-conductor or insulator.
Note.—Atoms are stationary, hence cannot form current. Electrons are so bound that they cannot flow to form current. The result is that no current can flow through this body.

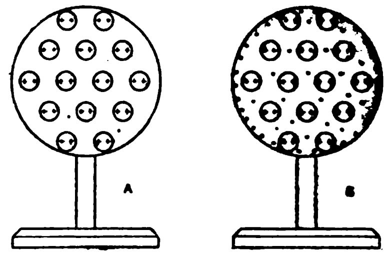


Fig. 3
A—Positively charged body.
B—Negatively charged body.
Note.—There is a deficiency in electrons in the positively charged body (less than two per atom), and an excess in the negatively charged body (more than two per atom).

and the other a "fluid." The so-called "negative" electricity is the fluid. The "positive" electricity, as we shall see later, is ordinary matter; possessing rigidity, as it does, it cannot move around. A negative charge is then an excess of negative fluid; a positive charge, a deficiency; and neutrality, just enough negative fluid to neutralize the effect of the positive. The positive electricity, being immovable, need not be considered in static electricity (see Fig. 1 to 5).

Reliable experiments have shown us that the negative fluid is composed of small particles, just as is matter. These small particles bear the name of "electrons." Positive electricity seems to be matter itself,—in fact, no particles of positive electricity have yet been detected which are smaller than the atom of hydrogen. Some have been found to be much larger. An "electron" has only about $\frac{1}{1700}$ of the mass of a hydrogen

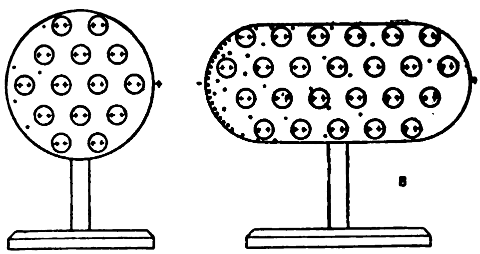


Fig. 4
A—Positively charged body.
B—Neutral conductor brought near the charged body.
Note.—Electrons in the conductor *B* have been attracted by the + charge on *A*, and, accordingly, have piled up on the end nearer *A*. If the body be cut in two and the charged body *A* be then removed, each half would be found to retain its charge (excess or deficiency in electrons).

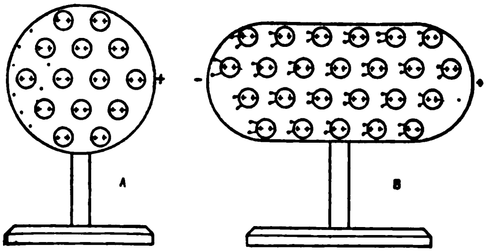


Fig. 5
A—Positively charged body.
B—Neutral insulator brought near the charged body.
Note.—In this case the electrons are held to the atoms by restraining bonds. If the body be cut in two and the charged body *A* be then removed, no trace of charge can be found on either half (showing that electrons did not leave their places to pile upon the end).

atom, yet it may be measured with considerable accuracy. The hydrogen atom itself is exceedingly small, as must be evident from the fact that there are about 4×10^{21} or 4,000 trillion atoms of hydrogen besides half as many more of oxygen in a single drop of water (H_2O.)

According to this new view, we should reasonably expect that a charged body would weigh more or less than it did before it was charged. Theory says that it does, but up to the present it has not been possible to detect any difference in weight, and for two reasons: the difference is so small, even with great charges, that present balances are not delicate enough to measure it, and, from the fact that a charged body exerts attractive force on all nearby bodies, we probably could not weigh it if a balance were found which is sensitive enough. A charged Leyden jar or other condenser certainly cannot have its weight altered because of the charge, for it loses as many electrons from one plate as it gains on the other, thus keeping the weight constant (see Fig. 6).

CURRENT ELECTRICITY

Metallic Conduction.—An electric charge in motion is an electrical current. In a metal we have the rigid body of the metal formed from atoms, and this constitutes the positive electricity. Evidently this framework of metal cannot flow when we have a current in the metal. Between the spaces of the framework of atoms, which is the structure of the metal, there are, however, the electrons, the particles of negative electricity, and it is upon these we must rely for the transmission of the current.

Since electricity (here only the negative electricity is considered) is made up of "grains" it is somewhat comparable with sand: a current of electricity through a metal wire is like a flow of sand through a pipe. A remarkable completion of the analogy is the fact that if we have a small enough opening, we can have an electric current come through in individual "grains," one at a time in slow succession, just as would be the case with a stream of sand through a small hole. "Electrometers" (special kinds of "electroscopes"), can be constructed which give a distinct indication for each individual electron.

ELECTROLYTIC CONDUCTION

The kind of conduction which occurs in the solution of a salt or acid in water is called "electrolytic" conduction. In metals we have to deal with the positive electricity "frozen" into a rigid body and only the negative free to move; but here we have both positive and negative electricity in a mobile condition.

For an example of electrolytic conduction, let us consider the case of a solution of copper sulphate containing copper electrodes. A molecule of copper sulphate ($CuSO_4$) is composed of an atom of copper (Cu^{++}) lacking two electrons, thus positively charged by two units, and a "sulphuric radicle" (SO_4^{--}) bearing two free electrons. When in the crystal condition, the copper atom and the sulphuric radicle are closely combined but the moment the crystal is dissolved in water, they "dissociate" into the two ions (Cu^{++}) and (SO_4^{--}). We have now a liquid in which are movable charges of electricity riding on special carriers called "ions" (Fig. 7).

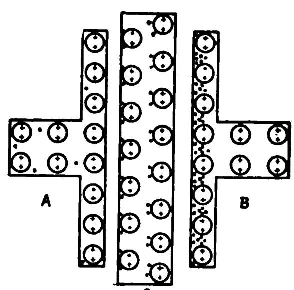


Fig. 6
Condition in a charged condenser.
A—Positive plate.
B—Negative plate.
C—Dielectric.
Note.—There is excess of electrons at negative plate, and deficiency at positive; also, dielectric is under electrical strain.

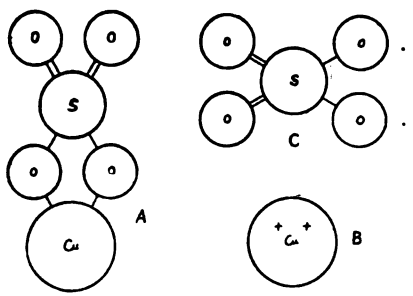


Fig. 7
A—Neutral molecule of copper sulphate ($CuSO_4$).
B—Copper ion (Cu + +).
C—Sulphuric ion (SO_4 – –).
Note.—The approximate size of the different atoms and of the electrons is correct. The actual arrangement of the atoms and electrons in the molecule is probably far different from that in the drawing.

In a metal we have only one kind of movable charge, but in a liquid we have two. In order that a current pass through the liquid, both positive and negative particles must become active, one going one way, the other the opposite. When a copper ion (Cu + +) arrives at the negative electrode, it draws two electrons from it and becomes a neutral atom of copper, which then attaches itself to the electrode. When a sulphuric ion (SO_4 – –) arrives at the positive electrode, it gives up its two free electrons, and seizing an atom of copper from the electrode, becomes a molecule of copper sulphate which dissolves in the liquid to take the place of the one just decomposed (Fig. 8).

In our solution of copper sulphate there is a whole cycle of changes during which every sulphuric radicle changes its partner many times. The positive electrode wears away, its substance being used in furnishing new partners to grasping sulphuric radicles which pay the price of two electrons; the negative electrode is the resting-place of all the tired-out and jilted copper ions which are each paid two electrons to stay and become neutral atoms. The result is that the negative electrode is built up by copper which goes through the solution, with the assistance of the sulphuric ions, and a stream of electrons is carried to the positive electrode. Each time a neutral sulphuric radicle captures a neutral copper ion to form a molecule of neutral copper sulphate ($CuSO_4$), the sulphate dissolves in water, the sulphuric radicle takes two electrons from the copper and both become ions, (Cu + +) and (SO_4 – –).

VACUUM CONDUCTION

There is good reason to believe that a perfect vacuum is a perfect insulator or non-conductor, but since no vacuum even approximately perfect has ever been attained, we need not consider a perfect vacuum. At the so-called vacuums which we find in X-ray tubes and Geissler tubes there is considerable conductivity. A very excellent vacuum may contain only about one millionth as much gas as the same space before exhaustion and yet contain an astounding number of atoms of the gas. A cubic inch of any gas contains about 65×10^{19} atoms at ordinary pressure and even if only one millionth of the gas is left there will still

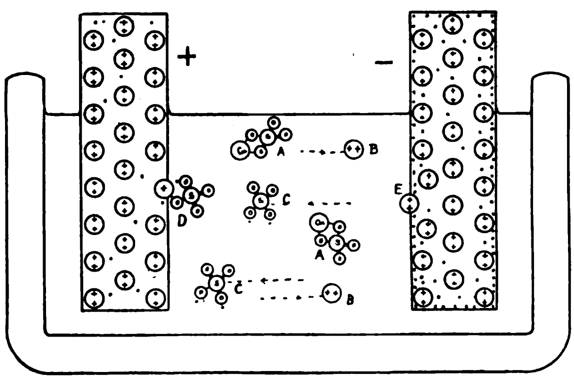


Fig. 8
Electric current flowing through $CuSO_4$ solution.
A—Undissociated molecules of $CuSO_4$.
B—Copper ions (Cu_4 + +).
C—Sulphuric ions (SO_4 – –).
D—Sulphuric ion just deposited on positive electrode, combining with an atom of copper to make a molecule of $CuSO_4$.
E—Copper ion which is attaching itself to negative electrode.

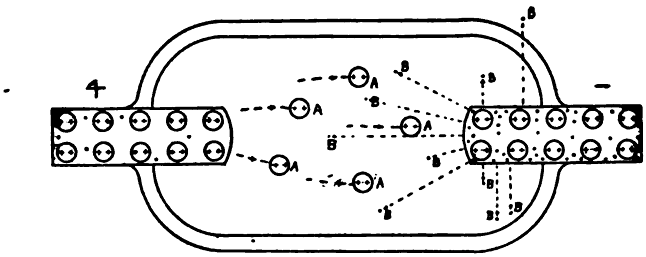


Fig. 9
Electric current flowing through vacuum tube (with metal electrodes.).
A—Copper atoms (acting as ions) crossing vacuum to deposit themselves on negative electrode.
B—Electrons, shot off at right angles to surface of electrode.

be 65×10^{18} or 650 trillion atoms left, and surely this is far from a perfect vacuum.

Experiment shows that when a current is flowing through a vacuum tube, the positive electrode (anode) wears away, while the negative electrode (cathode) increases in weight. This passage of matter through the tube shows that positive electricity acts here as in the case of solutions. Here, the outside atoms of the metal of the anode detach themselves and move through the "vacuum" and deposit themselves on the cathode (Fig. 9). Meanwhile the negative particles, the electrons, are not idle, although they do not act as they do in solutions where they have convenient "ions" on which to be ferried across. In this case, they have the singular property of shooting off at exactly right angles to the surface of the cathode and traveling away at a rate not much less than that of electricity in a wire (186,000 miles per second). In a short space they are slowed down by friction, but are usually able to actually get beyond the walls of the glass tube. A stream of these negative electrons is called a "cathode ray," more about which we shall consider under "X-rays."

CONDUCTIVITY OF AIR AT ORDINARY PRESSURE

Ordinarily, air is very nearly a non-conductor, but there are influencing factors such as flames, ultra-violet light, X-Rays, cathode-rays, and radium rays which "ionize" the air and make it conductive. This kind of conductivity will be taken up in detail under "Radium," and it will not be further dealt with at this time.

ELECTRICAL RESISTANCE

The electrical resistance of a conductor is the friction which the particles of electricity must encounter as they move through the conductor. Resistance varies with the length and cross-section of the conductor, and also with another quantity called the specific resistance, or resistance of a piece of given size. As a rule, the longer a conductor the greater its resistance—there is, however, an apparent exception in the case of air at ordinary pressures.

Under metallic conduction, we considered a piece of metal as a framework of the atoms of the metal which could not move to convey the current. As an illustration of the virtual condition of the atoms and electrons in a piece of metal, let us consider the particles of positive electricty, the atoms of the metal, as a honeycomb structure and the electrons, little insects which can fly around through the interstices of the honeycomb. An electric current is then a swarm of the insects flying in one direction, and electrical resistance is the opposition which they meet as they fly.

A curious fact in regard to the resistance of metals is that an alloy is always of higher resistance than would be expected from its components, and often higher than any of them. This is easily explained when we consider that electrical resistance is the opposition which the little insects of our illustration encounter as they fly through the honeycomb—the different metals form crystals of different shape, some crystallizing first and then others crystallizing into the holes which the first metals leave, thus tending to block up the passage. It will be noticed that, as a rule, the more different metals there are in the composition of an alloy, the higher its resistance. To state a few instances: alloys like German silver and "nichrome" have greater resistance than the two-metal alloys like brass, bronze, etc. This should follow directly from the above illustration.

The electrical resistance of "electrolytic" conductors, like solutions, decreases as we have more and more free "ions" present; in other words—depends upon the degree of dissociation of the dissolved salt. The degree of dissociation, as well as the friction which the ions encounter as they move through the solution, depends much on the temperature; liquids are better conductors when hot than when cold.

Temperature influences metallic as well as electrolytic conduction, but as a rule the resistance increases with the temperature. A notable exception is carbon. Recent experiments on the resistance of metals at very low temperatures have shown that all pure metals are practically perfect conductors at and near the absolute zero of cold (–273°C); in other words, their resistance becomes too small to measure. This is not true in the case of alloys. Insulators, as a rule, become conductors of the "electrolytic" type when they are strongly heated; for instance, the filament of a "Nernst" lamp is almost a perfect insulator when cold, and ordinary glass, at a red heat, is a fair conductor.

There is one element, selenium, which has its resistance altered not only by heat but by light. Another element, bismuth, has its resistance increased as much as 50 percent by a very strong magnetic field, although not proportionally as much by weaker fields. The last two cases, those of selenium and bismuth, are unique, and show properties which are much sought after.

SUMMARY

We have seen from the foregoing, that electricity is not a vague "something" which is so incomprehensible that we dare not express an opinion concerning it, but is something real and tangible. We saw that, as far as has been ascertained up to the present, there are two kinds of electricity; one kind, the positive, having atoms of ordinary matter for its ultimate particles; while the other, the negative, is made from perfectly real, but smaller particles called electrons.

We considered the rather homely analogy of a honeycomb of matter through which the insect electrons fly, in the case of metals. We saw how those chemical ferry-boats, the ions, convey the little electrical passengers in solutions. We saw how the pieces of the electrode themselves go through the vacuum tube to carry the current, and, particularly, how the little electrons go on a headlong dash, away from their electrode, not seeming to care where they go.

CONCLUSION

Substances possessing electrical properties like those of selenium and bismuth are always in great demand. Just at present, if a substance could be found which was more sensitive to light and more reliable in behavior than is selenium, there would be a revolution in the development of apparatus which enables one to see the person with whom he is talking over the telephone, and apparatus for telegraphing photographs, etc. A substance possessing the power of greatly varying its resistance in a weak magnetic field, as bismuth does in a strong, would be in great demand for the construction of telephone relays, wireless detectors, and many other similar instruments.

In our study of electro-chemistry, we shall consider many of the peculiar chemical and electrical properties of substances which may have great bearing on the development of new kinds of electrical apparatus in the future. Surely the recent views of electricity do much, at present, to clear up the doubtful views which we may now hold as to the "why" of many electrical phenomena.

Quality of Leather used in Belts

So much inferior leather is sold for belting that a test of some sort is of great importance to the user of belting. Cut a small piece from the belting to be tested and place in vinegar. If the leather has been well tanned and is of good quality, it will remain in the vinegar without any change other than a slightly darker color. If, on the other hand, it is of inferior grade, the fibers will promptly swell, and after a short time be converted into a gelatinous mass. This variety of leather is of no use as belting, and should be avoided, as it will not wear well and will prove an expensive proposition to the purchaser.

ADVANTAGES OF A HIGH-SPARK FREQUENCY

ROBERT E. BRADLEY

If two alternating currents of the same intensity but of different frequencies be sent through a telephone, it is found that the sound in the telephone produced by the current of higher frequency is much louder than that produced by the lower. This fact is due in part to the peculiarities of the human ear, which is more sensitive to high-pitched sounds than to low, and also due in part to the diaphragm of the telephone, which is usually of such a weight that it will vibrate most readily to a sound of rather high pitch. This fact has an important bearing on wireless telegraphy, for the pitch of the sound produced in the telephone connected to the detector at the receiving station depends simply on the number of sparks per second at the sending station. In order to determine exactly what is the relation between the strength of current required to produce an audible sound in the telephone and the frequency, a series of experiments were recently carried out on a pair of head telephones of the type usually used in wireless telegraphy.

It was found that it required about a thousand times as much voltage at a frequency of 60 to produce a sound as it required at a frequency of 900. We may assume, therefore, that if the number of sparks per second at the sending station be increased from 60 to 900, and the spark length kept the same, the effect at the receiving station would be increased one thousand times. If the number of sparks per second be increased in this way without reducing the spark length, it is evident that the energy made use of at the sending station must be greatly increased. If we assume that the energy is proportional to the number of sparks, and divide the relative increase in loudness of sound in the telephone for any frequency by the relative increase in the number of sparks per second, we will have a fair comparison of the efficiencies at the two frequencies. The results show that there would be a very slight advantage in replacing a 60-cycle alternator giving 120 sparks per second with one giving 240 sparks or a 120-cycle machine, but that the advantage increases rapidly as the frequency is increased. The maximum sensitiveness of the telephone appears to be in the neighborhood of 900.

In addition to the increase in sensitiveness of the telephone at high frequencies, there are other quite independent advantages in the use of a high-pitched spark. First, it is found in practice that a high-pitched musical signal is much more readily distinguished at the receiving station in the midst of ordinary interference and atmospheric disturbances; and second, at the sending station a shorter spark gap, which would generally be used with a high-frequency spark, puts less strain on the insulation of the condensers and other parts of the circuit, and reduces the losses due to brush discharges, which, in many stations, amount to a considerable share of the total power used.

A third advantage is that larger amounts of energy can be radiated from a moderate sized antenna without subjecting it to excessively high potentials.

Experiments have recently been carried out in which it has been shown that in moderate spark frequencies with stationary gaps there are nearly always secondary discharges, irregular, but giving very high tones, so that the advantage of high spark frequency, from the standpoint of telephone sensitiveness, is usually less than that indicated above. The advantages of ease of reading, the lessening of the strain on the instruments, and the increase in effective energy capacity of the antenna, especially when the latter is small, are very marked, so that it has been found possible to use small sets of 2 k.w. where formerly 5 and 10 k.w. were used.

Handy Cement for the Laboratory

Small pieces of gutta percha, which are sometimes discarded as useless, can be used to good advantage by dissolving them in benzole, and adding a little carmine or other color. This solution when brushed upon corks or other caps forms a tight-fitting and very efficient cement, impenetrable to air, dampness, alcohol and acids. When desirable to remove any article coated with this solution, a simple turn is all that is necessary and no difficulty is experienced from sticking, as is often the case with other cements.

SOME TYPES OF SLIDE VALVE MOTORS

"CHASSIS"

The term "slide-valve" includes the rotary valve (which simply slides in a circumferential direction) and the piston valve. It is the purpose of this article to describe some of many varied designs which fall under this broad definition of the slide valve.

The Knight motor should, perhaps, be described first, because it was the first type of slide valve motor to score a pronounced success in the motor-vehicle field and because it was, in great measure, the success achieved by this motor that set the designers of many a big concern to work developing the slide valve we have today.

The distinctive feature of the Knight motor is the pair of sleeves which reciprocate between the piston and the walls of the cylinder. The sleeves (A and B, Fig. 2) each have two ports on opposite sides near the top. The ports I and I_1 register with each other, and with a port I_2 in the cylinder wall during the suction stroke. Similarly, during the exhaust stroke, ports D and D_1 register with each other and with the port D_2 in the cylinder wall. During the compression and the working strokes none of these ports coincide in such a way as to permit communication between the combustion chamber and the outer air.

The sleeves are actuated by short connecting rods E, which join the sleeves to eccentrics carried on a shaft S. The latter is positively driven from the crankshaft (either by chain or gearing) in such a manner as to make one revolution to two revolutions of the crank. The eccentric driving the outer sleeve is displaced from 60 to 90 degrees from the eccentric driving the inner sleeve. This arrangement results in a motion of the two sleeves which is difficult to follow

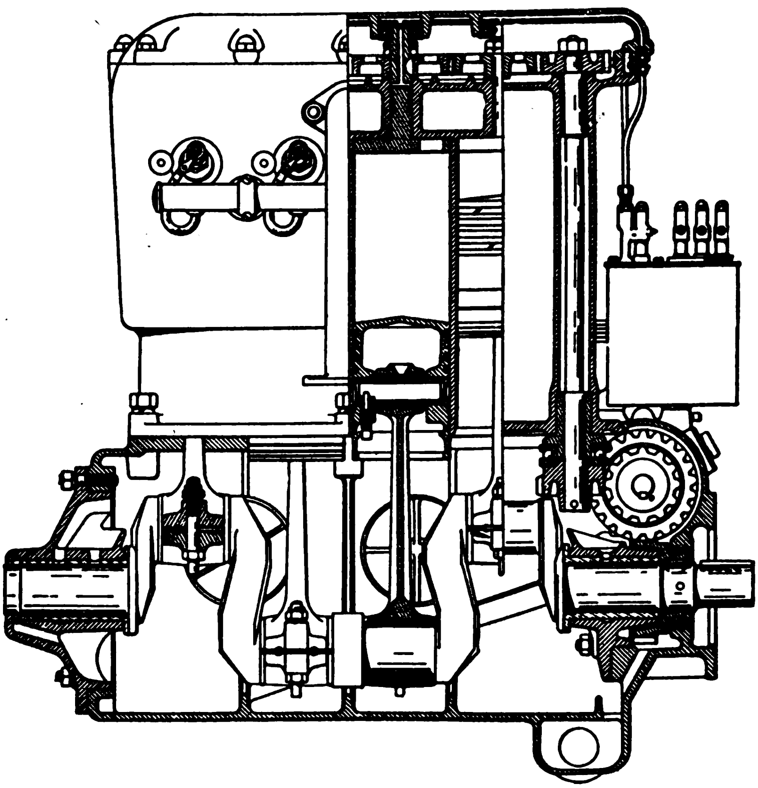


Fig. 1
Reynolds' Rotary Plate Valve Motor

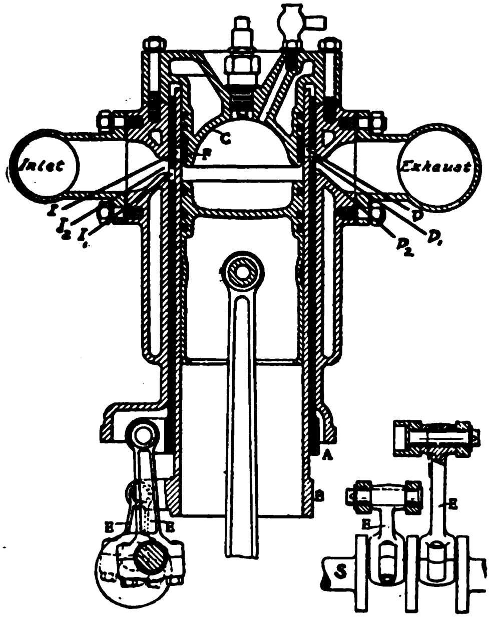


Fig. 2
Section of a Panhard-Knight Motor

in the mind, but which is a most advantageous one in respect to proper functioning of the motor.

The junk ring *F* is, in principle, the same as a wide piston ring. It bears against the inner sleeve, preventing leakage, and protecting the ports during the firing stroke.

It is worthy of note in this design, first, that the port opening may be made very large without sacrifice to the shape of the combustion chamber, thus yielding great power output for a given bore and stroke. Second, that the pressure occurring in the cylinder is balanced, *i.e.*, causes no pressure on the valve seat against which the valve must move. Wear is therefore but slight, and the problem of proper lubrication is correspondingly simplified. Third, that the ports of the valve which might be injured by the high temperature occurring within the cylinder are protected at the time of ignition and during a greater part of the expansion stroke. This fact also tends to minimize leakage.

The rotary valve motor has advantages in the way of simplicity which no other type possesses. Many engineers believe that some valve of this type will prove to be "the valve of the future." One of the simplest forms of the valve consists of two cylindrical members; which are really nothing more than pieces of solid cast iron "shafting" with slots drilled through one diameter. These valves are driven at one-quarter crank-shaft speed and run in a seat cast in the cylinder and so water-jacketed that excessive heating is eliminated.

One valve functions the exhaust, while the second controls the inlet. In a multi-cylinder engine using this construction the cylinders are cast *en-bloc*, and the two valves extend the length of the casting (parallel to the crank-shaft), one on each side of the cylinder head. Opposite each cylinder is placed the slot which uncovers, at the proper moment, the port through which the gases enter or leave the cylinder. These two pieces perform, in the case of a four-cylinder motor, the same functions performed by eight poppet valves, each with its spring, push rod, cam follower and cam—certainly a big saving in parts and a great gain in simplicity.

The operation of the valve is so simple that it hardly need be explained. The slots are so placed that they come opposite the ports in the cylinder wall at the proper time to permit the entrance of the charge and the exit of the burnt gases. During the compression and working strokes the valves seal the ports, preventing leakage. The valves are driven by worm gearing or some other form of positive mechanism.

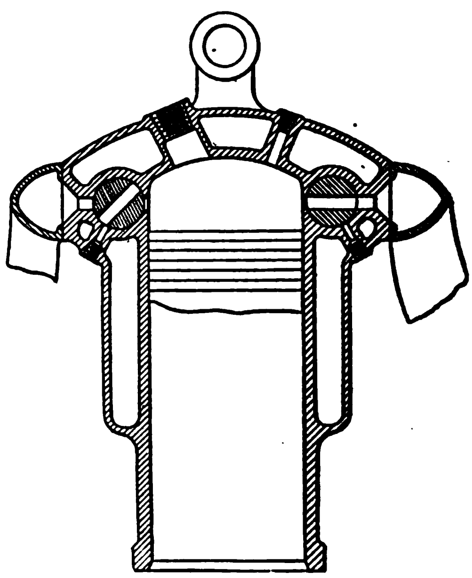


Fig. 3
Mead Rotary Valve Motor

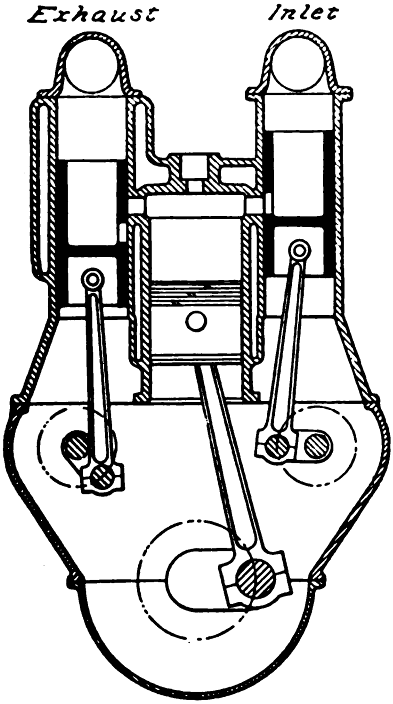


Fig. 4
Piston Valve Motor

At each side of the opening through the valve is a solid portion which rests in a bearing. One manufacturer states that he makes the clearance between valve and bearing about one and one-half thousandths, while the clearance in the zone opposite the ports is two thousandths of an inch. This clearance is apparently sufficient to allow for expansion by heat.

The valve is, of course, open to the pressure occurring in the combustion chamber and must, therefore, have adequate bearing surfaces. The latter are easily provided for, however.

Among the advantages of the construction are the following:

1. Simplicity in design (both of valve and cylinder casting) and small number of parts.
2. Silence due to uniform rotary motion and absence of striking parts, none of which have a reversal of strain due to a reciprocating motion.
3. Ample port area without sacrifice to improper shape of combustion space combined with positive functioning at all speeds. Also low speed of those surfaces of the valve which rub against the housing.

This valve mechanism has the disadvantage of tending to wear out-of-round and of a tendency to leak around the seat, short-comings which are not difficult to minimize (almost to the point where they become negligible) by good design. Some trouble is likely to be encountered also in boring and reaming the long valve seat so as to be perfectly true. This difficulty is not unsurmountable, however, requiring simply the proper tools and a reasonable amount of care.

A modification of this type,—which is an improvement in some particulars, although it is open to the criticism that it increases complication and cost—has been suggested. It contemplates placing a single sleeve between the piston and the cylinder wall, the sleeve to be operated in a manner similar to the sleeve of the Knight engine. In this case, the rotary valves are relieved from pressure occurring during the compression and working strokes, the sleeve ports registering with the ports in the cylinder wall only when the gases are entering and leaving the cylinder. This arrangement practically eliminates leakage and should reduce the wear on the valves very materially.

Another form of rotary valve is the disc-type, shown in Fig. 3. It consists of a circular plate rotating on a stem which is co-axial with the valve. Valves of this type are usually flat but may be "dished," *i.e.*, conial in form, the seat having, of course, the same shape as the face of the valve. Disc valves are placed against the cylinder head which forms their bearing surface. In the latter are cut the ports with which the openings in the valve register when admitting the charge and letting out the exhaust.

Disc valves are actuated by keying to the stem a gear which is positively driven from the crank-shaft. In a multiple cylinder design, such as is shown above, a chain of gears makes a very neat construction. The advantage of this type of valve over other types of rotary valves is largely one of construction. It can be made without special machine equipment. It possesses most of the advantages of the rotary type in general, however, although its disadvantages are perhaps somewhat greater. Chief among these is the fact that it operates at high temperatures and under high pressures, although the latter are, fortunately, periodically reversed, reducing to a value below atmospheric as often as they reach the high maximum. This condition tends to prevent the oil film from being forced out. Again, the rubbing speed of the valve near its periphery is high, unless its diameter is kept small, and lastly, the friction is likely to be rather high because anti-friction bearing surfaces cannot be used where the temperature is high, and because abundant lubrication (such as the connecting-rod bearing gets in a splash system) would create a smoky exhaust and deposits of carbon.

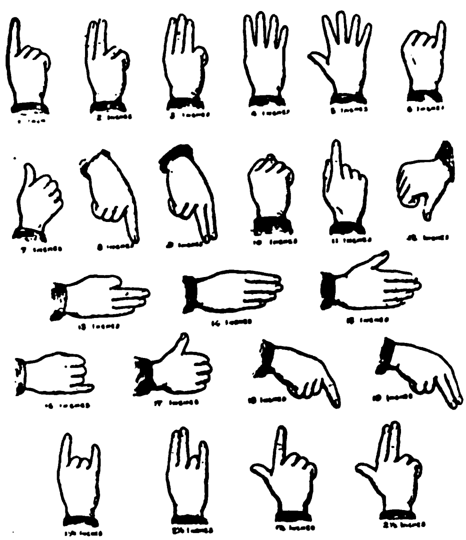
Still another type of sliding valve is the piston type—a form of valve which, like some of the other types mentioned above, had its prototype in certain forms of the steam engine valve. The piston valve has been applied in many forms, as have also the rotary valves just mentioned. One form is shown, in section, in Fig. 4. The pistons, driven from half-time crank-shafts, cover and uncover the ports in much the same manner as the sleeves of the Knight motor. There is no apparent reason why the piston used as valves should give any more trouble than the working piston. To this extent, therefore, the design is favorable, and should work well. It is, however, a rather cumbersome and bulky construction, being costly, also, in its manufacture. Nevertheless, it has many points in common with other slide valves which render it superior to the poppet valve. As a result, it has met with some favor abroad, and may prove its worth after more general use.—*Gas Review.*

SILENT LANGUAGE OF THE SAW MILLS

The accompanying set of illustrations, showing some of the silent signs used in the mills in the United States which are generally understood by mill men, is reproduced from the *West Coast Lumberman.*

The signs, up to and including twelve, are given simply by raising the hand, as indicated. From 13 to 19, inclusive, they are given by placing the hand in position as indicated, and then drawing the same across the body from left to right.

The illustrations showing the fractions



Signal Code Between Sawyers and Cutters

are given as examples of how the signs are are combined. In some cases it is not possible to give these signs, where there are combinations, in one movement. For instance, 3¼ cannot be given at one time, as the three first fingers represent three, and the little finger a quarter, so, given at the same time, it would be four; it is given, therefore, by first giving the sign of three, then closing the three fingers and raising the little finger for the quarter. Three-quarters following any unit is given by first giving the sign of three, then following with the little finger. The same thing pertains to ½, the thumb representing the half. For example, 4½ cannot be given with one motion, as a combination of the four fingers and thumb make five; it is given, therefore, by first raising the four fingers, with thumb closed, then closing the four fingers and raising thumb.

In giving the sign for an eighth, the sign for eight, index finger down, is used. Take 7⅜ as an example; hand closed with thumb up for 7, followed by three fingers up, then index finger down for ⅜.

Instructions to turn the log are given by raising open hand with palm out, then dropping same to side.

The order to set log for cutting off slab is given by raising closed fist and holding same up until the log has been set at proper place, then dropping fist to side.

EASILY MADE CHUCKS FOR SMALL BENCH LATHE

The purpose of this article is to describe some simple chucks, that are easily and cheaply madé, and that are suitable for one of the many small bench-lathes now on the market. Also they may be made from stock material, without the bother and expense of obtaining castings, which is a simplification the amateur usually appreciates. For the purpose of giving exact measurements, as a guide, it has been assumed that the screw-thread on the mandrel nose is ½ in. Whitworth, and ½ in. in length.

Assuming that the size of the mandrel-nose is as given above, it should be pointed out that the over-all dimension given for these chucks described are not rigid, in one way, at any rate. They may be made larger, if desired, but not smaller, as the dimensions given are practically the minimum to gain the requisite strength. Of course, if the stock material at hand is larger, it can be used as it is, without wasting time by turning down. The metal to be used, in most cases, may be either brass or mild steel (except where the metal to be used is specifically stated).

Of course, if the mandrel-nose on the lathe is larger than ½ in., the outside dimensions of the chucks given on the drawings will necessarily have to be larger in some cases; but the maker should easily be able to determine that point for himself.

FORK CHUCK

The first chuck required for wood-turning is the fork chuck, shown in Figs. 1 and 2. For this a piece of metal 1 in. in diameter by 1 in. in length is used, being drilled and tapped right through ½ in. to fit the mandrel-nose, as shown in the section Fig. 1. A piece of mild steel rod, ½ in. in diameter by 1 in. long,

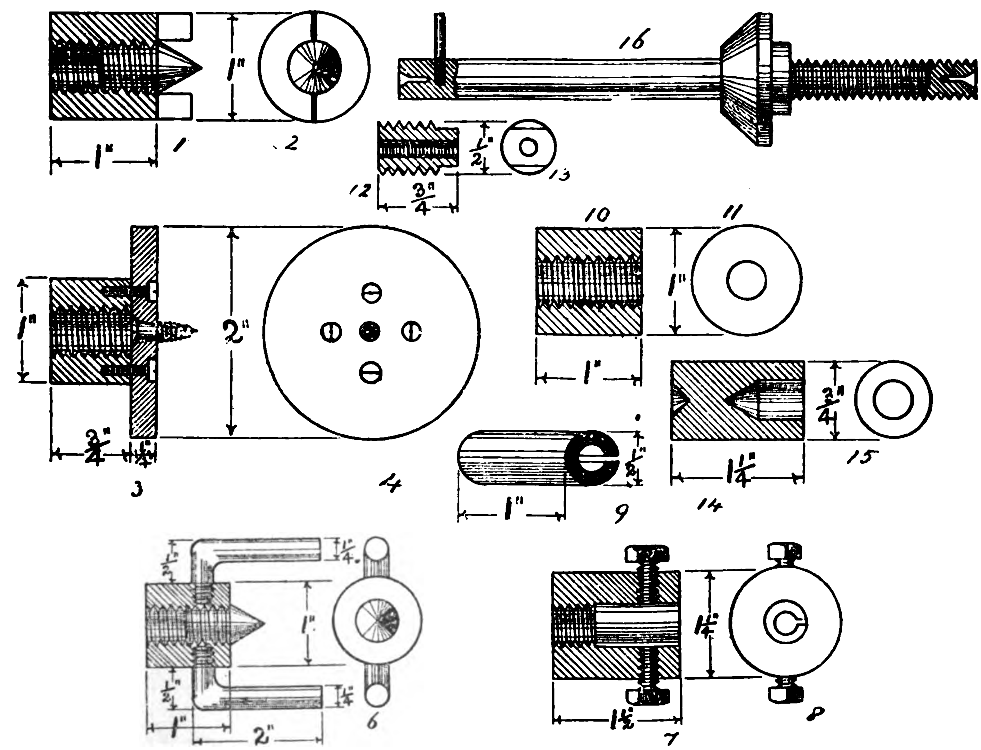


Fig. 1—Section of Fork Chuck, used for Wood-turning. Fig. 2—Front View of Fork Chuck. Fig. 3—Section of Taper Screw Chuck, used for Wood-turning. Fig. 4—Front View of Taper Screw Chuck. Fig. 5—Section of Carrier Chuck, used for Metal-turning. Fig. 6—Front View of Carrier Chuck. Fig. 7—Section of Drill Chuck. Fig. 8—Front View of Drill Chuck. Fig. 9—Metal Sleeve, for holding Drills in Drill Chuck. Fig. 10—Section of Chuck for Holding Screws. Fig. 11—Front View of Chuck for Holding Screws. Fig. 12—Section of Screwed Sleeve, for Chuck for holding Screws. Fig. 13—Front View of Screwed Sleeve. Fig. 14—Section of Female Center. Fig. 15.—End View of Female Center. Fig. 16—Spindle for Circular Saws and Emery Wheels.

is screwed next for ½ in. up, and screwed into the body of the chuck, which is then placed on the mandrel, and the projecting piece of mild steel rod is turned to form a center as shown in Fig. 1; also the face of the chuck should be trued up. Next the center is unscrewed from the body of the chuck, and a saw-cut made across the face of the chuck (or a groove made by a thin file instead) for the accommodation of two rather thin pieces of flat steel, as shown in Fig. 2. These pieces of steel should be embedded firmly in the chuck, one way of doing this being to file a small groove along the sides of the pieces of steel exactly on a line with the face of the chuck, which may be then riveted over into the grooves.

TAPER SCREW CHUCK

Another necessary chuck for wood-turning is the taper screw chuck, shown in Figs. 3 and 4. For this the best material to use is brass. One piece 1 in. in diameter by ¾ in. in length, and another 2 in. in diameter and ¼ in. thick, is required. The smaller piece is drilled and tapped right through ½ in. to fit the mandrel-nose, and the larger piece is then attached by means of three or four small screws, as shown in the section Fig. 3. The chuck is next placed on the mandrel, and a small hole made through the exact center of the large plate, while revolving in the lathe, which is then unscrewed from the smaller portion, and the small hole is reamered out from the back (using a taper reamer) to fit a wood-screw, as shown in Fig. 3. This hole should be countersunk at the back, and the screw is then securely soldered in place. Replace the circular plate, screwing tightly in place, and then the face of the chuck may be turned true in the lathe.

CARRIER CHUCK FOR METAL

For turning metal work between centers, a carrier chuck, as shown in Figs. 5 and 6, is used. For the body of this a piece of metal 1 in. in diameter by 1 in. in length is required, being drilled and tapped right through ½ in. to fit the mandrel nose, as shown in the section Fig. 5. A piece of mild steel rod 1 in. long by ½ in. diameter is screwed for ½ in. up, and screwed into the body of the chuck, which is then placed on the mandrel, and the projecting piece of steel rod turned to form a center, as shown in Fig. 5. Next, two pieces of mild steel rod, 2¾ in. long by ¼ in. diameter, are bent as shown in Fig. 5, and have a thread put on the bottom end for a short distance, being then screwed very tightly into the body of the chuck, as shown.

DRILL CHUCK

A drill chuck is a very handy addition to a lathe, and a simple one is shown in Figs. 7, 8 and 9. The body of this chuck consists of a piece of metal 1¼ in. in diameter by 1½ in. in length, and is drilled and tapped right through ½ in. to fit the mandrel nose. Next, the body is placed on the mandrel, and the projecting portion of the screwed hole is bored out to the full ½ in., which will leave a smooth, central hole in the body 1 in. long by ½ in. diameter. Next, two holes for ¼ in. set-screws are drilled and tapped, opposite to each other, as shown in the section, Fig. 7, these screws serving the purpose of gripping the drills securely. There are two ways of completing the drill-chuck. The first is, assuming that the drills to be used are made from steel rod ¼ in. in diameter, to make a metal sleeve 1 in. long by ½ in. diameter, as shown in Fig. 9, with a ¼ in. hole running through the middle (this hole being bored in the lathe, with the sleeve in position in the chuck), and with a saw-cut down one side. The use of this is obvious, the metal sleeve being placed inside the hole in the body of the chuck, and the drill inside the hole in the sleeve, when, owing to the slit, the drill will be securely gripped on tightening the two set-screws. The set-screws also offer a means of very fine adjustment for centering the drill accurately. The second method is, assuming twist-drills are to be used, to make a separate metal sleeve (1 in. long by ½ in. diameter, as described above) with a central hole to fit each different size of drill used.

CHUCK FOR HOLDING FINISHED SCREWS

For facing and turning heads of finished screws a chuck that will not spoil the thread on same is required, and such a one is shown in Figs. 10, 11, 12 and 13. The body of this chuck consists of a piece of metal, 1 in. in diameter by 1 in. in length, drilled and tapped right through

½ in. to fit the mandrel-nose, as shown in Figs. 10 and 11. For holding the screws, screwed metal sleeves are used, ¾ in. long by ½ in. diameter, as shown in Figs. 12 and 13. These sleeves screw into the body of the chuck, and each one has a hole drilled in the exact center (while revolving in the lathe, to insure accuracy), and tapped to fit the screw being turned. Of course, a number of sleeves with different sizes of hole will be required to fit varying screws. For removing these sleeves, a flat is filed on opposite sides of same, as shown in Figs. 12 and 13, to enable a spanner to be used for the purpose.

FEMALE CENTER

In drilling work mounted on the face-place a female center will be required to fit over the center on the loose head-stock. This may be made from a piece of metal 1¼ in. in length by ¾ in. in diameter. A hole is drilled at one end as shown in the section, Fig. 14, to fit over the loose headstock center, on which it is placed next, and a center drilled, as shown in Fig. 14, by means of a drill (with a suitable angle at the point) placed in the drill chuck on the mandrel.

SPINDLE FOR CIRCULAR SAWS, ETC.

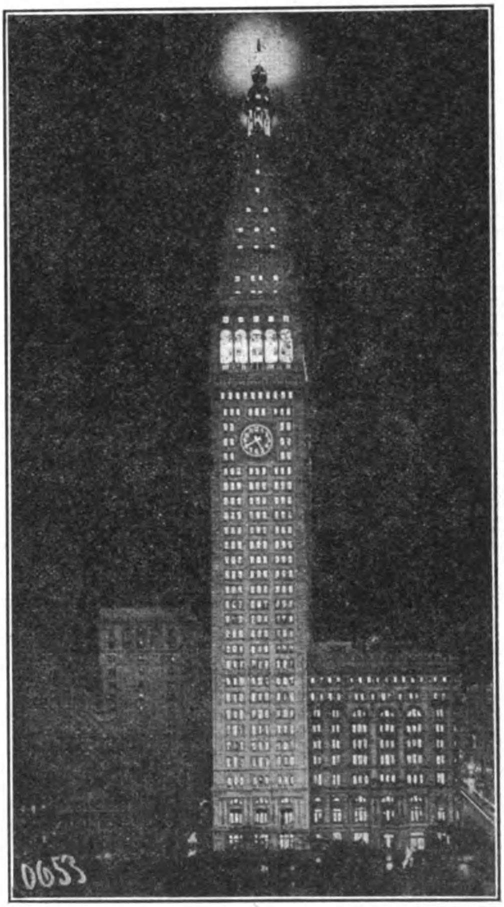
A simple method of making a mandrel for holding a circular saw or an emery wheel, is as follows: A piece of mild steel rod, of suitable diameter, has the ends marked, and center holes drilled, as shown in Fig. 16, as accurately in the middle as possible. Next, a brass or iron collar is either shrunk on or made a driving fit, and securely fixed with a screw right through into the steel rod. After screwing a small steel rod into the end, as shown, to act as a carrier, the mandrel may be placed in the lathe, and the portion to be screwed together with the collar turned true and to size. Finally, screwing the portion required completes the mandrel.

All of the chucks described will be found to answer their purpose very well in practice, although being of easy and simple construction, the assortment given should be found quite sufficient, with the addition of a face-plate (which should be purchased, as being more satisfactory) for all ordinary work required to be done in a small lathe.—*English Mechanic and World of Science.*

The World's Best Lighted Tower Clock

FELIX J. KOCH

Those qualified to know claim for the great clock in the tower of the Metropolitan Life Insurance Building, on Twenty-third Street, New York City, the distinction of being the best-lighted tower-clock in the world. The clock is connected with an electric cont roller



Metropolitan Building

which announces the arrival of the hour by 88 white lamps bursting into flame, and of the quarter and half hours by the illumining of 56 red lights.

Self-sufficiency is soldered down by useful knowledge, and men's minds become less arrogant in proportion as they become better informed.—BISHOP OF LITCHFIELD.

HOW TO MAKE AND INSTALL A STATIONARY VACUUM CLEANING SYSTEM

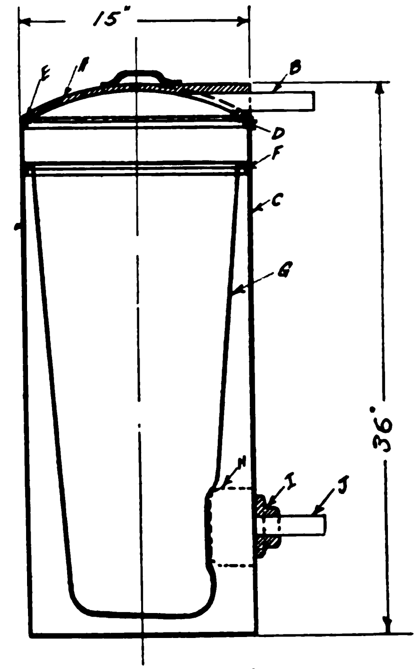
H. M. NICHOLS

The writer was lead to take up this subject by an inquiry from the owner of a light automobile for a vacuum cleaning system that he could operate from his automobile engine. It was his idea to buy a pump and rig up the rest of the system himself. This idea appeals to the writer as being the simplest solution of the problem, as outside of the pump the apparatus is quite simple and easy to make. With this idea in view, this article will be confined to the description of a suitable dust collector and other parts necessary to form a complete vacuum cleaning system, outside of the pump, which, it will be assumed, is already on the job.

The complete vacuum cleaning system can be divided into several heads, as follows: the pump or vacuum producer, the dust tank, the piping system, and the hose and cleaning tools.

The vacuum pump may be either of the rotary, the reciprocating, or centrifugal fan types. If one of the first two types of pumps mentioned (high vacuum types) is installed, it should have a displacement of at least 35 cu.ft. of air per minute, and should give a maximum vacuum of not less than 5 in. of mercury. If a centrifugal or fan exhauster (low-pressure type) is employed, it should have a displacement of at least 75 cu.ft. of air per minute, and be capable of producing a vacuum of at least 25 in. of water.

With the pump set in place, build a solid framework of timber around it. Use long lag screws to hold the pump firmly in place. Locate the pump as near the dust tank as possible, in order to save frictional losses in the piping. Make sure that the pump has the proper sized pulley to run it at its rated speed, when belted to the source of power. Use a piece of vacuum hose to connect the air inlet on the pump to the discharge pipe *J* of the dust tank, or if the run is a long one, use iron pipe and make the end connections with short lengths of hose. If it is desired to remove the foul air from the house, along with the dirt, pipe the exhaust side of the pump to the chimney or carry it through the wall, and allow the air to exhaust out-of-doors.



Dust Tank For Vacuum Cleaner

The dust tank is made from heavy sheet iron, with the seams either welded or soldered together. All the joints around the seams and rivets should be filled with iron cement or putty. Give the tank two coats of black shellac, soaking it in well around the joints.

The particular tank shown in the drawing is 36 in. high and 15 in. wide. However, the builder will probably find it more convenient to make the size of dust tank and parts fit the materials that he may have at hand, rather than attempt to build the tank to a given set of dimensions. With this idea in view the detail dimensions have been purposely left off from the tank drawing.

The dust is removed from the tank by lifting off the cover *A*, and then taking out the cloth bag *G* and shaking the dirt out.

The tank has an iron ring *D* riveted ¼ in. below the top. This ring forms a channel or groove which should have a strip of rubber cemented in it. This rubber ring serves as a packing, to insure a tight joint between the cover and the top of the tank. About 6 in. below this ring a second ring *F* is riveted to the inside of the dust tank. This second ring serves as a support for the dust bag. The tank can be held securely to the floor by riveting several angle straps to the side of the tank and fastening them to the floor with screws.

The dust tank cover *A* is made from either a brass or aluminum casting. The surface that comes in contact with the rubber packing should be machined smooth. In addition, the cover has a projecting ring on the inner side that holds it from slipping off the tank. A boss is provided on the side of the cover to carry the inlet pipe *B*. This boss is drilled to such a size that the inlet pipe can be driven in place, and make a snug fit. Of course the size of this pipe will depend on the size and kind of vacuum hose used. For a handle for the cover, use a malleable iron door handle, held on with small machine screws.

The dust bag *G* is made from extra heavy muslin or cotton cloth. It is gathered around a brass ring at the top and is tapered slightly to the bottom. A piece of packing is put between the dust-bag ring and the flange *F*, to keep any dust from leaking by the bag and thus getting into the vacuum pump. Make certain that all seams are tight and that there are no imperfect places in the cloth where the dust can leak through.

The exhaust pipe for the dust tank is shown at *J*. It is fitted into a flange fitting *F*, which is riveted to the tank. On the inside of the tank and over the inlet to this pipe there is a wire mesh screen *H*. This screen is intended to keep the dust bag from being drawn into the exhaust pipe by the rush of air. This screen should be about 10 in. in length and should hold the bag about 3 in. away from the mouth of the pipe.

Unless it is possible to reach all parts of the house from the dust tank, with the length of hose available, it will be necessary to run a pipe to the various floors. For this purpose, use standard weight wrought iron pipe and long turn recessed drainage fittings. These fittings are known as "Durham" fittings, and are the ones used by plumbers. They are especially adapted to vacuum cleaning piping, as when they are screwed up they make a bore that is smooth and continuous with the pipe, there being no sharp edges or ridges left for dirt to catch on and stop up the system. Wherever there is room to do so, always use the long turn fittings in preference to short turn fittings, as the long turn fittings are much less liable to stop up, due to their greater radius. Take care to have the pipe free from burs and pins, and screw the joints up tightly, using red lead on them. Provide inlets having air-tight covers for the hose on each floor. Use a short length of flexible vacuum hose to connect the bottom of the piping to the dust tank. The hose should be fastened to the inlet pipe on the dust tank in such a manner that it can be easily removed when it is desired to take the cover off for cleaning out the dust bag. If the hose makes a tight fit, just a slip joint will be sufficient to keep it from leaking.

For high vacuum pumps use 1¼ or 1½ in. pipe, and for low vacuum pumps use 2 or 2½ in. pipe, for the air line.

The size of hose and tools will vary with the type of pump used. The high vacuum pumps (rotary and reciprocating pumps) use ¾ in. and 1 in. hose, with tools to correspond. The 1 in. size will do far better work than the ¾ in. size, and in places where extra long lengths of hose are required, it would be desirable to use 1¼ in. hose. The low pressure type of exhauster (centrifugal fan) will require 1¼ in. or 1½ in. hose. The latter size will do the best work, but it is somewhat awkward to handle.

For sweeping carpets and rugs some type of carpet renovator and connecting rod will be required. These can be obtained from some local dealer in vacuum machines and tools. For cleaning and polishing hard wood floors, make a wooden shoe to fit on the cleaning face of the carpet renovator. Cover the rubbing surface of the shoe with heavy felt, leaving a slot to correspond with the slot in the renovator. For cleaning corners and places hard to get at with the carpet renovator, use the end of the vacuum hose. A good scheme would be to look at a set of cleaning tools and then duplicate any that might be desired, using heavy sheet copper or brass bent to shape and held together by soldering the joints.

When the vacuum system is all connected up and before starting the pump for the first time, prime the dust bag. This can be accomplished by putting about a quart of ordinary flour in the inlet to the dust tank and starting the pump slowly. The inrush of air will carry the flour into the pores of the cloth bag and render it dust proof. Then bring the pump up to full speed, stop up all the inlet valves on the system, and go over the piping and tank, listening carefully for any hissing noises, indicating leaks. If any leaks are found, stop them with putty. There will probably be a slight leakage that it will be impossible to locate and stop. To determine about what percentage of the total capacity of the pump is represented by this leakage, close all the inlets to the system, reduce the exhaust opening on the pump to about ½ in. and feel the strength of the breeze created by the discharged air. Then open the inlets to the vacuum piping and feel the rush of outflowing air again. These two comparisons will give a rough idea of how much air is being lost through leakage.

AERIAL NAVIES READY

France and Germany Well Matched as Regards Dirigibles

There is wide interest in the revelation just made of the real aerial military forces of France and Germany. While it has generally been believed that in case of war aeroplanes and dirigibles would be advantageously used by both sides, only well-informed persons have realized that two powerful rival aerial navies are already equipped.

It is understood in both countries that immediately after a declaration of war all private aeroplanes and airships will be requisitioned by the Government and they are already incorporated into the military aeronautic corps. Of the dirigible class France today possesses twenty-four airships and Germany, twenty-five; and it was to obtain appropriations to perfect the aerial corps that the French military authorities made known the exact strength of the French and German forces. Public opinion in France demands supremacy in the air, just as English public opinion demands supremacy on the sea.

The following table gives the clearest idea of the two rival airship forces:

FRENCH DIRIGIBLES—MILITARY

Name	System	Capacity Cub.M.	Length Cub.M.
Colonel Renard	Astra-Panhard	4,200	66
Liberté	Lebaudy-Panhard	4,800	69
Ville de Paris	Astra-Chenu	3,200	60–50
Capitaine Marchal	Lebaudy-Panhard	7,500	85
Adjutant Vincenot	Clement-Bayard	9,000	88
Le Temps	Zodiac-Dansette-Gillet	2,500	51
Clement-Bayard V	Clement-Bayard	9,000	88
Selle de Beauchamp	Lebaudy-Panhard	6,000	70
General Meusnier	Lebaudy-Panhard	10,000	95
Adjutant Réau	Astra-Brazier	8,950	86.80
Lieutenant Chauré	Astra-Panhard	8,850	83.80
Eclaireus Conte	Astra-Chenu	6,640	65
Capitaine Ferber	Zodiac-Dansette-Gillet	6,000	76
Commandant Coutelle	Zodiac-Dansette-Gillet	9,000	89
Spiers	Zodiac	11,000	104
FRENCH DIRIGIBLES—PRIVATE			
Clement-Bayard VI	Clement-Bayard	6,200	76
Astra I	Astra-Clement	4,475	18.60
Astra-Torres	Astra-Chenu	16,000	47.72
Croiseur-Transaerien	Astra-Chenu	9,000	76.25
Zodiac I	Zodiac-Ballot	910	35
Zodiac II	Zodiac-Ballot	1,600	42.50
GERMAN FORCES—MILITARY			
Z. I.	Zeppelin-Durr	12,000	134
Z. II, 1911	Zeppelin-Durr		132
M. I, 1908	Gross-Basenach	5,200	74
M. II, 1909	Gross-Basenach	5,200	74
P. I, 1908	Parseval	4,000	60
P. II, 1909	Parseval	6,000	70
P. III	Parseval	10,000	
M. IV, 1910	Gross-Basenach	9,200	
M. V	Gross-Basenach		
M. VI	Gross-Basenach		
P.L. XI	Parseval	10,000	96
Z. XI	Zeppelin	13,000	135
GERMAN DIRIGIBLES—PRIVATE			
P.L. VI, 1910	Parseval	6,800	70
P.L. VIII, 1910	Parseval	5,600	68
P.L. IX, 1910	Parseval	1,500	40
P.L. X, 1911	Parseval	1,510	40
Z. IX, Schwaben 1911	Zeppelin-Durr		
Siemens-Schuchert, 1910	S. Schuchert	13,000	120
Schutte-Lanz	Schutte	20,000	128
Veeh, 1911	Veeh	6,800	70
Bellonsanshelice, 1911		3,800	
Clouth, 1909	Clouth	19,000	42
Gaus Fabrice			
Suchard		12,000	76
Franz Steffen			

Three French airships do not figure in the chart, although they complete the number 24, while all the available German airships are mentioned. The Germans claim to have 29 units, but of these four are not military possibilities.

As to the relative value of the opposing air navies, this has yet to be proved by a conflict, although it may be said that what advantage the German airships possess in size and horse-power the French make up in speed and ease of handling.

With the new credits M. Millerand, Minister of War, proposes to ask for from Parliament and the funds to be raised by a public subscription, a still larger number of airships will shortly increase France's force by about one-third, to say nothing of private initiative, never more active than at present.

THE SLIDE RULE

C. W. WEBBER

The purpose of this article is to give the amateur an idea as to what a slide rule is, what its uses are, and why it performs mathematical computations mechanically.

The slide rule is very little known among non-professional men and seems to surprise them exceedingly when they are shown what it will do. The use of the rule is confined almost entirely to engineers and students in scientific schools.

The slide rule was made possible by the invention of logarithms about 1614, by John Napier, Baron of Merchiston, and their improvement by Professor Briggs. In 1630 the invention of the slide rule, by Edmund Wingate, followed.

The slide rule is an instrument by means of which mathematical computations can be performed mechanically. It consists of scales so arranged that one can be moved past the other.

In order to explain the instrument it is necessary that the reader understand the principle of logarithms. Any number can be expressed as the power of any other number; for example, 4 equals 2 raised to the second power; that is 2^2; and 64 equals 4 raised to the third power; that is 4^3. Now suppose we express all numbers as powers of 10; that is 10 equals 10^1, 100 equals 10^2, 1,000 equals 10^3, etc. It is seen that the numbers between 10 and 100 can be expressed as powers of 10, but that the powers will be greater than 1 and less than 2. For example it has been worked out that 45 equals $10^{1.6532}$. The exponent is called the logarithm of the number and the number which is raised to the power is called the base. Thus 1.6532 is the logarithm (commonly called log) of 45 to the base 10. The system of logarithms used in ordinary practice has 10 for a base, although the base used in higher mathematics is 2.718. The first system is called the Briggs or Common System, while the other is the Napierian or Natural System. We will, however, only concern ourselves with the Common System. Logarithms of numbers have been worked out and tabulated, so that to find the logarithm of any number it is only necessary to refer to a table.

A few logarithms are given below:

Number	Logarithm
1	0.0000
2	0.3010
3	0.4771
4	0.6021
5	0.6990
6	0.7782
7	0.8451
8	0.9031
9	0.9542
10	1.0000
20	1.3010
30	1.4771
100	2.0000
200	2.3010
300	2.4771

There are two parts to every logarithm: the part to the right and the part to the left of the decimal point. The part to the right is called the Mantissa, and the part to the left is called the Characteristic. Thus, in the above table log 300 equals 2.4771; 2 is the characteristic and 4,771 is the mantissa. The characteristic simply shows the location of the decimal point, while the mantissa shows what the number is. In the above table it is seen that 3, 30 and 300 all have the mantissae equal to 4,771, so that if we did not have

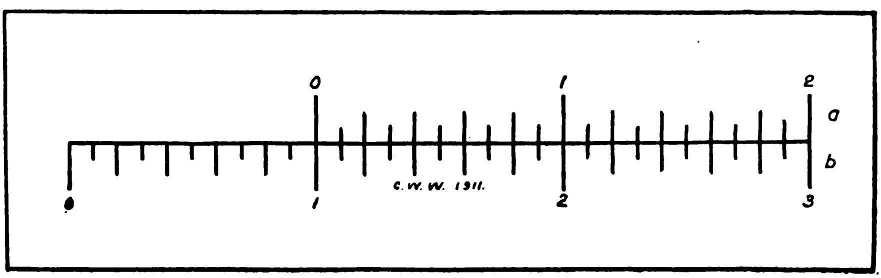


Fig. 1.

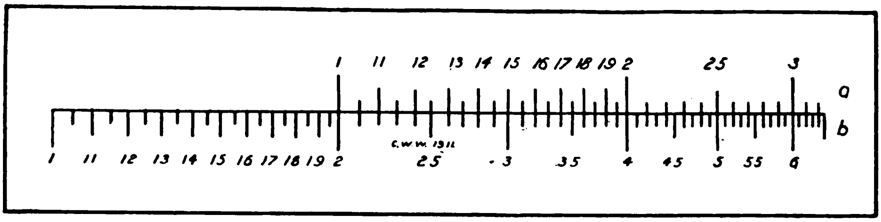


Fig. 2.

the characteristic, we could not tell what the number was.

In algebra, to multiply two numbers together we add their exponents thus, $X^3 \times X^2 = X^5$. Now as a logarithm is an exponent, if we wish to multiply two numbers together we add their logarithms. Suppose, for example, we wish to multiply 5 by 2. From the table we get

$$\begin{aligned} \log 5 &= 0.6990 \\ \log 2 &= 0.3010 \\ \hline & \ 1.0000 \end{aligned}$$

In the table we find that the number having a mantissa equal to .0000, and a characteristic equal to 1 is 10.

In dividing numbers we subtract exponents, so that in dividing 10 by 5 we get

$$\begin{aligned} \log 10 &= 1.0000 \\ \log 5 &= 0.6990 \\ \hline & \ 0.3010 \end{aligned}$$

which gives us 2, for 2 is the number whose logarithm is 0.3010.

Let us now apply this to the slide rule.

Suppose we have two scales equally divided and arranged so that one can be made to slide past the other. In Fig. 1 let the zero of scale *a* be the index. It would be well to follow this through, using two rulers and sliding one past the other. Now, if we place the index of scale *a* at the 1 on scale *b*, we have measured off one unit on scale *b*. Look along scale *a* until we come to the division marked 2, and under it on scale *b* we find 3; that is, we have laid off one unit on scale *b* and added to this two units by means of scale *a*, giving us three units as a result on scale *b*. In the same way any two numbers can be added.

Now, suppose that instead of the scale Fig. 1 we have a scale in which the divisions represent the logarithms of the numbers instead of the numbers themselves. Such a scale is shown in Fig. 2. The divisions are, however, marked with the numbers corresponding to the logarithms. In this case 1 will be the index. Suppose we wish to multiply 2 by 3, we lay off 2 on scale *b*, add to it 3 by means of scale *a* in the same manner as above, and the result is 6 on the scale *b*. In order to follow this through, the writer would advise that the reader obtain from a dealer in mathematical instruments a sheet of logarithmic plotting-paper and cut out two strips about ½ in. wide, and slide one past the other. The cost of a sheet of this paper is five cents.

To divide one number by another the operation is the reverse of the above; that is, to divide 6 by 3 (Fig. 2), we lay off log 6 on scale *b* and subtract from it log 3 by means of scale *a*, giving us 2 on scale *b*.

Any two numbers can be multiplied together in the same manner as above, so it is seen that the process of multiplication has been reduced to moving a slide. This is a great saving of time and labor.

There are many other things that can be done with the slide rule; for example, finding the squares and square roots of numbers, working out problems in proportion, finding the logarithms of numbers, and several other things. These will not be taken up, however, as they are explained at length in instruction books which come with each instrument.

In closing, the writer would advise the student to buy a cheap slide rule for practice, so that he may become familiar with this wonderful but simple instrument.

"Kind lady, I'm just merely trying to
keep
Soul and body together!"—he did
look thin;
But the lady did neither smile nor weep,
As she handed the tramp a safety-pin!

PRACTICAL OPERATING FAULTS OF THE ALTERNATING AND DIRECT CURRENT MOTOR

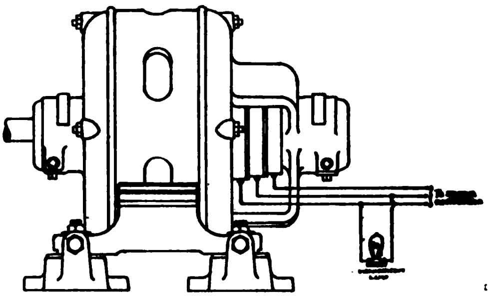
WM. G. MEROWITZ

It is always interesting to the practical mechanic to understand the construction and principles of operation of all machinery, especially those mechanisms which are associated with his daily work or to which most of his study is given. But a mere understanding of operation is not the only essential to a thorough knowledge of the machine performance. With this point in view, a few words on every-day faults in the operation of electric motors will not be amiss.

For alternating current circuits we have the synchronous motor, commutator motor and the induction motor, while for direct-current circuits we are using only a commutator motor. Of the A.C. motor, the type most commonly used at present is the induction motor, either of the single- or poly-phase winding, and of the squirrel-cage or wound-rotor type.

ALTERNATING CURRENT MACHINES

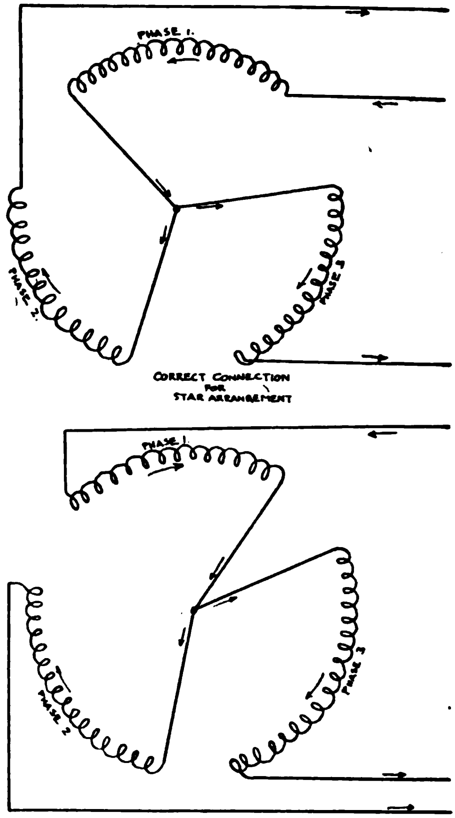
Before taking up the common faults in A.C. motor operation, it may be well to review briefly just what is going on in the performance of the squirrel-cage induction motor. If by closing a 3-pole switch, we connect the stator winding of a 3-phase motor to the line, then the armature, while at rest, corresponds to the secondary winding of a transformer, although the construction is somewhat different from that of an ordinary transformer. And the field does not pulsate like that of a transformer, but rotates. This rotating field produces electromotive forces both in the stator and rotor windings. The counter e.m.f. now produced in the stationary winding is like that of the primary coil of a transformer, nearly equal to the applied voltage, so that only the magnetizing current flows in the primary winding, when the secondary windings are not short-circuited. But the magnetizing current of a motor must be much larger than that of a transformer, for the lines of force do not only flow through iron, but have to pass through two air gaps. Although the space between rotor and stator is kept as small as possible, a much greater magnetizing



3-PHASE WOUND ROTOR
FIG. 1

force is required than in the case with a magnetic flux having a path entirely of iron. On starting the motor, the field rotates with full speed around the still stationary armature; hence, an excessive current will be produced in the short-circuited armature or rotor winding, which reacts on the stator field with the effect of so weakening it that a large current is drawn from the line. This lasts only for a short time, for the current flowing in the rotor winding causes the rotor to start with considerable torque. The quicker the rotor runs, the nearer it approaches the synchronous speed of the rotating field, and the fewer lines of force it will therefore cut. Consequently the e.m.f. and current induced in the rotor decrease, the reaction on the field becomes smaller, and the stator absorbs less current from the mains. To avoid these rushes of current, we must not short-circuit the rotor windings, but connect them with slip rings, so that a resistance may be placed in the rotor circuit, which is used for starting only, for when actually working under a load, there is no difference between a "short-circuit" and "wound rotor" secondary, as we finally short-circuit the starting resistance when the rotor has reached its maximum speed. With the foregoing explanation of operation principles, a discussion of the faults of A.C. motors will be better understood.

Sometime we may want to know whether the motor has a correct rotating field connection or not. With a properly connected 2- or 3-phase motor of the wound rotor type, this can be readily determined by observing the voltage



WRONG CONNECTION FOR STAR ARRANGEMENT

FIG. 2

induced in the windings of the rotor. A lamp connected with the slip rings, as shown in Fig. 1, will burn regularly as long as the rotor circuit, through the starting resistances, is not closed. The position of the rotor does not make any difference, since the field rotates with a uniform speed about the stationary rotor.

With a single-phase motor, however, we have no rotating, but a pulsating field; and the lamp would burn either brightly, or with little light, or no light at all, according to the position of the rotor coil in the pulsating field. Hence, if we connect a lamp or voltmeter with two slip rings of a wound rotor, and with a slow rotation of the armature, we observe that the voltage between the two slip rings varies considerably, then we can infer that there is something wrong with the revolving field. In the case of a squirrel-cage motor, one of the phases of a 3-phase motor may be connected in, in a reversed order, as in Fig. 2. This would be a mistake made in the shop where the machine was built, and would be recognized by the motor failing to attain its full speed. Then the three currents entering the motor are not alike, as they should be, and often at starting a considerable humming will be noticed. Another fault with induction motors is a sudden shut-down and resulting blowing of fuses. Upon investigating, all circuits may be O.K., and, in fact, the motor was probably operating satisfactorily for some time. But the common cause is the rotor rubbing on the stator teeth, on account of no air gap. Air gaps of induction motors are generally made very small, to insure good power factor for the magnetizing current, which lags behind the applied voltage and thus lowers the power factor. The magnetizing current is used principally to force the lines of force through the air gap, the iron parts of the magnetic circuit not taking much. Therefore, the smaller the air gap, the better the design, and in the case of a shut-down or blowing of fuses, the air gap should be investigated. This rubbing is also injurious to the winding, and, since the energy represented by it is shown as load, it may be of sufficient magnitude to destroy the insulation, introducing short-circuits and grounds. Low voltage on the line is another cause of induction motor trouble, since the output of an induction motor is proportional to the square of the applied voltage. Hence, if a motor has swings of load, carrying it up for a moment to someting near its maximum output, it may break down under such load conditions if the voltage is low. In starting a motor, too, a low starting torque will result from a low voltage. Low voltage on a motor may be caused by an unbalanced voltage on the line.

Short-circuits in the stator winding are a source of considerable bother with poor insulation. Such a short-circuited coil does not burn out at once, since the current induced in it by the pulsating flux, opposes the flux. About three times the normal voltage flows and creates a local heating, which may affect other coils, until finally the motor becomes inoperative. In a plant using motors it is well to measure the insulation resistance once a month, at least, to locate such faults soon after they appear.

If a single-phase motor will start free but will not start under load, it shows that either the line voltage is too low, the load too great or the frequency too high. The speed of the motor is directly proportional to the frequency of supply, therefore with high frequency we have a high speed. But the output is also proportional to the product of torque and speed; hence for a constant horse-power output the torque will decrease if the speed increases, and, as the torque is the real turning effort of the motor, the machine will not start if the torque is too low, due to a high frequency. The voltage and frequency with motor running should be within about 5 percent of the name-plate rating, and the voltage within 10 percent to 15 percent while starting. Vibration in an induction motor may be due to a shaft that is sprung or by a steady unbalanced magnetic pull caused by uneven air gap clearance, or the eccentricity of the rotor. If one phase of the stator is open-circuited in a Y-connected 3-phase motor, the motor will not start alone, and if started mechanically, it will operate as a single-phase motor, with a material reduction of power. An ammeter connected in each phase will give current readings in only two of the phases. If the motor is delta-connected current will flow in all three leads, but they will be unbalanced. If, however, the motor is not started mechanically, the rotor will remain stationary, acting as the secondary of a static transformer. In such events the whole machine will rise to an exceedingly high temperature, due to the heavy current drawn from the line; and if the line switch is closed for a long period, the conductors on the rotor will be badly burned or even melted in as many places as there are poles on the stator.

DIRECT CURRENT MACHINES

In direct current motors there is a liability of more operating faults occurring than in alternating current motors. This is owing to the simplicity and ruggedness of A.C. motor design and the more complicated D.C. construction, with its commutator and sparking troubles. All faults likely to occur in D.C. motors will produce one or more bad effects, which may be classified as follows: (1) Sparking at commutator; (2) Heating of armature; (3) Heating of commutator; (4) Heating of bearings; (5) Noisy operation; (6) Voltage not right; (7) Speed not right, or (8) Motor stops or fails to start. Any of these effects is evident to a person making a careful examination, and the next step is to find out if two effects are not being produced by one cause.

We will take up the causes and remedies of the common faults enumerated above.

(1) *Sparking at Commutator.*—This is a common trouble that is not usually objectionable, if moderate in duration and amount. If allowed to continue beyond these limits it will burn and roughen the commutator, thus encouraging the difficulty. Sparking may be caused in several ways, among which are: too much current on armature, brushes not set at neutral point, commutator has high bars or poor brush contact. To decrease the effect of sparking on account of armature carrying too much current, the driven load should be reduced, the strength of the magnetic field should be increased or decrease the size of driving pulley. If the motor starting-box has too little resistance, it will cause the motor to spark badly at first, owing to a very sudden start. In this case the only remedy is an increase of resistance to cut down the voltage applied to the armature terminals.

To find the correct neutral position for the brushes, carefully shift the brushes backward or forward until sparking is minimized. If the brushes are not exactly opposite in a two-pole machine or 90 degrees apart on a four-pole machine, they should be made so by counting the commutator bars and dividing by either two or four, as the case may be. To remedy high bars on the commutator or flat bars or projecting mica, smooth the commutator with a fine file or fine sandpaper, the latter being applied by a block of wood which exactly fits the commutator. If, however, the commutator is very rough or eccentric, it should be turned down in a lathe. On large machines, a slide-rest attachment is usually provided for either turning off or grinding the commutator without removing the armature from the bearings. To improve the brush contact, draw a strip of sandpaper back and forth beneath the brush with the rough side scraping the carbon. See that the brush holders work freely; this may be the cause for poor brush contact.

(2) *Heating of Armature.*—This may result from either moisture in armature coils, eddy currents in armature core and conductors, unequal strength of magnetic poles, or excessive current in the armature coils.

Moisture in armature coils is not a very common occurrence, but a motor that stands in a damp place, or one that has been inoperative for a long time, is likely to absorb some moisture in the armature windings. A sympton of this fault is that the armature takes considerable power to run free. This is really a case of short-circuit, as moisture has the effect of short-circuiting the coils through the insulation. To remedy this, the armature should be placed in an oven or other sufficiently warm place to drive out the moisture, but not hot enough to injure the insulation. A convenient way is to pass a current through it, about three-quarters of full-load current, and occasionally turn the armature over by hand.

Excessive amount of eddy currents in the armature iron will make the core hotter than the coils after a short run, and considerable power will be required to run the armature when the field is established and there is no load on the motor. Sparking is absent with temperature rise, due to eddy currents. To eliminate these stray currents, the armature core must be more perfectly laminated, which is a matter of first construction. If there are excessive eddy currents in the conductors and not in the iron, the conductors will become hotter than the core on no load. This trouble is due to the difference of voltage induced on the two sides of each armature conductor. In this case the conductors should be reduced in thickness or split up into a number of strips or strands, which should be twisted to equalize the effects. Beveling off the edges of the pole pieces may also reduce the trouble.

Unequal strength of magnetic poles will cause excessive currents to flow in the armature, thereby heating it abnormally, in the case of multipolar machines with parallel winding. This unequal strength is usually due to the fact that the armature is closer to one or more poles. This condition may be corrected by slightly shifting the bearings, but in some cases, especially when direct-connected, it is preferable to shift the field magnet. When the armature gets out of center from too much bearing wear, however, the proper procedure is to replace the bearings with new ones.

(3) *Heating of Commutator.*—This fault, like sparking, may occur in D.C. machines, and in the commutator types of A.C. machines. There are various causes for commutator heating, among which are: Heat spread from another part of machine, sparking, carbon brushes heated by current, friction of brushes on commutator or bad connections in the brush holder. If the heat in the commutator comes from another part of the machine, start up the motor with the parts cool and run for a short time. The seat of the trouble is in the part that heats first. Any of the causes of sparking will cause heating, which may be slight or serious.

An overheated commutator will decompose carbon brushes and cover the commutator with a black film which offers resistance to the efficient collection of current. Carbon brushes require less attention than copper, because they do not cut the commutator and their high specific resistance usually reduces sparking, but it may also cause them to heat more than copper brushes. The friction produced by the brushes will generate heat, which can be detected even when the brushes carry little or no current. Reduce the spring tension and decrease voltage, keeping up speed by weakening field strength. A little lubrication of a high-grade mineral oil, applied sparingly, will help to reduce the friction.

(4) *Heating of Bearings.*—The cause of bearings heating should be found and removed promptly, but may be reduced temporarily by applying cold water or ice to them. This should be resorted to only when it is absolutely necessary to keep running, and great care should be taken not to allow any water to get upon the commutator, armature or field coils, as it might short-circuit or ground them. If the bearing is very hot, the shaft should be kept revolving slowly, as it might stick to bearing, if stopped. Heating of bearings is due to a lack of oil, shaft rough, grit or other foreign matter in bearings, shaft and journal too tight, shaft sprung,

or bearings our of line, too great a load on belt, or bearings heated by hot armature, commutator or pulley. A rough shaft should be turned to smoothness in a lathe and the bearing fitted to the new diameter. It is very difficult to straighten a bent shaft; it might be bent back or turned true, however, but usually a new shaft will be necessary. In lining up bearings by either raising or lowering the bearing on its seat, or by moving it sideways, it is well to note that an even air gap must be maintained at all times, to avoid any trouble due to an unequalized magnetic pull on the armature. If there is too great a load or strain on belt, which would cause heating of bearings, reduce the belt tension or use larger pulleys and lighter belt, so as to relieve the side strain on the shaft. The slipping of the belt on the pulley may heat one or both bearings.

(5) *Noisy Operation.*—This may arise from various causes among which are: vibration due to pulley or armature out of balance, shoulder on shaft or shaft collar, strikes against bearings—this results from the armature being out of magnetic center—squeaking of brushes, flapping of belt or noise of belt joint going over pulley and slipping of belt on pulley.

To detect vibration due to unbalancing of any of the revolving parts, place the hand on the machine while it is running and change the speed. The vibration almost disappears at some speeds. The proper balance should be effected in such a case.

If the noise comes from a rattling against the bearings, it is evident that either the armature core is not properly located on the shaft or the bearings are too long. Squeaking brushes are usually the result of a rough or sticky commutator. The brushes on a new machine may be noisy, but this will be reduced after the machine has been running for a day or so.

For a noisy set of brushes, which may be detected by a sound of high pitch, apply a very little oil to the commutator with a cloth free from lint or threads. Carbon brushes are apt to squeak in starting up or at low speeds, but as the speed increases the noise diminishes. Always clean the commutator thoroughly after sandpapering it or filing it to smooth up the surface.

The flapping of a belt or the pounding of the belt joint can be distinguished from any other sound about the motor by its periodic occurrence: once for each complete revolution of the belt. To remedy such unnecessary noise, use either an endless belt, that is, one with ends glued together, or smooth up the joint by one of the many ways of lacing a belt.

(6) *Voltage not Right.*—This is a common difficulty which may arise with any machine. The main trouble is some fault of the generator supplying the energy to the line on which the motor is running. This generator trouble may result from the speed of the prime mover being too high or too low, field strength not right, brushes not in proper position or short-circuited armature or field coils. It is seldom that any trouble is experienced with the motor starting-box. However, if the line voltage is too low, the inexperienced operator would naturally think that something was wrong with the starter, when the motor would not come up to speed. It is advisable when the motor speed is low to test out for the line voltage the first thing, and a great deal of time may be saved, which would be important in a shop depending upon the motor for its driving power.

(7) *Speed not Right.*—This is generally a serious matter in an establishment where reliable speeds are essential. The speed may be either too low or too high. A low speed may come from either a low voltage, overload, short-circuit or ground in armature or shaft tight in bearings. A high speed may result from either a weak magnetic field, voltage too high, or motor too lightly loaded. Any of these faults can be easily remedied by adjusting the voltage, field or load to the name-plate rating. A short-circuited armature coil is often caused by a piece of solder or other metal getting between the commutator bars or their connections with the armature. If the short-circuit is within the coil itself, the only effective remedy is to rewind the coil.

(8) *Motor Stops or Fails to Start.*—This fault may arise from a variety of conditions, and usually causes some worry at the outset, because one knows that there are 101 things that can occur in a direct-current motor to make it stop or fail to

start. Oftentimes, after closing the switch and pushing over the starting-box lever, the operator will begin his hunt for trouble on the interior of the machine, when he finds it failed to start. As a matter of fact the real trouble is generally on the outside and is usually an open circuit of some kind. Such an open circuit may either result from a fuse blown out, a circuit breaker open, wire broken or slipped out of connection, circuit supplying motor open or brushes not in good contact with commutator. However, a motor may not start with an extreme overload or from very excessive friction due to armature touching pole pieces or shaft, bearings and other moving parts being jammed.

If the load is too great when the switch is closed, the motor will draw an excessive current, which will either melt the fuses or open the circuit breaker. Without these safeties in the circuit, the armature would likely burn out. The field circuit of a shunt-wound motor may be open, in which case the poles would not be magnetized and the armature would be drawing a large current. In such a case, or even when the field is only weak, the motor armature is apt to burn out, unless there are fuses or a circuit breaker in the circuit.

From the foregoing discussion of the practical faults in electric motor operation, it is easily seen that a thorough knowledge of the principles of operation of electric motors is of utmost importance to the efficient, economical operator. He need not be concerned with the design of these machines, but he must know what makes the machine go and how to keep it going.

SOME THINGS WORTH KNOWING

H. W. H. STILLWELL

To Make Corks Air Tight and Water Tight

In experimenting, much trouble is often experienced in the chemical laboratory in getting corks to be perfectly air or water tight, or to drill holes in them for the insertion of glass tubing, etc. Melt a quantity of paraffin in any suitable vessel, and allow the corks to be treated to remain beneath the surface of the melted paraffin. The corks may be held down by a perforated lid, wires, or any other convenient arrangement. Corks which have been treated in this manner can be cut or bored with ease and the exterior is perfectly smooth. When introduced in the neck of a flask or other piece of chemical apparatus, they form a perfect seal.

A Few Practical Hints

Clean and oil leather belts without breaking them off their pulleys. If taken off they will shrink, then a piece must be inserted in them and removed again after the belt has been run a few days.

For leading steam joints, mix the red lead or litharge with common commercial glycerine instead of linseed oil.

Too little attention is sometimes given to the bearings of engines, shafting, and other machinery. Often from 25 to 50 percent of the power is consumed through the lack of good quality of oil, or the lack of oil altogether. Machinery requires common-sense care, and if it is received, then you will be repaid many times by the increased efficiency of your equipment, and the life of same will be prolonged indefinitely.

The decay of stone, either in buildings or monuments, may be arrested by heating and treating with paraffin mixed with creosote. A common paint burner may be used to heat the stone.

In tubular boilers the hand-holes should often be opened and all the collections removed from over the fire. When boilers are fed in front, and are blown off through the same pipe, the collection of mud, sediment or scale in the rear end should be often removed.

Nearly all smoke may be consumed without the aid of any special apparatus by attending to a few simple common-sense rules. Suppose we have a battery of boilers and "soft coal" is the fuel. Go to the first boiler, shut the damper nearly up and fire up nearly one-half of the furnace, close the door, open the damper and go to the next boiler and repeat the same thing. By this method nearly all the smoke will be consumed.

RESTORING PICTURE FRAMES

G. F. RHEAD

The better class of ornamental picture frame, decorated by means of composition ornaments in gilt, is well worthy of restoration, especially the old-fashioned ones which may often be picked up, in a damaged condition, quite inexpensively from second-hand stores. They are quite within the scope of the amateur worker to repair, providing reasonable pains are taken and sufficient of the modeled ornament is left from which to make up missing parts. A fair sample of this class of frame was recently purchased by the writer for a mere song, same having been rather badly knocked about. Fig. 1 will give some idea of its condition, when it will be noticed that in many parts the ornament has been entirely broken away, although one corner is fairly complete, which fact will make it a comparatively easy matter to repair the rest. As the four corners of these frames are in almost every case alike, the method of repairing is to make a plaster mould of the undamaged portions, and from this mould to take "squeezes" in composition to replace those that are missing.

The first matter to see to is whether the miters of the old frame are firmly secured. Very often the wire nails which held them together have lost their hold, and in such a case new holes should be opened with the brad-awl and fresh nails entered. After this the frame should be given a thorough washing with warm soap and water, working in all the interstices with a small hog's-hair brush, the most convenient shape being shown in Fig. 2. Then set the frame aside to dry.

Usually with a little touching up one corner can be made pretty complete. In the case of the frame illustrated, the corner marked *x* had been only slightly damaged, so the missing parts, which were hardly noticeable, were built up by applying small pieces of composition

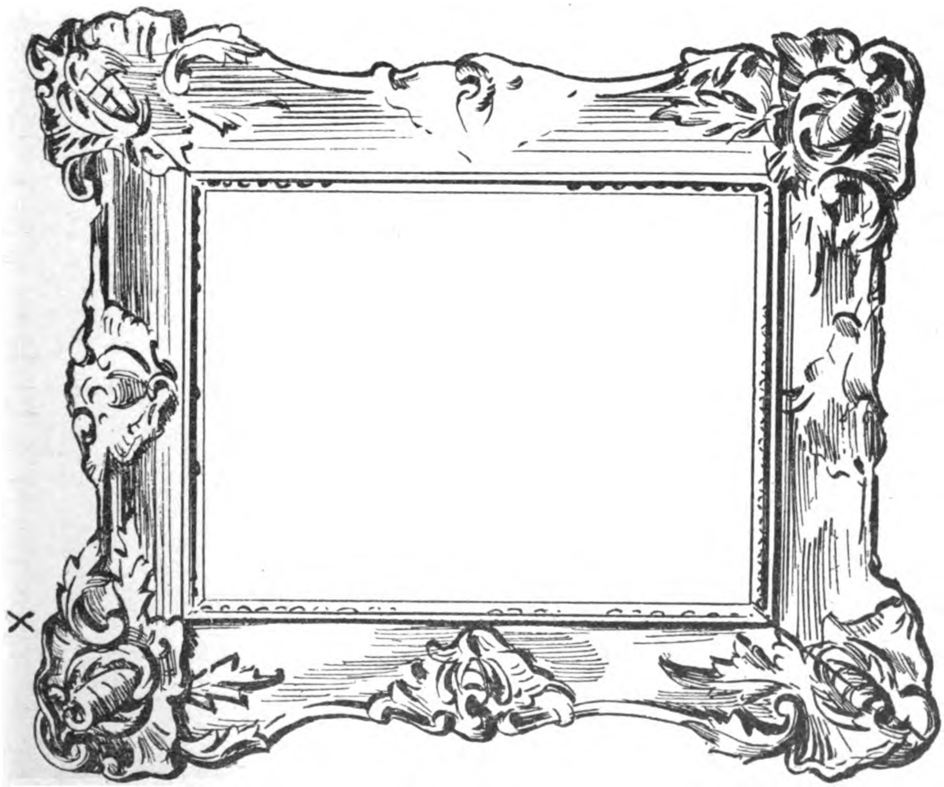


Fig. 1. Frame for Repairing

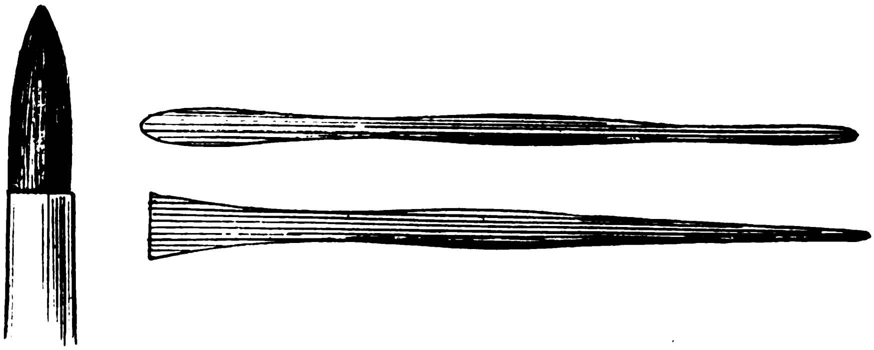


Fig. 2. Hog-hair Brush and Repairing Tools

formed into the shape of the missing parts as near as possible, with the aid of a modeling tool shaped from a piece of hard wood, two useful forms of which are shown in Fig. 2. If the best corner is rather badly damaged, molds are taken from the others of the required parts and impressions made, and so it is built up complete. The whole corner is then oiled and a little plaster of Paris mixed up to a fairly thick consistency and applied, care being taken to expel air bubbles from the hollows by blowing the wet plaster well into the crevices. This is left for a couple of hours to harden, when it should leave the frame quite easily if the portions were carefully oiled with linseed oil in the first instance. Fig. 3 shows two molds taken from the frame illustrated in Fig. 1.

In the case of frames that have been so badly damaged that the ornament is unrecognizable, the only method of restoring the frame is to entirely model a new corner and from this make a mold, as described, and take squeezes for the others. If the worker has a little knowledge of drawing and form, the modeling of such designs as shown in Fig. 4 will be a matter of no great difficulty to him. With the aid of a few tools and a suitable plastic material the production of frame corners will be a positive delight.

Composition or "compo," as it is known in the trade, may be obtained from dealers in picture frame makers' materials, fibrous plaster workers, etc. It may be made at home quite easily and then costs very little. The components are whiting, oil, glue and a little resin. Set in a jar to melt over the fire: four parts boiled linseed oil, six parts glue, and one part resin, allowing the mixture to boil together until all is thoroughly liquified, then add sufficient whiting to work up into a stiff dough. This makes a good "compo" that sets as hard as stone, but needs to be warmed and worked up each time, before using, to bring it to a plastic condition. In making it, the working up should be continued for some time, for the more it is worked the better

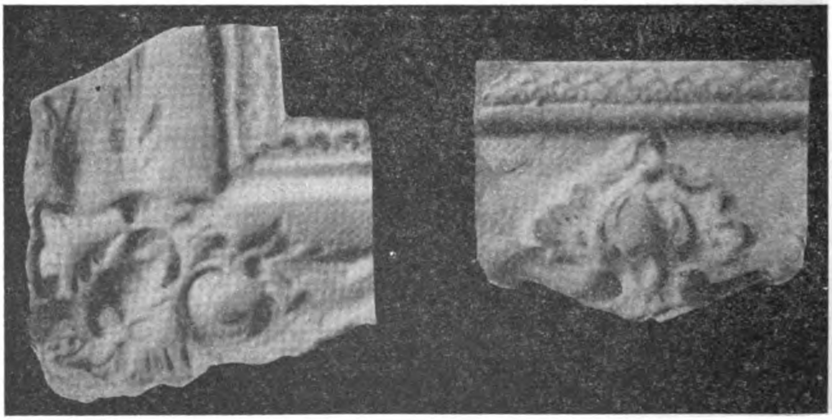


Fig. 3. Plaster Molds of Details

Fig. 4. Composition Frame Ornaments

it will become, and the less likely are lumps to interfere with a good impression.

The plaster molds having been made and dried (the drying being necessary to prevent sticking), an examination of the frame should be made to note the missing portions. If a great deal of a corner has been demolished, perhaps the best way will be to take an impression from the mold of the whole corner in "compo" and apply it to the frame, having previously removed the existing portions. In such a case, take a small piece of the compo, press it out flat, and then work it well into the depressions of the mold. Back it up with more if necessary, and cut the back smooth with fine wire. It will be found to leave the mold quite easily, if the latter is dry, by gently drawing away from one corner. The ornament is then applied to the frame, the latter having been given a thin coating of glue to afford an attachment. In the case of a small break, an impression is taken of this part only, and the piece of composition is cut in shape as near as possible to the piece broken away. Extreme care is necessary to avoid damaging the ornaments while in a plastic state, by pressure or otherwise, and should such damage occur it will be found more expeditious to take another copy from the mold than to attempt to restore the modeling to any extent, by hand. The wooden tools previously referred to, however, will be found most useful for pressing the sections in their places, and supplying small pieces of ground if they do not just fit.

The whole of the missing enrichments are replaced in this manner and cracks and fissures filled in with the composition, also holes where the brads have been entered (if any), when the frame should be left for a day or so, to thoroughly harden, and is then ready for gilding.

A SIMPLE RULE FOR FINDING THE DIRECTION OF A CURRENT

ROBERT E. BRADLEY

The novice often asks for some simple method for telling the direction of a current in a circuit. The ordinary rules for the deflection of a magnetic needle as the "swimming rule," the "hand and thumb rule," and the "cork-screw rule," are confusing to anyone, and especially so to the novice. The following rule is, perhaps, the simplest to be found:

"To tell the direction of the current in an ordinary galvanometer, look at the coil from either the east or the west side, and if the south pole of the needle be the nearer of the two poles to the observer, the current flows clockwise in the coil. If the north pole be the nearer, the current flows counter-clockwise."

The rule appears confusing at first, but it is easily remembered in the tabular form:

"South pole nearer, current flows clockwise.

"North pole nearer, current flows counter-clockwise."

By the "north pole of the needle" is meant the pole normally pointing toward the north pole of the earth, the "south pole" meaning, of course, the other pole. By "clockwise" is meant the direction in which the hands of a clock turn; "counter-clockwise" meaning the opposite direction.

The same rule may be applied to a current flowing in a straight wire or other conductor. The wire having been placed in a north and south position, with a small pocket compass either above or below it, by regarding the wire as an arc of a circle having the compass needle at its center, the rule is easily applied.

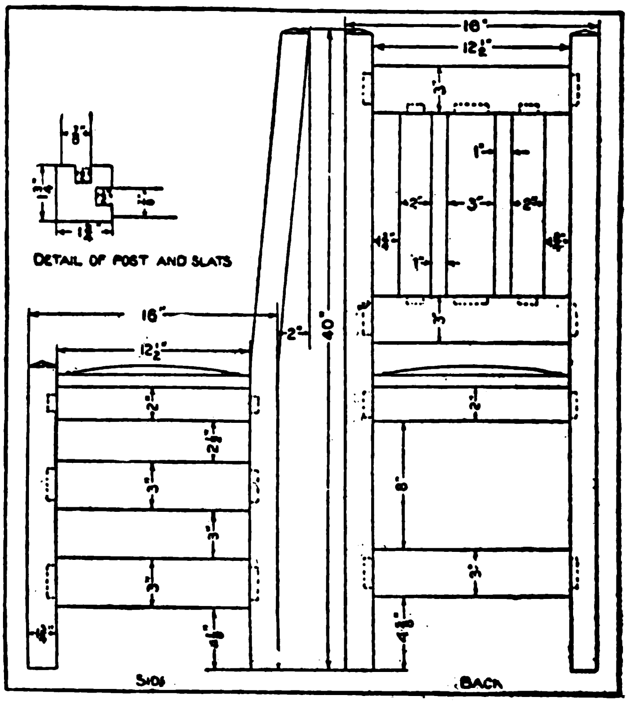
A SQUARE-CUT CHAIR

A chair suitable for the living room can be made from any one of the furniture woods. The materials can be secured from the planing mill, and the list can be made up from the dimensions given in the detail drawing. The front legs, as well as the back ones, are made from 1¾ in. square stock, the back ones having a slope of 2 in. from the seat to the top.

All the slats are made from ⅞ in. material and of such widths as are shown in the detail. The three upright slats in the back are ¾ in. material. The detail drawing shows the side and back, the front being the same as the back from the seat down. All joints are mortised in the posts, as shown. If making dowel joints they must be clamped very tight when glued and put together.

The seat can be made from one piece of ⅞ in. material, fitted with notches around the posts. This is then upholstered with leather without using springs. Leather must be selected, as to color, to suit the kind of wood used in making the chair. The seat can also be made with an open center for a cane bottom by making a square of four pieces of ⅞ in. material about 4 in. wide. These pieces are fitted neatly to the proper size and doweled firmly together. After the cane is put in the opening it is covered over and upholstered with leather.

Before the leather is put on, however, the chair should be stained and French polished, if a plain wood has been used; or polished only in the case of a better variety.—*Hobbies*.



THE CONSTRUCTION OF A SMALL WATER MOTOR

B. F. DASHIELL

Wherever the water pressure is sufficiently large, a water motor is one of the cheapest and easiest methods of obtaining light power.

It is especially desirable for running small dynamos for any length of time, such as in charging storage batteries, operating window displays, etc.

It is the purpose of this article to show in a simple manner, the construction of a water motor to operate any small dynamo

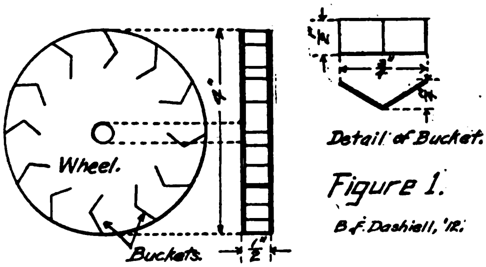


Figure 1.

having an output of 40 watts and under. For the construction of a water motor to operate larger machines, see the table of dimensions.

I have used a 25 watt dynamo in connection with this water motor and have had excellent results with same.

The water motor is very easy to construct, as it has no complicated parts.

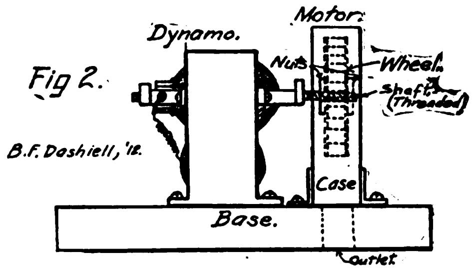
Fig. 1 shows the wheel and buckets, with all necessary dimensions. It is made of heavy tin and all parts should

Table of Water Motor Dimensions.

Greatest Horse-Power.	1/16	1/8	1/4	1/2	3/4 to 1 1/4
Dia. of Wheel.	4"	6"	9"	12"	16"
Greatest Speed.	3500	3000	2400	1800	1200
No. Buckets on Wheel.	12	12	16	20	24
Length of Bucket.	3/4"	3/4"	1"	1"	1 1/8"
Dia. Nozzle Inlet. (Jet).	1/8"	1/8"	3/16"	3/16"	1/4"
Diameter of Water Mains.	1/2"	1/2"	1/2"	3/4"	1"
Material In Wheel.	Heavy Tin	Heavy Tin	Sheet Brass 1/8"	Brass 1/4"	Brass 1/4"

be well soldered. As shown, the wheel has two sides, which gives stronger construction, but if the extending end of the dynamo shaft is not long enough, then the wheel may be made with only one side. This makes a somewhat weaker wheel.

The dynamo shaft should be threaded

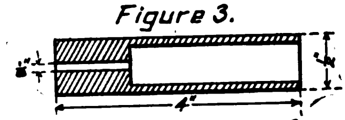


to within 1/4 in. of the bearing. This is done so that the wheel may be clamped between two nuts. See Fig. 2. The wheel should be painted with red lead so as to prevent rusting.

The containing case is made out of a tin box or can. It should be about 6 x 6 x 2 in. in dimensions. The place where the shaft goes through is found by experiment. A 1/4 in. hole is punched through at this place.

The nozzle is shown in Fig. 3. A cross sectional view is given. One end is soldered up and has a 1/8 in. hole drilled in it. This is to reduce the diameter of the issuing jet of water and to increase its kinetic energy.

Figure 3.

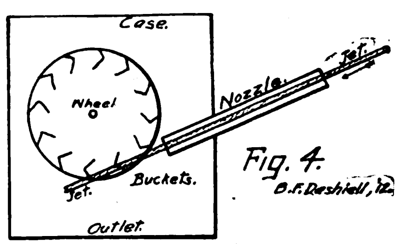


Cross Section of Nozzle.

B.F. Dashiell, '12.

A round hole is cut in the case and the nozzle soldered in place. Fig. 4 shows this and the correct direction of the nozzle. Care must be taken to direct the nozzle correctly as an error in its direction would seriously interfere with the successful operation of the motor.

The dynamo and water motor should be mounted on a heavy wooden base and connections made to a drain pipe so as to provide for the waste water. The



Direction of Nozzle.

nozzle is connected to a faucet by means of a hose. All connections should be very tight, as there is a high pressure in the hose and nozzle. The water motor ought to be provided with a front cover so that the interior may be readily inspected. The whole should have a coat of red lead on the outside and inside.

This motor attains a very high speed, owing to its small diameter. Its power will depend on the pressure. The faucet may have to be partly closed to prevent the dynamo from running too fast.

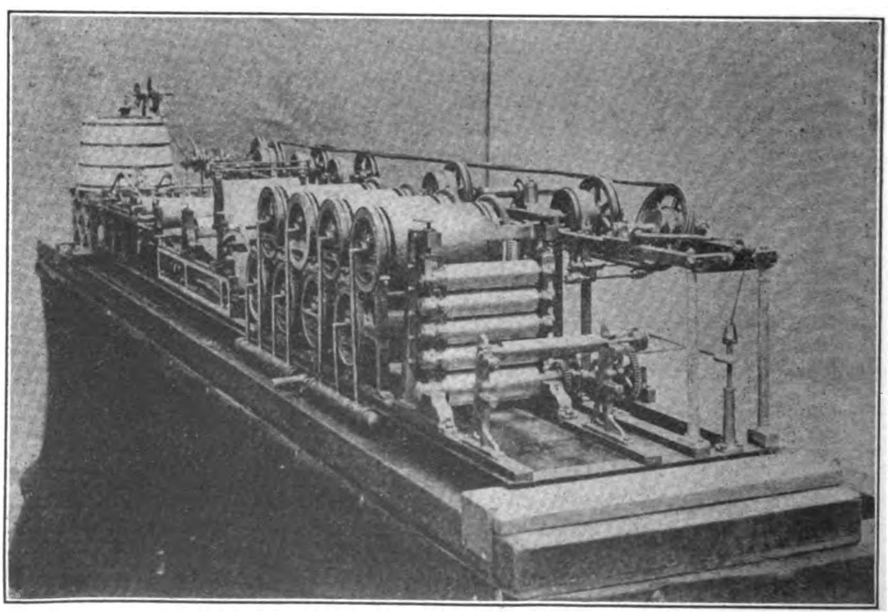
THE SMALLEST PAPER-MAKING MACHINE IN THE WORLD

THOS. H. GROZIER

The smallest paper-making machine in the world, actually producing a finished and continuous web of paper, is shown in the accompanying illustration. It is 8 ft. long by 1 ft. wide, and manufactures paper having a width of 4½ in.

The drying cylinders, which are eight in number, are heated by coal gas, an entirely new method, giving excellent results in this instance. When coal gas is not available, as sometimes happens, a special gasoline burner is attached to the cylinders, and the paper is then dried in exactly the same manner as with the coal gas. The machine uses all sorts of pulp and can turn out any kind of paper that is ordinarily produced on a large sized paper machine. The machine possesses a great advantage on account of its portability, and it can be sent from one place to another—no matter what distance—without being disconnected in any way. Owing to its self-contained properties it is possible to demonstrate the machine without creating any uncleanliness whatever, and it requires the attention of but one person. The motive power for driving is supplied by a ¼ h.p. electro motor, but when electric power is not at hand, a small gasoline engine substitutes.

The Miniature Paper-Making Machine was designed as a means of demonstrating in a practical way the entire process involved in converting fibrous pulp into the finished paper. It has fulfilled this task so well that the original model has been several times duplicated, and these are now being used by practical paper-makers, technical institutions, and even as a means of advertising the stationery departments of large stores, also by publishers who have used it in connection with public exhibits showing the scientific side of modern newspaper production.



The Miniature Paper-Making Machine

MEASURING AN ELECTRICAL CURRENT MECHANICALLY

JAMES A. SEAGER

Every mains engineer and installation contractor knows how important it is to be able not only to detect the presence of an electrical current in a cable, but also if possible to find out how much current there is actually flowing. Furthermore, it is sometimes inconvenient or impossible to disconnect the cable in order to use the necessary instruments of the ordinary type, and where such measuring instruments are not installed, or at any rate the proper calibrated resistance strip which can be used as a shunt to a millivoltmeter is not already in circuit, a considerable amount of ingenuity is necessary in order to find out what exactly is happening in the circuit under observation. It is, therefore, a very good thing for electrical engineers that the London firm of Messrs. Drake & Gorham, Ltd., have introduced an electrical current gauge of a strong and simple character, which is able to give a mechanical means of detecting the passing of a continuous current. This gauge, which is illustrated in front and side view in Fig. 1, is made under the Frisby patents, and consists of a device somewhat similar to a pair of pliers. One leg of this combination is a U-shaped bend of soft iron, which, under the circumstances becomes an electromagnet. The other leg at *B* is straight and forms the armature of this magnet, being pivoted at the center *J*. The continuation of the armature forms the lever, having attached to it a flat spring *D*, which, when *B* is closed on *A*, presses against the screw *E*. At the other end of this screw is a knob or handle *F*, to which is attached a pointer *P*. *K* is the main body of the instrument terminating in the handle *H*. Mounted on it is a dial over which the pointer plays, and the dial is calibrated so that the readings can be taken directly in amperes. When it is desired to bring the instrument into use, the pointer is first brought to the zero position and then the conductor which it is desired to test is encircled by the U-shaped bend *A*. The armature *B* is then pressed home against the magnet poles, care being taken to see that the

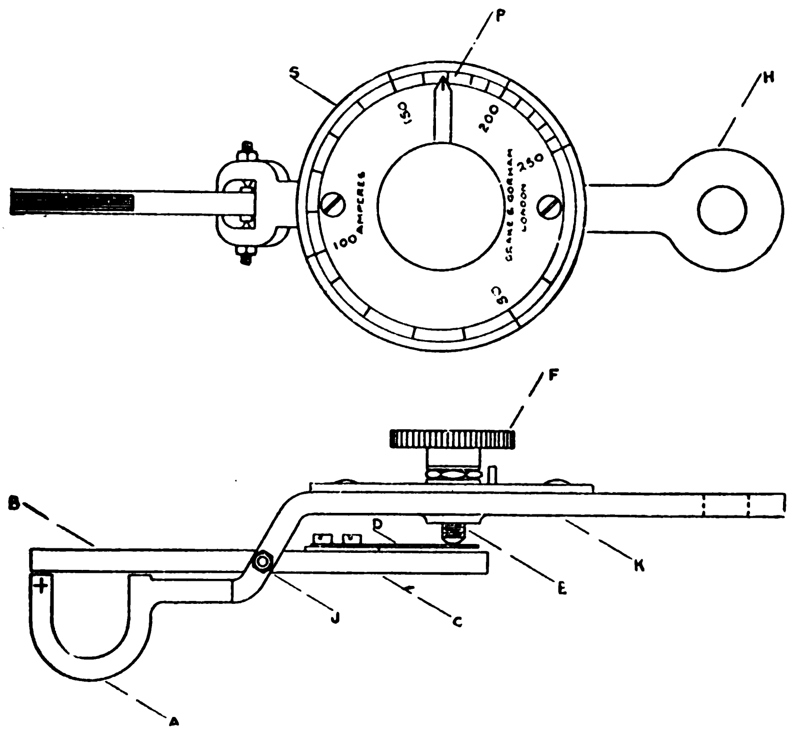


Fig. 1

conductor or its covering is free in the opening thus formed, so that the magnetic circuit does not come into mechanical contact with anything which would impede the movement of the parts. If the cable or conductor presses against the armature, the accuracy of the reading will be destroyed. When this is done the handle is held in one hand, and with the other the knob *F* is turned as slowly and evenly as possible without any jerking until the armature springs away from the poles of the U-shaped piece of iron. At this instant the pointer will indicate on the scale *S* the strength of the current which is passing through the conductor encircled by the device.

The readings can be obtained equally well in whatever way the cables are insulated, and are only slightly affected by the presence of steel armoring around the insulation. It is easy to make an experiment or so on a piece of armored cable in order to determine the correction to be applied to such an instrument for the presence of the steel. Vertical and horizontal conductors can be tested with equal ease, and it will be seen that the instrument is a simple application of first principles, namely, the utilization of the magnetic field which always surrounds a conductor carrying the electric current. Hence, the apparatus which depends on magnetic and mechanical effects and is independent of electrical contacts can be used for determining the current passing in a conductor without cutting or making any fresh connections, and this is an advantage which is peculiar to this kind of device alone. Moreover, there are many situations in which cables are placed which are difficult of access and in which the use of an ammeter would be impossible, and here again the advantages of this appliance are evident. Yet another point to be remembered is that as the action depends upon the field enclosed by the iron loop and its armature, the readings are unaffected by current passing in neighboring conductors.

It is, however, necessary to keep the poles and the armature perfectly clean, and when the direction of current in the detector is unknown, it is necessary to employ a pole finder which may now be described. This is shown in Fig. 2, and is designed on the same lines as the gauge above mentioned, but has a permanent magnet instead of a soft iron U. It is not a current measurer, but is employed to detect the presence and direction of the current in conductors, and two obvious applications of such a gauge may be mentioned. The first is when there is a fault in the cable network; the location of the fault can be easily traced by utilizing the gauge on the various junction boxes and finding the direction in which the current is flowing. It can also be employed for picking out one cable from a bunch, as when a number are run all together in one trench, by passing the current through the cable to be picked out, and testing for the presence and direction of current by means of this detector. The general description of the gauge is the same as the detector with one or two modifications. The detector is held by the handle *H*, and is first set by turning the knob *F* until the spring *D* just overcomes the magnetic attraction on the armature *B*. This determination of the "critical point" is, of course, done away from the cable to be tested. The conductor is encircled by the U loop, first one way round, pressing the armature *B* home against *R* and R_1, and then removing the hand from the armature *B*.

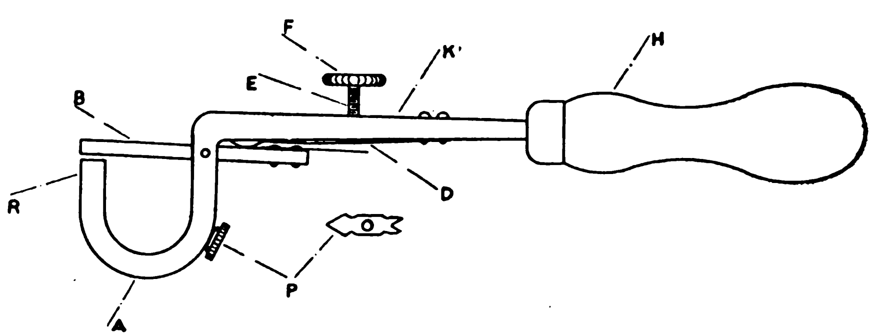


Fig. 2

If the armature now remains against the pole *R*, the direction of the current as shown by the pointer *P* mounted on the detector can be read. Supposing, however, that the armature does not remain against the pole *R*, this means that the magnetism surrounding the cable is to some extent neutralizing the permanent magnetic field of the U loop, and the position of the magnet should then be reversed so as to encircle the conductor again, but in the opposite direction. If it is now found that the armature is holding the magnet against the pole piece, the direction of the current can be read from the pointer. There is yet a third case. Supposing that after trying both ways it is found that the armature does not cling closely to the pole piece in either position it may be taken, on ordinary power circuits, that there is no current flowing in either direction in the cable. It should not be assumed, however that there is no pressure on the cable, as pressure may be applied at either end of the conductor, and if there is an open circuit there will be a static potential on the conductor resulting in no current, and therefore it would be dangerous to cut into the cable without first ascertaining that pressure was off. For determining actual presence of current, its value and also its direction, the two portable instruments which can be carried in any mains man's pocket or kit bag are invaluable to the saving of time, and will be greatly appreciated by practical men.

A QUICK SHAFT REPAIR

W. F. PERRY

While employed in a shop where motor repairing was a specialty, motors were frequently brought in, the armatures of which were frozen in the bearings, owing to the lack of proper oil.

On taking down the motor and breaking the tight-box away from the shaft, it was found that the shaft at this point was so badly scored and worn down, that it was a good deal smaller than at any place on the shaft. Owing to this a new box of the proper fit could not be made.

After swinging the armature in the lathe, the shaft (on the worn end), was turned down until it was of uniform size the whole length. A piece of steel tubing was sawed off the same length as the shaft, and (being of correct diameter) was forced onto the turned end. Two small holes were drilled through the tubing and shaft and pins driven through to make the sleeve secure. These pins were of a good driving fit. The armature was again placed in the lathe and the sleeve turned off to the regular size of the shaft, which is generally to be gotten from the opposite end of the shaft. When the job is finished up with emery and oil, and all rough places removed, the keyway should be cut through, if there is one, and the new bearing made. Upon re-assembling the motor will run as good as ever.

Shafts usually catch in the bearings, on the back or pulley end, owing to improper care in oiling or having too tight a belt. A bearing should always be renewed when the greatness of wear is first noticed. Failure to do this usually results in broken binding wires and torn armature coils.

How to Cut Glass Tubing

HOWARD TUCKER

Often, as in the making of oil cups, one wants to cut glass tubing that is over an inch in diameter. This cannot be broken by filing a nick in one side and snapping it by pressing the thumbs on the other side, as may be done in the case of smaller sized tubing. Neither will the often-told way of winding a cord saturated in alcohol around the tube and lighting it do. But, I have used the following way to good advantage, and have known it to work nine times out of ten. Bend a 1/8 or 3/16 in. round iron rod in the form of a quarter-circle and corresponding to the circumference of the tube to be cut. Then wind a wire around the tube at the point to be cut and heat the iron rod to a cherry red. Then bring the red-hot rod into contact with the tube and slowly revolve the tubing so as to heat all parts evenly, letting the rod press against the wire on the tube so as to make the portion cut off even.

When the rod shows signs of cooling plunge the tube down into cold water and it will break evenly all around at the point meant for it to break.

THE HOME CRAFTSMAN

RALPH F. WINDOES

FERNERY

Few articles combining simplicity of construction with beauty of appearance can be offered in a series such as ours, but we feel free to say that the fernery illustrated is foremost in the few. The main body is made of copper and the legs and binding strips around the top are composed of brass, fastened with large copper rivets. Inside is placed a zinc box into which the fern is set.

The material needed is the following, some of which the craftsman undoubtedly has on hand from previous projects:

1 pc. No. 18 gauge copper 14½ x 14½ in.
4 pcs. No. 18 gauge brass 1 x 6½ in.
4 pcs. No. 18 gauge brass, 2½ x 4½ in.
Some large copper rivets.
Steel Wool.
Lacquer (banana oil).
Zinc box, 3 x 6¼ x 6¼ in.

First, the pattern of the box should be laid out very accurately on a piece of paper, full size, and working from center lines so that both sides will be symmetrical. Transfer this to the copper and cut it out, bending it on the dotted lines shown on the drawing. Sharp bends may be secured by bending it over a hardwood block 7½ in. square.

Next rivet the top strips into place. These may be bent between two hardwood blocks placed in the vise, and afterward hammered nearly together. It may be easier for the craftsman to rivet them before bending up the sides of the copper piece, as he would then have nothing to interfere with his rivet set or hammer.

The corner strips come next. They should be cut and shaped as shown in the detail. A suggestion as to the forming of the correct angle on the bottom and on the projecting pieces would be to cut them straight, bend in the middle and place them on the box where they belong. Then the correct angle can easily be secured by laying them out parallel with the top of the box. This could be done with one piece and transferred to the other three.

The last operation consists in polishing and lacquering. This may be done with steel wool and banana oil. It is not a good plan to etch or otherwise decorate a piece of metal work in which both copper and brass are combined, as the contrast between the two when highly polished gives a most pleasing effect.

The zinc box should be made by the craftsman if he has mastered the art of soft soldering, but it is suggested that he have it made by a tinsmith if he has not. If the dimensions given on the drawing have been accurately followed, the zinc box will be 3 in. high and 6¼ in. square, but it is advised that the maker measure his fernery before ordering the box that size. The box should have five holes in the bottom of it, about ½ in. in diameter; also two rings soldered on the inside for handles.

PLATE RACK

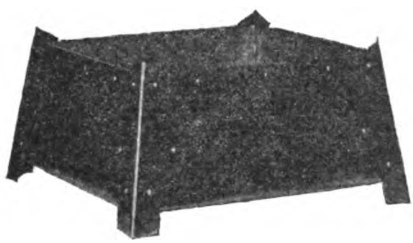
The plate rack illustrated is a combination of small, sharp angles, which give a most pleasing appearance to the whole. The material list is as follows, the lumber, quarter-sawed oak, to be planed and sanded at the mill:

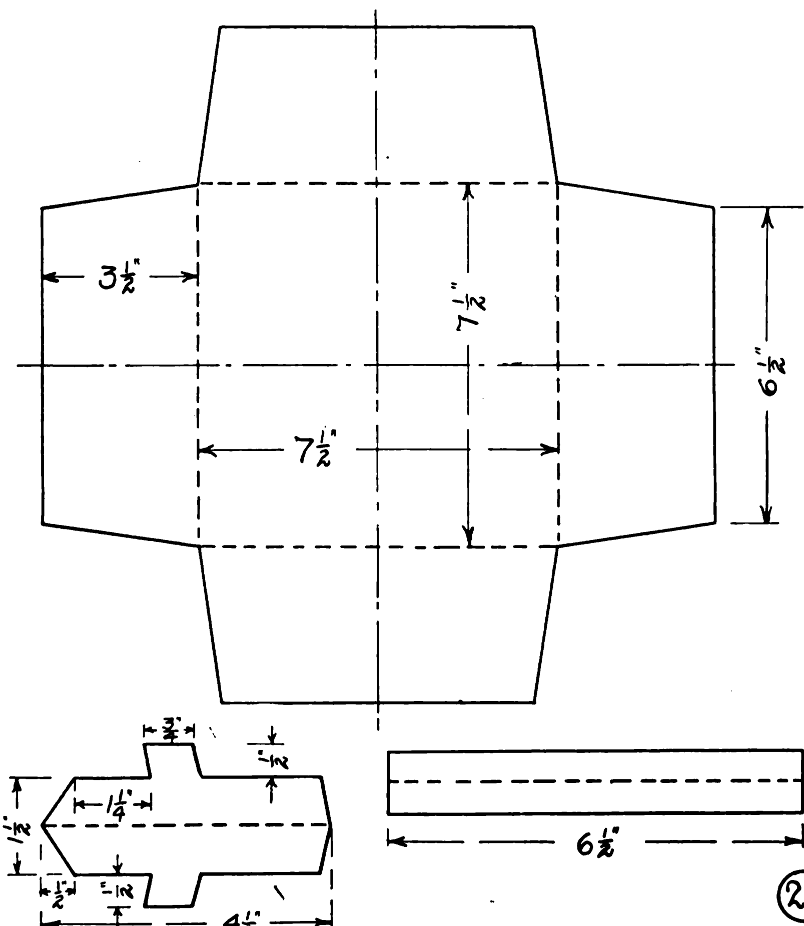
2 pcs. ⅞ x 3 x 20 in.
2 pcs. ⅞ x 2¼ x 7¾ in.
2 pcs. ⅞ x 3½ x 8 in.
8 pcs. ⅜ x 4 x 6½ in.
1 pc. ⅞ x 4½ x 34 in.
1 pc. ⅞ x 2 x 34 in.
1 pc. ⅞ x 3 x 34 in.
1 pc. ⅞ x 4½ x 36 in.
1 pc. ⅞ x 3½ x 35½ in.
1 pc. ½ x ⅞ x 33½ in.
1¾ in. 10s flat head screws.
Glue, stain, filler and wax.

The working drawing in the center section of the sheet gives the overall dimensions and shows mortise and tenon joints as most of the fastenings, the sides and shelves being screwed into place.

Cut each piece out as given in the details, and to exact dimensions. The upper shelf is not shown, but it is exactly like the lower, excepting that it is 3½ in.

FERNERY.—





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R.F.W. 1912

wide, 35½ in. long, and has but one groove down the middle of it. The eight back pieces of the lower section have their front edges beveled with a ³⁄₁₆ in. chamfer, giving them a matched wood appearance.

Where but one dimension is given on an angle, it is taken to be an angle of 45 degrees. The tee-bevel should be set at this angle and each laid off from it.

The back pieces must be placed before the mortises are glued up, or else it will be impossible to get them in. A suggestion might be given that would save the craftsman some time. He could have a groove ¼ in. deep and ⅜ in. wide sawed out of the bottom of piece *C* and the top of piece *D* when he orders the lumber, as by so doing he will save much chiseling, unless he happens to possess a grooving plow. The same suggestion might be given for the two shelves, but in case this is done, do not let the grooves be cut entirely across the pieces, as the ends should be covered by the side pieces.

As was mentioned before, the shelves are screwed to the sides and these latter to the back, which conveniently covers all screw heads, except in the bottom shelf, and these will not show when the rack is put to use.

Any style of finish may be applied to the piece, but a dark mission, well filled and waxed, is to be recommended, as it brings out the quartered flake to a better advantage than some of the other finishes.

Cypress as a Wood for Craftsman Furniture

In these articles, and others, quarter-sawed white oak has been recommended to craftsmen as the proper wood to use for furniture construction, and we still believe it to be the best. But in recent years another wood has come into popularity, which, on account of its cheaper price, lasting qualities, ease in working, and ability to take a good finish, is a close contender for the honors oak has gained. This wood is cypress, ordinary American bald cypress, as cut from the cypress swamps of our southern states.

Cypress varies in color from a near-white to a near-black, but the average is a yellowish brown, with the heart wood darker than the sap wood. It is comparatively cheap, can be secured from any dealer in the country, and if the craftsman does not care to invest much in a piece of furniture, cypress is to be highly recommended to him; and for outdoor furniture, such as garden seats, porch swings, etc., it stands in a class by itself.

It is a very easy wood to work, as it is rather soft, straight grained, and yields readily to sharp tools.

One of its greatest features lies in its beauty of finish. It may be left natural or given a deep brown color, a really beautiful tone. But before any finish whatever is applied, it is essential that the wood be perfectly dry. Of course the different pieces in the article should present the same natural color and character of grain.

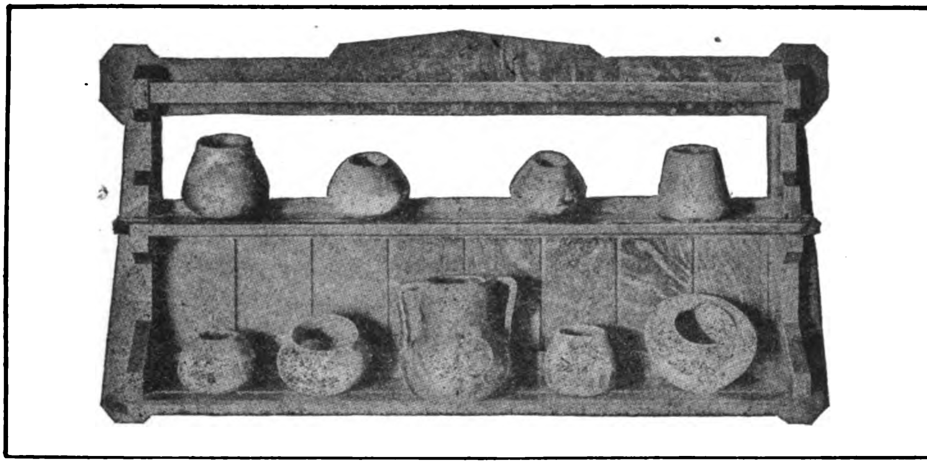
For the natural finish, we recommend three or more coats of good white shellac, each coat to be smoothed down with fine sandpaper, while the final coat may be rubbed with pumice and oil, giving the popular dull "egg shell" finish, as it is called. For the artificial color, asphaltum varnish, thinned out with turpentine, applied to the wood and soon rubbed off, gives it a wonderfully striking appearance. This should be left to dry thoroughly, then finished as above, or waxed.

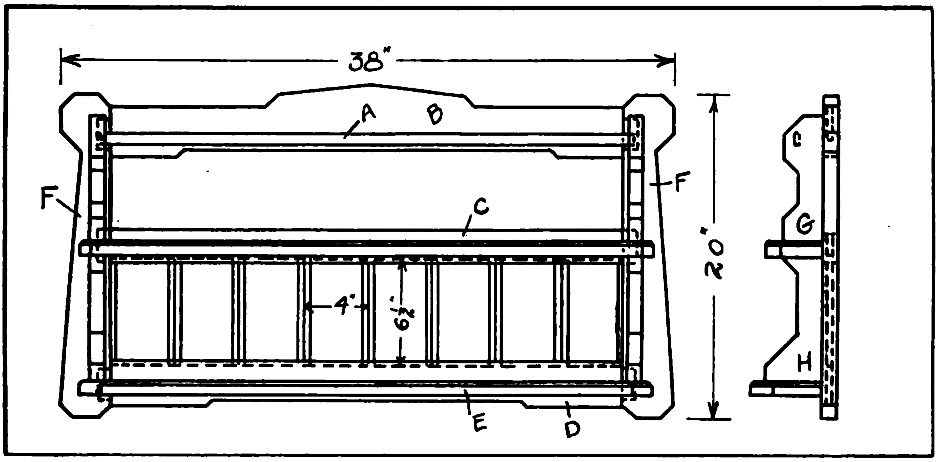
(*To be continued*)

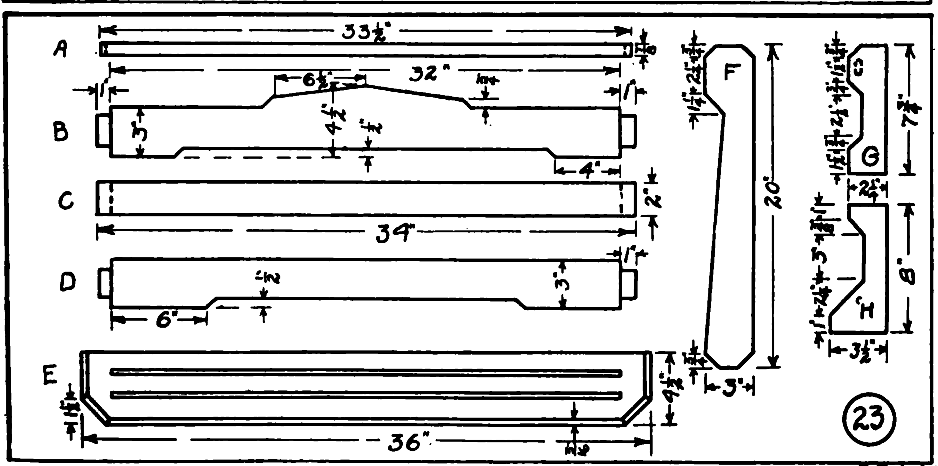
Lead in Enamels

Unscrupulous manufacturers sometimes add lead to their preparations for the coating of various household utensils, which is injurious, and vessels containing it should never be used. A very simple test and one which may be applied very rapidly is as follows: The vessel to be tested is cleaned to remove all grease, etc. A drop of strong nitric acid is then placed upon the enamel or tinning, and evaporated to dryness by gentle heat. The spot where the acid has acted is now wet by a drop of solution of potassium iodide (5 parts iodide to 100 water), when the presence of lead is at once shown by the formation of yellow lead iodide. Tin present in the enamel, etc., does not give a yellow spot when the potassium iodide is added, the stannic oxide formed by the nitric acid not being acted upon.

PLATE RACK.




38"
A
B
C
F
F
4"
6½"
20"
G
H
E
D


A
33½"
32"
6½"
B
4"
C
34"
2"
D
6"
3"
E
36"
F
20"
3"
G
7¾"
H
8"
3½"
23
R.F.W. Mc.

Wireless Telegraphy

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

NAVY TO WAR ON WIRELESS NOVICES

Investigation to be made as Result of Interference with Message of Distress—To Seek Federal Law—Officials, by Requiring Licenses, Hope to Check Amateur Operators who Hamper Seaboard Business

Serious and flagrant interference by amateur wireless operators in the transmission of legitimate messages along the Atlantic seaboard has aroused the Navy Department to such an extent that an official investigation will be begun today. Immediate action was prompted when a message of distress from the torpedo boat destroyer *Terry*, recently was interrupted by novice operators here, causing a delay of more than an hour.

Officials in the Brooklyn Navy Yard say they have the names of several young men who were responsible for the interference in the transmission of the message from the disabled *Terry*. While the pernicious interference cannot be stopped by law now, the naval officials hope to check it by a personal canvass of the amateur operators and by continued agitation cause the enactment of a federal law requiring all operators to obtain a license.

"The incident of the *Terry* is argument enough for a federal license law," said one of the navy investigators. "For more than an hour amateur operators interfered with the receipt of the message of distress. They were asked repeatedly to cease their activity in sending messages to each other. Instead of complying with the request, several of them retorted with impudent replies.

"During the delay the fierce gale and high seas that battered the distressed destroyer put her wireless outfit out of commission, and we were unable to learn her exact position to rush aid to her.

"Our country is the only one in the world in which all wireless operators are not required to have a license. There are approximately more than five hundred amateur operators in and around New York. Their interference is a serious menace when vessels are in distress, and exasperating to professional operators who have difficulty in receiving and sending legitimate messages.

"On Saturdays and Sundays the amateurs keep the air charged with messages, and it is next to impossible to carry on the regular business. It is from this fact that we deduct that most of the amateurs are schoolboys, who then have time to carry on their experiments. We have estimated that among 500 young men or amateurs who have outfits, at least half that number own and operate a sending equipment. It is the sending that causes the 'break' in messages being received by professional operators. Sometimes it is possible to check the amateurs by a process known as 'tuning them out.' But for the most part, the operators are powerless to 'call them off.'

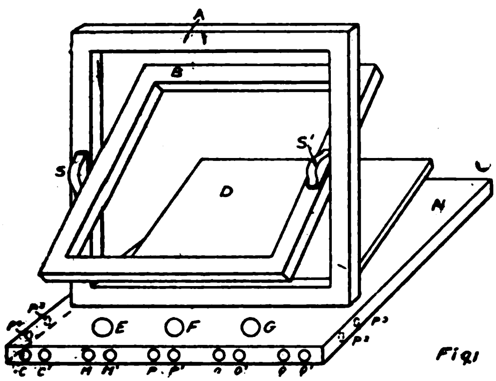
"We do not wish to be represented as discouraging young men who are ambitious in carrying on experiments in wireless operation. For the most part, they are young geniuses who have built their own stations. But when it is realized how serious their interference is at times, and what it might cost if some vessel was in distress, it can be appreciated that some action must be taken. The final solution lies in the federal license, but in the meantime we will do all in our power to discourage interference with legitimate messages."—*Aerogram*.

A THREE-CIRCUIT INDUCTIVE TUNING APPARATUS FOR WIRELESS TELEGRAPHY

With Description of Experimental Wireless Station at Richmond

G. G. BLAKE

Fig. 1 shows the wooden framework of the three-coil tuning inductance. The two frames, *A* and *B*, are made out of American whitewood, 1¼ x 1¼ in., in which is cut a groove ¾ in. wide; frame *A* is 14 in. square. *X*, Fig. 1A, is a



Wooden Framework of Three-Coil Tuning Inductance

section of one of the frames, and *Y* is the capping, which is screwed in place after the inductances have been wound in the grooves. The inductances *A* and *B* each consist of 12 turns of No. 14 insulated copper wire. *S* and S^1 are two switches (not shown in diagram, Fig. 4), by means of which either 3, 5 or all 12 turns can be brought into use as may be desired. The third inductance is wound on a board *D*, 12 in. square, in the form of a

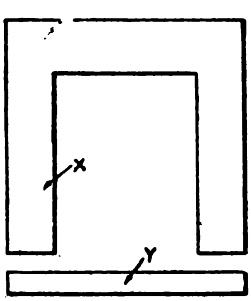


Fig. 1A
Section of Framework in Fig 1.

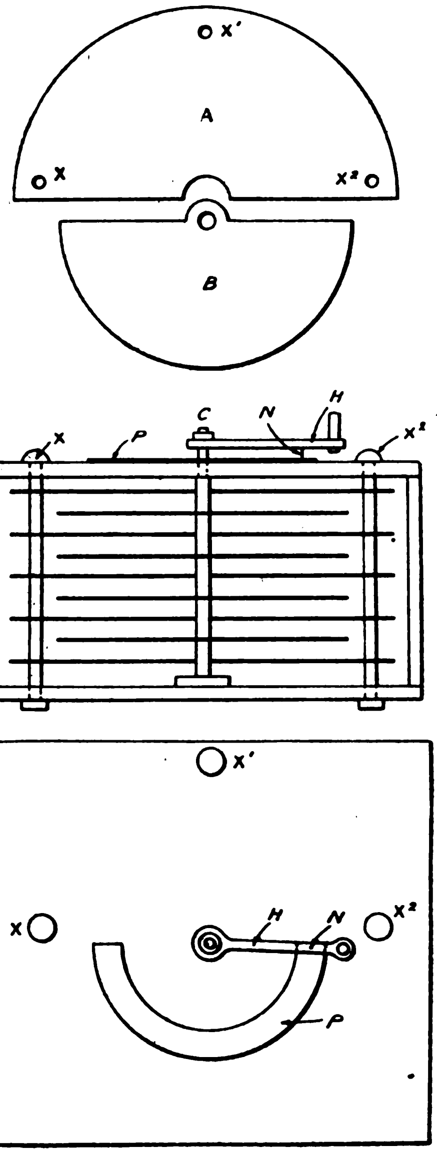


Fig. 2
Showing Construction of Condenser

spiral. No. 16 electric light wire is used for this, and is fastened in position as it is wound, with small pins driven through its insulation into the board.

Inductance frame *A* is screwed in an upright position near to one end of base-

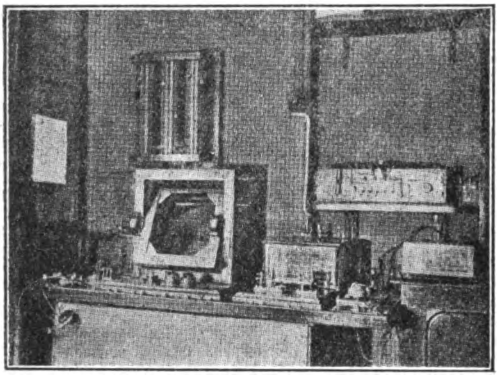


Fig. 3
A Group of Some of the Wireless Telegraphic Apparatus

board N, and inductance D is hinged to its base; inductance B is pivoted at its center. P^4 P^6, C C^1, M M^1, P P^1, O O^1, Q Q^1, P^2 P^3, are terminals for connection to condensers, aerial, etc.; E, F and G are respectively two-, three- and four-way double pole switches.

Two variable condensers, V and V^1, Fig. 4, are used in conjunction with this instrument. I have made my own of sheet zinc, separated by cycle washers, as in Fig. 2. Each condenser is made up of 25 large sheets, A, 8½ in. in diameter, and 24 smaller ditto, B, 6½ in. in diameter. Fig. 2 gives an idea of the construction. The large sheets, A, have a semicircular hole cut at each of their centers to allow the rod C (upon which the smaller sheets are fastened) to turn, and three bolt holes, X, X^1 and X^2, near their outer edges; the smaller sheets are cut with a projection and a hole in its center, through which the rod C passes.

Both the condensers are mounted, as can be seen by reference to the photograph, Fig. 3, in glass cases. The smaller sheets can be revolved round between (but without touching) the larger ones by means of small handles H, Fig. 2, an ordinary draughtsman's protractor P, which is calibrated to 180 degrees, serves as a scale; one is fixed on the top of each of the cases under a needle point N, soldered to the underside of each of the handles. Fig. 4 is a diagram of connections exactly as used at my station; 4 is a direct-coupled tuner, all the coils of which are connected in series, and which can be used in place of the 3-coil inductive tuner for stations of very great wave length. To use this, the aerial is disconnected from C^1 and connected to W^1, as shown, and the four-way detector switch is turned over to its fourth position, thus connecting P to L, and P^1 to L^1. The rest of the diagram, though somewhat complicated, needs very little explanation.

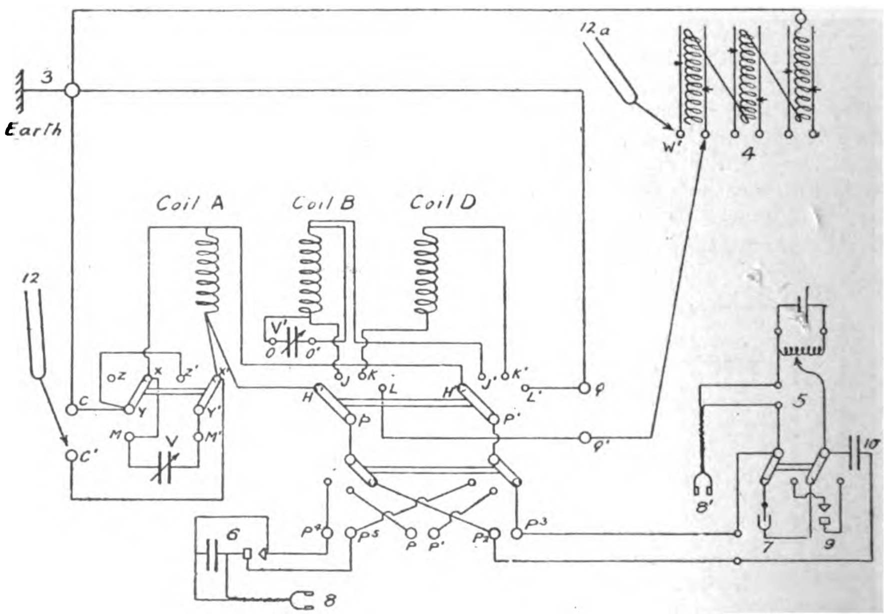


Fig. 4
Diagram of Connections

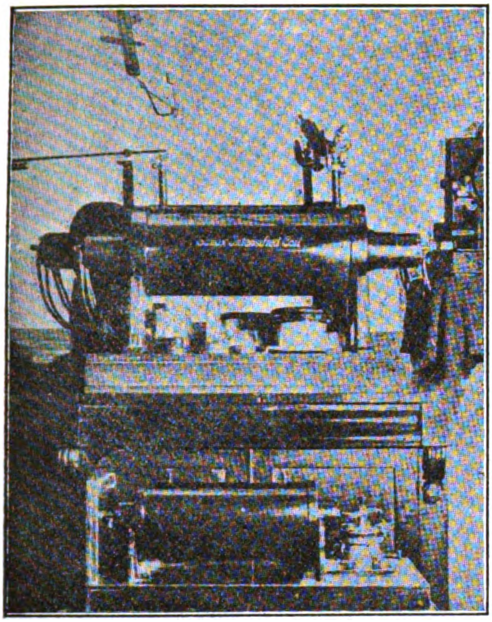


Fig. 5
General View of Mr. Blake's Coils

Coils A, B, and D are shown well separated from each other for the sake of clearness. V and V^1 are the two variable condensers; 5 is a potentiometer, with its battery and pair of phones 8, 8^1, which can be connected to either an electro-

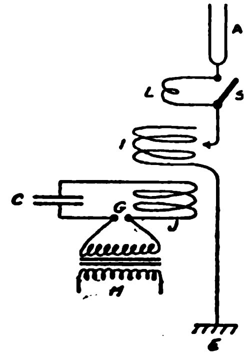


Fig. 7
Diagram of Transmitting Connections

lytic detector 7, or to a crystal and carborundum detector, 9, by means of a two-way switch. 10 is a small condenser of fixed capacity, 3 an earth connection, and 12 and 12A represent the aerial connections. P and P^1 are two extra connection terminals for testing any new form of detector. The two-way switch, marked E in Fig. 1, puts the variable condenser V, Fig. 4, either into parallel or series with the inductance A, as can be seen by following the connections shown in Fig. 4. The three-way switch F allows the tuner to be used with any

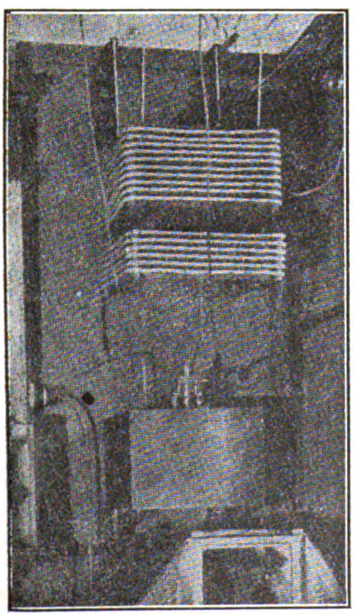


Fig. 6
Transmitting Inductance and Oil Condensers

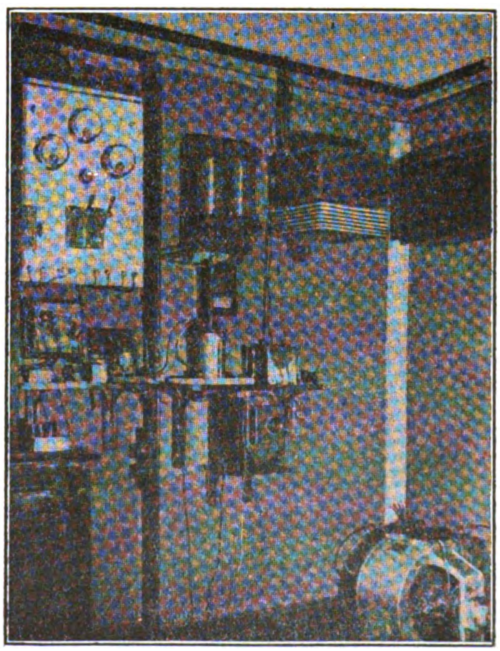


Fig. 8
Apparatus for Producing Undamped Waves for Wireless Telegraphy and Telephony

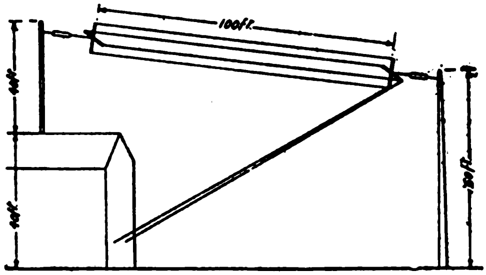


Fig. 9
Diagram of Author's Aerial

detectors connected to terminals P^4, P^5, P, P^1, or P^2, P^3.

The four-way switch *G* serves to connect up the detector across coil *A* as "stand by," or across coil *B*, in which case the signals are received inductively from coil *A*, and are, in consequence of their being more sharply tuned, much louder. The third position of the switch connects the detector across coil *D*, the third inductive coil, which is used to cut out interference when very sharp tuning, is necessary.

When switched over to its last position, the switch disconnects the three-coil tuner and connects the detector to the direct-coupled tuner 4. I think it is almost unnecessary to add that the various inductive circuits are brought into tune with each other by suitable selection of the number of turns of inductance by use of switches *S* and S^1 (Fig. 1), and by altering the capacities of the variable condensers *V* and V^1 by moving their handles.

The photograph, Fig. 3, also shows a magnetic detector on the shelf just above the right-hand variable condenser, and the motor starting switch (for mercury break used to interrupt current in the primary of coil when signaling), also the transmitting key.

Fig. 5 shows my coils, and Fig. 6 my transmitting inductances and oil condenser, which is in the box under the spark gap. Sometimes I use a rotary spark interrupter (not shown in the photograph) in place of the spark gap.

Fig. 7 shows the transmitting connections: *A* is the aerial; *L* a 16 c.p. 110 volt electric lamp, with short-circuiting switch *S*; *I* aerial inductance; and *E* earth connection.

The closed oscillatory circuit is composed of a condenser *C*, inductance *J* and spark gap *G*; *M* represents the spark coil which supplies the energy. The coupling between the two inductances can be altered at will to ensure sharp tuning. The usual wave length which I use is 300 meters, and my code call is "B O X."

Fig. 8 shows apparatus for producing undamped waves for wireless telephony and telegraphy, with one or two modifications; it is similar to the Lepel generator. It is worked from an alternator shown on the ground. The microphone used in telephone experiments is shown in the center of the photograph, and the transmitting inductances can be seen at the top of the room above the alternator. The switchboard and motor starting switches are also shown.

Fig. 9 is a diagram of my aerial, which is constructed with 7-22 copper wire, which I had made up especially for the purpose. Each strand is insulated separately; they are then twisted together, and the whole coated with insulating material.

The separation of the wires from each other allows the use of all the surface of the wire, and gives the aerial as large a capacity as possible. The guy wires holding up the masts are not shown in the diagram.—*Model Engineer and Electrician.*

SUMATRA, North Coast, Pulo Weh. The Netherlands Government has given notice that a wireless telegraph station, call letters SAB, has been established on Pulo Weh, north coast of Sumatra, near Tapa Gaja Point Light, in (approximately) latitude 5° 54′ 30″ N., longitude 95° 20′ 00″ E. The wireless signal is made from an iron mast 212 ft. high. (*Bericht aan Zeevarenden No.* 280 (2366), *'sGravenhage*, 1911). (N.M. 3, 1912.)

H. O. Charts Nos. 854*b* and 1595.

B. A. Chart No. 2760.

China Seat Directory, Vol. I, 1906, page 63.

H. O. Publication No. 87, International Code of Signals, 1911, page 120.

If a thought does not suggest other thoughts to the mind that receives it, either the thought or the mind is not worth much.

He who knows least, doubts most; at the same time he doubts not but that he knows best.

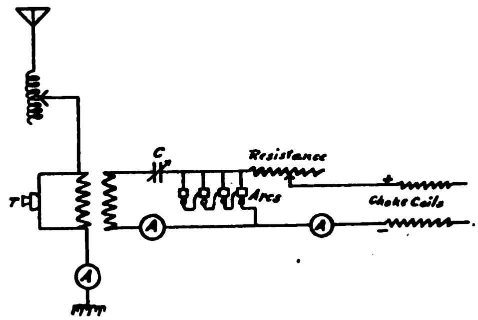
EXPERIENCES IN WIRELESS TELEPHONING

AUSTIN C. LESCARBOURA

During the latter part of 1908 and the beginning of the succeeding year, a number of wireless telephone experiments were conducted by several wireless companies, in view of proving the practicability of their respective sets and receive an order for equipment from the United States Signal Corps. The tests were between Fort Hancock, Sandy Hook, N.J., and Fort Wood located on Bedloes Island in New York Bay, the latter being on the same island as the Statue of Liberty. The total distance between the stations was 18 miles, with the high hills of Staten Island separating both. The writer at the time was in the employ of one of the competing concerns, and aided in the operating of the transmitting wireless telephone set at Fort Hancock. The experience, both from a technical and humorous point of view is interesting, and in the following paragraphs, a few incidents and descriptions are faithfully given.

Fort Hancock, as stated before, is located at Sandy Hook, a long and narrow stretch of sandy waste extending into the Atlantic Ocean and forming the lower portion of New York Bay and entrance. In summer the heat is extreme, for the sun heats the sand to a tropical heat, while in winter, the cold wind blows in from the open sea with Arctic vigor. The temperature is usually in one extreme or another, but during several months in the spring and autumn, the weather may be fair at intervals.

On a morning in the latter part of October, 1908, another man and the writer started for Sandy Hook from New York in the U.S.S. *Ordnance*. This "steamer" in reality is an overgrown and comfortable tug boat, equipped for carrying freight and passengers to the many forts in New York Harbor. After a rough trip, we arrived at 9 o'clock and immediately walked to the wireless station. This station consisted of a two-story concrete structure, with a wooden mast in the rear supporting an umbrella aerial. The wireless apparatus consisted of a 1 k.w. transformer mounted in a cabinet with the spark gap and condensers. A large desk contained the receiving apparatus consisting of a large tuning coil with silicon and electrolytic detectors. The key was mounted on a rubber base, with a long lever passing through a slot and into a tank of oil in the desk, where the contacts were located.



Wiring Diagram

Our telephone set was mounted on a large table with a back board. The transmitting set consisted of ten arc units in series, each unit comprising of a copper cylinder which was filled with water and mounted on a wooden frame; and a large carbon rod held on a long spring. The carbon rods could be adjusted by a thumb screw located at one end, which also contained a large handle, so that all the springs could be pressed down and thus start the arcs if desired. Two sets of five arc lights each were placed at both sides of the table, while the oil condenser was located in the center, in back of a switch for connecting the receiver or transmitter to the aerial and ground. On the backboard, two hot-wire ammeters were mounted, one of these indicating the high-frequency in the aerial circuit, while the other indicated the energy in the oscillation circuit. The third ammeter was of the standard magnetic type, and indicated the amperage consumed by the arcs. The current was furnished by a 500 to 600 volt C.&W. generator, directly connected to a 110-volt, 7 h.p. motor. Suitable field control, enabled us to obtain voltages from 400 to 600 volts. The microphone, which is one of the "missing links" in all wireless telephone sets, consisted of a round enclosed case with a diaphragm in front and an insulated contact in the rear. Having a number of these microphone units, we were able to slip a new one into place whenever necessary, by merely giving the mouthpiece a slight turn, and replacing the old microphone with a new one.

The first morning we arrived, the apparatus had already been delivered and was unpacked in the operating room, only the temporary wiring being necessary. We connected the motor-generator and the regular operator of the station called the power house on the telephone with orders to start up another generator for the peak load to follow. One wire from the generator was then attached to the tin side of a can, and the other wire attached to a voltmeter and then allowed to dip in the can of water. The meter then indicated whether the connections were correct, so that the positive pole could be identified. The meter did not read higher than 125 volts, and for this reason the water resistance had to be inserted. The positive and negative wires were then connected to their proper terminals on the transmitting apparatus. The water having been placed in all the copper cylinders, the arcs were started, and the condenser adjusted. This condenser consisted of 24 stationary and 23 rotary plates, the glass containing jar being filled with paraffin oil. After an hour or more of adjustment and changes, the ammeter in the oscillation circuit indicated that the current was steady. The aerial circuit was then connected to the aerial, and immediately the needles on both ammeters began to flicker again, finally coming to rest after another period of adjustment. The microphone then being slipped into place, the words were shouted into the mouth-piece. At every sound the needles on both ammeters fluctuated, the variation being more pronounced the higher the pitch, and phonograph conversation or music producing the greatest results. After a few minutes of phonograph concert, the needles of the ammeters would become inactive, which signified that the microphone had become "baked" or useless. A wooden stick or other article was then used to hit the microphone case, but having little effect on the ruined carbon grains, another microphone was inserted. From time to time the microphone had to be knocked in order to keep it from "baking," and the best results were noticed when the microphone was continually being turned; which would suggest that a carbon microphone being slowly revolved by a mechanical device would be more suitable to withstand the high amperage, since it is continually moving the carbon grains. At one time a large dog was brought into the operating room and placed on a large box with his head near the mouth-piece. He was finally coaxed into barking, which, judging from the deflection of the ammeters, must have been heard by the stations within our range. This is the first record of a dog "speaking" over a wireless telephone!

On a cold November morning we again set out for Sandy Hook on the same boat as before. On nearing the fort, the writer became worried in failing to see the wires of the aerial. A gale had swept the coast the night before, and it was not impossible that the wires had been blown down. The pole was plainly visible, but no wires could be noticed. Both of us became excited, for we knew that without the aerial, we would have a whole day wasted with nothing to do but to walk around the reservation. However, on reaching a few hundred feet from the fort, we noticed that the wires were still there and that these happened to be of a very small gauge. In fact, we believed at the time that our failure to cover a greater range was due to the inefficient aerial, which was composed of small wire and had but a single wire lead to the aerial from the station. On making the necessary connections, the starting-box lever was moved, but the motor did not start. An instant later the 60-ampere fuse in the cut-out went off, and indicated something wrong. On trying to turn the armature by hand, it was found to be firmly held by the bearings so that it could not turn. This was probably due to the extreme cold, but any way, the application of the blow-torch on the bearings for a few minutes seems to have freed the shaft so that it turned at the moving of the starting-box lever.

There was still more delay in another direction, when we found that the glass jar of the variable condenser had been broken with the extreme cold and that the oil had covered the floor. The plates were thickly coated with dust and the condenser would be unfit for use until thoroughly cleaned and placed in another jar. We substituted another condenser of the same type and started the arcs. After the customary adjusting and dickering, the meters finally came to a reasonable rest, and the phonograph started. After a short while, in which the phonograph was continually playing and only the occasional knocking or replacing of the microphone was found necessary, there suddenly came a slight noise similar to that caused by escaping steam, but just for an instant, and immediately the arcs and ammeters went wrong. It proved to be the short-circuiting of the variable condenser, a spark having jumped between two plates, and a little black dirt appeared between the plates. This dirt is a compound of carbon from the paraffin oil, and conducts the current from one plate to another, thus rendering the condenser useless for high voltage currents. Happily, we still had a large condenser belonging to the Dönitz wavemeter, which was inserted in place. It might be stated here, that this condenser, though it had the plates separated only 1/16 in. apart, withstood the potential without breaking down, while condensers with plates spaced 1/8 in. and built in this country were continually breaking down. This illustrates the accuracy of German mechanics, for the plates of the German condensers were perfectly true, which cannot be said of the others.

During the course of the afternoon, a battleship, which was passing Sandy Hook on its journey to the Hudson River where it was to anchor, called the operator and asked him the name of the set being used. On being told, he telegraphed back: "The music is fine, give us some more." We heard later that all the officers on the battleship had been called by the operator to hear the music in the telephone receivers.

In all our tests, between times when the phonograph was not working, the conversation usually ran: "Hello, Hello, Hello Fort Wood, how do you get me now? One, Two, Three, Four, Five," and so on, most of the words being shouted very slowly and drawn out. It is rather a peculiar feeling to be talking into the mouth-piece of a wireless telephone, and not knowing whether the speech is being heard or whether it is not being heard. The phonograph is used the greater portion of the time, for it carries better than the human voice. That afternoon our concert was heard at 20 miles, the Brooklyn Navy Yard operator having listened the greater part of the morning and afternoon. At four o'clock we returned to the boat for New York.

The third and last test of this series, if the writer correctly recollects, occurred in January of 1909. After all the preliminaries, such as the wiring, adjusting, substituting, and swearing, the phonograph was started, and for upwards of an hour we did not think of changing the record. The one playing happened to be, "The Anvil Chorus," from the opera, "Il Trovatore." This selection was played by a band with a number of persons whistling, and proved to be a very effective record for fluctuating the ammeters, which was a desired feature. After an hour had passed with the continual playing of the same record, we shut down the generator and arcs, while the operator listened in to hear whether Fort Wood would call us. Upon calling Fort Wood, he received no reply from that station, but Manhattan Beach (DF) immediately called, and upon being told to go ahead, telegraphed: "For —— sake change the tune." When asked whether he had received all we had spoken and played, he said that he could get all of it without trouble, but was disgusted with the same record continuously. We did change, and for the rest of the morning played different records. At 12 o'clock, a telegram arrived via the Postal Telegraph station telling us to abandon the tests as the interference was too powerful in the upper bay and while we had been heard clearly at times, the extreme proximity of the other stations completely overcame our signals. We had to wait until 4 o'clock for the boat, so devoted the time to visiting the buildings and looking over the various interesting features of the reservation. A humorous incident, the writer recalls, is the reporting of steamers sighted at Sandy Hook. The two telegraph companies, Postal and Western Union, are located at the end of the Hook, and both have tall buildings resembling lighthouses. The one we visited was maintained by an old time operator who had six wires to handle beside the reporting of the steamships sighted. There is great rivalry between the two companies as to which one reports a steamer first. The old-time operator had erected a few wires from a pole to his telegraph station, and with the aid of the wireless station operator and other local talent had succeeded in constructing a simple receiving set. He would then listen with the telephones placed on his head, and hear the different steamers report to Fire Island, about 40 miles away. Upon the first sign of smoke over the horizon about an hour and a half later, he would immediately telegraph to New York that the steamer was sighted. Meanwhile, the other operator in the other building was straining his eyes through a 5 ft. telescope to get a glimpse at the funnels of the boat. For sometime the competing operator was at a loss to understand how the veteran operator could report the ships before they could even be seen, and on asking him was informed that the operator recognized them by the smoke only! The news finally leaked out, and the wireless was abandoned for the purpose, only the long telescopes being used.

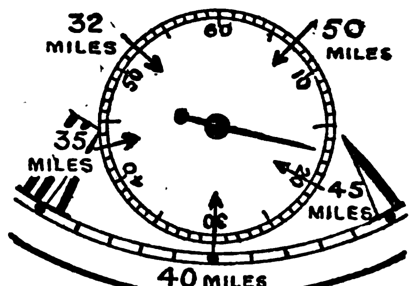
Through these tests the practicability of the wireless telephone was found to be uncertain. Though these tests were performed over three years ago, no definite advancement has been made in the art. The greatest difficulties are in the arc, condenser, and microphone. The arcs will never become practical as they exist at present, for there are periods when the oscillations are perfectly steady, but in the middle of an important conversation, the arcs will suddenly sputter and the words are lost. The condensers are a continual source of worry, and, unless accurately constructed, will break down rapidly. The microphone, likewise, is unreliable, and continually requiring attention. These weak points cause the wireless telephone to be uncertain.

The points to be learned from these tests are: to employ an aerial having a large capacity and many leads to and from the aerial; that a microphone of the carbon grain type with a continuous rotating device will overcome the "baking" to a great extent; that the condenser should be made with rotary plates in oil, and that these plates may be larger and separated by a larger gap to overcome the breaking down as experienced with smaller gaps; that many arcs give greater results than a single arc; and, finally, that hot-wire ammeters are necessary in both the aerial and oscillation circuit to determine whether the set is actually transmitting high-frequency waves and whether these are smooth so that the conversation and music will be heard at the receiving end.

Timing Fast Trains

Perhaps you have often been curious to know just how fast you were traveling on a railroad train. Many roads have little white posts beside the track, marking the miles and usually the quarter and half miles also, but these may not be on your side of the train.

There is another way to tell the miles. The telegraph poles are almost invariably placed fifty yards apart, except when they carry a very large number of wires, and if you count thirty-five of them it will be a mile. If you have a watch with second hands on it you can tell just how many miles the train is traveling in an hour.



Showing Method of Timing the Train

Note the time from one mile post to the next. Anything more than a minute is slower than sixty miles an hour. If the second hand gets past the minute and down to thirty seconds you are going forty miles an hour. If it gets only twelve seconds past the minute you are going fifty miles an hour and so on.

You may cut this out and take it with you on the train next time you make a railway journey, and see if you can determine your speed.—*New York Sun*.

Be thankful every day; don't pile your gratitude all onto one day. The man who is thankful only when the Governor says he must, never is very thankful any day.

WIRELESS NEWS

The Amateur Wireless Telegraph Association of New Bedford has at present twenty-four members, and is desirous of extending to other Amateurs in New Bedford and vicinity the benefits of same through their becoming members. The purposes of the Association are to promote wireless telegraphy among individuals for both knowledge and pleasure; through becoming members of the Association amateurs aid in preventing interference and also extend their knowledge of wireless telegraphy and other affiliated arts; Practical demonstrations and lectures being arranged for every meeting of the Association; The Association has measuring and testing instruments of various kinds which are loaned to members free of any charge, also a technical library to which members can refer, including all magazines pertaining to wireless.

The rating of members' transmitting sets are from a 1 in. coil to a 3 kw. open core transformer, the Association having the use of a 1 kw. set with which they conduct experiments of research.

The officers of the Association are: Chas. Praihanzels, president; Chester Dable, vice-president; Edw. De Mello, Secretary; Wm. Isherwood, treasurer; Herbert Charnley, collector; Lester Jenkins, operator and librarian; Chester Dahl and Geo. W. Pope, auditors.

Vancouver, B.C., Sept. 18, 1911.

On August 17th, at a meeting of the Wireless Amateurs of Vancouver, B.C., a Wireless Association was formed.

The object of this club is to assist its members in the study of Wireless Telegraphy and Telephony, and to prevent interference with the government and commercial stations.

The officers are: President, Cliff C. Watson; Vice-President, J. Arnott; Secretary, A. H. Mackay; Treasurer and Chief Operator, E. Kelley; Assistant Operator, H. Jones; Corresponding Secretary, C. Riesterer.

The Club would like to communicate with other Associations organized for the same purpose. Communications should be addressed to Corresponding Secretary, 1934 William St., Vancouver, B.C.

North Carolina.—Frying Pan Shoals Lightvessel—Wireless telegraph station established.—A wireless telegraph station, call letters "NLC," has been established on board Frying Pan Shoals Lightvessel, No. 94, seacoast of North Carolina.

Approx. position: Lat. 33° 33′ 30″ N. Long. 77° 48′ 20″ W.

(See Notice to Mariners No. 47(3401) of 1911). (N.M. 6, 1912.)

(*Notice to Mariners* No. 5 (146), *Bureau of Lighthouses, Washington,* 1912).

H. O. Charts Nos. 21*a*, 1411 and 943.

U.S. Coast Survey Charts Nos. 11, 149 and 150.

List of Lights on the Atlantic and Gulf Coasts, 1911, Nos. 977 and 978.

U.S. Coast Pilot, Part VII, 1906, page 16.

List of Wireless Telegraph Stations of the World

A complete list of the naval wireless shore stations and ships of the Navy equipped with wireless apparatus is published in the "List of Wireless Telegraph Stations of the World," copies of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a cost of 15 cents each (money order).

The above takes the place of Special Notice to Mariners No. 47*a*, of November 22, 1904.

Wireless from Spitzbergen

The first press telegrams from Spitzbergen were received in Christiania on November 30th, 1911. The wireless station at that far northern place has also been in communication from time to time with Norddeich, Germany; Poldhu, England; and Paris. It is reported that 150 persons are spending the present winter in Spitzbergen, including six women and two children.—*Scientific American.*

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.

1745. **Electroplating.** H. S. M., Syracuse, N.Y., has been trying to plate iron with copper, using an ordinary solution of sulphate of copper. The results are not satisfactory, and he asks for advice. Ans.—While the sulphate solution may be used for the body of the deposit, a preliminary coating should be made in a bath consisting of the double cyanide of potassium and copper. To make this, proceed as follows: In 500 parts of warm water, dissolve 30 parts of neutral copper acetate, 30 parts of crystallized sodium sulphite, and 5 parts of ammonium carbonate. In another 500 parts of water now dissolve 35 parts of 98 percent or 99 percent potassium cyanide, and pour this into the former solution, while heating. All parts are by weight. Be sure you recognize the poisonous character of the cyanide.

1746. **Transformer Control.** H. B. P., Franklin, N.H., (1) has a 1½ kw. open-core transformer for wireless use that seems to draw too much current from the 110-volt 60-cycle lighting mains, and subjects him to severe criticism for interference with the regular electric lights. He asks if a choke coil can be inserted that will reduce this trouble without cutting down the power. (2) In regard to examinations for securing a position in the U.S. Navy as a wireless operator, are there examinations to take other than those specified in the January magazine? Ans.—(1) Evidently you are drawing a pretty large current, and the electric lighting company ought to require you to remedy the trouble. This you cannot do and retain present location and wiring without reducing the power of the apparatus. We would advise you to try a water rheostat, using merely a wooden pail with an iron grate or pulley at top and bottom, and a solution of carbonate of soda. By varying the strength of solution and distance between plates, you can get a wide range of control, and perhaps find that less current than you have been using will suffice. (2) Write to the U.S. Civil Service Commission, Washington, D.C. They will furnish all the information desired, even to sending sample examination papers.

1747. **Fly Wheel Enigma.** F. R. W., Independence, Mo., asks where he can buy a device to conserve the power in a fly wheel. Ans.—We do not know whether you are in earnest in this question or merely joking, for it is only another way of asking for perpetual motion. In this search you will meet the inevitable fate that the laws of nature have prescribed.

1748. **Induction Motor.** F. M., Corvallis, Ore., wishes to rewind a 7½ h.p. 3-phase, 60-cycle, 220-volt motor that has been through a fire. He asks for information. Ans.—The simplest and altogether sufficient method will be to take off the burned coils, make a suitable wooden form on which to wind new coils of the same shape as original ones. From the name-plate on motor, copy all the data and send it to the manufacturer with the request that they send a blue-print showing the method of connection. You can purchase coils from them all ready to put in place, and perhaps cheaper than you can make them yourself.

1749. **Reciprocating Motor.** C. B. D. asks what there is impractical about such a device. Electromagnets would seem to be enormously strong and capable of producing vigorous rotative power. Ans.—This was the first form of electric motors, and by all odds they were the poorest that have ever been made. The magnetic pull can be enormous, and even give the builder difficulty in providing sufficient strength of structure to withstand it. Time, however, is required for a current to establish itself in the electromagnets, and this means a low speed of rotation. Wasteful eddy currents will flow in magnet cores and armatures, and this means low efficiency. The worst feature is the requirement for make-and-break contacts. Of all things in an electric motor there must be a continuity of the circuit. Even the feeble sparking at the brushes of an ordinary motor is objectionable. In your motor, you would require a continuous performance of what you see when a trolley wheel leaves the wire. It is impossible to conceive any motive power acting under more favorable conditions than in the ordinary electric motor, where the action of the field flux on the currents in the armature conductors produces a continuous and highly efficient torque. See our article on electric motors in the January, 1907, magazine.

1750. **Patents.** G. T. C., Saco, Me., asks if there are now any patents on the "squirrel-cage" rotor for induction motors, or on the "split-phase" scheme of making single-phase induction motors self-starting, or indeed on any other part or scheme of single-phase motors? Ans.—All the fundamental patents on three-phase motors have now expired, as also those on the split-phase construction. It is of interest, however, that patents were issued on January 30, 1911, covering the "compensated repulsion-induction" single-phase motor. While the patentee, Latour, of France, made his application in 1904, it has been the subject of an interference of a similar application by Winter and Eichberg, of Germany. In this country the motor appears as one of the products of the General Electric Company, and is designated as the "RI" type.

1751. **Induction Coil.** G. M., Jr., Philadelphia, Pa., asks: (1) I am building the coil described in the February, 1911, issue. Will you tell me how much wire I will need for primary wire? Please tell me in pounds so I can go to the store and buy the right amount. (2) Will black fiber do instead of red? (3) What do you mean by "oiled linen" for the core? (4) What kind of oil will I use for the linen? (5) The primary has three layers of wire; what will I do with the ends? Ans.—(1) The primary will require approximately 2 lbs. of wire. (2) Black fiber will answer the purpose. (3) By "oiled linen," the author refers to the high-grade insulating medium known to the trade as "empire cloth," which may be obtained from any large electrical supply house. (4) The object of bringing out the loops in the primary winding is to enable the user to take taps from any one of the three layers, or, in other words, to vary the number of turns in primary winding at will. This will permit of the use of several types of interrupters. For instance, with an electrolytic interrupter, the best results will be obtained by using the full three layers of wire, making connection at the ends of the winding. The ordinary vibrator interrupter will show better results on either one or two layers, depending upon the speed of vibrator and the impressed voltage. (5) There is no reason for cutting the loops as you suggest, and, indeed, such a proceeding is very likely to result in confusion, as it is evident that you do not understand the underlying principles of the work you are doing. We suggest that you bring leads to four binding posts, lettering them *A*, *B*, *C* and *D* for convenience as per the diagram. By connecting to *A* and *B* you will then include one layer in your circuit; from *A* to *C* will give two layers and from *A* to *D*, three, or the total number of layers.

1752. **Wireless.** L. V. A., Homer, Mich., asks: (1) Are the Thos. M. St. John wireless instruments up to the standard? (2) Will I have to get a permit to put up a wireless station with a sending range of 17 miles and receiving range either 700 or from 1,500 to 2,000 miles? (3) I live about half way between the east and west borders of Michigan (lower peninsula) and in the second row of counties from the bottom. Do ocean ships send far enough to reach me from 200 or 300 miles out in the Atlantic? Ans.—(1) We have heard nothing against them and believe they are worth the prices asked. We would advise you to buy the highest-class instruments you can afford. (2) Not at present. Legislation to this effect is sought by the navy department, but is warmly opposed by several interests. (3) Not under ordinary circumstances.

1753. **Indoor Aerial.** L. D. H., Manchester, Eng., asks: (1) Is it possible to telegraph over the distance of one mile, using an indoor aerial and suitable apparatus? If so, please give details of aerial. (2) Any American handbooks or books dealing with construction of wireless apparatus from an amateur's point of view with prices of same. Ans.—(1) It is possible, but hadly practical to use an indoor aerial to send one mile should you happen to live in a house with a high attic and have the apparatus on the first floor. If you can attain an antenna height of 30 ft. above the instruments, a 2 in. spark coil used in conjunction with loose-coupled sending set and electrolytic or crystal detector should work very nicely. (2) We can supply a list of good books on the subject of wireless, and one can also be found in the current number of the magazine.

1754. **Diagram for Wireless Set.** F. M. L., Portland, Ore., asks: (1) Where can I find a diagram for the following set: aerial, six aluminum wires No. 14 B.&S., 2 ft. apart, 60 ft. high, 75 ft. long, three-slide tuning coil, No. 24 B.&S. enameled wire on core 3 in. in diameter, 9 in. long, silicon detector, variable and fixed condensers? (2) The wave length of the set? (3) How can I improve the set? Ans.—(1) See Fig. 48, page 97, of the "Manual of Wireless Telegraphy" for Use of Naval Electricians, 1909 edition. This will give you a choice of several diagrams employing the instruments mentioned. (2) Impossible to state, owing to variation caused by local conditions. (3) By using an inductively coupled tuner.

1755. **Wireless.** H. A. M., Silver Creek, N.Y., asks: (1) If the following dimensions are reasonably correct for the construction of a 1 kw. open-core transformer for wireless use, when used on 60-cycle, 110-volt current, please advise approximate output when used on 120-cycle 110-volt current. Core 1½ in. diameter, 14 in. long, primary winding two layers of No. 12 d.c.c. wire, secondary winding 12 lbs. of No. 32 s.s.c. wire. (2) What would the corresponding dimensions and data be, for construction of a transformer of 1 kw. output, same to be used on 110-volt, 120-cycle alternating current, transformer to be of the open-core type? Approximate secondary voltage desired 15,000 to 20,000. (3) If answers to above questions require an inordinate amount of research or calculation, will you kindly advise me approximately the proportion of difference between the dimensions and windings of transformers, open-core, when same are made to be used on 60-cycle current, or when made to be used on 120-cycle current? That is, if the core for a given size of 60-cycle transformer is 1½ in. x 14 in., as above, how would the core for a 120-cycle instrument compare in size, if output is same as the 60-cycle one? Ans.—(1) While you could undoubtedly use the above transformer up to 1 kw., so far as input is concerned, we are of the opinion that the output would be very disappointing. The core is too small and there are not enough turns in the primary. By using the inevitable impedance coil, you can use the transformer on either 60- or 120-cycle circuits. (2 and 3) The design and calculation of open-core transformers are by no means as simple and reliable as in the case of the closed-core type, and for your purpose the calculation becomes even more complex. We would suggest that you look up an article in our August, 1911, issue, on Experimental High-Frequency Apparatus, for data in regard to a ½ kw. open-core transformer; and in the following number, an article on the design and calculation of closed-core instruments. The advantages offered by the open-core transformer are very nearly offset by its low efficiency and difficulty of securing correct design for the purpose. The closed-core type is easily built, and is much less expensive, owing partly to its smaller size for a given output, and when properly designed is superior to the open-core for charging condensers. A transformer designed for use on 60-cycle circuits may be used at somewhat lower output on 120-cycle circuits. It is common practice, however, to reduce the volume of iron in the core when the higher frequency is used.

1756. **Transformer.** W. H. H., Pittsburgh, Pa., says: I am constructing the transformer and rectifier, as described in the January, 1911, issue, and have run into a little trouble. Instead of getting 100 turns per layer of the No. 16 D.C.C. wire, I can wind only 88 turns in the space of 5½ in., and of the No. 20 D.C.C. wire, I can wind but 128 turns in the space. The wire is of correct gauge, for I have proved it with a micrometer, so I do not see how it would be possible to wind more turns than stated above. I use a lathe to wind. You will note, with the number of turns mentioned above, the voltage would be about 13½ and 25 as intended (but I would like to know whether it is all right to use but 768 turns on the primary or whether I should add the 7th layer to make the number specified in magazine. I have the coil wound (176 turns on secondary and 768 turns—6 layers—primary), but have not cut the wire, and will await your advices before completing. Ans.—While the smaller number of turns will work the iron at a somewhat higher density than intended, still the core is generous and if you do not intend to use the transformer for greater periods of time than, say, half an hour without turning off the current, the smaller number of turns will give very satisfactory results. We advise, however, that you wind the full number as specified, in order to get the greatest efficiency.

SENDING SECOND-CLASS MAIL BY FREIGHT

A few months since the Post Office Department, inspired by a desire to show an apparent bookkeeping surplus which has never been demanded by the American public or its representatives in Congress, changed the method of transporting second-class matter in an important particular. The larger portion of the monthly mailing of *Electrician and Mechanic* is no longer transported by mail trains, but goes by so-called fast freight to various central distributing points or often to its final destination. The result has been an unprecedented number of complaints in regard to delayed delivery of the magazine. The Post Office Department seems not to know how long it will take magazines to reach a given point, and in some instances from three to six weeks have been required for copies to reach our subscribers in Texas or on the Pacific Coast, whereas the mail trains formerly carried the magazines to the most distant part of the continental United States within a week. The publisher is unable to help out his subscribers in this matter. The present attitude of the Post Office Department to publishers is that they are receiving from the government an unwarranted subsidy, and every effort is being exerted to raise the second-class postal rate. Under these circumstances any complaint as to the quality of service furnished is met with retort that the cheapest that can be given is too good for the price we are paying.

As to the justice of the present postal rate to the government, to the publisher, and to the subscriber, we shall not argue. The subscriber to American magazines receives far more for his money than is the case in any other country in the world, and it may truthfully be said that the whole advantage of the low postal rate has been passed on to the subscriber. If the postal rate is increased many publishers will go out of business and the subscriber will pay a higher price for magazines. It is for the public to decide if they desire this to happen; and the subscribers to this magazine can serve themselves effectively if they will give the publisher definite information of any undue delay in the arrival of magazines. A complaint that a magazine has not arrived is not of so much value as a definite statement of the date of arrival of a magazine which has been delayed. To help the publishers of the magazines, and of this magazine in particular, if you do not receive your magazine within one day of the usual time, will you kindly inform your local postmaster and ask him to start an inquiry and also report the facts to us?

TRADE NOTES

The catalog recently issued by the Ferro Machine and Foundry Co., of Cleveland, Ohio, will especially please anyone who is at all interested in marine engines. This company, which is probably the largest marine engine building concern in the world, have included in their catalog a well written and exceedingly interesting practical treatise on the correct design and construction of marine engines and their equipment. Some of the topics taken up in this treatise are: The Gasoline Engine of the Past and Present; How Marine Gasoline Engines Operate; The Carburetor; Ignition; The Make and Break System of Ignition; Sources of Electrical Current; Installation of Ignition, Cooling System and Lubrication. The Company has attempted to make this treatise as comprehensive as was possible in the space available. Much of the information is entirely new and is the result of extensive search on the part of their Engineering and Experimental departments. Technical expressions, which are likely to be unfamiliar to some of their readers, have been carefully explained in a glossary of terms, which is included in the catalog. Also, believing that photographs would be more easily understood by the laymen than would mechanical drawings, a large number of photographs have been used to illustrate the treatise. Copies of the catalog may be obtained by writing the Ferro Machine and Foundry Company, Cleveland, Ohio, and mentioning the *Electrician and Mechanic*.

The Clapp-Eastham Co., of Cambridge, Mass., are manufacturing a most excellent line of metal mast antennae. These antennae are made from 3 in. galvanized iron pipe coming in 10 ft. sections, having telescoping joints, which may be fitted together to form a pole of any height up to 80 ft., beyond which it is not practical to go. Each pole is fitted with a metal cap for excluding rain and snow, and the pole is insulated from the ground by means of a high-tension insulator supplied with the mast. The pole is extremely light, weighing only about 5 lbs. per 10 ft. section, and is supported by means of guy wires fastened to lugs, which are placed at intervals along the pole. This type of mast is slightly difficult to erect, in that it must be supported by guy wires held at four corners, while being raised, as it will not support its own weight without buckling. However, if a little care is used to keep the mast in a vertical position while going up, it will prove a very substantial antenna, owing to the strength of the supporting guys. The leading-in wire is fastened directly to the base of the pole, and both the pole and guy wires act as a part of the antenna, the latter being insulated by means of strain insulators at their lower end.

This type of antenna may not only be erected on the ground, but also lends itself well to insulation on the roof of a building, in which case the smallest diameter of the building should not be less than the height of the pole which it is proposed to erect.

This company will supply these aerials complete, including mast, antenna wire, insulating base and strain insulators as follows: 30 ft. mast complete, $16.15; 40 ft., $19.30; 50 ft., $25.15; 60 ft., $30.50; 80 ft., $43.15.

Above prices are net cash with order F.O.B., Cambridge, Mass.

It may be of interest to many of our readers to know that the Boston School of Telegraphy is now giving a special course which is devoted exclusively to the training of amateurs on the subject of wireless telegraphy. It is the purpose of this course to especially meet the needs of those who are desirous of entering the Commercial Wireless Telegraphy Service.

Mr. Harold J. Power of Tufts College, a well-known wireless expert, and who was formerly an operator on the *Harvard* and *Yale* boats and also upon Col. Astor's private yacht will give special instructions.

Recent General Electric Bulletins

In Bulletin No. 4924 is described the General Electric Company's Thomson Prepayment Watt-hour Meters for direct and alternating current, Types CP–4 and IP–4.

Bulletin No. 4887 is a rather attractive bulletin —illustrating and describing the General Electric Company's Turbo-Generator Sets in capacities of from 5 to 300 k.w All of these sets are of the horizontal type and can be arranged to operate either condensing or non-condensing, and at any steam pressure above 80 lbs. for the smaller sizes, and 100 lbs. for the larger.

Bulletin No. 4900, just issued by the General Electric Company, is devoted to apparatus used in connection with Series Incandescent Street Lighting, and supersedes in part the Company's previous bulletin on this subject. The bulletin is practically an ordering catalogue and contains no description other than that afforded by the illustrations. It lists lamp brackets of various style (giving their dimensions), tungsten economy diffusers, G–E Edison Mazda street series lamps, constant current transformers, switchboard panels, and lightning arresters.

"Small Plant Direct Current Switchboards" is the title of Bulletin No. 4919, recently issued by the General Electric Company. The bulletin is devoted to a description of panels which are designed for the control of three-wire generators. The panels are arranged for 125 and 250 volts, and in capacities of from 25 to 100 kw.

The General Electric Company's Bulletin No. 4904, illustrates and describes three-phase panels for use in small or isolated plants containing but one generator. These panels are not intended for the parallel operation of generators, but for installation in a switchboard consisting of two or more panels.

Bulletin No. 4905 is devoted to panels designed for general use in small central stations and isolated plants, and are for use with one set of bus-bars, to which the generators and feeders are connected, and are suited to the parallel operation of generators.

Each of the above bulletins contains connection and dimension diagrams of panels of various sizes.

Bulletin No. 4901, just issued by the General Electric Company, is devoted to Alternating Current Switchboard Panels with Oil Switches attached, and designed for three-phase, three-wire circuits: 240, 480 and 600 volts, 25-60 cycles. This supersedes the Company's previous bulletin on this subject.

Bulletin No. 4907, recently issued by the General Electric Company, contains interesting data relative to the lighting of offices, banks and public buildings by G.E. Edison Mazda lamps. In this connection are shown illustrations of numerous buildings lighted with these lamps and data are included giving the number and sizes of the lamps in each installation. The publication also contains a history of the development of the incandescent lamp, and other information of interest to the consumer of current for lighting purposes.

Without doubt, the lighting of textile mills exerts an important influence on the amount and cost of production, the quality of the product, the amount of spoilage, the safety of the employees and their willingness and ability to furnish the best possible returns in labor.

Bulletin No. 4906, just published by the General Electric Company, is devoted to this subject, and in this connection considers those items briefly. It describes the new drawn wire G.E. Edison Mazda Lamps, which are particularly suited to this class of illumination, contains illustrations of various installations of these lamps, and makes recommendations relative to the illumination of various departments of textile mills. The publication is enclosed in a rather striking cover.

Bulletin No. 4893, recently issued by the General Electric Company, is devoted to a general description of two automatic time switches manufactured by that Company. The bulletin contains diagrams and dimensions.

The General Electric Company has just issued a bulletin, No. 4920, describing its G.E. 203A Railway Motor which is of the box frame, commutating pole type, rated at 50 h.p. on 600 volts, and 40 h.p. on 500 volts. The motor embodies radically new features of construction which have been developed with a view to effecting greater economy in railway motor operation, and it is considerably lighter per horse-power output than the previous design.

The General Electric Company has recently issued Bulletin No. 4918, which illustrates and describes panels designed by that Company for general use in central stations. The list of panels contains both generator and feeder types. and the panels are made for 125, 225 and 600 volts.

Cloth Pinions

The General Electric Company has just issued Bulletin No. 4878, which is devoted to Cloth Pinions. This remarkable and somewhat radical form of machine element is offered for a wide variety of application in mechanical transmission of power where, because of noise or for other reasons, the meshing of metallic pinions, with metallic gears is impracticable or undesirable. The advantages claimed for these pinions are great tooth strength, noiseless operation, freedom from damage by exposure to dampness, dryness or temperature changes, elasticity of teeth, self lubrication and long life. These pinions are made in various styles and sizes which are illustrated in the publication.

BOOK REVIEWS

Telephony. By Samuel G. McMeen and Kempster B. Miller. Chicago, Ill., American School of Correspondence, 1912. Price, $4.00.

An excellent treatise on the theory and practice of all phases of Telephone Engineering, particular attention being paid to the recent developments in automatic systems. The volume contains 960 pages, of a page size 7 x 10 in., and is well illustrated by 700 drawings, diagrams and photos. It is clearly printed on a good quality of paper and is bound in vellum de luxe.

The authors are men who fully understand both the practical and theoretical sides of telephone engineering, and they have put into this book the knowledge gained from their years of experience.

In "Telephony," is covered the installation, maintenance and operation of all types of telephone systems and also an unprejudiced discussion of the relative merits of automatic and manual exchanges.

The Steam Turbine. By Sir C. A. Parsons. New York, G. P. Putnam's Sons, 1911. Price, 50 cents.

There has recently been published a small cloth-bound volume entitled "The Steam Turbine." While but little attempt has been made to explain the theory of the turbine, the subject is treated in a clear and elementary manner. The author describes some of the earlier forms of turbines and also those used at the present time, such as the Curtis, DeLaval and Parsons.

The Kingdom of Dust. By J. G. Ogden, Ph.D., Chicago, Popular Mechanics Co., 1912. Price, 50 cents.

One of a series of handbooks on industrial subjects which are being published by the Popular Mechanics Company. The book is both interesting and entertaining. It is well printed, contains many illustrations and is cloth-bound.

Audel's Answers on Automobiles. By Gideon Harris and Associates. New York, Theo. Audel & Co., 1912. Price, $1.50.

The prospective automobile purchaser, driver or repair-man will probably be unable to find a book which is more suited to his needs than is the book recently published by the firm of Theo. Audel & Company. If one wishes to keep his car in good running order every day in the year, it is necessary that he fully understand each part of the car and in case any breakdown should occur, that he know the proper way to repair it. In this 512-page book the reader is told, in language so simple that even the beginner can understand it, all about the various parts of the automobile and how to keep the machine in perfect adjustment. The book is well illustrated with 380 diagrams and drawings, and the text consists of a collection of Questions and Answers which fully explain the principles of construction and operation of the Motor Car in a clear and helpful way.

Some of the topics treated in the various chapters are, Carburetors, Ignition, Gas Engine Operation, How to Run an Automobile, Overhauling the car, Motorcycles and Electric Automobiles and Trucks.

Wireless Telegraphy

In response to many requests, we publish below a list of books on wireless telegraphy, with the prices at which we can furnish them, postpaid.

BISHOP, LEON W.
The Wireless Operator's Pocketbook of Information and Diagrams.—Thoroughly describes latest transmitting and receiving instruments. 150 illustrations. All tables necessary for wireless operators, one showing how to compute roughly, sending and receiving distances. Full leather, flexible, pocket size........................... $1.50
Leatherette.......... $1.25 Cloth............ 1.00

MASSIE, W. W., and UNDERHILL, C. R.
Wireless Telegraphy and Telephony Popularly Explained.................................... 1.08

MAVER, W.
Wireless Telegraphy.............................. 2.00

TESLA, N.
Experiments with Alternate Currents of High Potential and High Frequency.—A classic work and the authority on the subject.................... 1.00

FLEMING, J. A.
Principles of Electric Wave Telegraphy.—A comprehensive digest of wireless telegraphy in all of its branches. One of the most complete and practical books ever published on this subject......... 6.60
Elementary Manual of Radio-telegraphy and Radio-telephony for Students and Operators............ 2.00

HOWGRAVE-GRAHAM, R. P.
Wireless Telegraphy for Amateurs................. 1.00

KENNELLY, A. E.
Wireless Telegraphy and Telephony, enlarged and reprinted.................................... 1.14

HARRISON, NEWTON, E.E.
Making Wireless Outfits.—A concise and simple explanation on the construction and use of simple and inexpensive wireless equipments, for sending and receiving up to 100 miles, giving full details and drawings of apparatus, diagrams of circuits and tables. 12 mo. cloth, 50 cents; in paper covers.. .25
Wireless Telephone Construction.—How to make and use an inexpensive equipment. Cloth....... .50
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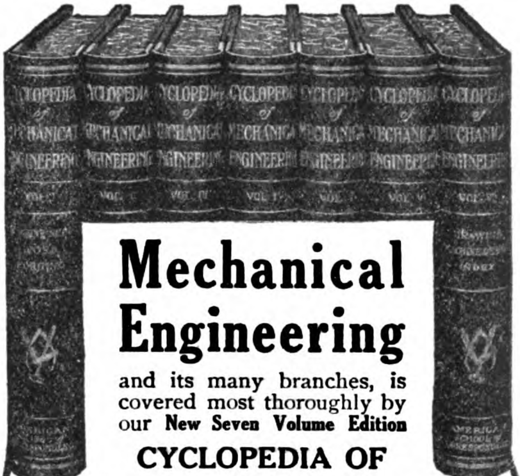
TWINING, H. LaV., A.B.
Wireless Telegraphy and High Frequency Electricity.—A most complete manual containing detailed information for the construction of transformers of from 100 watts to 5 k.w. capacity; wireless telegraph and high-frequency apparatus, with chapters on their theory and operation. 1909.... 1.50

MORGAN, ALFRED POWELL.
Wireless Telegraph Construction for Amateurs.—A manual of practical information for those who wish to build experimental wireless instruments, which can be considered as something more than toys, but are still considerably less expensive than a high-grade commercial set. No attention has been paid to the history of the art, the space, instead, being devoted to short but complete explanations of the uses of the various instruments, as well as the structural details. 1910........... 1.50

HALLER, GEO. F., and CUNNINGHAM, ELMER T.
The Tesla High-Frequency Coil. Its Construction and Uses.—Full and explicit directions for the construction of apparatus needed for experimenting with high-frequency currents. This book fills a long-felt vacancy in scientific literature. Intended for the advanced experimenter. 1910... 1.25

ROBINSON, Lieut. Com. S.S.
Manual of Wireless Telegraphy For Use of Naval Electricians.—An excellent complete and instructive book for the wireless operator.......... 1.50

Sampson Pub. Co., Boston, Mass.



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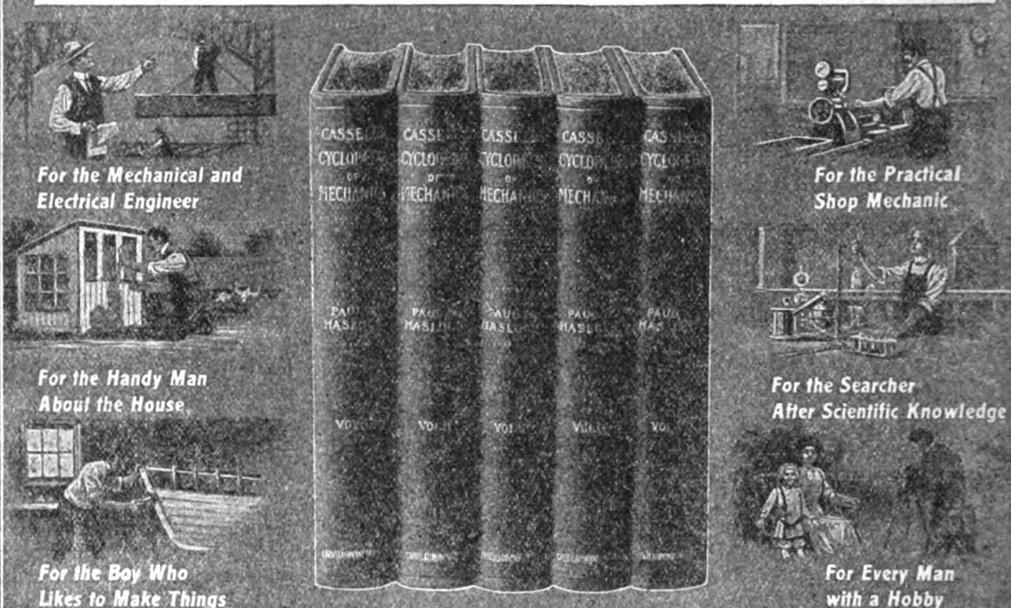

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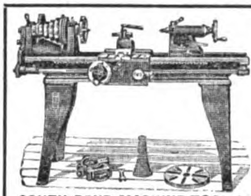

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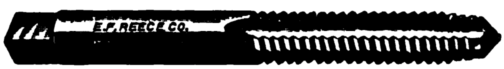

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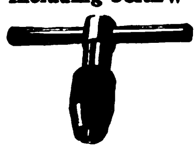

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