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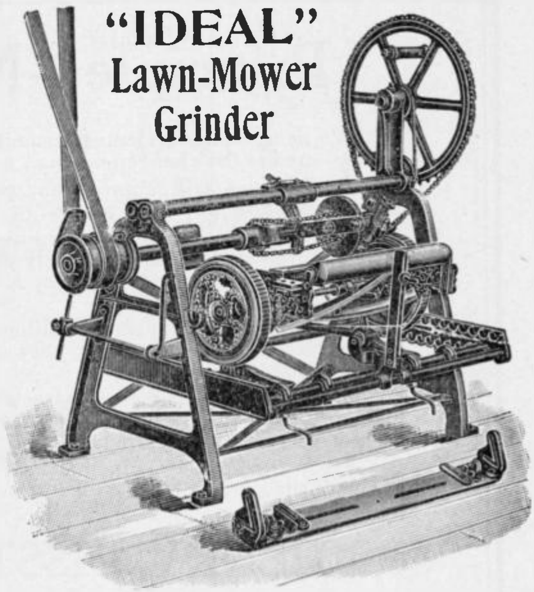

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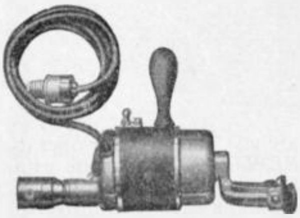

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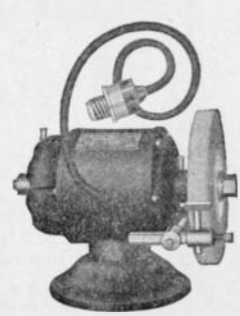

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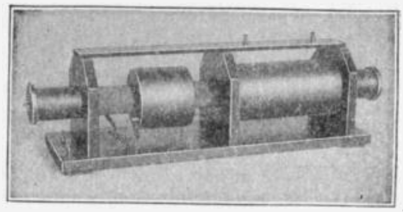

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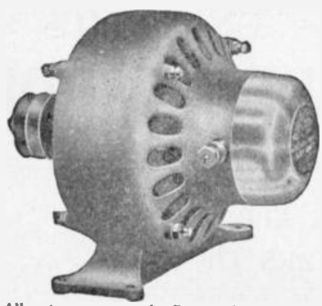

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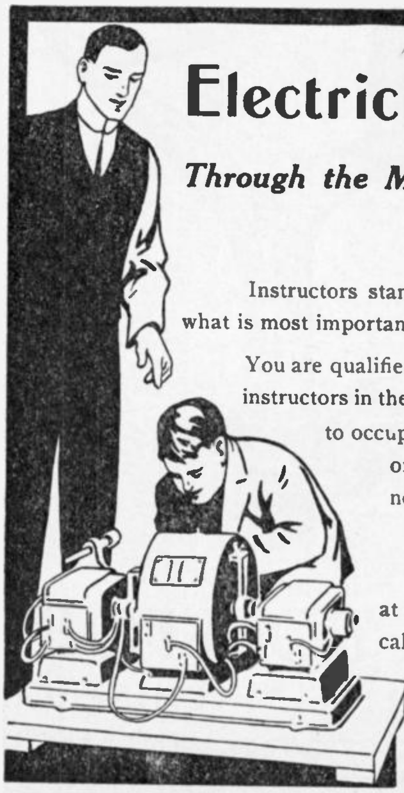

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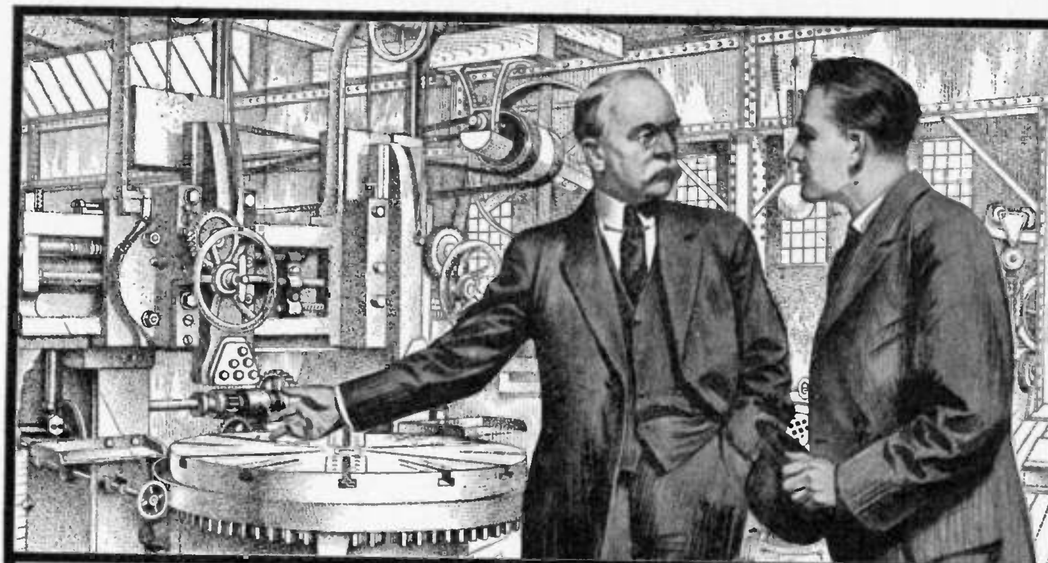

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Vol. XXI. JULY, 1910 No. 1

TABLE OF CONTENTS

Electrician and Mechanic

VOLUME XXI JULY, 1910 NUMBER I

CONSTRUCTION OF A WATER MOTOR

STANLEY CURTIS

Probably one of the greatest problems of the amateur is to secure a light motive power to run small dynamos, static machines, etc. The electric motor of course stands at the top of the list for cleanliness, economy, and general convenience; but as this source of power frequently is not available, the experimenter must have recourse to the next best, which seems to be the water motor.

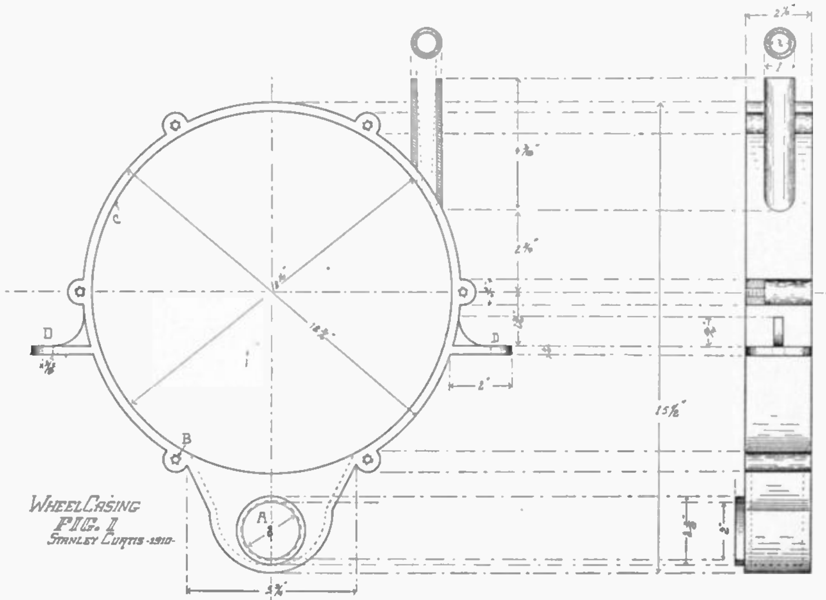
Most water motors now on the market will yield excellent results when operated by a high pressure of water, but are absolutely useless where the pressure falls below 50 or 60 lbs. .

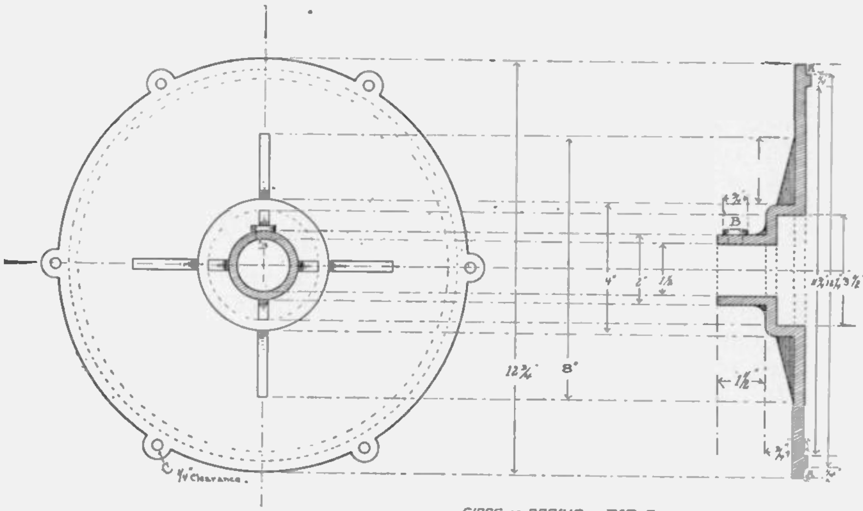
The little machine described in the following paragraphs was successfully used to drive a 75-watt dynamo on 35 lbs. water pressure.

The patterns for the castings used are of a form easily constructed by the amateur and very little machine work is required to properly finish the rough castings.

Reference to Figs. 1 and 2 will show the general form of the wheel casing. This is a light iron casting. It will not be necessary to plane the edges of the main casting (Fig. 1), as these may be smoothed up with a good flat file. The opening *A* should be threaded for a 2 in. exhaust pipe. Holes *B* should be drilled and tapped for the ¼–20 machine screws which hold sides, Fig. 2, in position. Holes *D*, Fig. 1, should next be drilled in the feet for bolting motor down to a suitable base. The inside surface of casting *C* should be carefully cleared out with the grinder or a half-round file and all lumps or projections removed, as there is a clearance of but ⅛ in. between water wheel and casing.

The sides of casing, Fig. 2, may be held in the lathe chuck and a light cut taken off at *A*. The holes *B* and *C* are next drilled. The two castings for the sides may be cast from the same pat-





SIDES OF CASING FIG. 2
STANLEY CURTIS 1910

tern, as they are alike in every particular.

The water wheel consists of two brass castings of the dimensions shown in Fig. 3, the hub *C*, the rim of ⅛ in. sheet brass *F* and the buckets *D*.

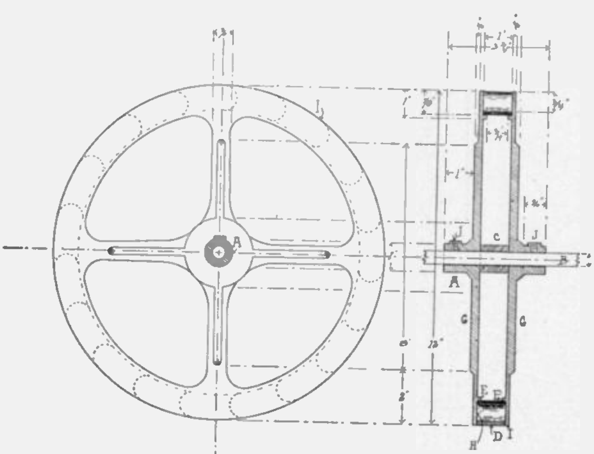
The castings *G* are held in the chuck at shoulder *A*, centered, drilled and reamed for the ½ in. steel shaft *B*. They are then mounted on a ½ in. arbor and a light cut taken off the edges *I*. The surface *H* is next faced off and great care must be used in this operation, else the casting will be sprung.

The buckets *D*, 19 in number, are made as follows:

A piece of ¾ in. brass tubing, 10 in. long, is cut off in ten sections, by means of a hack saw. These pieces are then cut in two lengthwise, thus forming the curved pieces shown at *D*, Fig. 3*A*.

The rim *F*, Fig. 3, is a strip of ⅛ in. sheet brass, 1 in. wide, and long enough to reach entirely around the castings *G* when they are placed in position on the shaft. Hub *C* is turned up from a piece of 1 in. round brass rod.

Place castings on the shaft with hub between them, and secure by means of set screws *J*. Put rim in position between castings, with ends abutting and solder. The buckets are soldered in



WATER WHEEL
FIG. 3
STANLEY CURTIS 1910.

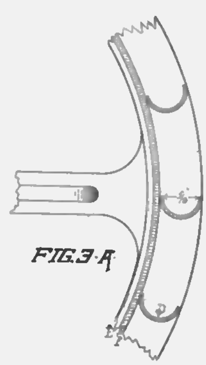


FIG. 3-A

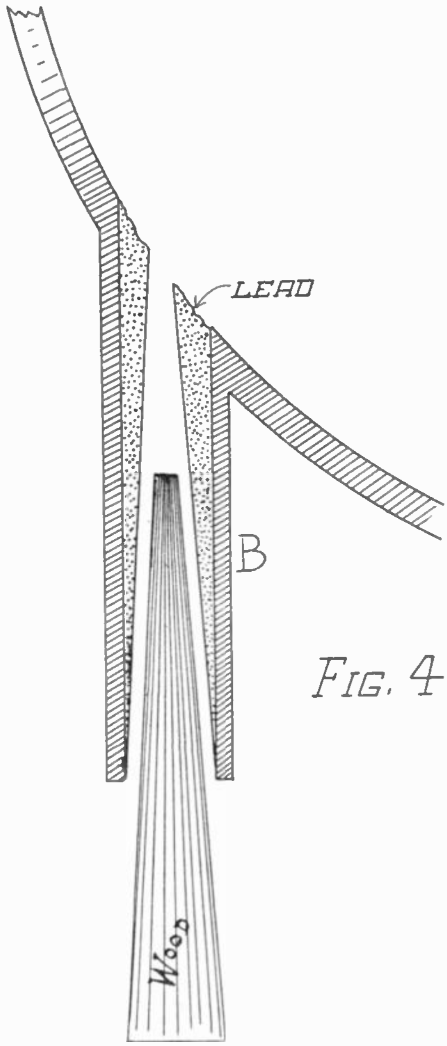


FIG. 4

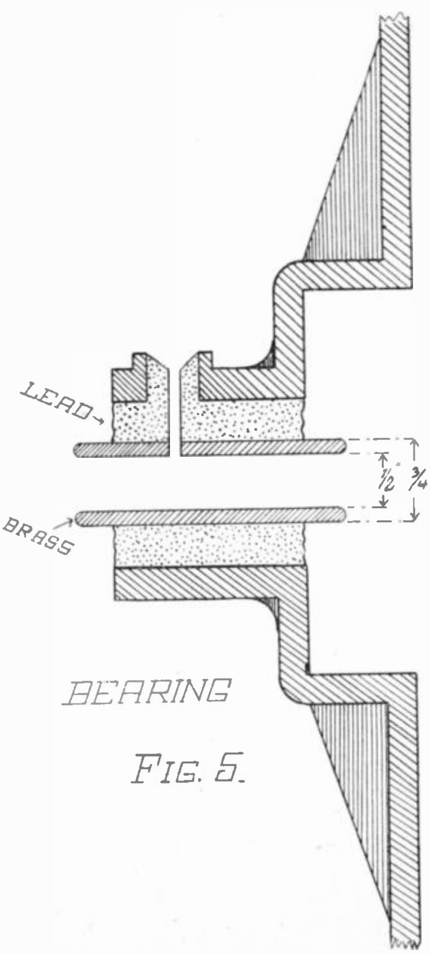
position at equal distances around the circumference of the wheel. As the diameter of the wheel is 12 in., the circumference is 37.7 in., therefore the buckets will be spaced approximately 2 in. apart.

After wheel is completed it must be balanced, otherwise the motor will vibrate violently when running at high speed. A drop of solder on the rim at the light places will be the most convenient method of securing perfect balance.

The method of making the nozzle is clearly shown in Fig. 4. The wheel casing is inverted and a wooden plug turned to a taper, as shown, is inserted in the neck *B*. Melted lead is then poured in from the inside. The plug is removed when lead cools, and a very satisfactory tapering nozzle is the result. A coupling is hardly necessary as the pressure hose may be slipped over the neck *B* and clamped there.

The bearings of a machine are, as a rule, quite troublesome to construct; but by making them after the style shown in Figs. 5 and 6, practically all machine work is eliminated. Two pieces of brass tubing, 2½ in. long, slightly under ½ in. inside diameter and having at least ⅛ in. wall, are reamed out until they are a good running fit over the ½ in. steel shaft *C*, Fig. 6. The ends of the tubing are slightly counterbored to prevent oil running out along the shaft.

Place casing *D*, Fig. 6, in an upright



BEARING

FIG. 5.

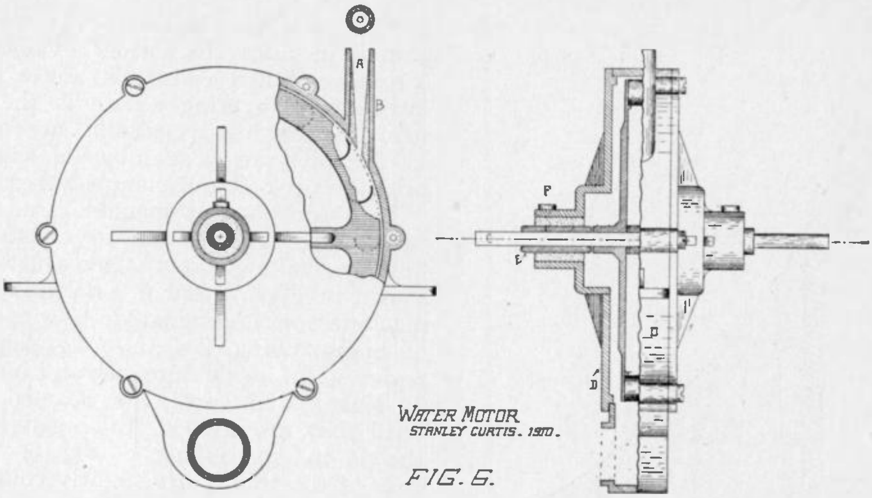


FIG. 6.

position. Wrap heavy paper around edge of water wheel until it will fit tightly inside casing. Fasten side plates on casing and slip the brass sleeves on to shaft in position shown at *E*, Fig. 6. Stop up ends of the open space with putty and pour melted lead in the hole *F*. When this has cooled remove side plates, and take paper packing from around wheel. Oil holes are drilled down through the lead and brass, Fig. 5.

The wheel and side plates may now be replaced, and if the work has been properly done the shaft may be easily turned by hand without binding at any point.

Fig. 6 shows the appearance of the finished machine. A portion of the casing is removed in order to show relative positions of nozzle, buckets, etc.

White lead should be liberally smeared over the edges of the casing before the side plates are permanently fastened on, so that the joint will be water tight.

This motor was set up in the basement of the writer's home and connected by ordinary garden hose to a ¾ in. supply pipe. A small shunt dynamo, wound for 110 volts at 1,800 revolutions per minute, was directly connected to the water motor. The speed indicator showed slightly above 2,000 revolutions per minute when no load was on the dynamo. When three 25-watt 110-volt Tungsten lamps were connected to the terminals, the speed was lowered to a trifle over 1,800 revolutions per minute. The voltmeter showed 116 volts and the three lamps were brilliantly lighted.

Of course when any faucet in the house was turned on, the speed was greatly reduced, and the lights would grow dim. However, this drawback is of small consequence and the general usefulness of the machine will well repay the builder the trouble and expense of constructing it. On high pressure the power developed would be far greater.

Where the speed and other conditions will permit, it is always preferable to connect the shaft of the water motor direct to the shaft of the machine to be driven, as the loss by friction and slipping of a belt is entirely eliminated by this method. An emery or buffing wheel mounted on the shaft will give very good service. However, if it is necessary to use a belt, a flat one made of thin, pliable leather will prove more satisfactory than a round one.

Remedy for "Balky" Clocks

H. M. NICHOLS

A clock that has become so gummed up and dirty that it will not run properly can often be made to work all right by keeping a little can of kerosene in the base. The vapor rising from the kerosene will cut the gum and lubricate the works. I have known of a large clock to "balk up" and then run over two years without any attention except winding and the occasional filling of the small kerosene can in the base. This kerosene cure works well on clocks that lose time, as it is often due to an accumulation of gummed oil that is easily removed by the kerosene vapor.

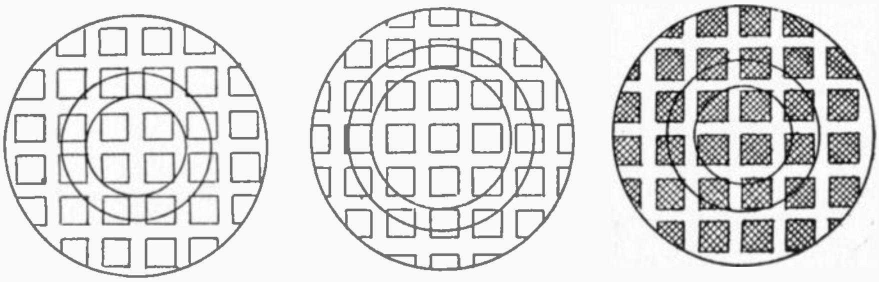
A CHEAP NINE-INCH REFLECTOR.—III.

Construction of the Polisher

M. A. AINSLEY

We have now arrived at the point where the worker will begin to appreciate the real difficulties of the work. Up to this point all has been fairly easy; but the beginner must not be discouraged if his early attempts at the construction of polishers are failures, and he must be prepared to exercise unlimited patience. The pleasure of seeing the wonders of the heavens through a telescope of his own construction will amply repay him for his time and trouble.

pitch,—it will certainly stick to you," and "if it is a good friend, it does sometimes stick closer than a brother." But I am glad to say that there is one thing that pitch does not show any brotherly affection for, and that is wet blotting-paper. Provide, therefore, an ample supply of blotting-paper in sheets not less than 10 in. square, if possible. A large sheet of plate-glass or marble 14 in. square should be provided, and we shall require a stamper to form the square, and a frame of wood to retain the pitch



The pitch used, as before recommended, should be Swedish pitch, in 2 lb. boxes,—about 2 lbs. will be required. Also we must obtain some rouge. I got mine in ¼ lb. packets through a jeweller, who specially ordered it for me, and it is important to get the very best that can be got. If there is any difficulty about it, an optician would probably be able to supply it. It is somewhat expensive,—$2.50 the lb. or so, —but ¼ lb. will be ample. An iron ladle to melt the pitch and an iron spoon to stir it are, of course, necessary, and an ample supply of turpentine.

There are two distinct methods that I have tried of making the polisher: One is to pour the pitch directly on the tool and stamp grooves in it to form the necessary facets. The other is to make the squares of pitch separately and mount them independently on the tool. I prefer the latter method, if only because a slight flaw in the polisher does not necessitate the renewal of the whole thing,—local repairs being quite easy.

Now pitch is, as I have said, a good friend but a bad enemy. As I was told by an expert correspondent: "Stick to

till cool. The frame should be, for a 6 in. mirror, 10 in. square inside and 12 in. outside, the sides being therefore 1 in. broad, and it should be ⅜ in. deep. For a larger mirror it should, of course, be larger, the inside measurement being about 1 in. larger than the diameter of the mirror. This is to allow for a few extra squares in case any get broken. The stamper is made by screwing two flat pieces of wood, 12 in. x 1½ x ¼ in. to the sides of a rod 1 in. square and about 18 in. long. The ends of the rod may be rounded off to form handles, and the flat side pieces should project about ½ in. and have V-shaped edges.

The hardness of the pitch is a matter of some importance, and authorities differ to a large extent. I found in my own case, that if a quarter, standing on its edge, left five complete impressions of the "mill" in one minute, it was about right; the temperature makes a difference, the pitch being harder when cold, so that the test should be carried out at the same temperature as that of the room in which it is proposed to work. I do not recommend the beginner to have his pitch any softer than I have indicated; it may be even a little harder.

The pitch having been melted as before directed (in my second chapter), its hardness should be tested by pouring a little on a piece of glass; and turpentine should be added slowly till it is about right, the pitch being thoroughly and constantly stirred while the turpentine is added. If too soft it should be kept at the melting point and allowed to evaporate, when it will harden. But I did not find this necessary, as the pitch is now poured out steadily on to the slab till it has a depth rather less than that of the frame, say 5/16 in. Any impurities must be kept back with the iron spoon.

After it has cooled down a bit, but before it hardens,—and this may be tested by touching it with a blunt wooden point covered with wet blotting-paper,—the frame may be removed. This is quite easy if the blotting-paper is used, but not so easy if it is omitted,—and a cake of pitch 10 in. square by 5/16 is left.

We now bring the stamper into action. A series of grooves are stamped out parallel with one side of the pitch cake. Each groove is stamped twice, the following edge of the stamper being placed in the groove just vacated by the leading edge. In this way the squares are all kept of the same size. A similar set of grooves at right angles to the first are stamped and the pitch cake is then divided in 1 in. squares separated by ¼ in. grooves. It is protected from dust without, of course, being touched, and left to get thoroughly cold. When cold it is slid to the edge of the glass slab and broken into squares very much as if it were toffee or chocolate. After a little practice this can be done without splintering the squares if care is taken; but as there are plenty of squares made, the loss of a few does not matter. The hands and pitch must be kept wet, to avoid the latter sticking to the fingers; and the pitch squares, when broken off, should be placed in a basin of cold water till required.

We have now to mount these squares of pitch on to the glass roof to make the polisher, and I may say at once that the position of the central square with regard to the centre of the tool is a matter of the greatest importance. It might seem at first sight as though the most obvious way of securing uniformity of curve in the mirror would be to let the centre of the tool coincide either with the centre of a square or with the intersection of two grooves. This is not so. A glance at Fig. 1 will show that under these conditions a circle struck from the centre of the tool would either fall almost entirely on the squares or between them. This would result in rings of unequal polish, and therefore of unequal figure, being produced in the mirror, and such rings are very hard to get rid of if once produced. They can be completely obviated, however, if care is taken to place the centre of the tool in such a position with regard to the pitch that any circle struck from this centre falls about equally on the squares and between them. For this purpose the centre square of pitch is placed so that the centre of the tool falls just within one corner of the square, as in Fig. 2.

The first thing, therefore, is to mark the centre of the tool accurately. Lines may then be drawn in two series at right angles to guide in placing the pitch squares. This is not absolutely necessary, as they can be placed with sufficient accuracy by eye after a little practice.

The central squares may now be placed in position as above, and I found that the easiest method was to smear the tool with a little turpentine and hold each square just above the chimney of an ordinary paraffin lamp until the under surface was melted, when it was rapidly placed in the proper position on the tool, and pressed down for a few seconds. The squares should be dried on blotting-paper as they are taken from the water, and it is very necessary that no water should be allowed to be set between the squares and the tool. The back of the tool should be examined from time to time to insure that each square has made good contact, as if any of the squares are not thoroughly stuck to the glass they are sure to come loose in the polishing. The squares may be placed about ¼ or ½ in. apart. This is to allow for a good deal of subsequent trimming. When the polisher is ready for work the intervals between the squares should be upwards of ½ in.

A slight difficulty arises with regard to the facets at the edge of the tool. I found it best to stick the squares on without attempting to break them to shape, and cut them off afterwards. When the tool is completely covered with squares, the mirror should be covered with wet blotting-paper and placed on the polisher, the edges of the mirror and polisher coinciding accurately. A chisel, held vertically and lightly struck with a small mallet, is then used to cut off the portions projecting beyond the edge, and great care must be taken that the squares at the edge of the tool are properly stuck on.

The polisher should now be warmed, either by holding it in front of a fire or by means of hot water, to soften the pitch. The mirror, still covered with wet blotting-paper, may be allowed to rest on it for a few seconds to mould the surface of the pitch to the curve of the glass, and the squares should be neatly and accurately trimmed off by means of a sharp knife or a chisel held vertically. If both chisel and pitch are kept thoroughly wet all the time (indeed, it is a good plan to do the trimming of the squares under water) there is little danger of splintering the pitch.

The polisher is alternately pressed and trimmed until all the squares have made good contact, and until they are all exactly the same size and have neat, sharp edges. Too much care and patience cannot be brought to bear on this, as a neatly and accurately made polisher is half the battle; any want of accuracy in the size of the squares is sure to cause trouble.

When the polisher is satisfactory, we may begin to think about the rouge. The rouge as sold is liable to contain a few coarse particles, and I found it essential to mix it with plenty of water and allow it to stand for a few moments to let these coarse particles settle. The rouge and water are then poured into another vessel and allowed to stand for several hours, the water being poured away. A mud or paste of rouge is left which is free from grit and which will not cause scratches.

The polisher may now be warmed up for the last time; and the mirror, painted evenly and densely with rouge and a flat camel's-hair brush, is placed on it, the blotting-paper being omitted. It is moved slowly to and fro, without pressure, and in a few minutes the pitch will have assumed the exact curve of the mirror, and be fit for use. If any square does not make good contact, the warming and pressing should be continued for a bit longer; but this should not be necessary. It is a good plan to scratch each square diagonally, as shown in the figure, after the polisher is moulded to the curve. This lessens the friction, and makes it easier to control the stroke in polishing.

In my practice I invariably apply the rouge to the speculum, and not to the polisher; it is easier to get it even, and renders the motion much easier and more regular. The speculum is held in a triangle of hard wood, with pieces screwed on at the corners to grip the glass. A cotton-reel screwed to the centre of the triangle forms a convenient handle, and the glass should be held just tight, and not subjected to any pressure, which might distort the figure. It need hardly be said that every trace of emery must be thoroughly and completely got rid of; it is very easy to scratch the surface of the glass, and impossible to get the scratches out once they are there.

In the actual polishing I hold the handle at the back of the triangle in one hand and give a stroke of about half the diameter of the mirror. The mirror is allowed to rotate quite freely, the motion being always right-handed; the stroke given is elliptical, the ellipse having a breadth of about 2 in.; also the centre of the ellipse is kept moving from side to side to the extent of an inch or two. This prevents rings appearing on the surface and tends to uniformity of curve. At first the friction of polishing will be considerable, but it lessens as the polish on the glass improves, and if the polisher is neatly and accurately made, the motion will be easy and regular. The stroke should always be made (round the ellipse) in the same direction—right-handed or "clockwise," in my case,—as if it is attempted to move the mirror in the other direction over the polisher, the friction is enormously increased and sticking is the result. Why this should be I do not know, but it has been invariably the case in my experience.

The polish will ere long begin to appear on the glass with surprising rapidity—and as soon as it does testing should be commenced. This will form the subject of my next chapter, when I shall endeavor to make the theory and practice of testing as plain as possible.

In cleaning the rouge off the mirror, to test or for any other purpose, I found it better to let the mirror get quite dry, and then to clean off the rouge with soft blotting-paper. This obviates staining the hands with rouge, and is more cleanly and satisfactory.

The polisher should, of course, be carefully protected from dust when not in use, and the mirror should never be allowed to remain at rest on the polisher. The quantity of water required is difficult to describe, but it should not be too much or sticking is the result.

HOW TO MAKE A SERVICEABLE FISHING ROD

The first consideration in constructing a fishing-rod is that of suitable wood. Greenheart, hickory and lancewood are commonly used because of their strength in thin lengths. The most suitable of these woods, for the purposes of the amateur, is greenheart; it works up well, for the grain is not so liable to pull up, as is often the case with the others.

The number of lengths in a rod depend on the total length. A rod 12 ft. or 14 ft. long, for instance, should be made in at least three parts, two 4 ft. 6 in. or 5 ft. lengths, with the top 3 ft. or 4 ft. long; it will be much better, however, for the amateur to have four parts, two lower pieces, each 3 ft. 6 in., a third 3 ft., and the top 2 ft. in a rod 12 ft. long.

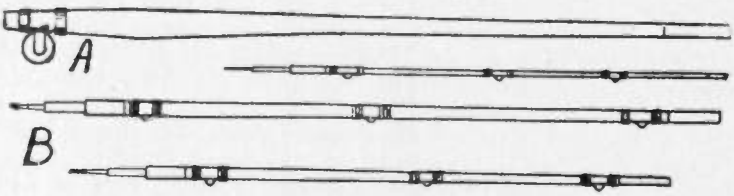


FIG. 1.—A THREE GROUTED FISHING-ROD.

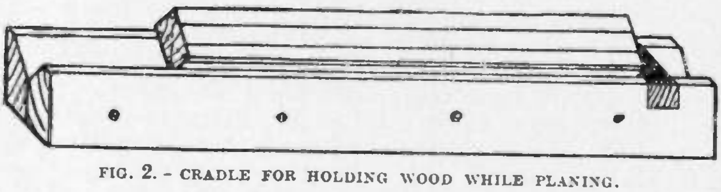


FIG. 2. - CRADLE FOR HOLDING WOOD WHILE PLANING.

FIG. 3.—PLAIN FERRULE JOINT.

It is of the greatest importance to get the best wood, and of course specially selected lumber is always more expensive. It will be advisable to get two or three times more than the actual amount required for the rod, to allow for shakes or defective lengths, which may not be evident in the rough, but show when the stuff is planed up.

The butt or handle end should be $1\frac{1}{2}$ in. square wood, and shaped as shown at *A*, Fig. 1. The greatest diameter, $1\frac{1}{2}$ in., being from 6 in. to 12 in. from the end, which should be about $\frac{7}{8}$ in. diameter; the small end of the handle length should be $\frac{5}{8}$ in. diameter.

To shape the wood, it will be necessary to use a cradle made of two long lengths of wood, bevelled on the inside corners and nailed together, as shown at Fig. 2; a wooden stop should be let in at one end. First mark the diagonals on each end and draw circles, one ⅞ in. and the other ⅝ in. diameter, and outside these draw another 1¼ in. Mark half the length of the diagonal along from each side, as shown, and then plane down to an octagonal shape. Plane the corners down again until a circular form is given to the length, and then the taper may be given, as shown at *A*, using a spoke-shave. The second length should be ¾ in. square, a ⅝ in. circle being marked out one end, and a ½ in. circle the other, the method of planing being the same, using a trying plane to get accuracy in planing.

The third length tapers from ½ in. to ⅜ in., and the top from ⅜ in. to ¼ in.

It is essential to the proper balance of the rod that the planing be very accurately done, the slightest amount out of truth often being quite sufficient to throw the rod out.

When the lengths have been planed up, they should be cleared up with several grades of sandpaper, commencing with No. 2, and finishing with No. 0; each piece should then be perfectly smooth.

The joints or ferrules should now be fitted on the ends; the cheapest way of joining the pieces is shown at Fig. 3, plain lengths of tubing being used, and the wood very carefully fitted; the best method, although it is more expensive, is to use double brazed joints, with or without a locking attachment. The ordinary form of joint is shown at *B*, Fig. 1, the method of shaping the ends being similar to that shown at Fig. 3.

To securely attach the joints to the wood, use strong fish-glue, or caementium, and be careful to leave the work undisturbed until the cement has had time to set.

Rod rings, should be fixed on, as shown at Fig. 4, waxed twine or thread being used to secure them, the thread being wrapped tightly round eight or ten times and the ends carefully secured. The top ring may be fixed, as shown at *A*, Fig. 5, or may be a swivel fitting, let in the end, which should be carefully bound up.

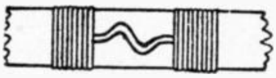


FIG. 4.—RING.

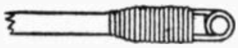


FIG. 5—.END RING.

The winch fittings may be purchased from any tackle shop, or of hardware firms, the diameters of the tapering butt being specified when ordering.

To complete the rod, varnish with finest copal varnish, rub down the first two coats with No. 0 sand-paper, and the third coat will be quite glossy and smooth when dry.

Electric Locomotives

The limitation of output of motors of the gearless and normal geared type has led to the development, in the last ten years, of a class of electric locomotives built somewhat on the same lines as those driven by steam. The motor or a motor with reduction gear, is mounted solid on to the frame or truck, and is attached to the driving wheels by means of cranks, connecting rods and coupling rods. This class of locomotive has some considerable advantages for dealing with heavy main-line passenger and goods traffic. The motor can be of large diameter and placed between the axles or where it is most convenient, the armature or rotar can be of larger diameter than the driving wheels, and by means of small drivers a high speed of revolution can be secured with a large starting torque, due to the large armature diameter. Due to the high peripheral speed, the motor can be of economical design, and there is ample width available, as the cranks are placed on the outer sides of the driving wheels.—*Cassier's Magazine.*

The agreement between the miners and operators, insuring industrial peace in the anthracite coal regions for another period of three years, has been signed by the representatives of the employes and the men. With slight modifications, it is the same as that of three years ago.

CAST IRON BRAZING AND AUTOGENOUS WELDING

F. A. SAYLOR

Brazing is the process of uniting two parts of iron, steel and copper by means of brass and is analogous to the uniting of broken china by means of a cement.

It has been in use for many years by bicycle makers and manufacturers of small articles that require a greater strength of union than is afforded by soldering or sweating, or in the manufacture of which the cost of silver soldering is too great. Copper and brass workers have used it, but as their work is of a different character we will disregard them.

In the work above mentioned, the articles were made of soft steel or wrought iron, which are comparatively free from carbon; but here and there could be found a mechanic who had successfully brazed cast iron articles though these articles were always very small, never weighing more than a couple of pounds.

Their apparatus usually consisted of a forge or gasoline torch, and occasionally a crudely built gas torch, giving a very imperfect combustion and consequently depositing a heavy coat of carbon on the article to be brazed.

A few years ago a German invented, and patented in this country, a compound by the use of which heavy cast iron pieces could be brazed successfully, and a tremendous saving has been effected in a great many shops, mills, railroads, mines, etc., either by the use of a plant in the place or by having the work done by one of the many brazing repair shops which have sprung into existence since the introduction of the compound.

Castings weighing many tons have been brazed, and after five years constant use are as good as ever. Heavy pieces such as the shear arms of large cutters, punch frames, trip hammer housings, cylinders of steam hammers, 75,000 lb. fly wheels are all in use today that have been repaired by brazing, which would otherwise have made their way to the junk dealer.

In one instance that came to my observation, a balance wheel from an air compressor that was broken into four pieces was repaired and is running today. The wheel weighed 2,500 lbs., was of the split type, and the spokes were entirely separated from the rim. When the job was completed it was found that the wheel was out of true 1/32 in., which was of course negligible in a piece of this size.

Among the manufacturers who have found that there is a great saving to be made by the use of cast iron brazing are textile machinery users who, having many machines of light frame and hard usage, suffer to a greater extent than others. Mines are usually situated at some distance from the larger cities and a breakage of machinery is of great moment to them, and they, too, have availed themselves of the process. The cost of a plant was saved many times over recently in a large mine when a section of the master gear wheel in the hoisting apparatus was repaired in a couple of hours, when to have made a new casting would have taken several days.

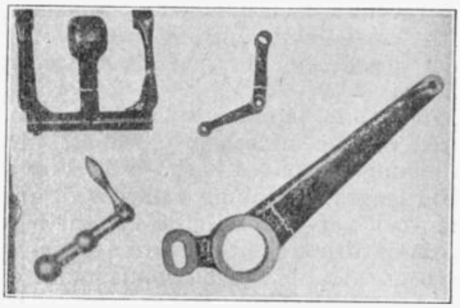


Fig. 1
Machinery Repaired by Brazing

Street railways are finding it very effective in repairing broken motor shells, gear cases, truck frames, etc., but at the present time the largest user of cast iron brazing is the automobile owner, repairsman and garage man.

More automobile parts are brought into the brazing repair shops than any other one type of machinery. I believe that this is accounted for by the fact that autos are used by very many people who know little or nothing of mechanics, and the signs of trouble that would be clear to the mechanic are unheeded and

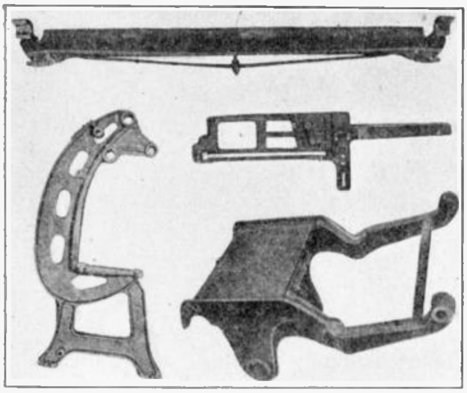


Fig. 2
Machinery Repaired by Brazing

ignored simply through ignorance, consequently the breakage is in proportion.

Cuts Nos. 1 and 2 show some examples of machinery repaired by brazing. They consist of textile and printing machinery, and small engine and lathe parts. The break is clearly shown by the white line which indicates where the repair has been made.

Cut No. 3 shows an auto cylinder with broken water jacket and a vise with broken jaw.

There is a tremendous field open for mechanics to go into the brazing repair business, as there are few plants running now and the returns are large for the investment. In connection with a machine repair shop of an auto garage there would seem to be the best opening for a tool of this character. The space required being small and the cost low, a very wide margin of profit should result. This business being on the order of salvage work, prices are accordingly high. It is usually taken that where a machine valued at a certain figure, which would otherwise be thrown into the scrap heap can be saved, a percentage of the cost of a new machine should be charged for the repair work, and this percentage depends, of course, upon the capacity or good-will of the repairsman. In making their charge the element of time is also considered. As an instance, a man who had broken a small but important part of an elevator which he could not replace except by having a new casting made, will pay many times the value of a broken piece if it can be repaired for him in an hour or two, especially if he has a large building full of tenants and only one elevator. Very frequently a small part of an important machine will break and an entire factory be shut down until the machine can be repaired. In cases of this kind the brazing repairsman makes his charge according to the need of the customer.

Cut No. 4 shows an oil burning brazing plant complete with an auto cylinder prepared in the furnace (which is open) ready to be brazed. This type of brazing plant is the kind that is usually installed in mills, factories and small repair shops which take care of their own work. Larger plants are made use of by the brazing repair shops and in such places as it may be available, either natural or artificial gas is used with a small compressor to give air pressure necessary to complete combustion, in place of the oil (kerosene) burning plants. The type of plant illustrated is large enough to take care of castings up to 600 or 800 lbs., or if the cross section of break is not too great, of even larger sizes.

The apparatus shown consists of an iron table on which is placed a bed of fire-brick. The casting (an auto cylinder) is placed on the fire-brick bed, and

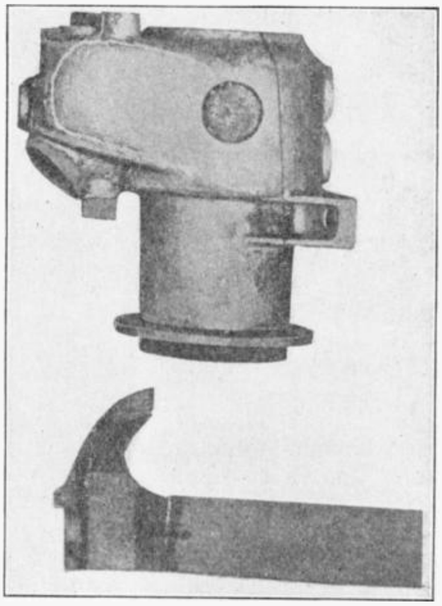


Fig. 3
Auto Cylinder with Broken Water Jacket
Vise with Broken Jaw

a temporary furnace of fire-brick built around it with the front left open for the insertion of the torches.

Standing in front of the furnace, pointing at the casting, are the two torches which are connected with the tank by wire wound hose. The tank is of seamless steel tested to several times the working pressure and is equipped with manifold for the torches, pressure gauge, sight feeds, self-contained pump and all necessary valves, strainers, etc. The torches are the principal part of the plant and are so designed as to give complete combustion without carbonization. A few strokes of the pump will give the pressure of air necessary and a temperature of 2,700° in the open flame can be obtained. The flame can be adjusted to give an intense blue flame or can be reduced to a much softer yellow flame by changing the air pressure.

Cast iron contains a large percentage of carbon and for this reason it has been impossible to braze any except the smallest pieces, as the brass will not adhere to the iron in the presence of carbon. Wherever the carbon is encountered the brass flows off like oil on water, and the object of all who have experimented with brazing compounds has been to reduce the graphitic carbon without materially weakening the iron. This has been accomplished finally and repair of castings by brazing is universally accepted. The process is as follows:

The casting to be brazed is cleaned of all grease and dirt, either by washing with alternate baths of dilute muriatic acid and solutions of caustic soda, which are run through the crack and then washed off with pure water, or, what is much better, heat is applied to the casting until it has reached a dull red color. It is then allowed to cool and the broken surfaces brushed with a wire brush. The fracture is then painted with compound and the pieces set together and held in alignment. The casting is then placed on a bed of fire-brick, care being taken to keep the alignment of the pieces by building up under them with fire-brick and fire-clay that has been mixed with a small quantity of raw clay and salt. A temporary furnace of fire-brick is built around it, care being taken that space is left under it so that it can readily be seen when the spelter drips through the crack. The top of the furnace can be covered with asbestos and an opening left in front for the application of the torches. The number of the torches is dependent upon the size of the piece and the nature of the crack. Allowance must be made for expansion and heat applied in such a manner as to make the expansion as nearly even as possible, otherwise fresh cracks are likely to appear.

Heat is then applied, and when the casting reaches the brazing heat (light straw color), flux is placed on the fracture and allowed to melt. As soon as it runs through the crack freely, spelter is applied and as it melts and runs down to the fire-brick floor, it is spooned up with the steel spoons and reapplied until it is seen that the crack is full of brass. If it does not run freely additional flux is applied with the spelter. With the small castings this is all that is required, but in the larger sizes a current of cold air is sometimes applied to the bottom of the crack to chill the brass at the bottom while it is running in at the top. When the crack is full the torches are removed and the aperture in the furnace is closed with more brick, the casting being allowed to cool gradually in the furnace. Closing the front where the torches were applied also prevents sudden draughts from striking the casting and chilling one place more than another, resulting in new cracks or the opening of the old.

When the casting is cold the furnace can be torn down, the casting removed and cleaned of excess brass and flux by filing and chipping. A good job upon cleaning will show a thin thread of brass where the fracture formerly existed, and if care has been taken to keep the alignment, the casting will be as good as new, or rather, it will be better, for it is now stronger along the line of fracture than originally and will never break in the same place as before. This may seem strange but is easily understood when you remember that the tensile strength of brass is almost double that of cast iron, and the brass in the fracture is so closely united to the iron that it is impossible to separate them except by the use of heat.

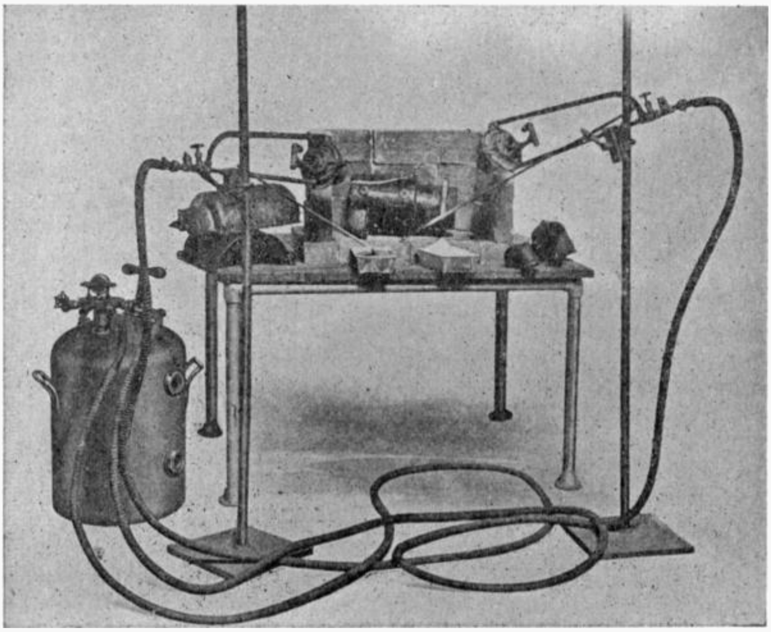


Fig. 4
Oil Burning Brazing Plant Complete

This is proven when you try to chip the brass away from the iron. Invariably a skin on the iron is taken away with the brass and in breaking along the line of the old fracture fresh iron is always carried with it.

The important item, as in all work, is of course the cost, and with brazing the relation between cost and saving effected is an astonishingly large percentage.

The cost of operating a two-torch plant is as follows:

Labor at 25 cts. per hour.......	$0.25
Gas at $1 per thousand per torch	.15
Spelter, flux, compound, etc....	.05
6% yearly interest on investment	.005
Rent, taxes, insurance, etc......	.10
10% depreciation	.01
Total, per hour............	$0.565

This cost of 56½ cents per hour is a running cost and must be divided by all the work done in that hour as more than one job is under way at the same time. When one job is heating the operator is working on another, cleaning it or setting up ready to braze, or burning off preparatory to setting up.

The average receipts of the brazing repair shops in New York and Philadelphia range from $7,500 to $10,000 per year, so that there is a very comfortable profit in the work.

The important points to remember in brazing are:

1. Have the work clean.
2. Good alignment.
3. Get the casting hot enough: more work is spoiled by trying to work at too low a heat than is injured by too great a heat.
4. Have the flux running through the crack before applying the spelter.
5. See that the crack is full before taking off the heat and ceasing to braze.
6. Care in applying the heat so that the expansion is even.

If these points are carefully observed a good braze will result, but unless a good compound that will reduce the graphitic carbon in the iron is used all the rest is wasted time. This is the most important point of all as without it nothing can be accomplished.

Sometimes folks get a good many irons in the fire at the same time in spite of themselves. Jobs come thick and fast, some days. The best way to do, then, is to keep calm and go straight ahead.

THE TROUBLES OF A SWITCHBOARD ATTENDANT

J. A. S.

It is popularly supposed that the switchboard attendant in an electricity supply station is an overpaid individual whose chief duties are to prevent himself from going to sleep upon watch, and as occasion demands to brew tea for the engineer in charge of the shift. He varies this occupation by occasionally tapping the voltmeter and adjusting the field regulating resistance. When called upon to do a bit of original thinking he is usually not there.

It may be argued that although the salaries paid to switchboard attendants appear to bear out this theory as to their usefulness, there are occasions upon which even a switchboard attendant may be of service and in order to demonstrate this interesting and simple fact a few instances of the troubles which beset a switchboard attendant may be given. It is not, of course, pretended that these are every-day experiences, otherwise it is possible that he would get more recognition. Just as much as an emergency governor upon an engine is useful in proportion to the way in which it does its duty when the engine runs away, so the switchboard attendant is worth his salt in proportion to the way in which he can deal with electrical emergencies in the station as they arise. In order to illustrate what is meant, the following instances may be taken:

In a certain generating station the voltage of the machine was controlled by means of field resistances constructed of high resistance wire embedded in a species of enamel and placed in a round insulated iron frame. This was fixed under the switchboard gallery and the attendant found during his watch that in regulating the output of the machine violent voltage fluctuations were thrown on to the system. Upon investigation he found that when the spindle of the resistance running through the gallery floor was regulated to a certain position the voltage dropped considerably but on the next stop rose again to an equal extent. This occurred at several places on the resistance and it was therefore thought advisable to transfer the load as quickly as possible from this particular machine to the other. When the machine had been shut down the field resistance was taken down and examined and it was found then that the trouble was due to a very simple cause, namely, the bad contact of the switch arm upon certain of the contacts. The switch arm or contact lever and the stops were cleaned with fine emery, then polished and the lever was replaced. The pressure of the contact springs was then carefully adjusted so as to make contact on all the stops which were then very lightly vaselined. After this incident the duty of the switchboard attendant included the periodical inspection and vaselining of contacts.

Another interesting experience which occurred on a traction switchboard was with an automatic no-load and reverse-current combined circuit-breaker which persisted in dropping out at inconvenient times for no apparent reason. As this occurred usually on about three-quarter load considerable trouble was given and the switchboard attendant set himself to trace out and examine the connections behind the switchboard. As a result it was discovered that one of the leads to the reverse-current or shunt wound coil of the circuit-breaker had worked loose from the terminal and was not making contact. The displacement had probably occurred some time when the back of the board was being dusted. The terminal was of course tightened up again and all the connections of this and other switches were carefully examined. At the first convenient opportunity all the connections were gone over with a spanner, and after this occurrence periodical examination and tightening up of connections and nuts was made a part of the routine. As a matter of fact these circuit-breakers were found to be of not very much practical value on supply systems and therefore it became the custom after switching in a machine to wedge up the circuit-breakers until it was actually necessary to shut the machine down again. The wedges were then again removed and the switches allowed to cut themselves out automatically on no load. It is, however, a debatable point as to whether it is advisable to put such a protective device out of action, as the generator might for some reason fail suddenly, and it is to be feared that in this instance safety was to some extent sacrificed to convenience.

A good many of the troubles with which the switchboard attendant is afflicted occur as a result of causes beyond his control. Should the trouble happen within the generating station he can usually look to his engineer in charge to put things right; but when events begin to happen upon the transmission or distribution system the attendant is very often faced with immediate and sudden difficulty with which he has to cope on his own initiative. For example, there was on one occasion a heavy overload and drop of pressure at a generating station due to heavy fault on an interconnected net work. This fault occurred on a night shift when an 80 kw. steam balancing set was taking the load. It was subsequently found that the trouble was a combined earth and short circuit on the outers of a vulcanized bitumen distributing cable laid solid in the ground. The voltage dropped at once 50% when the trouble occurred and as the short circuit was intermittent the pressure was very fluctuating. Another machine was gotten into operation as quickly as possible; but under the circumstances it was rather a difficult matter to parallel them. Even this was of very little avail, as the pressure could not be raised without generating an excessive amount of current from the machine, for the fault was so heavy that it could not be burned out and the pressure was only raised very slightly. It was therefore necessary to cut the supply off entirely by shutting down the machine, light in the station being obtained in the meantime by emergency oil lamps, and it was hoped by these means to extinguish the arc on the cable and thus to restore more or less normal working conditions. When a sufficient amount of time had been judged to be given, the large machine was started up again and put on supply and it was then found that the means adopted had proved effective, absolutely normal conditions of pressure being obtained. An examination of the fault next day by the main engineer showed that the cores of the cable had entirely separated and the molten mass of vulcanized bitumen around the fault had effectually insulated the burnt cores. Shutting down had thus eliminated the fault and saved several yards of cable and the cost of joining in a fresh cable was thereby considerably reduced.

Reference was made in the above paragraph to the fact that the temporary lighting of the station had to be carried on by means of oil lamps. This emphasizes the trouble which from time to time afflicts switchboard attendants, and indeed every one interested in the running of the station, due to insufficient forethought on the part of those responsible for the design. It is, however, felt more by the switchboard man because, in the event of a shut down of the station lighting, the engine attendants can generally tell within a yard or two where the stop valves and other gears are situated, whereas in a good many modern switchboards made according to space-saving ideas the switches are so crowded together that in the dark a miscalculation of 6 in. would be enough to cause a serious mistake in the switching operations or even loss of life. In some stations where alternating current is used no better provision for lighting has been devised by the chief engineer than a small transformer fed from the main bus bars and connected on its low tension side to the station wiring. This it need hardly be said, is absurd in the extreme; other men have gone a stage further and connected the station lighting to the exciter board; but even this is not satisfactory, as not only can the exciter fail, but also the power for the station lighting should be generated quite separately from the main steam supply, for it is known that boiler troubles frequently happen. It would, of course, be expensive to keep a separate boiler and engine of small capacity for such a purpose and therefore the only thing which can be done and which ought always to be arranged for is that the station and particularly the switchboard should be equipped with emergency oil lamps which should be kept

Continued on page 28

MODEL AEROPLANES

A. E. HORN, B.S.
Member of Aeronautic Society

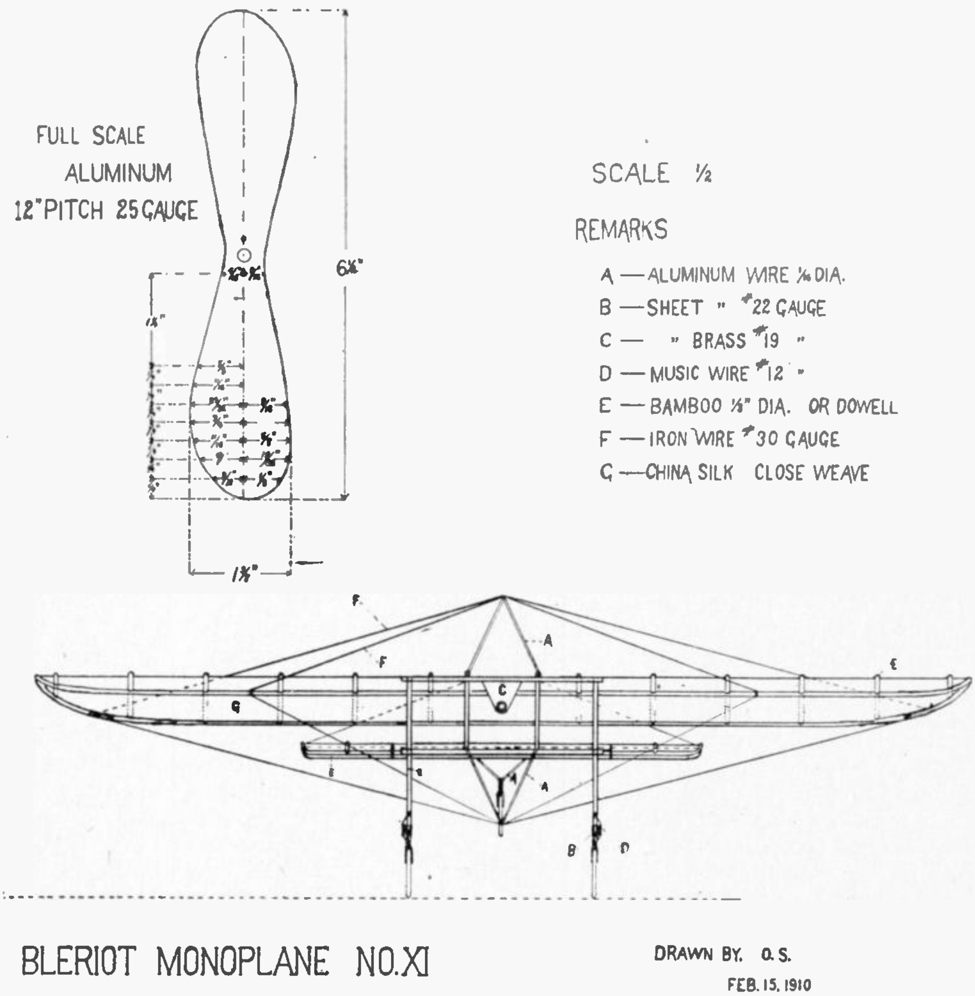
The value of model aeroplanes need hardly be dwelt upon here. As a means of studying the fundamental principles of aeronautics, stability, supporting surface per unit of mass, etc., at small expense they are unsurpassed.

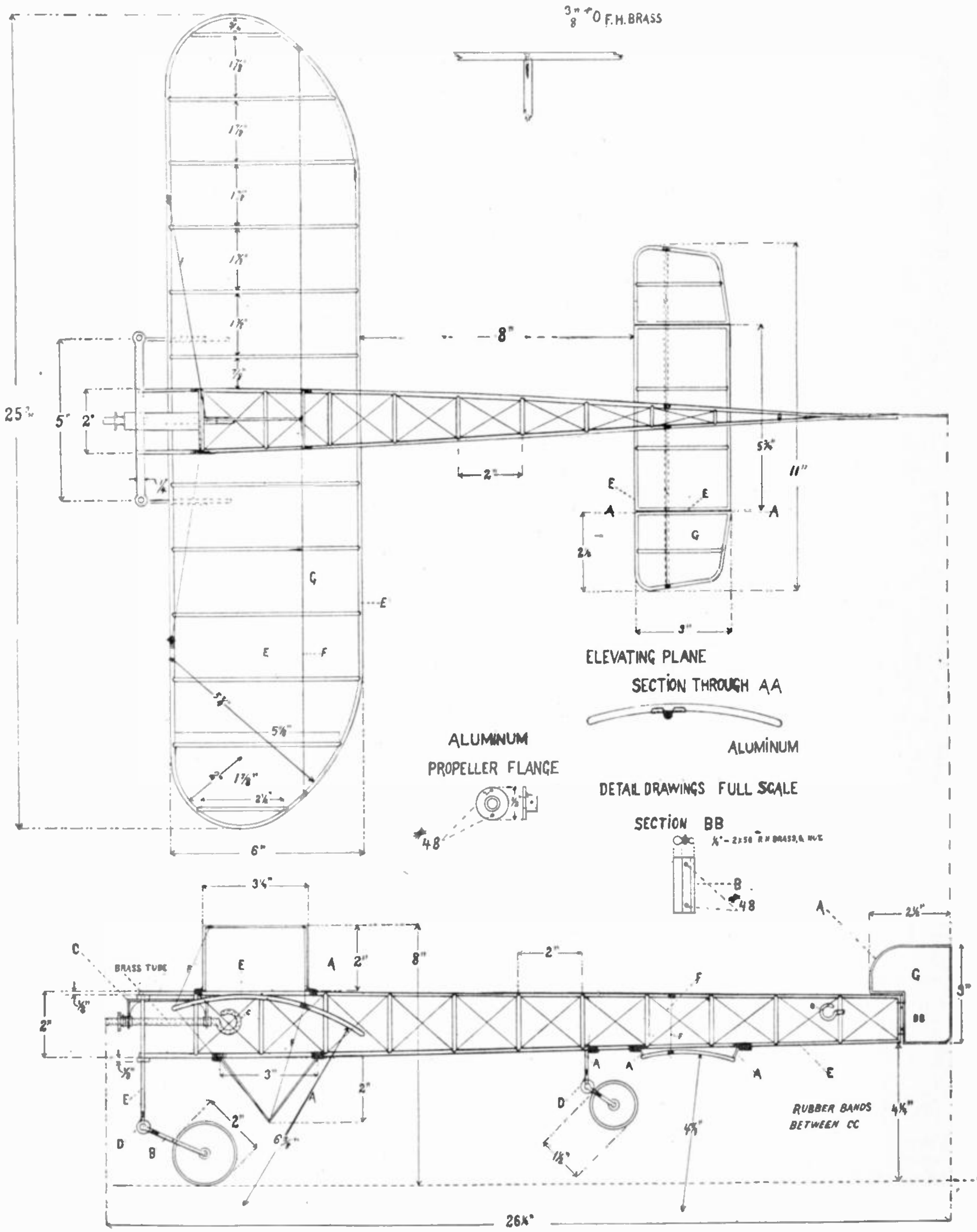
Before one constructs an aeroplane it is advisable that one have a thorough knowledge of kites, for what is an aeroplane but a large kite with a self-contained means of producing a current. The difference between an aeroplane and a kite, such as the Hargrave, more familiarly known as the box kite, is that the latter is held stationary in a current of air, produced externally while the aeroplane makes its own air current and moves itself.

A problem that has remained unsolved in the man-carrying planes, but which the model builder is forced to consider, is a device for automatic stability. This alone offers a large field to investigators.

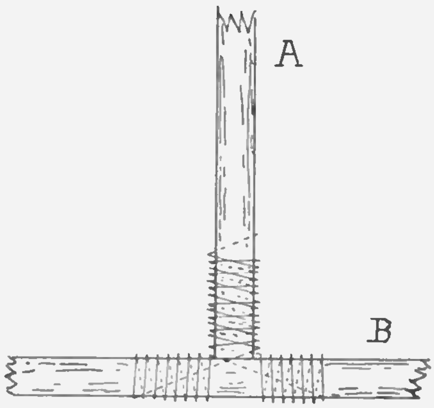
A model aeroplane rises by the action of the resistance to the pressure of the air beneath its rapidly moving surfaces. The aeroplane passes over a large mass of air in a unit of time sufficient to support it.

An ounce of prevention being worth a pound of cure, a thorough under-




ELEVATING PLANE
SECTION THROUGH AA
ALUMINUM
ALUMINUM
PROPELLER FLANGE
DETAIL DRAWINGS FULL SCALE
SECTION BB
BRASS TUBE
RUBBER BANDS
BETWEEN CC

standing of a principle that is bound to be violated in original construction is necessary. As the surface increases as the square, the mass increases as the cube. Suppose you had a surface containing 4 sq. ft. which weighed 4 oz. This would measure 2 x 2 ft. Now suppose you double the measurements, making the plane 4 x 4 ft., 16 sq. ft. in all. Of course the plane would require sticks or rods twice as thick to support the increased weight. According to the principle the weight would increase as the cube 2 x 2 x 2 equals 8 times the weight of the smaller plane or 32 oz. One can readily see that there is a limit to the size of a flying machine. If this is kept in mind many failures will be be avoided and explained.

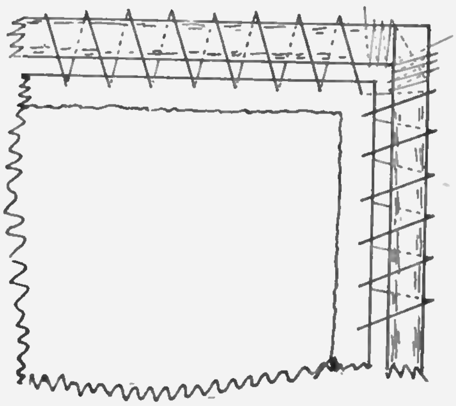


A JOINT
FIG. 1.

The elements in construction that require consideration are: (1) joints; (2) covering a plane; (3) construction of a propeller; (4) arrangement; of motive power.

The strength of your aeroplane will in a large measure depend on the firmness of your joints. To insure a strong joint, wind a fine silk thread around your bamboo at *A*, Fig. 1, then wind around either side of *B*, and back again to *A*, giving each winding a coat of carpenter's glue.

To cover your plane use a close weave china silk. Measure out your silk, or material used, ¼ in. larger than the frame to be covered. Then make a ⅜ in. hem. Your cloth will now be ⅛ in. smaller than your frame. Cross stitch this to your frame as in diagram. Your cloth ought to be tightly stretched with not the slightest sag.



COVERING A PLANE
FIG. 2.

For the arrangement of your rubber band motor and propeller, see detail plan in working drawing, Fig. 2.

When your model is completed it will require a little practice to fly it. Wind your propeller to the left about 150 times. Hold your plane in your right hand and release the propeller, allowing it to revolve a few times and throw it gently forward. The model will sail gracefully in a straight line, and when the power is exhausted will glide gently to the ground.

An account should be kept of every trial, the distance flown, the conditions under which it flies (with or against the wind), and the course or direction taken by the machine.

A recent report of the American Telephone and Telegraph Company shows that at the end of 1909 the Bell companies owned 3,500,000 telephones, while 1,500,000 were owned by companies under contract agreements with the associated Bell companies. This is an increase of 600,000 telephones during the year. The system comprises 10,250,000 miles of wire, 400,000 miles of which were added last year. Half of the total mileage is underground.

FORGING FOR AMATEURS.—Part XX
Crank Shafts

F. W. PUTNAM, B.S.

One of the very common examples of steam hammer work is that of the forging of a crank shaft. They are forged with a steam hammer in about the same way as if made by hand on the anvil.

Fig. 211 shows a special shaped tool which can be used to advantage for making the cuts on each side of the crank cheek or shoulder. If these cuts are to be very deep, it is better to make them first with a hot chisel and then spread them with a spreading tool. If the shoulder is not very high, however, both of the operations of cutting and spreading may be done at the same time with the spreading tool. After these cuts have been marked and opened out care must be taken to allow the collecting of the metal due to a turn of it getting too cold to work well under the hammer.

Fig. 212 shows the use of a block of steel which is used for squaring up against the shoulder. When a shoulder is to be formed on both sides a block is usually placed below and a second block above the work in very much the same way as was shown in Fig. 199, the round bars shown in that figure being, of course, replaced with square ones.

CONNECTING ROD

In the drawing out of a connecting rod between shoulders, cuts are made with the spreading tool which is used in connection with a short block of the same shape as the tool, or else a second tool, one of which is placed above and the other below the work as is shown in Fig. 213. After the cuts have been made, the stock between them must be drawn down to the proper size and then finished.

Sometimes the distance between the shoulders is so very short that the cuts are closer together than the width of the faces of the dies. This makes it impossible to draw out the work by the use of flat dies and is overcome very easily by using two narrow blocks as indicated in Fig. 214.

RINGS WITHOUT A WELD

It frequently becomes necessary to forge rings and forgings of similar shape without a weld. When this is done by hand on the anvil, the method is simply that of expanding a punched or split hole over the horn of the anvil. Rings of this sort are made very rapidly under the steam hammer by slight modification of this method.

The discs are shaped and punched and then hammered to size over a mandril. A U-shaped rest is placed over the anvil of the steam hammer and the mandril is slipped through the hole in the disc and placed on the U-shaped rest. The blows will, of course, come directly down upon the top side of the ring which is turned between each two blows. The ring rests only upon the mandril. This necessitates larger mandrils being used as the hole increases in size, care being taken to keep the mandril as nearly as possible the same size as the hole. A good blacksmith can take stock, cut from the bar, and forge and true up a ring in one heat.

Fig. 215 shows a forging for a die which is to be made of tool steel. The method of forging this die is about the same as for the making of weldless rings, the stock being cut, shaped into a flat disc, punched and finally worked over a mandril until it becomes of the shape shown at *A*, Fig. 216.

Fig. 215 shows a lug *C*, which projects toward the centre from the flat edge of the die. This lug must be shaped on a special mandril and the method to be followed is clearly shown at *B*, Fig. 216. Here the thick side of the ring is shown as being driven into a groove of the proper shape cut in a mandril, after which it is shaped up as shown at *C*, this being a sectional view of the mandril and ring.

Sometimes the flat edge of the die is quite long, in which case it will require straightening. This is done by using a flat mandril and working each side of the projecting lug after the lug has been formed on the special mandril. Fig. 217 shows the forging as it leaves the hammer. The forging has its sharp finished in the anvil with hand tools as is shown at *B* and *C*, these figures showing how the corner is worked up by using a flatter.

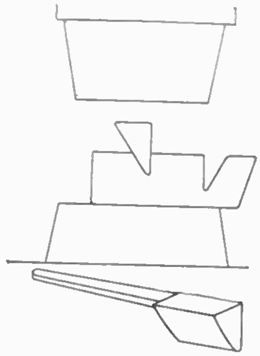


Fig. 211

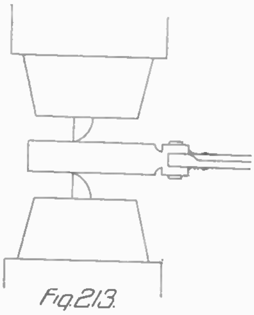


Fig. 213.

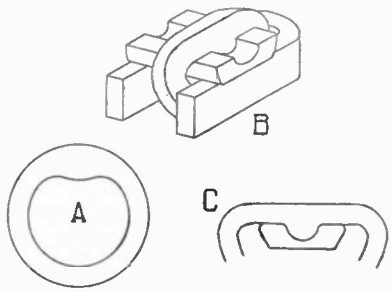


Fig. 216.

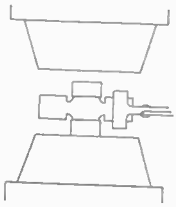


Fig. 214

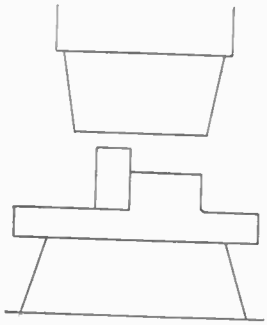


Fig. 212

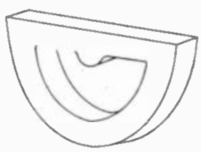


Fig. 215.

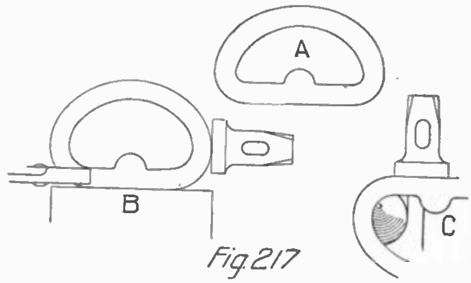


Fig. 217

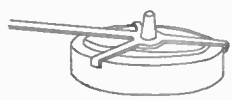


Fig. 220

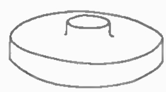


Fig. 220-A

Fig. 218

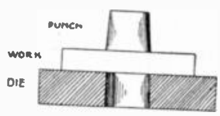


Fig. 219

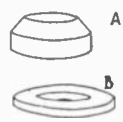


Fig. 221

Fig. 222

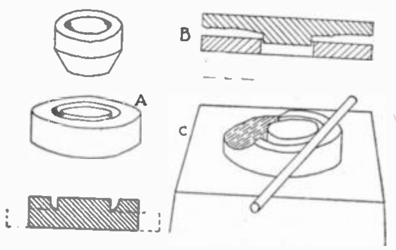


Fig. 223

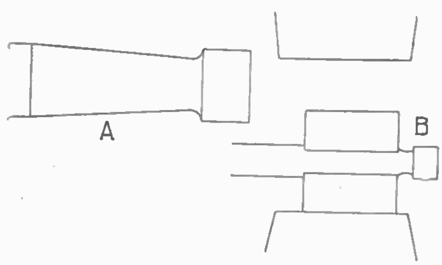


Fig. 224

PUNCHES

For practically all punching work done with the steam hammer, the punches used must be short and thick. Fig. 218 shows a common method of holding a punch where the punch is really a short tapering pin, having a small groove formed around it about one-third of the length down from the big end. For the handle a bar of 3/8 in. round iron is heated, wrapped around the punch in the groove and then twisted tight, as is shown in the figure.

The punch is used in exactly the same way as a small hand anvil, it being driven to a depth of about one-half to two-thirds the thickness of the stock when the work lies flat on the anvil.

The piece is next turned over and the punch started, with the work still flat on the anvil, after which the hole is completed by placing a hollow disc or collar on the anvil, the stock being placed on the disc so that the holes will come in line so that the punch will come through the hole in the disc.

The end of the punch should never be allowed to get red hot. Of course, if the punch is left in contact with the work too long, it will become heated and then, after a few blows, we find the end has spread out and sticks in the hole. This can be prevented by lifting the punch out of the hole and cooling it between every few blows.

Fig. 219 shows an arrangement which is used where a hole can be accurately determined. The punch shown is only a very little longer than the thickness of the stock to be punched. Notice that the big end is to be placed down against the work as shown in the figure. The punch is driven together with a piece of metal which is sheared out down through into the hole in the die, which is just a little bit larger so as to give clearance to the punch.

Fig. 220 shows a very common arrangement used for centrally locating the punch with the hole in the die. The die must be somewhat larger in diameter than the stock to be punched. The work is first placed on the die with the punch over it, the punch being located by using a spire-shaped arrangement made out of thin iron. This arrangement has a central ring with a hole in the centre of sufficient size to slip easily over the punch. Branching out radially from the ring are four arms, three of which have their ends bent down so as to fit around the outside of the die. The fourth arm is considerably longer and is used for a handle.

The ends of the three bent arms should be so shaped that where they touch the outside of the die the central hole comes directly over the hole in the die. This is an extremely convenient arrangement for locating the punch, and requires only a light blow of the hammer to start the punch, after which the spire can be removed and the punch driven through the remainder of the thickness of the stock.

FLANGE BOSSES

Fig. 220*A* shows a boss which is frequently necessary on a flange or some other flat piece. It may very easily be formed under the hammer by the use of a few simple tools. The special tools necessary are shown in Fig. 222 and consist of a round cutter which is used for starting the boss shown at *A*, a section of which is shown in Fig. 221, and a flat disc shown at *B*, which is used for flattening and finishing the metal around the boss. The stock must first be forged into shape somewhat thicker than the dimension to which the boss is to be finished, since it naturally flattens down somewhat in the forging.

To start the boss, we first make a cut with the circular cutter, as is shown at *A*, Fig. 223. This figure also shows a section of the forging after the cut has been made. The metal outside of the cut is next to be flattened out, the general shape being indicated by the dotted lines. The drawing out and flattening of this piece is usually done with the aid of a bar of round steel, as is shown at *C*. This bar is placed in such a position as to fall just outside of the boss. Having struck a blow or two with the hammer, the bar is then moved further out toward the edge of the work and the piece turned a little. By this method, the stock is roughly thinned out, leaving the projection of the boss in the centre.

To finish the work, the forge is next turned bottomside up over the disc so that the boss extends down into the hole into the disc as shown at *B*. The disc is finally forced up around the boss with a few blows of the hammer, so that the metal is finished off smoothly. Note that it is not necessary that the disc be large enough to extend out to the extreme edge of the work.

After a disc, as just described, is used to finish around the boss, the outside edge of the work may be drawn down under the hammer in the usual way. Indeed, it is not absolutely necessary to use a disc at all, but with the aid of it, the work may be more carefully done and much more quickly finished.

ROUND TAPERING FORGINGS

Fig. 224 at *A* shows a round tapering shape which is a common problem of steam hammer work. To forge this, it is usually started by working in the shoulder next the head with a round bar, as was shown in Fig. 199. The roughing work may be done with square or flat pieces, using them in much the same way, or it is possible to use one piece only, the work being allowed to lie flat on the anvil with the head projecting over the edge.

After this roughing work has been done, the work is to be finished with swages. These swages, if used in the ordinary way, would leave the forging straight with the opposite sides parallel. To form the taper, it is necessary to hold a thin strip on the top of the upper swage, very close to and parallel with one of the edges, as shown at *B*, Fig. 224. This strip, of course, causes the swage to spread and tip and gives us the tapering shape as desired.

MISCELLANEOUS WORK

There are a wide variety of problems which come up from time to time and which call for considerable ingenuity on the part of the blacksmith. It would be impossible in a series of articles like this to cover all of these miscellaneous problems, but there are one or two kinds of work, which deserve at least a brief mention at this time before closing these articles.

One subject is brazing and another soldering. Brazing is used where the parts are so small or thin that they would be burned or waste away if they were to be raised to a welding heat. Brazing is also used where finished bars that cannot be stretched or else upset by hammering are to be joined. The process of brazing is very simple. The parts to be joined are made bright and cleaned thoroughly of all acid or grease on the surfaces where they are to come in contact with each other. These parts are usually painted with some flux, such as borax, and raised to the melting point of the brass, brass filings being sprinkled over the paint. The parts to be joined must, of course, be firmly fastened while being heated and this is done by binding them with wire or holding them with some sort of a clamp. The flux is heated to prevent the oxidization of the surfaces and the prepared brass, usually called spelter, is sprinkled over the joint so that when the heat is raised to the point where the brass melts, it will flow into the joint, thus making a union between the pieces. Usually a bright red or dull yellow heat is necessary in order to melt the brass properly. Considerable might be said about the brass which is used as spelter. You cannot well braze forgings or machine parts with cast brass filings; instead you should use granulated brazier spelter or set brass clippings, and where the work is to be finished, bright, white set metal is used. The brass will give the best results when it contains sufficient zinc, so that its melting point is well below that of the iron. In other conditions, it should reach the melting point when the iron or steel has only come to a bright cherry red. The brass, as I have before stated, must melt thoroughly, otherwise it will not adhere to the metal.

Care must be taken not to get the iron too hot, and the heating should be preferably done on a charcoal or anthracite fire, soft coal being used only where the greatest care is taken, because the usual presence of sulphur in soft coal will give very poor results.

A method that is not very commonly used at the present time, is to employ a graphite crucible, in which a quantity of brass has been melted. The parts to be brazed are cleaned or brightened and fastened together in the usual way, after which they are painted with the borax paste.

The parts that are not to be joined are painted with an anti-flux. For this, a special preparation of graphite made by the Dixon Crucible Company is used. After the melting of the brass, the parts are plunged into the molten metal and held there until they have risen to the temperature of the same, after which they are taken out, cleaned, and the superfluous metal filed away. This is the method which is used for the brazing of bicycle frames. Almost any metal that will stand the heat can be brazed, but exceeding care should be used when brazing cast iron to have the surfaces in contact thoroughly cleaned to start with and then properly protected from the oxidizing influences of the fire and outside air while being heated.

MACHINE SHOP PRACTICE.—Part II

The Drill-Press

P. LE ROY FLANSBURG

The subject of "drilling" being so generally understood, it seems only right that the drill-press and drill-press work, should be among the first topics to be treated under the title, "Machine Shop Practice." The machine itself is easily understood and requires but a reasonable amount of skill on the part of its operator. By referring to the large drawing, it may be readily seen what the various parts of a drill press are called. The heavy upright of the machine is securely bolted to the base plate, and upon this upright the various parts of the press are fastened. The spindle is that part of the machine which holds the drill; and the feed, or downward motion of the drill spindle may be accomplished either by hand or by power. For the purpose of raising or lowering the drill spindle more easily, a heavy weight is fastened to the counterweight chain, this weight counter-balancing the weight of the spindle.

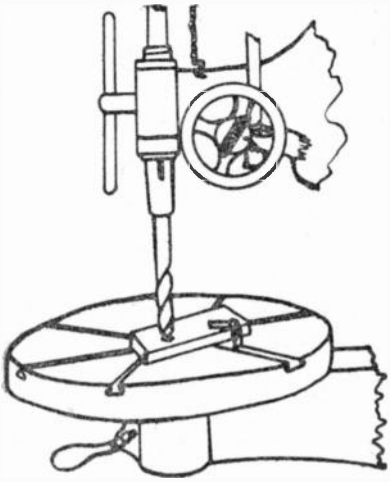


Fig. I.

For transmitting power to the machine pulleys are used and by varying the relative diameters of the pulleys on the driving cone and on the driven cone, it is possible to obtain four or more different speeds. In order to still further increase the range of available speeds, a back gear is employed.

The table may be either raised or lowered at will and may then be clamped in the desired position. However it often happens that when large pieces of work are to be drilled, it is more convenient to simply swing the table out of the way and securely bolt the piece of work to the base plate.

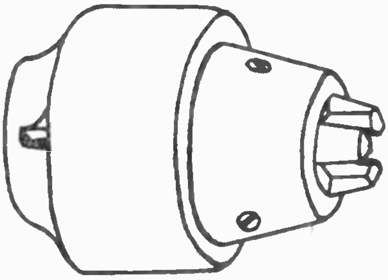
The drills themselves are pushed into the spindle and are held there by friction, thus revolving with the spindle.

In Fig. 1, it is clearly shown how the drill spindle, drill and table look when a piece of work (clamped to the table) is being drilled.

In the case of the smaller drills, the shank of the drill is too small in diameter

Fig. 2.

to fit tightly into the spindle, and in this case a sleeve similar to the one shown in Fig. 2 is used. This sleeve simply serves to increase the diameter of that part of the drill which fits into the spindle, and thus bush the hole. In the case of drills ½ in. or less in diameter it is found more convenient to hold them in a drill chuck similar to those shown in the drawings.



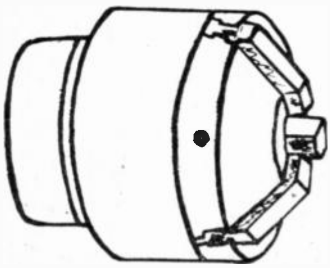
"Skinner" Chuck.

SKINNER CHUCK

These chucks fit into the drill spindle and the small drills are held in these chucks.

CUSHMAN CHUCK

The drills in common use are of two classes, flat and fluted: fluted drills being of two types, one with a straight flute and the other with a spiral flute (called a twist drill). In recent years twist drills have been employed for drilling holes up to 3 in. in diameter, almost to the exclusion of all other forms. In many of the larger establishments the drills are always sharpened or ground by a tool-maker in the tool room on a special grinding machine.



"Cushman" Chuck.

In the twist drill the diameter of the drill gradually diminishes toward the shank end and it is relieved or "backed off" for clearance from the advance lip toward the next groove or flute: the lips should also be ground of equal length to avoid an irregularly shaped hole and a small amount of clearance should be given the cutting edge or lip in order to obtain the best results. The flutes of the drill carry the chips up and out of the hole and also form the cutting edges at the end of the drill.

A flat drill should be ground with its point exactly in the centre or it will drill a hole larger than the actual diameter of the drill; that is, the hole will be about twice as large as the greatest radial distance from the point of the drill to the end of the lip. The angle between the edges of the two lips should be about 110°.

In case the lips of the drill are not ground of equal length an irregularly shaped hole is drilled. Fig. 3 shows a case in which the lips are of unequal length, while Fig. 4 shows the case where the lips are properly ground.

Whenever a hole has to be drilled there is usually another hole to be drilled in a counter location on some other part of the work, so that when the two parts are assembled together, the holes will coincide. If the number of pieces will warrant the expense, the work is "jigged," so as to save the time which would be occupied in laying out, setting up the work and starting it correctly. When the work is jigged at all, a separate jig is generally made for

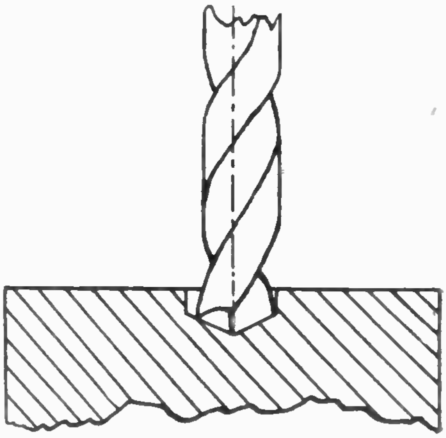


Fig. 3.

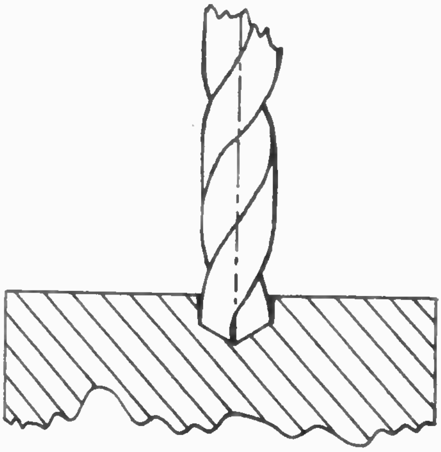
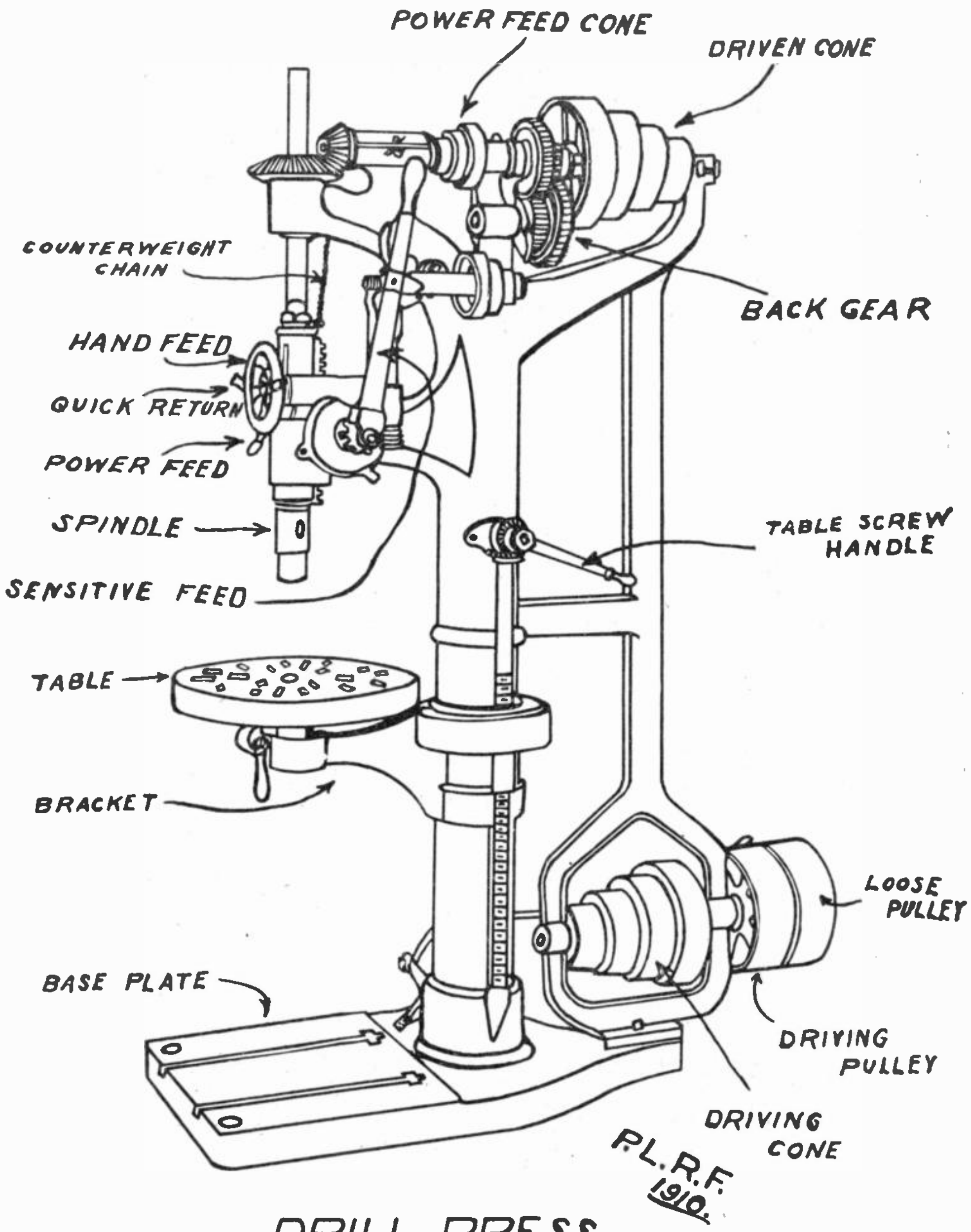


Fig. 4.



DRILL PRESS.

each part, the jig having flanges, lugs, or depressions thereon or therein, by which the work can be located on or within the jig; or *vice versa*, by which the jig can be located on or within the work.

When the quantity of pieces is below the minimum where the cost of jigging can be considered, there are three methods by which the holes can be correctly located.

The first method and the one which is the most often employed, is to lay out each part of the work separately.

The second method is to lay out one piece of the work and using that piece as a template, mark the rest of the work or else use that piece as a jig to drill the others by. A great deal of time can be saved and a surprising degree of accuracy attained by this method. As, for instance, in drilling one or more cylinders and cylinder-heads that are not to be jigged, one of the cylinder-heads can be laid out and then used to drill the cylinder or cylinders by (and in many cases the rest of the cylinder-heads also). The variety of work which can be drilled in this manner is large and in most cases the results are much better than when each piece is laid out separately.

The third method of locating the holes consists in making a template that can be used for laying out either or both parts of the work.

The compounding of jigs can be almost universally applied with a certainty of success. But this should not be carried to an extreme where real economy ceases to exist. However, when it is possible at a slight additional expense to so construct the jigs that they can be used for drilling both parts of the work, greater economy and accuracy can be readily secured and with but a fraction of the trouble.

Another form of drill-press known as the "Radial" drill-press is now being extensively used. It is so arranged that the drill spindle can travel in a horizontal plane, and at the same time the arm upon which it travels may be swung around the upright of the machine and clamped in the desired position. These machines are largely used for drilling heavy, cumbersome pieces of work; for where you have a number of holes to drill in a heavy piece of work, it is found much easier to clamp the piece of work to the base plate and then move the drill spindle, than it would be to allow the drill spindle to remain fixed and move the piece of work each time. These advantages are still further increased by the machine called the "Universal Radial" drill-press, in which the vertical spindle carrying the drill may also be rotated in a vertical plane, thus making it possible to drill holes in any position and at any angle. There are also many other types of drill-presses in general use, and each having certain advantages, but it would be beyond the scope of these articles to attempt to treat all of the various types.

In the August issue of this publication, the machine known as the shaper (and closely allied to the planer) will be treated.

Major Von Parseval's Air Ship

HOW TO FIT AND FIX SHELVES

The fixing of shelves in various positions comes to every one of us sooner or later, usually sooner *and* later, and simple as it looks, most of us find that it is not so easy as we thought it would be.

In this chapter we propose to deal with the fixing of shelves in a recess, as in Fig. 1 or Fig. 2, the one being kept back from the corner, while the other is brought out to the extreme width.

Fig. 3 shows the two side and one back bearer fixed, while Fig. 4 shows the side bearers only used; the length of shelves should determine as to whether the back bearer is necessary; anything over 4 ft. should be supported at back as well as at the ends. Figs. 5 and 6 show how the bearers should be finished, the former being the best method.

The bearers fixed, the fitting of the shelf comes next. This should be placed in the position shown in Fig. 7, the back edge being against the wall, and the end resting on the bearer both at back and front; then with a pair of compasses as shown, mark across the shelf, thus transferring the outline of the wall to the board as at *A*, Fig. 8. Cut the shelf off to this mark, then measure across from side to side of the recess, at the front, transfer this to the front edge of the shelf as *B*, and placing the shelf in the recess, sloping the other way, "scribe" this end in the same way as before. Cut off, and then the shelf should fit easily, but closely in position, and two nails at each end, inserted as at *C* (not as *D*), Fig. 9, will fix it.

In fixing the bearers, nail them as Fig. 10, rather than as Fig. 11, this latter method often resulting in the bearer splitting in two. If a back bearer is used, fix the side ones first, then fit the back tightly between them, cutting the ends as Fig. 12, or if preferred the back one may be fitted first, cutting away the ends as Fig. 13, and cutting the ends of the side bearers as Fig. 14; the back bearer thus supports the end bearers to a certain extent. In preparing the bearers, the section shown in Fig. 15 will be found to look better than Fig. 16.

If it is desired to fix shelves in a recess without damaging the walls, side boards may be placed at each side, resting on the skirting as in Fig. 17, and instead of fixing bearers for the shelves to rest on, the upright boards

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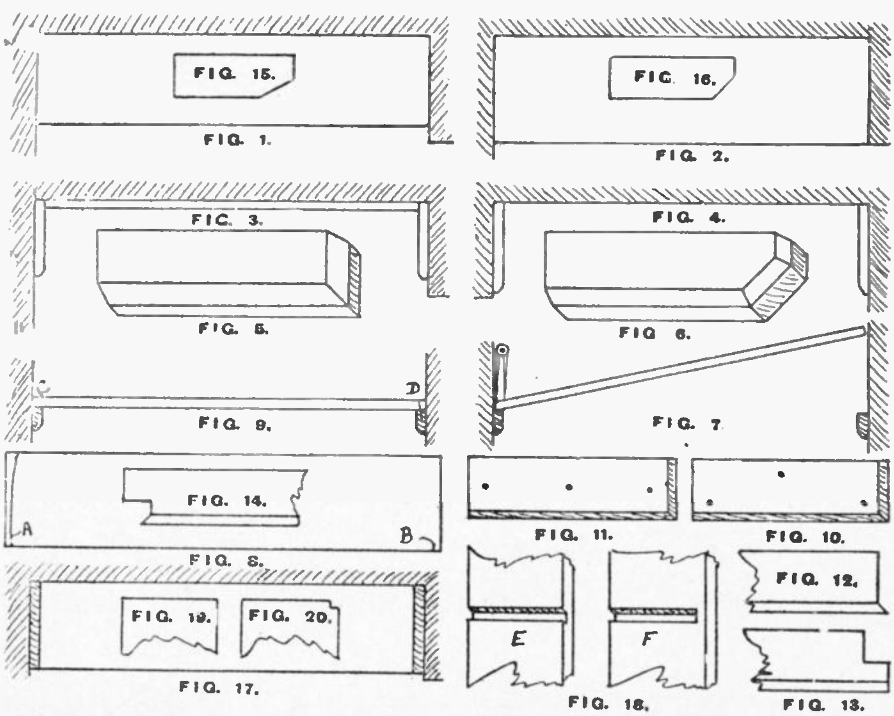


Our New Offices

NEW QUARTERS

The growth of ELECTRICIAN AND MECHANIC in the last two or three years has been so rapid that we have been continually cramped for space. We have enlarged our office quarters several times, but have never been able to get the elbow-room we needed. On the first of July, therefore, we shall move from our present address to the Pope Building, 221 Columbus Avenue, Boston. Here we shall have adequate space, occupying the entire front of the top floor, 80 ft. in width, and extending back some 40 ft. Here we invite our friends to view our new offices, and get in touch with us.

This number is the first of a new volume, and we appear in a new dress, namely, with a new cover, and also start a department, Machine Shop, Theory and Practice, edited by Oscar E. Perrigo, M.E., a very able gentleman.

We congratulate our many subscribers in giving us their support in the past and hope succeeding issues and succeeding volumes will meet the needs and expectations of all.

Concluded from page 15

burning low at all times of darkness, ready to be turned up at a moment's notice. Such a simple precaution can quite easily save the loss of hundreds of dollars' worth of apparatus during the time that the switchboard attendant was finding a match.

In conclusion, just a line may be written to show that in spite of his usually low salary the switchboard attendant is not the only idiot upon earth. One day in an alternating current station serious accident was narrowly averted by the fact that the switchboard attendant discovered that the connections of the synchronizing transformer which had just been put into commission had been connected up the wrong way around by the electrician employed upon this work. It therefore follows that a switchboard attendant occasionally has his uses.

MACHINE SHOP THEORY AND PRACTICE

Edited by OSCAR E. PERRIGO, M.E.

THE MODERN APPRENTICE

It is sometimes quite as well to know where we came from as where we are going to, and it is useful in many ways to take occasionally a retrospective glance over the road by which we have reached our present status and position. This idea applies with quite as much force to the apprenticeship questions, now under discussion, as to many others which affect the manufacturing situation of the present day.

There was a time when apprentices in almost any trade, including that of machinist, were nearly all of the same general class. Frequently those in the machinist class were attracted to it, or perhaps drifted into it, because their fathers were machinists. Often it was because of the necessity of working in *some* shop, and a machine shop happened to be the most convenient. Scarcely ever was it because of any previous educational training, any special fitness, or any very strong inclination or tendency toward the particular trade or avocation into which they had been thrust, or really blundered, and which was to be their life-work in the years to come.

This more or less accidental entry into the shop by young men, frequently not at all adapted by any previous inclination, training or fitness, did not tend to procure the class most desirable for the work, and the success of the apprentice, made such under these conditions, was governed principally by his personal ambition and his capacity to adapt himself to the conditions by which he was surrounded and under which he was working.

If we were to have asked the average shop foreman, superintendent or proprietor to classify the apprentices who came into the shop in this manner, he probably would have told us that they were good, bad and indifferent; and volunteered the additional information that he had a majority of the latter class, many bad ones and a few that he could really call good.

Yet by reason of these more or less deterrent conditions or in spite of them as the case may have been, and of the emphasis which they laid upon personal ambition and force of character, the result was the production of many of the best and most thoroughly good mechanics of which the country has ever been able to boast.

Then came the era of specialization in manufacturing, due to the introduction of automatic machinery, creating what is usually known as the American Factory System, or the interchangeable system of manufacturing. These machines being more or less automatic in their action required, not machinists, but operators of one machine, or at most one class of machines or one class of operations, differing but little from each other.

These machine operators, working continually upon a very limited set of operations would naturally become very efficient in them and turn out a large quantity of good work, for which they were paid much more than it was possible for the proprietor to pay an apprentice, or than it was possible for the apprentice to honestly earn. The result was that young men, finding the work of the machine operator much more remunerative than that of an apprentice, ceased to be attracted to the comparatively slow, and to many of them, uninteresting work of the apprentice.

In consequence of these conditions the relative number of apprentices grew less and less until the real apprentice with a fixed determination to learn the trade was rare. Manufacturers and shop officials seeing the tendency of the times set about finding some means of counteracting these tendencies, since the prospect was that the shops would soon be flooded with operators, and that the time would come when the then "all-round machinists" having passed away there would be no apprentices learning the trade with sufficient thoroughness to take their places.

The results of this agitation have been the establishment of such schools as the Manual Training Schools, Mechanic Arts High Schools and others of similar nature and organization. The technical schools provided workshops or increased their equipment in this respect and additional facilities were offered their students with the purpose of stimulating the acquisition of mechanical knowledge.

This fact was a very hopeful sign and a long step in advance. It was countermanced and encouraged by the good mechanics themselves as well as by the officials of manufacturing plants and the members of the American Society of Mechanical Engineers and other technical professions having to do with the operations of manufacturing.

The work of organization was, however, principally done by professional educators who, being academically trained, quite naturally proceeded with it "along lines of least resistance," with the results that their plans were more or less a repetition of those which had preceded them. Consequently it will be proper to inquire as to the educational advantages that are offered by these schools to young men who desire to fit themselves for a life of practical usefulness in the modern manufacturing plant, since schools as well as apprentices are liable to be classed as "good, bad and indifferent," and if we apply the time honored test of "by their fruits shall ye know them," and judge them by the graduates they send out into the world, we shall be likely to come to about the same conclusion as that of the practical shopman as cited above.

In order to ascertain how well adapted these schools were for the purposes for which they were intended by the well disposed persons who had agitated the question of their practical necessity and who had thus aided in their establishment, the writer made quite an extended and detailed examination of them in several different states and succeeded in ascertaining some very important facts in relation to their real aims and how they were organized to carry them out.

There are some of these schools in which a young fellow just leaving the grammar school may find valuable and practical teaching that will be of much use to him after he gets into the shop; but these schools are few.. They can be counted up on the fingers of one hand. In the others the courses of instruction are overloaded with academic subjects to the exclusion of all but very few subjects really connected with the future practical work of the pupil. In addition to this condition the pupil is permitted to spend but a very small portion of his time on practical studies or subjects that will be useful to him in the shop.

Still the fact that there are schools which have made some sort of preparation for mechanical studies, although they have apparently been forced to do so by the urgent demands of parents, pupils and perhaps more important than both of these, the manufacturers who desired to procure a higher grade of prospective apprentices is important, however they may have mistaken the real needs of such schools.

One example of what was found in a Mechanic Arts High School was more or less true of the others. The idea of the organization of this school was, as announced by its head master, "not to teach mechanical subjects except incidentally; not to make mechanically trained young men but to broaden the views and education of the pupils in the interests of good citizenship." And this was about all they could do, since the instructors from the head master down were school teachers academically trained, with no practical or shop experience whatever.

And as these men become too old to do further work their places are taken by others educated in the same manner, surrounded by an academic atmosphere, imbued with it, saturated with it, to the exclusion of nearly all practical ideas of mechanics, or of teaching the boy how to earn an honest living by any mechanical pursuit.

And yet these boys, many of whom will have to depend upon their own labor for their living, are expected to spend four years in this school broadening their education in the interests of good citizenship by learning to draw series of geometrical forms and other similar models in the nature of toys for exhibition purposes, the character of which would be of very little benefit as a means of mechanical education.

Again, providing that the meagre rudiments of mechanics that the pupils may get in such a school are of any real value, we must take into consideration the important fact that he devotes but a small fraction of the school time, about three hours per week, to any work of a mechanical nature, his academical studies occupying all the remainder of his school time.

When we consider that the mechanical work arranged for these pupils consists of a number of branches, such as machine work, mechanical drawing, pattern work, wood carving, etc. and that these different occupations are crowded into a few hours each week, it is easy to realize that there is little opportunity for the acquisition of any very practical amount of mechanical knowledge..

That there are grave doubts in the minds of the public officials of the practical usefulness of such schools as the Manual Training Schools and the Mechanic Arts High Schools is evident from the following which is quoted from an official document signed by the mayor of a prominent city, relating to a proposed appropriation for extending the buildings of its Mechanic Arts High School:

"When the matter was up before the School Committee, the Schoolhouse Commissioners and myself for consideration, I expressed the opinion that it was very questionable as to how far we should go in the matter of the Mechanic Arts High School; that the results which were being obtained were not of the most satisfactory nature, and that in view of similar projects, under both public and private auspices, it was a serious problem as to whether the city should go any further in the matter of providing accommodations for pupils seeking special trade or industrial education."

With these schools organized by academically taught men, with no engineering or mechanical training or experience, with instructors educated along the same lines, and with but three hours a week devoted to mechanical work, how is it possible that practical and useful results can be expected?

Evidently the remedy in such a condition of affairs would be, not larger buildings, but the elimination of a large portion of the academic work, and a corresponding expansion of useful mechanical work along practical lines, and in charge of either practical engineering or experienced shop men.

But just here is where the professional educator and the practical manufacturer do not seem to be able to meet on a common ground, owing principally to the fact that the man of academic training wants to "broaden the mind in the interests of good citizenship," etc., while the other man wants the practical knowledge which will produce practical results.

In consequence of this condition a few manufacturers have organized schools of their own, in which their apprentices would be able to get such technical or engineering education as might be necessary by attending classroom studies for a portion of their time and devoting the remainder to the regular routine of shop work.

In brief the plan is: To admit apprentices only on written contracts, to distribute them among the different departments as is now usually done, and to have them under the control of the several foremen who, so far as administrative authority goes, treats them the same as he does the skilled workmen, but whose time is in no wise occupied with their practical or theoretical instruction. To provide a special man as instructor whose particular business it is to look after their interests and be responsible for their practical instruction in shop work. He is also to see that when one class of work is well learned, they are given other and more difficult work, so as to individually carry them along in a progressive manner as fast as their knowledge, expertness and efficiency will allow.

In addition to this they are to have an educational instructor, preferably a draftsman, who instructs them in a two-hour session, twice a week, in mathematics and mechanical drawing, and who is responsible for their progress in theoretical knowledge of the business.

The practical instructor keeps daily and the educational instructor semi-weekly accounts of the work and progress of each apprentice. These facts are put in tabulated form and incorporated in a monthly report of the progress of each apprentice, which is presented to the shop superintendent or manager, and by which the individual and collective standing of the apprentice force is known and followed up.

The applicant should be of good moral character between the ages of 16 and 19 years; have at least a good common school education sufficient to enable him to read and write the English language; to have had such training in arithmetic as to enable him to work examples in addition, subtraction, multiplication and division up to four figures, and have a reasonable knowledge of common and decimal fractions.

They should be received on a verbal agreement for a probation of not over two months, during which time they may leave of their own accord or be discharged upon the recommendation of the two instructors and the shop foreman.

Having successfully passed this probationary period, the contract is signed and they become regular apprentices, subject to shop regulations and may be discharged for cause, the same as other workmen.

This contract is for four years, with a provision by which this time may be shortened if the apprentice succeeds in qualifying as a skilled workman before the end of this term. This will always be an incentive to an ambitious apprentice to do his best in learning the trade. It is well known and recognized that while the term of apprenticeship in this country is usually four years, it is an injustice to many bright and intelligent boys, having natural mechancal ability, to keep them at apprentice work and pay for the same term as their less intelligent and less ambitious fellows. The bright boy will learn as many processes in two years as the other fellow will in four, and he will learn them much more thoroughly. It is well, however, to make the minimum time three years, in order that even the bright and ambitious apprentice may become, not only well grounded in the principles and practice of shop work, but have enough time on practical working to become a profitable workman on all branches of the trade, otherwise an "all-round man."

In the average machine shop there can be one apprentice to every ten skilled workmen, and in many classes of work even more, since the aim of the management should be eventually to raise up and educate their own skilled workmen, knowing the particular work of the concern and all its conditions, and hence, much more efficient and valuable men than those from other shops who will require much time to become thoroughly acquainted with these conditions.

The term of four years is divided into eight periods of six months each, at the expiration of each of which the apprentice's pay is advanced according to a fixed schedule made to conform to a certain percentage of the rate of pay of skilled workmen, which is 30 cents per hour, the apprentice for the first six months receiving one-third of that sum, or ten cents per hour. This amount will be increased one cent per hour with the beginning of each new period. This will make the compensation for the last period 16 cents per hour.

For the encouragement and reward of exceptionally good work any of these periods may be shortened, the time thus deducted not aggregating more than 25 per cent. of any one period, or of the entire apprenticeship course.

The practical instructor, the educational instructor and the shop foreman under whom the apprentice works, constitute a committee who make to the superintendent or manager such recommendations as to the course, promotion, transfer and final qualification of the apprentice as they think proper, which, if approved by him, become the authority for such action. Thus any one or all of the six-month periods may be shortened to four and a half months as a reward for an individual good record and excellence of work.

However, these promotions should not be made unless the aggregate rating of the apprentice for the previous term has been 100 per cent. although some deductions of time may be made for a less percentage. For instance, a mark of 95 per cent. may take off four weeks of the period, and a mark of 90 per cent. two weeks. These conditions should always tend to stimulate the apprentice to more diligent work, and the young man who is so dull as not to appreciate such conditions, is not likely ever to rise above a mediocre position, whatever advantages may be presented to him.

Upon the satisfactory completion of the term of apprenticeship the apprentice is given a certificate of the fact and showing his qualifications expressed in a percentage obtained from the monthly reports during his entire term. A mark of 100 should only be give when he has fulfilled every requirement during his entire term, and would therefore be an exceptional case. In any case the certificate should be such that it will carry weight and influence with it wherever it is presented by its fortunate possessor.

The apprenticeship question is more or less of a bugbear to superintendents and foremen. While many of them realize the necessity of instructing a force of apprentices in order to have a body of good all-round workmen to draw from, very few of them have the time, even if they have the inclination, to instruct the apprentices as they know they ought to be instructed. Again, a foreman may have both the time and the desire to instruct, but not the ability, although he may be a good administrative foreman.

Further, in the case of the apprentice passing from one department to another, he comes under various foremen, each with his individual peculiarities and ways of doing work, and is liable to have the methods of one foreman entirely upset by the ideas of the next one. These are inevitable conditions under the old system.

In the proposed system any shop having a dozen or more apprentices can well afford to employ a man as practical or shop instructor whose entire time is devoted to this work, going from one department to another as may be necessary. We may find it difficult to select just the right man for this work, as he must possess peculiar qualifications. Among these will be: first, that he is a good mechanic and well versed in all mechanical methods and processes; second, that he possesses the ability to *give instruction* in a plain, interesting and easily remembered manner; and third, that he understands human nature, particularly boy nature, and from a study of each individual apprentice can adapt his methods of instruction to the personal characteristics of each apprentice. A man having these qualities is of inestimable value to the apprentices, and hence to the establishment. He will study the foreman as well as the apprentices and there will be no need to fear that there will be any clash or friction between him and any of the shop officials on account of his frequently coming between them and the apprentices.

Thus we see that the kind of instruction which the apprentice will receive will be eminently practical and of the kind that is best adapted to fit him for the work which he will eventually have to do as a skilled mechanic.

We will also very readily realize that when this method of instruction is compared with that given in the usual Manual Training School or Mechanic Arts High School, the impractical nature of these schools and their present plans of organization and routine are painfully apparent.

Concluded from page 27

may be cut out as *E* or *F*, Fig. 18. If cut through as *E*, which is the easier method, the ends of the shelves will be as Fig. 19; but if stopped, as *F*, which is the better way, the shelves must be cut as Fig. 20. In the former case the uprights may be placed in position, and the shelves driven in from the front; but if the stopped method is adopted, the whole must be put together outside, and placed in position after. A slight nail or two through each of the uprights will be all that is required in the way of fixing.—*Hobbies*.

WIRELESS TELEGRAPHY

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

EFFECT OF SUNLIGHT ON TRANSMISSION OF MESSAGES

EDMUND BURKE MOORE

The early experiments of Marconi brought out the astonishing fact that signals could be transmitted a greater distance by night than by day. In his trans-Atlantic work communication was possible at periods during which the two stations were in total darkness. It was naturally deduced from this phenomenon that sunlight plays an important part with electric oscillations and in some unknown way exerted a retarding force upon the waves sent from the transmitting station.

Many theories have been advanced to explain this strange action. One theory claims the sun's rays have a direct action on the electric oscillations, exerting a damping force against them. Another states that the rays produce an effect in the ether, through which the rays and the oscillations pass, in such a manner as to render the etheric medium more dense, by so doing, diminishing the distance over which messages could be transmitted with a given amount of energy. All these explanations have been at this writing disapproved.

Extensive experiments with vacuum tubes show the conductivity of rarefied air is much greater than the conductivity of sea water. . The idea naturally suggests itself that the upper strata of rarefied air might be an important factor in the propagation of electric waves. At an altitude of 30 k.m. there is unquestionably an exceedingly high degree of rarefaction. This state of conditions may partially resemble those found in exhausted tubes. If the demarcation was very abrupt between the normal atmosphere and the layers of rarefied gas it might be expected striking results would be produced,—the top of the waves would then be guided as well as the lower end.

It is a fact if a metal sheet of copper of large dimensions be interposed between the spark gap, the series of waves dispersed by the discharge across this gap will conform to the surface of the metal sheet. The propagation of the wave train is guided by the metallic conductor cutting the waves. If the sheet is bent the waves will, for all values of time, remain perpendicular to the sheet and will travel along its surface.

Bearing this in mind it can be seen if there was a sudden demarcation between the air and the rarefied gas at an altitude of roughly 30 k.m. similar to that of air and the surface of the sea a directional effect would be produced not unlike in action to the effect of the copper plate. The upper portion of the wave in transmission would be guided by this demarcation as the lower end is by the earth. If this was what happened, the waves would expand in only two directions. It, however, is not the case. That there is no sudden division between the high vacuum and the air is conclusive from the above facts that the waves expand in more than two directions. Instead there must be a gradual merging from the high pressure gas to the regions of high vacua.

In the common vacuum tube ionization of the gas is possible. Also in this space it is possible to induce electric currents by oscillatory currents passing through them. The state of gas at the altitude of 30 k.m. very nearly resembles that found in exhausted tubes. Consequently it is not unreasonable to expect a process of ionization to take place by the direct effect of the rays of the sun. The gas is forced to "break" or disseminate into its constituent parts. This divorce is caused by the action of the ultra-violet light which disintegrates the constituents of the gas into positive and negative particles called ions (+) and cations (—).

When electric oscillations are propagated through a medium in the above state of disintegration, the electric current resulting from the magnetic flux of the wave causes a displacement of the minute particles—attraction and repulsion. To perform this work a certain amount of energy is necessarily consumed. Or better still the electrical energy of the wave causes this attraction and repulsion, and energy is lost in the work done. The energy of the wave sent out from the transmitting station is considerably lessened by this action.

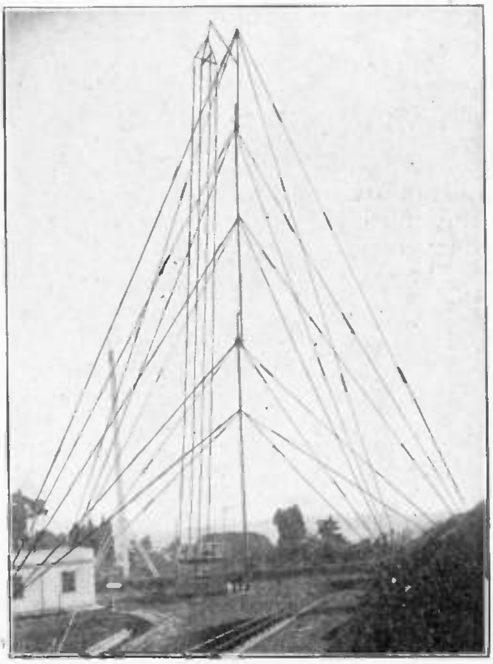
All facts obtainable tend to substantiate this theory. In the tropics, where the sun's rays are parallel, the energy being greater from the sun causes a higher degree of ionization, with a corresponding increase in the amount of electrical energy lost from the wave. It is a recorded fact that transmission of messages over long distances in the daytime in tropical countries is a difficult feat.

The strange action of the sun is not effected by clouds, or is it prominent over short distances. It would lead us to believe that the retarding action takes place at an exceedingly high altitude. The effect due to the sun's rays is often so great that messages can be sent ten times further by night than by day. The most startling case at hand was where the transmission was cut down 1,000 per cent. from night to day radiation. Stations 50 to 100 k.m. apart are not affected to any marked degree by this sunlight damping. However, over a span of 1,000 to 2,000 k.m., the energy absorbed is considerable and renders transmission of messages by day a serious problem. Great difficulties are encountered in trans-Atlantic service where incessant communication is demanded by the public.

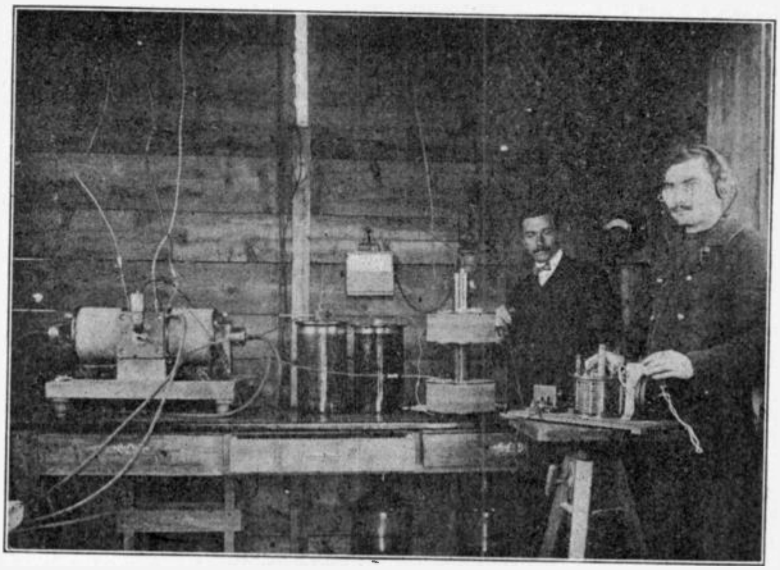
WIRELESS TELEPHONY IN ITALY

FRANK C. PERKINS

As Italy is utilized to great credit for experimental work to wireless telegraphy through the work of Marconi, it may be of interest to note that some most interesting experiments have been made in wireless telephony at Rome, Italy, by Professor Q. Majorana, who is director of the L'Institute Superieur Postage Telegraphique. His experiments at Fort Monte-Mario in radio-telephony have been most successful and interesting, and the electrical equipment and wireless instruments at this station are shown in the accompanying illustration, Fig. 1. Telephone communication over distances of 500 k.m. has been carried on by Professor Majorana, who holds that for practical working two fundamental conditions are necessary, the first being the generation of undamped, continuous electrical oscillations and the use of an extremely powerful transmitter, carrying heavy currents and considerable difference of potential.



Radio Telegraphic Station, Monte-Mario, Rome



The Cabin of the Station at Monte-Mario

The Majorana receiving station is equipped with another oscillatory circuit with antenna and a thermo-electric detector composed of two metals in contact, which, under the influence of waves which strike them, are warmed to a greater or less degree, thus producing modifications or current in correspondence with the electric waves received, and therefore with the voice of the person speaking at the transmitter station. In the telephone receiver these variations of current are reproduced and it is stated a special syntonization system has been designed which gives perfect atunement of the receiving and transmitting equipment for very distinct communication.

Three wireless telephone stations on the Majorana system are proposed: one at Palermo, Sicily; another at Caglisri in Sardinia; and a third at Naples, Italy. Some most satisfactory experiments were made in the earthquake district between Messina in Sicily and Monte-Mario. A distance of 500 k.m. were also made between Monte-Mario and the torpedo boat *Lanciere* on the Mediterranean Sea while it was a distance of 200 k.m. away. The telephonic communication, it is maintained, was perfect in the above test, the voice being heard strong and clear, it being possible to recognize the person who is speaking, even at a slight distance from the telephone receiver, not only between the wireless station of Monte-Mario to Rome and Anzio, a distance of 60 k.m., but also as far away as Ponza, 120 m. away. The conversation was very clearly heard at Magdalena, near the Island of Sardinia, about 300 k.m. distance.

Majorana first employed a rotating oscillator consisting of a motor, upon the axle of which was fixed a disc of ebonite which carried upon its opposite faces two rings of metal. There were two brushes of metal resting upon these rings and connected with a discharge circuit. To the metal rings running parallel between them were attached two steel wires 70 c.m. long and 2 m.m. in diameter, their extremities being placed both together and forming a spark gap.

To the secondary of a static transformer were connected two wires of the oscillator, the primary winding carrying an alternating current from an electric light circuit. The two wires of the oscillator turn with the rotating motor, the sparks passing across the gap being subjected to violent air pressure, so that each one was separated and broken up into a large number of discharges. These minor discharges at the rate of 20,000 per second supplied the necessary interrupted series of sparks, and for the modulation of the same corresponding to spoken words, a transmitter was designed by Professor Majorana which has produced wonderful results not only in wireless telephony, but also in ordinary telephone service. This so-called hydraulic Italian transmitter is quite suited to the requirements of wireless telephony on account of its low electrical resistance and its ability to carry the heavy current and high voltage usually employed for producing electro-magnetic waves.

This new hydraulic transmitter was designed so as not to heat up on a current of several amperes and is capable of working with considerable differences of electrical pressure, it being based on the capillary properties of liquid jets, and consists of a small tube of glass, from the opening of which is projected a jet of acidulated water under a pressure carefully regulated. To the diaphragm of the transmitter the small tube is so fixed that it can follow the vibration without difficulty, the liquid jet falling between two platinum electrodes and forming an electrical liquid connection between them, thus giving the characteristic resistance of the transmitter. The variations of this resistance determines the transmission of the words or other sounds as the person speaks before the transmitter diaphragm as it vibrates in the same manner as the ordinary telephone transmitter. The variations in the resistance of the liquid interposed between the two electrodes of platinum is caused by the little tube vibrating with the diaphragm and forming contractions in the liquid jet, these fluctuations of resistance being in perfect accordance with the sounds causing them. This hydraulic transmitter when connected with the rotating oscillator produced variations in the intensity of the discharges, corresponding to the sounds applied to the transmitter, and Professor Majorana was able to reproduce the voice at long distance and to receive speech clearly by the use of the ordinary receiver of wireless telegraphy more than two years ago.

Since the Poulsen discovery of producing undamped electro-magnetic waves absolutely in an uninterrupted train, Professor Majorana discarded the rotating oscillator and adopted similar apparatus to Poulsen, consisting of a voltaic arc burning in an atmosphere of hydrogen. Poulsen was able to increase both the intensity and the frequency of waves, the arc producing alternating currents of a frequency varying from a quarter of a million to a million vibrations per second, and the currents being of considerable intensity.

Two electro-magnets fed by the same current as the arc created the transverse magnetic field, and these magnets maintained the position of the arc with reference to the electrodes and render the productions of the waves more constant and more efficient as well.

Majorana has applied this generator of uninterrupted waves to his system of wireless telephony, as shown in the accompanying figure. In the transmitting station the arc is enclosed in an atmosphere between one electrode of copper and another electrode of carbon, the oscillatory circuit containing a capacity and the primary winding of a transformer on the Tesla type. The antenna is connected to one terminal of the secondary of this transformer, the other terminal being connected to the hydraulic transmitter which is in turn connected with the ground.

A medical prescription sent to the Nantucket Shoals lightship No. 85, in response to a hurry call for advice, brought about the recovery of Capt. Frank S. Doane, the master of the light vessel, from a severe illness. There is a medicine chest on board the lightship fitted with remedies for all the troubles sailormen are supposed to be liable to, but Capt. Doane's symptoms were so unusual that he was at a loss to select the medicine that would meet the emergency.

The wireless operator came to his aid, and, calling the naval torpedo station at Newport, R.I., described the captain's malady. Immediately afterward a reply was sent embodying a prescription from the medical officer at the naval station, and another wireless message from the lightship later in the day brought the announcement that the patient had taken what the doctor ordered and was practically recovered.

A SIMPLE HELIX

Below I give a description of a helix which every amateur ought to be able to make, and one which will give excellent results, if constructed properly. Then, same is much easier to operate than those wound on a frame as, in this case, *all* of the turns may be reached by the operator at any time.

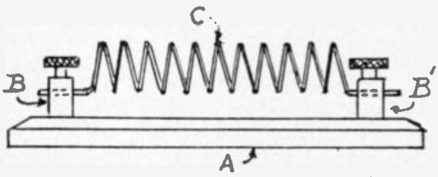


FIG.—1.

Referring to Fig. 1, *A* represents a base of suitable material, preferably of oak, which may be made of any dimensions, although it is of an advantage to have same rectangular in shape, as it will take up less space than if square or round. Same may have beveled edges to give it a neat appearance. *B* represents binding posts which are of the type for a single wire. These are placed at the ends as shown. *C* represents a large copper wire which is wound like a spring and may be of a diameter from 6 to 12 in. The wire would be about No. 10 to give best results, as if a small wire was used the turns are liable to fall against one another, thereby short-circuiting these turns and rendering the helix useless for any purpose. If No. 10 wire is used, same will give a very rigid construction, which in this instance is very desirable and essential. Binding posts which will allow this size of wire to be used may be purchased from almost any electrical supply house. If you cannot find them in your own city, write to the Electro-Importing Co., of New York City.

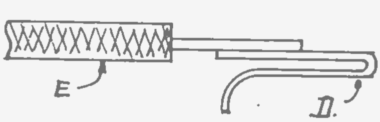


FIG.—2.

Referring to Fig. 2, *D* represents a strip of spring brass bent as shown for connecting clips. Same must be made of sufficient thickness to allow the clip to clamp to wire tight enough to insure perfect contact. The end is bent back as shown in order to open same easily in case the operator wishes to change the point of connection, or increase or lessen the active turns of the helix. *E* represents rubber-covered wire as same must be used for connecting wires for the reason that it is liable to lay against the turns of the helix, and bare wire would short-circuit every turn against which it laid. The end of this wire is soldered to the back of the clip as shown.

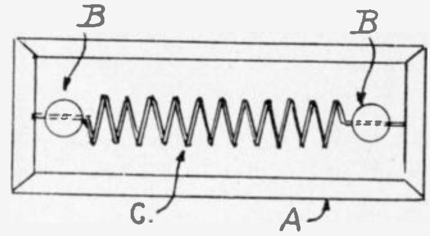


FIG.—3.

Fig. 3 represents a top view of the helix and the same will be seen to rest in the centre of the base. The connecting wire between the spiral and the binding posts is a part of the wire contained in the spiral bent as shown in order to fasten the helix in the proper position.

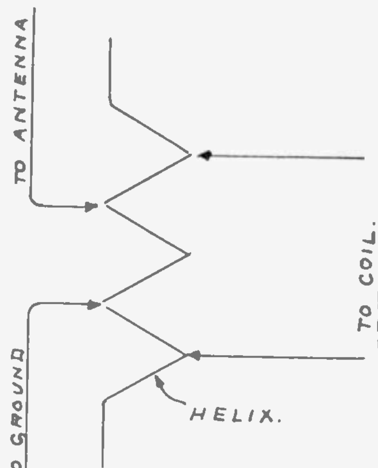


FIG.—4.

Fig. 4 shows connections.

Any one making this helix will find that his time has not been spent in vain for the convenience alone found in this helix will more than pay for same.

The operation of this helix is the same as any other.

J. R. JESSE.

The Seattle Wireless Club was organized January 29, at the Broadway High School, Seattle.

The aim of the Club is to promote the general advancement of the amateur operators.

The present officers are: H. Read, president; W. Bonnell, vice-president; E. Ferguson, secretary; C. Miller, treasurer.

Starting May 10, and every other Tuesday evening thereafter, meeting will be held in the Chamber of Commerce Hall, Central building.

SEATTLE WIRELESS CLUB,
Per E. Ferguson, *Secretary*.
Seattle, Washington.

Wireless Outfit of W. Reidt, Jr., Portland, Ore.

Outfit of W. Reidt, Jr.

Wireless telegraphy as a pastime is growing in favor, and one young man who has been studying the interesting science has perfected some attachments to his instruments by which he has shown his ability to take and send messages even as far as Los Angeles and Alaska. This is W. Reidt, Jr., 410 East Eleventh Street north, Portland, Oregon, who has installed a private wireless telegraph station in the billiard-room at his home.

Mr. Reidt's instruments are said to be the most powerful in Portland. He has a 3½ kw. transmitting outfit and has improved his receiving apparatus so that he is able to take messages from Los Angeles. Every day Reidt interests himself in the movements of vessels at sea, and he can tell just when a boat is going into or leaving the harbor at San Francisco.

A message taken the other day showed the wonderful power of his instruments. This was a call from the wireless man on the steamer *Elder*, which said:

"I caught you 20 miles from Los Angeles when you called up the *Rose City* near Frisco."

Mr. Reidt has evolved a new idea of insulation, which aids materially in making his long-distance messages possible, and although he has not had this idea patented, he believes therein he has one of the great secrets of successful wireless telegraphy. He has also installed a system of his own for receiving, which he believes gives him one-third greater radius for taking messages. Mr. Reidt's call letters are "K.W."

Poulsen's High Speed System

A note on a recent demonstration given at the wireless telegraph station at Cullercoats with Poulsen's high speed system of transmission. In this system the receiving apparatus is exceedingly simple. A thermocouple, or contact rectifier, is used as a detector; the unidirectional current thus obtained is passed through an Einthoven galvanometer, the vibrating wire of which is of platinum or gold, prepared by the Wollaston process, about 6 cm. long, and having a resistance of 100 ohms if of gold and 400 ohms if of platinum. Its motion is made deadbeat by shunting it with a resistance of about 1,500 ohms. A vertical image of this wire (the image being considerably improved by smearing the wire with a little lampblack) is projected by means of a microscope on to a horizontal slit behind which moves a strip of sensitive paper. This strip, passing the slit, is guided by pulleys through the troughs of two bird fountains, being developed in the first and partially fixed in the second. If a permanent record is required, the tape, on leaving the instrument, is run into a second fixing bath. The rectifier actually used in the experiments shown consisted of a small fragment of galena and one of metallic tellurium pressed together. The highest speed at which messages have been received at Cullercoats from Lyngby is 100 words per minute.—Lond. *Electrician*, Sept. 17.

Electric Wave Telegraphy was for some time regarded as the Cinderella of Telegraphy by her two older sisters, land and submarine telegraphy. Events, however, have long since justified the opinions formed by many persons who witnessed the early work of Marconi, that his form of wireless telegraphy was destined to be of the very greatest utility. Its important application in naval operations and in connection with ordinary maritime communication have given it a unique position.—*Fleming.*

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.

1371. **Aerial.** J. J., Bel Air, Md. (1) A vertical aerial is best. Make it as high as possible, use 5 wires spaced 2 ft. apart, uninsulated wire No. 12 or 14.

1372. **Telephones for Wireless Telegraphy.** R. E. A., Everett, Mass. (1) See article by Mr. Getz in February issue of this magazine. Low resistance telephones are of no value in long distance work. (3) See wiring diagrams in April issue.

1373. **Aerial.** E. H. S., Oak Park, Ill. (1) The second one is the better. (2) Five No. 12 spaced 2 ft. apart.

1374. **Aerial.** E. H. M., Rochester, Ind. (1) 50 ft. high. (2) No, bridge around condenser.

1375. **Insurance Laws in Regard to Aerials.** C. N., Davenport, N.D. (1) Ground your aerial by means of a 100 ampere switch placed on the outside of the house to a No. 4 copper wire which is soldered to the water pipes before they enter the house. (1) It is used with a coherer set to close the local circuit and actuate the tapper or de-coherer. Any standard book on wireless telegraphy will furnish sufficient data. (2) No, the battery is not short-circuited, the resistance of the potentiometer prevents any appreciable amount of current from flowing through the circuit.

1376. **Electrolytic Rectifier.** F. J. W., Winnipeg, Man. (1) See article on electrolytic rectifiers in the November, 1908, issue of this magazine.

1377. **Wire for Telephone.** L. E. W., East Brady, Pa. (1) We take it that you mean the dielectric constant, which is about the same in both cases. (2) Yes, more turns of No. 50 wire may be wound in given space, thus making the telephone more sensitive (3) When the condenser is connected in the circuit, the battery charges the condenser with a small amount of electricity and a momentary current flows through the circuit, which causes a click in the telephone.

1378. **Acid for Electrolytic Detector.** R. C. H., Newtonhook, N.Y. (1) See article by Mr. Getz, in the February issue of this magazine. (2) Use 20% solution of chemically pure nitric acid. (3) The potentiometer regulates the voltage so as to produce the best results.

1379. **Metallurgy.** G. A. H. Z., Woodbine, Kan., asks: (1) How to tell what per cent. of carbon is in various grades of steel, as for instance, the sorts used for razors, spindles, etc.? (2) Can a "Midget" dynamo be used to operate a spark coil for gasoline engine ignition? Ans.—(1) A person skilled in the art can judge closely by examination of the metal at point of fracture, by various tests of elongation, torsion and ductility, and by microscopic examination of polished sections. An accurate estimate is obtained by chemical analysis only. A book on metallurgy would be interesting and helpful to you. (2) No, for the self-induction of the machine is too great, and its entire output too small to be the equivalent of a primary battery.

1380. **Adapting Motors.** J. R. P., Elizabeth, N.J., asks: If certain 50 volt and 110 volt 60 cycle fan motors can be rewound so as to be used on 230 volt direct current circuits? Ans.—No, this is not practicable. The cost of changing the machines would exceed the price for new ones of the right kind. While a person whose time was no object might utilize some of the existing parts, he would need to replace the squirrel-cage rotor with a definitely wound armature, and then he would probably find no space for the commutator. The Interior Conduit Insulation Co.'s make is possibly a little better to revise than the other, but in this case you will need to take the armature apart, remove the short-circuited bars, and then rewind the direct current portion over again with more turns of finer wire. The field magnets will also need more turns. The alternating current fan motors have four poles, but for direct current operation two poles are better.

1381. **Electrical Books.** L. deQ., New York City, asks for advice as to the best books to get that will treat on practical wiring, etc. Ans.—You will find the series of thirty-one articles on "Electrical Engineering," that we published between July, 1906, and February, 1909, gives a valuable and comprehensive survey of the entire field. We have constantly been receiving expressions of commendation regarding them. Three small and inexpensive books will be of great value: "The Electrical Engineer's Handbook," by the International Textbook Co., "Cushing's Standard Wiring," and "Clayton & Craig's Questions and Answers about Electrical Apparatus."

1382. **Vibrator Condenser.** W. S. T., Ft. Worth, Tex., asks: (1) Would a 6 in. spark injure a man? (2) Could I use either 110 volt d.c. or dry cells? (3) Will I need a condenser to use in parallel with the vibrator? Ans.—(1) Yes, a 6 in. spark is very dangerous. (2) You do not state for what purpose you intend to use 110 d.c. or dry batteries. The current in a dry cell is direct, and hence, with the introduction of a suitable resistance, 110 volt d.c. could be used whenever dry cells are used. (3) Yes, a condenser must be bridged around the vibrator to insure a sharp break of the current.

1383. **Wireless Book.** C. S., Jr., Boise, Idaho, asks: (1) Please tell me a good book telling how to make a wireless telegraph for about 1,000 miles. Ans.—"Wireless Telegraphy," by H. LaV. Twining, is a very good book on wireless instruments. We can mail it to you upon receipt of $1.50. See also Mr. Guilford's article in recent issues of the *Electrician and Mechanic*.

1384. **Sending Distance.** P. H. W., Newark, N.J., asks: (1) Will you kindly tell me how far I can receive with following instruments: 100 ohm telephone receiver, silicon detector and a small single slide tuner. (2) With a double slide tuner, 2,000 ohm receivers, fixed and variable condensers, a silicon detector and a loop aerial, consisting of No. 4 14 aluminum wires 16 in. apart to be used in connecting with both sets; aerial 50 ft. high, 60 ft. long. (3) How far can I send with a 1 in. coil, two pint Leyden jars, a helix and key? Ans.—(1) and (2) See article by Mr. Getz in February, 1910, issue of this magazine. (3) Your sending range is about 1 mile with ordinary aerial.

1385. **Leyden Jars for Small Coil.** T. F., Ardmore, Okla., asks: How many Leyden jars are needed as a condenser for a ¼ in. spark induction coil? Ans.—One Leyden jar about the size of a drinking glass would be sufficient for the secondary. The condenser to be bridged around the vibrator should be made of tinfoil with paper as dielectric. 30 sheets of tinfoil 3 x 1¼ will suffice.

1386. **Receiving Distance.** G. Y., Hillsboro, Tex., asks: (1) With the following instruments could I be able to receive wireless messages from Galveston (350 miles)? Electrolytic detector, loose-coupling tuning coil, variable and fixed condenser, 1,000 ohm receiver, potentiometer and doughnut transformer as described in the November issue of *Electrician and Mechanic*. My aerial is 100 ft. high. (2) If this would not receive the above named distance, what instruments would you advise me to use? Ans.—Yes, you should receive the Galveston station, provided that they use 5 k.w. transmitting instruments. (2) I would advise you to add a double slide tuning coil and a pericon detector.

1387. **Resistance of Telephone.** L. G., E. Toledo, Ohio, asks: (1) How to tell the ohms resistance in a telephone receiver? I got several telephone receivers and at the time of purchase I did not inquire their ohms resistance. (2) How many times can dry cell batteries be discharged, also give me a good formula for recharging? (3) Will a door bell ringer of 6 volts between one outside pole and the middle, 13 volts between the other outside pole and the middle pole and 19 volts between the two outside poles be all right to overrate an induction coil of ½ in. spark capacity? Ans.—(1) Certain measuring instruments are necessary. Send them to the manufacturer who made them and he will undoubtedly enlighten you. (2) Dry cells cannot be recharged. They are sometimes renewed by moistening the interior with vinegar or a solution of either salt and water or sal ammoniac and water. (3) It is doubtful if such a ringer would do the work you require of it. It is probably an a.c. generator, and its output in amperes cannot be very much.

1388. **Battery Motor on 110 a.c.** J. B. S., Oklahoma City, Okla., asks: (1) Can a small shunt wound battery motor be run on 110 volts a.c. 60 cycle by connecting the field in series with the armature and putting a lamp or two in series with it? (2) Will it burn the motor out to run it too long at one time in that way? Ans.—(1) Yes. (2) Not if the proper amount of current flows through it.

1389. **Lightning Arrester.** H. L. L., Clark, So. Dak., asks: (1) In a lightning arrester of this make, why does not the lightning go through the telephone. The company claims that it will not. The manager of the telephone company here claims it will go through the telephone. It is about 5-32 in. between the line wire plate and the middle plate. (2) What is the nearest wireless telegraph station to Clark, So. Dak.? Ans.—(1) We must refer you to the makers of the instrument you mention. (2) There are commercial stations at St. Louis and at Chicago.

1390. **Spark Coil.** H. E. H., Jersey City, N.J., asks: for dimensions and data of a spark coil, giving 8 in., to be wound with No. 28 S.C.C. wire, such as length and diameter of core, size of wire and number of layers in primary, diameter, number and size of sections of secondary. Ans.—It would be very impractical to build a coil giving such a length of spark, using the wire you mention. If your only object is to obtain a long spark, why don't you use a much smaller wire?

1391. **Size of Spark.** P. P., Brooklyn, N.Y., asks: (1) I have made an induction coil with 12 in. core 1⅛ in. diameter, 2 layers No. 12 for primary, hard rubber tube over primary 3-16 in. thick; secondary about 5 lbs. No. 36 wound in 28 sections, 5 in. outside diameter ¼ in. thick. How far would this coil transmit under average conditions, with aerials about 50 ft. high and 50 ft. long, using up-to-date receiving instruments? (2) How far if coil was wound with No. 32 instead of No. 36 wire on secondary? Ans ?

1392. **Wiring Diagram.** W. McM., Portland, Ore., asks: (1) My aerial consists of 4 iron wires. It is 37 ft. long. My pole is 38 ft. high. I have a loose coupling tuning coil, adjustable condenser, electrolytic detector, 75 ohm receiver. I have two ground connections, one of zinc 1 ft. square, and another connected to a water pipe. Does this increase my radius any? My sending consists of a 1 in. spark coil, a condenser of 3 sheets of glass, helix of 10 turns of No. 8 copper wire, wound on a frame 12 in. high and 8 in. in diameter. (2) Is the enclosed sketch of connections good? Ans.—(1) The water pipe ground is the best. (2) No. See Mr. Guilford's article in May, 1910, issue.

1393. **Telephone Line Induction.** S. J. G. P., Aladdin, Wyo., asks: I have a question on telephone matters which I should like to get answered from any of the readers of the *Electrician and Mechanic*. I had the telephone in working order and doing all right, having had a permit to string the wire for a quarter of a mile on a company's poles, then cut off across country. One day I called up the owner on the other end of the line. Out of curiosity I pulled down the receiver and heard some person talking. I could not make out so I started to investigate to try to find where the connections were. There should be none on this line as it was private. I thought someone was playing a joke on me. I was told that the electrical wave was jumping from one wire to the other. I told the other person that I did not believe it was possible as there was 15 in. between the two wires and only three wires on the poles altogether and they were all bridging phones with ground connections. I should like to have the editors' and readers' opinion on this matter through the *Electrician and Mechanic* in some late number. Ans.—Your trouble was due to what is known as induction. When a varying current of electricity flows through a wire which is in juxtaposition to another, a current of electricity is set up in the second wire. This will happen every time the wires are close to one another, and when they are in no way connected to one another.

1394. **Induction Coil.** W. T. B., Somerset, Ky., asks: (1) I have a coil, core 16 in. x 1⅜ in., primary wound with two turns No. 14 wire; secondary wound with 8½ lbs. No. 36 wire in 46 sections, ³⁄₁₆ in. x 5¾ in., using two Leyden jars across spark gap; I only get 1 in. spark with 12 volts and 12 amperes. Have 100 5 x 10 sheets tinfoil in condenser across make and break in primary. Advise how to get best results with above apparatus. Ans.—Your primary is altogether too small in proportion to your secondary. We should advise using about 2 lbs. No. 10 double cotton covered wire on primary. You would then obtain a 9 in. spark.

1395. **Condenser - Transformer.** E. T. Z., Buffalo, N.Y., asks: (1) How many glass plates shall I use as condenser for a transformer of the following dimensions: closed laminated core 10 in. x 1½ in. deep, *i.e.*, 1½ in. x 4 in. cross section; iron primary winding 104 double turns No. 10 D.C.C. magnet wire, 52 double turns on each leg arranged for either series or parallel connection; secondary, 30,000 turns 15,000 on each leg of No. 28 black enamel wire developing a voltage of about 17,500? (2) Is this transformer too powerful to use for an aerial 125 ft. long, 60 ft. high and four No. 14 bare copper wires? If so about what size aerial should be used? Ans.—(1) Your condenser is too small. Add more condensers, constructing in sections according to article in March, 1910, issue of this magazine, and add enough sections to obtain a loud crackling spark. (2) No.

1396. **Closed Core Transformer.** "Maryland," asks: (1) Give data for building a ¼ k.w. closed core transformer. (2) Give diagram showing how to connect a ¼ k.w. transformer, condenser, spark gap and helix to secure the best results. (3) Could any satisfying results be gotten by using an oscillation transformer with a ¼ k.w. transformer? If so, give diagram to connect, also the size of wire to use. (4) What will my sending range be with the instruments in question (3). With aerial 50 ft. long, 50 ft. high at one end, and 30 ft. high at other end, three wires? Ans.—(1) This was fully written up in July, 1909, and August, 1909, issues of this magazine which can be had for 10 cents a copy. (2) See "Construction of a 1,000 mile Wireless Station"—Part IV., in the May issue. (3) Yes, use No. 10 copper wire on secondary and primary, or better still, see article "Construction of a 1,000 Mile Wireless Station"—Part II, in March issue of this magazine. (4) You cannot depend on sending more than 15 to 20 miles with such an aerial.

1397. **Aerial Pole.** F. L. B., Moosup, Conn., asks: (1) Does it make much difference whether wireless instruments are near the ground or in a second story of a building? (2) What instrument is it necessary to use in testing a receiving set which is connected as shown by my sketch sent herewith? (3) How could a pole made of iron piping be insulated from the ground so as to be practical for a wireless aerial, and would insulators such as are used on trolley wires be suitable for insulating guy wires of same? Ans.—(1) The height above ground will not affect the wireless instruments. (2) Ring a bell or a buzzer about 6 ft. away from the instruments; the resulting spark will set up a series of waves which can be plainly heard in the receivers. (3) Set it in a porcelain bowl or in a large porcelain insulator such as are used on high voltage transmission lines. Yes, such insulators have been used with success by amateurs.

1398. **Sending Range.** P. C. L., Philadelphia, Pa., asks: (1) I have a wireless outfit consisting of sending: ½ in. spark coil, the spark which is a flame about ¹⁄₁₆ in. thick and ½ in. long; variable condenser of 11 plates 7 x 5; spark gap; helix, and 20 ft. of No. 6 aluminum wire. Receiving: silicon detector; fixed condenser; tuning coil, 2½ in. x 12 in. wound with No. 24 wire; two 1,000 ohm receivers; two 2,000 ohm receivers. Ground, gaspipe. Aerial 60 ft. high, 4 wires No. 14 copper, 100 ft. long, slanting to 25 ft. from ground. What is sending and receiving radius with two 1,000 ohm and two 2,000 ohm receivers? (2) Where can I buy a ¼ h.p. gasoline or steam engine? Ans.—(1) See query 1311 in May issue. Your sending range is about two miles. (2) You might advertise in the columns of this magazine for such an engine. You can probably secure a second-hand one very cheaply.

1399. **Anchorage for Mast.** J. C., Sharon, Pa., asks: (1) How far from the base of a 60 ft. mast would it be necessary to anchor the guys to make it safe? (2) Of a 100 ft. mast? Ans.—(1) 30 ft. (2) 50 ft.

1400. **Sending Range.** F. M. B., Hingham Centre, Mass., asks: Please state my receiving and sending radius of the following: receiving: tuning coil 300 ft. No. 20 enameled wire; Seth W. Fuller silicon detector; two 75 ohm receivers; one 500 ohm receiver, fixed condenser, variable condenser, potentiometer; aerial, highest end 45 ft., 150 ft. long, four wires. Sending: helix, 1½ in. spark coil, zinc spark gap, 12 dry batteries, Morse key, 6½ pt. Leyden jars. Ans.—See query 1311, in May issue of this magazine. You should be able to send about 4 miles.

1401. **Galvanometer.** W. G. L., Barton, Md., asks: (1) In the April, 1910, number, of your splendid publication, Mr. W. C. Getz says (in first paragraph on page 358) that "$G = R \times a$," when obtaining the resistance of galvanometer by method shown in Fig. 5 on page 359. How can $G = R \times a$ when $G = \frac{bR}{a}$? (2) Why does moving the brass tube in and out of the shocking coil (described on page 209 of December, 1909 number) vary the induced E.M.F.? (3) What is the reluctance of brass compared to that of air? Ans.—(1) This is an error. It should read $G = \frac{R \times b}{a}$, in both paragraphs 1 and 2; the correct formula is given on the sketches. (2) Because the brass tube acts as a short-circuited secondary winding and absorbs a portion of the energy that would otherwise go to the primary winding, thus altering the E.M.F. of the secondary winding. (3) The reluctance of any non-magnetic material is independent of the flux-density and is practically the same as a vacuum or air. Thus the reluctance of brass and air are practically equal.

1402. **Induction Coil. Dynamo.** E. T. K., Cambridge, Mass., asks: (1) How long a spark will a coil give that has a core 9 in. long, wound with three layers of No. 18 wire in primary, and 1 lb. of No. 30 wire in secondary? (2) A toy dynamo has a 3-prong armature 1½ in. in diameter and 1 in. in length. Each of the three armature coils has 24 turns of No. 24 wire, and field has 48 turns of No. 20 wire. How many volts will it give? Ans.—(1) If the coil is well insulated, and this cannot be well done unless there are several sections in the secondary, and there is good separation from the primary, you ought to get 1 in. sparks. You will improve the operation if, for the primary, you use two layers of No. 16 instead of what you propose. Condenser may have 100 sheets of tinfoil, each 5 in. x 7 in. (2) You did not give the diameter of the field core, so we cannot judge what the output is likely to be. In general, we should expect you to put several times as much wire on the field, and then perhaps you might get 5 volts.

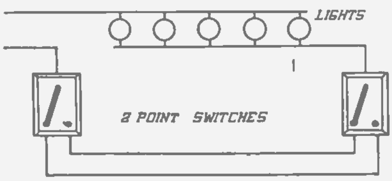
1403. **Armature Winding.** W. W., Chicago, Ill., has tried to rewind the armature of a fan motor, and while the work is free from grounds, the machine will not run. Can we surmise the reason? Ans.—With such fine wire and few slots there ought to be no great difficulty, and we think your next attempt will be successful. With the slots conceived as being numbered 1 to 12, inclusive, wind in 1 and 7, until the space is half occupied, letting about half the wires pass on one side of shaft, the rest on other side. Then twist a loop in the wire, so that it will come between slots 1 and 2. Continue the winding into slots 2 and 8, until they are also half full, and leave a loop between slots 2 and 3. Proceed in this manner, until there is wire in all the slots, and there are 5 loops. Continue directly on top of the first coil that was wound, until this is completely filled, and a loop is left between slots 7 and 8. In like manner proceed until all the slots are filled, and you have 11 loops, and finally, a twelfth is obtained by twisting the very beginning with the end. These connect with the 12 commutator segments. It may be improper, however, to lead these directly to the nearest segments, but to give them all a twist, so that the brushes will rest on segments that connect with coils lying between the two pole tips.

1404. **Large Induction Coil.** R. B. T., Jamestown, N.Y. proposes to make a coil having a core composed of a bundle 3 in. in diameter of No. 22 iron wires, 27 in. long. Primary, two layers of No.10 wire. He asks what would be proper winding for the secondary, and would 110 volts be suitable to operate the coil? Ans.—We have no data for coils above 18 in. in length, and one of that length would have 3 layers of No. 10 wire in primary, 12 lbs. of No. 33 in secondary. Condenser, 60 sheets of tinfoil, 8 in. x 12 in. Before attempting such an expensive structure it would be well for you to look up, in some library, a description of Spottiswood's celebrated coil, 42 in. in length. The 110 volts would be entirely unsuitable, the number of turns to fit it having altogether too much self-induction: 10 volts with quite a heavy current would be needed.

1405. **Rotary Converter.** H. C. C., West Winfield, N.Y., asks several quesitons about the 75 watt machine described in the last April magazine. Particularly he asks about the method of winding the 36 poles of the armature. Ans.—You quite mistake the scheme of the winding, for the machine has six poles, not 36. In winding the armature, a group of six teeth is enclosed by each one of the formed coils, to match the field poles. There is an extended description of this method of winding drum armatures in the magazine for November, 1908.

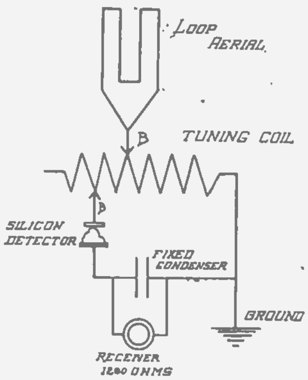
1406. **Solenoid.** H. W. M., Spokane, Wash., asks: (1) What size of solenoid and wire should be used to give the greatest amount of pull when connected to a 110 volt circuit? Momentary large currents would be permissible. (2) Would the pulling capacity be increased by bunching the winding near the end towards which the core moves? (3) What metal would be most suitable for the contacts to allow for small pressure and freedom from sparking? Ans.—(1) You give no idea as to what dimensions you wish, whether the device should use 40 lbs. of wire and exert a pull of perhaps 100 lbs., at an expenditure of ½ h.p. power of electrical energy, or whether the device should weigh only a few ounces and exert a correspondingly small pull. If you use a single straight core the pull will not be over one quarter of what two parallel coils will give when acting on a U-shaped core. The distance through which the pull will act will be, however, rather longer in the first case. You will find valuable information on such matters in Underwood's book, entitled "The Electromagnet." Also in an article by Goldsborough, in the *Electrical World* for July 28, 1900. (2) Yes, this is often done, but you may as well wind the whole to the same diameter, especially if the distance over which the pull is to act is long. (3) A good method is to use flat copper contacts under paraffin oil, thus imitating the common scheme of "oil switches." Let one contact be fixed and at the lower end of a slender arm; let another be of about the same dimensions, but insulated from the first and hinging at the top. A finger piece at right angles will serve to actuate it. Set a tumbler of oil below, so as to have the contacts well immersed. If the disruptive electromotive of self-induction, at the moment of the break, is too vigorous, and endangers the insulation of other apparatus, say of the potential coil of the meters, you can lessen its effect by connecting an incandescent lamp across the contacts.

1407. **Wireless Telegraphy.** R. E. R., Central Village, Conn., asks: (1) Would wiring several lights in the manner shown below work all right to turn on and off at two different places? (2) How far would the following instruments receive with an



aerial 30 ft. high and 25 ft. long of six insulated wires No. 16. Electrolytic detector, two slide tuning coil, potentiometer, adjustable condenser, pair of 1,500 ohm receivers and batteries? (3) What wireless firm would you recommend to be reliable? Ans.—(1) Yes. (2) See article by W. C. Getz in February, 1910, issue of this magazine. About 300 miles. (3) Any firm advertising in our columns.

1408. **Wireless Telegraphy.** F. P. H., Baltimore, Md., asks: (1) I have a wireless receiving station and the instruments are connected as in the diagram shown. When I remove both slide contacts *A* and *B* from the coil and place two fingers from slide *A* to slide *B*, I can hear a loud humming noise like in a telephone, sometimes being louder and then again faint and sometimes not at all. I can hear it by removing slide spring *A* from coil and touching slide rod *A* with one hand and touching one terminal of the receiver with the other hand. Is this noise due to induction of nearby wires or does it show that there is ground somewhere although the aerial is well insulated? (2) Give me some data for the construction of a tuning transformer for long distance work, with movable primary? Please give size of wire, length



of coil and diameter and number of slides? Would like to make primary without slide rod. Ans.—(1) The noise is due to induction of nearby wires. (2) See February, 1910, issue of this magazine.

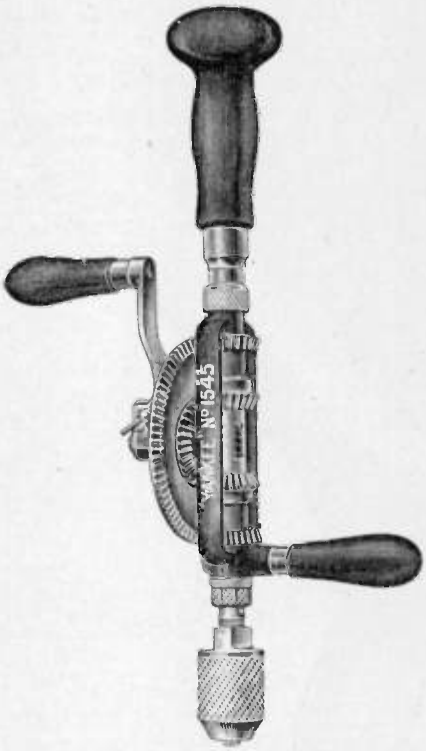
1409. **Copper Wire.** E. S., Providence, R.I., asks: (1) Where can I buy cellulose acetate for enameling wire? (2) Where could I buy copper wire cheap? (3) Could I make an induction coil having the primary and secondary end to end on a core without the secondary being wound over the primary? Does a small core make any difference to the strength of the aerial? I would like to make a coil out of wound copper wire on spools by connecting the spools of the secondary together. Only one spool of primary. Ans.—(1) See question No. 1338, June, 1910, issue. (2) Copper wire cannot be bought "cheap." It is a standard commodity, the prices of which fluctuate only with the market quotations. (3) Yes, such construction is possible. There is a straight core transformer now on the market which is constructed on that manner. The size of the core influences the length of spark of the secondary.

1410. **Spark Gap.** W. C. S., Camden, N.J., asks: (1) Is a steel spark gap more efficient than a zinc one for amateur stations? (2) Which is best for an aerial, aluminum or copper wire and what size? Ans.—(1) Steel or a steel alloy is now generally used in place of zinc. When steel is used the spark has less of a tendency to arc than when zinc is used. (2) Both kinds of wire receive equally well. Aluminum is used where a light aerial is wanted.

1411. **Aerial Mast.** P. H. M., Jamaica, N.Y., asks: (1) Can a pericon detector such as described in the January, 1910, number, be used on the portable outfit? (2) Could a 1½ in. or 1¼ in. iron pipe be used for the aerial mast (in section) instead of the heavy wood sections? (3) If dry batteries are used what are the dimensions of each. Ans.—(1) Yes. (2) For heights below 60 ft. it is practical to use iron pipe. There is always the possibility, however, that the pipe will buckle while it is being erected. Use 1½ in. pipe. (3) 15 volt 25 ampere cells are used.

TRADE NOTES

North Bros. Mfg. Co. have just placed on the market a new drill. It has every feature that has made the "Yankee" Breast Drills so popular. It is a somewhat smaller style of drill than those many of you know so well, and has a handle that can be held in the hand or against the body when in use.



The special feature is the simple mechanism for changing action of the tool and operated by merely moving the shifter on cylinder between the small gears on spindle and the simple device for changing speed.

Note the little slide on cylinder between gears and the notches. With slide in first notch (at top), it is a plain drill, in second a left-hand ratchet, in third a right-hand ratchet, in fourth a double ratchet where any movement of crank forward or backward causes the drill to cut continuously, a time saver and convenience when working in corners where crank cannot be turned. In fifth (at bottom) gearing, etc., is locked to open or close chuck.

The 2-jaw chuck holds accurately and securely both square or round shanks, and 3-jaw round shanks only, up to ⅜ in.

Adjustable ball bearings take all strain.

The side handle can be unscrewed and has screw driver bit to fit screws in drill.

The frame is malleable iron, finished in dead black color. The chuck body is malleable iron, polished and nickel-plated. The jaws are of steel, drop-forged and hardened. The spindle of steel and gears are cast iron with cut teeth. The driving gears are 4½ and 2 in. diameter, and driven gears on spindle 1½ in. diameter.

BOOK REVIEWS

Dynamo Building for Amateurs; or, How to Construct a Fifty-Watt Dynamo. By Arthur J. Weed, Member of N.Y. Electrical Society. Norman W. Henley Pub. Co., New York, N.Y., 1910. Price, paper, 50 cents; cloth, $1.00.

This book is a practical treatise, showing in detail the construction of a small dynamo or motor, the entire machine work of which can be done on a small foot lathe. Dimensioned working drawings are given for each piece of machine work, and each operation is clearly described. This machine when used as a dynamo has an output of fifty watts; when used as a motor it will drive a small drill-press or lathe. It can be used to drive a sewing machine on any and all ordinary work.

A. B. C. of the Motorcycle. Text and Illustrations that Make the Mechanism and Operation of the Machine Clear to those Directly and Indirectly Interested. A book for the Use of People who want the show-how features. By W. J. Jackman, M.E. The Charles C. Thompson Co., Chicago, Ill., 1910. Price, $1.00, cloth; $1.50, leather.

With the growing importance of the motorcycle as a means of both economical and pleasurable travel, there is a growing demand for a book which will serve as an elementary text-book for those who desire to learn to operate such machines. Of course, the standard books on automobiles give many useful hints; but after all, the peculiarities of the motorcycle are such that it deserves special treatment. This is given it in this useful handbook, which is most complete and helpful. Some idea of the usefulness may be obtained by perusal of the following list of contents: Inception and Evolution of the Motorcycle, Modern Machines and their Vital Parts, How to Master the Mechanism, Production and Application of Motive Power, Construction and Operation of the Carbureter, What the Carbureter Does, Ignition Systems, Batteries and Magnetos, Practical Methods of Handling, Various Types of Motors, Theory and Effect of Internal Combustion, Troubles of all Kinds and How to Avoid or Overcome Them, Lubrication Methods, Transmission or Drive Systems, How to Compute Horse Power, Relation of Power and Speed, Weather Effects on Gasolene Engines, Cost of Maintenance on Basis of Mileage, Some Don'ts that will Save Time and Money, Selecting a Motorcycle, Hints for the Buyer, What an Owner should do on Receiving a New Machine, The First Ride.

Selected Words for the Ad.-Writer. By B. S. Tait, 1250 North J St., Tacoma, Wash., 1910. Price, $1.00.

The author of this useful little handbook, which is gotten up in pocket form, so that it may be easily carried about for instant reference, has collected in the form of a dictionary, of synonyms, practically all of the words in the English language, which express quality, advantages, and price. A miscellaneous list gives other words, useful in advertising construction, and then follows a long list of advertising sentences. By the use of this book, the man who is writing advertisements may instantly find the exact word which he desires to express his idea, and in writing a series of advertisements on the same subject can introduce a most useful variety.

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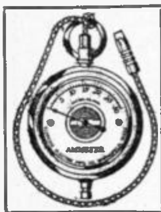

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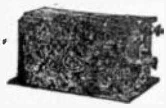

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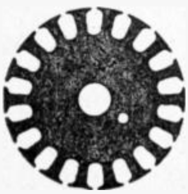

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