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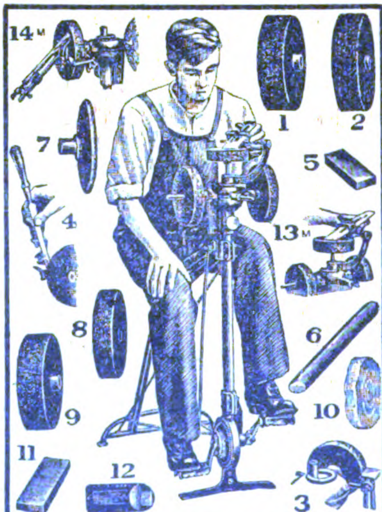

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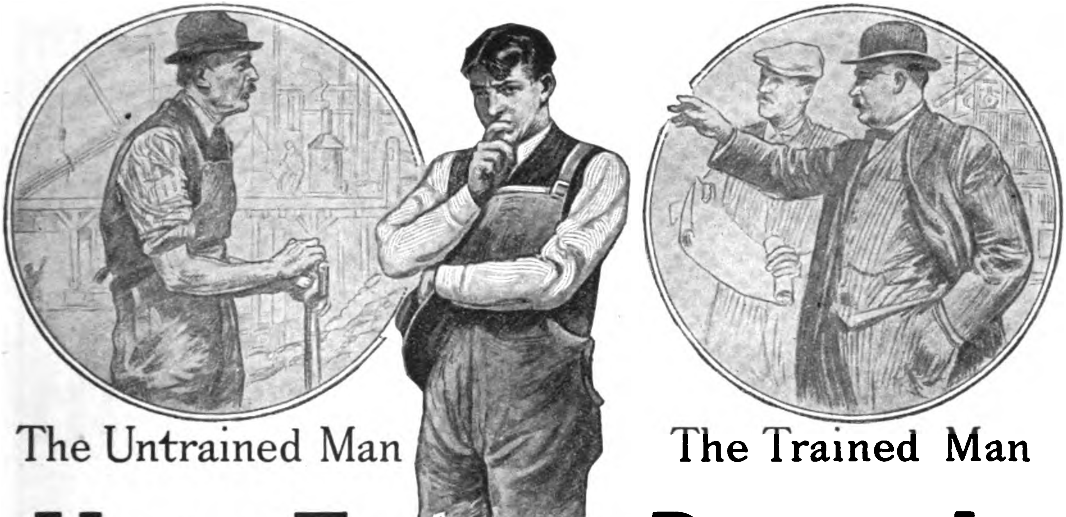

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ELECTRICIAN & MECHANIC

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CONSTRUCTION AND OPERATION OF A DECREMETER

A. S. BLATTERMAN

In the January issue of ELECTRICIAN AND MECHANIC, Mr. H. B. Kirtland explained a method of determining the logarithmic decrement. As he points out, there are required for the work (1), a calibrated wave-meter, and (2) either a calibrated hot-wire ammeter or a low-resistance galvanometer and platinum-tellurium thermo-element.

It appears to me that while his method is technically all that is claimed for it in point of accuracy, etc., it is not, in general, suited to the use of the amateur

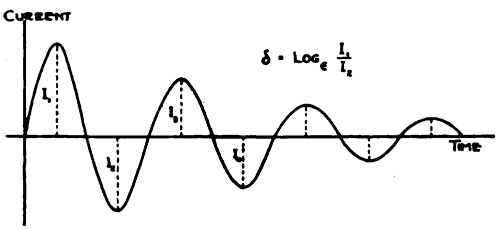
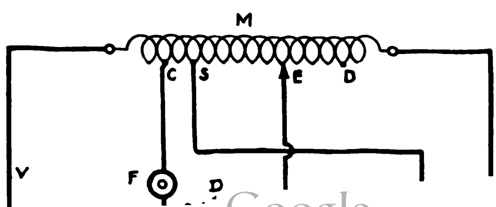


Fig. 1

telegrapher who seldom has access to apparatus of the above character. And, moreover, granting the availability of the necessary apparatus, the final determination of the damping coefficient necessitates calculation. I therefore recommend the following apparatus and methods, adapted from the Marconi decrement determinations, to be used by the amateur, and these in at least one instance permit the reading of decrement direct from a table which is here furnished for the purpose. In another instance the plotting of the resonance curve and a tially one which involves a determination of a relation between the current values in the wave-train and the time or period of oscillation. This is evident to students of the subject. Though this may at first seem to be a rather hopeless task, a little thought will show that while it may not be possible directly to measure instantaneous current values or to take the time of oscillation, the effects produced by the current and the elements governing the frequency are both easily accessible and definitely observable.

To be explicit, the phenomenon of resonance is made use of exactly as is done in wavemeter work, and with a few alterations and additions to the latter an instrument constructed which allows direct determinations of the logarithmic decrement. Such a piece of apparatus is known as a decrement meter or simply a "decremeter."

It involves primarily a fixed inductance and a variable capacity, and in this respect it resembles the wavemeter. In fact, if the values of inductance and capacity are known, wave-lengths may be read from the decremeter as precisely, though perhaps not so readily, as from



the wavemeter itself. Both are instruments involving the resonance phenomenon and incorporating a means of quick and accurate adjustment to different frequencies. However, the decremeter (here described), not dealing with the actual numerical values of frequency and wave-length, need not have its high-frequency units evaluated, although some consideration must be given to this feature of the instrument in its design. For the special use of the amateur it must be applicable to the measurement of decrements occurring in impulses whose wave-lengths are 200 meters or less. The following instrument is suitable.

APPARATUS

A schematic diagram of apparatus and connections is shown in Fig. 2. The apparatus there indicated is as follows:

K=Adjustable condenser
F=75 ohm head telephone
D=carborundum detector
M=a long coil
N=a shorter coil.

Also there will be required a double-pole, double-throw switch.

The long coil *M* is constructed as follows: Turn up a round wooden mandrel 12 in. in length and ½ in. (scant) in diameter and leave the surface of the wood unfinished—that is, do not paint it or use shellac. Wind with one layer of No. 22 d.c.c. wire B.&S. gauge starting and finishing 1 in. from the ends. As the winding proceeds apply a good glue to the mandrel and wind the wire right in it. Take off a tap 26 turns from one end of the finished winding and another one 52 turns from the same end and bare the wire for the sliding contact shown at *E*, in Fig. 1. *C* and *S* in the diagram represent the points of tapping. The finished coil may be mounted in any convenient manner, but precaution should be taken to so arrange matters that a short indicating pointer attached to the handle of the slider may move over a scale which should be laid out thus.

On the strip of paper or celluloid which is to serve as scale lay off a distance of 8 in., and divide it into 100 equal parts. Mount the scale so that its zero mark will be exactly opposite the point marked *C* on the coil and its 100 mark at some point *D* (see figure).

The smaller coil *N* has the following dimensions:

26 turns No. 22 d.c.c. wire, B.&S. gauge on wooden mandrel 1¾ x ½ in. This coil has no slider or taps. All that is necessary is to bring off the two terminal wires to the connecting points shown in the diagram.

The adjustable capacity should take the form of a rotary condenser of the semi-circular plate type. Its capacity (maximum) should be about 0.0005 microfarads, and any of the several condensers of this size now on the market is suitable.

This completes the apparatus required and it should be wired up as shown.

MANIPULATION

Turning now to the manipulation of the apparatus and the methods to be employed in the definite determination of the decrement, there are two separate processes which recommend themselves. The first excludes the use of the small coil *N*, and is dependent upon the plotting of a resonance curve. The second is more mechanical and more rapid, though it lacks some of the instructiveness to be gained from the plotting of the tuning curve. In either case the underlying principles are the same.

Method I.—It is assumed that when a long coil, such as *M* is subjected to the passing of high-frequency oscillatory currents, the potential along it varies in direct proportion to lengths along it—*if the ends of the coil are neglected.* Therefore, referring to the figure, the greater the distance separating *C* and *E*, the greater will be the potential difference at the detector terminals.

Set up the instrument some little distance from the transmitting antenna circuit and excite the latter. Throw the switch to position 1—2, and with the slider *E* at about 50 on the scale, adjust the rotary condenser until the signals in the phone are loud. Now diminish the scale reading of *E*, *i.e.*, move the slider toward the point *C*, and at the same time alter the condenser for maximum signal strength. Continue this until a point is reached where the signals are a little more than barely audible.

Note exactly the reading *CE* and the reading of the condenser. Now change the reading of the latter a few degrees, say from 2 to 5 degrees, depending on the proximity and power of the transmitter.

This will cause the signals to disappear. Bring them back again to their original strength by adjusting slider *E*, making reading *CE* larger. Again note this latter reading and the corresponding condenser position.

Repeat the above, making slight reductions in the condenser capacity and subsequent adjustments of the slider for signal audibility until the value of *CE* is large (about 80 or 90). Note each set of component readings of condenser and slider scales and enter the values in a table of the following form.

CE	$\frac{1}{CE}$	Condenser Readings in Degrees = *R*	Square Root of Cond. Read's = $\sqrt{R}$

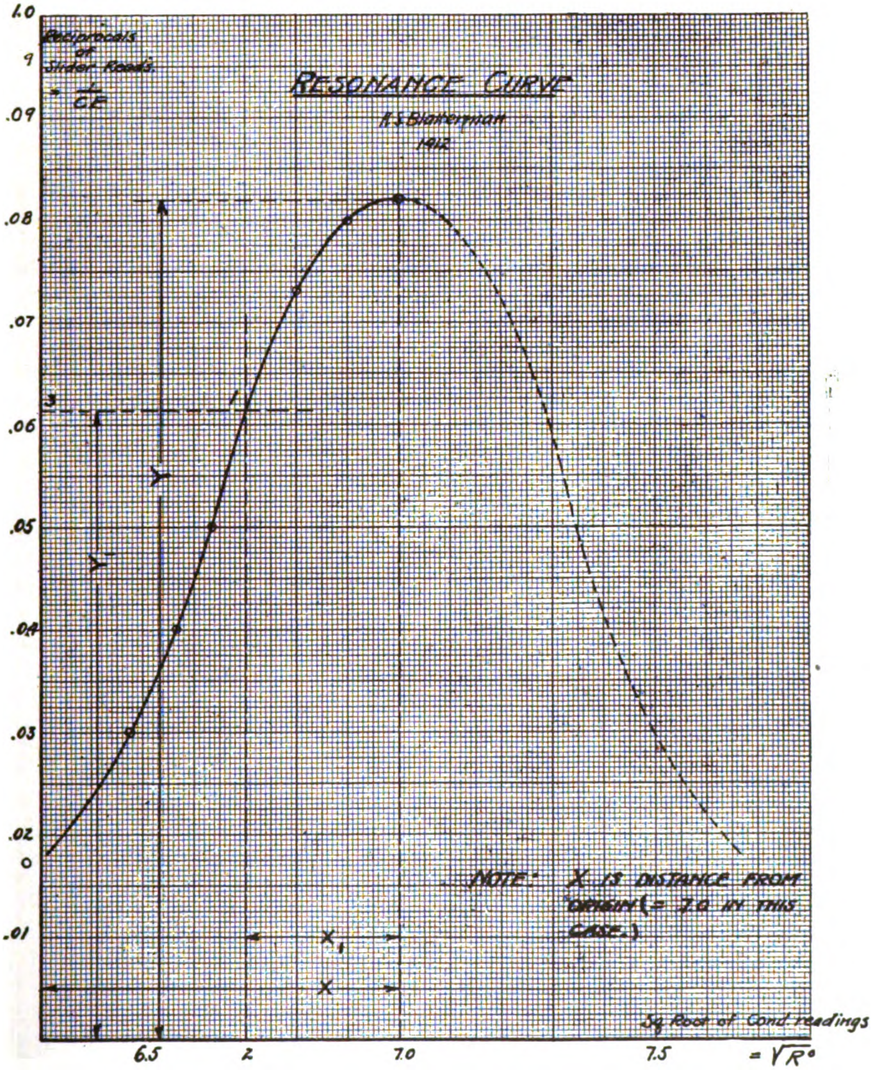


FIGURE 3.

The two columns headed respectively "*CE*" and "Condenser Readings=*R*" contain the observed values, while the other two columns are computed as indicated.

As above stated, the potential along

the coil M varies in direct proportion to lengths along it; that is, the potentials impressed upon the detector, and consequently the strength of the signals are directly proportional to the values of the scale readings CE. It is plain then that the smaller CE is made, the more nearly must the circuit of the decremeter be brought into resonance with that of the transmitter—if the detector and telephone are to respond; and when CE has attained the smallest possible value at which the signals are still audible and the condenser adjusted accordingly, then the decremeter circuit is oscillating in a period identical with that of the transmitter. This is the initial setting and affords the first set of readings.

Now as K is changed more and more from this first resonance position the circuit is thrown continuously more and more out of exact "tune," and more wire must be tapped off the coil M to obtain current sufficient to actuate the detector.

The method of procedure then is to calculate the reciprocals of the readings CE, since as K is changed the current values in the circuit $MVKI$ diminish and CE increases. Also since the wavelength is directly proportional to the square root of the capacity ($\lambda = 2\pi V\sqrt{LC}$) and since the latter is directly proportional to the scale readings on the condenser we may compute in each case the square root of the condenser readings in degrees ($=\sqrt{R}$).

Having done this the next step is to obtain a piece of cross-section paper and as shown in Fig. 3 plot the values of $\frac{1}{CE}$ against the values of $\sqrt{\text{Cond. readings}} = \sqrt{R}$. The curve obtained is one-half of the resonance curve, and is all that is needed for our purposes. Now select some point on the curve as "1" and draw through it a horizontal and a vertical line, cutting the co-ordinate axes in points 2 and 3. Read off directly the distances marked respectively $X_1—X$, $Y_1—Y$, and substitute in this formula

$$\delta = 3.1416 \frac{X_1 Y_1}{X\sqrt{Y^2 - Y_1^2}},$$

which gives with accuracy the required value of the logarithmic decrement.

One word of caution. Care should be exercised in the selection of the point "1" on the curve. It should be so chosen that the value of the ratio $\frac{X_1}{X}$ in the formula shall not exceed $\frac{1}{20}$. As an illustration, let us take the case actually plotted in Fig. 3:

$X = 7.0$
$X_1 = 0.3$
$Y = 0.082$
$Y_1 = 0.0614$

Substituting in the formula:

$$\delta = 3.1416 \frac{0.3 \times 0.0614}{7.0\sqrt{(0.082)^2 - (0.0614)^2}}$$
$$= 0.147$$

One objection to this method of determining the decrement is that time is consumed in plotting the curve and errors may enter in the subsequent determination of the values required for computation. It is, however, interesting physically, is quite applicable to observations on slightly damped impulses, and is in use in commercial work.

The following method is more expeditious:

Method 2.—Set the detector, throw the switch in position 3–4, and adjust the condenser K for maximum signal strength. Do not have the decremeter too close to the circuit being measured, or the final value of damping obtained will be larger than the true value. When, by adjusting the condenser, a maximum response is obtained in the phone, note carefully its intensity, fixing the strength and character of the sound firmly in your mind.

Then throw the switch to position 1–2, having previously moved the slider E up very close to position C of Fig. 1. It will be seen that the switching change has cut the small coil out of the circuit and as a result the wave-length of the instrument is shortened and the signals are no longer audible. They may, however, be brought back, as in *Method* 1, by means of the slider E; and this is the method of procedure.

Move the slider back from C toward D until the strength of the signals is just what has previously been observed with the switching connections at 3–4. It is not difficult to thus establish and recognize two sounds of equal intensities, and the process is quite rapid.

Note the reading *CE* on the scale under the slider when this is accomplished, and refer to Table II, from which the value of the logarithmic decrement can be read directly.

TABLE II

CE	δ	
25	Infinitely Large	
30	0.189	
31	0.172	
32	0.157	
33	0.146	
34	0.136	
35	0.129	
36	0.121	
37	0.115	
38	0.110	
39	0.105	
40	0.100	Legal limit
41	0.097	
42	0.093	
43	0.090	
44	0.087	
45	0.084	
50	0.073	
55	0.064	
60	0.058	
65	0.052	
70	0.048	
80	0.041	
90	0.036	
100	0.032	

It may be well to state that better results will be obtained if the decremeter and transmitting apparatus are rather widely separated so that the signals resultant are not overintense. It is much easier to compare two weak sounds than two strong ones.

The above method (2) is that embodied in the operation of the decrement meter manufactured and used by the Marconi Company, and is to be recommended on account of its quickness, accuracy and simplicity.

The values of δ determined by the methods of this paper are decrements per half period, *i.e.*, for one single oscillation.

How to Wind Irregular-shaped Springs

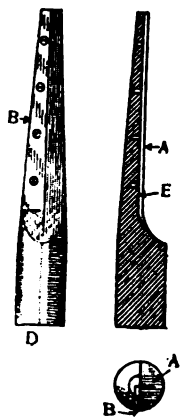
A writer in *Popular Mechanics* gives the following method of winding springs shaped like those on stove lifter handles, stove doors, etc., having made a tool as shown in the illustration and used it in his lathe with good results.

Each piece *A* is made of spring steel and riveted to a shaft with two rivets on one end, while the other end fits into an individual notch in the collar *C*. This collar is kept from turning on the shaft

by a key. Turning nut *B* up against the collar pushes on the ends of the springs, causing them to bulge outward in the middle. When the proper size is secured on these springs, one end of the wire is fastened to it and the coil is wound. When through winding, loosen the nut and slip the finished coil over the opposite end of the shaft from the collar.

A Taper Reamer for Roughing Out Holes

The drawing herewith reproduced shows a first-class reamer for roughing out all kinds of tapered holes for valves and petcocks. The shank and cutter holder *D* is turned from tool steel to within 1/32 in. of the size wanted, then milled as shown at *A*. A second cut is taken on the milling machine, as shown at *E*, leaving a recess to take the cutter blade *B*. The screwholes in blade should be a little large to allow adjustment for wear, which can be taken up with strips of paper inserted behind it. The holder and blade must be



A Taper Reamer

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

ISOMETRIC PROJECTION

In one of the previous articles of this series, it was shown how an object could be represented on two or more suitably chosen planes. Frequently it is desired to produce a pictorial effect when representing an object and at the same time to preserve the relative proportions of the various parts, in order that they may be drawn to some suitable scale. One of the most common methods or systems of doing this is called *isometric projection* or *isometric drawing*. This method requires but a single plane of projection.

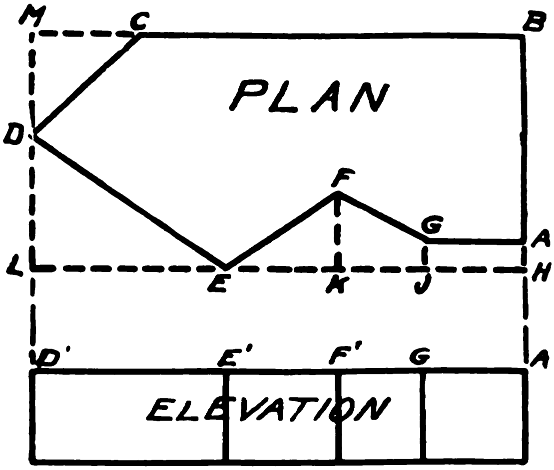


Fig. 2

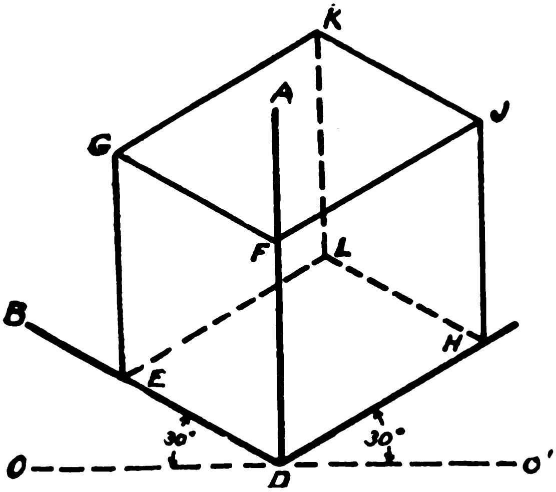


Fig. 1

In *mechanical drawing* the object is represented on two planes which are called the horizontal plane of projection and the vertical plane of projection. Very often a third plane is also used as a plane of projection, and this plane is taken perpendicular to the other two planes. The projections of the object on these three planes are termed the plan, the front view and the side view of the object.

In *isometric projection* or *isometric drawing* it is not necessary to show these several views and the plan of the object, and instead, a representation is made of the object, the view being taken, as it were, cornerwise to the observer. In other words, the lines belonging to the three systems of parallel edges which bound all rectangular objects, are drawn parallel, respectively, to three axes called the *isometric axes*. This fact is illustrated quite clearly in Fig. 1. The figure shows the *isometric* representation of a parallelopiped.

To obtain the *isometric projection*, it is supposed that the solid is so placed relatively to a plane surface that the

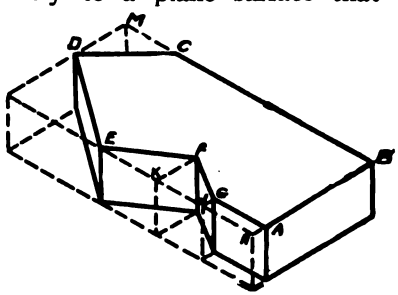


Fig. 3

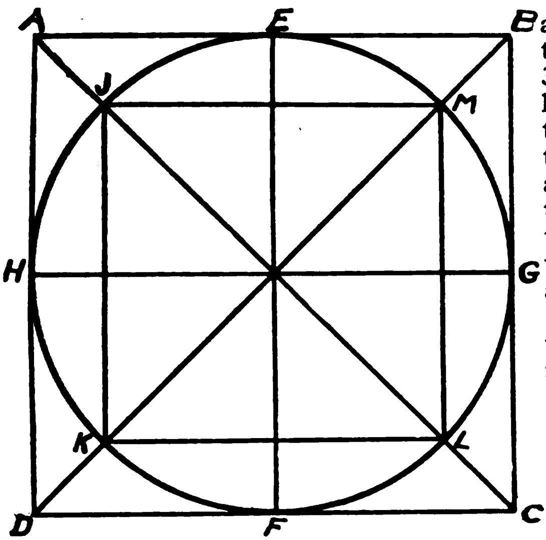


Fig. 4

three surfaces forming the solid angle *D* in Fig. 1 are equally inclined to the plane and that the solid is projected into the plane, by projectors which are perpendicular to the plane. The lines *BD*, *AD* and *CD* are called the *isometric axes*. The lines *BD* and *CD* make angles of 30 degrees with a horizontal, while the line *AD* is drawn vertical. When an *isometric projection* is made, it is evident that all edges of the figure or object which are inclined to the vertical projection plane, appear shorter than they actually are on the object. The length of an edge of the object is to its isometric length as $\sqrt{3}$ is to $\sqrt{2}$. Since all edges are equally foreshortened, it is usual, for the sake of convenience, to make the lines in an *isometric drawing* equal to their true length. It is not possible to measure directly the angle between lines on an *isometric drawing*. In any case of *isometric drawing*, the following rule is adhered to, that all horizontal edges of the object are represented by lines making 30 degrees with the horizontal, that all lines are drawn to the same scale, and that there is no "vanishing." The distinction between an *isometric projection* and an *isometric drawing* lies in the fact that the *isometric projection* has all of the lines drawn 0.814 of full scale size, while in the *isometric drawing* all lines are drawn to full scale size.

In *isometric drawing* invisible lines are usually omitted to avoid confusion. It is customary to draw shade lines for the division between light and dark surfaces, and the direction of the light is at 30 degrees downward to the right.

When making an *isometric drawing* of any irregularly shaped object, the object should be enclosed in a rectangular solid and the *isometric drawing* of this solid should be made before making that of the irregularly shaped object. After the *isometric drawing* has been made of the rectangular solid, it is a comparatively easy matter to inscribe the *isometric* of the irregularly shaped object.

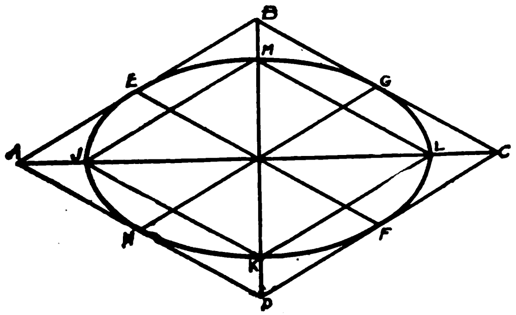


Fig. 5

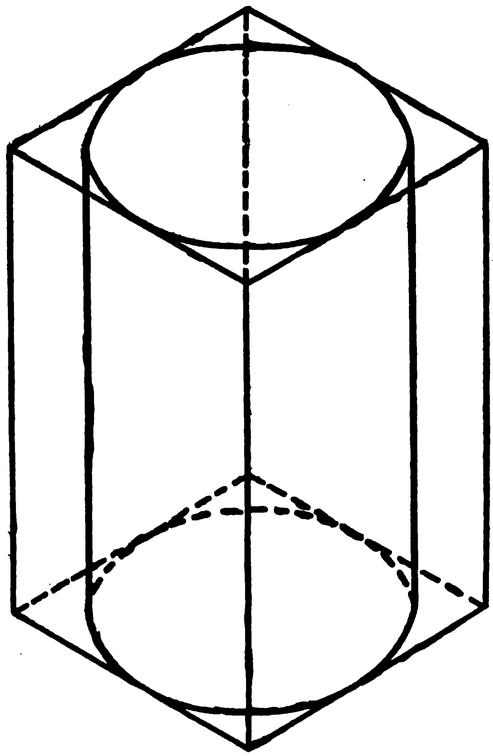


Fig. 6

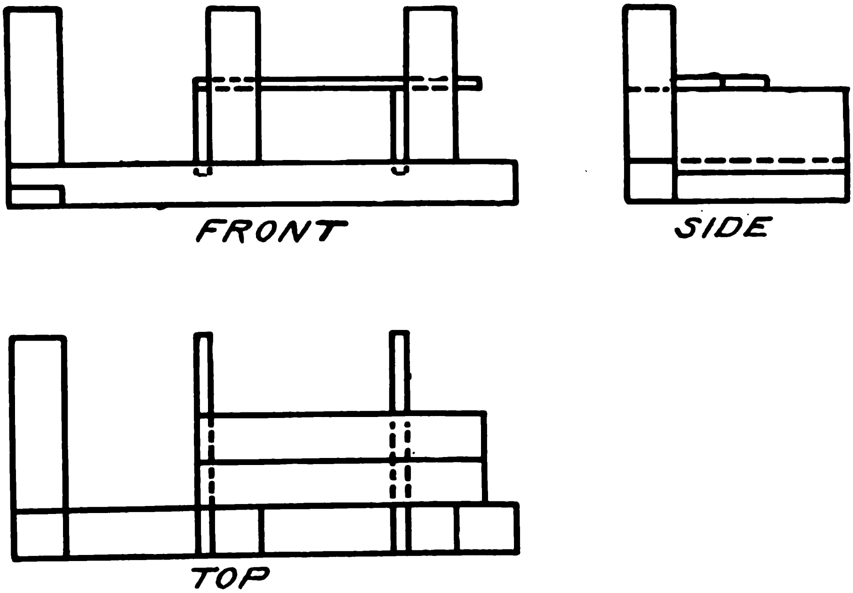


Fig. 7

The method of making such an *isometric drawing* is shown in Figs. 2 and 3. Fig. 2 shows the plan and elevation of a given irregularly shaped solid. *BCMDLEKJHA* is the plan of the enclosing rectangular solid. Fig. 3 shows the *isometric drawing* of the two solids.

Figs. 4 and 5 show the method of drawing the *isometric* of a circle. Fig. 4 shows the given circle. About this circle, describe the square *ADCB* and draw the diagonals and diameters of the square. Through the points at which the diagonals cut the circle, draw lines as *JK*, *KL*, *LM* and *MJ* parallel to the sides of the square *ADCB*. To put both squares into the *isometric projection*, Fig. 5, make all lines a similar length, *i.e.*, *AD* in the first figure equal to *AD* in the second figure, *BC* in the first figure equal to *BC* in the second figure, etc. Now draw the diagonals and the diameters. Having thus located eight points through which the curve representing the circle will pass, draw in the curve either free-hand or by the use of French curves. The *isometric* of a circle is an ellipse, the exact construction of which would require the locating of a large number of points.

Fig. 6 is the *isometric* of a cylinder which is standing on its base. The cylinder is circumscribed by a square prism and the ellipses which form the top and base of the cylinder are simply circles drawn in *isometric projection* by the method just described.

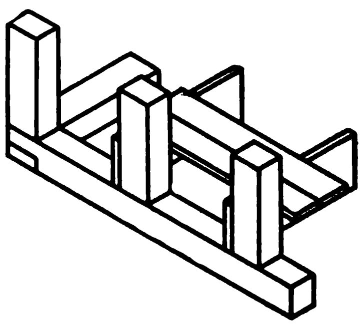


Fig. 8

Fig. 7 is the front, top and side elevations of some carpentry work. The *isometric* of this same piece of work is shown in Fig. 8. To obtain this *isometric drawing*, it is simply necessary to follow the general principles described in the early part of this article. It should be noticed that the *isometric drawing* gives a more complete but less detailed picture than does the *mechanical drawing*. For this reason *isometric drawing* does not pretend to supplant the ordinary *orthographic projection*. It is largely used when making sketches of machines and details, since it is often better and more time-saving than is the system of making the three ordinary views. It is particularly well adapted to any work which

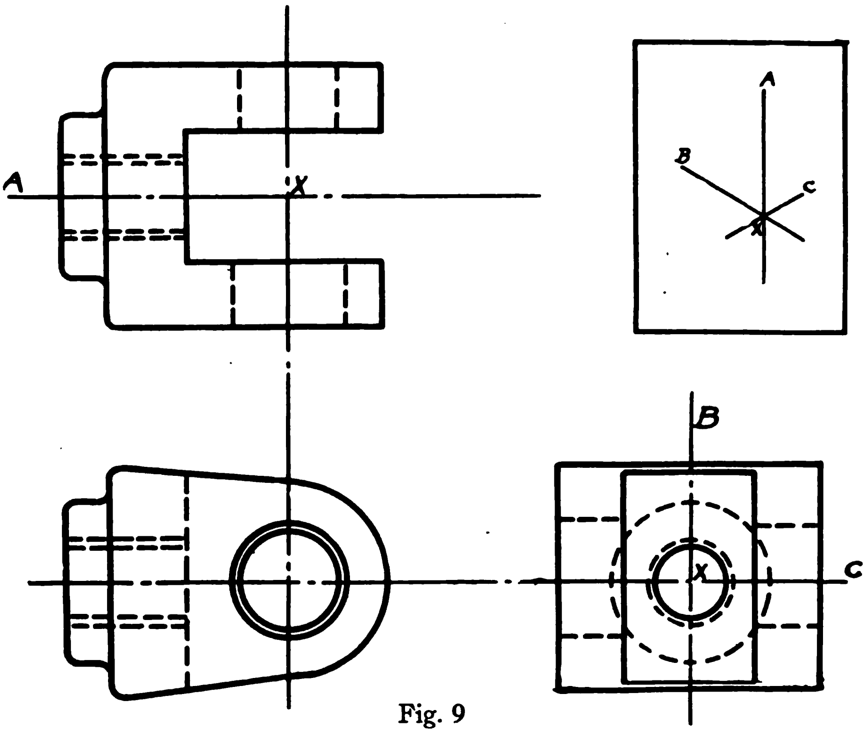


Fig. 9

does not require a view of the internal construction of the object.

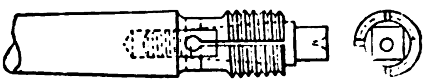
The problem for this month will be to make the *isometric drawing* of the connecting rod strap illustrated in Fig. 9. The three axes are $A{\cdot}X$, BX and CX. The *isometric drawing* should be drawn first in pencil, then in ink, and of such a size as will make a well-balanced plate. The outside dimensions of the plate are to be 10 x 14 in.

A MANDREL FOR FACING NUTS

F. C. S. STUDENT

The shank of this mandrel is turned taper to fit the lathe spindle; then a hole is drilled, and turned out taper, the bottom part of the hole being left straight and tapped out. Then the thread is cut on the outside to fit the nut.

At back of the thread, two holes are drilled crosswise and slots cut into the



Mandrel for Facing Nuts

holes. The screw is turned to fit the taper hole, and the end is squared to apply a wrench. The end of the screw may be centered and hardened so that the tail-stock center may be brought up to support it.

This kind of mandrel can also be used for turning small castings having a reamed hole. In that case, instead of the thread on the outside, the end is turned to fit the hole, so that the casting can be pushed on.

When the screw is tightened, the mandrel expands, and the nut or casting is held tight.—*American Machinist.*

Wireless Operator Killed

FIRST CASE ON RECORD—MAN AT GREAT GERMAN STATION THE VICTIM

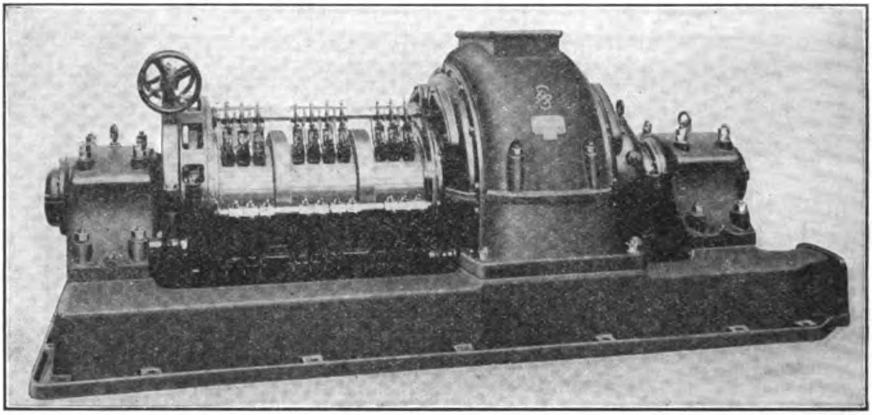
New York, December 24.—Wireless operators here say that the death of an operator in the great German wireless station at Norddeich, near the North Sea, on Sunday, is probably the first case on record of a wireless operator being killed at his post. The Berlin dispatches indicated that the operator, a man named Mueller, must have carelessly come into contact with the wires employed for the creation of electric waves, which are charged with such powerful voltage that death comes instantaneously to anyone touching them.

MODERN GERMAN STEAM TURBINE GENERATORS

FRANK C. PERKINS

It may be of interest to study the construction of the steam turbine generators of German design of both alternating and direct current type, and note the method employed for keeping the windings cool during heavy load.

The accompanying illustration shows each phase is 724 amperes. Exciting current is conducted to the slip-rings at a pressure of 220 volts, the exciter dynamo being directly coupled to the extended shaft of the alternator outside the main bearing and mounted on the extender sub-base.



a direct current generator of the Siemens-Schuckert type supplying a current at 110, 440 and 600 volts at the Zentral Krefeld. It is directly coupled to a Zolley steam turbine having a capacity of 1,950 h.p. It will be noted that to collect the heavy current—1,135 amperes—a very long commutator is used, and to provide against the great centrifugal stresses when revolving at a speed of 3,000 revolutions per minute, steel rings are shrunk on over the segments in several places. Mica insulation separates the rings from electrical contact.

This armature is constructed in the form of a ventilator or blower, the current of air being forced through and around the windings by the rotation in the same manner as a ventilating fan or turbine blower.

The ventilation of the rotating field

Short Rules for Price Making

To figure the profit on an article correctly, subtract cost from selling price, divide the result decimally by the selling price and the result will be the true profit. Thus: Cost, Rs. 10; selling price, Rs. 15; profit, Rs. 5; and Rs. 15 is contained in Rs. 5 .333 times, showing a profit of 33⅓ per cent., and not 50 per cent., as some think. The same calculation applies in making so many percent. discount on your clearance sale.

We give the following short and simple way by which goods can readily be marked at any of the percentages common to business:

"To make a profit of 16⅔ per cent., add 20 per cent. to cost.

"To make a profit of 20 per cent., add 33⅓ per cent. to cost.

[illegible] per cent.,

ACTION OF HYTONE GAP

ASHLEY C. ZWICKER

A quench spark is one which causes the primary oscillation of a radio transmitter circuit, that is the condenser, the spark gap, and the primary of the helix, to cease oscillating when the secondary of the helix has attained its full amplitude of oscillation. A sketch will illustrate this fully. Fig. 1 shows the primary and the secondary oscillations of an ordinary spark set in which the primary excites oscillations in the secondary, which in turn again renews the train of oscillations in the primary circuit. This causes serious loss of energy from the heating of the spark gap, due to the constant sparking. Fig. 2 shows the primary and the secondary oscillations of a quench spark system. This is attained when the spark gap quickly cools sufficiently to cause the path of the previous spark to assume its natural high resistance. In this case the primary oscillations cease, while the secondary circuit continues to oscillate at its own natural period until the energy in it has been radiated.

The quenched spark is very efficient and is much sought for wireless work; and when we can combine the quenched spark with a high-pitched note, we have two very important assets for good wireless work. This high-pitched note has been produced in several ways. We have the shunted arc, the rotary gap, and the high-frequency alternator. Each has its advantages as well as its disadvantages. The shunted arc requires direct current of an uncommon voltage and needs very careful and constant attention. Besides, the oscillations are of the ultra audibility variety, being far above the reach of the human ear or the sensitiveness of a telephone diaphragm and requiring to be broken into groups at either the receiving or the sending end. The 500-cycle alternator used by the Telefunken Company has the disadvantage of not being able to work to the higher powers. This set works on the principle of one spark per alternation, and so the whole energy stored in the condenser per alternation is discharged across the gap in one spark. This spark makes its first jump at one point, and when larger powers are used, the energy is sufficient actually to tear out small bits of the copper surface of the gap, causing poor quality of tone and lower efficiency.

The new "Hytone" gap, as manufactured by a well-known firm engaged in construction of wireless apparatus, has several marked advantages which we will here enumerate. First: The gap can be worked on any commercial frequency of alternating current, thus doing away with the expensive special alternators on motor generator sets. Second: The potentials used in connection with the gap are very low, insuring safety of

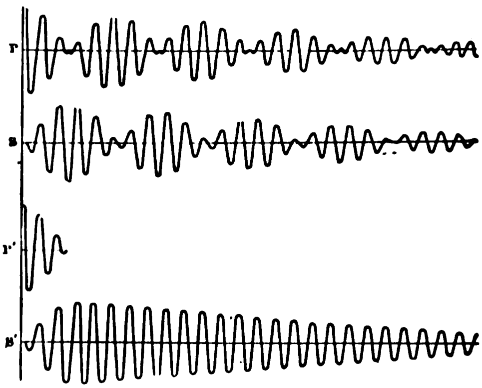


Fig. 1—P. and S. Primary and Secondary, Ordinary Spark.
Fig. 2—P'. and S'. Primary and Secondary, Quenched Spark.

handling and eliminating breakdown of condensers. Third: Efficiency is very high with this type of gap, comparing favorably with any commercial apparatus now in use and being approximately double that of the ordinary spark set. Fourth: The gap is practically noiseless in operation, doing away with the loud reports and flashes of the spark sets.

Patents have just been allowed for the method of producing the tone effects as well as covering several of the mechanical features of the gap. The gap consists primarily of two segmented copper discs, one stationary and the other rotary. The condenser discharges across the gap (which, but for the segments, would be continuous throughout each alternation) are divided into groups, the number of groups per second producing the tone. The discs are made of copper, as copper is a better conductor of heat than other metals except silver.

We shall here consider the gap designed for a 1 k.w. set. In this gap each disc has 36 segments and a speed of about 1,800 revolutions per minute. This gives us about 1,080 groups per second, or 8 per alternation, 16 per cycle. Each group has 25 to 30 highly damped sparks, depending on the amount of condenser we are using. Were we rotating plain discs instead of segmented ones, we should have not groups but a continuous train of damped sparks throughout each alternation of a frequency of about 60,000. These are reduced, due to the segments, to about 30,000, but this, as we know, is above audibility and of practical use only for telephone work.

This same gap may be used with direct current of 1,000 volts, and will show

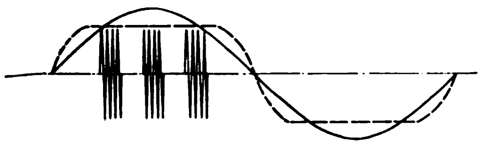


Fig. 3—Action of Gap and Voltage Across it

slightly better efficiency than the alternating current. In fact, the advantage of direct current over alternating current seems to be great enough to justify, in larger sets at least, the installation of a mercury arc rectifier. But the sets so far manufactured are for alternating current 60 cycle, and operate with an efficiency of 60 to 70 per cent., producing a high-pitched note. The rotating disc constantly brings cool copper in place of the heated spot, thus keeping up the high resistance of the gap and producing the quenching of the sparks. Also, instead of the whole energy of one alternation's being discharged at one time, it is discharged in 8 groups, or 250 sparks, thus allowing higher powers to be used.

A sketch will perhaps show the action of the gap and the secondary voltage across it. The magnetic leakage transformer is so constructed that the secondary voltage does not follow the sine curve of the supply but assumes a form following closely the heavier line of the sketch. From the beginning of the cycle the potential rises rather sharper than the true sine curve, but as the iron approaches saturation the curves flatten out, being flat on top and continuing so until almost the end of the alternation, then dropping sharply as at the beginning. Of course, working under load, the potential across the terminals and the gap is the same, and when a spark passes, or about 200 times per alternation, it is about zero.

This rapid rise and fall of potential cannot follow the windings far into the coils, but is choked, causing an actual difference of potential of full secondary voltage across a comparatively few turns at each end of the coil. To counteract this, the first and the last 250 turns of secondary winding are spaced with extra insulations between layers. This effect is usually spoken of as the high-frequency current backing into the secondary. In operating the Hytone gap, the manufacturers strongly recommend adjusting the length of the gap while not in motion, as otherwise there is liability of the two discs' running together, the segments interlocking and causing serious damage to the gap.

It should be stated in passing that the shorter the gap the higher the efficiency will run, but the set should not be run on short gap when out of tune, as the whole energy is then being used up in heating the gap, and the copper will expand, causing the discs to catch, as mentioned before.

An interesting and instructive apparatus for studying the frequency of oscillations can be made by rotating a vacuum tube at a speed about synchronous with the speed of the Hytone gap. By connecting the tube through the bearing with one side of the gap, the tube will be lighted at each group of sparks; and by observing closely in a dark room, the number of sparks per group may be noted. The tube may be enclosed in a box painted black inside with a window for observation, the tube being mounted on a disc inside the box and belted to a motor mounted on top. Or, if one has not the extra motor, it may be driven by the same motor that runs the gap by means of a rubber band around one of the coupling discs.

You have *pleasure* when you please another—*profits* are shared by you together.

NOTES ON THE USES OF ANGLE-PLATES

ALFRED PARR

The term "angle-plate" is given to an accessory much used in every workshop where metal is tooled—from the heaviest class of marine work down to the smallest model. It is usually made of tough cast iron, and has its adjacent sides accurately machine-faced, so as to form a right angle (90 degrees). These most useful appliances deserve consideration, and for convenience may be classified in two sections. First, those employed on rectangular surfaces at the planing, shaping, and milling machines, also for supporting work to be bored or drilled. The second class can be called "lathe angle-plates," which, indeed, are capable of a further division, as those employed on general lathe work, and those made expressly for special work at the lathe.

It will be seen that there are advantages to be obtained by these distinctions peculiar to each section. For instance, it frequently occurs that almost every available inch in a rectangular angle-plate is in requisition when certain classes of work are to be planed or milled, and the same may be said when it is required to support the same pieces of work at the drilling or the boring machine.

This inconvenience, however, is not so general in lathe work, hence the necessity for the above divisions. It will not be without interest to discuss some forms of plates designed for general work, in the first place, and consider those of a more special character afterwards. Figs. 1 and 2 illustrate an ancient and a modern angle-plate respectively. Fig. 1 has had its weak back broken through too much coring in the pattern—a defect to be again referred to.

It will be seen that Fig. 2 is a more typical design—the length of the plate is about twice the depth; it is provided with cored slots of a rectangular form, spaced at fairly uniform intervals; there

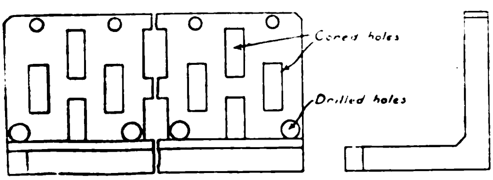


Fig. 1. Showing a Weak Angle-plate

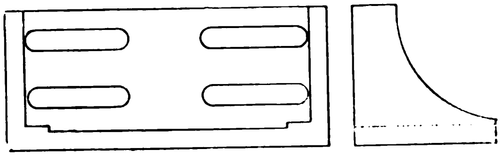


Fig. 2. A Modern Angle-plate

is a good fillet, and each end is tied with a substantial web to prevent any possibility of warping. This plate was recently purchased; its weight is 47 lbs., and for general work at the planing machine, the shaper, or drill it is quite in place, and is none too strong to resist all the strains to which it is there subjected. Now a ¾ in. bolt, having a squared neck, is a little over 1 in. measured diagonally, and although ¾ in. bolts are very strong, yet there is no margin of material left to prevent their turning even when used in an angle-plate 7 x 7 x 15 in., such as is given in Fig. 2. When this happens, it is necessary to hold a spanner on the head of the bolt to prevent its turning; but the work is frequently of such a character as to require holding in position, and a second pair of hands must be engaged to assist with it. This is always best avoided, and, indeed, could be in the above case if the slots in the angle-plate were of a smaller size.

Why is it that cores 1 in. wide should be put in so small a plate? The only answer is—that there is no agreement in the dimensions of the slots in machine table, therefore the slots in angle-plates are made to agree with the largest tables. Our readers may never require an angle-plate weighing 47 lbs., but they will require true and reliable plates nevertheless. Such plates may be purchased or "made to order," but are better still if made by the amateurs themselves. Small angle-plates can be cast and tooled, leaving out the consideration of holes until their proper position can be located; then, and only then, should holes be drilled. By thus carefully considering how the plate is to be fastened down on one face, and how the work can best be secured on the other, the plate will be kept in its most reliable condition, *i.e.*, always true.

On the other hand, if cored holes are decided upon, they should always be as *few* and as *small* as is consistent with the dimensions of the work they are intended to support and the machines at which they are to be used.

An angle-plate with surfaces well riddled with holes can be bought cheap enough at a dealer's, but too much accommodation in these appliances may quickly prove to be worse than none, especially to an amateur, whose work is always particular, and whose bolts and tools are small and delicate. The most skillful mechanics will never use an angle-plate without first overhauling it, that is, all burrs are removed and a reliable try-square is applied to the faces; even after the plate is fastened down, a further test for truth will be made. This shows that the plates are sometimes bent by an overstrain, and when this occurs thin strips of paper are used for packing, and the plate secured hard down, and then tried at different points with the square until the plate is true. There are two causes for a bent plate—one, abuse; the other shows a permanent weakness. Obviously, the packing inserted will do the surface no real good, and after a time the surfaces must be re-tooled and made true again.

If matters could remain thus, no further overhaul would be necessary; but, unfortunately, after truing a bent plate, it is made a little thinner, and therefore a little less liable to resist bending. It will now be clear that original plates—to do good service—must be thick and well tied with fillets and webs to keep them accurate.

The great disadvantage of using an angle-plate at the lathe is owing to the increased weight overhanging the spindle nose; the smaller the lathe, the greater this defect is to be seen. It will be noticeable in different ways, the most frequent one being an increased vibration of the whole lathe, especially when the gearing is out of use. Another thing will be the heating of the front bearing, because of the downward pressure on the spindle neck. Journal bearings, being provided with a shoulder fitting each Conical bearings are so sensitive that an oval bearing will quickly be formed if any slack whatever is allowed at the front end of the spindle cone.

When turning has to be done the horizontal thrust can generally be given a considerable help by placing a drill between the work and the poppet center. Cored work can be similarly treated, or a thin shaft used instead of the drill. Articles to be turned and bored while thus carried on an angle-plate give the best results when bored first, in which case a fitting shaft or mandrel can be inserted. This ensures the work being tooled concentrically, and permits of deeper cuts being taken.

There is still one further suggestion respecting the downward thrust on the

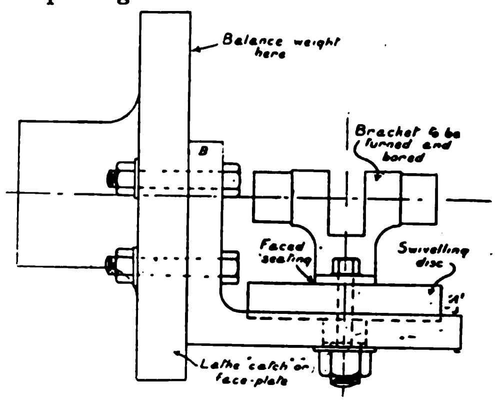


Fig. 3. Showing the Use of the Angle-plate in the Lathe

spindle neck, and that is to place wood blocks in the lathe gap and then drive in a wooden wedge between the blocks and the rim of the faceplate, the lathe being first started, and the rim of the plate oiled before the wedge is inserted.

Now the unfortunate thing is that small lathes are ever provided with gap-beds, the gap being bridged over by a satisfactory plate, which can be secured so that the bed becomes as rigid as one made solid. It is, however, when the gap is open that the trouble may commence; the saddle is robbed of an important part of its support just at the time when it is most needed—that is, when overhanging work has to be tooled while riding on an angle-plate or other that faces A and $A1$ are tooled parallel to each other and at right angles to B, and that by fixing the work on the table $A1$ instead of the face A, the face B can be turned inwards towards the center of the faceplate. By this alteration the advantages are threefold—more room for bolts, little or no overhang (therefore, less wear and vibration), and the bed bridge kept intact. Compare Figs. 3 and 6, which represent a piece of work from the same pattern.

The above points should be sufficiently conclusive to warrant the adoption of this method by all readers who have small lathes and who have been content to use one angle-plate for all purposes, such a plate being dressed only on its adjacent sides.

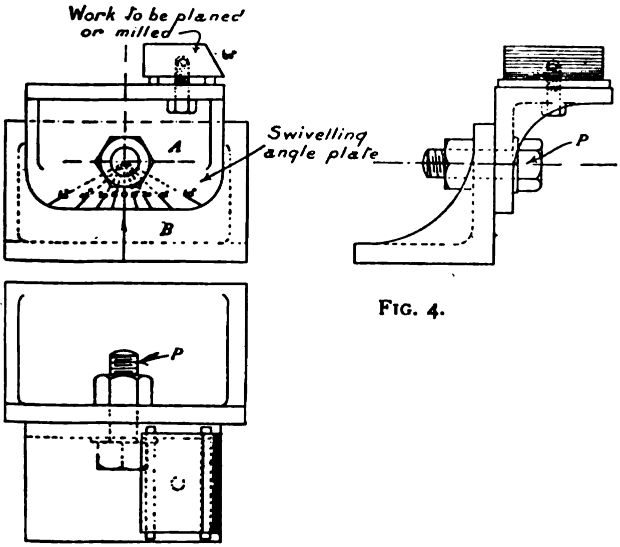


FIG. 4.

In works where it is the practice to manufacture a specialty, such, for instance, as brass valves and cocks, then special angle-plates are necessary. The pattern for the plate is designed to carry one particular piece of work, in which case the plate is converted into a "holding jig," and the castings are simply placed on the jigplate and are self-set, needing only to be clamped down.

Another form of angle-plate is shown in Fig. 4, which is really a combination of two plates fitted face to face, one of which is capable of swivelling on a turned pin P. It will be seen that the face of the plate A is divided into degrees of a circle and the plate B fitted with an indicator. By this arrangement the exact position of any surface can be determined and any desired angle obtained with precision without the necessity of first marking out the work, as is the case in the ordinary way of working. Two plates used in this way considerably facilitate the output in some classes of work. Take the example illustrated in Fig. 4, which represents a "strip" for a machine slide, which requires tooling on each of the four faces. There will be two "settings" of the work instead of three, because the angular surface can be swivelled into the horizontal plane, and there treated without altering the cutting tool. While for amateur milling—where it is practised—slab cutters can generally be utilized, instead of

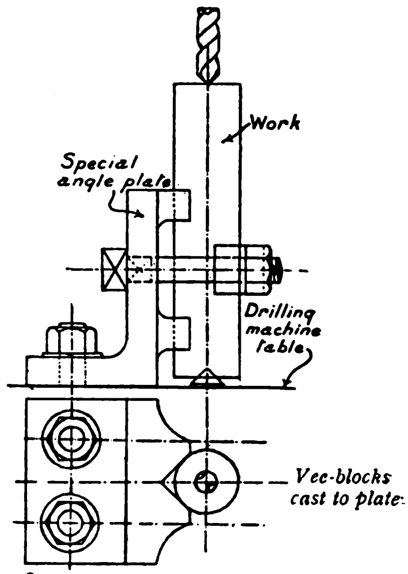


FIG. 5.

purchasing special cutters for angular work. Readers who may not have the convenience of an accurately divided wheel can get the angle-plate done, *i.e.*, graduated, at any reliable tool-makers, or, if they choose to dispense with the indications, they will have to mark out their work first and then use the swivelling-plate, locking it in position, as shown, and testing by the use of a surface gauge on each surface to be tooled.

The above combination of plates is equally useful at the drilling machine whenever holes are to be made at an angle, either to each other or to any given surface. By having radial slots suitably

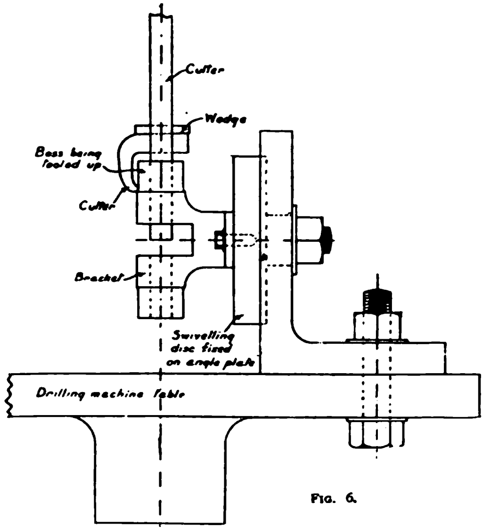


FIG. 6.

placed in each plate, and a bolt placed on either side of the center-pin, ample support is given for almost any class of work.

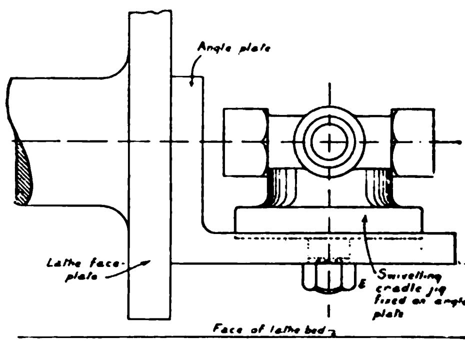
There are many pieces of work which could be accomplished at the drilling machine quite satisfactorily if "special angle-plates" could be used. This, of course, could not be considered for single jobs, but where examples recur they should always be considered.

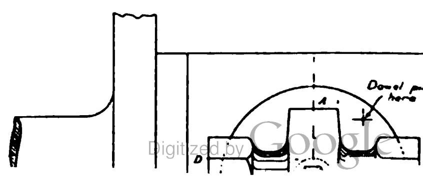
A simple case is to bore or drill a deep hole in a cylindrical shaft. Ordinarily, this would be mounted in a "self-centering chuck," or a "bell chuck" in the lathe, while the outer end of the shaft would require a "stay" or "boring collar stay" to support it. An ordinary angle-plate could be used and a pair of V-blocks taken from the marking-out table; but when a number of these shafts require drilling, then it is advisable to cast a pair of V-blocks to an angle-plate, and, after planing, shaping, or milling up the surfaces, the plate is ready for use with just a bolt and a clip with which to secure the shaft in place without setting. This arrangement is shown with a shaft ready for drilling in Fig. 5. It will be seen that the extremity of the shaft stands on a center point; this is to ensure the shaft's being properly located axially in

work: the bracket would be mounted upon an angle-plate after the base had been tooled either by shaping or milling, and the holes drilled, bored, and reamed. Afterwards the bracket would be fitted with a mandrel and mounted on the lathe centers, each boss being tooled in turn. Now by using an angle-plate in the way illustrated, all the tooling can be accomplished at a drilling machine quite satisfactorily.

If the brackets are to be anything less than ¾ in. bore they can be more reliably tooled when the bosses are cast solid; the drills can also be run at a much higher speed and with less damaging effects.

In this case the angle-plate is fitted with an indicated disc controlled by a "central pin" and "dowel pin" for further security. The angle-plate proper is bored for the pin and counterbored a little to receive the disc. The drawing is simple, and should fully explain the arrangement. It is by this principle, in which boring bars taking a bearing in the machine table, that drilling machines can compare favorably with lathes on many jobs of a similar kind. (See also Fig. 3.) Of course, the angle-plate in all work of the above character remains





in a permanent position until all work of a given pattern has been executed, for by so doing the original dimensions are accurately repeated in each example without any possibility of error; the appliance, therefore, resolves itself into a "jig," illustrating a method of working now fast becoming universal.

It will be seen that the same appliance could be used at the lathe without alteration, but nothing would be gained unless a turret carrying all the required tools were employed; then, of course, the lathe would surely make a decided gain, because it would be much more easily manipulated.

An angle-plate of a special character is given in Fig. 7, illustrating a piece of work to be tooled on four faces without removal when once properly set. The example given has to be bored and screw-cut on the two opposite ends *BD*, while *CA* has to be bored taper and faced at each end.

The disc is accurately divided into four, and these four lines are made to agree in turn with an index mark on the face at the front of the angle-plate. Of course, one angle-plate will answer for a considerable number of different discs; but each disc, being specially designed to fit a certain form of casting, can be quickly changed, as required.

To ensure the work's remaining in one position after fixing in the jig, a clip made of the same contour is placed above the work. This has to be very carefully adjusted in the first instance, but when once properly made to coincide no possible movement can be given to the work during tooling operations. Tools carried in a turret may each take their respective turn, and thus reduce the time, the skill, and the cost to a minimum, points of growing importance in work of a repetitionary character.—*The Model Engineer and Electrician.*

PROF. FESSENDEN ADDRESSES THE NEW ENGLAND WIRELESS SOCIETY

One of the most interesting talks of the series being given under the direction of the New England Wireless Society, was given Saturday evening, February 1, at Boston, Mass., by Prof. Fessenden. The speaker did not confine himself to any one particular subject, but pleased the audience by exhibiting with the aid of a stereopticon, a large number of photographs of actual apparatus that he had designed. Each photograph was accompanied with a detailed explanation. These explanations contained so much valuable information that it is worth while to enumerate some of them here.

The first series of photographs were of gaps used for the production of high-frequency alternations. Various types of gaps from the earliest experimental forms to the one now being used at the 100 k.w. Arlington station were shown and explained. In this series were the gaps used for radio-telephony. The conclusion arrived at by Prof. Fessenden is that for radio-telephony the most satisfactory gap now employed is the water-cooled arc, and one which does not use hydrogen. The hydrogen appears to have a too high resistance to be of good service in such arcs. In connection with the arcs, several other photographs pertaining to radio-telephony were exhibited. Among these was the loud-speaking transmitter. Experiments have shown that not a group of transmitters, but one effectively cooled transmitter is best for such work. In connection with this point a discussion arose as to the limitations of such a transmitter, and the final decision appeared to be that since a properly designed transmitter should absorb energy equal to that radiated by the antenna, the limitation comes at about ½ k.w. of radiated energy. Just how far this consumption of energy can be increased the speaker did not commit himself, but he did favor his listeners by giving and explaining diagrams whereby it is possible to overcome many of the difficulties of radio-telephony. This part of the talk was concluded by showing several photographs of the gap now employed at the new government station at Arlington, Va. This gap is very efficient and the photographs of the gap in operation with the casing removed showed how effectively the spark was kept at the electrodes instead of arcing before and after the proper time of discharge. The brilliant effects produced by this spark on discharge resemble those produced by a brilliant arc lamp.

The next part of the talk concerned

high-frequency alternators. The discussion of this subject was particularly interesting. The various types, from some of the early ones having 10 in. rotors to the later ones with 30 in. rotors, were shown. The great difficulty with these machines is that owing to the fact that since they run with a peripheral speed of as high as 12½ miles per minute, they must have a very rigid mechanical construction, and they must be kept very carefully oiled. These alternators have been constructed with a frequency as high as 50,000 cycles when run at 35 k.w. by a De Laval turbine The highest frequencies that have been very successfully obtained for work of this sort is 200,000 cycles per second. The efficiency of these alternators has repeatedly shown itself to be higher than the commercial 60-cycle alternators. In connection with these alternators the non-tuned system of radio-telegraphy, in which the hetradyne receivers are used, was explained. Prof. Fessenden called attention to the fact that this system has an efficiency of about one hundred times that of the crystal rectifiers.

The last series of photographs were of the old Brant Rock, Mass., the Scotland, and the new Arlington, Va., stations. These were especially interesting because of the trials now being conducted by the government on the latter station. The type of poles used at the Brant Rock and at the Scotland stations caused considerable comment. These poles are 425 ft. high and are constructed of hollow steel tubes varying from 3/16 to 5/16 in. in thickness. It was necessary to design these poles for wind pressures of 125 miles per hour and to withstand 500,000 volts without leaking. In order to keep the pole from bending under the high wind stresses, it is pivoted at the bottom so that it will bend as a unit, and in that way will not develop any undue fiber stresses. Glazed porcelain insulators are used. Special features are employed to overcome any unequal electrical stresses, thus protecting the insulators from being chipped by spark discharges. After explaining the pole construction, photographs of the apparatus then at Brant Rock, but now at the Arlington station, were shown. At the Arlington station three towers, the tallest of which is 600 ft., take the place of the single pole. The special features, such as the air condensers with plates but ⅛ in. apart, and the automatic break for the 100 k.w., were also described. This station is able to work with an efficiency of as high as 80 per cent.

After the formal talk by Prof. Fessenden, an informal discussion took place. Many new points in radio-telegraphy are brought out in these discussions, for the most prominent men interested in wireless in New England take part in them. At this meeting Mr. G. W. Pickard, the radio-inspector for New England, government officers from the Charlestown Navy Yard, and many others including representatives of the Marconi and other commercial companies presented very interesting points. In conclusion Prof. Fessenden commented of the very large audience present, and he suggested that the science of radio-telegraphy must be making very rapid strides in order to stir up so much enthusiasm. The society is composed of members from the various colleges and scientific institutions of New England, and of commercial and experimental men at large. Any information regarding the society may be had by addressing the Secretary, Mr. E. W. Chapen, 43 Thayer Hall, Cambridge, Mass. The meetings are held in or near Boston, Mass., the first Saturday of each month. Any person not a member of the society may attend these meetings on the invitation of a member or by addressing the Secretary. All persons interested in wireless are cordially welcome.

Union Pacific Wireless Line.

RAILWAY APPLIES FOR FEDERAL LICENSE FOR CONSTRUCTION OF EXPERIMENT STATION

OMAHA, NEB., December 24.—The Union Pacific Railway has made application to the Department of Commerce and Labor at Washington for a license to operate and maintain a wireless telegraph system along its lines. The company wishes to install a technical experiment station and the Government is requested to give permission for such a station, which, it is stated, will be the second of the kind in the country. Several wireless stations, it is announced, will be constructed when the license is issued.

A HIGH VOLTAGE INSULATION TESTING OUTFIT

CHAS. F. FRAASA, JR.

Insulation tests are very common in every electrical shop, yet very few are prepared with suitable apparatus to make the most satisfactory test. For most ground tests, a voltage of from 500 to 1,500 volts will be satisfactory. The highest pressure usually obtainable is about 110 volts alternating. Some means of raising the voltage to the desired pressure should be employed. This is accomplished by means of the step-up transformer, taking 60-cycle alternating current at 110 volts, and transforming it to from 500 to 1,500 volts. The design given in this article is used by a large electrical manufacturing company for testing for grounds or leaks in armatures, field magnets, controllers, etc., several being provided in its different departments.

The complete outfit consists of a step-up transformer, providing the high voltage, a switchboard, and two test leads. The switchboard, Figs. 1 and 2, provides the necessary connections or the apparatus, and a mounting for the transformer and switches. The fuse *A* is in the primary circuit of the transformer. The pilot lamp *B* is used to show when there

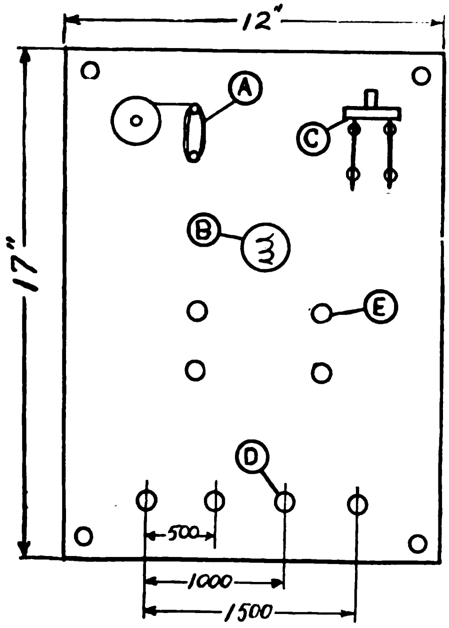


Fig. 1—Switchboard

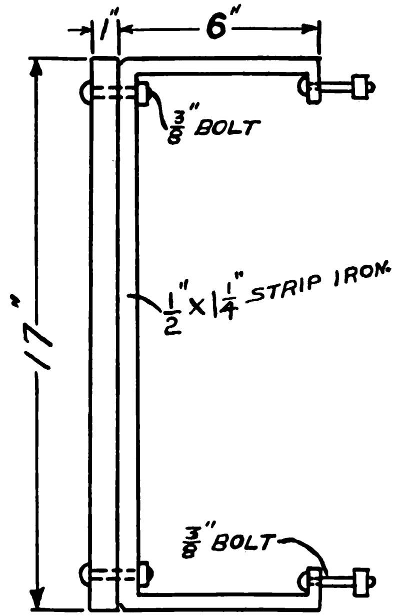


Fig. 2—Switchboard

is current in the primary. The switch *C* is in the primary circuit, and the plug holes *D*, which provide taps of 500, 1,000 and 1,500 volts, are in the secondary circuit. The transformer, illustrated in Fig. 3, is mounted on the back of the switchboard by means of the bolts *E*, Fig. 1, connections being made by wiring on the back of the board.

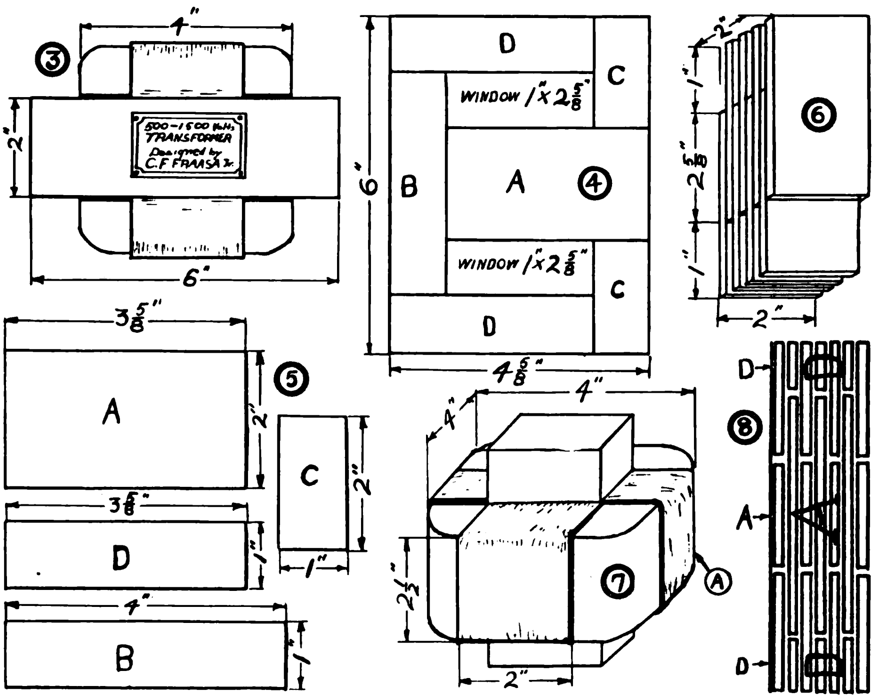
The transformer is of the step-up, shell type, and steps up 110 volts alternating current of 60 cycles to a pressure of 1,500 volts. Taps are provided to obtain 500, 1,000 and 1,500 volts for testing. The general appearance of the finished transformer is shown in Fig. 3. For convenience in assembling the core around the coils, it was designed to be made in plain, straight strips. This also has the advantage of requiring no special punchings, since the plain strips can readily be cut up on an ordinary tinner's squaring shears. The various parts, of which there are four sizes, are lettered *A*, *B*, *C* and *D*, Fig. 4, which shows the core construction. Alternate layers are laid in this way. Those coming between are just the reverse. These parts are dimensioned in Fig. 5, the letters on the different strips referring to Fig. 4.

The transformer core is cut from some No. 27 gauge sheet iron. Enough of the *A* and *B* strips should be cut to make a stack of each 2 in. thick, and of the *C* and *D* strips to make a stack of each 4 in. thick. To cut down the heating due to eddy currents in the core, the core sheets should be insulated from one another. This may be done by shellacking one side of each strip or by dipping alternate strips in shellac. Assemble the *A* pieces as in Fig. 6, laying the strips so that they alternately lap first on one end and then on the other, for a distance of 1 in.

1/32 in. thick, and bend the ends back over the blocks. The core is then ready to receive the windings.

The customary practice is to wind the secondary coil directly over the core, and under the primary, to obtain good regulation. In this transformer the secondary will be wound outside the primary for convenience in making the taps, and to prevent undue currents when the secondary is short circuited through a ground.

The primary winding, consisting of 345 turns of No. 21 d.c.c. magnet wire, should then be wound on evenly and in layers between the end blocks. As the the winding proceeds, interpose layers of



When the *A* strips have been assembled, wrap a layer or two of friction tape around the solid center portion, to bind the strips together. To insulate the core from the primary, wind on two layers of manila paper and one of twine, and apply a liberal coat of shellac.

Get two pieces of 7/8 in. wood, and cut a

paper, and when completed, wind on one or two layers of duck, and over this a layer of twine, then shellac the whole, using at least two coats. Then wind on the secondary of 5,175 turns of No. 34 enameled wire. Be careful to wind this on evenly, and in layers. This secondary winding should be most carefully handled

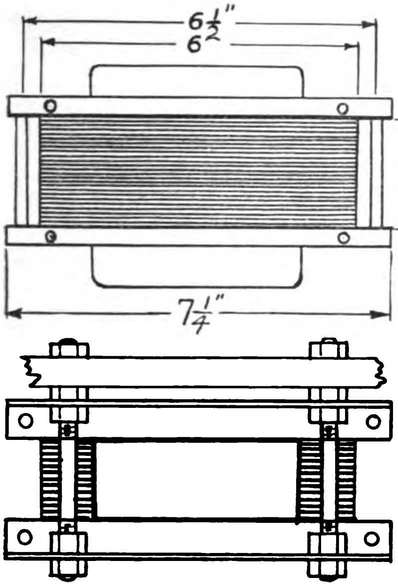


Fig. 9—Transformer Detail

coil. Over the whole coil, and the fiber strips, wind a protecting layer or two of heavy duck, filling each layer heavily with shellac.

On the 1,725 turn, bring out the first tap for 500 volts; on the 3,450 turn, the second tap for 1,000 volts. These taps should have a short piece of lamp cord soldered to them for the connections to the plugs on the switchboard.

The *D* pieces should then be assembled as were the *A* pieces, and the loose sheets bound together with tape. Set the *A* core up on end, and insert the *B* pieces in the open spaces in the end of the core, letting the ends of the strips project 1 in. on each side of the core. Then set one *D* core on each side of the *A* core, touching the *B* strips. Fill in the spaces in the *D* cores and in between the *B* strips with the *C* strips. Fig. 8 shows a top view of the assembled core, and shows how the various pieces are placed.

The core is clamped together by the angle irons shown in Fig. 9. The 5/16 in. bolts which hold the angle irons together are long enough to extend through the mounting board, providing a means of mounting the transformer. The illustration shows clearly how the transformer is mounted, and dimensions the angle irons.

The switchboard, Figs. 1 and 2, may be made of slate, marble, or any insulating substance that may be available. It should be about 1 in. thick. At the top of the board, provide three brass rods to hold the fuse spool and the fuse. The two rods holding the fuse are 1½ in. apart. Provide a lamp socket at *B* for an 8 c.p. incandescent lamp, which is wired in parallel with the transformer primary. This is used to indicate a current in the primary. The switch *C* is an ordinary double-pole single-throw knife switch, having the upper clips connected to the 110-volt line; and the pilot lamp and the transformer connected in parallel to the lower clips. The four holes *D* are provided for the secondary plug switch.

The construction of the plug switch is illustrated in Fig. 10. The plug *A* consists of a hard wooden handle *D* turned to the shape shown, and a brass

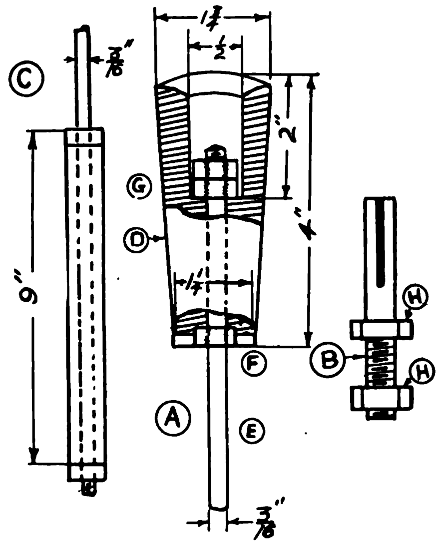


Fig. 10

rod *E* fastened into the handle by the nuts *F* and *G*. A piece of flexible cord is connected to the end of the brass rod in the handle. The switch socket construction is detailed in the same figure, at *B*. A piece of brass tube having an internal diameter slightly larger than the diameter of the brass rod in the plug has one end threaded to receive the two nuts *H* which fix it in the holes provided in the board. The other end of the tube has two slots sawed in it at right angles to one another. The four prongs of the tube are then lightly driven together with a hammer. When the plug is inserted the four parts of the tube will bind it

(*Continued on page* 159)

A RAILWAY IN THE AIR

S. A. JAMES

Grade difficulties in connection with transport are sufficiently well known to engineers to make it unnecessary to dilate on the difficulties encountered. These are enhanced when instead of the grounds being fairly level, a steep incline has to be encountered and the problem of transport either of goods or passengers up heavy inclines such as a mountain side of irregular formation are very great indeed. The simplest method is to raise the whole railway above the level of the irregularities, but this is easier said than

Fig. 1

done, and it is very largely owing to the enterprise of the firm of Messrs. Adolph Bleichert & Co., of Leipzig and London, that the modern system of transport by means of aerial cables has been developed. A very remarkable instance of this class of work is found in a railway which has illustration of this railway which incidentally gives some idea of the tremendous grades which are encountered. The cars, which are suspended from steel cables, are as comfortable as a modern tramcar of small size, and travel in a smooth and easy manner along steel suspension cables, the total length of which is 1,650 meters, and which are carried by twelve structural steel supports of the form shown in the figure. Each car is capable of holding fifteen passengers and the driver, and two cars travel simultaneously each way at one time. The speed is such that in thirteen minutes a difference of level of 840 meters is secured, each car being pulled by two traction cables which receive their motion from a power station placed close to the line. The object of duplicating the cables is to secure safety in case of the breakdown of one of the cables, and the same means is adopted in connection with the suspension cables. Each car is supported from a traveling mechanism carried by eight pulleys; each of the steel cables on which these pulleys rest being 44 millimetres in diameter. The car can swing like a pendulum, a brake retarding any undue oscillation; while any fear of derailment due to oscillation sideways is avoided by the fact that the carrying cables themselves swing with the car. The drive is electrical, and in order to secure immunity from breakdown of the transmission system even if the power plant fails to operate, a buffer battery is installed which operates in parallel with the dynamos. In order to effect communication, a system of telephones and electric signals is installed throughout the track, and the driver from any part of the line can communicate with either the upper or lower terminal station. The cars cannot be started before the necessary signals have been given between the two stations and confirmed so that there is no danger of mistake. In addition to this, safety is most efficiently studied in connection with every detail of the equipment. The traveling mechanism of the car contains cable breaks or if a fracture occurs on either one or both of the hauling cables. Moreover, the driver can put his brakes into action by hand, the operation being simple and quick. When this catching device is put into action steel jaws grip the carrying cables at eight different places, the friction being sufficient to hold the car firmly in position even on an incline. Simultaneously, by the movement of the same mechanism, the supply of electricity to the driving motor is stopped and the brake is instantly applied.

In order further to secure the safety of the passengers in the event of a breakdown, a spare car is kept at each station in readiness to go to the point where the ordinary car is left suspended and transfer the passengers and bring them back to the nearest available station, while the ordinary car is also fitted with a special device in the floor by means of which it is possible to lower the passengers to the ground from the car direct, this hoist being fitted with a brake to prevent undue speed of descent. Should the driving gear of the whole line break down, thus stranding the cars in the middle of their route, an auxiliary winder is available for bringing the cars back to their terminal position. It will, therefore, be seen that this novel and interesting application of electric traction has been carefully thought out and designed in all its details in order to secure safety and reliability of service, and it is apparent that in this aerial system of transmission a great number of difficulties have been avoided which would otherwise have been encountered in proceeding over such a rough and mountainous section of route.

SMALL CASE-HARDENING FURNACE

OWEN LINLEY

The following is a makeshift furnace that I used some years ago in the early days of motor-cars for hardening gears, etc., and it gave good results, and wanted but little attention. Lay a circle of bricks on the floor, if it is of earth or brick. The bricks should be laid on their flats, with a space of 3 in. between the ends, and on this circle lay another one just similar, the bricks of which go over the openings of the first, and continue this until the required height is obtained. Do not build the furnace on a grating, with the idea of getting a draught, as this is inclined to make the bottom of the pot hotter than the rest, which is bad for the work. The best way to light a fire in the bottom of the furnace is to make some coal or coke hot in a forge, if one is at hand, and put it in the bottom of the fireplace, and it will start other fuel that is put on it. Between the openings of the bricks put some irons to support the pot, and this should be three bricks from the ground. Fill the furnace up with coke until the pot is covered, and let the fire burn. No artificial draught is wanted, and this is the advantage of this arrangement, as it is thus almost impossible to overheat the pot, and if the fireplace than the other, it is easily damped on the side required by closing the gaps between the ends of the bricks with earth or ashes. It wants hardly any attention otherwise. We used to let the pots get just fairly red-hot, and keep them so for from four to six hours, and mostly put a test-piece in, which we hardened and broke, so as to show the depth of the skin.

A High Voltage Insulation Testing Outfit

(*Concluded from page* 157)

tightly and make contact. The taps from the transformer are connected to the brass tube and soldered between the two nuts. The test leads are dimensioned in Fig. 10, *C*. They consist of two long fiber tubes through which run a 3/16 in. brass or copper rod. The fiber tube is kept in place by means of a nut at each end of the rod. These leads are connected and soldered to the ends of the flexible conductor running from the plugs *A*.

The plugs are inserted in the sockets giving the proper testing voltage, and the switch *C*, Fig. 1, is thrown up. The lamp will then light up, indicating a current in the primary circuit. The fuse *A* should be 1 ampere fuse, and several

FIRST TALK OVER THE TELEPHONE

It seems almost incredible that ten days should elapse between the first conversation ever carried on by word of mouth over a wire and the announcement of it in the newspapers of the day. *New England Telephone Topics* says that, however, was the fact away back in October, 1876, when Professor Bell used the telegraph line owned by the Walworth Manufacturing Company, extending from their office in Kilby St., Boston, to their factory in Cambridgeport, a distance of about two miles, for the first telephonic conversation in history.

The night before this successful experiment took place Professor Bell asked the night watchman of the Walworth Building whether he could use that telegraph wire. The watchman told Professor Bell that he would inquire of the head of the firm and let the professor know the next morning whether the privilege would be granted. Professor Bell called at the office and was given permission, the group surrounding him jeering at his "play toy," and wondering what crazy notions he had in his head.

One of the officers of the Walworth Company recently told the writer that Mr. Bell had a considerable bill with the Walworth Manufacturing Company in 1876, and that he several times offered to pay the bill in telephone stock. On the morning when Professor Bell received permission to use the telegraph wire he again offered enough stock at twenty-five cents per share to pay the bill, but the offer was scorned.

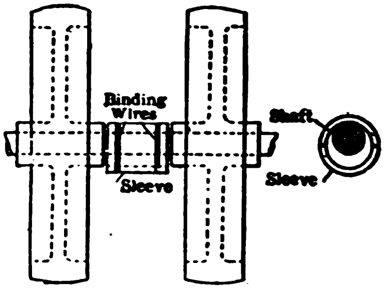
The experiment took place on the evening of October 9, 1876, between Professor Bell and Thomas A. Watson, the latter being located at the Cambridge end of the wire. Each at his respective post took notes of what was said and heard, and a comparison of the two records is most interesting as showing the accuracy of what was then called the "electrical transmission" of their conversation.

This experiment proved so successful. Professor Bell was told that his stock was going up too fast and the offer was not accepted.

On Thursday morning, October 19, the Boston *Daily Advertiser* printed an account of the experiment. The article was headed: "Telephony—Audible Speech Conveyed Two Miles by Telegraph. Professor A. Graham Bell's Discovery. Successful and Interesting Experiment. A Record of the Conversation Carried on Between Boston and Cambridgeport." The article states that the "company's battery consisting of nine Daniel's cells was removed from the circuit and another of ten carbon elements substituted. Articulate conversation then took place through the wire. The sounds, at first faint and indistinct, became suddenly quite loud and intelligent."

To Save Belt Wear

A writer to the *American Machinist* gives the following hint for avoiding the undesirability of an idle belt hanging loose on a revolving shaft. Take two



wood bushings a little larger than the shaft, and bind them on with soft wire at the place where the belt will rest when idle. The sketch herewith shows the device.

She Meant Well

He—"The last time I played football

MAKING BRASS BEARINGS

"SREGOR"

The accompanying sketches show methods of machining accurately the common form of engine and general machine bearings. Most readers who have attempted to make this plain bearing on accurate lines, and to produce same quickly, no doubt have realized the difficulty of ensuring the joint face's being exactly in the center of the two halves of the brass, the necessity of this accuracy depending upon the general design of the machine or parts

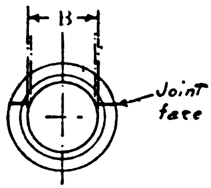


Fig. 1

into which the bearing fits. But, theoretically speaking, the joint face should be at the center of the two halves, from the fact that when one half is less than the other (as shown in Fig. 1, exaggerated) it cannot receive the journal *B* it is intended for; but a reasonable amount of difference is not very noticeable, as the bearing is usually scraped away each side of the joint face to provide a clearance

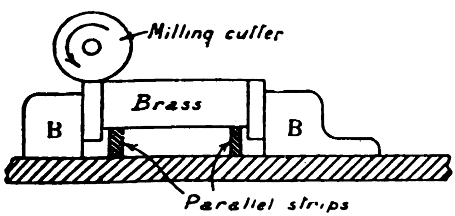


Fig. 2

for oil. But to ensure accuracy, say to two or three thousandths of an inch, special provision must be provided. The first thing to determine is the amount of metal there is to remove from the casting

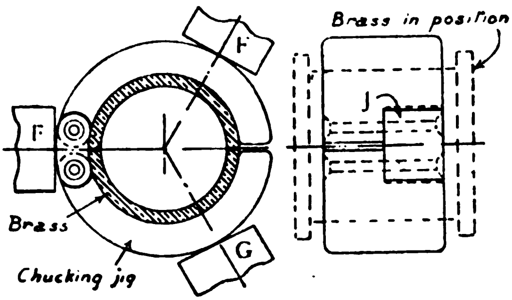
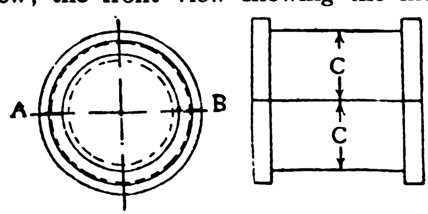
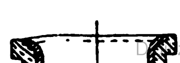


Fig. 3—Front and Side Elevation

ter is once set, any number of castings can be milled to the same size (allowing, of course, when necessary to grind cutter). Having milled the joint faces, they are ready for the first operation on the lathe. A very suitable method of chucking these is to provide a split ring hinged at one side (as shown in Fig. 3). The more common practice is to hold the one flange in the chuck and fix a cramp on the other; but owing to the small amount of grip available on the narrow flange and the distance the opposite end projects from chuck, it is impracticable to take a heavy cut. The split ring overcomes these difficulties; the brass being firmly gripped in the center and the diameter of ring securely held in a three-jaw self-centering chuck, with one side of the ring pressed against the chuck jaws, which should ensure the joint faces of the brass running true. This arrangement is shown in Fig. 3, a front and side view; the front view showing the most





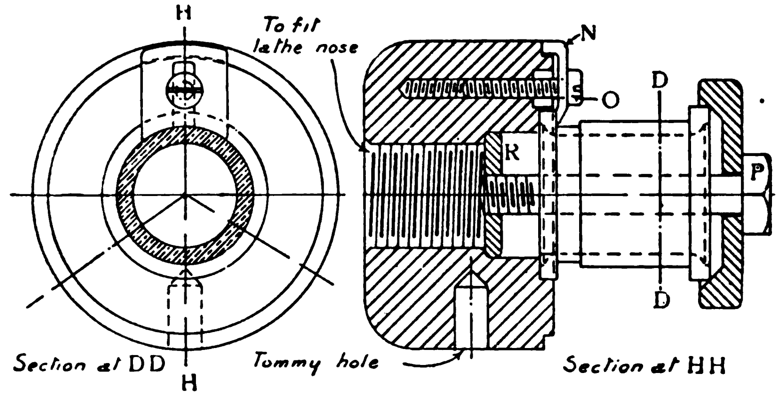


Fig. 6

suitable position for the chuck ring to be held in the jaws to equalize the pressure from same. The idea of the chuck ring's being hinged is to keep the two halves together, being thus much more convenient to handle, as shown. The ring is split through the center and a portion of one side is shaped away to receive the hinge block *J*. The brass can now be bored and one side of the flange faced and a radius formed, if the design of brass is as shown in Fig. 4; also the diameter of the flange must be turned to finished size which completes the first lathe operation.

The chuck jaws should now be eased back and the ring and brass reversed in the jaws, taking care that the brasses do not move when changing the position, and again pressing the back of chuck ring hard against lathe chuck jaws to ensure running true. The other flange, face, and diameter can now be turned, and the radius formed, if necessary. The last operation is accomplished by fixing the brasses on the mandrel (as shown in Fig. 5), which consists of the center-piece *BB*, which is turned to clear the bore slightly. The two flanges serve to hold the two halves of brass true and tight together under the pressure of the nut *C*, when the center part of brass can be readily turned to size with the mandrel between the centers in the usual way. The angle part of the flanges readily center the brasses by locating on the edges of the already turned flanges. The adjustable loose sleeve *D* should be a nice sliding fit on the mandrel, and designed with a long bearing, as shown, to eliminate any possibility of the face of flange tipping out of the true position.

Another method, and one which is more applicable to the ordinary capstan, and dispenses with the necessity of the lathe centers, is that shown in Fig. 6, which illustrates a plain cast-iron casting of suitable size, and bored and screwed to fit the capstan nose, after which it is recessed as shown, to receive the turned flange of the brass after the first operation, Fig. 7. The diameter is also reduced to a distance (as shown in Fig. 6), to receive the holding-down clip *N*; these clips are slotted with an open end, so that they can readily be slipped on and off the set pins *O*. The three holes are drilled and tapped equidistant around the face for the clips; the outer end of these holes are recessed to receive the pin heads, so that they may be readily screwed in out of the way for the next operation. The arrangement, as shown, can be used for facing the one end flange and turning

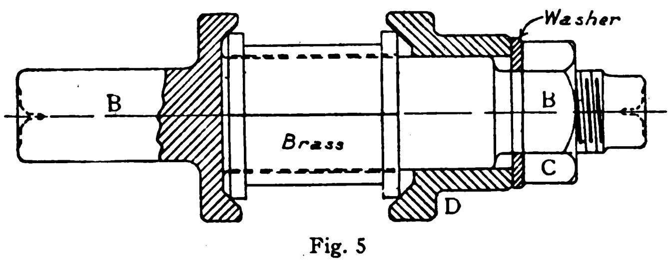


Fig. 5

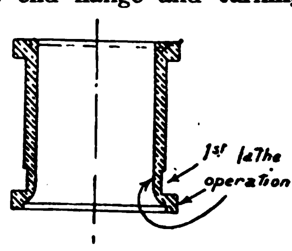
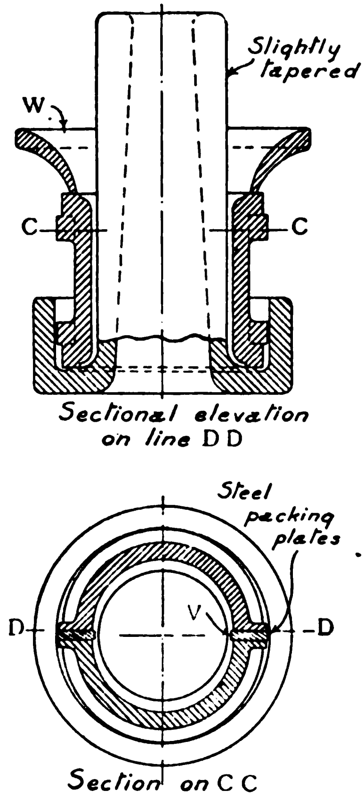


Fig. 7

diameter of same, and forming the radius as the second operation on the brass, as shown in Fig. 6. The clips serve to hold the two halves of brass in position in the recess during the operation of turning the opposite end flange, after which the end plate, which is similar to that shown on the mandrel, Fig. 5, is held against the flange with the bolt *D*, which screws into the piece *R*, which must be secured in position. The plate or clip *N* can now be released and the pins *O* screwed into the casting out of the way and the center part finished and turned, which completes the brass.

The three views shown in Fig. 4 are the outline of the finished brass. The sectional plan shows a liner of white metal in the bore. I shall show farther on a suitable design for a mold for running the metal into position on the brass, and method of machining same to ensure even thickness of metal, etc.

The following description is intended to illustrate method of producing bearings, either if used as a plain brass or white metal surface, and to be on absolute interchangeable accuracy. Of course what is inferred by accuracy in the case of this article is meant that whichever method is used will guarantee the ordinary degree of accuracy, that is, so that the bore shall be a true, round, and parallel hole, and the outer diameters shall be concentric with same; and whether the joint face is exactly central and parallel with bore does not make any material difference as regards the function of the bearing. But in the event of attempting to produce each half of the bearing exactly the same, and to guarantee interchangeability, the joint face obviously must be exactly central to the two pieces. Most up-to-date engine manufacturers will attempt to obtain this accuracy, and it is the object of this article to illustrate how the writer has obtained the desired end. It will be observed, from the illustrations previously shown, that the method there described provides for ordinary accuracy combined with cheap production. The points of difference between that method and the one described in the following lines are: The fact that the castings of the brasses are provided with special locating pieces, as shown in Fig. 8. It will be observed that the width of these pieces is greater



JIG FOR WHITE METALLING BEARIN--

Fig. 9

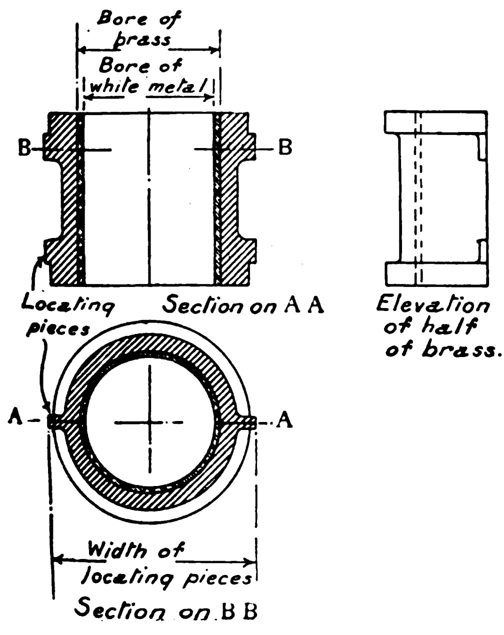


Fig. 8

than the diameter of the flanges of the brass. The object of this is to provide a definite interchangeable width, to locate and fit the jig into which it fits for the turning operations. The second point of difference is the design of the jig for boring and turning. As shown in illustration, Fig. 10, this consists of the angle plates *L*, which locate on the plug *M*, which, of course, is turned to size in position, to guarantee running true. While mentioning this plug, I would suggest that this should be made a definite decimal standard size, say 1 in., to fit a standard 1-in. reamered hole, from the fact that, knowing the exact size, it will be useful for gauging purposes for other operations, not particularly applicable in this article. Continuing the parts ter. It will be observed that only the one-half brass has the locating piece cast on.

The operations on the brasses are as follows, and a difference of processes between this and that described previously is: The brasses are made and used as a brass bearing in the previous pages, but in this it is the intention to show how to produce the two halves as a white metal bearing. The advantage of the latter type as a bearing is in the virtue of the white metal, an alloy which, in the writer's experience, is second to none as a high-speed bearing which can readily be renewed when worn. Again, the cost of the two classes of brass that may be used will differ considerably. A good mixture should be used in the former class, whereas a comparatively soft cheap

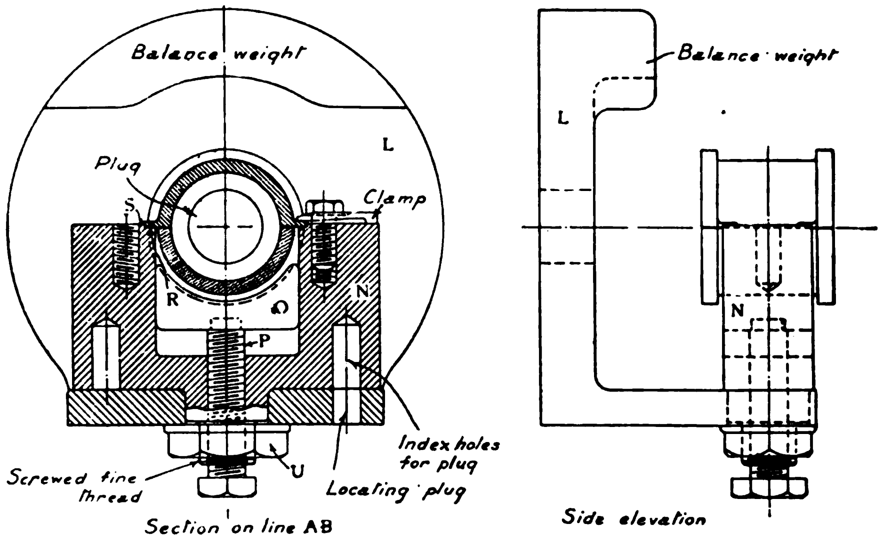


Fig. 10

of the jig, upon the angle plate is mounted the reversible block *N*, into which one half of the complete brass is located. The other half brass is held in position by the block *O* and screw *P*. The reversible block *N* is provided with a hole, which must be absolutely in alignment with center of lathe. These are used for indexing the block when reversing to operate on the opposite end of the work when in position in the jig. Obviously, the two flat faces *R* must be exactly in line with the center of the lathe, otherwise the bore of the two brasses will not be equal depth from the joint face. Also the two side locating faces *S* must be equal distances from lathe cen-

material can be used in the latter, ensuring cheapness and rapid manufacture. The machining operation on the white metal bearing in the first cost will be more than the plain brass bearing, but this is well counterbalanced by the advantage of being able to renew the metal in the old bearing when repairing. I shall show an addition to the jig, shown in Fig. 10, to deal effectively with the remetalling and boring of the repair bearings to ensure accuracy later in the article.

The operations for the white metal bearing here described are: Facing the joint faces with the milling cutters, as described previously for the plain brass, with the addition of two side-facing cutters to clean up the sides of the locating pieces, which ensures all brasses will be exactly same width, and snugly fit the jigs. This is accomplished at one cut. The other half of the brass receives a cut over the joint face. The pair of brasses are now located in the turning and boring jig as shown in Fig. 10, the locating half being secured by the two straps *T*, while the other half is held tight against the other by the saddle piece *O*, and the fine threaded screw *P*. Referring to the plan view, Fig. 11, it will be seen that the two flanges of bearing overlap the jig, which provides for these being turned at the same setting as for boring. Having secured the brasses in position, the bore can be machined, and when used for white metal it should be a coarse traverse and a rough finish; also the outer flange can be turned to size and the end faced, after which the nut *U* is slackened slightly, and the locating plug removed, when the reversible block can be turned round until the other hole comes in line with the locating plug holes, which give the correct position. This brings the other flange to the front, and this can now be turned to size, and the end of bore radiused, as shown in Fig. 9, if necessary. In the event of the ends of brass being radiused, it is advisable to recess the ends, as shown in Fig. 9, which provides for an even amount of metal at the radiused part, as along the bore. This completes the boring operation. The two halves can be removed from jig, and secured on the special mandrel, as shown previously, and the center part of the bearing finished, which completes the bearing in the event of its being used as a plain brass bearing. But as a white metal surface the bore must be tinned and lined with this metal. A jig is shown in Fig. 9 for this purpose. When a quantity is required to be metalled, a jig, such as shown, will be a great advantage, as it provides for a minimum amount of metal's being used, and ensures a clean job, and protects the joint faces from getting covered with it. The process is to place the bearing in the jig after the rough boring operation. It will be observed that pieces of steel packing are placed between the joint face of the two brasses; this is to provide a space, and the small amount of metal, as shown at *V*, can be readily cut through with a saw. Also the thickness of these two packing

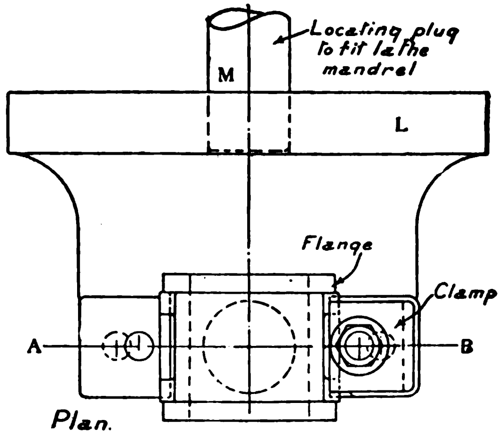


Fig. 11

pieces must be such as to provide that the diameter of the brasses at right angles to the packing will be about equal to the diameter across the locating pads. This gives a definite location in the recess in the jig. The diameter of the bore of jig should be such as to allow the brass to enter easily, after which a plain cramp can be applied against sides of brasses holding the two halves and packing pieces tightly together. The bell-mouth top-piece *W* serves as a receiver for the molten metal, and guides same into the brass. The center portion of jig should be slightly smaller at the top than the bottom, so that it will more readily leave the metal when withdrawing after the brass is lined. The hole in center of jig is intended to receive the Bunsen flame of gas readily to heat the jig, this being the essential part to be hot when running the metal. As soon as the metal is set, and jig cooling down slightly, a blow on the top of jig with a wooden mallet will separate the brasses from the jig, when the two packing pieces can be removed, and the two halves separated, when they are ready to locate again in the turning jig, Fig. 10, to be bored; after which they will be finished on special mandrel same as previously described for the processes on plain bearings. The boring jig must, of course, be provided with at least two holes in back of angle plate at convenient places to bolt jig to lathe face-plate. The jig can readily be removed and accurately refixed by locating on the plug. The jig angle plate is provided with an enlargement to counterbalance the opposite side.—*The Model Engineer and Electrician.*

PERPETUAL MOTION

R. P. HOWGRAVE-GRAHAM, A.M.I.E.E.

Verbal definitions are not always wholly satisfactory, and to state them requires a certain amount of courage when that which is to be defined is in any sense controversial. To gain a clear mental picture of the position, we must stop down our mental lens and get sharp definition in its more abstract sense, even if this involves rather a long exposure.

Perhaps we may fairly start with the following definition:

A perpetual motor is one which will maintain continuous motion for an infinite time by its own perpetual conservation or intrinsic generation of energy, so long as no outside disturbing influence alters the original conditions.

Disturbing influences may reasonably include stoppage through wear of bearings or working parts and rust or general decay. Setting aside these last, it is obvious that if the machine could be isolated in space at a point infinitely far removed from all sources of energy, such as radiating suns, nebulae, or other bodies, it would continue in action for all time.

The first type of perpetual motion device which will be considered involves an attempt at the complete conservation of an initial supply of energy imparted to the mechanism once and for all. Such motion is theoretically possible, but is unattainable by reason of strict limitations of space. If we could reach a point in free and matterless space where gravitational and other forces were either non-existent or equal and opposite in all directions, all frictional or analogous effects being absent, a mass set in rotation about its center of gravity would spin forever, but would only constitute a perpetual motion machine in a very limited sense; no sort of work could be done by it without a corresponding withdrawal of its energy, together with a retardation which would eventually bring it to rest.

Similarly, if a mass were set in motion in space along a straight line, and could travel indefinitely without encountering any extraneous influence, its motion would continue for all time, though here again it could do no work.

By similar principles, orbital motion of one body about another could be maintained if all conceivable tidal, frictional, or electrical retarding action could be annulled. Attempts have been made to attain the necessary conditions by eliminating every energy-loss. A weighted spring vibrating in the highest vacuum obtainable will convert its store of energy into heat by molecular friction in the spring, and by friction with the residual gases.

Even in a perfect vacuum a rotating mass must be supported by some kind of pivot which must cause friction, or by magnetic fields, which cannot be so applied as to avoid loss by hysteresis and eddy-currents. Such devices might move for many days, but could not move perpetually. The motion only exists by virtue of energy stored in the system, or we might say that the energy only exists by virtue of the motion. This apparent contradiction merely means that the energy and motion are co-existent and inter-dependent, so that in providing any opposing force for the system to do work upon, the energy and the motion would be taken from them together, the former being transferred to some other medium or body with or without change of kind. In the case of the weighted spring the energy oscillates between static and dynamic forms.

Once and for all let it be understood that these and other apparently dogmatic statements are based on enunciations known as "laws of Nature," *which have not been found false in any known case up to the present.*

We can be certain of nothing, but knowledge supplemented by common-sense should hold us from the old beaten tracks of fallacious thought, argument and experiment. We must also be guarded in speaking of "all time" and "infinity"—terms involving conceptions which our finite minds can only dimly apprehend.

The second type of machine involves the supposed intrinsic generation of energy by the system itself, usually in sufficient quantity to do useful work in addition to that which is required for the mere maintenance of motion.

Endless are the drawings, patent specifications, articles, and mental activities which have been and are still wasted in this direction. Among these are arrangements of radial rods hinged in one direction to give greater leverage on one side of the axis of rotation; devices with tubes containing rolling balls, or moving masses of mercury; machines for utilizing the surface tension of liquids; dynamos and motors coupled electrically and mechanically, and countless other inventions. When tried all are soon abandoned, for in all the algebraic sum of the work done by the various portions is zero. In fact, energy cannot be manufactured; it can only be transferred and transmuted, and as in the technical sense energy is the power to do work, it follows that all such machines must be inoperative.

There still remains the third class of machines, in which the energy is drawn from some natural available source, and here one of the correspondents of this paper naively thinks it quite possible that the rising and falling of the barometer (meaning the mercury) could be converted into continuous motion. How modest! Where is the difficulty? When once one admits the idea of tapping Nature's numberless sources of energy, possibilities crowd on one so fast that one scarcely knows where to turn.

But would baro-motors and their like be perpetual motors? In a limited practical sense, yes! In the scientific and real sense, no! The available sources of energy on the earth are none of them permanent, and the terms of their activities are all relative and only differ in degree. A rotting hay-rick might keep some form of heat-engine or thermopile and motor active for months, but it would eventually rot away. Yet to an intelligent colony of microbes in which ripe wisdom gave place to senility and death at the age of two seconds, these motors would seem perpetual.

Niagara Falls, which can supply power continuously to turbines, will exist for thousands of years longer than the rotting hay-rick if no violent geological or celestial disturbances intervene, but they must eventually cease to exist; their energy is part of the accumulated energy which the sun distributes over the surface of the earth, for they are supplied by rainfall resulting from evaporation, which can only take place by absorption of heat energy.

The local variation of the sun's radiant heat could be made to produce sufficient alternate expansion and contraction to keep mechanisms in continuous motion, but the sun will almost certainly grow cold eventually. Tides, again, afford energy which can be stored and used continuously and usefully. Now if we were to take the rick-engine, the turbine, the solar motor, and the tidal machine, to the isolated and uninfluenced spot in space, they would not work, and therefore they would not meet the requirements of our definition.

With regard to radium, the wonderful and epoch-making discoveries in connection with it and kindred substances led to very wild and unfounded statements from the very beginning. Radium has upset no known law, and has not solved the problem of perpetual motion, neither is its energy inexhaustible. At most it has changed our conceptions of what we mean by a chemical element, but here the interference is with a *definition* and not with a *law*. Moreover, the more thoughtful among scientists have usually made verbal and mental reservations in defining an element, thus leaving room for any growth of knowledge or change of conception.

Possibly there are cases in which the motion of electrons in atoms of matter is perpetual within the limitations which are satisfied by the rotating mass isolated in space, but no continuous emission of radiant or other energy would permit perpetuity of action.

The enormous energy stored in a mass of radium is continuously expended in the production of heat, light and ether pulses of the X-ray type; also streams of ionized particles are projected with great violence. These in themselves are further degraded, forming successive emanations of increasingly inert material, each change being accompanied by *loss* of energy. Thus the energetic radium actually changes into inactive matter and *loses weight* in the process.

In some far away period of geological history a certain quantity of matter became possessed of a great and highly concentrated store of energy by virtue of its existence as the highly active and unstable element radium. The ultimate transference of all this energy is as much a matter of time as the stoppage of a

"PERPETUAL MOTION" MACHINES

Inoperative Machines		Operative Machines, but the Motion not Perpetual in the true Sense.
Principle.—Conservation of Energy.	Principle.—Production of Energy.	Principle.—Utilization of Natural Energy.
Initial Supply of Energy to a System Freed from all Retarding Actions (Retarding Actions cannot be eliminated).	*All fallacious.*	
Example: Pendulum swinging in a vacuum.	*Examples:* Dynamo and motor coupled mechanically and electrically; arrangements of hinged levers, large cisterns forcing water to a higher level through small pipes, etc.	*Examples:* Tidal, radium and solar motors.

steam engine when all the coal has been consumed.

If an ounce of radium could be made to deliver its 30 h.p. for 2,000 years, it would by that time be correspondingly lighter, and eventually the last trace of it would vanish coincidently with the performance of the last scrap of work done by it.

If we alter our definition to cover machines *which work perpetually so far as man's experience is likely to go*, we include this last class of machines, but where shall the limit be fixed, and is such an expanded definition admissible when man's range of earthly experience in the universe is by comparison less than the beat of a fly's wing in ten thousand years? The comparison is truly inconceivable, yet less unthinkable than the infinite reality.

The three classes of perpetual motion machine may be tabulated as below, and those who are still unconvinced may try to discover a fourth class or to vitiate the arguments used to support either of the three which are given. In any case they are advised to try to fit their pet devices into one or other of the columns. If they *must* demonstrate the wonderful possibilities of mental inertia and perpetual motion along one line of thought leading to infinite and unproductive voids, let them at least attempt to think clearly and scientifically before giving final direction to the energy-impulses of their brains.

How to Make Wood Fire- and Acid-Proof

While the title is something of an exaggeration—for wood cannot wholly be so protected—a treatment that is highly beneficial, especially for table tops in chemical laboratories, is as follows: Prepare a solution by dissolving aniline hydroxide—commonly known as aniline "salts"—in water, to about the appearance of thoroughly black writing ink, also a saturated solution of sulphate of copper (blue vitriol), by dissolving as much of the chemical as possible in water. Give the table top several alternate washings with the two solutions, the aniline first, waiting for each to dry in. It is surprising to what extent the wood will then be immune from action of burning matches, filter paper, heat from gas burners, etc., while liquids can be washed as from tile or marble.

GEAR WHEELS AND GEARING SIMPLY EXPLAINED

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

One of the common methods of transmitting motion is by means of wheels which make contact, or gear, as it is called, with one another. Movement being given to the first wheel, it is communicated by it to the second wheel. Any number of such wheels can be geared together—the movement of the first wheel can be communicated to the second wheel, and by the second to the third, and so on. Two such wheels are called a pair; if there are more than two, the arrangement is called a train of wheels. If the edges or surfaces by which contact is made between one wheel and another are smooth, the power is transmitted by means of the friction existing between the surfaces. The wheel which is transmitting the power is called the driving wheel, and the

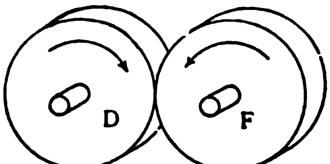


Fig. 1.

one receiving it is called the driven or following wheel. The wheels may be of equal size, or one may be larger than the other. In this latter instance the smaller wheel is called a pinion. Fig. 1 shows a diagram of a pair of wheels in gear. If *D* is the driver, *F* is the driven wheel or follower. Fig. 2 shows a diagram of a train of wheels; if *A* is the driver, its motion will be transmitted by *B* and *C* in turn to *D*. Any one of the wheels can be made the driver; for example, *B*, which will then communicate its movement to *A* and to *D* through *C*. Fig. 3 shows a wheel *W* and pinion *P*. The driven wheel will resist the action of the driving wheel. It will do this because some friction must exist at its bearings even if no other load is placed upon it. The amount of power transmitted by the driver will vary according to the resistance to motion offered by the driven wheel. If this resistance is too great to be overcome by the frictional grip existing between the contact surfaces of the wheels, the driven wheel will lose movement, and there will be slip between

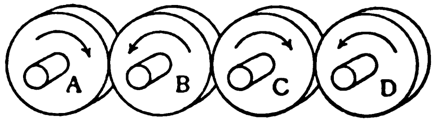


Fig 2

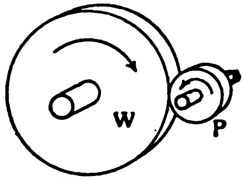


Fig. 3

the contact surfaces. To prevent it the surfaces are cogged or cut into teeth and made to engage positively with each other so that there can be no slip. By this means an accurate transmission of the motion is ensured. Such wheels are called spur or cog wheels.

Imagine a pair of gear wheels, *AB*, Fig. 4; *B* is the driver giving motion to *A*. If we fix a tooth *T* upon *B* to prevent slip, we must cut a groove *G* in *A* for it to engage with or the wheels cannot continue to rotate. A series of such teeth spaced at equal distances may be fixed upon the circumference of *B*, and a series of grooves to receive them cut in the circumference of *A*. Slip cannot then take place. *B* is geared into *A* and drives that wheel positively, or *A* may be the driver and give motion to *B*. This positive engagement between the two wheels is entirely due to the teeth *T* projecting beyond the circumferential surface of *B*. Matters will be equalized, and the time during which any particular tooth of one wheel is engaged with the other wheel will be prolonged, if teeth are placed upon the circumferences of both wheels. In this instance we should place

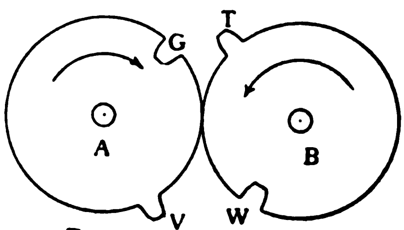


Fig. 4.

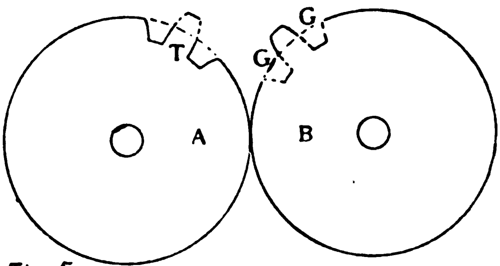


Fig 5.

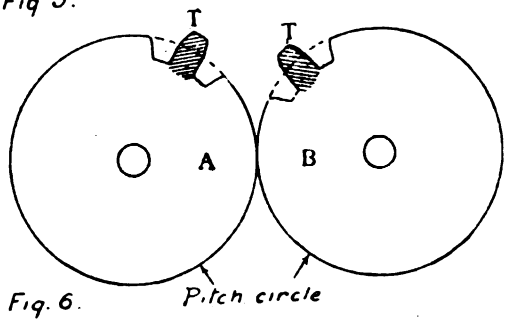
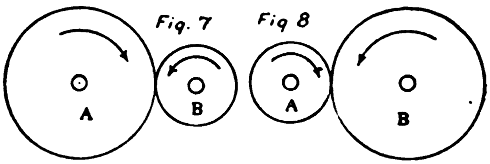


Fig. 6.

teeth *V* upon wheel *A* for this purpose. We must then cut grooves *W* in *B* to receive these teeth. As *A* is already cut with a series of grooves, and *B* is provided with a series of teeth, the new grooves and teeth must be placed at the unoccupied parts of the respective circumferences. The teeth will therefore be placed on the parts *T* of *A*, Fig. 5, and the grooves cut in the parts *G* of *B*, as indicated by the dotted lines.

This explains that the teeth of a cogged wheel are made up of two parts, one of which is inside and the other outside the true circumference of the wheel, as indicated by the shaded parts *T*, Fig. 6. When designing a pair or train of toothed wheels we should, therefore, primarily imagine them to be without teeth and merely rolling against one another with frictional contact only. In fact, we should plan them as friction gearing and merely add the teeth to the plain wheels thus designed. The circumference of such a plain wheel is called the pitch surface, usually referred to as the pitch circle, because when setting out the gear upon paper, circles are drawn to represent these pitch surfaces. In Fig. 6, these circles are shown, and represent the imagined pair of plain wheels in contact at their pitch surfaces. The part of the contact surface of the tooth which is outside the pitch circle is called the face, and that part inside the pitch circle is called the flank. The entire portion of a tooth which is outside the pitch circle is called the addendum. When planning a pair or train of wheels, the first consideration is the value or ratio of the gearing. This means the relation between the number of complete revolutions made by the first and last wheels respectively, in any given interval of time; or time can be left out of consideration and the value of the gearing be regarded as the number of complete revolutions which the last wheel will make while the first wheel makes one complete revolution. The first wheel is considered to be the one which sets the whole train in motion. If the last wheel makes one complete revolution while the first wheel also makes one revolution, the train is said to be of equal gear ratio. But if we arrange the sizes of the wheels in suitable proportion, the last wheel can be made to give more or less than one revolution for each revolution of the first wheel.



If it has rotated more than once when the first wheel has made one complete revolution, the train is said to be geared up; if less, it is said to be geared down.

The ratio of revolutions is determined by the diameters of the pitch surfaces. Thus, if the wheels *A* and *B*, Fig. 6, are to make equal revolutions, *B* making a complete revolution for each complete revolution of *A*, the pitch circles must be equal in diameter. If *B* is to make two revolutions for each one made by *A*, the pitch circle of *B* must be exactly one-half the diameter of the pitch circle of *A*, Fig. 7. Suppose that *A* is to make one and one-half revolutions for each revolution of *B*; the pitch circle of *B* must be one and one-half times as large as that of *A*, Fig. 8. Thus, the required ratio of revolutions between the driver and driven wheel is determined, not by their diameters as measured over the points of the teeth, but by temporarily leaving the teeth out of consideration and calculating the sizes of the pitch circles as if there were to be no teeth. Having decided the diameters of the pitch circles the diameters of the wheels measured over the tops of the teeth is determined by adding an allowance sufficient for that part of the teeth which projects beyond the pitch circles. This is shown by Fig. 9, the pitch circles being the dotted lines and the full circles the overall diameters of the wheels. The part of the teeth which projects beyond the pitch circle is shaded. Patterns or blanks from which the wheels will be made would, therefore, be turned to this overall diameter, which thus provides the requisite allowance to complete the teeth. When turning up the wheels in the lathe it is frequently the practice to mark a line representing the pitch circle upon the side of the wheel. This serves as a guide when cutting the teeth and fitting them in their place for working.

The ratio of revolutions between one wheel and the other also depends upon the relative numbers of teeth. If wheel *A* has 20 teeth and wheel *B* 30 teeth, *A* will rotate one and a half turns to one complete revolution of *B*. Therefore, we must not only design the pitch surfaces so that their diameters bear the proper proportion, but we must also make the numbers of the teeth in the same proportion. To some extent this question decides itself, because the teeth upon *A* must be spaced at a distance apart to correspond with the spacing of the teeth which are upon *B*, or the two sets will not fit properly together; the numbers of teeth should, however, always be calculated and made to correspond correctly in proportion to the diameters of the pitch surfaces. Some difficulty may occur in doing this. The distance from the center of one tooth to the center of the next is called the pitch. It is measured along the pitch circle. If the two wheels are to gear properly together, the pitch of the teeth upon *A* must be the same as the pitch of those upon *B*.

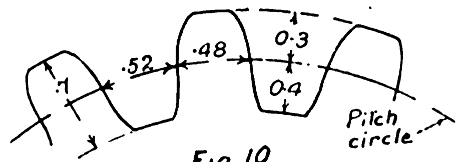


Fig 10

When determining the number of teeth for, say, wheel *B*, you may find that any number which gives a reasonable pitch and is a convenient fraction of an inch, such as ⅛ in. or ¼ in., will not divide the pitch circle of *A* into the correct number of teeth. You cannot have fractions of teeth. If the wheel centers are not fixed, the matter may perhaps be adjusted by a slight alteration in the sizes of the pitch circles, still keeping them to the desired proportion. If the centers cannot be altered, you must then arrange a pitch which is as near as possible suitable to the available cutters, if the teeth are to be cut, or make a special cutter. There is another method of reckoning the pitch. Instead of measuring it along the circumference, it is measured as so many teeth per inch diameter of the pitch circle. Thus, if a wheel having a pitch circle diameter of 3 in. is to have 24 teeth, they are said to be 8 pitch, because there are 8 teeth in 1 in. of the pitch circle diameter. Awkward fractions of an inch can thus be dealt with in a simple way; No. 8 diametrical pitch would be .393 circumferential pitch. If the circumference of the pitch circle is made of such a size that fractions are avoided, the diameter may be some awkward dimension. By working to diametrical pitch, the pitch circle diameter can be made to a dimension which is convenient to measure. Tool makers use this method to a considerable extent, and supply a variety of cutters made to diametrical pitch. Therefore, as a rule, there is no need

The diameter of the pitch circle multiplied by 3.1416 and divided by the number of teeth will give the circumferential pitch.

The diameter of the pitch circle multiplied by 3.1416 and divided by the pitch will give the number of teeth.

To obtain the diametrical pitch from the circumferential (also called circular) pitch, divide 3.1416 by the circumferential pitch.

To obtain the circumferential pitch from the diametrical pitch, divide 3.1416 by the diametrical pitch.

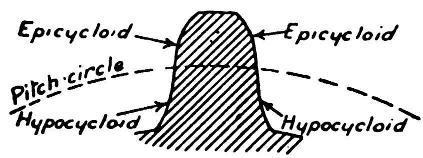


FIG. 11.

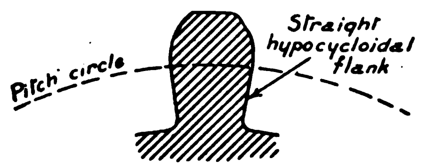


FIG. 12.

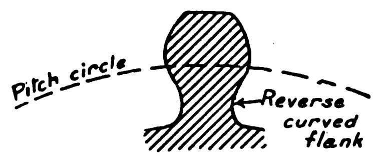


Fig. 13

The size of the teeth is determined according to the power which they have to transmit. They tend to break at the lowest portion—that is, at the root. If the wheels are well fitted, and the teeth make contact throughout the entire width, they will resist the strain much better than if they are inaccurately fitted. In the latter case they may make contact at some place near the edge so that the strain is concentrated mainly upon a small portion of the metal. The power which a gear wheel can transmit increases with the speed of the rotation. If a wheel has a slow speed of rotation, therefore, its teeth must be larger than they need be if the speed is higher to transmit a given amount of power. Generally, there will be two pairs of teeth or more in contact simultaneously, so that you can reckon that the pressure is distributed upon two teeth. All the small classes of gearing likely to be used by amateurs will, in all probability, have sufficient strength when the teeth are made of recognized good proportions so that no calculations need be made for this. If the teeth are to be cut from the solid—and this is the best method for small wheels—the blanks can be sent to a gear-cutter who will select a suitable tool. It will only be necessary to state the sizes of the pitch circles and the number of teeth to be cut in each wheel. When deciding upon the numbers, arrange to have as many teeth as possible consistent with strength and wear. It is not advisable to have less than seven teeth in any wheel.

The teeth are usually proportioned according to the length of the pitch. Different makers vary the dimensions to a small extent. The well-known authority, Professor Unwin, in his "Elements of Machine Design," gives the following (see Fig. 10), the unit being the pitch. These dimensions show that the thickness of a tooth measured on the pitch circle should be slightly less than the width of the interval between the teeth (called the space). Also that there will be a clearance space between the point of the tooth of one wheel and the bottom of the space of the wheel into which it is geared. The width of the wheel is usually about 2 to 2½ times the pitch. When a pair of wheels are in gear, the pitch circles should touch. If such proportions for the teeth and spaces as given in Fig. 10 have been adopted, there will then be a small amount of play between the teeth, as the thickness of the teeth is slightly less than the width of the spaces, and the height above the pitch circle is less than the depth inside it. This clearance allows for very small irregularities, and enables the wheels to run without jamming; it should not be produced by extending the distance between the centers of the wheels.

There is a kind of gearing used in mill work called mortise wheels. In this one wheel of a pair is fitted with wooden teeth dovetailed into slots in the rim. When these are used the proportions of the teeth are altered, the wooden teeth being made thicker than the metal teeth of the wheel with which it is geared. The object of the gear is to reduce noise. It would scarcely be used for small gearing except as a model of a large gear.

The teeth of cog-wheels require to be made of peculiar shape. It is not sufficient to make teeth of any pattern which will allow them to engage and disengage during rotation without binding. There is a further consideration: they must be of such a shape that the relative velocities of the pitch circles will not be disturbed as they roll one against the other. The pitch circles should continue to roll as if there were no teeth and no slip. Mathematicians have discovered that if the teeth are shaped according to certain well-known geometrical curves, this condition will be practically fulfilled. The three curves which are used in practice are the epicycloid, the hypocycloid and the involute. When made on the cycloidal principle the contact surfaces of each tooth are composed of two curves. That part which is outside the pitch circle is curved to the epicycloid, and that part which is inside the pitch circle is curved to the hypocycloid (see Fig. 11). A cycloid is the curve which is described by a point fixed at the circumference of a circle when that circle is rolled in contact with a straight line. An epicycloid is the curve which would be described by the point if the circle were rolled upon the circumference of another circle. A hypocycloid is the curve which would be described if the circle were rolled in contact with, but inside, the circumference of another circle.

If the curves of the faces of the teeth on one wheel are formed by the same rolling circle which is used to form the flanks of the teeth on the wheel with which it is to gear, the relative velocities of the pitch circles will not be disturbed by the engagement of the respective teeth. This is actually done in practice. The curves are sometimes really produced by rolling a disc representing the curve-generating circle upon another disc or template representing the pitch circle, or are drawn by compasses to some geometrical construction which gives arcs of circles very closely approximating to the real curve. Constructions of this kind are given in text-books on machine construction. The same generating circle can be used to describe the curves for the faces and flanks of the teeth of each wheel; this is convenient and usual in practice, though two generating circles could be used—one for the flanks of the driver teeth and faces of the driven teeth, and the other for the faces of the driver and flanks of the driven teeth. If more than two wheels are in gear together, or if a number of wheels are required to gear indiscriminately with each other—as in the case of a set of change-wheels for a lathe or other machine—it is necessary to use one circle only to generate the curves for the faces and flanks of the teeth of all the wheels.

Many wheels are made with teeth which have straight instead of curved flanks, the lines being radial. This is quite correct, because a hypocycloid generated by a circle whose diameter is equal to the radius of the pitch circle inside which it rolls is a straight line, Fig. 12. The generating circle should not be made larger than this, as the straight line then becomes a reverse curve, producing a weak form of tooth at the root, as indicated by Fig. 13. For this reason the diameter of the generating circle to form the teeth of a set of wheels of different sizes is usually made equal to the radius of the pitch circle of the smallest wheel. The flanks of the teeth of that wheel will then be straight lines, and those of all the others will be curves. But all will be hypocycloids, and the teeth will not be weak at the root. According to Molesworth, the best diameter of the generating circle is given by 2.22 times the pitch, provided the number of teeth in any one of the wheels is not less than fourteen. If the number be less, the diameter of the generating circle should be equal to the number of teeth multiplied by the pitch and divided by 6.3.

Teeth shaped upon the cycloidal principle preserve the relative velocities of the pitch circles only if the wheel centers are at the proper distance apart. If the centers are spread so that the pitch circles do not rotate in contact, the relative velocity is not maintained. If the teeth are shaped upon the involute principle, this condition need not be strictly observed; the relative velocities will not be disturbed if the centers are spread or brought more closely together to a small extent. Any normal wear of the bearings would thus not interfere with the proper action of the teeth. The involute is a geometrical curve produced by the end of a stretched cord which is being unwound off a cylinder or the circumference of a circle; it would also be produced by the end of a straight line which is being rocked upon the circumference of a circle. In either case the circle is called the base circle, and the curve produced is called the involute of that circle. Teeth shaped upon this principle do not have two curves for their contact surfaces; the face and flank at each side of a tooth is formed by one and the same involute curve (see Fig. 14). The curve is produced by the end of the line *B*, which represents the

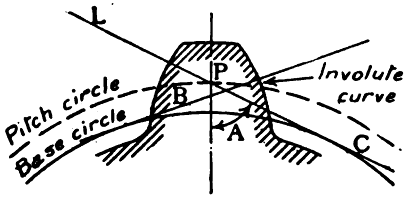


Fig. 14

cord or straight line rocking upon the base circle. Such teeth are of strong shape, and all wheels with involute teeth will work correctly together if the teeth are of the same pitch and obliquity of line of contact. That is, a line *LC*, Fig. 14, making contact with the base circle and passing through the pitch point *P*. For a set of wheels, any pair to work together, the radii of the base circles must bear the same proportion as the radii of the pitch circles. A curve consisting of an arc of a circle can be produced which is very near to the true involute curve; geometrical constructions for this are given in text-books on gearing and machine construction. According to some authorities, teeth shaped to the involute curve exert a thrust along the line joining the centers of the wheels (called the line of centers), thus exerting extra pressure

teeth. The wheels were tried with the teeth engaging at various depths, and did not show any tendency to thrust the centers apart until they were placed with the teeth engaged only to a depth of ¼ in. out of a total depth of 1½ in.; even then the tendency to separate the centers was very slight. Involute cutters are stocked by tool dealers, and the curve is favored in American practice. If the angle *A*, Fig. 14, be made as large as practicable, involute teeth appear to give good results in working. The effect of increasing the angle *A* is to bring the circumference of the base circle close to that of the pitch circle, the result being short teeth.

(*To be continued*)

Wireless Telegraphy without Sparks

According to the *Matin*, a young French engineer has made a discovery which is likely to revolutionize wireless telegraphy. The article in the *Matin* says: "The author of this wonderful discovery is M. Julien Béthenod, a favorite pupil of Henri Poincaré and a personal friend of M. Branly. This young scientist is already known as the inventor of an alternator, by means of which messages are sent out by wireless sound sparks. This alternator is in use at the Eiffel Tower, and is employed for military and naval purposes in several places in the Colonies. The invention of M. Julien Béthenod consists in the main in this, that it substitutes for wireless telegraphy with sparks wireless telegraphy without sparks. In the case of wireless telegraphy with sparks, the materials required are: (1) an alternator; (2) a transformer; (3) a self-induction coil; (4) a condenser; (5) an oscillator; (6) an antenna. With wireless telegraphy without sparks, on the other hand, all that is necessary is an alternator and an antenna. Of course, it is a special antenna that is required, as well as a machine that is capable of sending out waves on the antenna that

INFLUENCE OF ANTIQUE MODELS ON PRESENT-DAY FURNITURE

Various Forms of Tables Described—The Tray Table—The Telephone Table

PAUL D. OTTER

It will be found that the influence of "periods" actively determines our form of furniture as does the period style of the building determine the nature and decoration of the room within, and so it is with the intention of dividing the furniture family under headings that the subject of tables is now considered. It is not so much what we make for ourselves in unrestrained enthusiasm, urged on by watching the clean shavings curl from our plane, but it is what others might think of our product when we get through with it that impels us to consider with some deference, what is in the market?—what kind of furniture is the home furnisher seeking?

In this inspection of present furniture it will inspire the practical tool user with increased confidence to know that many of the furniture forms bought by discriminating purchasers he can make for his own home and use also as models for private orders.

With this idea in mind the present subject has been prepared, presenting types of simple construction and of a character which will harmonize well in the furnishing of the modest home; particularly will others fit in well with the bungalow and concrete order of home, the character of which originally springs from the same source as shown in many under consideration.

Having a two-fold use, Fig. 1 is very desirable in the small cottage or bungalow home where the dining-room is frequently the living-room. It is well adapted for beginners in the home life, and when not in use looks well against the wall as a settle, particularly when the room has a timbered or paneled treatment.

It might be well to note here in passing that all such pieces of furniture never look well in natural or light finish, even golden oak finish, for much of the square furniture is too light. The main purpose and most satisfactory color finish is to get age brown tones immediately, as they blend well with draperies, rugs and all other furnishings. Such a tone, you will notice, accords well with standard tones adopted by the architect and decorator. This age tone is commonly known under

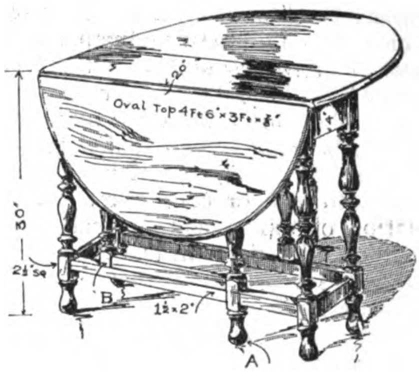
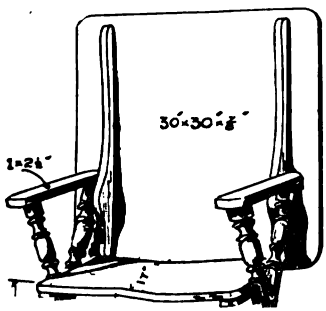
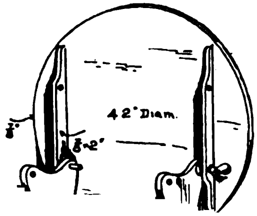
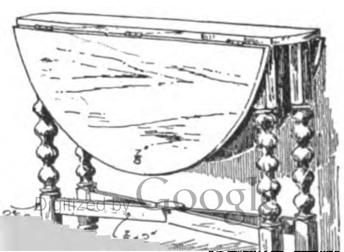


Fig. 4—A Gate Leg Table







the name of "fumed oak." "Cathedral oak" is another pleasing shade of brown. Oak is also a safe wood to use for furniture of a medieval type, or that which partakes of a sturdy character and possesses a combination of square and round-turned parts.

It is assumed a sufficient working drawing be made showing the end view of the subject and also one-half of the front view. With the skill of a workman and the experience in getting out and handling stock much of unnecessary and familiar detail need not be placed on the drawing if time does not permit. The use of the drawing will be to pencil in between determined measurements unknown detail of form and outline. Other simple parts may with judgment be arranged for and fitted as the work proceeds.

These remarks do not, of course, minimize the value of a clearly defined working drawing, should there be any need of referring to it at some later time or of making a modified interpretation of the same class of subject.

Well-seasoned wood should at all times be made use of and generous well-fitting tenons be given to the cross stretchers, which should go clear through the thickness of cross legs and be further secured either by a headless brad or a hardwood peg. The top of the table may operate on a bolt or lag screw secured through a hole in the enlarged part of batten and pass into arm or back post. This is a matter of experimenting and also the location of top in central position over the base when down in place.

Little need be said of the settle table in Fig. 2, except to call attention to another use of the compartment under the lift-up seat. This is entirely of ⅞ in. boards. The drawing here shown represents a familiar type of early English or early colony utility table. It admits, however, of varied outline and more elaborate treatment. Sometimes the seat is padded and upholstered with a padded and upholstered panel treatment, covering much of the space within the battens of the underside of the top. This, then, to use an expression, "puts it in another class" and identifies it more with the furnishings of a craftsman's living room.

It is desired by the aid of the cuts shown to excite individual expression as much as possible. Much of the old furniture is interesting from the ingenious devices or construction, designed just as much then as today to serve a double purpose, and it is hoped that the spark of inventive genius may be fanned into a flame oi enthusiasm for other simplifying means or comfort-giving features. Meanwhile curb any desire to change good form for some untrained outline or erratic profile to your turnings; rather seek out and make a rough pencil sketch of a bit of turning or an approved outline which you think would apply to a particular form of furniture needing a little more grace or livelier expression to it by a change of outline, or an added bit of modest carving or molding.

Fig. 3 presents an English breakfast table which is coming again into renewed favor. It has its advantages of looking well when not used as a meal table and of being useful for other purposes.

The marked revival of needlework among ladies demands attractiveness in table designs, and for this reason the antique models are more than ever being reproduced, fashion dictating that luncheons be served on bare table tops over open lace-work doilies and scarfs. A becoming design of table is therefore much in demand. A simple turned shape to the posts of the Jacobean period is shown, although other profiles may be used. Two specially fitted hinges screwed firmly in the usual way to ends of leg strainers and brought together by a central pin covered by finishing cap will provide one of the many ways of throwing open the legs to a square position under the table top.

Certain unobtrusive stops and a locking device are to be provided to check the posts at a determined position. Whatever may be the diameter of the table, make the center of the table about 3 in. less than a third of the diameter.

The size of leg stock shown on cut is for the larger size of table, 48 x 48 in.

Fig. 4 is now one of the very popular forms of gate leg tables—most frequently made in mahogany. This fits in well with furniture of a mahogany order, as does most of the William and Mary style, of which this is a suggestion.

The gate with the halved out post *A* fitting into cross rail correspondingly halved in a loose fitting manner, pivots or swings out from post, loosely pivoting on top of rail. The corresponding gate on other side of table swings out in a similar but alternating direction, stopping at a check at right angles with the table frame. All dropleaf tables should be treated with a rule joint contact with leaf and top of table.

Fig. 5 meets with favor now even though its class was replaced by the pedestal table; yet it, too, has the merit of side-wall attractiveness which the modern table cannot have. The leaves are usually supported by a stiff swinging cross bar set into top of apron rail. Care should be used in the selection of dry lumber for the tops and also to screw on a batten, using *no glue*, but setting each screw in a small slot so that the top may shrink and expand unretarded.

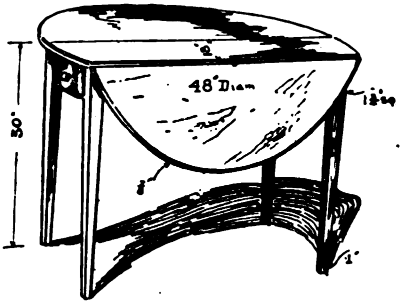


Fig. 5—A "Sheraton" Dining Table, 42 or 48 In. in Diameter

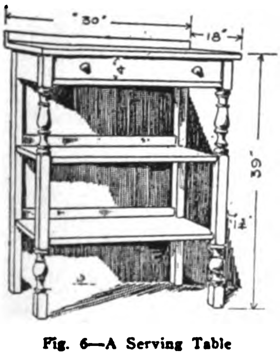


Fig. 6—A Serving Table

Mahogany, or mahogany-finished birch is properly the wood for this table, and more particularly if it is made in a smaller size than a 42-in. top.

We used to feel very well satisfied with the ordinary dining-table and a direct communication to the kitchen and the pantry, but now our needs, through a process of refinement, must take on considerable complexity, all of which adds to home charms and the wife's pleasure in displaying in an attractive way and on suitable furniture her growing collection of silver, cut glass, decorated ware, and last but not least, her linen, for every day or on festal occasions. This requires us to show Fig. 6, a serving table, which is very simple and plain, being a sort of second cousin of the more aristocratic sideboard. It is one remove from the buffet, and consequently, about fits in with our modest ideas of living, and the useful furniture we need about a bungalow or that class of home.

Little need be said about this, except that a form of frame made similar to one suggested in Fig. 13, is to be used as a base of construction, and the two lower shelves are to be cut out and fitted in a similar manner. The shelves may be secured to posts from the underside by means of a counterbored screw hole bored on a long slant. This simple sideboard is becoming a necessity, as in a home without servants it permits of extra table furnishings and the desserts to be placed in readiness before the meal is begun, thus creating greater repose for the housewife.

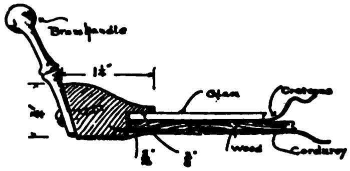


Fig. 8—Section of Serving Tray for the Tray Table Shown in Fig. 7

Fig. 7—A Tray Table to Fit Glass Tray 10 x 25 In.

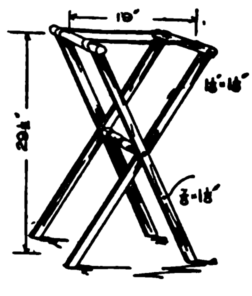


Fig. 9—Tray Stand to Be Used in Connection with Glass Tray, Fig. 8

Fig. 7 offers a good substitute or even an adjunct to Fig. 6, being a tray table which provides a proper resting-place for the glass-filled tray when not in use.

We do not pass the social hour or two without on many occasions being served with refreshments, and the tray has truly become a necessary article, and like everything else an object of attractiveness and friendly rivalry as to who will own the prettiest tray.

Fig. 7 may properly have a second drawer, although where the lower shelf might be used for a fruit bowl such an addition may destroy the decorative effect.

The glass tray, Fig. 8, which in this instance determines the size of table top for Fig. 7, consists of a molding of oak or mahogany cut from a stick ¾ x 1¼ in. of a section, preferably the one shown. These pieces are cut to a mitered frame measuring over all 16 x 25 in. Long brads properly set in and concealed, or a ⅛-in. saw kerf run across the glued up frame at an angle of 45 degrees with a slip of wood set in glue and trimmed off, will probably produce a more dependable joint. A piece of good, clear, clean single thick glass, a piece of attractive figured cretonne with birds, foliage or flowers, a piece of dry thin board or flat stiff straw board, are to be cut to fit not too tightly within the rabbet size of the frame, then with a number of stiff, thin brads securely nail in position; a small, round reed or stick is sometimes used to brad in over the backing. As a final covering of this surface and also to extend over the bottom face of frame, glue on an extra large piece of corduroy, preferably brown, green or gray, starting from one end, and using some stiff paste, or rather thick prepared glue, which has little moisture. After this covering is set and dry, use a sharp knife in trimming off the material overhanging outer edges. Brass handles are now to be had for such trays, and care should be taken to set the screws into the light frame in a prepared hole small enough to make the screw draw up firmly.

Fig. 9 is a collapsible table or stand to support tray in kitchen or pantry when receiving contents previous to carrying to dining-room tray table, Fig. 7, or in to guests during some social gathering. It is quite a useful article for large gatherings where other table space is being used, and is also necessary for the welfare of a handsome tray when away from its proper place.

THE SEWING TABLE

Among the many kinds of tables the sewing table provides an orderly place for materials and ample space to lay out work on the top and extending leaves. The plain and less expensive type shown in Fig. 10 in mission style is here used as a basis for any different treatment the reader may wish to give it and not depart from form or size of parts. The legs may be treated with a squared neck or lessening of stock under the lower drawer frame and the major part of post reduced to a taper and expanded again before it reaches the floor into a square ball effect; or this full length may be turned by using some well selected taper form. The shelf and top may then be treated with a molded edge and slightly rounded corners and the rule joint be used instead of plain square.

Fig. 11 is a more pretentious table properly made in mahogany. This is the type the interested worker will find gives him the opportunity for skilled workmanship, and in the drawers he may insert various small compartments and specified divisions which would delight the future possessor of such an article.

By the use of Fig. 12 the manner of gluing up stock is shown, and may be resorted to for producing a flowing shape or outline, which is frequently wider than stock obtainable. The heavy line shows the proposed shape of one-half of lyre pedestal to work table, Fig. 11, allowing length for large tenons, top and bottom *A* to fit in mortise in frame, Fig. 13, and the lower tenon to fit in molded base above scroll feet in Fig. 11. Before the outline indicated in heavy line is sawed out, unite the two halves by gluing. This will enable you to use long clamps on flat surfaces. When dry, saw out on band saw and cut tenons.

The frame, Fig. 13, here shown is a base in most all forms of modern construction of carcass work. If the reader will inspect any available piece of furniture of a case of like nature, he will find this frame to be a convenient one upon which to secure other constructional parts. In many instances it is not in outward evidence, while in the case of the sewing table, Fig. 11, it appears between the two drawers and above and below. Where thus exposed to view the stile should either be faced with veneer or be of the same kind of wood as the entire construction; these frames otherwise may be made of inferior wood, generally of ¾ or ⅞ in. thickness, and 2 or more inches wide, judgment showing whether one or more crossbars will be needed for extra stiffness.

A preparatory working drawing which you should make will indicate where you are to relish out the corners, as instanced in Fig. 13, to provide a place for the jamb blocks on each side of drawer. The ends of the carcass hidden by the drop leaves in the cut are glued and secured by screws to these frames by screws countersunk or set in, as shown at *B*.

USE OF CORNER BLOCKS

A double insurance of strength and stiffness is always secured in cabinet work by setting in frequent corner blocks; out and provide certain ingenious devices which further embody personality in one's productions. Various holding-up methods are used on such tables, the

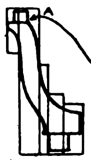


Fig. 12—Half Shape of Lyre Pedestal Showing Manner of Gluing Up Irregular Shape

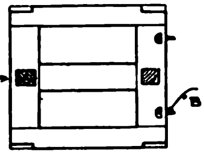


Fig. 13—Frame for Sewing Table

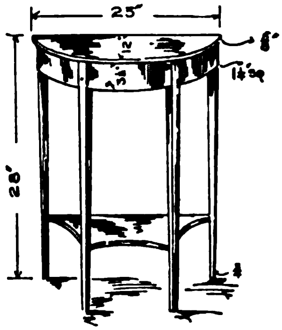


Fig. 15—A "Sheraton" Side Table

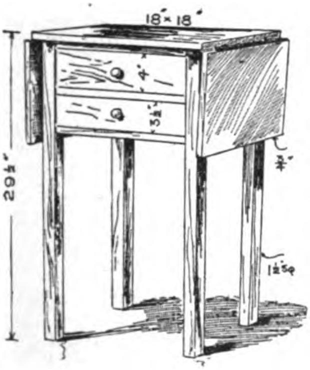


Fig. 10—Serving Table Having Top Area When the Leaves are up, 18 x 33 In.

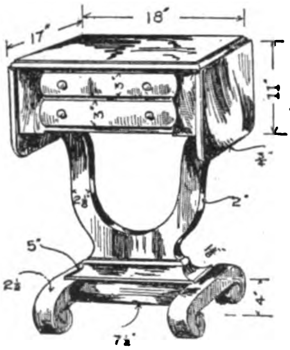


Fig. 11—Colonial Sewing Table 30 In. High and Top When Both Leaves Are Up, 18 x 40 in.

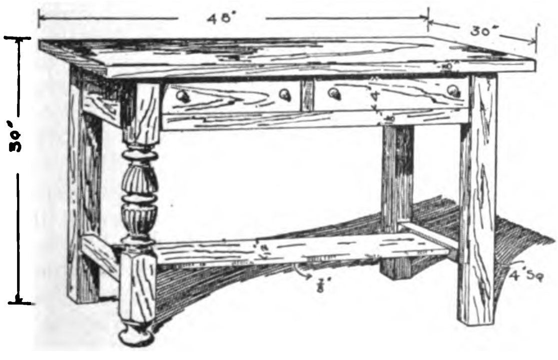


Fig. 14—Mission Table Showing "Elizabethan" Treatment on Left Leg

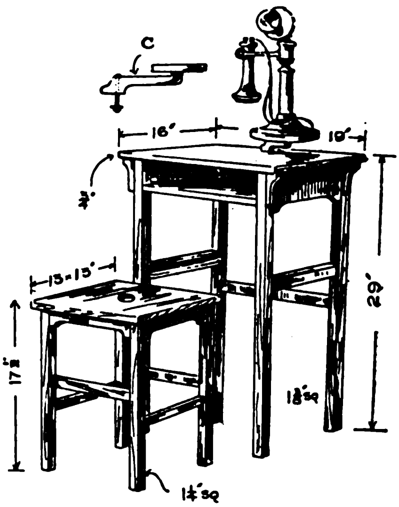


Fig. 16—A Telephone Table and Stool

these may be made of neatly cut triangular blocks or strips two or more inches in length.

The upholding of the drop leaves may be secured by various means, and I take it that if it is a pleasure to construct an article it is equally interesting to study simplest possibly being a swing bar, space for which must be provided for its action under the middle part of the table top, or sufficient space may be provided on your drawing so that the middle top shall hang over sufficiently to hinge to each side of the case a ¾-in. swing bracket long enough properly to support the drop leaf when drawn up.

Our broad-handed way of living makes the subject of tables very varied, as each room appears to demand a special form of table, but I am going to give the parlor cant attention at present, for that room s falling much into disfavor. Fig. 14 shows a very popular and approved form of convenience table for the living-room. It is of the mission order, yet for those who wish a less heavy effect, the left leg is shown turned in the Elizabethan style, which will be found to modify the over-weighty appearance, and permit of its use in greater harmony with a mixed assortment of furniture patterns, which are generally to be found in a living-room. Such tables are generally made in three sizes, 40 x 30 in., 42 x 28 in. and 36 x 26 in.

Fig. 15 is a graceful form of table adapted to a ladies' room, parlor or reception hall, and should be made in mahogany or other rare wood.

The top is semi-circular and the apron is sawed in conformity and set under very slightly, about 3/8 in.; the legs are 1¼ in. square and mortised between the aprons and reduced by a taper to ¾ in. at floor. By making a small grooving tool or plane, a groove of 3-32 in. square may be plowed in ¼ in. away from edges of legs on front and also on apron front and one groove in edge of table top, into which may be set in glue a strip of wood or veneer of a lighter color. Let dry and then scrape flush with cabinet scraper and sand smooth with No. 00 sandpaper.

THE TELEPHONE TABLE

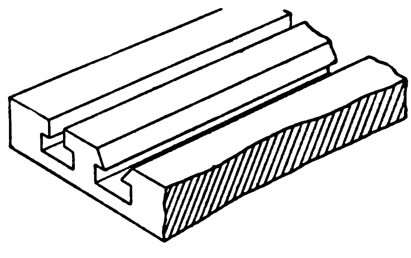
The telephone table, Fig. 16, I am sure will be highly valued in the home, particularly by the feminine members of the family. The style is a modified type fitting in well with the "Mission," "Quaint" or "Arts and Crafts" style so prevalent. The simple general form is one permitting various changes in leg treatment and shape of outline to apron. An undershelf in table provides for the telephone book. The top, shelves and side rails are of ¾-in. material. The table stand is so made with the side strainers or stretchers provided with a

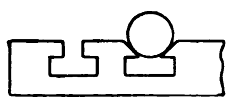
of stool top to facilitate withdrawing it. A wooden arm represented in *C* and a turned disc to hold telephone stand is secured by a bolt with nut and washers to table top at back so that instrument may be swung back or forward for convenience.—*Building Age.*

A Hint for Cutting Keyways

AN APPRENTICE

The accompanying sketches show an easy and practical way of ensuring a keyway to run parallel with the shaft. Most planing and shaping machines have one or more slots running longitudinally with the table. If one of these slots be planed





A Method of Cutting Keyways Parallel

the whole length of the table to an angle of 90 degrees so that a shaft may rest in it as in a V-block, it will amply repay one for the trouble expended on it. It will also stop the shaft from buckling under the pressure of the cutting tool.

Reporting Obstructions by Radio Telegraphy

Shipmasters in the North Atlantic are invited to communicate reports of dangerous obstructions to navigation to the Hydrographic Office, Washington, D.C., or to the nearest Branch Hydrographic Office, by radio telegraphy at or near the time of seeing the obstruction. Such messages should be brief and in English. They should be addressed *via* any naval or commercial radio telegraph station along the coast of the United States. The cost of their overland transmission will be borne by the Hydrographic Office. Particular attention is invited to the

INDUCTION MOTORS AND HOW THEY WORK

NORMAN E. NOBLE

In this article it is intended to deal with the description of induction motors and principle upon which they work. This is a subject that most amateurs (whose study of alternating current motors has not progressed very far) consider somewhat of a mystery, and it is for their benefit that this article is written. I have endeavored, as far as possible, to keep the description and drawings as clear as I can, considering the nature of the subject; also the mathematics of induction motors have been left out entirely, as they are rather complex and might have induced the amateur to slip over some of the most important points. It has been assumed that those who wish to study the principle of induction motors have a good all-round knowledge of the properties of direct-current motors and apparatus, and have also a slight knowledge of the fundamental principles of alternating currents and one or two of its peculiarities, as induction motors depend upon alternating current for their power. However, for those whose knowledge is slightly rusty, I will commence with a brief description of their derivation.

An alternating current is one that is neither constant in direction or pressure, but varies—first flowing in one direction round the circuit, commencing from a zero value and rising to maximum, and then back to zero; it then changes its direction and flows round the circuit in the opposite direction: from zero to a maximum, and back to zero. This cycle of operations is repeated at regular intervals of time.

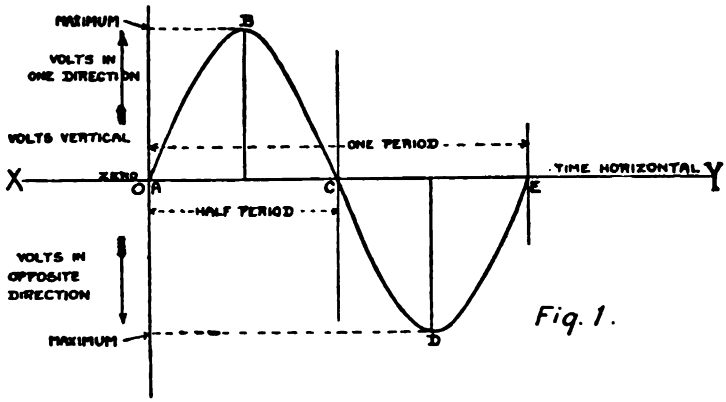
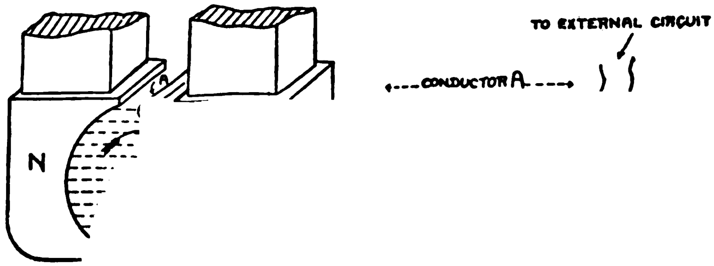


Fig. 1.

Let us now consider Fig. 1, in which the curved line represents an alternating current, and shows the variation in direction and pressure. The line *X Y* represents the zero line—volts in one direction being marked above the line, and volts in the opposite direction below the line, time being marked horizontally. The current starts at a zero value at *A*, and increases, at a varying rate (as shown by



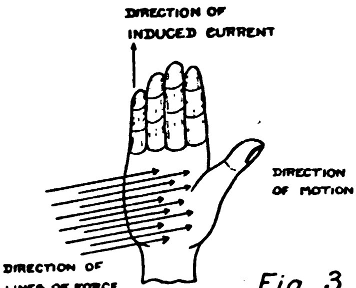


Fig. 3.

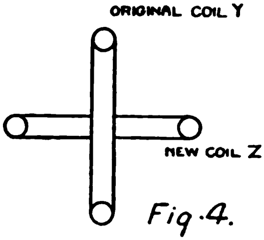


Fig. 4.

the curve), to a maximum value at *B*; then it decreases from a maximum to a zero value marked *C*, all in one distance round the circuit. The direction is now changed, and the current increases from a zero value at *C* to a maximum value at *D*, and then down to a zero value at *E*—all in the opposite direction round the circuit. This complete cycle of variations—that is, from *A* to *E*—is called one period; this period or cycle of variations is repeated at regular intervals of time, each period occupying 1-50 or 1-25 second, according to the design of the alternator supplying the current. Thus, we get a current having 50 or 25 complete periods of variation per second; of course, we can get currents having 100 or 60, or any other number of complete periods of variation, but 25 and 50 periods per second are the most common; the periodicity or frequency of the current being a fixed quantity for any particular alternator at its proper speed.

We will now consider how these alternating currents can be produced. For our illustration let us consider a single coil of wire revolving in a direct-current magnetic field, and each end of the coil being connected to a separate slip-ring. (See Fig. 2.) The coil *E* is assumed to be rotating in a clockwise direction, as indicated. As the coil revolves, the conductor *A* cuts the lines of force in one direction; this induces an e.m.f. in the conductor, which causes a current to flow, the direction of which can be easily determined by remembering the following simple rule: "Hold the palm of the right hand so as to meet the lines of force (coming from the N. pole to the S. pole), and place the hand so that the thumb indicates the direction of motion of the conductor, and the fingers will point out the direction of the induced current." (See Fig. 3).

If this rule be applied to Fig. 2, the induced currents will be found to flow in the direction shown by the arrows. We will now deal with the currents generated during the first quarter of a revolution (that is, 90 degrees). Considering the conductor *A*, this will start cutting the lines of force gradually, and as it rotates will cut an increasing number of lines, until, when it has moved 90 degrees, it is cutting a maximum number of lines. Now the e.m.f. induced in any conductor is directly proportional to the rate of cutting; therefore, it will be seen that the e.m.f. generated during the first 90 degrees of a revolution corresponds to that portion of the curve, Fig. 1, from *A* to *B*. Of course, at the same time there is an e.m.f. generated in the conductor *B*, Fig. 2, which assists that generated in the conductor *A*. During the second quarter of the revolution (that is, from 90 degrees to 180 degrees), the number of lines cut is a maximum at the commencement, and gradually decreases to zero; thus, the e.m.f. generated in this portion of the revolution will vary from a maximum to a zero

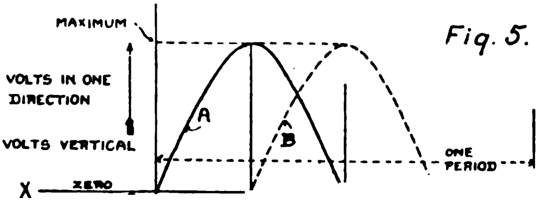


Fig. 5.

conductors cut the lines of force in the reverse direction; the e.m.f. generated will vary in pressure from zero to a maximum, as in the first quarter of a revolution, and will correspond to that part of the curve C to D, and, finally, in the last quarter (that is, from 270 degrees to 360 degrees), the e.m.f. generated will vary from a maximum to a zero value (as in the second quarter), and corresponds to that portion of the curve D to E, Fig. 1.

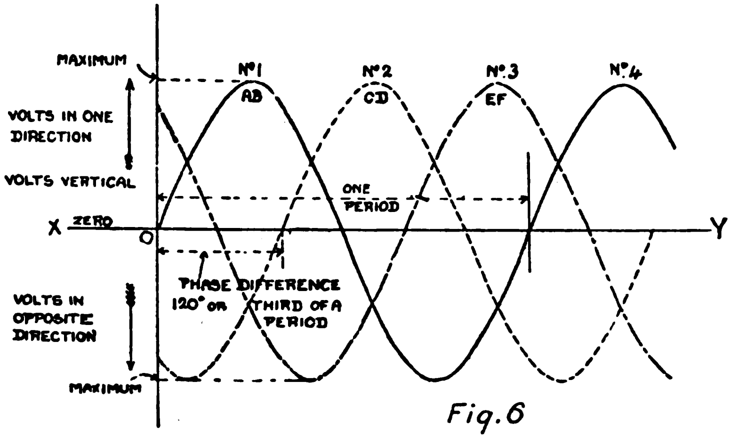


Fig. 6

The current produced by this single coil revolving in a two-pole field, as in Fig. 2, is a single-phase alternating current, and we get one complete period produced during one revolution of the coil; therefore, to get 50 periods per second, we must rotate the coil at 50 revolutions per second. If we had a four-pole field, we should get *two* complete periods during one revolution of the coil; so, under these conditions, we need only revolve the coil at 1,500 revolutions per minute to produce 50 periods per second. Hence, as we increase the number of poles of the field, we increase the periodicity of the current (that is, of course, for a given speed). Therefore, to find the periodicity of an alternator, we have: Periodicity per second equals revolutions per second times number of pairs of poles.

Referring back to Fig. 2, we had one coil only. Now, suppose we wind another similar coil at right angles to the original coil, and connect it to two more slip-rings (that is, four altogether), Fig. 4. The coil Z would be generating a maximum e.m.f. when the coil Y was generating no e.m.f., and *vice versa*; so, if we revolve these two coils in a two-pole magnetic field, as before, we shall get two alternating currents, one having its maximum value when the other has its zero value, the difference between the two being 90 degrees, Fig. 5. This is called a two-phase current, the phase difference being 90 degrees. Curve A represents one phase, and the curve B represents the other phase. As regards the periodicity of the currents, it is exactly the same as previously pointed out—that is, it depends on the speed and the number of pairs of poles. If we had to wind three coils having 120 degrees between each of them, we should get three currents having a phase difference of 120 degrees, Fig. 6. This is all that will be said on the derivation of alternating currents.

Induction motors can be made to run on either single-, two- or three-phase current circuits. We will consider two-phase motors first. Let us take a soft iron ring-shaped core, as shown in Fig. 7—(it must, of course, be laminated to prevent eddy currents)—and wind a coil of wire in two halves, A and B, on opposite sides of the ring. If we now pass a direct current through the coils in the direction shown, we shall get a magnetic field produced inside the ring, as indicated

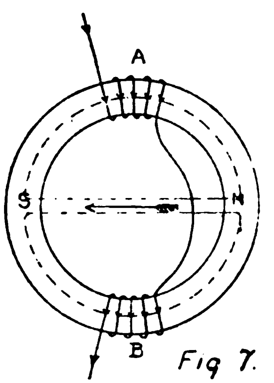


Fig 7.

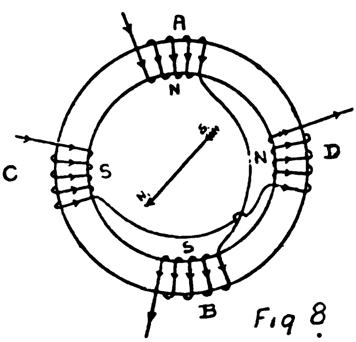


Fig 8

by the dotted lines, the N. and S. poles being as shown; if we put a small compass needle in the center of the ring, it will, of course, take up a horizontal position. Let us now wind another similar coil of wire in two halves C and D, and at right angles to the coils A and B, Fig. 8. If we pass a direct current through the coils C and D in the direction indicated, we get a vertical magnetic field, having its N. pole at the top and its S. pole at the bottom. If we now pass the same current through both coils in the directions shown, simultaneously, we get two magnetic fields at right angles to one another, and a compass needle placed inside the ring will take up a position midway between the two fields, as shown in Fig. 8. Turning back to Fig. 7, let us supply the coils A and B with an alternating current (single-phase); therefore, we shall get a current flowing first in one direction, and then in the other. At one particular instant the current would be flowing as indicated by the arrows, and consequently would produce a magnetic field having its N. and S. poles in the ring, as shown. The strength of the field would gradually increase from zero to a maximum, and then decrease to zero. Then, with the current changing its direction, the poles of the magnetic field would be reversed—that is, the N. pole would become S., and *vice versa*, during the period that the current was flowing in the opposite direction to that shown. The result is—we get what is called a pulsating field, and a compass needle placed inside the ring under these conditions would first be pulled in one direction and then the other; and if we looked closely at the needle we should be able to see a visible vibration, but no rotation, unless we first gave the needle a twist; the reason being that the needle has not time enough to turn partly round in one direction before it is

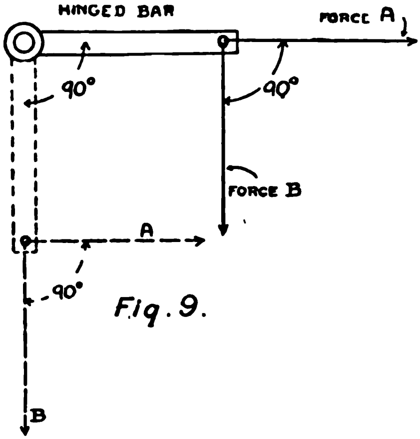


Fig. 9.

the two methods is suitable for producing rotation. To produce rotation we require a rotating field, and not a pulsating field.

The production of a rotating field can be accomplished by supplying two or more suitably placed coils with alternating currents differing in phase; by that is meant—one current attains its maximum value a certain fixed time after or before the other. Let us take a two-phase current (that is, one quarter of a period phase difference, Fig. 5), and supply the coils A and B with one phase of the current, say, the lagging current, and the coils C and D with the other phase (that is, the leading current), Fig. 8. Under these conditions we shall get a rotating magnetic field revolving at a uniform rate in a clockwise direction in this case, and if the following explanation be carefully studied, the reader will have got over the most difficult part, and one which causes trouble to many amateurs. At that instant when the current in the coils A and B is at zero, the current in the coils C and D is at a maximum, and is assumed to be flowing in the direction ... the magnetic field poles as per Fig. 8. This would be the case if we consider the coils separately; but as the magnetic field due to the coils *C* and *D* is weakening, owing to the current's decreasing in value, the magnetic field due to the coils *A* and *B* is increasing in strength, hence the two fields act upon one another at right angles and produce a rotating field having its position at any instant in between the two fields, and its relative position between the two being directly in proportion to the strengths of the two fields. Thus, at the beginning the field produced by the coils *C* and *D* is vertical, and the field due to the two coils *A* and *B* is at zero value; now, when the currents have passed through a quarter of a period, the field due to the coils *C* and *D* is at zero, and that produced by the coils *A* and *B* is at a maximum and is horizontal; therefore, it will be seen that the magnetic field has moved a quarter of a revolution in a clockwise direction in the same amount of time that the currents have passed through a quarter of a period variation. Now, the movement of the magnetic field from one position to another is not instantaneous but is uniform, because when one set of coils is producing its maximum magnetic field (which gradually decreases to zero), the other set of coils is producing a zero field (which gradually increases to a maximum value), and both are varying at the same rate of change. This can perhaps be made a little clearer by comparison with an everyday fact: Suppose we have two ropes attached to a hinged bar, Fig. 9, at right angles to each other, a force *A* pulling at one rope, and a force *B* pulling at the other. Assume that the force *A* starts at 10 lbs. and gradually decreases at a certain rate to nothing; and the force *B* starts at nothing and gradually increases (at the same rate that *A* decreases) to 10 lbs. It is quite evident that at the commencement, the hinged bar will be in a position as shown by the full lines, and that at the completion of the experiment the hinged bar will be in a position as shown by the dotted lines; also, at any intermediate point between the initial and final positions, the bar will be in that position the resultant of the two forces occupies, seeing that the two forces are varying continually and at the same rate of change; therefore, the resultant must be constantly changing its position. These two varying pulls *A* and *B* are comparable with the two varying field-strengths produced by the coils in the previous case, and the hinged bar is comparable with the revolving field. This analogy, no doubt, will help the reader to understand how a rotating force can be produced with alternating currents.

Returning back to our consideration of Fig. 8, we had arrived at the point when the field due to the coil *A* and *B* was at a maximum and horizontal. The current in these coils now begins to diminish to zero, but at the same time the current in the coils *C* and *D* begins to increase from zero to a maximum value, but the direction of the field is reversed, owing to the current's having changed its direction.

The resultant field, or revolving field, will now move away from the weakening field and towards the strengthening field—that is, it will move another quarter of a revolution in a clockwise direction during a quarter of a period in variation of the currents. If the remaining operations be gone through in a similar manner to the above, we shall get one complete revolution of the magnetic field for one complete period of variation of the currents, Fig. 5.

We shall now have to consider how we can utilize the rotating magnetic field so as to produce a rotary movement of a body in it. It is quite true that if we placed a compass needle inside the ring supplied with two-phase currents, that we should get a constant rotation of the needle, this being so because the needle is bound to lie in the magnetic field, and compelled to revolve because the field does.

Now let us consider a well-known fact, and see how it will help us. It is known by most amateur electricians that if we rapidly rotate an iron ring or a solid piece of iron in a strong magnetic field, the iron will eventually become warm, and perhaps very hot, if the speed be high enough; the explanation of this being that the rotating ring cuts the lines of force, and an e.m.f. is induced which produces currents which circulate in the iron and cause heating effects. These induced currents oppose the motion which causes them (by Lenz's law). The same effect would be produced if we rotated a magnetic field round a stationary iron ring. Thus, if we place an iron ring in the rotating field—as produced by the two-phase currents in Fig. 8—before we pass current through the coils, the iron ring will be stationary. Now, when we switch the current on, a rotating field is produced, which, as it revolves, cuts the ring, and obviously, from the above example, induces currents in the ring. These currents produce a magnetic field which opposes the rotating field; but the iron ring, being free to revolve, is carried round with the rotating field, because it cannot stop it.

Let us now consider a simple form of induction motor, as in Fig. 10. The motor consists essentially of an external ring-shaped iron core, which is called the stator, because it comprises the stationary part; on the inside of same are cut slots into which the field coils can be wound. The rotating part, named the rotor, consists of an iron core with slots in the periphery, in which the rotor conductors are placed. The conductors can be connected in many ways; the method we will deal with first is shown in Fig. 11, and is known as a squirrel-cage rotor. In this type of rotor both ends of the conductors are short-circuited by means of copper rings, Fig. 11. In both the case of the stator and rotor cores, they are composed of thin sheets of iron insulated from one another; this is done to prevent eddy or induced currents flowing in them.

In the stator there are four slots, *A* and *B* being for one winding of the two-phase current, and *C* and *D* for the other phase winding. When the slots are wound and each coil supplied with one

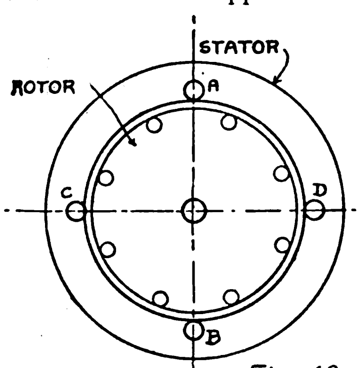


Fig. 10.

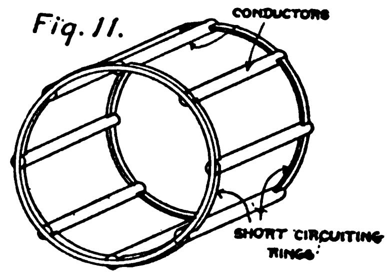


Fig. 11.

phase of a two-phase supply, we get a rotating field. As the field rotates it cuts the rotor conductors and induces an e.m.f.; and because the rotor conductors form a circuit, a current flows in them which produces a magnetic field opposing the rotation of the stator field. The rotor, however, is free to rotate and is carried round with stator field, and we can derive mechanical energy from the rotor shaft. The speed of the revolving field depends on the periodicity of the supply, and also on the number of pairs of poles of the revolving field. For example, in the above case the revolving field has one pair of poles; assume the periodicity of the supply to be 50 cycles per second. Now speed of field in revolution per second is equal to

$$\frac{\text{periodicity of supply}}{\text{number of pairs of poles}};$$

therefore, in the previous example we shall get a field speed of 50 revolutions per second, or 3,000 revolutions per minute, which is the same as we got from Fig. 8—that is, one revolution of the field for one period in variation of the currents. The induced e.m.f. in any conductor depends on the rate the lines of force cut it and the strength of the magnetic field; hence, when we switch the stator windings onto the supply, the field immediately revolves at full speed and the rotor is at rest, consequently, the lines of force of the revolving field cut the rotor conductors at a maximum rate, and an induced current flows in them, producing a magnetic field which opposes the rotation of the stator field and tries to stop it; but as long as we pass current through the stator windings, the field will revolve at a constant rate, hence the rotor is carried round with it in the same direction as the stator field revolves in.

Now, with a supply having a periodicity of 50 cycles per minute, we get with a motor, as shown in Fig. 10 (that is, a two-pole motor), a field revolving at 3,000 revolutions per minute, and just as the rotor is starting from rest, we get the lines of force of the stator field cutting the rotor conductors at a maximum rate, hence inducing a maximum current, which, in turn, gives a maximum turning effort. Assuming the motor is running light, the rotor will quickly increase in speed, and will reach almost the same speed as the revolving field, which is rotating at 3,000 revolutions per minute. It cannot, of course, reach exactly the same speed, because if it did the stator field would not cut the rotor conductors, hence no currents would be induced and, consequently, no turning effort available. But a motor running on light load only requires a sufficient torque to overcome the frictional and air-resistances of the moving parts, and it would be found very difficult to determine by means of a tachometer any appreciable difference between the theoretical speed of stator field and the rotor speed. It will be quite evident to the reader, that, as the speed of the rotor increases from zero, the rate at which the conductors are cut decreases, due to its catching up the speed of the stator field. Now, as pointed out before, the rotor speed at light loads is nearly the same as the stator field speed, and, if we load up the motor a little, it gives out extra power. To do this a number of things have to happen, *viz.*: first, the torque must increase; second, more current is required to produce the increased torque, which requires a greater e.m.f. to be generated in the rotor conductors; this means that the stator field must cut the rotor conductors at an increased speed. Now the speed of the stator field is a fixed quantity, because it depends on the frequency of the supply, which is unalterable unless we vary the speed of the generator; therefore, the only thing that can happen to satisfy the above conditions is for the rotor speed to drop, which is exactly what happens. It may be asked why the stator field strength does not increase, which would produce the effect required; but to answer this question would open a very big argument, and would necessitate comparison with a loaded transformer; therefore, we will take it for granted that the stator flux is, for our considerations, constant, and independent of the load; the only variation of the field strength is caused by volt drop on the windings, caused by the increased currents in same where load is applied; of course, this is not very great up to full load currents. Returning to our considerations, we had decided that the load when applied to a motor causes the rotor speed to drop; the amount of drop being governed by the load. This difference between the field speed and rotor speed is termed the slip of the motor; for example, if the field speed was 3,000 revolutions per minute, and for a given load the rotor speed was 2,900 revolutions per minute, the slip would be 100 revolutions per minute, or, expressed as a fraction of the field speed, the slip would be

$$\frac{100}{3,000} = \frac{1}{30} \text{ or } 3\frac{1}{3} \text{ per cent.}$$

(*To be continued*)

A Historic Site

It is probable that few among the throngs of people who daily pass the 31-story building recently completed at the northwest corner of Wall and Nassau Streets, opposite the Sub-Treasury in New York City, realize that its site is one of the most interesting historical spots in the country. A portion of it was occupied more than a century ago by a Presbyterian church which was used as a military hospital during the occupation of the city by the British.

In front of this lot there was a demonstration over the news of the battle of Lexington and the seizure of the City Hall by the Sons of Liberty in 1775. In the tavern of John Simmons, which was subsequently erected on the site of the church, a banquet was held in 1783 to celebrate the evacuation of the city by the British and the triumphal entry of the American army at which Washington, his officers and leading citizens were present. One year later in the same tavern James Duane, the first Mayor of New York, was inaugurated.

A Traveler's Tale

"Is it true, Mr. Romer, that you were once captured by cannibals?"

"Yes, I was on the bill of fare for a wedding banquet."

"Mercy! How did you escape?"

"Oh, the bride broke the engagement."

THE DIBBLE TRIPLE VALVE FOR RAILWAY TRAIN AIR BRAKES

O. J. GRIMES

As an improvement over the present method of controlling trains by air-brakes, a new triple valve is offered, supplanting the quick-action triple valve, and dispensing with the retaining valve.

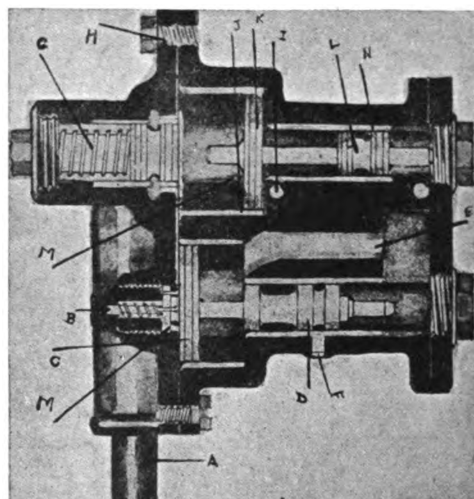
The numerous wrecks formerly due to loss of control of trains on heavy grades, when hand brakes alone were used, led to the invention first of the pressure brake, as now used on single electric cars, then to the vacuum brake, as adapted for train operation.

At first, the only way to recharge the auxiliaries after the brakes had been set, was to release the brakes; and the engineer having no control over the brakes during the period of recharging, runaways and disastrous wrecks were the results. Later, the device now in use, the retaining valve, was placed on the end of each car. With this attachment a pressure of 15 lbs. is retained in the brake cylinder while the auxiliaries are being recharged, but it is not controlled by the engineer and has been found deficient on steep grades. Many experiments have been made with the idea of overcoming these defects only to be abandoned as impracticable.

The inventor began work on his invention in 1900, but not until ten years later were his efforts crowned with success. Since then he has been adding new features and correcting small defects, and the device is now before the public for its inspection. With it in service the auxiliaries can be recharged at any time, placing the train in control of the engineer at all times.

The train-line pressure enters under both pistons and forces them to normal position. The release piston valve opens the exhaust port from the ...

and the hub on the lower side of the release piston seats on a gasket which covers about 1 sq. in. of piston, making it differential, and opens the vent port under the hub, releasing the air in the small chamber in the hub. The auxiliary piston moves down at the same time and admits air from the auxiliary to the brake cylinder, closing when the auxiliary pressure becomes a fraction weaker than the train-line pressure. The engineer now puts his brake valve in running position and charges up the auxiliary to normal. The release piston holds seat on



A. Branch pipe. B. Vent valve. C. Release piston. D. Release piston valve. E. Auxiliary pressure. F. Exhaust port. G. Emergency valve and spring. H. Emergency port. I. Port to auxiliary. J. Feed groove. K. Admitting piston. L. Admitting valve. M.M. Train-line pressure. N. Port from auxiliary to brake cylinder.

... pressure

A STORAGE BATTERY HAND LANTERN

JAMES P. LEWIS

A storage battery flashlight, or lantern, designed to take the place of an ordinary oil lantern about the house is very useful and well worth the trouble of constructing.

The lantern shown in the accompanying drawing is but little larger than a large flashlight, and will give as much light on a single charge; the price for re-charging being much cheaper than a new dry battery.

The cells, of which there are two, are carried in an outer case *A*, Fig. 1, of some hard wood, such as oak. This should be neatly and carefully put together with screws and glue, and afterwards varnished or polished, so as to

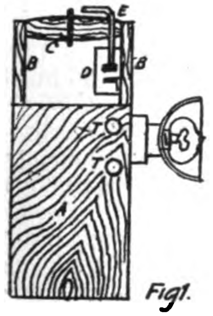


Fig1.

Fig2.

Fig3.

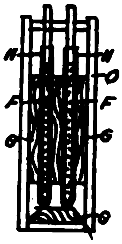


Fig4.

present a good appearance. The two end pieces should be left longer and cut to shape shown in Fig. 3. To form a support for the handle, about 1/4 in. material should be used if the case is made say 2 1/2 x 2 1/2 in. by 4 in. high.

For each cell there are two plates (a positive and a negative), and they are held in separate containers inside the wooden case. These containers are made of 1/8 in. hard fiber, the pieces being held together with a good tough cement aided by a few 2-56 machine screws. After the jars are finished, they are boiled one or two hours in melted paraffin to render them thoroughly acid-proof.

The plates are made as shown in Figs. 2 and 4 at *F*, each being a long strip of 1-25 in. sheet lead bent double, first punching them very full of 1/16-in. holes. The 1/8-in. space left between the sides of the plates is filled with a paste made as follows: Mix one part of sulphuric acid in 20 parts water. Use part of this solution to make a stiff paste with red lead for the two positive plates, and with litharge for the two negative plates. After the paste has hardened, rivet (using lead rivets) a strip of 1/8 x 1/4 in. lead, between the top edges of the plates. One end of each strip projects about 1 in., and is bent up at right angles so as to project through the end to form a terminal. The two open edges of the filled plates are now squeezed together with a pair of pliers, so as to prevent any paste from falling out. Small paraffined wooden strips *G* are used to wedge the plates in the cells, and to hold them apart and from the bottom. There should be about 1/8 in. between each pair of plates. The lids are now cemented on with paraffin, a 1/4-in. hole being bored in them to pour in the electrolyte. This hole is fitted with a soft rubber cork, which is removed when charging.

A 4-volt tungsten miniature bulb fitted with reflector is mounted on the outer case, also two binding-posts for connection when charging battery.

A good switch or push is made as shown in Figs. 1 and 3. It consists merely of a spring brass piece *K*, having one end secured to the base and the other carrying a contact which touches a contact *N* when spring is pushed down by rod *E*, which projects through the handle and is bent over at right angles on top. When a permanent contact is desired a ring on the handle *C* is slipped over the bent end of rod to hold same down. A small brass case *D* is made to inclose these switch parts, the main purpose of which is to inclose the tiny spark at the contacts when they are broken, so that the lantern may be used without danger around gasoline fumes, etc.

The electrolyte is made of six parts water to one of sulphuric acid.

The cells are connected in series and

(*Continued on page* 190)

WIRELESS AS AN AID TO SAFETY AT SEA

The advances made during the past five years in the application of wireless telegraphy have been remarkable, but in no direction have results so beneficial been achieved as in the marine field. Safety of ships at sea is a question upon which public attention has been focused since the loss of the *Titanic*. The advantages of wireless telegraphy for ship to ship, ship to shore, and shore to ship communication are obvious enough, and it is satisfactory to learn, says the *London Times*, that no rivalry between different systems will in the future prevent that free interchange of signals between ship and shore stations which is essential if the full benefits of wireless communication are to be assured to shipping interests. Nearly all passenger vessels now possess a wireless installation, either on the Marconi or the Telefunken system, and the number of shore stations is being rapidly increased. The latest phase of Marconi development is the agreement with the Government for a chain of wireless stations round the world on British soil. The existence of these long-distance stations should be of advantage to shipping interests.

Hitherto the ship installations of wireless plants have been almost entirely confined to war vessels and passenger steamers. The 1½ k.w. apparatus which is usually fitted in passenger ships is designed to have a large working range, and to be capable of being turned to various wave-lengths. The equipment of cargo steamers has hitherto been retarded by the absence of a sufficiently small, compact and efficient set, but there has been provided a ½ k.w. set which is specially adapted to the requirements of cargo vessels. This is a small power installation designed to produce transmitting waves of 250 to 600 metres, the transmitting range depending upon the height, length and shape of the aerial. The receiving apparatus provides for tuned reception of all waves between 250 and 1600 metres.

Another development of comparatively recent date is the wireless compass. The great development in the size and speed of modern ships has brought with it an increase of responsibility to those entrusted with their navigation. The need for a ready means of determining the position of a ship under all conditions has grown more urgent. It is claimed that the wireless compass is destined to prove an important new aid to navigation. It is not necessary to enter into the technical details of the apparatus; it will be enough to say that it does not give magnetic bearings, but positions with regard to the axis of the ship, which is determined by the magnetic compass. This being known, the wireless compass can be employed to give the position of the ship in relation to any shore station as well as the direction of an approaching or overtaking ship. The apparatus is designed to work with ship standard wave-lengths.

The great increase in the number of passenger vessels fitted for wireless communication—it is stated that 1000 were fitted in 1911 compared with 468 in 1910—is due partly to the initiative of shipowners, but is also to be attributed to the laws now in force in several countries which compel passenger vessels that carry more than a certain number of passengers to be equipped with wireless apparatus.

Almost simultaneously with the first application of wireless telegraphy to marine communication, the necessity, not only for the duplication of essential parts of the apparatus itself, but also for the provision of a source of electric current independent of the ship's dynamo, was foreseen, and special apparatus was designed for this purpose. This was over twelve years ago in the *Republic*. With engineroom flooded and all electric lights out, the wireless station was able to continue work for several hours by means of the emergency gear and call other steamers to her aid. Recently the principal powers have in their regulations made an emergency transmitting apparatus a compulsory part of a ship's installation.

A Storage Battery Hand Lantern

(*Continued from page* 189)

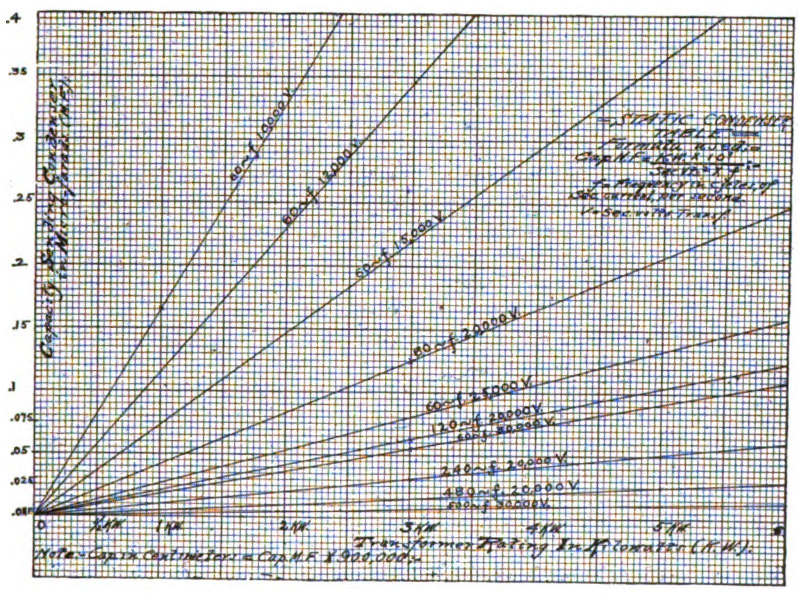
should be charged with 5 volts and ½ ampere for from four to six hours, a longer time being required for the first charge. Gravity cells may be used if no better source of current is available. They will hold the charge much better if the acid, lead, and paste are chemically pure.

SOME PRACTICAL HINTS ABOUT WIRELESS STATIONS

H. WINFIELD SECOR, A.M.A.I.E.E.

Now that the new wireless law has gone into effect, and the wireless industry, both experimental and commercial, has found itself, so to speak, the principal points to be watched in wireless plants will be, how to increase the efficiency with a given power, and how to have the station conform to the Underwriters' rules. Hence, the following may be of interest to those just installing or overhauling their stations.

A set of curves is presented herewith, enabling the proper capacity of transmitting condenser to be used with various voltages, and frequencies to be readily ascertained without any computations. Formulas have been given from time to time, in this and other periodicals, for calculating the capacity and dimensions of glass plate condensers for transmitters, and so I am not going to repeat them here.



A few figures on the capacity per unit area of active dielectric may simplify matters considerably, however, and the following value has been found by tests made for the author by Dr. A. N. Goldsmith, at the Radio Laboratory, The College of the City of New York.

The glass tested was an ordinary grade, and the value of the specific inductive capacity, or K, was ascertained to average 4.21 ± 0.02 at 5 volts, and 300,000 cycles frequency (1,000 meters wavelength), while at 50 volts and 60 cycles frequency K averaged 4.0 ± 0.2. The value of K thus found is of interest, as it is at these higher frequencies that the glass is used for transmitting condensers. The thickness of the glass tested was about 1.5 mm. or 1/16 in. nearly (.059 in. +). The capacity in microfarads (mf.) per 1 sq. in. of active air dielectric, 1/16 in. thick, is .000003596 mf., and for common glass similar to the above, the unit capacity per 1 sq. in. active area (covered on both sides by charging surface) is .00001513916 mf. for a thickness of 1/16 in.; and if the glass is 1/8 in. thick, the unit capacity per 1 sq. in. of active glass used, will be only one-half this value. The capacity is directly dependent upon the thickness of the glass; being higher for a decreasing thickness of dielectric, but of course the glass must be strong enough electrically to stand the charging voltage, or else it will break down or puncture.

The capacities of sending condensers required, as given by the curves here, are all right for fixed or quenched spark gaps; but for rotary gaps having a number of studs on them, the capacity may be approximated by dividing the number of breaks per second, by 2, and using this factor for the value of *f*, in the formula given on the curve table. It is seen that the higher the voltage the less condenser capacity is required, and this varies inversely as the square of the voltage. The higher the frequency of the current charging the condenser, the smaller its capacity must be, or else it cannot become fully charged at each spark. For this reason an adjustable condenser is of great advantage in tuning up a transmitting set, especially where electrolytic interrupters or rotary spark gaps of variable speed are employed.

The connections of the transmitting apparatus are quite important, and are often overlooked by the experimenter. The primary wiring, supposing that commercial current from light or power circuits is employed to operate the transmitter, should be as carefully installed as all regular electric wiring, and if anything, more so. Copies of the Underwriters' Rules should be obtained from their offices in the larger cities. The primary wire should be rubber-covered, single braid if exposed, and double braid if enclosed; and flexible or rigid metal conduit may be used, or the wires can be run on porcelain knobs or cleats. Where the wire passes through any woodwork, or touches it, it should be encased in a porcelain tube in such a manner that the tube cannot slip away from its original location, and allow the wire to come in contact with the wood. Mount all the transmitting apparatus on hardwood strips or pieces of fiber, and these in turn on large porcelain knobs, so as to keep the high voltage current from leaking away, and thus lowering the working efficiency of the set.

The primary circuit of the transmitter should be provided with proper size and type of fuses, to protect the circuit against undue overloads, short-circuits, etc. The Underwriters' Rules require that the primary wireless circuit be protected against surges or kick-backs, by the connection of two fixed condensers, having at least ½ mf. each, in series across the primary wires, close up to the transformer terminals, with connection between the condensers grounded by an independent ground wire to the nearest water pipe or the station ground. A fixed condenser, having ½ mf.+ capacity, and easily made, may be composed of 1,845 sq. in. of .003 in. thick paraffined paper, coated on both sides with tin-foil. The paper should be about ½ in. larger all around than the tin-foil; and in this design, 16 sheets of 3½ x 35 in. tin-foil, with 15 waxed paper leaves between them, and one on top and bottom, and then the whole rolled up, have been employed.

It is well to use about 2,000 sq. in. of paraffined paper, as the thickness may vary, and also the tightness with which it is compressed. Every other tin-foil leaf is joined to a common terminal. A 5-ampere plug fuse should be inserted in series with each condenser, in case they happen to break down or short-circuit.

As is generally known the Underwriters require that the aerial lead-in wire and ground wire from the antenna switch or lightning switch shall be No. 4 B.&S. gauge copper at least, and while solid wire gives good results, much greater efficiency, both in the transmitting and receiving range, is noticeable if No. 4, or larger, stranded copper cable is used. This cable is best rubber-covered, but need not necessarily be. It should be run on large glass or porcelain insulators. The usual ground connection is on the street side of all meters, etc., on a water main. Failing this, an artificial ground must be formed; and one of the best, and at present used by the Federal Telegraph Co. at their large stations on the western coast of the United States, is the radial ground. This is formed of a number of radiating wires joined to one large conductor, and these wires are buried under the ground a few feet, but have been employed with the radial wires laying on top of the ground. For a small station, the wires may extend out 20 to 30 ft. or more from the central conductor. A dozen or so wires may constitute the radial system.

A good idea followed out by the Marconi Co., and others, is to provide choke or impedance coils at the secondary terminals of wireless transformers, to prevent the wasteful and dangerous surges from the condenser or oscillating circuit from backing up into the secondary of the transformer.

(*Continued on page* 197)

BECOMING A COMMERCIAL RADIO OPERATOR

Every summer a large number of students in the various high schools and colleges throughout the country find very pleasant occupation as radio operators on the vessels engaged in coastwise trade. A large number of extra ships are put into service, or are changed from freighters to passenger ships during the summer months, causing accordingly a great demand for radio operators. In the past the supply has nearly always equaled the demand, oftentimes surpassing it, but things have a different aspect this year. The new wireless law makes the number of cases where it is necessary to employ radio operators far in excess of what it has been in the past. At the same time the law has placed many restrictions on the class of operators that may be employed. Many wireless amateurs throughout the country who are considering entering this occupation next summer are inquiring as to what they must know in order to obtain the necessary federal license. With the view of answering these inquiries, we have compiled for our readers a set of questions such as are being asked at the examinations at the various Navy Yards.

Before giving this list, it might be well to consider the duties and the pay of a radio operator. The new law has caused many changes to be made in both of these. As far as they place restrictions on the operator his duties are defined in the text of the law. In general, however, the duties of a radio operator depend upon the kind of station he is placed in. There are two grades of commercial radio operators: a commercial first grade and a commercial second grade. As far as the exact statement of the law goes, the only difference between these grades is the speed of operating. A commercial first-grade operator must be able to receive and transmit in Continental Morse code at a rate of twenty words per minute, while a second-grade operator is only required to have a speed of twelve words per minute. This, however, is not the essential difference. Since had actual experience in wireless work, pirmarily in commercial work. This is done as a protection to those persons who make wireless their profession, and it is a just ruling. The larger steamers which take several days between ports have, for the most part, two operators, one of which is a first-grade and the other may be either first or second-grade. The first-grade operator is directly responsible for the care of the station and its instruments. The smaller steamers usually have but one operator, which in most cases is a first-grade. The operator in charge of the station is responsible for all of the wireless apparatus including the aerial, although the law is so framed that the company in whose employ the operator is, is required to furnish him with the necessary apparatus. He must take care of the motor generator set and the storage batteries, being able to make small repairs to either. Since he is employed by a wireless company, and not the steamship company, he reports any grievances to the wireless company. He is, however, subject to the orders of the commanding officer of the vessel in so far as they pertain to his duties as radio operator. In case the orders of the commanding officer conflict with his duties as required by law, he is to obey the law; and if the commanding officer refuses to permit the fulfilment of the law, the radio inspector should be informed at once on the docking of the vessel. Such circumstances as these are infrequent occurrences, yet they do happen. The commanding officer may request the removal of any unsatisfactory operator, and he may make any rulings regarding the operating room or the operators' quarters that he deems necessary. Where there are several classes of service, the radio operator usually takes his meals in the second cabin. On the whole the duties of a radio operator are light and pleasant.

Since the law has gone into effect various changes have been made in the wage scale. The scarcity of operators has receive. It would vary very largely with the kind of vessel he got on. One company formerly doing business on the Atlantic coast paid thirty dollars a month and found. In addition to this, ten per cent. was allowed as a commission on all paid messages transmitted. This latter provision added very materially to the pay of the operators. Cases have occurred where operators on coastwise boats completing their trip in a day have cleared fifteen dollars on a trip, but these cases are exceptional and should never be relied on. Another company paid the operators in charge of ship stations eighty-five dollars a month and the operators in charge of land stations one hundred and fifty dollars a month. This scale has been somewhat reduced since the new law went into effect, because it has been necessary to employ two operators where one was sufficient before. The amount which an operator can make in the three summer months would probably vary from one to four hundred dollars. Of course it is understood that a new operator cannot expect to receive as much as an experienced operator.

After deciding whether or not a person wants to take up the occupation of a radio operator, either for permanent or for summer work, the next thing for him to do is to familiarize himself with the subject matter of the examination. He should be able to receive and transmit twenty-five words per minute, although the law only requires twenty. This would allow him a margin in case he made a mistake in the speed test. He should be thoroughly familiar with the new law and the Berlin Convention. If living near a seaport he should visit as many ship stations as possible because he will be required to state the types of apparatus with which he is familiar. He should be careful not to make any false statements in regard to the extent of his knowledge, because in the oral part of the examination he may be asked to describe anything which he claims to be familiar with. A thorough knowledge of some type of auxiliary set should be obtained, especially that part which deals with the storage cells. Great emphasis has been laid on this point. The subject of motor generator sets is taken up from a practical point of view rather than from a theoretical viewpoint.

When the prospective radio operator has satisfied himself that he can fulfill the requirements he should write to the examining officer of the nearest place where the examinations are held for Form 756. The places where examinations are now being held are: The Navy Yards at Boston, Mass., Brooklyn, N.Y., Philadelphia, Pa., Washington, D.C., Norfolk, Va., Charleston, S.C., New Orleans, La., Mare Island (San Francisco), Cal., Puget Sound, Wash.; at the Naval Academy, Annapolis, Md.; also at Fort Sam Houston, San Antonio, Tex., Fort Wood, New York Harbor, Fort Omaha, Neb., Fort Leavenworth, Kan.; at the Army stations at St. Michaels, Alaska and Fairbanks, Alaska; also at the Bureau of Standards, Washington, D.C. After filling out this form he should return it and await an appointment for the time when he may appear for his examination. When he goes to take this examination he is first given a question blank to fill out which requires information regarding experience and familiarity with radio apparatus. Besides this, information of a personal character is asked for. After this form has been filled out the written examination commences. The questions are passed out one by one, and no question is passed out until the one preceding it is finished. These questions are about all matters pertaining to radio telegraphy. After the written examination is completed, the speed test is taken, although in some cases this is left until last. Where it is taken in the middle, in some of the Navy Yards it is necessary to take a quarter of a mile walk between the building where the speed test is taken and where the rest of the examination is held. In this speed test five letters are counted to the word, deductions being made for running the words together. Numbers as well as letters are sent. When the speed test is finished, the examining officer asks several oral questions to which oral answers must be given. This part of the examination is divided into three parts: general knowledge of international regulations and Acts of Congress to regulate radio communication; the care of an auxiliary; general adjustment, operation and care of apparatus. Three separate marks are given for this part of the examination. When these questions have been answered. the examination is completed. About four hours is required for the entire examination. The time which the applicant has to wait before he is informed whether or not he has passed is anywhere from one to four weeks.

The type of questions that are being asked are given in the following list. Most of these questions have been taken from examinations given during the past month at the various Navy Yards. The list includes the oral as well as the written questions. It has not been an infrequent occurrence for the same question to be asked both on the written and oral parts.

1. What do you understand by the Berlin Convention?
2. Explain the method of calling a station and the form of transmitting a message as prescribed by the Berlin Convention.
3. What words are counted in giving the check for a message?
4. How are numbers counted in giving the check for a message?
5. What restrictions does the Act of August 13, 1912 place on radio operators?
6. What provisions are made for the secrecy of messages?
7. What is the fine for disobeying the regulation for the secrecy of messages?
8. What is the fine for disobeying the regulation regarding the sending of false signals?
9. What is the international distress call?
10. What wave-length must this call be sent on if it is possible for the ship to obtain that wave-length?
11. What would you do if you heard the distress signal?
12. If you were to send a distress signal and wanted some particular station to answer, how would you send the additional information and what would it consist of?
13. What wave-lengths are ships permitted to use?
14. What wave-lengths are reserved for government stations?
15. Upon what does the wave-length of an oscillatory circuit depend?
16. Suppose a transmitting station was emitting a wave-length of 300 meters, and the natural period of your antenna was 600 meters, how would you place your receiving set in tune with the 300-meter wave?
17. How would you measure the wave-length of your transmitting set if it was properly tuned?
18. How do you tell when your transmitting set is properly tuned?
19. How would you determine the natural period of your antenna?
20. How would you tell whether or not your aerial was radiating energy?
21. Give the formula for determining the wave-length emitted from a simple oscillatory circuit, considered to be made up only of capacity and inductance.
22. What relation exists between the frequency of a simple oscillatory circuit and its wave-length?
23. What is meant by electromagnetic waves?
24. What is their velocity?
25. What is meant by resonance between two circuits?
26. Where would you insert a loading coil in the receiving set and what effect would it have on the wave-length?
27. In a receiving set show by a diagram and explain what the difference between a tuned and untuned oscillating circuit is.
28. Describe a hot-wire ammeter and explain its uses in the transmitting set.
29. What are the uses of a wavemeter.
30. Draw a complete circuit diagram of a wavemeter and explain the principle on which it works.
31. If you increased only the capacity of the closed oscillating circuit of your transmitting set, would you change the emitted wave? Would your set still be in tune?
32. Draw circuit diagrams and explain the necessary steps to take in adjusting a transmitting set to a 300-meter wave-length.
33. Explain how you would change the wave-length of your transmitting set from 300 to 600 meters.
34. Explain what you understand between tight and loose coupling. Where does the division between them come?
35. What is meant by mutual inductance, and what effect has it upon coupled circuits?
36. What two forms of coupling are used in wireless, and what are the advantages and disadvantages of each?
37. What are damped and undamped oscillations, and the advantages and disadvantages of each?

38. Explain the meaning of the logarithmic decrement.

39. In the receiving set, what do the open and closed circuits include?

40. In an inductively coupled transmitting or receiving set, how does the energy get from the primary to the secondary circuit?

41. What is meant by a pure wave?

42. What are the advantages or disadvantages of a pure wave?

43. What does the new law say about pure waves?

44. What is a potentiometer used for in a receiving set?

45. If you should fail to receive any signals and you knew that they were coming, explain how you would test the various pieces of apparatus in the receiving set for faults.

46. If you knew that your receiving apparatus was all right and you still failed to receive the signals, what other tests would you make?

47. Explain how a silicon detector works.

48. If one of the condenser jars of the transmitting set became punctured and you did not have another to replace it with, how would you place your set in tune?

49. Draw a complete circuit diagram of a transmitting set from the direct current mains to the antenna, showing all switches and protective devices.

50. Describe the principal parts of the transmitting set, giving the uses of each instrument.

51. Describe three forms of condensers used in transmitting sets.

52. What is meant by a step-up transformer?

53. Describe an induction coil and explain the circuit diagrams in detail.

54. Describe and give the advantages or disadvantages of three types of spark gaps commonly used on transmitting sets.

55. What is meant by a synchronous spark gap. Explain its advantages.

56. What is the most common cause of the breaking down of high-potential condensers?

57. Describe the type of switch for changing from the receiving to the transmitting set that you are familiar with.

58. Draw a complete circuit diagram of a direct-coupled tuner and detector including the battery, potentiometer, and head phones.

59. Draw a complete circuit diagram of an inductive coupled receiving set, including one fixed and two variable condensers.

60. Explain the difference between a fixed, an adjustable, and a variable condenser.

61. Does it make any difference in the direction which the battery current flows through a carborundum crystal?

62. Name and describe four kinds of detectors.

63. What is meant by a rectifier, and why is it used in charging storage cells from A.C. mains?

64. Show how you would connect twelve Leyden jars so that there would be four in series and three in parallel.

65. What is an auto transformer and why is it used in place of an inductively connected transformer?

66. How would you locate a short-circuited field coil in a motor?

67. How would you locate a short-circuited armature coil in a motor?

68. Why is there a commutator on the motor and none on the generator?

69. What is the effect of changing the brush lead on the motor?

70. Suppose upon starting a motor generator set it refused to generate current, where would you look for the trouble?

71. Draw a circuit diagram of a differentially wound motor generator.

72. What is the advantage of using a differentially wound motor?

73. What would you do if the two field rheostats should burn out while you were at sea?

74. Explain the mechanism of the automatic break of the starting box.

75. How would you increase the voltage on the A.C. side of the motor generator set? Within what limits would you consider it permissible to increase this voltage?

76. Considering the brushes of the motor fixed, how would you increase the speed of the motor generator set without the use of a field rheostat?

77. What are some of the causes of sparking at the commutator?

78. How would you attempt to stop the sparking at the commutator?

79. Suppose that by some accident it was necessary to remove the connections to the motor generator set in order

to rewind a coil in the armature, upon starting the set again it was found that the armature ran backwards, how would you adjust matters so that it would again run in the right direction?

80. Suppose that the generator was wound for a frequency of 60 cycles, would it be possible to obtain 120 cycles from it at full load? Why? How?

81. Suppose that you decrease the current flow in the field coils of the shunt motor of the motor generator set ten per cent., what effect would it have on the speed of the set? Would the output vary?

82. What kind of current is supplied to the field coils of the motor of the motor generator set, and where is it obtained? What kind of current is supplied to the armature?

83. What kind of current is supplied to the field coils of the generator of the motor generator set, and where is it obtained? What kind of current is delivered by the armature?

84. Describe three protective devices that may be used in the motor generator circuit?

85. What is the cause of pounding in the motor generator set?

86. If by some accident the field coils of the motor should become demagnetized, how would you go about remagnetizing them?

87. Upon starting the motor generator set after you had found it necessary to take it apart for repairs, you should find that it was turning over at an excessive speed, where would you look for the trouble?

88. Assuming that the windings were designed for an overload current and that the insulation was good for an overload voltage, what would be the objection, if any, to running the motor generator set at a high overload speed?

89. In what cases is it necessary to employ a motor generator set?

90. Describe a lead plate storage cell with which you are familiar. What is the electrolyte used in this cell?

94. What is meant by the specific gravity of a solution, and what does it show?

95. Suppose that your cells should become sulphated, how would you remedy their condition?

96. When the solution becomes low in your cells, what do you add to fill up the cells?

97. Describe the new Edison storage cell, giving the positive and negative poles, also the electrolyte employed.

98. What is the voltage range of the lead storage cell? Of the new Edison cells?

99. Describe the underload protector used in charging storage cells.

100. Draw a circuit diagram showing the connections used in charging a storage battery. Mark the positive poles of the battery and of the generator. Include all protective devices and controlling rheostats. Show where the volt and ampere meters are placed.

Some Practical Hints about Wireless Stations

(*Continued from page* 192)

The author made some tests with such choke coils on an E. I. Co. ½ k.w. open core, 30,000 volt, transformer coils, in their Radio Laboratory; and with a coil composed of 8 turns of No. 4 B.&S. solid copper wire, having a mean diameter of 1¾ in., and turns spaced ½ in. apart, connected to each secondary terminal, the radiation current as indicated on a hot-wire ammeter was increased from 12 to 15 per cent. This shows that previously there was evidently a heavy surging from the condenser circuit back into the secondary of the transformer. The above test was performed with an electrolytic interrupter in the primary, and consequently the secondary frequency was very high, and the choke coils used were probably about right, but where 110 volt a.c. 60 or 120 cycle current and transformers are employed, these

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.

1935. **Calibrating Ammeter.** J. A. E., Haddonfield, N.J., says: I am trying to find a way that can be used by amateur radio operators in calibrating a hot-wire ammeter accurately in amperes. Having made the wavemeter described in the September issue of your magazine, I am following up the same line of work on my own account. Since Ohm's law, I equals E/R, is not true for high-frequency currents (frequencies of near a million), how may it be changed to apply, or what law may be used in its place; so that, given any two of the three quantities, the third may be found? Ans.—Your case is that of many amateurs where it is impossible to obtain an ammeter to calibrate another instrument by. We do not see how it will be possible for you to calibrate your instrument unless you can obtain some form of a standard instrument. We could give you other methods but they would be more expensive than purchasing an instrument outright. Is there no laboratory where you could take it and get it calibrated? The assistants of college or technical school laboratories are usually glad to do such work at a small cost. Although the relation does not strictly hold, the more general method for calibration of hot-wire ammeters is to compare them with a standard meter on steady direct current. What you measure on the meter when used in connection with a wireless set is the equivalent heating effect as compared with unit direct current.

1936. **Dynamo Construction.** A. J. G., Hartford, Conn., says: I intend to build a dynamo that will generate 8 volts at 3,000 revolutions per minute. For the field magnet I have a field of a G.C. a.c. fan motor, on which I intend to put cast-iron extensions, as shown in the drawing. The machine is to have 8 brushes, shunt winding, and a rheostat between one set of brushes and the field. (1) What will be the size of the armature, number of slots, and where can I buy the stampings? (2) What will be the windings for this machine? (3) What kind of storage cells are there that are not in practical use? Ans.—(1) We presume you intend to have the cast-iron flanges match the 8 poles their entire length, though cased off with liberally rounded edges. If you have sheet iron only within the field spools, there will be no residual magnetism with which to enable the generator to start. The cast-iron extensions will hold sufficient magnetism. The 8 spools can be wound with No. 20 single cotton-covered wire, 24 turns per layer, and at least 7 layers—8 if possible. After winding two coils with 8 layers, try them on adjacent poles, and if they will go on without interference, wind all with this number. If there is difficulty in placing them, remove one layer. There will be no harm in having the spools with alternately 7 and 8 layers. The idea is to get on all the wire possible. For armature punchings you can correspond with the W. & S. Mfg. Co., Worcester, Mass., or F. E. Averill, Buffalo, N.Y. Perhaps the nearest size will be 3¾ in. in diameter, just the size of your field bore, and in that case you would need to bore the field space out about 1-16 in. larger. If you get punchings with an even number of slots or holes, the number should be divisible by 8. In this case you will have to adopt a "multiple" winding and employ 8 brushes, just as you propose. If you can get punchings with certain odd numbers of slots—those nearly divisible by 8—you may adopt a "series" armature winding, such as is common in railway motors, and use but two brushes, these being in your case 45 degrees apart; 25 slots will be a permissible number, and if you succeed in getting such stock we will be pleased to give definite directions as to the winding. Why not utilize the regular rotor punchings that belong with the present machine? They have an odd number of slots.

1937. **Aerial.** P. H. M., Beaver Dam, Wis., asks: (1) Would aerial as shown by sketch be satisfactory? (2) If it would not be a good aerial, would you please tell me how to make it so? (3) Would there be much induction from the electric light wires? Ans.—(1) Yes. (2) It would be better to use a single electrose insulator in place of the porcelain cleats. The additional cost of the electrose insulator is warranted by the increased efficiency. (3) The chances are that if any ground on the light wires occurred you would be troubled. It would be better to shift the antenna so as to have it at right angles to the electric light wires.

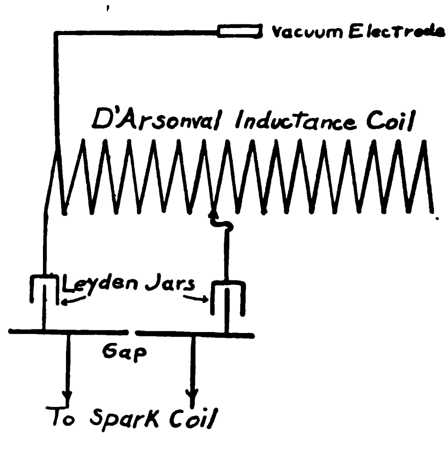
1938. **Electric Furnace.** H. F. D. S., New Haven, Conn., says: I have an electric furnace for the remelting of metals, in which I use a heater (carbon resister) in its well, and another carbon resister above the same for the actual work or the fusing of the metals by its generated heat, which is a success. Now, each of these resisters is directly connected by separate switches with the line provided with an intermediary rheostat to reduce the direct current of 50 k.w. from 220 volts to 110 volts in five steps. Now, under these conditions, can both resisters be operated together at the same time? The electrician making the switchboard and connections denies this and claims that the voltage would increase by one-half if both resisters were put into the circuit at the same time, and consequently make it inoperative. Is this correct? Ans.—As far as we can see your contention is correct, but we would be glad to see a diagram of the connections as provided by the electrician. Why not try the experiment? You have instruments and fuses in circuit, so as to note the result and prevent accidents.

1939. **Advisability of Patenting.** G. W., Canastota, N.Y., says: I have an arrangement by which I change a direct current to an alternating one to be used in a transformer. I just tried it tonight. I got a spark across the gap in an ordinary spark plug with about 12 or 15 volts in primary without the use of a vibrator. The article can be made for from about 5 cents each up. Do you think there would be any demand for an article of this nature that would be worth while getting it patented? Ans.—As you give no clue to the principle involved in the invention, we cannot undertake to guess whether it is valuable or not. Perhaps the idea is really an old one. Anyway, we would advise you to give the device a thorough test before spending any money. Try to operate it weak without stop and thus demonstrate what the test of time will do. Certainly if you can obviate the use of an interrupter you have a suspiciously good thing.

1940. **Rheostat.** X. Y. Z., Mattapan, Mass., says: Will you kindly tell me how to construct a rheostat that will cut 110 volts direct current to 10 volts? I wish to charge a 10-volt, 60-ampere-hour storage battery, but the ordinary 110-volt direct current is too strong for this purpose. Ans.—You do not state at what rate you wish to charge the cells, but we imagine 2 or 3 amperes will be proper. Incandescent lamps make about the best and cheapest sort of rheostat. Provide five or six "key receptacles" for standard incandescent lamps. Wire them together in parallel, in the ordinary manner. From your incandescent lighting circuit, lead one wire to one side of the row of lamps; from the other side lead a wire to the battery; from other side of battery lead a wire to remaining side of lighting circuit. Of course it would be well to provide a fuse cut-out, but the regular one in the distribution cabinet will suffice. Put 100-volt or 110-volt 16 c.p. lamps in the sockets, and by turning on more or less of them considerable variation in charging current will be offered, each lamp taking about one-half an ampere. If desirable to charge at a higher rate, 32 c.p. lamps can be used. To avoid running the lamps entirely at loss, they may be distributed in some otherwise dark corridor or basement, and by selecting the 100-volt sort, full candle-power will be realized. Of course the lamps should not be used when not charging batteries, for while they would give a fine light, they would soon burn out.

1941. **Voltage Regulator.** J. B., Bridgeport, Wash., says: (1) I have thought out a device which will automatically regulate the voltage on a lighting or power system. It is in the form of two plungers working inside of two wire-wound magnets and an arm is attached to a sliding bar on the current regulator. I want to know whether it is on the market or in use. (2) Cannot the telephone be arranged to ring the bell from the battery instead of using a generator to ring the bell, and have the bell ring by a push button contact in the battery circuit? Ans.—This idea is an old one, and in the past has been largely used, especially in connection with water-driven dynamos. The principal defect in the apparatus is that it is too sluggish or goes too far. It acts like a man "making" first base. He runs over. The name formerly associated with regulators of this class is Chapman, and probably no one has made a greater variety than he. We would advise you to consult the indexes of the electrical magazines of 15 to 20 years ago. At the present time the "Tirrell" regulator has displaced all other sorts. (2) Yes, house telephones, or those for short private lines, ordinarily utilize the batteries for ringing. In this case the bells are of the ordinary household type, fitted with make-and-break contacts, rather than of the "polarized" type, which operates on alternating currents only.

1942. **High-Frequency Apparatus.** L. H. B., Stockton, Cal., asks: Will you have the kindness to inform me whether there is any book published which gives practical working directions for the making of a d'Arsonval apparatus together with an Oudin resonator for generating high-frequency currents? If there is no such book or pamphlet printed, will you kindly advise me as to the best method of obtaining the desired information? Ans.—The June and July, 1911, issues of the *Electrician and Mechanic,* which



we can furnish for 15 cents each, contain a description of an Oudin resonator for the production of high-frequency currents. If you care for a more detailed description of apparatus for high-frequency work, we can furnish you with a book on the subject by Haller and Cunningham, for $1.25. In case you are going to use the description given in the above-mentioned magazines, the sketch will show you how to connect up for a d'Arsonval apparatus. The inductance coil is the primary described in the articles, but for this purpose it might be well to add a few extra turns to the number necessary for the primary of an Oudin resonator.

1943. **Mercury Interrupter.** P. E. R., Los Gatos, Cal., asks: How can I make a rotary, mercury interrupter that will break 25 amperes of storage battery current, with a frequency of about 200 sparks per second? Would a small metal wheel with four or six studs dipping into a cup of mercury be possible for such an interrupter? Ans.—A rotary, mercury interrupter to successfully break 25 amperes would have to be very carefully constructed. The arc produced at the break of a poorly-made interrupter would render its use impossible for wireless work. It is very hard to break the current quickly with a wheel having studs dipping in and out of mercury. The usual type of interrupter is the turbine type. It would be impossible to give a working description of such an interrupter in this column, but you will find a description of several types in "The Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming, pages 54 to 68.

1944. **Wireless License.** G. R., Springfield, Mass., asks: I have a set with an aerial about 100 ft. long and 30 ft. high. Receiving part only. (1) Is it necessary that I have a license for the same? (2) If so where is the nearest place I can get one? (3) Can I get it by mail? Ans.—(1) For receiving only you will not need a license for your station. (2) For New England the office of the Radio Inspector is at Long Wharf, Dept. of Labor and Commerce, Boston Mass. (3) Second grade operators' licenses may be obtained in this manner. For an operator's license apply also to the Radio Inspector at Boston.

1945. **Wave-length.** J. R. P., Grand Manan, Can., asks: With the help of the enclosed rough sketch, will you please determine for me (1) my wave-length; and how far I should be able to send; (2) Is my oscillation transformer constructed on the proper lines? (3) Please say if there are any alterations I can make that will improve the apparatus. The X marks the position of my station, and the surrounding hills are about 350 ft. high, wooded and about 2 miles from my station. With my receiving instruments I am able to hear Cape Cod, and by using an old telephone line for an extra aerial I can get Glace Bay very plainly. I would be very grateful for any suggestions you could give me that would improve my sending instruments. Ans.—(1) Local conditions make such a difference that it is impossible to give any data on wave-lengths or sending distances; still, from the dimensions given on your drawing it would be surprising if you could obtain a wave-length less than 300 meters. (2) Yes. (3) You might replace your stationary gap by a rotary or quenched gap.

1946. **Poulsen System.** C. E. W., Pikeville, Ky., asks: Will you give me as much information as possible on the Poulsen system of Wireless Telegraphy? (1) Can 220 volts d.c. be used instead of 550 volts d.c., and what would be the range of such a transmitting set? (2) Can an arc lamp run on 220 volts d.c. be used for sending? If not, what kind of arc can be used, and could you tell me how I can make one? (3) What ... gram of both sending and receiving of this system. (6) Can d.c. be changed to a.c. when run through a rectifier? If so, give me a wiring diagram. (7) Can you tell me where I can get a book on Poulsen Wireless System? Ans.—In order to be fair to all of our subscribers it is necessary to limit the number of questions asked in any issue to three. You will see by reading the heading of this column that since you did not comply with the requirements of this department that your questions are not entitled to consideration, but as you have not taken your full liberty in the use of this department we will make an exception and answer your questions this time, but in the future it will be necessary to enforce the rule. (1) Yes. The range would depend on the other instruments used in the set as well as on the arc. (2) Not the regular carbon arc. It would take too much space in this column to even attempt to explain the Poulsen apparatus, but you will find several excellent photographs and a complete description of the construction and theory of this type of apparatus in the "Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming, which we can furnish for $7.50. (3) This is to increase the potential difference across the condenser. See the book by Fleming for a description. (4) Not that we know of. (6) No. (5) and (7) See book by Fleming.

1947. **Damped Waves.** L. L. R., Brookville, Pa., asks: (1) Kindly give me some rule or formula by which the frequency or number of sparks per second of a spark coil can be obtained. (2) Give rule for finding capacity of condensers, receiving and sending. (3) Explain damped and undamped waves. Ans.—(1) It is impossible to give any formula that one not well acquainted with high-frequency measurements could use. J. A. Fleming describes in his book on "Wireless Telegraphy and Telephony" a photographic spark counter devised by himself. In his description he gives the formula applicable to that particular counter. (2) In the March, 1911, *Electrician and Mechanic* you will find an explanation of the formula by which you can readily calculate the capacity of your condensers. (3) A highly or strongly damped wave is one in which the number of oscillations is small before the energy of the wave train is consumed. The greater the number of oscillations the less damped is the wave. The greater the value of the logarithmic decrement the more damped is the wave.

1948. **Wireless Telephone.** E. A. L., Sask., Can., asks: Where can I get reliable information about how to construct the best wireless telephone with earth or water connections in place of using an aerial, with diagrams of same? Ans.—You are evidently mistaken about the possibilities of using a wireless telephone without an aerial connection. If you were to connect the ground side to the ground and what is normally the antenna side to a water ground you would be grounding both sides. You cannot construct a wireless telephone that will cover any appreciable distance without using some form of aerial. We can furnish you coils. Ans.—It would be much cheaper for you to read some book on the subject of spark coils and learn the complete methods of building a coil than for you to try to construct one on the small amount of information that we can give you in this column. If you cannot purchase a book on the subject in your own country, we can send you one if you desire. If you want to construct a coil without any further study we are glad to give you the dimensions for the size you desire. A 10-in. spark coil would be about the equivalent of a 1 k.w. transformer. This coil will not develop an actual 10-in. spark, but the output will be equivalent to one of that size. The core is 24 in. long by 3 in. in diameter. It is made up of soft iron wire of about 1/8 in. in diameter. The primary consists of two layers of No. 12 B.&S. gauge double cotton-covered wire. The secondary is made up of about 40 pies, each 1/8 in. thick, with an inside diameter of 3 3/4 in. and an outside diameter of 7 1/2 in. For these pies about 15 lbs. of No. 28 d.c.c. wire will be required. The primary is insulated with a hard rubber of micanite tube. About 25 volts should be delivered at the terminals. If you use this coil on 110-volt mains it will be necessary to use a regulator, as the drop through the interrupter will not be sufficient to cut down the voltage to the desired value. To tune your set, first disconnect your ground and variometer, leaving just the primary oscillation circuit. Tune this circuit to the wave-length you desire by varying the condenser or the number of turns on the inductance. When you have a sharp wave-length of the desired value, as shown by the wavemeter, connect the ground and variometer, and by adjusting the variometer, tune until you get the maximum reading on the hot-wire ammeter and a sharp wave, as shown by the wavemeter. If you have done this carefully you should not have any wave that is stronger than 10 per cent. of the desired one.

1950. **Oiling Belts.** C. J. P., Columbus, O., asks: Please outline an effective process to drive oil and grease from old leather belts. Ans.—Certain oils are not harmful to belts, but if the size in mind is not too large we would suggest that you soak them in kerosene, and let them dry. Do not leave them in this condition, however, but proceed regularly to administer castor oil—the very best preservative yet known. It will contribute to frictional qualities, and give a fine black gloss that will refuse to attract dust. Further, the belts will be largely free from electro-static tendencies.

1951. **Transformer Construction.** L. O., Minneapolis, Minn., has made an experimental transformer, of best iron, stack of laminations being 1 1/2 in. thick, and winding space on each leg 1 1/2 in. x 1 1/2 section and 9 1/2 in. long. One leg is wound with four layers of No. 12 d.c.c. wire, taps being brought out at the 242d, 347th and 459th (last) turn. Other winding is on other leg, consisting of 18 sections of 2,000 turns [illegible] wire. There is room be[illegible]

primary cases? (4) Will a condenser be necessary? Ans.—(1) The tongue will be desirable, for its action or absence will enlarge the range of usefulness of the transformer. Without the tongue, the voltage regulation will be much better than with it, but for constant current experimenting, or even when desiring merely a choke coil, the presence of the tongue will make the apparatus more "fool proof." It will be well to have the secondary sections not permanently connected in series, but to leave them open in several places when experimenting with the other winding alone, thereby reducing the potential stress on the insulation. (2) 8 to 10 amperes. (3) Applying the 110 volts to the 232 primary turns, the secondary e.m.f. on open circuit will be about 17,000 volts; with 347 turns, 11,450 volts; with the whole 459 turns, 8,650 volts. Current should be limited to about .1 ampere. In consequence of the primary and secondary windings being on opposite legs, the regulation will be poor, that is, as soon as you try to draw current from the secondary, the voltage will greatly fall off. Lighting transformers always have primary and secondary windings equally divided on the two legs. In your case this was impracticable. (4) No.

1952. **Motor Winding.** E. E. H., Nazareth, Pa., says: I have several 12 in. fan motors, 125 cycles, 110 to 115 volts, 8 poles, a.c., built by the General Electric Company. Will you kindly advise me through your "Questions and Answers" Column if these motors can be changed so that they can be used in connection with 60 cycles, 110 volt, alternating current, and if so, how must they be changed to produce the maximum efficiency? Ans.—The eight field coils are connected so as to produce alternately north and south poles. To adapt operation to 60-cycle circuits, and yet get full speed, there should be but four poles. It will be a good idea to experiment on one of the motors by reconnecting the eight coils so as to get the effect of four poles, by having two adjacent poles alike, say north, then the next two south, and so on. The winding, however, will not be so effective as if you made entirely new coils of somewhat like twice the span so as to embrace two poles instead of one. For this new winding try one size smaller wire than that at present. These tests will not cost much, but will be instructive, and we, too, would be glad to learn the results.

1953. **Gear Calculations.** W. F. C., Fall River, Mass., says: Please enlighten me on the following questions: (1) Rule or formula for calculating the size of a gear (teeth, pitch, etc.); belts and shafting for transmitting a given horsepower. (2) What chemical is used for treating wood so that it will be fire-proof? Ans.—(1) The present accepted method of estimating gears is by the "diametrical" pitch, an expression that means a certain number of teeth on the circumference per inch of diameter. To take an example, a familiar case of railway motor gearing may be cited: the pitch is 3, that is, for

12 or 16, or even 24 should be chosen. To resume the railway reference, the gear on the axle has 67 teeth; its pitch diameter will then be 67 divided by 3, or 22⅓ in.; the pinion on the armature shaft has 14 teeth, its pitch diameter being, therefore, 14 divided by 3, or 4⅔ in. The outside diameter to which a gear blank is to be turned previous to cutting the teeth is of course larger than the pitch diameter, and the scheme of the diametrical method makes this determination very simple. Make a fraction of which 2 is the numerator and the pitch the denominator, and add this part of an inch to the pitch diameter and the result is the outside diameter. In the above cases the fraction will be ⅔; adding this to the figures given and 23 in. and 5⅓ in. are what the blanks should measure. The distance between the centers of gears for correct running is one-half the sum of the pitch diameters. In the above case the sum is 27 in., therefore the distance between center of armature shaft and center of axle should be 13½ in. A good rule for determining the size of a single-ply leather belt is to allow 1 in. of width per horse-power for every 600 ft. per minute of speed. Dynamo belts move much faster, but the proportion still holds. Thus, if power is to be transmitted between two 24 in. diameter pulleys running at 300 revolutions per minute, the belt speed will be about 1,900 ft. per minute, and 3 h.p. for every inch width of belt can be delivered. (2) Usually sodium silicate or tungstate.

1954. **House Lighting.** J. G., Baltimore, Md., asks: Can you kindly let me know how many 20 c.p. tungsten lamps the ½ h.p. dynamo in Mr. Watson's book will burn, and if I can get castings for same? Will it deliver the current for 500 yds., as I would like to build one of that size or larger for a water wheel to light our home. Ans.—The machine is liberally rated and can readily supply 400 watts for indefinite runs without undue heating, and 500 watts for limited "peak" runs—say, of an hour or so. Such a lamp as you mention requires about 25 to 30 watts, so you can operate 16 to 20 at once. Of course the house can be wired for a much larger number. 1,500 ft. is a long distance to transmit such a small amount of power, and we do not think the expense of the pole line and wires would be warranted. At any rate carefully compare the installation expense with that of driving the dynamo by a gasoline engine. Even if the expense of the water power utilization might be allowable you would still have to arrange for controlling the voltage. Excellent castings for the dynamo can be obtained by addressing the author through our office, and we would be pleased to advise you further with the project.

1955. **Motor Construction.** C. H. P., Elizabeth, N.J., has small motor parts that he would like to rewind, and run with about six dry batteries. The dimensions of field are 2½ in. bore, 1¼ in. long, with a single magnet core. The armature is of the laminated type, and is 1 in. thick and 2¼ in. in diameter. It has 12 ¼ in. slots. Commutator has six segments. Ans.—You must recognize that the motor cannot exert more power than is put into it, and that dry cells are but meager sources of energy. 1 volt pressure inefficient, the actual realization at the pulley would be less than one-half of this small amount. Even six cells would not exert enough power to hurt a person. If, therefore, you make the motor do any work at all, regard the result as a sort of triumph. If you wind armature with No. 23 wire and field with No. 20, all you can get on—you will get a good machine. The armature core should be a better fit in the field magnet, as long axially—1¼ in., and in diameter only 1-16 in. less than field bore.

1956. **Switches.** W. C. J. H., Manomet, Mass., asks: Will you please tell me where I can get diagrams of electric light switches for using different combinations and controlling lights from different points? Ans.—If you mean regular 3-point and 4-point "circuit" switches, you will find such regularly listed in the catalogs in any electrical equipment store. In the failure of such a search, we would advise you to address the Pettingell-Andrews Company or the Wetmore-Savage Company, both of Boston.

1957. **Motor Winding.** J. B., Worcester, Mass., has a "Knapp" 6-volt, 1-40 h.p. motor. The armature is made of punchings, and has its six slots wound with No. 28 wire, connected to a three-part commutator. The two field magnet coils are wound with No. 20. I wish to rewind this to give 6 volts and 1 or 2 amperes, speed about 2,200 revolutions per minute. Ans.—1-40 h.p. corresponds to about 20 watts, and at 6 volts the current would then be—assuming efficiency of motor at 100 per cent.—3 amperes. Such small machines never reach even to so high an efficiency as 50 per cent., therefore to get the rated horse-power you would have to put in at least 6 amperes. Now, No. 28 wire has a section of only 160 circular mils, and supposing the winding to be of the closed circuit order, 320 circular mils would represent the total current carrying capacity. While momentarily a current of several amperes might be tolerable, the regular capacity would not be over 1½ amperes. It looks, therefore, as if you could not with advantage wind the armature with any different size of wire. There would be a distinct gain, however, by rewinding so as to permit the use of a six-segment commutator. The field magnet should be shunt wound, and for this you should get on all the No. 30 s.c.c. wire possible.

1958. **Light from Sugar.** E. F. B., Sound Beach, Conn., asks: Why, when you break a lump of sugar or a wintergreen lozenge in a dark room, does it make a light? Ans.—The reason of the luminous accompaniment to the breaking of a lump of sugar in a dark room has been a subject of considerable discussion. The best opinion is that in the fracture of the crystalline structure of the sugar there is a molecular rearrangement involved which causes a disengagement of energy manifested as light.

1959. **Miscellaneous.** A. J. A., Milton, N.D., (1) What would be the best way to cover streaks on the inside of a mohair auto-top? The top has received the streaks from rubbing while folded together. (2) Could dye be put on with a paint brush? (3) Can as good pictures be

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BOOK REVIEWS

Experimental Wireless Stations. Their Design, Construction and Operation, with particular respect to the requirements of the new wireless law. By Philip E. Edelman. Published by P. E. Edelman, 1912, and for sale by the Sampson Publishing Co., Boston, Mass. Price, $2.00 net.

It is not often that the experimenter entering a new field is given the careful attention that the wireless experimenter receives from this excellent volume. It is neither entirely elementary nor entirely theoretical. It is just what the experimenter has been waiting for. The author presents in a clear manner the fundamental principles of electricity and wireless telegraphy, giving actual examples of the use of the apparatus envolving the application of these principles in practice. In all cases complete dimensions for the construction of the various pieces of apparatus essential to a wireless station are given so that one reading the book is never in doubt as to how the described apparatus is built in practice. Supplementing these descriptions are several tables containing data for the construction of most of the common sizes of spark coils, transformers, and other common pieces of apparatus. Besides these are simplified formulas for the calculation of capacity, inductance, and other bothersome electrical quantities. Above all, the author is up to the minute, so that no experimenter in wireless can afford to miss reading this practical little volume.

Wireless Telegraphy and Telephony Simply Explained. A Practical Treatise Embracing Complete and Detailed Explanations of the Theory and Practice of Modern Radio Apparatus and its Present-Day Applications, together with a chapter on the Possibilities of its Future Development. By Alfred P. Morgan. The Norman W. Henley Publishing Co. New York, 1913. Price, $1.00 net.

A new book on wireless valuable for its clearness. The 150 engravings of sets in actual operation and wiring diagrams of these sets shown in perspective make this book well worth reading. In a simple—not too technical manner—the phenomenon of wireless telegraphy and telegraphy are so well explained that one reading the discussions should obtain a clear idea of the principles underlying the transmission and reception of wireless signals and speech. Each piece of apparatus used in a wireless station is completely described and in most cases illustrated by actual photographs of various types of the instrument. This book should prove valuable both for th[illegible]

Lessons in Wireless Telegraphy. By Cole and Morgan. Published by Cole and Morgan, New York, 1912. Price, 25 cents.

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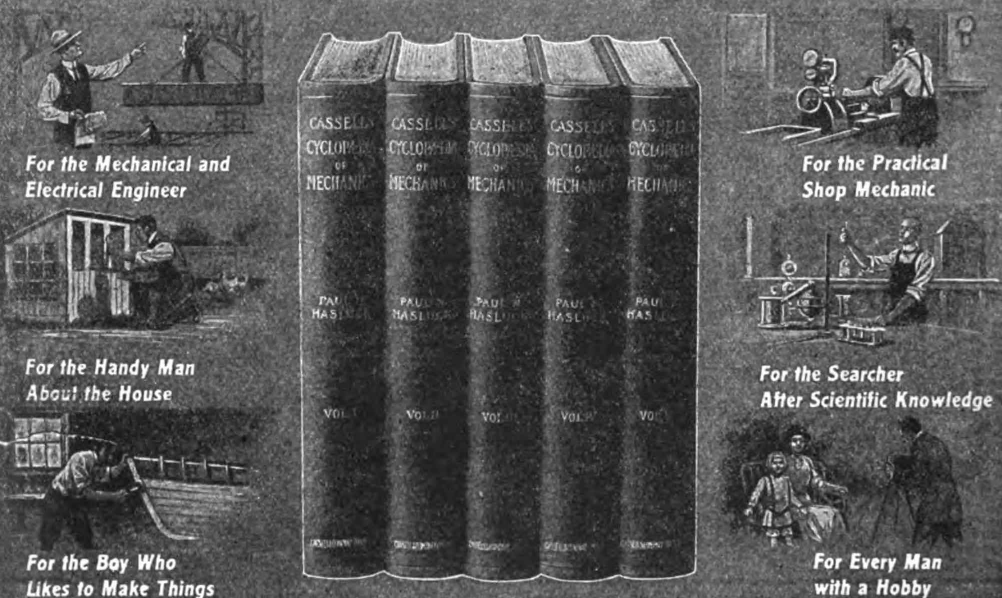

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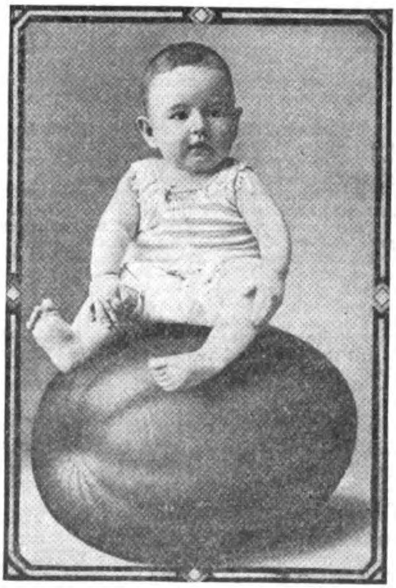

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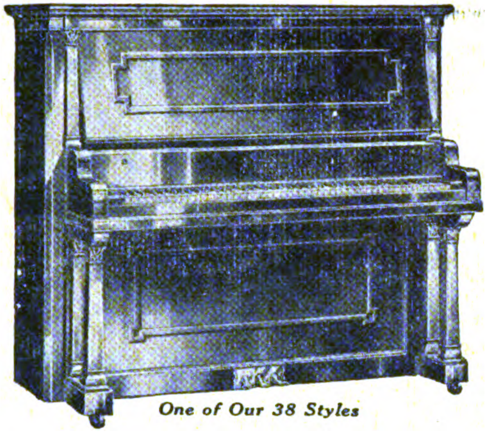

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But here is our answer: "A Wing is sent out on approval, returnable at our expense. When our piano must do its talking all alone while glib-talking salesmen stand around 'boosting' some other make—even then the Wing Piano nearly always stays in the home while the dealer's piano is returned.

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