

ELECTRICIAN & MECHANIC

Armature Windings

Power Rating of Wireless Stations

How to Build a Canvas Canoe

Gasoline Engine

Mission Furniture

Wireless Telegraphy

Home-made Jewelry

The Differential Gear

Lighting by Storage Batteries

Cistern Barometer

How to Make a Still

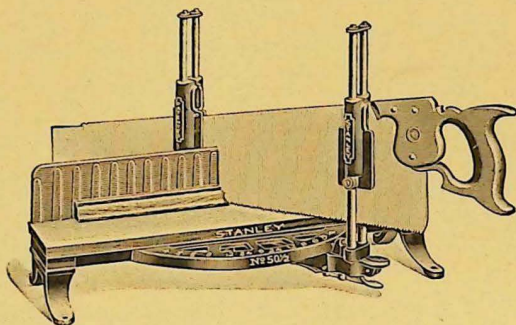
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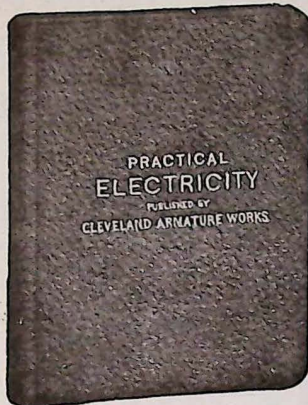


TABLE OF SUBJECTS

Chapter

- I. Wiring
- II. Electric Batteries, Electro-Plating
- III. Magnetism
- IV. The Magnetic Circuit
- V. Magnetic Traction
- VI. Magnetic Leakage
- VII. Energy in Electric Circuit
- VIII. Calculation of Size of Wire for Magnetizing Coils
- IX. Calculation of E.M.F.'s in Electric Machines
- X. Counter E. M. F.
- XI. Hysteresis and Eddy Currents

Chapter

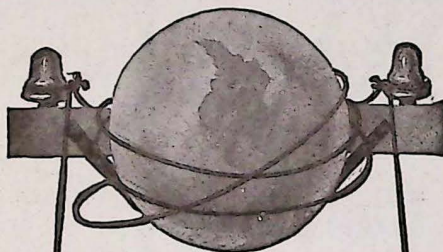
- XII. Armature Reaction
- XIII. Sparking
- XIV. Winding of Dynamos and Motors
- XV. Proper Method of Connecting Dynamos and Motors—Self-Excitation
- XVI. Diseases of Dynamos and Motors, their Symptoms and How to Cure Them
- XVII. Arc and Incandescent Lamps
- XVIII. Measuring Instruments
- XIX. Alternating Current
- XX. Automobiles

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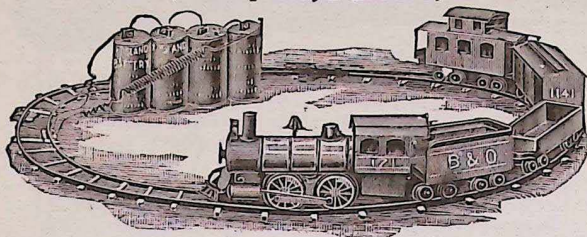
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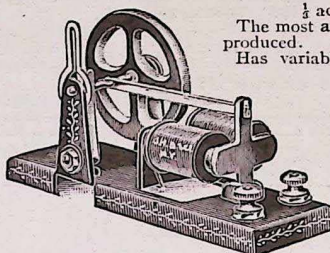
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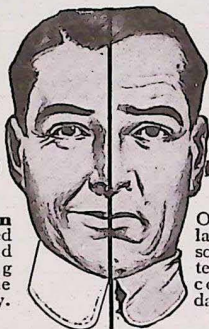
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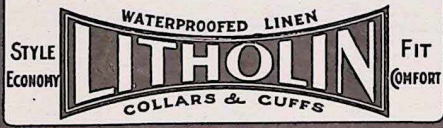
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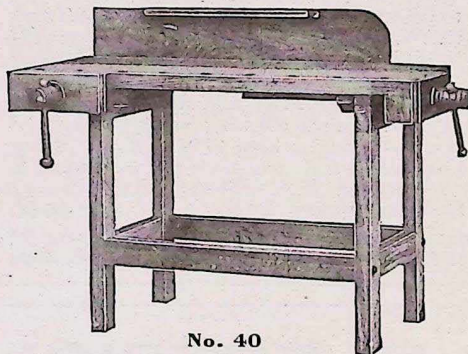
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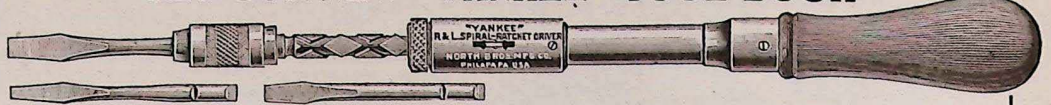
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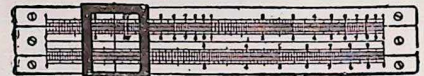
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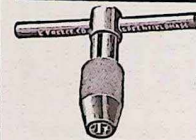
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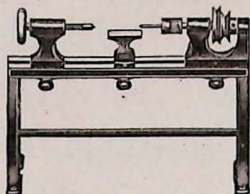
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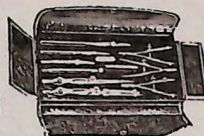
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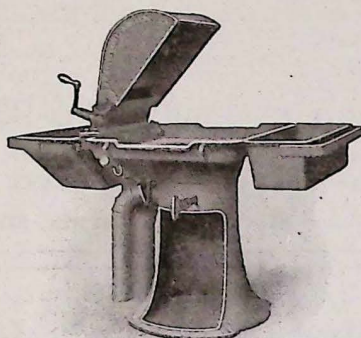
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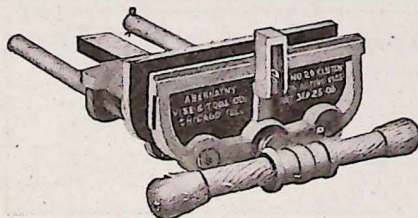
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TABLE OF CONTENTS

Armature Windings. Chapter IV. For Two-phase and Three-phase Alternating Currents	<i>A. E. Watson</i>	275
Power Rating of Wireless Stations	<i>Sewall Cabot</i>	281
How to build a Canvas Canoe. Part II	<i>W. Daniels</i>	284
The Economical Operation of a Gasoline Engine	<i>E. A. White</i>	287
A Mission Wall Clock	<i>Mabel V. H. Hunt</i>	290
A Mission Sideboard	<i>Mabel V. H. Hunt</i>	292
Wireless Telegraphy	<i>Prof. Elihu Thomson</i>	294
Home-made Jewelry. Part IV	<i>Chas. B. Dyer</i>	300
Storage Batteries for Small Lighting Plants	<i>W. H. Coles</i>	302
How to make a Bichromate Battery		304
The Differential Gear	<i>H. C. Fetsch</i>	305
How to make a Cistern Barometer		307
How to make a Simple Still		308
The Tungsten Lamp	<i>Francis W. Willcox</i>	309
Editorial		310
Questions and Answers		312
Our Wireless Club		316
Book Reviews		318
Things Received		318

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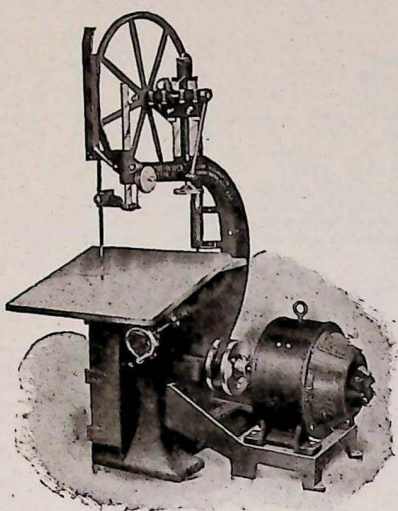
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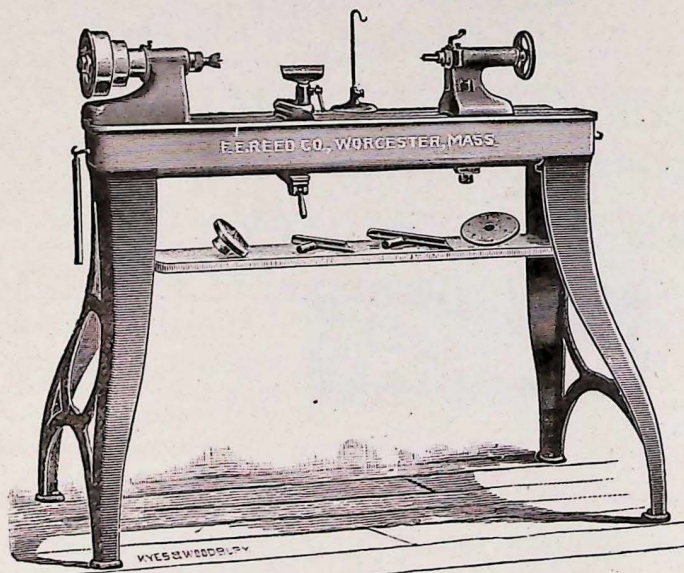
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VOLUME XIX

JANUARY, 1909

NUMBER 7

ARMATURE WINDINGS—Chapter IV FOR TWO-PHASE AND THREE-PHASE ALTERNATING CURRENTS

A. E. WATSON, E. E., PH.D.

THE interested reader approaches this particular section with a distinct enthusiasm. Though these windings have been known and utilized to a marvelous extent during the past fifteen years, enough of novelty still attaches to their principles and working as to attract and hold one's attention. Perhaps more of a suspicion of mystery is associated with them than with those previously described, and the text-books and trade publications do not always clear the way. Often, to give the impression that if two phases are better than one, or sometimes three better than two, the expression "polyphase" or "multiphase" is applied, and to ferret out such complexity the ordinary reader is inclined to doubt his ability. With the admission that these Greek and Latin prefixes merely refer to the subdividing of the coils already explained as "distributed," the reader need feel no further alarm.

As in other cases, the primary illustration, and marvelous for its clearness, is that of the simple ring-wound armature in a two-pole field, such as was given in Fig. 18, in the December issue. By adding two more rings and attaching them to points in the winding midway between those shown for the single phase, two separate circuits could be supplied, one being energized to its maximum extent at an instant one quarter period later than the other. A "period" in this case would mean the time required for the armature to make one complete revolution. If there were more poles, the time estimated would be that required for a given pole to move from one pole to the next of the same sign. The analogy of the two-crank steam-engine suggests the relation. By utilizing only three rings, and connecting them to equidistant points in the winding one third

of the circumference apart, three-phase alternating currents may be led away. The steam-engine analogy also meets this case, *i.e.*, that of the triple expansion marine type.

A peculiarity and advantage of these two sorts of winding over the simple single-phase is that, whereas in with the latter there are

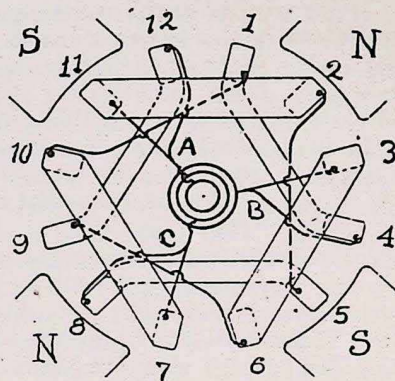


Fig. 24. Three-phase Armature Winding adapted for a Four-pole Field-magnet. (Concentrated Coils, Delta Connected)

periodic intervals during which no energy is being delivered, there is no instant when the others are not delivering energy, and that, too, at a uniform rate. As with the two and three crank steam-engines, there is no relaxation of effort, or no "dead-center," as it is called, so with the armatures of this kind, they are always doing work. In the starting and running of induction motors this continuous action, or "torque," gives them great superiority over those of single-phase characteristics.

A number of elementary considerations in naming particular groupings of the coils, and some of their relative qualifications and applications were given in Chapter XIV, of

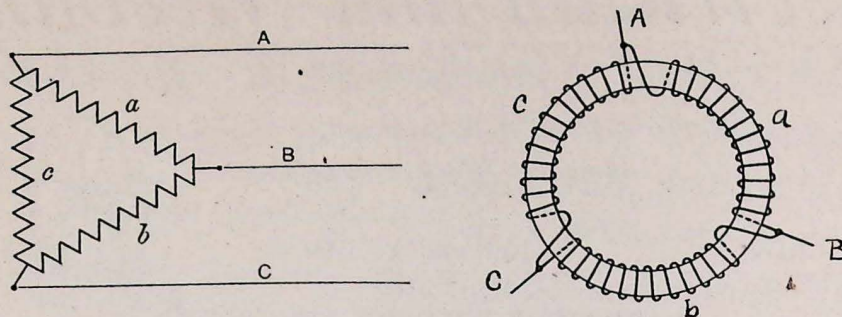


Fig. 25. Diagrammatic Representation of the Conditions to be imitated in Fig. 24

the Engineering series. The reader will find it useful to review that article.

Practical interest and value are ordinarily attached to three-phase windings adapted for multipolar field-magnets. However, for low frequency generators, driven by steam turbines, the simple two-pole field-magnet will be found regularly in use. As a four-pole field is logically next in order, some care will be taken to develop its essentials. In Fig. 24 is given an arrangement of coils, involving two different shapes, that the reader is to compare with the elementary representation given in Fig. 25. In the former, six coils are shown as filling twelve slots. In actually winding such an armature the inner coils occupying slots 1 and 4, 5 and 8, and 9 and 12, respectively, would first be put on. They could best be wound in place, but if left with considerable leeway at the ends, they might be wound in forms and then sprung into place. Ordinarily, however, "form" winding is limited to cases in which the pairs of slots are much more nearly parallel than is possible with a 4-pole spacing. By letting these three coils hug the ends of the armature core rather closely, the three remaining coils that must overlap the others will not cause the entire winding to be unduly extended nor to have too high a resistance.

With the six coils in place, and with the delta connections desired, the grouping is quite clearly indicated. Each terminal must be interpreted in the light of the representation of the diagram in Fig. 25. As an assistance in tracing the circuits, the same lettering in the two parts of this diagram has been adopted. The end of one group of coils and the beginning of the next, as at A, B, and C, lead to the three collector rings. The entire voltage generated by the winding must be that produced in any one of the

coils, but as far as current capacity is concerned, there are always two paths in parallel.

The symmetrical order of the coils should be observed, and their position as regards the poles. For example, those lying in slots 1, 2, and 3 represent the three different phases. Of these, 3 may be imagined as having just passed from under the N pole, 2 for an instant is directly under the middle of the pole, and 1 is just approaching it. Current is dying out in 3, is at a maximum in 2, and is beginning in 1. Thus all three conditions are accounted for. There will be similar action in the other coils, and their effect added to these.

In case more voltage is desired from the same coils, they can be grouped in the "Y" order, which gives the effect of coils in series rather than in parallel with each other. The appropriate connections are given in Fig. 26, with their key in the diagrammatic representation of Fig. 27. As before, three rings for the brushes are indicated, but in addition a fourth is convenient for accomplishing the Y connection. In Fig. 27 this is properly shown in the very center of

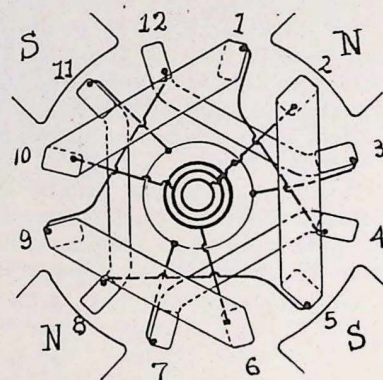


Fig. 26. Same Armature as in Fig. 24, but with Coils Y Connected

the figure, and gives reason for this particular designation; in the actual machine, however, this space is occupied by the shaft, and to encircle it means a fourth ring. It is a good idea to make this one identical with the others, then a fourth brush can be applied, — convenient for experimental purposes, and also often demanded by central station managers. For protection against lightning when a wire is to be grounded, this fourth one is selected. Then, too, for the operation of single-phase distribution circuits for incandescent lighting, taps are led, consecutively, from the three mains to this sort of "neutral." Motors of large size would connect with the three mains only, but small ones would ordinarily be found with only single-phase winding and connected in the same manner as lamps.

In order to compute the winding and output of a given or desired three-phase generator, the builder can best limit the calculations at first to a consideration of what any one of the phases should do, then by a simple and obvious step extend the estimate to the entire machine. As in the case of a direct current armature, the field flux through any one pole is assumed or calculated, the speed arbitrarily assumed, then from the desired frequency the proper number of poles is computed. With these factors known, the application of a standard formula gives the required number of conductors for producing the terminal electromotive force. While this formula is readily derived from fundamental considerations, and is not difficult to follow, this part will here be omitted. The number of amperes obtainable from the winding depends, of course, not on the number of conductors, but upon their size and grouping.

Frequency, or number of cycles, is found by multiplying the number of pairs of poles by the number of revolutions per second.

In algebraic form it is often expressed as pn . Flux can be represented by F , and the number of conductors by N ; two conductors make one turn. Then the formula for the effective electromotive force, E , can be written, $E = \frac{2.2 FNpn}{10^8}$.

For an illustration of the application of the formula, suppose a 4-pole steel field-magnet with faces of 16 square inches area, cores within spools of 7.5 square inches cross-section. Through each such pole there could readily flow a useful flux of half a million lines. If a frequency of 60 cycles was desired, this number divided by 2, — the number of pairs of poles, — will give 30, the required number of revolutions of the armature per second; this means 1800 revolutions per minute. The size of armature to fit such a field-magnet would be about 6.5 inches in diameter and 3.5 inches in axial length. With the scheme of winding shown in Fig. 24 the 12 slots could be assumed as about $\frac{3}{4}$ inch wide and 1 inch deep.

In such an armature considerable allowance for voltage lost in self-induction would be necessary, hence, if 110 volts were desired at full load, not less than 175 should be entered in the computation. Inserting this number and solving the equation for N , the number of conductors is found to be, $N = \frac{17,500,000,000}{66,000,000}$, or 270. For the delta,

(or mesh) winding this will be the approximate number of conductors per phase, but if the Y (or star) connection is preferred, this number should be divided by 1.73, giving about 150 per phase. Since there are to be 12 slots, the actual number should be apportioned to give an economical arrangement. Therefore, instead of 270 conductors there might well be 288, allowing 24 per slot, with a 4 x 6 order, or in case of the other grouping, 180 conductors, or 15 per slot, with a 3 x 5

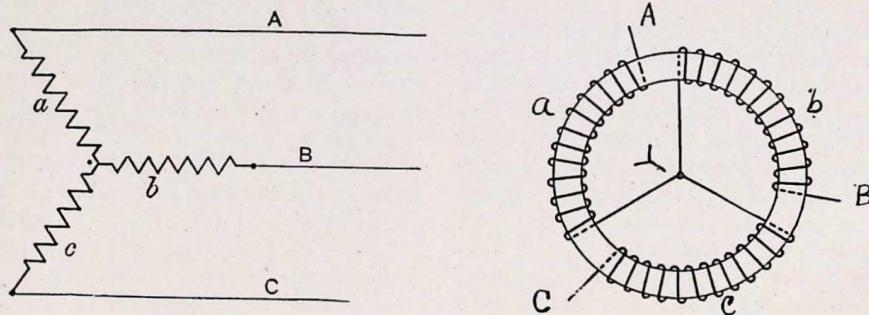


Fig. 27 Diagrammatic Representation of Conditions for Fig. 26

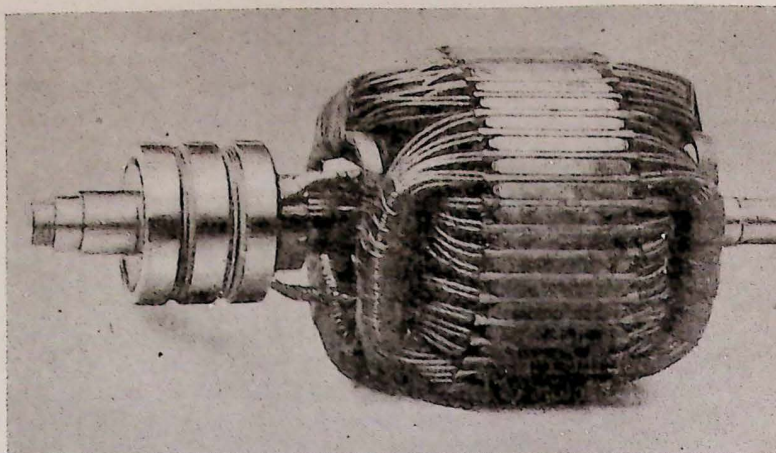


Fig. 28. Three-phase, Wire-wound Core with Distributed Coils, Polyphase or Multiple Arrangement. Adapted to serve as Armature of Generator or as Rotor of Induction Motor

grouping. The former is seen to be nearer the desired result.

For determining the proper size of wire to use, reference must be had to a table of double cotton-covered magnet wires, and from this it will be found that the largest size, that, with allowance for insulation and binding wires, will accommodate six in depth in a 1-inch slot will be No. 8. For the four in width only $\frac{3}{8}$ -inch slots will be needed in place of the $\frac{3}{4}$ inch proposed. In many cases of dynamo design, the size of slot will have to be corrected after the preliminary computations are made.

To compute the current capacity of the armature, it is safe to allow 500 circular mils per ampere. Since No. 8 wire has a cross-section of 16,500 circular mils, it can carry upwards of 30 amperes, and this will be the rating per phase. With the delta connection current comes from the other part of the winding in a sort of parallel manner, and increases the total to 1.73 times as much, or to about 50 amperes in all. The result is thus seen to be a machine probably good for 5 k.w. at 110 volts.

A considerable better wave form could be secured by adopting a distributed winding, giving, as already suggested, what some manufacturers call the polyphase scheme. This could be accomplished by using either 36 or 48 slots, and spreading into each set of three or four the wires that are otherwise understood to be in only one slot. In the particular case being considered, the 36 slots would not fit the 24 conductors, but the 48 will, admirably, for then there would be 8 wires per slot, just one wire wide in each.

A similar winding of this sort, with 2 wires wide per slot, is given in Fig. 28. This shows with remarkable clearness how the two shapes of coils are arranged. The three inner coils represent the 1-4, 5-8, 9-12 grouping of Fig. 24, while the three outer ones give the 3-6, 7-10, and 12-2 coils. The three terminals lead as shown to the collector rings. At the relatively high speeds of rotation employed to give the required frequency, centrifugal forces play considerable importance, and suitable precautions must be taken to hold the end wires firmly in place. In the slots themselves there may be notches cut, into which are driven fiber strips to give the security needed, but these outer wires demand binding with strong cord, or else be held under metal clamps. These items are recognized in the cut.

Such an armature as has just been described is suitable for generating three-phase currents when rotating under the influence of a 4-pole stationary field-magnet, and as far as this latter member is concerned, the machine would be identical with the requirements for a direct current dynamo. To serve as a generator would not be its only qualifications, however, for it entirely fills the requirements for the rotor of an induction motor, when a powerful starting torque or variable speed is required. When neither of these conditions is imperative, the simple short-circuited rotor, known as the "squirrel-cage," and fully described in Chapter XIV of the Engineering series, is sufficient, cheaper, and indeed preferable. For the unavoidable cases mentioned, a triple rheostat would be connected to the three brushes

resting on the three collector rings, whence by the variation of the ohmic resistances, the rotor currents would be properly controlled in value, and the amount of lag of the rotor current largely reduced.

In case these resistances in the rotor circuit were desired at starting only, and not for continual control of speed,—as for

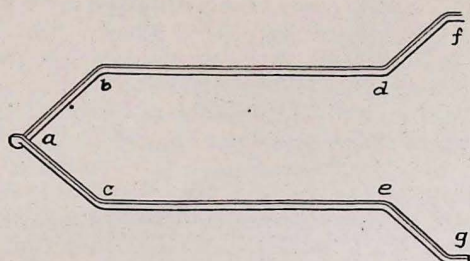


Fig. 29. Bar Coil for Low Resistance Winding for either Rotor or Stator

hoisting or traction purposes,—the rings and brushes could be omitted, thereby saving the maintenance of these parts, and as a substitute, endwise sliding contacts can be provided on the shaft, operated from a loose knob protruding from the end, as shown in Fig. 68 of the article just referred to. This scheme is used on large rotors, even when wound with bars instead of wires.

The winding of a large rotor with bars, whether for use in an induction motor, or for a low voltage generator, involves novel problems, and while the bars may be somewhat difficult to bend, the scheme may be simply represented and easily understood. First, the bars are to be bent in the form required for ordinary "wave" wound direct drum armatures, as are shown in Fig. 17 of Chapter II of this series. A given length may comprise only one conductor or a whole turn. The latter case, with all the needed bends, is given in Fig. 29. As will be observed, the very short bend at *a* is to allow one member of the loop to occupy the bottom half of one slot and the other member the upper half of the slot distant from first by the required spacing. If the stock is so large as to preclude this reverse bend, two separate conductors can be used, with a joint composed of a copper ribbon soldered on, preferably after the bars are in place. When the slots are wide open at the top, such conductors can readily be laid in, but if nearly closed, as is best for induction motors, the bars must necessarily be pushed in from one end. For this method, the bends at *b* and *c* can be

made beforehand, but those at *d*, *e*, *f*, and *g*, of course, cannot. In case these later bends prove difficult, the expedient can be adopted of dividing the conductor into several thinner strips and bending one at a time. All the conductors at one end of the rotor are to be joined, as shown in the figure, hence no further mention need be made of them,—they are like the bars of a direct current armature at the pulley end. At the other ends, however, there is quite a departure from the direct current procedure, and a special drawing will be necessary.

Figure 30 shows the bars of a large rotor of this sort, as adapted for an 8-pole field, whether of generator or stator of induction motor. The numerous squares representing the bars must persistently be regarded not as the conductors directly under the poles, but as their outer ends, marked *f* and *g* in Fig. 29. To make the matter entirely clear, the reader should draw the development of the diagram either in the form of the winding shown in the Fig. 17 referred to, or after the manner of Fig. 23 of Chapter III of this series. The short black radial lines joining outer and inner bars are strips of sheet copper, bent around and soldered. These connections resemble those that com-

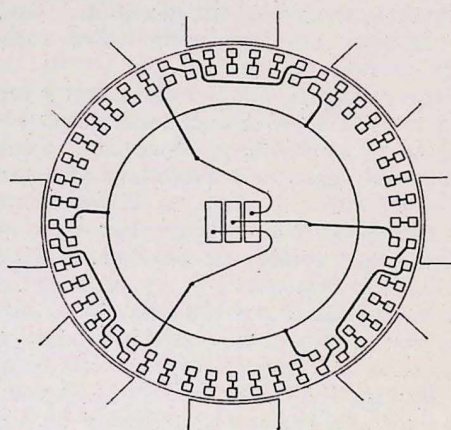


Fig. 30. End Connections of Three-phase, Bar Wound Rotor adapted for an Eight-pole Stator

pletely give the order at the other end of the conductors. They do not, as is recollected, connect conductors lying in the same slot. In six places there are diagonal connectors, whereby a necessary progression is given to the winding; then, just included within these diagonals, are three long loops, and just outside them are three connections representing

the Y, and three more for the collector rings. To make complete representations of such a winding and to comprehend its symmetry will give a student a clearness of vision of alternating current machinery that can hardly be equaled in any other way.

Small machines for ordinary voltages would require wire-wound coils in place of the bars. These could be composed of any desired number of turns per coil, with terminals left out as indicated at 1 and 1', in Fig. 14 of Chapter II, in the November issue. These ends could be connected in precisely the same order as if they were the bars of Fig. 30. The voltage would clearly be proportional to the number of turns, the current allowable being correspondingly diminished in consequence of the smaller size of conductors.

To apply the principles already given to the construction of machines with stationary armatures, which are at once also the stators of induction motors, is a simple task, and needs little description. For high voltages, few slots, thick insulation, and consequently but few coils per pole per phase can be allowed. A clear illustration of such a winding and grouping was given in Fig. 61 of Chapter XIV of the Engineering series. Up to 500 volts, and sometimes, in large machines, up to 2000 volts, the distributed winding, with its resulting better wave form, should be utilized.

In the preceding chapter there was given, in Fig. 22, the shape of coils for a simple single-phase stator winding, or for what would equally well serve as a stationary armature for a generator. It may be of interest to show the same scheme somewhat extended and covering the case of a three-phase winding. This is shown in Fig. 31, representing the final appearance of the first sets of coils for 8 poles, with three coils per pole per phase, thus accounting for the entire seventy-two slots indicated. A few of these are numbered, and the rest can readily be estimated. For the next phase the start would be made in slots 9 and 16, then 8 and 17, and 7 and 18. The third phase can be imagined as similarly extending between slots 4 and 69, 5 and 68, 6 and 67. The order of connections would need to be followed out from the principles given in diagrams in the first part of this article.

Not much reference has here been paid to windings of the two-phase order. They are, of course, important, but more so to the central station manager than to the usual

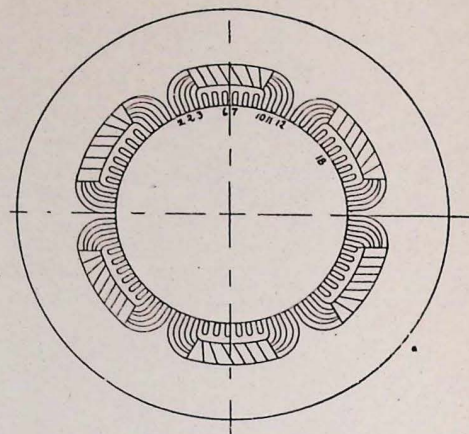


Fig. 31. End View of Stator Winding for Eight-pole Three-phase Stator, Three Coils per Pole per Phase

experimenter or student. The requirement of four-line wires militates against their adoption for general distribution. On the whole, the method is rather simpler to understand than those of the three-phases, so when the necessity arises, the reader could readily comprehend and apply the standard diagrams. If two-phase currents are actually desired, and only a three-phase circuit is available, recourse may be taken to the "Scott" connection of two transformers, as was explained in Chapter XVIII and in the December, 1907, magazine. Electrical engineers are now prophesying that two-phase apparatus is destined gradually to disappear.

AIRSHIP TRESPASS

It is still a moot point whether the flying of airships over private property may be legally opposed. In England there is an ancient maxim embodied in the English common law which says *Cujus est solum, ejus est usque ad cælum*. (He who owns the land owns it up to the skies.) This venerable rule, a legal authority points out, is as good to-day as ever it was, and is full of menacing significance to the airship builder.

Its effect is to give the owner of land the exclusive right to the free enjoyment of the air over and above the four corners of his holding, and any interference with that enjoyment, however apparently slight and harmless, constitutes a trespass, for which an action may be brought. Applications for injunctions against airship owners and actions for trespass by aggrieved land owners are not unlikely proceedings in the near future.

POWER RATING OF WIRELESS STATIONS

SEWALL CABOT

To those engaged in wireless telegraphy a question of pressing interest in considering an installation is, "What is its power?"

Power may be defined as the rate at which energy is dissipated, or as the amount of energy dissipated in one second of time, and its unit in electricity is the "watt."

When the sending key of a wireless station is depressed, an electrostatic capacity having a definite value in Farads (c) is charged to a definite potential in volts (v). To do this a certain definite amount of electrical energy is required.

Electrical energy is the product of watts and seconds, and this definite amount may be shown to have a value of $\frac{1}{2} cv^2$ watt-seconds. When the potential attains the value v volts, a disruptive discharge occurs across the spark-balls, and this quantity of energy is very suddenly dissipated in forming radiant electrical energy and heat in the spark-gap and wires comprising the oscillating circuits. When this energy has been almost completely dissipated in the above manner, the circuit through metal vapor at the spark-gap opens and the condenser is ready to store another charge of watt-seconds.

The power or rate of energy consumption in watts by the oscillating circuit is determined by the number of times this phenomenon of disruptive discharge occurs in one second, and is thus equal to $\frac{1}{2} cv^2 n$, where n is the number of discharges per second.

It will thus be seen that power necessary to excite an oscillating circuit used for the production of radiant electrical energy is defined by product of three quantities and varies directly with the size of the capacity, directly as the square of the breakdown potential of the spark-gap in volts, and directly as the number of oscillatory discharges per second.

It is interesting to compare the storage of electrical energy in the condenser with its mechanical analogue of the storage of mechanical energy in a perfect spring. We might define the perfect spring as one whose length is always proportional to the tension applied, and which when under no tension has infinitely small length. We might choose as a means to define the magnitude of this spring, the length in feet c it would occupy when under a tension of 1 pound. This spring thus stretched would be capable of

exerting a tension which started at 1 pound and ended with 0 over a distance of c feet. The average tension it exerted over this distance would be $\frac{1}{2}$ a pound, and the energy stored would be therefore $\frac{1}{2} c$ foot-pounds. If, now, the tension were increased from 1 pound to v pounds, the average tension would be increased v times its former value, and also the length c feet would be increased v times. The energy stored would thus be $\frac{1}{2} cv^2$ foot-pounds. If this spring were stretched until $\frac{1}{2} cv^2$ foot-pounds were stored, the stored energy dissipated and the process repeated n times in one second, the rate at which it would be necessary to furnish energy would be $\frac{1}{2} cv^2 n$ foot-pounds per second, or $\frac{cv^2 n}{1100}$ h. p.

Let us now pass to a consideration of the question of how maximum range is effected by variation of power in the oscillating circuit above defined.

We might define maximum range as the greatest distance at which the operator in a specific receiving station could decipher intelligibly sounds in his head telephone produced by signals sent from the transmitting station. In other words, he must hear a "buzz" sufficiently clearly to recognize its exact duration and thus distinguish dots from dashes. Now this "buzz" is composed of a succession of "ticks," there being one tick for each discharge of the oscillating current. The loudness of each tick is dependent on the number of watt-seconds in each wave train, or on the value of $\frac{1}{2} cv^2$.

A wave train at the average wave length used in wireless telegraphy at the present time, and consisting of say ten effective swings, occupies only about $\frac{1}{10000}$ of a second, which is too short a time to affect the drum of the ear. This difficulty is obviated by the fact that the detector saves up the total energy in the train and delivers it to the telephone diaphragm, which then responds as fast as it is capable of so doing, and with a magnitude somewhat proportional to the total energy. This movement of the telephone diaphragm is well within the time to which the ear is responsive, and furthermore, it has been shown that a telephone diaphragm has a slight and highly damped natural period of its own, so that it shows a tendency to transmit to the ear-drum a very short and highly damped train of sound-waves at the

frequency of its natural period, when a single impulse is transmitted to it by the magnet. This natural period is usually around the frequency of sound-waves (about 900 per second), to which the ear is most sensitive, and renders very minute currents, applied suddenly, clearly audible.

We have seen power of a station is dependent on the value of $\frac{1}{2} cv^2 n$, and the intensity of each "tick" dependent on the value of $\frac{1}{2} cv^2$.

It would seem from this that to get maximum range with a given power we should make n (the number of ticks per second) a minimum value, and thus make $\frac{1}{2} cv^2$ a maximum for a given power. We might assume 60 per second for this minimum value, as this might be taken as the slowest frequency which would not interfere with Morse sending at the average rate.

On the other hand, it is a well-known fact that the ear is not as sensitive to detect minute sounds recurring 60 times per second as it is at greater frequencies. Lord Rayleigh and others have made measurements to determine the smallest value of current which would be audible on a telephone using a sine-wave of alternating current whose frequency could be varied. These measurements show roughly that doubling the frequency causes the ear to be able to detect a current ten times as small, until frequencies about 500 per second are reached. After this point in frequency per second is reached further increase causes little gain in this ability, and still further increase commences to cause loss instead of gain. A frequency of 512 per second corresponds to a musical note an octave above middle C on the piano, and if we gave the value 1 to the smallest current which could be heard, then at middle C, or 256 per second, this value would be 10, at an octave below middle C, or 128 per second, this value would be 100, and at two octaves below middle C, or 64 per second, this value would be 1000.

If energy in each wave train were delivered to telephone by the detector in the form of a sine-wave, we should obviously choose a value for n of about 480 instead of about 60. The increase in frequency would cause us to use about eight times the former power if we kept the energy in each wave train $\frac{1}{2} cv^2$ the same; but this would be unnecessary, since if we made this energy about $\frac{1}{10000}$ of its former value at $n=60$, we would get the same result, and the power necessary in watts at

$n=480$ would be $\frac{1}{10000}$ of that necessary at $n=60$.

Practical results in wireless do not, however, show such a large decrease in power necessary for a given range as n is increased from 60 to 480. The reason for this is probably that sound in the telephone is not a sine-wave but a succession of highly damped trains of sound-waves at a frequency of about 900 per second, with intervals of silence between.

If the receiving operator were in an absolutely sound-proof vault and concentrated all his faculties in listening, he might possibly be able to detect signals sent with $n=60$ and the same value of $\frac{1}{2} cv^2$ as he would be able to detect with $n=480$, since in each case his ear would be detecting short trains of sound-waves with a period of the diaphragm fundamental. In the case of $n=60$ the resultant sound would be a "buzz," which would have to be listened for with great concentration of the faculties, and in the case of $n=480$ the resultant sound would be a high musical note about an octave above middle C, which would fix the attention without conscious effort. If we had the sound-proof vault available at the receiving station, absolute absence of other sounds than the received signals in the telephone, and did not mind wear and tear on the operator's nerves, we might then choose a value for n around 60, with a given value of $\frac{1}{2} cv^2$, and thus save power; these are, however, not very practical conditions.

In the writer's opinion the most practical value for n is the slowest frequency, which is a note of a distinctly musical character, and which readily fixes the operator's attention in the presence of extraneous noises, sounds, and buzzes. This value is somewhat a matter of taste, and can only best be fixed by comparing the opinions of a large number of independent experimenters. In the writer's opinion this value is in the neighborhood of $n=240$. If an alternating current source is used to excite the oscillating circuit, the value of n will be twice the value of its cycles per second when the spark is properly regulated to allow only one spark per half cycle. This regulation is made by making the distance between the spark-gap electrodes a maximum that will give a clear even sounding spark for a given amount of power supplied the system, and insures attaining a maximum value of $\frac{1}{2} cv^2$ or energy in each wave train for a given power. It is possible to increase the value of n at the expense of $\frac{1}{2} cv^2$

by adjusting the spark-gap electrodes to give a smaller value of v^2 , and thus allowing more than one spark per half cycle. This does not, however, give a clear musical note corresponding to the number of discharges per second, for the reason that the discharges do not have equal intervals of time between them. From the writer's experience he would say that the maximum range for a given power is decreased when this phenomena of more than one spark per half cycle is allowed to manifest itself. It comes in advantageously sometimes, however, when trying to work through atmospheric disturbances with alternating source around 60 cycles or lower, as the quality of the spark, when it is allowed to make several discharges per half cycle, is somewhat easier to fix the attention upon amid the extraneous sounds in the telephone receiver. When more than one spark per half cycle is allowed, difficulties usually begin to manifest themselves in getting the value v^2 up to what it should be with a given distance between spark-gap electrodes. This is probably due to the fact that several sparks occur very close together at the peak of each half cycle, and it is almost impossible to get the metal vapor thoroughly cleared away in the excessively short intervals of time between them.

Having shown how the values c , v^2 , and n affect range and power consumption, let us consider how they may most easily be roughly measured.

The value of c may be computed if we know the dimensions of the condenser in centimeters, and is given by the formula:—

$$KS$$

$$1.13 T \quad 10,000,000,000,000$$

in which

K = the specific inductive capacity of the dielectric (in the case of glass about 6).

S = the area in square centimeters of the dielectric included between the metal plates.

T = the thickness in centimeters of the dielectric.

The value of v may be measured by obtaining two brass balls of about 1 c.m. radius and using them as electrodes in a test spark-gap. This gap is placed in shunt to regular gap and the balls adjusted until spark occurs intermittently on either gap; the distance between balls is then measured. The approximate result in volts is given in the following table, which is taken from Professor Fleming's book:—

Distance between Spark-balls in Millimeters	Spark Potential in Volts
1	4700
2	8100
3	11400
4	14500
5	17500
6	20400
7	23250
8	26100
9	28800
10	31300
11	33300
12	35500
13	37200
14	38700
15	40300
16	41300
17	43200
18	44700
19	46100
20	47400

The value of n may perhaps most easily be determined by arranging a dark band, forming a belt, between two pulleys, one of which is driven by a small motor. The band should be about 2 meters long, and it should pass around at a rate of about once per second. It should carry a marker of white thread or other material about 1-32d of an inch broad, and be arranged to carry this marker through the zone which is brilliantly illuminated by the spark. The room should be dark and the observer in a position to watch the band in its most brilliantly illuminated zone with his eyes shielded from the direct light of the spark. While the spark is running, stationary images of the marker will appear about once per second. The distance between these images is observed and distance the marker travels in one second is measured. Distance per second divided by distance between images will give the value of n . If alternating current is used, the phenomenon of more than one spark per half cycle will be shown by groups of images with dark spaces between.

In conclusion, it would seem that a thorough knowledge of the values and characteristics of the capacity, spark-gap voltage, and spark-gap frequency in a wireless station affords the best insight into its power and possibilities of long range. There has in the past been considerable tendency to rate stations by the amount of power it was necessary for the furnishing source to deliver, no account being taken of where or how it went, and it would seem a considerably less accurate method of rating than the above-outlined one of rating stations in their $\frac{1}{2} cv^2 n$ value of watts.

HOW TO BUILD A CANVAS CANOE.—Part II

W. DANIELS

THE next thing to do is to prepare for framing together, for which stocks will be required. These are necessary in order to insure the canoe being built perfectly straight. Take four pieces of deal, about 1 foot by 7 inches by 2 inches. Place them on edge, at right angles to line of keel, and nail securely to floor. The end ones should be about 10 feet 6 inches apart, the other two being placed in between, at equal distances apart. Stretch a line from center to center of the two end ones, and mark on all four the center line of keel. Measure $7\frac{1}{16}$ inch on either side of center line and cut notches to fit the keel, the two end ones being $1\frac{3}{4}$ inches deep and the inner ones 3 inches. Place the keel in the notches, and fix it by partly driving one or two nails in the stocks. In the event of a workshop of sufficient size not being available, making it necessary to build the canoe out-of-doors, the stocks should be made into trestles by nailing legs to them, which should be firmly bedded in the ground, the tops being kept level.

Place ribs 4 and 8 in the notches prepared for them, and fix by means of small iron brackets screwed to the back of ribs and top of keel. Stretch a line from center of B.P. to center of S.P., and see that the centers of ribs come in direct line with it. If this is not so, unloosen the brackets and rectify it. This line should be kept on, as a guide, until the ribbands are fixed.

Braces *d* and *d* can now be fixed. Measure along keel the distance in between ribs 4 and 8, and mark the shoulder lines on the under edges of braces. Cut out the $\frac{3}{4}$ inch shoulders, and fix to ribs. Next, fix the braces *c* and *c*. First fix one end of each to the B.P. and S.P. respectively, by means of small iron or wood brackets, as shown in Fig. 4. Then fix the other ends to ribs, seeing that the ribs are square up from keel.

Struts should now be placed against either side of B.P. or S.P., and ribs 4 and 8, taking care that the ribs are at right angles with braces *c* and *c*, and that the latter are in direct line with the line you have stretched from B.P. to S.P. The gunwales and ribbands can now be fixed. The gunwales are fixed at either end, so that the bevel of top edges come in line with the bevel on either side of braces *c* and *c*. They are notched and screwed into the B.P. and S.P., so that the outside of gunwale is flush with the inside edge of groove. The ribbands are fixed in

like manner (see Figs. 3 and 4). You now have the shape of canoe, and can get the exact size and shape of the other ribs by taking measurements and molds of thin wood, or cardboard, in the positions where they have to be fixed. First prepare Nos. 2 and 10. These are notched out in the center for braces *c* and *c*, in the same manner as 4 and 8.

Take a mold of one side of canoe, taking it from the under side of gunwale to center of the $\frac{1}{4}$ inch notch in keel. The mold can be

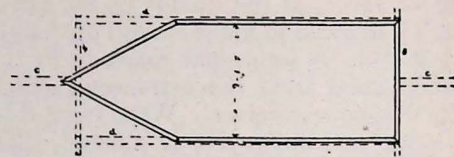


Fig. 7. Plans for Coaming

taken at either 2 or 10, as they should both be exactly alike. When this is done, measure the height from top of brace to bottom of notch in keel, and from top of gunwale to bottom of notch in keel. Also measure the width between gunwales.

Take a piece of deal board, 1 foot 4 inches by $11\frac{1}{2}$ inches by $\frac{1}{2}$ inch, and plane the bottom edge straight. Square up first a center line, and then the inside lines of gunwales, at equal distances on either side of it. Mark on the outside lines, the height to top of gunwales. From these points measure down $1\frac{1}{4}$ inches (the depth of gunwales) and square out $\frac{1}{4}$ inch for notching. This will give you the top of the inside line of ribbands. From here to the bottom of center line, mark the curves on either side with the mold you have made. Measure up center line the height to top of brace, and from there to top of gunwales mark the top lines of rib. Cut rib out to shape, and mark the other one to it. Notch out in centers for braces *c* and *c*, and fix to keel with brackets, in the same manner as ribs 4 and 8. Screw the gunwales and ribbands, keeping the ribs square with braces.

Now prepare the ash ribs. With the exception of No. 6, these also will be set out in pairs. These ribs only come up as far as the top of gunwales, into which they are notched $\frac{1}{4}$ inch, making them flush with the inside. Take No. 6 first. Mark its position on gunwales, and cut out the notching. Now take a mold, from the top of gunwale to center of keel, the mold being taken from the inside of

the notches in either. Measure the distance from top of gunwale to bottom of notch in keel, also the distance between gunwales (inside of notches). Either upon the floor of workshop, or wherever convenient, set out rib in similar manner to the previous ones. First, mark the bottom line of rib, then, parallel with this, mark the line of top of gunwales; square up a center line, measure on

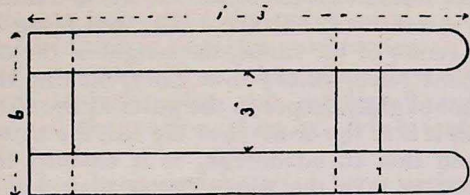


Fig. 8. Details of Backboard

either side the distance to inside of notches in gunwales; mark the curves with the mold, and you have the outside line of rib. Nail some small blocks around the outside, and some more $\frac{1}{4}$ inch inside of these. After the rib has been steamed, bend it in between the blocks. Take a piece of deal, of the same width as rib, and $\frac{1}{2}$ inch thick, the length being the exact distance between inside of gunwales; screw it in between the two ends of rib, level with the line of top of gunwales (see Fig. 6, page 258). The other three pairs are prepared in the same manner.

Should the space be obtainable, it is, of course, best to set out all the ribs first, and then steam them all together. A good way to do this is to get a piece of hot-water pipe, about 3 feet 6 inches long and 3 inches in diameter, one end having a stop-end screwed on to it. Place the ribs inside, and fill with water. Put the bottom end of pipe in the fire, and let the water boil for an hour or two, stuffing a rag in the top to keep the steam in. The ribs should be kept in their molds until quite dry, then, after having marked the center line, take them out, and fix in the notches prepared for them. Screw down through the center line into keel with $1\frac{1}{2}$ inch screws, the gunwales and ribbands being screwed from the outside with $\frac{1}{2}$ inch screws (see Fig. 4). For ribs 5, 6, and 7, the stiffening pieces that are screwed between the tops of ribs should have 1 foot 6 inches cut out of their centers, the ends being notched and screwed into the top of braces *d* and *d* at either side.

The bilge-keels should now be prepared and fitted. They will require to be 4 feet 6 inches long, and should be kept in line with

ribbands Nos. 4 and 4, as shown in Fig. 3. Screw into ribs 4 and 8 from the outside, and through 5, 6, and 7 from the inside. After having screwed them in position, take them off, refixing them after the canvas is on. The coaming is also first fitted in position, and then refixed after the canvas is on. For this 11 feet of $3 \times \frac{3}{4}$ inches will be required. Cut and fix it as shown in Fig. 7. Screw down into ribs 4 and 8, while along braces *d* and *d* it can be screwed from the under side.

The end piece will have to be cut to fit the top of rib 8, so that in the center, where it fits over brace *c*, the projection will be $1\frac{3}{4}$ inches. The front pieces should be tapered on the under edge, from 3 inches where they are fixed to the side pieces, to $1\frac{3}{4}$ inches, where they are fixed to rib 4. This will give the same projection above braces *c* and *c* at back and front.

The bottom boards *f*, *f*, and *f*, in Fig. 3, can now be fitted, though they should not be fixed until both the inside of well and they themselves have been painted. The center one should be screwed to the keel, while the side ones can be fixed to small slips, screwed on to ribs 4 and 8.

The back-rest should be made as shown in Fig. 8. It is made out of $1\frac{1}{2} \times \frac{1}{2}$ inch stuff, and should be hinged to the center bottom board, and about 3 inches away from rib 8. When not in use, it will lie flat in the bottom of canoe, and when in use can be kept in position by a small hook.

The framing should now be given a coat of priming paint, first smoothing off all sharp edges that would be likely to cut the canvas.

When this is dry, the canvas can be fixed. For this, the writer found stout unbleached linen of a close texture very satisfactory. Three pieces will be required, the two side pieces being $4\frac{1}{2}$ yards long by 22 inches wide, and the top piece $4\frac{1}{2}$ yards by 30 inches. It is fixed with $\frac{1}{2}$ inch copper tacks, the edges of canvas being doubled. The side pieces are fixed first. Bed the groove with white lead, and then tack one edge of canvas along keel, as far as the joints of B.P. and S.P. at either end. When this is done, stretch the canvas tight, and tack along the top edge of gunwale to within about 1 foot 6 inches of either end. Then cut the ends to shape, taking care to allow sufficient to turn under, and continue the fixing around groove, afterwards finishing along gunwale. When both sides are done, cover the top over completely, tacking the edges along the outside of gunwales; then

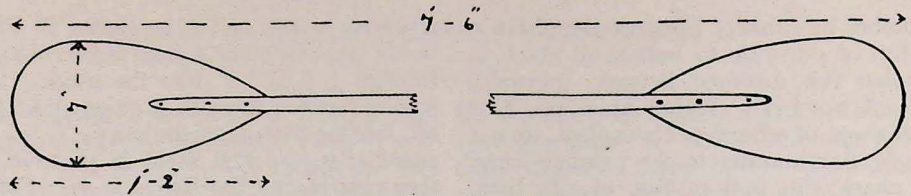


Fig. 9. Construction of Paddle

cut out for the well-hole, leaving a 2 inch margin of canvas inside of braces and ribs, for the purpose of turning up and fixing to inside of coaming, which can then be fixed. Before fixing the latter, round the top edges and paint the bottom. Screw into position, nail the mitres, and tack the canvas around the inside.

The canvas should now be given two coats of linseed oil. It should be thoroughly soaked with the oil, and the first coat allowed to dry before the second is put on. After it has stood for a few days, give it a coat of priming paint, including the inside of well.

Now fix the bottom boards, back-rest, and bilge-keels, the latter being fixed first. Bed along grooves with white lead, so as to cover the heads of tacks; this makes the joint perfectly water-tight. The whole should then be given two coats of white paint, or whatever color may be desired.

The paddle is made as shown in Fig. 9. It is 7 feet 6 inches from tip to tip, the handle being 6 feet 4 inches by $1\frac{1}{2}$ inches by $1\frac{1}{4}$ inches, and the blades 1 foot 2 inches by 7 inches by $\frac{5}{16}$ inch. The handle may be made of deal, though the blades should be of ash or mahogany. First cut the blades to shape, as shown, then take the handle, and on its widest face cut a slot 7 inches long, at either end, to take the blades. After the latter have been fitted, taper the handle to about $1\frac{1}{4}$ x $\frac{3}{4}$ inches at either end, and then round it. Bevel the blades on either side, so that they are about $\frac{1}{8}$ inch thick at the edge, but leaving them at their full thickness where fixed into handles. Paint the joints and screw into position, first slipping two rubber rings on the handle, in order to prevent the water running down it. The handle should be well oiled, but not painted. The blades look well if painted the same color as canoe.

The cheapest way to buy the paint is to procure the ingredients and mix them oneself. For white paint take about 8 pounds of white lead, $1\frac{1}{2}$ pints boiled linseed oil, $\frac{1}{2}$ pint turpentine, $\frac{1}{2}$ pound driers, and mix the whole together. For the priming coat, a little red lead is added.

For a seat, a cushion will be found the most suitable, as the lower one sits in a canoe the easier it is to balance. The well being in the center of the canoe, the weight of the occupant comes chiefly over rib 7, making the canoe slightly deeper in the water at the stern than it is at the bow. For the sea, the writer found this an advantage, as it enabled the canoe to take the waves better than would have otherwise been the case.

Should a canoe capable of seating two persons be required, it should be 14 feet long, with 2 feet 6 inches beam, and the timbers used in its construction should be considerably thicker than those previously given, and the well would require to be 6 feet long at the least.

In conclusion, the writer hopes that all to whom this article may be of service will find as much pleasure in making and paddling their own canoe as he himself did.

MR. HENRY FARMAN intends to thoroughly demonstrate the powers of flight of his aeroplane in an altered form with the third plane placed high above the second. The machine now presents a curious appearance. Mr. Farman declares it is more stable than it was before. He has also fitted small wings in order to help the lateral balance, but so far he has had no occasion to use them when in flight. The machine has been vastly improved since Mr. Farman left Issy-les-Moulineaux, but it is still very much behind Wright's machine. This is the opinion expressed by all impartial observers who have watched both machines in flight. Although the motor of the Farman aeroplane has more than double the power that is employed by the Wright machine, it cannot lift anything like the weight the Wright machine can carry, nor can it be controlled so easily. Mr. Farman is about in the position that Wright's records show he and his brother had attained five years ago, but Mr. Farman is working hard and making improvements on his machine every day, so it seems more than likely that he will achieve great results if he continues to progress.

THE ECONOMICAL OPERATION OF A GASOLINE ENGINE

E. A. WHITE

EVERY one who owns or contemplates purchasing a gasoline engine should know that the design of internal combustion engines has reached such a stage of perfection that with any of the standard machines on the market to-day, economical operation depends more upon the purchase of an engine adapted in size and construction to the work for which it is intended, with a thorough understanding and intelligent operation of the engine, than all other factors combined.

It has been demonstrated by experiment stations and practical builders, that if a gasoline engine is to do work most economically it should not be regularly loaded to over three fourths of its rated capacity. In selecting an engine, get one big enough for the work. The writer emphasizes "big enough" because the majority of engines are too small for the tasks assigned them, the purchaser forgetting that a few dollars saved in the original cost by the purchase of a small engine are eaten up more than once in the life of the engine by the extra amount of gasoline used. On the other hand, it is just as extravagant to run a 12 h. p. engine to perform 3 h. p. of work. Economy in operation cannot be secured unless the size of the engine and amount of work correspond to each other.

Before purchasing an engine the individual problem should be studied and the following decided:—

What general type and size of engine should be purchased?

What cooling system should it have?

What style of governor?

What form of ignition?

The following may be suggestive on the above-named points: If there is only from 2 to 6 h. p. of work to perform, an upright, air-cooled, would be very satisfactory. If the work demands a larger size, a water-cooled, horizontal engine will be more successful.

On most farm engines to-day the hit and miss type of governor is found. With a variable load they are the most economical of any on the market, but where the engine is constantly loaded to its running capacity a throttling governor will give a steadier motion and be just as economical as the hit and miss type. On practically every en-

gine built to-day there is some form of electric ignition. On most farm engines batteries are used to furnish the current, but as they are always causing an endless amount of trouble besides being very expensive, because they must be replaced so often, an auto-sparker or magneto can very profitably be used on an engine where economical operation is being sought. To be sure the first cost will be greater, but a good auto-sparker or magneto will last as long as an engine and is always ready to go, while the battery may balk most any time, besides having to be frequently replaced.

After due attention has been paid to the above points the engine must be located where it can work as effectively as possible. A stationary engine should be set upon a firm base (one made of concrete and extending at least 2 feet below the engine bed is best), and well housed that it may have a chance to wear out instead of rusting out. Any one traveling over the country, if he is at all observing, will be shocked at the amount of waste caused by unhoused machinery on our farms. A gasoline engine properly housed on a solid foundation will work twice or three times as long as one left out of doors spiked to a couple of 4 x 4s where it was the most convenient. It is worse than poor economy, it is extravagance to leave an engine without protection from the weather.

After the right engine has been properly located there are only a few things one must master to have the essentials of economical operation. The chief points are: proper compression, proper timing of the spark, intake, and exhaust valves, judicious use of gasoline and proper lubrication.

Compression. — The most economical running of an engine, other things being equal, is on a high compression. This cannot be obtained if there are leaks in the various parts. As most operators know, there are three standard places to look for leaks, viz., the valves, intake, and exhaust, the packing in the various places about the cylinder head, etc., and between the piston and cylinder walls.

As this is not an article on troubles we will not go into details on the remedies for these various things, but will very forcibly call attention to the fact that it is absolutely impossible to work an engine anywhere near

its maximum running capacity, let alone economically, without having strong compression.

Perfect compression means complete combustion with an application of the greater part of the force to the piston from which it is transformed into work.

Timing. — There are three working parts, the timing of which is important, viz., the sparker, the intake valve, and the exhaust valve, each one of which must be performing its task at just the proper time if we are to have economy in the operation of the engine. Every one who operates an engine is acquainted with the igniting devices which fire the charge of fuel by means of a spark inside of the cylinder. In order that the engine may receive the most power from a charge of fuel the explosion must be timed so that its greatest force will come just as the piston is on the dead center at the beginning of the power stroke. By having the spark so timed the engine will not work against the force of the explosion, nor will the power be generated so late that it acts upon a rapidly receding piston. One would naturally think that the spark should be made just as the piston is on the dead center, but such is not the case, for it takes the gasoline a little time to burn, and as the piston is traveling at a very high rate of speed, it is able to cover a very appreciable distance from the time the spark is made until the full force of the explosion occurs. In order to meet this the spark is made shortly before the piston reaches the end of the compression stroke. This is called "advancing the spark" or giving the piston "lead." Experiments show that five degrees for every one hundred revolutions per minute is the proper amount. Lead can be regulated on most engines by a wrench or screw driver in the hand of a careful operator as follows:

For convenience, take an engine which has a fly-wheel with six spokes in it, from the center of one spoke to the center of the next on the rim of the wheel will be 360° divided by 6, or 60° . This engine makes three hundred revolutions per minute. We want an advance or lead of five degrees for every one hundred revolutions per minute of fifteen degrees. Turn the fly-wheel until the piston is just at the end of the compression stroke. Make a mark on the rim of the fly-wheel exactly opposite the center of a spoke and make a corresponding mark on the engine bed. Turn the fly-wheel backwards fifteen degrees, or in this case (60 di-

vided by 15 equals 4) one quarter of the distance between the spokes. Regulate the mechanism so that the sparks will come when the piston and fly-wheels are in the above position, in this case fifteen degrees before dead center. The amount of lead will of course vary with engines, depending upon their speed. Every gasoline engine operator should master this particular point, for an engine may be working apparently perfectly in every way and its efficiency reduced one half simply because the spark is not properly timed.

The intake valve should open at the beginning of the charging stroke and close exactly at the beginning of the compression stroke. This will allow the cylinder to be completely filled with gas while the valve will be closed when the piston is working towards it so there can be no leaks of unburned fuel back into the carburetor. If the intake valve opens by suction it will not begin to open until the piston has traveled far enough to produce a vacuum, which force will overcome the tension of the spring. If this spring is not too loose the valve will close the instant the piston begins to return on the compression stroke. If the spring on the intake is loose the valve will be pulled open so far that it cannot close as the piston begins to return, thus allowing unburned gas to be forced back into the carburetor, giving a weakened compression, which always means poor economy in operation. If the intake valve opens and closes automatically, turn the wheels over slowly and adjust in accordance with the above.

Exhaust Valve. — The exhaust valve or part through which the burned gas is discharged from the engine should be open during the entire cleaning stroke. If the valve begins to open just at the beginning of this stroke the rapidly traveling piston will cover a considerable distance, in some engines as much as one half the length of the cylinder, before the valve is completely open, thus greatly retarding the rapid and complete discharge of burned gas. To overcome this the exhaust valve should start to open from twenty to twenty-five degrees before the end of the power stroke, closing exactly at the end of the compression stroke, thus insuring a maximum discharge of the burned fuel.

Amount of Gasoline. — After all the above points have been carefully looked after the engine is in condition, with skilful operation, to reach its maximum efficiency. The amount of gasoline used will still depend al-

most entirely upon the skill of the operator. Under ideal conditions an engine can be run with 1-10th of a gallon of gasoline per h. p. per hour. With careless operation it is easy to burn twice this amount of fuel without obtaining any more power. If a large excess of gasoline is being used there will be a heavy black smoke in the exhaust. To remedy this, restrict the opening in the carburetor until the engine emits no smoke but continues to carry its load. Even under these conditions the engine may not be running on the least possible amount of gasoline. It is by the ear that the skilful operator finally regulates the amount of fuel used. Restrict the needle valve until the engine carries its load upon the fewest possible number of regular explosions. It is easily possible to so restrict the fuel passage that not enough gasoline is taken in to produce a full explosion, making the engine "bark for fuel," which is very wasteful. Therefore each operator should study his own engine until he has found the proper "set" for the needle valve if economical operation is to be secured.

Lubrication. — The cylinder of a gas engine is very sensitive to lubrication. Ordinary grades of cylinder oil cannot be used because of the high temperature causing them to burn. There is found upon the market a special grade of oil, "gas engine cylinder oil," which should always be used

to lubricate the cylinder of the gasoline engine. Cheap grades of oil simply burn, leaving a deposit of carbon on the piston, valves, etc., causing the piston rings to stick and valves to leak, which will immediately result in loss of compression, the first member of the poor economy family. Too much good lubricating oil, indicated by a gray smoke in the exhaust, will have much the same effect as a poor oil. For an 8 h. p. engine from twelve to fifteen drops of lubricating oil per minute are usually sufficient. Here again the operator must study his engine. Too little oil allows the cylinder to cut, and that very quickly, and too much gums the working parts, causing loss of compression. The happy medium is wanted here for economy. The bearings should also be supplied with a good grade of machine or hard oil.

To Sum Up. — The economical running of a gasoline engine depends almost entirely upon the skill of the operator. Any engine will respond wonderfully when good hard sense is used by the engineer.

Purchase an engine of the proper style and size. Locate it on a solid foundation well protected from the weather. See that it has strong compression. Do not use too much fuel. Use a No. 1 lubricating oil in the cylinder and in proper amounts. Study your own engine thoroughly and learn its possibilities.—*Gas Review*.

THE AIRSHIP IN WAR

THE airship Zeppelin I, says the *Armée Correspondenz*, although taken over for \$412,500 by the German War Office, must remain where it is for the present until a suitable shed has been built for it. The staff of the airship will be composed of 75 men, and 10 men will suffice to man it for a trip. These 10 include the pilot, the chauffeurs, and the observation officers. It will be possible, however, to carry several passengers in addition.

Major Gross is seeking a suitable spot for the quarters of the 75 men, and balloon officers and privates will be trained at once for serving the Zeppelin I. The army authorities have told Count Zeppelin that he need not go through the stipulated flight of 24 hours, as in their opinion the Zeppelin I is now quite ready to be used in warfare. As a matter of fact, it is scarcely likely that the airship will ever be called upon to make

a trip of 24 hours consecutively, at least in Europe.

The German War Office is now busily engaged in gunnery trials directed against airships. The experiments made on land have been failures. Elaborate maneuvers with captive balloons were attempted, but they proved useless. Besides, the maneuvering grounds were not large enough and the safety of the surrounding towns was endangered.

Now fresh trials have been ordered to take place at sea off Swinemunde and in Danzig Bay. The naval guns to be employed are mounted on newly invented carriages which permit firing at angles up to 60°, but projectiles as used at present do not reach a height of more than 4000 feet. Great activity is being displayed in endeavors to improve angle firing, and a new kind of air shrapnel is to be tested.

MISSION WALL CLOCK

MABEL V. H. HUNT

In keeping with the other furnishings of the bungalow living room is the wall clock herewith presented.

The framework of the clock may be made to match, in color, the other articles of furniture, and it may be hung against the wall, where it may be easily seen. A good place for it is beside the desk.

This clock is made from perfectly cured kiln-dried wood, with a good grain. Quartered oak is suggested, it requiring about 28 feet, 1 foot in width, $\frac{7}{8}$ inch in thickness.

For accuracy, draw out on paper patterns, actual size, the design shown in the accompanying cut; lay patterns on boards, outline, and cut.

First saw out the back, No. 7, the hole at the top being to hang the clock to the wall by means of a large lag-screw.

Before sawing out the front, No. 4, cut out the circle for the face of the clock in order to prevent the section from splitting. This circle may be placed at any height and may be made any size to correspond to the size of clock you wish to use.

Then saw out the front section. The left side is in three parts — No. 1, the top; No. 2, the door for easy access to the works; No. 3, the lower part; No. 8 is the right side.

Small clover leaf shaped ornaments are sawed entirely through the thickness of the wood, giving clearness to the tone, should the clock be one which strikes.

No. 6 is the top, and the notch shows where the back fits into it. No. 5 is the base. No. 2, being a door, may be attached by outside hinges of brass or small invisible hinges, and the back may be treated in like manner.

Having all these sections sawed out and smoothed ready to put together, fasten No. 8 to Nos. 7 and 4 by means of screws. Then screw Nos. 1 and 3 to No. 2. Then attach top and base.

Before screws are inserted, bore $\frac{1}{2}$ inch holes $\frac{3}{4}$ inch into the wood, and sink screws into these, using $\frac{3}{4}$ inch flat-head screws.

When all is put together, cut 20 pieces of $\frac{1}{2}$ inch doweling, each 1 inch long, glue *thoroughly*, and plug screw holes, allowing $\frac{5}{8}$ ths to project. If desired, these may be allowed to remain projecting from top and base as well as from the sides, but it looks better to have these former portions smooth.

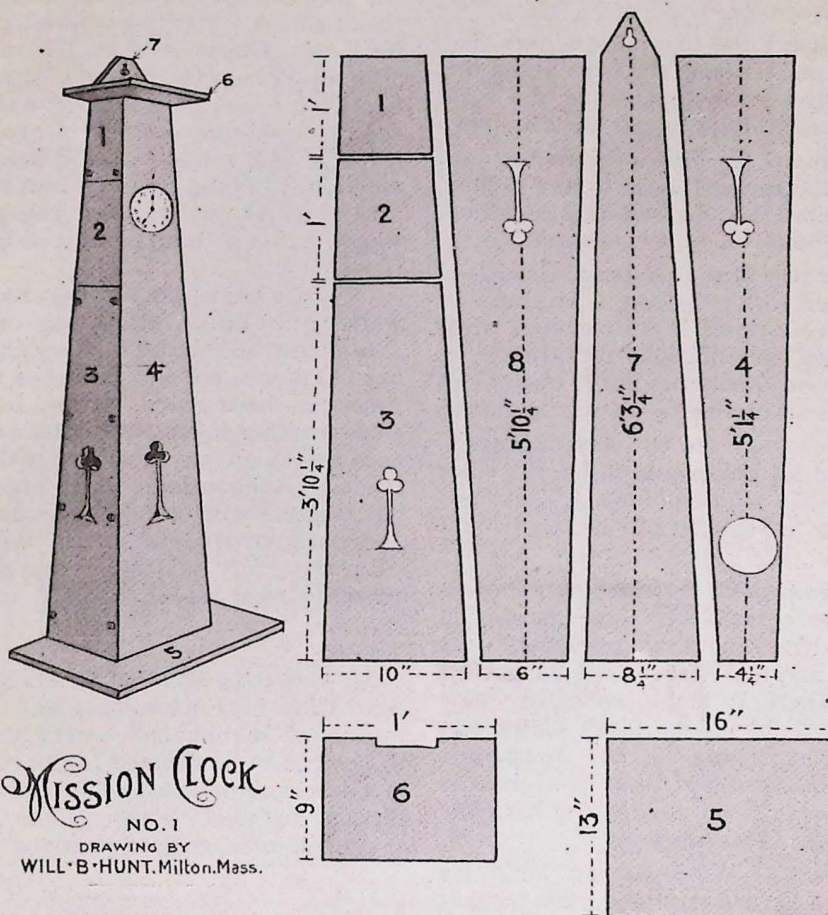
This is an excellent way to utilize an old clock which has become out of date, provided the works are in good condition, for they may be removed from their old setting and screwed into the new one. Not having an old clock, a jeweler will sell one of suitable size, of one's own selection.

The projecting base of the clock is a convenient resting-place for a photo or one or two small vases; a pair of Japanese ware would be artistic, one on either side.

The Rubbing Process

To secure a good job, the varnished surface should be made perfectly level before rubbing. Never rub across the grain of the wood; it will scratch the surface. Don't bear on heavily at start and finish, or you will get the beginning and end worn off too much; bear evenly all the way through. Never rub the varnish until it is perfectly dry, which will cause it to sweat through, and you will have to rub it a second time. There are several grades of pumicestone powder, or degrees of fineness, designated by the letters O and F; thus FF (double F) is the finest, and OO (double O) the coarsest. The finer the grade, the slower the cutting; but there is less danger of scratching. A pad of rubbing felt about 3 x 5 inches is used. For irregular surfaces, prepare a piece of wood to conform to the surface of the job, and glue a bit of felt to it. Shellac would be better than glue in case of water rubbing. For oil rubbing, use an oil that is not gummy; dip the pad or felt in the oil, then in the pumicestone; the same with water rubbing. There is danger with the use of oil that needs to be pointed out to the new hand at rubbing. If the oil is allowed to remain too long on the job, it will soften up the varnish and you will rub through in spots; with water this, of course, will not occur; but, on the contrary, the water, especially if cold, will harden the varnish. Water rubbing gives a deader appearing effect than oil rubbing.

ONE of London's underground railways passes 185 feet below the surface at points. This is the depth record for subway transportation.



MISSION SIDEBOARD

MABEL V. H. HUNT

THE dining room of the six-roomed bungalow needs a sideboard to complete its furnishings. Naturally, to be in keeping with the rest of the house, it must be simple, yet substantial.

Often such a cottage is built near the salt water, the dampness of which is detrimental to the polish of mirrors, therefore this bit of handicraft is designed without a glass.

In effect it is taller than an ordinary sideboard, particularly from the floor to the first shelf, thus giving the appearance of a high-boy. Its beauty lies in its extreme simplicity.

There are no dimensions given for this, because of the various places it may occupy, and the size is left to the builder's discretion, as he best knows where it is to stand.

The lower part of the sideboard consists of a closet closed with two doors. This may be used as a wine closet if desired, and while there are no specifications for shelves, it would be an easy matter to put in one or two if compartments are deemed more convenient.

Above the closet are two small drawers, one intended for knives and forks, the other for the table linen in daily use. These two drawers may be replaced by one large one if one wishes.

The upper part of the sideboard consists of two shelves separated by three uprights on each side which take away from the heavy appearance and makes the whole thing more graceful. There is ample room on these shelves for all the glasses, fancy plates, and cracker jars necessary for use in summer life, but a display of silver is to be avoided as in very poor taste and quite out of harmony with the other furnishings.

To build this sideboard, first build the back the size desired, and using this back as a standard for dimensions, keep the other parts in good proportion. To the back dowel Nos. 2 and 3, then dowel to Nos. 2 and 3, Nos. 6 and 7. To this framework add Nos. 4, 5, and 10 in order. This leaves it ready for No. 12 to be put into place. Next add the posts, No. 13, and when they are firmly fastened place the top shelf, No. 11, in its place. Next fit in the bottom, hang the doors, build the drawers and fit into their places. Last of all add No. 1, the back of the shelf section.

Provide the drawers with handles and the

closet doors with knobs, and a lock and key if one cares to do so. This completes the furnishing of the small summer camp.

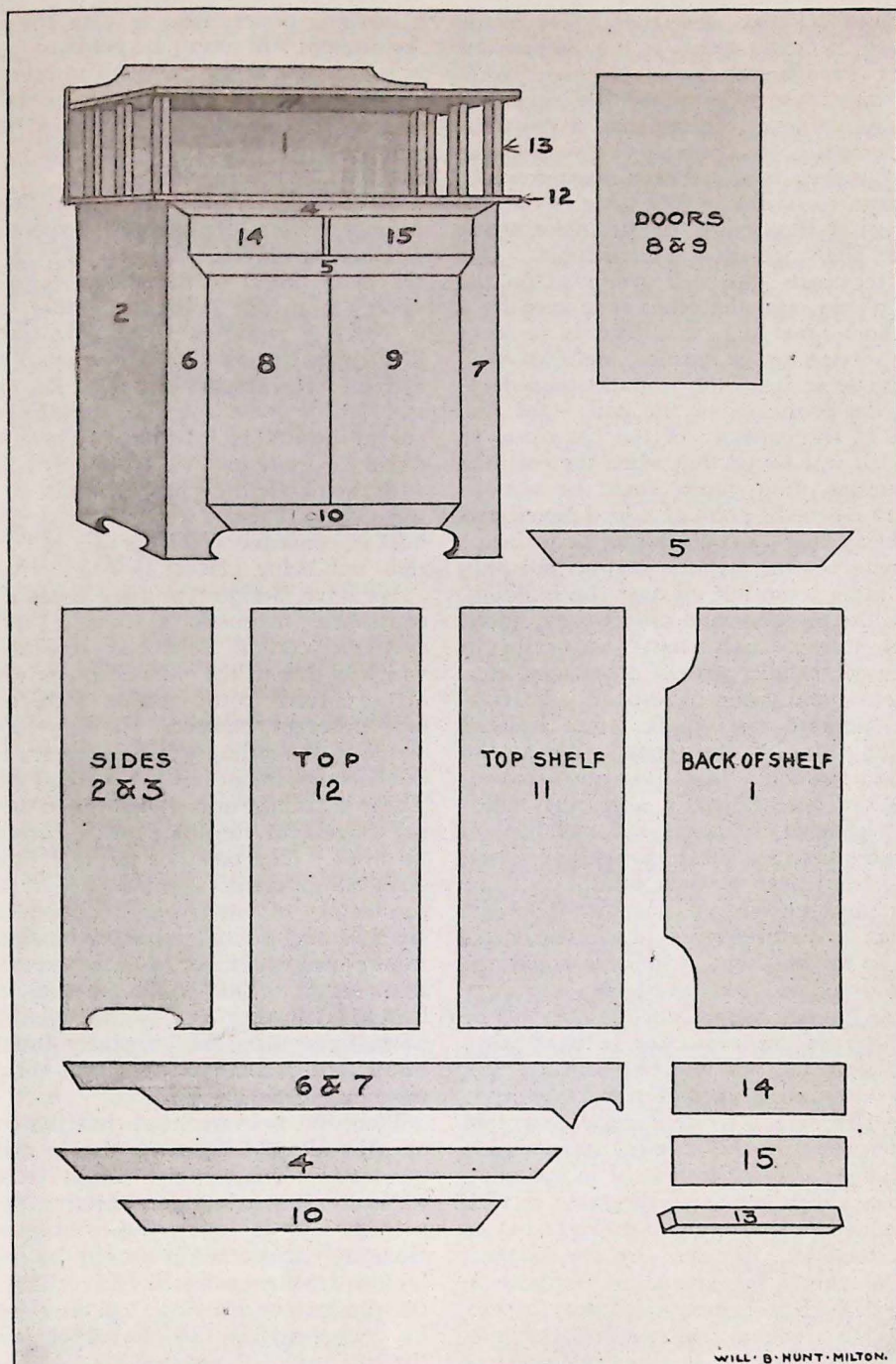
Speaking of Mission furniture, which had its origin with the Spanish Mission Fathers, a subscriber, Mrs. Lucy Hester Abbott, writes from Cuba:—

"Old furniture is fast disappearing from Cuba. After the Ten Years' War, which left the wealthier class of Cubans impoverished, almost everything of value passed into the hands of their creditors. Here and there a family, through some good fortune having kept their heads above the wave of debt, can show you real treasures which have descended through generation after generation, and are valued beyond price. From these beautiful originals we get the cheaper copies which, however, fall far short of their prototypes.

"For the most part, the lofty rooms whose white walls threw into strong contrast the rich polish and beautiful carvings of these fine old pieces, are now furnished with cheap American-made goods. These, being mostly glued together, fall to pieces after a short time, and can in no way compare with even the crudest Cuban articles, which are invariably put together with wooden pegs and the seat and back covered with calf skin, usually with the hairy side up, giving a primitive air to the most modern room."

M. GEORGES BESANCON, secretary of the Aero Club de France, proposes to raise by means of a national lottery the sum of \$1,000,000 to be devoted to the construction of a fleet of aeroplanes and navigable balloons for the national defense. The scheme is said to be making good progress.

M. SANTOS DUMONT's new flying machine is so small that it travels comfortably on the back of his motor-car. It is a monoplane, with a 24 h. p. Antoinette motor, weighing 58 kilos, and making 1400 revolutions a minute. The total weight is about 150 kilos. The aeroplane was expected to fly at 80 kilometers an hour, and to rise from the ground as soon as it attained a speed on its three wheels of 50 kilometers an hour on the fourth trial. Dumont flew, but was unfortunate enough to damage one of the new machine's wheels.



WIRELESS TELEGRAPHY

PROF. ELIHU THOMSON

SOMETHING over thirty years ago, Professor E. J. Houston and the writer made some experiments, which in the light of our present knowledge, have acquired additional interest to that which they originally possessed as novel experiments at the time.

An induction coil, capable of giving sparks several inches long between its terminals, was operated on the lecture table of the Department of Physics, on the first floor of the Central High School of Philadelphia. One of its terminals was well grounded on the water piping, and the other connected by a wire about 2 feet long, to a large tin vessel of 2 or 3 square feet of surface, mounted on a glass jar as an insulator. Sparks passed between the terminals of the coil—the discharge of the capacity of the tin vessel to earth. It was found that when the coil was in operation, tiny sparks could be seen in the dark when the point of a lead pencil was brought as near as could be to, or to incipient contact with, metallic bodies; not only in the same room but all over the building, even to the top floor and observatory, about 90 feet above. Instruments, apparatus in glass cases, metallic vessels, doorknobs, etc., were tested and found to respond. Particularly noticeable were sparks from isolated stoves in some of the rooms. We at the time had no doubt that these disturbances could have been noted in adjoining buildings. Lightning discharges, as is well known, frequently produce local sparking between metal bodies near to each other.

The phenomenon was significant of the fact that a sudden relief of electric stress might be far reaching, if delicate apparatus for its detection were available.

In the present paper, an attempt will be made to trace the connection between wireless transmission and the ordinary low frequency alternating current transmission; so as to arrive at a consistent development of ideas whereby, in the wireless transmission system, there may be seen to be in operation principles which are much the same as with low frequency alternating arrangements of circuit; modified, however, by the different values of effects introduced in response to the use of high frequency oscillatory or sustained high frequency alternating currents. There is no intention to describe forms of apparatus used in transmission or in receiving, nor other details which are quite widely

varied, and which have been fully described in various papers dealing with the subject. An attempt will simply be made to present a point of view in the endeavor to render clear to those who have not given special attention to the conditions of wireless transmission, the nature of the operations which are involved.

In the ordinary low frequency alternating current system, the energy is expended in a number of different ways; and, of course, the main object of the system is to convey energy from one point to another, as from a source of power in a station to translating devices or motors somewhere upon the line system. In carrying out this plan of transmission, however, there are certain losses of energy inevitably involved. Where the frequency is quite low, we are chiefly concerned with the ohmic drop in the circuit, or the absorption of energy which is converted into heat in consequence of the fact of our materials not being perfect in conductivity.

We have, besides the mere losses in ohmic resistance, magnetic hysteresis, and eddy currents, certain enhanced resistance loss which is due to the skin effect, or crowding of the current to the outside of the conductors; an effect, however, which is not appreciable in the ordinary low frequency circuits, but becomes important as the frequency rises. There is also the added loss due to the charging current of the line, which current does no work. The parts of the line simultaneously at different potentials act as charged conductors or condenser surfaces, and are charged and discharged at each alternation, superposing an idle or leading current on the line current. This effect, however, may be balanced more or less by inductance, either normally existing or purposely introduced; but where iron is used to secure this, added magnetic losses are involved.

Were the dielectrics between the conductors (the air and other insulating materials) perfect dielectrics which could be electrostatically stressed and released without involving loss of energy, the losses due to charging current could usually be neglected in low frequency work. In cables, where the conductors are close together, separated by comparatively thin layers of dielectric, the loss may be considerable, even at comparatively low frequencies, unless the dielectric has been chosen for low leakage and low

dielectric hysteresis. The leakage of the line also adds a loss due to the flow of current from one side to the other over paths which are not intended to exist, but which cannot be avoided — as when the insulators are imperfect in insulation.

These effects, of course, are enhanced by increase of potential, as is also another source of loss, namely, surface ionization (or electrification to a certain distance from the surface of the conductor), which indicates its presence by a bluish light in the dark (called aureola or corona) and a hissing sound in air. Here the dielectric layer, or air layer around the conductor, is actually penetrated by incipient spark discharges, with the production of heat and loss of energy. Mershon has shown that even below the critical point, or point where this blue discharge begins, there is a leakage, or loss in air, increasing with the product of two influences; namely, the amount of water vapor present in a given volume, and the degree of humidity or saturation of the air, which in turn depends upon temperature.

Ordinarily only these losses just enumerated are noticeable with the common frequencies of alternating currents. Generally no account is taken of another slight loss of energy; namely, that due to radiation. The periodic changes of potential of the lines, especially when separated some distance, are accompanied by a wave of stress in the surrounding medium, the ether, which, however, spreads out to an unlimited extent, like the dropping of a stone in a pool of water producing waves which extend onward indefinitely.

Accompanying the periodic flow of current in the conductor, there is also, in the surrounding medium, a magnetic radiation originating at the conductor in the lines of force which surround it, spreading outwardly to illimitable space in magnetic waves. It may be said, then, that any conductor conveying a current, or subject to alterations of its electrical condition, produces in the ethereal medium of space a radiation of energy in the form of electromagnetic waves. When, however, the conductors of a system are so enclosed or arranged that one surrounds the other, with a dielectric between, this radiation is neutralized; for the magnetic lines are then generated in the space between the conductors, and the dielectric stresses are also located in that space. If, however, the conductors stand

alone, far away from any neighboring conductor, then the radiation or electromagnetic wave production goes on unhampered, or one may say, the radiation is free.

It has many times been pointed out that the actual conveyance of energy in an electric circuit is not in the wire, but in the medium or ether surrounding the wire, or in the ether or dielectric between the wires where the conductors are concentric. The radiation, therefore, would represent that small fraction of the energy which, during a pulse or half wave, starts outward with the velocity of light to stress the surrounding ether; and which continues outward, like the waves in the pool when the stone is dropped, spreading onward to an indefinite or infinite distance. It would avail nothing to attempt to stop the wave, to pull the stone back the moment it was dropped, for the wave having once started, does not return. In the same way, the electric pulse having started the electromagnetic disturbance, a portion of the energy expended continues on outwardly. If in the case of the stone in the water we give it a periodical raising and lowering, this sets up a continued system of waves spreading outward. So in the alternating current circuit the changes in the electric condition set up similar electromagnetic waves extending outwardly, only in this case they are represented by the electrostatic stresses in the ether, or electromagnetic lines around the conductor.

We have assumed in the foregoing that the frequency is low. Let us suppose that the ordinary frequency is raised one hundred times, so that instead of, say, 60 cycles we have 6000 cycles per second. It will now be found that the skin effect is so enhanced that it is desirable to spread the conductor out in sheets, or use multiple wires some distance apart, or make the conductor a hollow tube, taking out, as it were, the ineffective core and using the material to enlarge the diameter. We will find, also, that the charging current, in relation to the line current, has greatly increased; in fact, in about direct proportion to the frequency; while the extension of the conductors into sheets or tubes still further increases the value of the charging current, or the condenser effect of the line. Naturally, if there is a dielectric loss, this also is increased in the same way. The ohmic drop, except for the skin effect, and the leakage drop (such losses as are dependent upon resistance purely) would be unaffected, except for the increased values of

the current due to the increased charging current, etc.

As each wave will at any given potential produce a radiation effect depending on the gradient of stress, or rate of change, and not upon the periodicity, the radiation of energy will increase with the frequency or pitch of the waves. Hence, as the frequency rises, more and more of the energy under any given potential will be sent out into surrounding space. As stated before, the skin effect may be avoided by spreading out our conductors; the significance of this in wireless work will be shown later.

If we continue raising the frequency, we may reach a point at which a dynamo supplying given energy is sufficiently loaded with a very moderate length of circuit, due to the radiation losses and charging current; so that we no longer need to assume that the system is one for transmitting energy, in the ordinary sense, to translating devices connected across the circuit. The system becomes, as it were, merely an arrangement for the enhancement of the effects of the charging current and the radiation, with the practical abolition of the other conditions of working that are normal to a low frequency line. With a frequency of, say, 100,000 cycles to 500,000 cycles, our conductor must become a surface if we are to avoid the opposition or attenuation due to self-induction. A very moderate length of line suffices to absorb the load, and the system becomes, substantially, a radiating system.

In the Hertzian wave apparatus we have the extreme of this case. Here an induction coil simply feeds into a Hertzian oscillator; consisting of two polished balls separated somewhat by a small space, with wings sometimes extending outward from the balls. Such an arrangement may be said to be a sort of electrical tuning fork, or one in which the discharges occurring between the two parts, oscillate with a fairly definite period or rate, depending upon the electrical constants of the apparatus. As a rule, the shorter and the smaller the affair is, the higher the frequency, so that with small polished balls, frequencies in the hundred of millions per second may be obtained. The Hertzian apparatus was particularly well adapted to the radiation of energy quickly. The waves damped themselves rapidly. If the two wings of the apparatus had been brought nearly together, more or less parallel, the frequency with any given size would fall and the oscillations be more sustained. In

this case, the energy stored would be radiated over a longer period. At the same time, the apparatus would be capable of storing more energy.

To come now to consideration of the conditions in wireless work, where one half of the Hertzian wave apparatus is abolished, and where one terminal of the oscillating system is put to ground — originally through a spark-gap, but later by direct connection through adjusting or air core induction coils — we will find we have substantially an alternating system in which one terminal is grounded; as if an alternating dynamo had one terminal grounded while the other terminal was connected to a wire or structure, which, while it led away, did not lead to a distant point completing the circuit through translating devices to ground, but merely terminated at some height in the air. Here the function of the charging or energy supplying system is merely to furnish that energy which, with other and comparatively minor losses, is expended in radiation from the antenna into space around it.

Such a system, as in the case of the Hertzian arrangement, may have a period of normal frequency; as when the antenna discharges through a spark-gap to the ground, such a discharge of the charged upright wire taking place as a high frequency oscillatory current, while the energy of the discharge is to a large extent radiated in ether waves in all directions around the wire. While originally a spark-gap was put between the lower end of the antenna and the ground, it is now usual to employ an air core coil and supply the energy by induction, and in receiving apparatus the same arrangement is put into use, for the system is reversible. Dynamos, as initially planned by Professor Fessenden, can be constructed of sufficiently high frequency to become the source of excitation of a well-tuned system.

To digress a moment, it may be even said with truth that a lightning discharge is akin to the discharge of the elevated antenna. Here the cloud contains an electric charge which frequently finds the earth by opening a path for itself downward, but it is to be doubted whether, in such case, it is anything in the nature of a real oscillatory current. According to a definite law enunciated by Kelvin, it is an essential, in order that the discharge shall be oscillatory, that the system shall not contain too much resistance, or any oscillations would be damped out at

their inception. That there is large resistance in lightning stroke is seemingly evidenced alone by the heating effect throughout the whole length of the spark discharge.

At any rate, if oscillations do occur, it does not seem possible that they should be rapid. The breakdown of the dielectric between cloud and earth is, of course, extremely sudden; the pulse front is steep, and it may give rise to high frequency oscillations in metallic systems beneath, such as electric circuits, the frequency of such oscillations depending more on the constants of the circuit oscillating, or upon the portions of the circuit affected, than upon the induced effects of the lightning itself; just as a bell may be struck by a mallet a sharp blow, but the mallet does not vibrate as the bell does, the bell taking on its own rate.

Suppose we have a body insulated, say a vertical wire, and a charge therein which may be assumed positive. Then electrostatic stresses, sometimes called tubes of force, extend all round to the earth's surface, which becomes in the vicinity negative. If the positive charge now runs down to earth through a spark-gap, the stress lines are immediately changed in relation, and an electric current flows, producing magnetic disturbances in the ether around the wire in the form of magnetic whirls or surrounding lines. If the circuit be capable of oscillating, that is, if the discharge gap be proper and there be no great resistance, the positive charge in passing to earth, owing to self-induction, overruns; and the negative going up, in like manner overruns; so that the next instant the vertical wire is negative while the ground below is positive. This overrunning or oscillation takes place in progressively decreasing amplitude, until the energy stored in the original charge has been dissipated; partly in the spark-gap, partly in resistance, partly in dielectric hysteresis, and partly in the radiation of electromagnetic disturbances or waves of definite frequency around the antenna.

These disturbances spread out in circles around the axis of emanation, or the center of the antenna; but current also runs out at the foot of the antenna to join and neutralize the charges of the earth's surface near thereto. In each case of the current moving outward from the foot of the antenna, there is a feeble current extending therefrom, which in ordinary cases follows the upper part only of the moist earth layer below; or better yet, if the apparatus is directly connected with the

sea, follows the surface of the salt water, spreads out as an oscillatory current in the surface so far as the magnetic whirls around the antenna extend, and so far as the electrostatic stress lines arising from each alternating charge extend. To put it differently, the surface of the sea is the conductor in the system, more important than the antenna itself in directing the spread of the electromagnetic disturbance or radiation of energy. The surface of the ground or sea then performs the function of the conducting wire in an ordinary alternating system. It is, however, an indefinitely extended sheet, and may be curved as is the surface of the earth. The electromagnetic waves cast off in consequence of the increased density of stress or lateral pressure in the antenna wire as compared with that of the surrounding earth have, so to speak, their feet in the water.

If one could picture the effect, assuming a wireless station in mid-ocean on a ship, the surface of the ocean would be traversed by a high frequency current, consisting of charged areas, generally circular, of alternating positive and negative character, with neutral or zero zones between; and the spacing of these would depend upon the frequency of the emission. Above these areas would be an extended system of stress lines or tubes of force, projecting from one electrified zone to the other, the zones widening and speeding onward and outward with the velocity of light. Over the centers of the electrified zones as a maximum would be a system of magnetic whirls, parallel to the surface of the sea, consisting of nearly circular magnetic lines ever expanding and passing outward, while guided by the current in the sea itself; just as the current in an ordinary alternating circuit guides the energy which is flowing in the ether outside thereof.

In the early days of the wireless transmission work, there was considerable discussion and mystery as to the reason why the waves seemed to follow the curvature of the earth, instead of spreading out in straight lines from the axis of the antenna; just as it was at first thought by many that the spark-gap was the locus of the radiation. If we bear in mind, however, that as the function of the disk-like conductor, the sea or surface of the earth, is that of a guiding and directing circuit, it is easily understood why the curvature of the earth furnishes no barrier to wireless transmission.

In such a system of radiation of electric energy, practically all the energy of the circuit exists in the electrostatic and magnetic waves spreading outwardly; but as this spreading occurs in all directions, assuming that the conductivity of the surface below is uniform in all directions, it is manifest that at any one point at which the signals are to be received, an almost infinitesimal part of the energy sent out can be caught. The greater the distance away, the less this fraction will be; but here comes into operation the principle which enables us to enhance the effects of the transmission. If the frequencies of sending and receiving be controlled, or the receiving antenna, which extends upward into the region through which electrostatic and electromagnetic waves pass, is arranged so that its natural period of electric vibration or oscillation is the same as that of the transmitter apparatus, then interference is checked, or in the latter case, each minute impulse is added in its effect to that of the one preceding, and a definite amount of energy is so obtained suitable for the working of the delicate receiving instruments. The manner of the delivery of such energy to the receiving antenna may be briefly referred to.

The traveling electrostatic waves, together with the magnetic whirls, spreading outward from the sending antenna, reach the receiving antenna; and since they represent disturbances of electrostatic conditions or stress, and also since they represent extending magnetic lines which cut the upright antenna, there is generated an electromotive force in the receiving antenna which tends to make its upper extension differ in electric potential, or become oppositely electrified from the lower end or earth below, following the waves which move at enormous velocity or the speed of light. By tuning or sympathy of sending and receiving apparatus, the first slight disturbance may be added to, so as to affect the delicate receiver, which is either placed directly in the circuit between the antenna and earth, or is inductively related thereto through an air core transformer.

It is not to be understood that for mere conveyance of signals, tuning or sympathy is an essential, but it depends somewhat on the principle of action of the receiver. But if non-interference of stations is to be secured, then some form of adjustment of such stations to different rates of oscillation or selection of frequencies, will become a necessity.

Inasmuch, however, as the frequency is necessarily high, and may be hundreds of thousands per second, a minute fraction of a second only is needed for a considerable number of impulses to produce accumulative effects in the resonant or attuned antenna; so that rapid transmission, or many signals per second, can be secured.

It has been found as a matter of experience, that, particularly during sunshine in the daytime, wireless transmission with the usual frequencies of 500,000 or 600,000, has been often impracticable, or very feeble as compared with transmission during the night. It would seem that the sunshine, perhaps through the ultra-violet rays, produces an electric ionization of the air, and converts it into what might be called an electrically muddy medium; the ionized gases and particles in the atmosphere disturbing the clarity of the ether as a transmitting medium, by opposing the uniform and direct progress of the radiation of electromagnetic waves. It becomes an absorbing medium, so to speak, receiving and probably converting the energy in its progress into heat. This is somewhat exemplified by the known absorption of the higher frequency waves of light by fog, while the lower waves, such as red light, penetrate fog much more freely. Professor Fessenden has shown, however, that if the frequency be lowered to the rate of from 70,000 to 100,000, then, although the response at night-time may be much more feeble, the response in daytime is retained at a workable value. He has therefore introduced into wireless systems, under collaboration with engineers of the General Electric Company, high frequency dynamos; remarkable machines capable of developing the considerable output of 1 to 3 kilowatts, at frequencies of 75,000 to 100,000 cycles. Such machines can, of course, through suitable air core transformers, be made to impress upon the antenna the desired potentials; and may, as pointed out by Professor Fessenden, be made with large outputs. Naturally the intensity of the electrostatic stress in the ether surrounding the antenna would depend upon the amplitude of the waves, or the maximum potential difference reached; while the magnetic effects which are produced around the antenna, due to the oscillation of the charges or the currents, will depend upon the maximum currents which are present in the vertical antenna.

It will be seen that, theoretically, if the surface of the earth were of uniform nature

or conductivity, there should be a culmination of effect at the direct antipodes of the transmission station. It is probable, however, that the damping effect, or energy-absorbing effect, of the land surface in relation to the sea, is so great as to prevent any such result. It may, however, be possible that, as in the case of all such waves spreading out, there be places where there is a certain enhancement due to the culmination of impulses coming in different directions from the transmitting station, as around land areas. Such culmination may be, however, of too low value to be easily noted, and would naturally, if it exists at all, differ with different frequencies of transmission.

In the above, an attempt has been made to present, if possible, a mental picture of the actions which occur in wireless transmission, with a comparison of the electrical effects with those normally present in other alternating circuits.

Manifestly, since the guiding transmission conductor is the water surface, or moist

land surface, on account of the conductivity, it will be difficult, if not impossible, to effect a wireless transmission across a barrier of dry rock, such as a mountain chain without much moisture. Even a range of hills broken by rocky outcrops or dry soil beds, may constitute such a barrier. Transmission, however, might occur from one point to another on each side of such a barrier, if both stations were near a body of salt water which connected around the barrier; for the signals, though enfeebled by the roundabout course, as tending to follow and be guided by the conducting surface, might still be of force sufficient to affect the almost inexpressibly delicate receiving devices which have been invented by the able workers in the field. Moreover, as pointed out by Professor Fessenden, the electrical shadows of obstacles would be far less sharp with low than with high frequencies,—a fact which may be of importance when obstacles of the nature mentioned above are encountered. — *General Electric Review*.

A SYSTEM by which a wireless telegraphic apparatus may control from a central station the clocks of a whole city is now in use in Vienna, where it was experimentally established three years ago. The clocks are actuated by any desired means; the electric waves interfere each minute to set the hands correctly. Attempts made before this by various persons have failed, because of perturbations occasioned by strange waves, by atmospheric discharges, for example. The inventor, to eliminate these difficulties, conceived the idea of placing the receiving clock in connection with the receiving antenna for only a short interval — one second during each minute. During 59 seconds the clock is isolated and remains unaffected by the emission of waves. During the sixtieth second the receiving apparatus (a radio-conductor actuating an electro-magnetic arrangement) is placed automatically in circuit with the antenna; the wave sent out by the central clock then disconnects the minute-hand for the following minute. If a foreign wave strikes the clock at this moment no great harm is done; the clock gains not more than one second and is set exactly at the following minute. A central station was installed in 1905 in the Electro-Technical Institute of Vienna. The waves sent out by the antenna are about 2500 feet long, and

easily traverse by diffraction all the obstacles and inequalities of ground of a great city, gliding around large metallic masses such as the cupola of St. Charles's Church. Two receiving-clocks were set up for the trials, one at Breitensee, the other at the Siemens-Schuckert factories on the Praterquai, with receiving antennæ about 66 feet in height. During the storm that raged over Vienna on July 17, 1907, with extraordinary violence, the system was not at all impaired. Despite the atmospheric discharges, one of which struck the post of the transmitting antenna (and escaped to earth across the lightning-guard) and despite the torrential rain, the clocks maintained their rate of progress exactly. The regulating clock of the central station is an electric-pendulum clock with mercury contacts, which at the desired moment discharges into the transmitting antenna the electric energy accumulated in a battery of 100 Leyden jars. Such an installation is very interesting; it may furnish the exact time, without great cost, to an unlimited number of mechanical clocks, set up not only within the limits of a great city, but even throughout an entire province; and in any case it makes superfluous the complicated and expensive network of electric conductors necessitated by other systems of electric time-distribution.

HOME-MADE JEWELRY—Part IV

CHARLES B. DYER

A DESIGN like the one shown may be executed in three ways: it may be "etched," "applied," or "tooled." Although etching is not considered a craftsman's method (and by some workmen is even frowned upon as a cheap makeshift), for some work it can be used. For workers who have not yet made their punches, or who feel they would like to try this method anyway, the following will serve:—

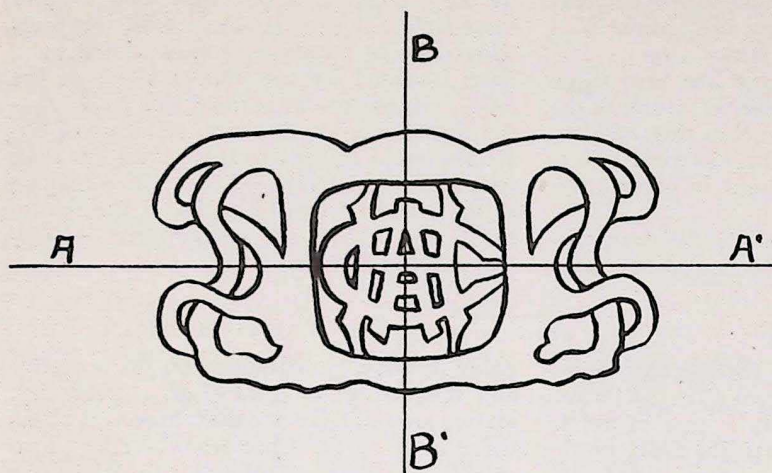


Fig. 1

Make your design carefully on paper first. Use draftsman's tracing paper and draw one half of the design, as shown in Fig. 1. Use the cross lines a.a.' and b.b.' (which are at right angles) as guides to get your design straight. When the first half of the design has been drawn, use a mirror along line b.b.' to see how the complete design will look. If satisfactory, fold the paper along line b.b.' and trace the second half. This method saves working out both sides and assures that they will be exactly alike. Of course if the two sides of the design are not to be exactly the same, they must be drawn separately. Those who have done little work in design, and therefore have never used the aid of a thin, flat edge mirror to change ideas, complete halves, and make repeats, will find this simple method very helpful.

Transfer the design to the metal by the use of carbon paper and scratch it in with the steel pencil. The metal should now be cleaned from oil or grease of any kind—even that of finger marks.

To keep the acid from attacking the face of the design, that part must be protected by a resist. (See formula in July issue.) Use a fine camel's-hair brush and carefully cover all parts of the metal, both front and back, which are to be saved. Be sure to allow the resist to get perfectly dry before dipping the piece in acid. If the part to be etched is small, or the metal too large to cover all over with resist, a "dam" of wax may be built around the part to be worked upon. This wax may be secured from any electrotype foundry.

After the resist is dry, lay the piece in a flat, wide dish and cover with the acid. (See July issue.) Rock the dish gently to keep the acid in motion so the action will be more rapid. After the acid has been allowed to act for a while, examine the piece carefully to see that the resist is not disturbed and to

see that the edges are not working back under the resist. If the background is to be made very deep, the piece must be removed from

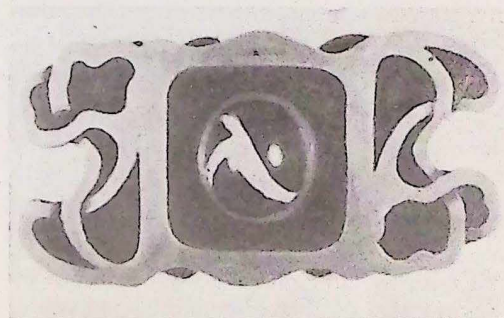


Fig. 2

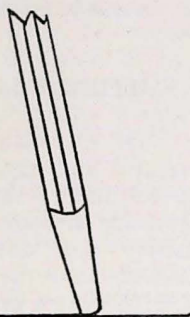
the acid and carefully washed (to free it from acid); then, with the camel's-hair brush, carefully cover the edges all around the design, which were made by the action of the acid. Also touch up any spots on the face of the design which look thin, or ready to cut

through. After this new coat of resist has been allowed to dry again, place the work in the acid bath. If small spots appear in the background where the action does not take place, rub these spots with a sharpened stick of soft wood, until they disappear. Be careful not to breathe the fumes of this acid and the gas made by its action. It is best to place the dish outside the window while the acid is working.

When the background has been etched deep enough, wash the work free of acid with warm water and clean off the resist with turpentine. If the surface and edges of the design have been well covered, they will be found in good condition, but if they have not been well protected, they will be ragged and uneven.

Saw out the outlines of the design and solder the catch and joint on the back. Oxidize and rub off the high lights and the pin is done.

Another way to work up design of a similar nature is to mark the design on a thin piece



About the correct angle to hold punch

Fig 3 —————
As line will show if punch is lifted each stroke

Fig 4 —————
As it will show if not raised

of metal,—silver or copper,—say from gauge 19 to 24, and saw out the entire design both inside and out. Coat the back with borax and lay on small pieces of thin solder, enough so that when it is melted, it will cover from edge to edge. Now turn the piece over and lay it flat on another sheet of metal somewhat thicker and large enough to take the whole design. If the solder has been put on with wet borax and allowed to dry, it will not drop off when the piece is turned over.

Be careful and do not allow the solder to stick out from under the edges, as it will melt there and show white and rough.

Heat the work as evenly as possible until

the solder flows and spreads well under all parts. Saw out the outlines, solder the catch and joint on the back, oxidize and rub off the high lights.

Some very effective results may be obtained by applying silver to copper, or brass to copper, in this same manner.

The best way, from a craftsman's viewpoint, to work up a piece of this kind, is to tool it out. Use either silver or copper, gauge 17. Transfer your design and scratch it on as in the other work. Be very sure your metal has been annealed well before you start to work.

Warm your wax block and metal and put the metal face up upon the wax. Take an outline tool (shown in June issue), and outline the entire design except the outside lines. On the first pieces it would not be a bad idea to outline even the outside lines for the practice it would give. Choose a punch the size best suited to the curve to be run. Hold the punch at an angle of about 80°, so one edge will be slightly raised and may be advanced without raising the punch clear of the metal. Do not strike too hard at first until you see the effect. Do not lift the punch clear of the metal and set it down in a new place each time, but after the blow has been struck, push the punch gently along about two thirds its face length, and strike again. The drawing, Fig. 3, shows the effect of raising the punch and setting it down in a new place after each stroke. Figure 4 shows the line as it should go. After a little practice, a line may be carried right along without the least pause between strokes of the hammer, simply by keeping one edge of the punch raised and advanced slightly after each blow. Do not try to make the line too deep the first time over, but by repeated tracing it may be straightened and carried to any depth desired.

After outlining the design, take a round tool with a very slightly rounded face and depress the background. Set this tool in the groove made by the outline tool and drive down the inside or background. This tool should be held straight up, but the blows should not be too hard at first, and the tools must be advanced just a little at a time, so as not to show the individual marks. If this operation is carefully executed, the entire background will not have to be gone over, as it will be carried down with the edges. Of course if the background is to have the appearance of hammer marks, a round-faced tool is used (see June issue);

but this is done after the piece has been taken from the wax. Lay it on the steel block and go carefully over the entire background with the round-face punch. The wax should be kept slightly warm whenever any work is being done upon it, so it will give way under the metal. Except when a piece is ready to be smoothed up, the wax may then be allowed to cool and grow hard, as you do not want it to give under the light planishing strokes.

Wherever parts of a design cross and should seem to go, one over the other, the underneath one is simply depressed a little on each side of the crossing bar. This depression showing black after the piece is oxidized gives the desired effect. Care should be taken that the under bar is not widened when driven down, as this effect keeps the design from being clean and clear cut.

The catch joint and pin, as well as the oxidizing, are done just the same as on the other pins.

The wax may be removed from the back of the metal by warming and rubbing with a

greased cloth and then washed in gasoline or ammonia and soap.

A good way to transfer the design to the metal without the aid of carbon paper is to use lithographer's gelatine. This can be had from any large supply house. Use a steel pencil to scratch the design into the gelatine. The slight burr thrown up by the pencil is first rubbed off by rubbing over the lines with the edge of a small piece of the gelatine. Pencil dust or powdered red kale is now rubbed into the lines. The metal must first be cleaned, then dimmed. This is done by rubbing a finger over some damp soap, then over the metal. Now apply a little talcum powder or prepared chalk. The same effect may be produced with whiting mixed in alcohol.

Turn the gelatine with the scratched side down and rub the back all over with a burnisher. The design will then show on the metal and may be scratched in with the steel pencil.

Gelatine is very nice to use because it can so easily be reversed and turned in any way.

STORAGE BATTERIES FOR SMALL LIGHTING PLANTS

W. H. COLES

THE question of storage batteries for use in connection with small isolated electric lighting plants is, in many instances, not comprehensively understood by the average person contemplating such an equipment.

On first consideration, the apparent advantage of being able to operate the engine and dynamo throughout the daytime for storing current into a battery from which it can be used throughout the evening and night, seems to be attractive, in that it relieves the user of the necessity of keeping the engine running after the day's work is done.

A further investigation of this matter, however, frequently leads to the conclusion that the cost of such a battery is so great as to render an installation of this character impracticable, as the price of a storage battery is frequently equal to the combined cost of both dynamo and engine; consequently, in doubling up the cost of an equipment, the price advances to a point which renders it prohibitive.

To any one familiar with storage battery installations, still another obstacle presents itself, because it must be conceded that a storage battery of any liberal proportions is a comparatively delicate piece of mechanism,

requiring careful and experienced attention in order to maintain it in satisfactory and efficient operating condition. With such a storage battery any abuse inadvertently given it is disastrous to its maintenance and life. This is true to a greater degree than with a dynamo, engine, or similar apparatus.

For the above reasons, an investigation of the storage battery question frequently leads to the conclusion that a battery is so desirable a feature of a lighting equipment that no electric equipment would be satisfactory without it, and that inasmuch as insurmountable difficulties seem to be encountered prohibiting its installation, the whole electric lighting question is considered to be impracticable.

However, analyzing the above seemingly impregnable position, several fallacies are discovered which, if investigated thoroughly, will materially modify the attitude of the investigator toward such installation and will lead to a widely divergent conclusion.

In the first place, the advantage lying in the possibility of operating the engine throughout the daytime, is an apparent rather than a real advantage. It is throughout the day that the engine is in use for general work, and

if to this work is added the requirement of driving the dynamo, it becomes necessary to increase the capacity of the engine. Consequently, it is only by subdividing the work in utilizing the engine for general purposes throughout the day and for driving the dynamo throughout the evening that a minimum capacity in the engine can be secured and utilized and a proportionately higher operating efficiency obtained.

It is also evident to any one familiar with gasoline engines that their operation throughout the evening is not a disadvantage, for the reason that any reliable make of engine in good condition does not require attention while it is running. This fact is confirmed by thousands upon thousands of engines which are not touched from the time they are started until they are shut down. It can therefore be seen that in order to secure lights throughout the evening, all that is necessary is to start the engine and shut it down when the heavy requirements are over. Such an installation offers a decided advantage over any other character of lighting equipment which might be considered. The only objection which can be raised lies in the question of supplying lights throughout the night after the engine is shut down, but fortunately this phase of the problem furnishes a ready solution.

Within the last few years storage batteries, such as are most suitable for electric lighting installation, have been placed on the market in capacities smaller than those formerly manufactured. These batteries for isolated lighting plants in the hands of the average user offer a twofold advantage over batteries of larger capacity.

The first lies in the fact that the cost of a battery to store abundant current for the use of night lights is considerably reduced, and the price of a battery of liberal capacity for this service is comparatively cheap. The second advantage consists in the elimination of danger of injury to the battery through improper handling; for, while a few general rules relative to the maintenance of such a battery must be observed, yet these rules are simple and understandable, and a temporary lack of conformity to them is not so disastrous to the life of the battery as would be the case with an equipment of greater capacity. Consequently, having adopted a storage battery of small proportions, the question of price has been satisfactorily settled, and the objection incident to the need of

careful operation has been materially overcome.

With an installation such as is above outlined, every advantage possible to a lighting plant can be secured at a cost which is not excessive. The engine can be started up in the early evening and shut down at bedtime without the need of attention during the intermediate time. When the engine is stopped, by simply throwing one switch, light can be secured by means of the battery from any lamp the same as if engine and dynamo were running.

With the exception of a small amount of additional wiring sufficient to conduct the current to and from the battery, no changes are required in the installation, and inasmuch as this wiring is located between the dynamo and battery, it can all be done in the dynamo room, and with very slight expense. The storage battery can be installed at the time the dynamo and engine are put in place, or if its installation is delayed, there is no necessity of altering either the dynamo or the wiring, except in the simple way as above indicated. A storage battery of this character does not require a special construction in the dynamo, or any modification in the wiring throughout the building.

The cost of maintenance of a storage battery is very slight. In larger installations, the rapid deterioration as the result of abuse has led to a widely spread belief that the cost of operation and maintenance was excessive. The practical elimination of danger and mishandling in the smaller batteries has overcome the greater part of storage battery expense. It can be stated definitely that such an equipment as above outlined is an entirely practicable installation, even though it is operated and maintained by a user who is untechnical and inexperienced in electrical lines.

With these facts in mind, it can be recognized that an electric lighting equipment can be installed at a reasonable price which furnishes every advantage to be desired in an equipment of this kind. It is well adapted to the conditions under which such equipments are installed, and can easily be maintained by the class of users who would be interested in a lighting equipment of this character. Hundreds of such lighting plants are in daily service, furnishing a light equivalent to any which can be produced by the best city lighting station, and yielding this result without inconvenience, annoyance, or undue expense to the owner. — *Gas Review*.

HOW TO MAKE A BICHROMATE BATTERY

For intermittent electric lighting, such as an electric flash, torch, or night light, or for working induction coils, the bichromate is the best and handiest battery to use. The word battery is here used in the general sense to mean one or more cells, although, strictly speaking, a battery is only the plural form — viz., when there are at least two cells.

Much work from an amateur's point of view can be done with one cell, and, if made according to the following instructions with the lifting arrangements, the cell will only work when actually in use.

A bichromate battery employs bichromate of potash as the depolarizer or to absorb the hydrogen which is set free in the battery; this, if not absorbed, would cover the negative element of the cell — in this case the zinc — and so neutralize or prevent the proper working of the cell.

Only a small cell is needed to work amateurs' coils, and a suitable one can be made from an outer glass jar having a wide, open mouth, and holding about a quarter pint of bichromate of potash and sulphuric acid solution. A strip of carbon of such dimensions as to almost fit in the jar on one side is required; also a half-inch square bar of zinc of such a length as to stand up half an inch above the top of the jar when resting on the bottom. The top or upper end of the carbon should be coated with electrotype copper for a distance of half an inch, and a brass terminal soldered on. A round top should now be fitted to the top of the jar with a slot large enough for the carbon plate to fit, and a circular hole A (see Fig. 1) to take the zinc bar (Z).

The illustration, Fig. 1, shows a plan of the cell with carbon (B) and zinc bar in position. In lieu of the ebonite top, stout paraffined cardboard can be used, but in this case an ebonite ring must surround the zinc bar. With the carbon strip and cover in place, pour in some melted pitch or marine glue in the opening at A so as to fix the bottom of the carbon rod in place. Next amalgamate the zinc bar with mercury, which is done by thoroughly cleaning the zinc and then rolling it in the mercury until it is brightly coated. The zinc may now be inserted in the cells as shown in Fig. 1. T is the terminal.

Some provision must be made for connecting the wire to the zinc, and a good method of doing this is to make a fork arrangement out of brass to the shape shown in

Fig. 2, so that the zinc bar fits between the tongs and is secured by the set-screw shown. With a brass support to take the end C of the forked piece, Fig. 2, such as is shown at D in plan at Fig. 3, connection for the wire can be obtained by putting the bared end of the wire in the fork of the support as indicated.

When the coil is not in use, the zinc bar should be raised up out of the solution so as to prevent chemical action taking place and running down the cell. When the solution turns green, it is a sign that it is of no use for further action and must be thrown away, and fresh solution employed. This solution, as previously mentioned, is a mixture of bichromate of potash and sulphuric acid in water. It must be made carefully, and the best method is as follows: Dissolve 3 ounces of bichromate of potash in 1 pint of boiling water, then stir into it with a glass rod 3 fluid ounces of sulphuric acid (oil of vitriol). This acid must be poured in slowly, as otherwise it will spurt.

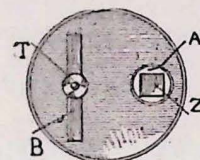


FIG. 1. PLAN OF CELL, WITH ZINC AND CARBON IN POSITION.

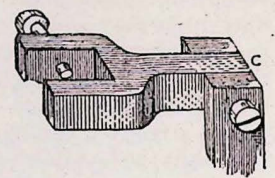


FIG. 2. CONNECTION FITTING.

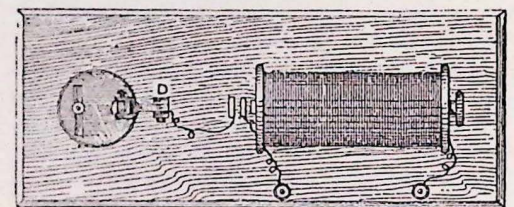


FIG. 3. SHOWING BATTERY CONNECTED TO SMALL COIL FOR EXPERIMENTAL PURPOSES.

The coil is started immediately the connections are made, assuming the zinc bar has been lowered, and the current is stopped immediately a wire is disconnected or the zinc bar raised up out of the solution. It is a good plan to remove the zinc bar entirely when the coil is not in use, washing it, then wiping it dry and storing for future use, afterwards fitting in an india-rubber cork in the opening A to prevent evaporation.

Such a cell as the one described is known as the "single fluid cell," and one or more of such cells are quite suitable for ordinary small coils. If, however, long spark coils are employed, or for wireless telegraphy work, then a more constant form of cell, such as the "double fluid" variety, is required. This consists of an outer jar containing a porous inner vessel to hold the dilute sulphuric acid and zinc rod. The carbon plate is put in the outer vessel, and the jar charged with a solution of bichromate of potash. Some means must also be used for lifting the zinc out of the solution; otherwise the solution will

soon be useless. If one or more of the cells are required, they must be connected "in series" — that is, the carbon of one cell is connected to the zinc of the next with short pieces of copper wire. When thus connected the electromotive force generated in one cell is carried forward by the wire to the next cell, and consequently the total E. M. F. of the battery is equal to that of one cell multiplied by the number of cells in use. When thus connected the battery has power to send its current through a high resistance, and thus increase the strength of current passing through the coil.

THE DIFFERENTIAL GEAR

(TREATED FROM A NON-TECHNICAL STANDPOINT)

H. C. FETSCH

THE important part which the differential or compensating gear plays in the successful operation of the automobile of to-day is well known to the manufacturer and to the automobile enthusiast. Nevertheless, notwithstanding its importance, comparatively little has been written upon this type of mechanism in a strictly non-technical way to show its operation. In the above diagram the essential parts of the differential gear are shown. By studying the motion of these various parts in the several cases that arise, its operation will be clearly understood.

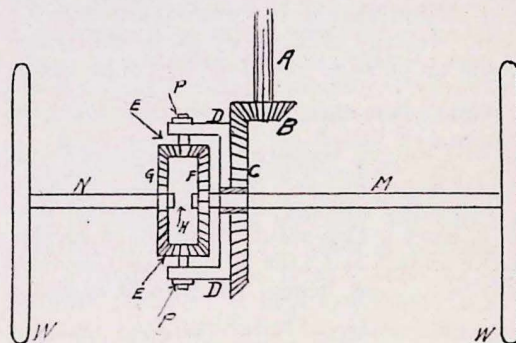
The above diagram is that of the bevel differential gear in common use at present. Another type, the spur differential, possessing several advantages over the bevel differential, will be mentioned later.

A is the driving shaft, to which is attached the pinion B, which communicates motion to C. The arms D, D, are fast to the pinion C and revolve with C. E and E are small bevel pinions, meshing with the gears F and G, and which are free to revolve in the pivots P, P. The shaft is divided at H into two parts M and N, respectively keyed to the gears F and G. The bevel wheel C is not fast to M, but free to revolve loosely upon M.

The essential idea of the differential gear is to transmit power to both driving wheels W, W, at all times while the car is in motion, whether it be traveling along a straight course or turning a corner. When an automobile turns a corner the wheels on the outside of the curve revolve faster than those on the inside, and consequently, if both rear wheels are rigidly attached to the same axle, one of

them would have to slip in so doing. This would cause wear upon the tires; and to obviate this the driving wheels must revolve independent of each other, and at the same time both must be coupled to the driving power. The differential gear solves this problem.

Let us first examine the case when the car moves along a straight course. Assume that the wheel C is revolving forward. Since the arms D, D, are fast to C, they necessarily revolve in the same direction as C, carrying



with them the pinions E, E. Now, since the resistance to the turning of both the wheels W, W, is the same, the power is transmitted to F and G through the teeth of the pinions E, E; and hence, the pinions E, E, do not revolve in their pivots P, P. In this case, then, the wheels F and G have the same forward or backward velocity of the wheel C.

In the case when the car is turning a corner we have a different action. Assume that

the car turns to the right, and therefore the left-hand wheel must turn faster than the right-hand wheel, since it passes over a greater distance. More resistance is offered to the right-hand wheel and less to the left-hand wheel, hence the wheel which turns the easier can revolve the faster. Therefore the wheel G must revolve faster than F, and if G revolves faster than F, and at the same time the pinions E, E, are carried around with D, D, in the same direction, the pinions E, E, revolve in their pivots, but always are transmitting power to both F and G.

The equation showing the relation between the velocities of the wheel C, F, and G, is $\frac{f + g}{2} = c$, where

f represents the velocity of F in revolution per minute.

g represents the velocity of G in revolution per minute.

c represents the velocity of C in revolution per minute.

Several simple experiments, such as the following, will show the operation of the gear more clearly. Suppose wheels W, W, are raised from the ground, and that one of the wheels, W (*i.e.*, the left-hand wheel), is revolved. This would cause G to revolve at the same speed and in the same direction. G would cause E, E, to revolve and E, E, would cause F to revolve in the opposite direction to G and at the same speed as G. No motion should be communicated to C, hence velocity of C is 0, or in the above equation, $c = 0$. Putting $c = 0$ in above equation, we have $\frac{f + g}{2} = 0$, or $f + g =$

0, or $f = -g$; showing that velocity of F and G are the same, but in opposite directions.

Secondly, suppose C to revolve and that F is fixed. This would cause G to revolve twice as fast as C, for if F is fixed, its velocity is 0, and hence, $f = 0$, and in above equation we have $\frac{0 + g}{2} = c$, or $g = 2c$,

which shows that the velocity of G would be twice that of C, and in the same direction.

It is easily seen that the small pinions E, E, tend to wedge the gears F and G apart, causing wear and tear on the teeth. This is partly overcome by having a thrust bearing on each of the wheels F and G, and also by incasing the entire differential gear in an oil bath.

The latter defect of this mechanism is overcome by the design of a spur differential

in which the bevels F, G, and E, E, are replaced by spur gears. The action, however, is just the same and needs no special explanation.

The Flemish Oak Effect

WHAT is known as Flemish oak is more properly a black oak, for it is done with black all through. The method is to dissolve $\frac{1}{2}$ pound of bichromate of potash in 1 gallon of water; apply this, when it has been strained, and when it is perfectly dry, sandpaper with fine paper down smooth. Now mix up some japan drop black with turpentine to a thin liquid, and apply one coat. In a few minutes you may wipe off clean, coat with grain alcohol shellac, and sandpaper with fine paper. The wax finish is made from beeswax, 1 pound to the gallon of turpentine, adding 4 ounces of the best drop black. Wipe off clean with cheesecloth.

PROFESSOR PUPIN, speaking of the claim of Bellini and Tosi, two Italian inventors, that by means of two rectangular aerials fixed at right angles, attached to the apparatus for reception and transmission, so as to permit the transmission of unequal currents, two electromagnetic forces unite to produce an electromagnetic field, and that the Hertzian waves are projected in a single vertical plane which can be alternated instantly by means of the Bobine device, says that with a perfect apparatus of this kind the operator would be able to transmit a message to any given point, while no other wireless operator not in a direct line between the objective point and the point of transmission or in a vertical plane passing through that line would be able to pick up the message. In the experiments made by Bellini and Tosi, however, Professor Pupin says, the results obtained have been only partly successful. Although they have been able to confine the waves within a comparatively small angle, they have not yet succeeded in confining them to a single vertical plane. In the ordinary wireless apparatus in common use the Hertzian waves emanate toward every point of the compass from the starting-point. Only one rectangular shaped transmission wire is used. In the device employed by the Italian inventors, as explained above, two rectangular-shaped transmission wires are used, placed at right angles to each other.

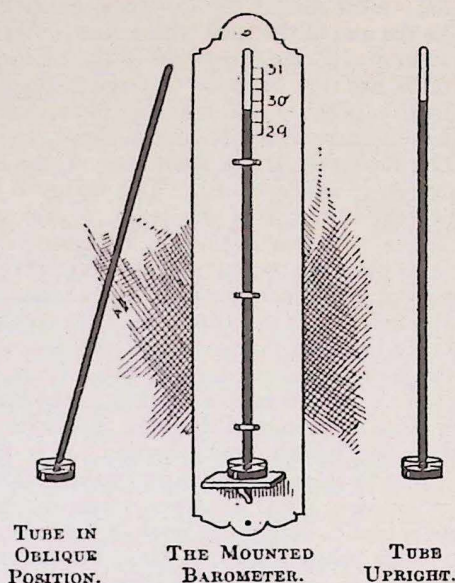
HOW TO MAKE A CISTERN BAROMETER

To make a cistern barometer it is first necessary to purchase from a dealer in scientific apparatus, or from an ordinary chemist, a barometer tube, a 2-inch crystallizing basin, and a pound or more of mercury, according to the diameter of the barometer tube. The barometer will be required to be mounted, and for this purpose a hard wood board about 40 inches long by 6 inches wide will be suitable. A small shelf near the lower edge of the board supports the mercury trough, and the tube is fixed to the board by metal bands, which may be readily cut with strong scissors from a piece of sheet brass.

For making a barometer, mercury is chosen before any other liquid for several reasons. Since it is the heaviest of all liquids the barometer made of mercury is the shortest. If glycerine be used, the vertical tube must be nearly 28 feet long, and if water, it will be 34 feet. Obviously such instruments would be impossible for the ordinary householder. Mercury also has the advantage that it does not adhere to the inside walls of the glass tube.

Thus, so far as this matter is concerned, the mercury barometer registers accurately, however rapid the change in atmospheric pressure, whereas with a glycerine or water barometer the height of the column after a rapid fall is lower than it ought to be, because some of the liquid remains, moistening the glass. Impure mercury may, of course, wet the glass, hence, unless a chemical laboratory is at one's disposal, it is better to purchase pure mercury. Then impure mercury has not the same density as the pure metal, and consequently a barometer in which the mercury is not pure cannot be accurate. If suitable apparatus can be secured, a cheaper mercury may be purchased and purified in the usual manner by treatment with dilute nitric acid and by distillation.

The difficulty in filling the barometer consists in getting rid of every particle of air and of water. If any air or aqueous vapor be left in the tube, it exerts pressure and depresses the mercurial column, and hence makes the instrument inaccurate. The filling of the tube, however, presents no insuperable difficulty. A large tea tray (failing a proper mercury tray) should be placed on the table, and the process of filling the tube performed over this, so that if any mercury be spilled, as is certain to be the case, it is



not lost, but is caught by the tray. A spirit lamp or Bunsen burner is also required.

The tube is gently warmed along its whole length. A little mercury is then poured in, and this is boiled in the barometer tube. As the vapor of mercury is given off, it carries with it any aqueous vapor which may be in the liquid or on the sides of the tube. Care must be taken in this operation or the barometer tube will be cracked. The closed end should not be suddenly plunged into the flame, but should be gradually raised in temperature before being brought to the full heat.

When the mercury has boiled for a minute or so it is allowed to cool, and then additional mercury, itself warmed in a glass vessel of some kind (a test-tube will do, or a beaker or evaporating basin if obtainable) is poured into the tube. This is again boiled, allowed to cool somewhat, and a further quantity added. This process is repeated until the tube is quite full of mercury and a globule stands up above the open end of the tube.

The remaining mercury is then poured into the crystallizing basin, the thumb firmly pressed on the open end of the tube, which is inverted over the mercury. The thumb must not be removed until the open end of the tube is well under the mercury. It will now be found that if the tube be placed upright it is no longer full of the metal. On placing it in an oblique position, however,

the mercury should run quite to the top, and if the metal is sufficiently pure, it should strike the end of the tube with a sharp, metallic sound. If the sound is dull, then the metal is not free from air or aqueous vapor, and the process of filling should be repeated, with more care in the boiling of the metal.

The next step is the mounting of the instrument upon the board. This can well be left to the initiative of the reader. A cover for the crystallizing basin should be provided so as to keep the mercury clean, and prevent it spilling if the instrument receives a knock.

The height of the barometer is the vertical distance between the surface of the mercury in the trough and the level of the column in the tube. Now it is obvious that as the mercury flows in or out of the tube, the level of that in the trough must change. It is not sufficient to mark one level and gauge others from that one. For example, when the barometer is at 29 inches the level in the tube is not 1 inch below what it is when the barometer is at 30 inches. The simplest method of marking the barometer is to paste a strip of paper at the side of the tube, and mark this with each change of level, measuring on every occasion from the then level of the mercury in the trough. The measuring should be done along a strictly vertical line, which is most readily secured by using a plumb line. This graduation may spread over some weeks, and then the permanent marking of the board may be done. It must be remembered, however, that if any mercury be spilled from the trough, the graduation must be done again.

The most usual use of the barometer is to furnish a weather forecast. It has been noticed that in the British Isles when the weather is fine the barometer is generally over 30 inches, and indeed, from many observations, the following table has been drawn out:—

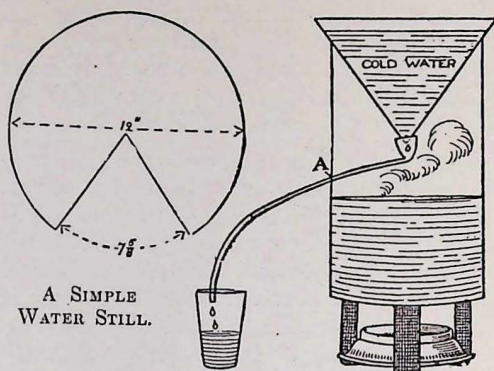
31 inches.	Very dry.	30 $\frac{3}{4}$ inches.
Settled weather.	30 $\frac{1}{2}$ inches.	Fine weather.
30 inches.	Variable.	29 $\frac{3}{4}$ inches.
Rain or wind.	29 $\frac{1}{2}$ inches.	
Much rain.	29 inches.	Tempest.

It must, however, be borne in mind that the barometer only registers the pressure of the atmosphere, and that although a change in pressure usually goes along with a change in the weather, the two do not necessarily coincide. The position of the British Isles is such that a fall in the barometer usually precedes rain. When the barometer rises or falls slowly the indications then are very re-

liable, whereas sudden changes, either showing a rise or fall, indicate stormy weather. — *Home Handicrafts.*

HOW TO MAKE A SIMPLE STILL

A CONVENIENT and easily made still, which would be of great use to the amateur photographer in supplying him with distilled water in small quantities, is shown below.



Obtain, or make, a large canister about 14 inches high and 8 inches in diameter. A tin such as is used for sending out sweets to the retailer would serve the purpose admirably. The bottom should be of stout material and water-tight. It will be seen that the can contains a hole about 7 inches from the top (A). Through this hole is thrust the stem of a new clay pipe, or a metal contrivance that would answer the same purpose, which is either soldered in position or fixed with red lead to make the joint water-tight. The canister requires a cone-shaped lid. To make this, set out on a sheet of tin the dimensions shown on the plan. Lap one edge over the other and solder the joint. It should be carefully adjusted to fit properly on the canister and allow no steam to escape. The tip of the cone should stand directly over the bowl of the afore-mentioned pipe.

A piece of india-rubber tubing of convenient length is fixed on the portion of the pipe-stem protruding, to carry away the water. The apparatus works in the following manner: Water is poured in the canister, and cold or iced water into the conical lid, which is fixed in position. Heat is then applied to the bottom of the can by means of a spirit lamp, which causes steam to arise and settle on the cone in the form of small drops. These drops will trickle from the tip of the cone through the pipe into a vessel provided outside to receive them.

THE TUNGSTEN LAMP

FRANCIS W. WILLCOX

THE filament of tungsten lamps is not a wire of metal like copper or iron wire. Tungsten is too brittle to be drawn, and although the metal has been known for considerably over a century, it is only in the past few years that it has been possible to build a wire of it, a feat which has given us the tungsten lamp.

In order to make a filament of tungsten, the fine particles of the metal powder (its general form) are made into a paste with some binding material and this paste squirted through a die, which die must be made from a diamond as the only material suitable. The filament so obtained is dried, the binding material removed by suitable processes, and the particles of tungsten welded together into a continuous wire.

Metallic conductivity is generally high, and to obtain the necessary resistance with tungsten for 100 to 125 volt lamps, long and very thin filaments are required. As such filaments are somewhat delicate and soften when burning, it is necessary to provide special means for their support. The General Electric Company support their filaments in their lamps with a special and clever form of anchor, which permits burning the lamps in any position, whereas most of the tungsten lamps can be burned only in a vertical pendant position.

Although the filament of the tungsten lamp is fragile, this difficulty can be and is being overcome by special methods of packing and greater care in handling the lamps. We have the evidence of the Welsbach mantle to prove that fragility is not a very serious difficulty. The early carbon filaments were as delicate and fragile as those of tungsten are now, and nobody would have then believed that a carbon filament would be made as durable as we know it to be to-day.

The General Electric Company in the past few months have shipped over 300,000 tungsten lamps to all parts of the country, with positive and direct information from most of the packages as to breakage. The results show an average not exceeding $1\frac{1}{2}$ per cent breakage, which result compares favorably with breakage on ordinary lamps.

A point of value occurs here. It is found that tungsten filaments while burning cannot readily be broken; so if customers will keep lamps lighted while cleaning lamp, globe, or fixture, the breakage will be minimized.

The positive temperature coefficient of tungsten (and tantalum) lamps causes them to suffer much smaller changes of candle-power and life for any change in voltage, than occur with the carbon filament lamp; all of which makes these new lamps better able to stand the fluctuations of service conditions than the old.

As is well known, the multiple tungsten lamps are now being made in this country in 25 watt, 40 watt, 60 watt, 100 watt, and 250 watt sizes, and to September 1, 1908, over 1,000,000 of such American made lamps have been made and sold. The available supply for the ensuing twelve months will be from 8,000,000 to 12,000,000 lamps. This will be enough to enable the central stations of the country to displace some gas arcs and take on additional business.

The tungsten lamp is used to the best advantage with the bowl form of holophane reflector, particularly with the frosted type which gives a very soft and agreeable lighting effect.

It must be realized that the tungsten lamp in 40 watt and larger sizes is a radically new proposition in many respects. It is not a lamp to replace ordinary ones everywhere, as it has too large a candle-power and is too brilliant. It requires to be used in a somewhat more special way — above the line of vision, or in any event, suitably enclosed in frosted or opal globes, or shaded so as to avoid glare.

We have in the tungsten lamp a wholly new condition, as by reason of its very high efficiency, we are no longer required to depend upon the near-by illuminant, but can flood a room or shop with a daylight brilliancy, at reasonable costs, with lamps placed well above the view. Enclosed globes and spheres can now be economically illuminated to a full and satisfactory brilliancy. All previous limitations are removed, opening up a new era of daylight illumination.

We also have in the tungsten lamp a wonderfully attractive quality of light of the brilliant resplendency of sunlight, reproducing the daylight and bringing out every color in its true tone and shade.

Finally we have in the tungsten, a lamp that practically does not change in candle-power or brilliancy, giving a good long life of 800 hours or more of (as far as the eye can tell) undimmed illumination. — *General Electric Review.*

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 A. E. WATSON, E. E. Ph.D. } *Editors*
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EDITORIALS

A STRONG desire seems to exist among amateur wireless operators to obtain lists of the call letters of commercial and naval stations, whether on land or on ship. There are various ways in which these may be learned. The Navy Department has published a list of the wireless stations of the world. This is now considerably more than a year old, but is the only list to be had which makes any pretence to completeness. It lists many stations, however, which have never been established, some which have been discontinued, and by no means all that now exist. Many call letters are incorrectly given and practically all the Marconi calls are given as two-letter calls, while in practice they are now all three-letter calls.

SEVERAL individuals are advertising and selling lists of wireless calls. We have purchased and examined all we have been able to find. All of them contain many errors, and are manifestly based upon the Navy list.

* * *

It has been suggested by many of our readers that we publish a complete and up-to-date list of at least all calls of American land stations and ships plying in American waters. We have taken this question up with all the commercial wireless companies, but they have raised such strong objections that we have decided that the plan is not one to be carried out. The commercial companies claim that their business is greatly interfered with by experimenters, who call up their stations and break in upon commercial messages.

* * *

ALTHOUGH we possess a complete and official list of call letters of all American stations, therefore, we have decided to publish no more information of this character except with the consent of the companies concerned.

* * *

WE wish to call to the attention of the members of our wireless club the serious damage they may do to the cause of wireless experimenting by careless or mischievous interference with commercial and naval work. Many experimenters are so anxious to have some one to communicate with that they call up any station in the vicinity whenever they want to talk. Oftentimes commercial operators are willing and able to talk to amateurs, but usually they are not. In such cases, we understand it is not uncommon for the amateur to deliberately interfere with the receiving of messages on important matters, to get even, as they express it. We are informed that one crabbed individual living near Boston has installed a very powerful apparatus, and spends his evenings in deliberately drowning every message sent or received by a naval station near by. This is an extreme case, and the naval authorities will eventually catch this man. But carelessness may be as effectual as malice in interfering with business, and we ask our readers to be careful not to interfere with other wireless work.

* * *

THERE is a very good reason for this request. The Navy Department and the commercial companies together will make a

strenuous effort this winter to get a bill through Congress requiring all wireless stations to be licensed. It is not probable nor desirable that this should occur, but every case of interference strengthens the argument for licensing. So always stop sending, when asked to by those whose business means something to the world. Don't get the idea that the ether is free, for Uncle Sam has police powers even over the ether, if he cares to exercise them.

* * *

WE are preparing to assign wireless calls to all members of our wireless club. In order to prevent any confusion, we have consulted with the commercial companies, and find the situation is as follows: The United States Navy has utilized about half the possible two-letter combinations. The United Wireless Company has a very large number of two-letter calls and some one-letter calls. The Marconi Company uses three-letter calls exclusively. We have charted all these calls and shall assign *three-letter* calls to all our members. Every call will have prefixed the letter E. The other two letters will be so chosen as not to conflict with any commercial station within three hundred miles.

* * *

CHICAGO is hustling as usual. The first local wireless club, Local No. 1, is already organized. New York will probably be second. Who will form No. 3?

* * *

WE learn that many of you would like to earn the wireless set (the \$175 one), but are afraid to begin because some one must have such a good start that it is no use. Now just get over that. There are a few others getting to work, but we want to tell you right here that if you will go out and get half a dozen subscriptions to-day you will be in the first fifteen or twenty, and have as good a chance as anybody. The real scrap will come in January, but get busy right off, and you will probably land the set. If you all hold back now and see some one cantering off with the prize with less subscriptions than you could easily get, you'll be sorry.

* * *

To new readers this month we would say that last month we published a fine list of

premium and subscription offers. Send for it and see how easily you can get that tool you wanted.

NOTICE. No premiums are given on combination subscriptions to more than one magazine. The reduction in price, is all the concession we can make.

* * *

WHEN the United States officials at Washington advertise for bids on airships or wireless apparatus, they are ten years ahead of science. Witness the specifications for the 100-kilowatt station for Washington. The man who can come up to them has solved the whole wireless problem for all time.

* * *

In sending questions, put them on a separate sheet, always, or they may be greatly delayed in reaching the proper editor. Address all questions on wireless to Wireless Department. Address all other questions to Query Department. Questions are usually not answered before second number after receipt.

* * *

The seemingly erratic behavior of air when employed as a conductor of electricity, has been one of the most puzzling electrical phenomena, but it is now believed to be fully explained by the presence of radium emanation, which causes the air to act as a conductor. Another interesting question is to explain how the earth manages to maintain its negative charge if it is surrounded by a conducting atmosphere. The negative charge should be neutralized rapidly by the positive electricity of the air. The fact that this neutralization is going on continuously has been established by Wilson, who found that the rate of neutralization is sufficient to discharge the earth in an hour if the negative charge were not being continuously given back to the earth. How this is done has not yet been explained, but Thomson thinks that rain plays a large part in it, if it is not, in fact, the sole agent. Drops of water form more easily on negatively charged particles. Rain may be thought of, then, as forming on the negatively charged dust particles, and as it falls to the earth it not only clears the air but restores to the earth its negative charge.

QUESTIONS AND ANSWERS

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

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for the 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.

854. **Winding Ring Transformer.** A. E. N., Britt, Iowa, asks (1) How large to make the core of an electromagnet that will require 40 watts for its excitation? (2) What should be the dimensions of core and winding of a ring transformer to use on an 80-volt, 25-cycle circuit, and draw not over 1 ampere for the primary, and give either .75 volt or 5 volts in the secondary? What would be the secondary currents? (3) What would be the resistance of a 6 x 8 bichromate cell having eight electric light carbons and three zincs of same size, and would two such cells suffice to run a 5-volt, 1-ampere motor? Ans. — (1) This question is entirely indefinite; the magnet might be of almost any dimensions, and yet take only 40 watts. (2) Wind up a ring of annealed iron wire, such as tin-smiths use, about 3½ inches inside diameter, and of a circular section about 1½ inches in diameter. For secondary, put on six separate coils of No. 10 wire, each consisting of nine turns. Wind them alike, and mark the ends as inside or outside. For primary, wind on, over the secondary, after again insulating, seven hundred and thirty turns of No. 19 wire. This can be spread uniformly over the entire surface; bring out the terminals fairly close together. By connecting all the secondary coils in series, — inside to outside, all along, except the finals, — you can get about 5 volts; with all in parallel, — all the inside ends forming one terminal, the outer ends the other terminal, — about .75 volt will result. The current can be 10 to 15 amperes, or six times that, respectively. (3) About 3 ohms. You would need about four cells.

855. **Choke Coil.** R. C. S., Millensburg, Ohio, refers to the description of the choke coil in the last October issue, and asks what changes to make to adapt it to use with 30 instead of 50 amperes? Ans. — We have not had time to correspond with the author, but we rather look askance at the rating of 50 amperes. No. 12 wire is good for a continuous carrying of about 6 to 7.5 amperes, and two wires in parallel would of course give twice that capacity. Perhaps the coil could carry 20 amperes, especially if the ventilation was good. We think if you make it just as described it will fill your demands. If, however, it gets too hot, bend back the sheet iron, wind on a third coil of the same number of turns as the others, and you will increase the current carrying capacity.

856. **Motor Rating.** O. C. M., Valdez, Alaska, asks (1) What is the process by which photographs or drawings are made into cuts for

printing? (2) A motor is spoken of as having a rating of 20 amperes at 100 volts. Does this mean for one hour? (3) For what does B. T. U. stand? Ans. — (1) This is by process of photographing on a zinc plate, and then etching away the desired portions by use of nitric acid. There is no electric action. (2) It means that the machine has a continuous capacity for that current. It may be used for a few moments only, or run for a week without stop. (3) British thermal units.

857. **Boiler and Engine Construction.** H. E. S., East Vassalboro, Me., asks various questions about the design of a 1 h. p. steam-engine and a flash boiler to operate at 200 pounds pressure. Ans. — We are afraid you have automobile construction on the brain, and we beg to be excused from committing ourselves on that topic. There are excellent designs published in various technical magazines devoted to that line of trade, and we must refer you to them.

858. **Current Capacity of Wire.** R. R. LaR., Placeville, Cal., asks (1) What is the formula for finding the horse power of a stream of water? (2) How many amperes will a No. 18 copper wire carry? Various authorities give all the way between 2.5 and 8.1. Ans. — (1) The flow in cubic feet per minute must be determined, and the available head. Then, allowing eighty per cent as the maximum efficiency of the water-wheel, the actual horse power will be found by multiplying the head, in feet, by the cubic feet, per minute, of the flow, and dividing by 650. (2) It is certain that no such differing estimates should exist, yet there is some reason for this extreme divergence. The lower rating is, however, high for some conditions, to say nothing about the higher value. In dynamo machinery the estimates are ordinarily made on the basis of so many "circular mils" (not mills) per ampere. For the field-magnets of small dynamos the allowance may be as low as 800 circular mils per ampere, but in sizes above a few horse power, there should be not less than 1000, while 1200 to even 1500 might be demanded in still larger machines. On armatures for direct current dynamos, the lesser depth of winding and its good chance at radiation allows values about one half these figures, or 400 to 800 circular mils per ampere. If the machine is a revolving field alternator, these ratings would be reversed. In transformers there is no moving part to establish a circulation of air, and low current density would be enforced. Now No. 18 wire has an area of cross-section of 1624 circular mils, hence its current

carrying capacity under these ratings would be from 1 to 4 amperes. For line wiring, the insurance rules allow 3 amperes to this size of wire when the insulation is rubber, and 5 amperes for other materials less affected by heat. Except for momentary use the rating of 8.1 amperes is quite out of place, and when so far beyond the practical limit, the solitary fraction of .1 looks funny. Perhaps by a typographical error 8.1 was given instead of 3.1.

859. **Wireless Transformer.** C. S., Newark, N. J., asks (1) What is the size of wire sent? (2) What voltage does the transformer give that is described on pages 57-62 of the August magazine? (3) Could No. 36 wire be used instead of No. 30? Ans. — (1) No. 26. (2) The article explicitly states that it is impossible to compute the voltage of such coils, so why do you ask? (3) Yes, if you want to, but when the insulation would break down with any more turns of wire than the No. 30 will give, why seek to use it? We think this particular article an admirable one from the comprehensive explanations given as to the limits of voltage which the amateur usually disregards with amazing persistency.

860. **Addresses.** S. K., Baltimore, Md., asks for: (1) Address of firms that manufacture miniature battery lamps? (2) Address of firms that manufacture magnet wire of cotton, silk, and enameled covered copper. (3) Address of firm that manufactures (a) platinum wire and (b) German silver wire? Ans. — (1) General Electric Co., Lamp Department, Harrison, N. J. Jaeger Miniature Lamp Manufacturing Co., Bible House, New York City. (2) Massachusetts Electric Manufacturing Co., West Lynn, Mass. John A. Roebling's Sons Co., Trenton, N. J. (3) (a) Baker & Co., Newark, N. J., American Platinum Works, Newark, N. J. (b) Driver Harris Wire Co., Harrison, N. J.

861. **Wireless Telegraphy.** H. M. S., San Mateo, Cal., asks (1) Could a telephone condenser, consisting of two pieces of thin tin-foil, between 30 and 36 feet long by $3\frac{1}{2}$ inches wide, be used on a 4 or 6 inch coil? If any, which best? (2) How can a condenser be tested? Ans. — (1) The best possible condenser, often called the "optimum condenser," must be determined by actual trial. (2) A condenser may be "tested" for many of its properties, e.g., dielectric hysteresis, leakage, absorption, capacity, puncturing voltage, short circuit, etc. To test for short circuit, for example, join up two or three dry cells in series with a 4-ohm sounder and the given condenser. If the sounder responds on the closing of the circuit, the condenser is short-circuited.

862. **Wireless Telegraphy.** S. F. W., Lawrence, Mass., asks (1) What is the magnetic induction in the arc light circuit? (2) Where can enameled wire be purchased? (3) How many words a minute should an operator be able to send, and when does the Charlestown Navy Yard do their long-distance transmitting? Ans. — (1) We do not understand your question. (2) General Electric Co., Schenectady, N. Y. (3) The standard is from 25 to 30 per minute, but it must be clean and sharp. Between ten and twelve p. m.

863. **Wireless Telegraphy.** G. A. D., New Orleans, La., asks (1) Please give circuit showing how the transformer described in the August

number by V. W. Delves-Broughton is connected up; especially the condenser. (2) Is the condenser intended for the Leyden jars used in the closed oscillatory circuit, or is it to be connected to the primary, same as an induction coil? Ans. — (1) The terminals of the transformer primary are to be connected to the two alternating current mains. The condenser is not necessary in this circuit. (2) No. The condenser is to be used only when the coil is used as an induction coil, in which case it is to be connected across the terminals of the interrupter.

864. **Wireless Telegraphy.** H. E. W., Reading, Mass., asks, Would you kindly give some practical hints as to the making of transformer to be used in connection with silicon receiving "wireless" set? Given specifications: $2\frac{1}{2} \times 4$ inches over all. Large wire outside. Nos. 24 and 36 to be used. Ans. — We would refer you to an article on this subject in the July number of this magazine.

865. **Wireless Telegraphy.** E. J. S., asks (1) Would this coil do for wireless up to two hundred yards distance? The winding space is $4\frac{1}{2}$ inches between ends and $\frac{3}{4}$ inch radius from outside of core. The core 6 inches long by $\frac{1}{2}$ inch thick, with $\frac{1}{8}$ inch fiber tube slipped over it, with four layers of No. 14 d.c.c. wire for primary, with fiber tube 1-16th inch wall over this and secondary wound in washer-like sections of No. 23 d.c.c. wire. (2) Would the magnetic detector described in the April number do for same? (3) What sort of interrupter should be used? (4) How many dry cells would be needed at each station? Ans. — (1) Your coil would be more efficient if your secondary were wound with a much smaller wire, say, No. 36, s.s.c. Possibly the present coil would do the work with a long antenna and a good ground connection. See article in *ELECTRICIAN AND MECHANIC*, April, 1908. "An Indoor Wireless." (2) Yes, if suitably made. (3) A high speed interrupter. (4) Not more than four in series should be sufficient.

866. **Wireless Telegraphy.** F. P. F., South Swansea, Mass., says, I have a double strand aerial 30 feet high at the highest point, and extending from the house to the barn, a distance of about 60 feet. My aerial is made of galvanized telephone wire. I use a carborundum detector, tuning coil, three dry batteries, and a 75-ohm telephone receiver. (1) What ought my receiving radius to be under favorable conditions? (2) How could I improve it without raising aerial? Ans. — (1) With good ground connections and with a powerful transmitting station you should receive at least seventy-five miles over land and greater distance over water. (2) By using a high-resistance telephone 1000 ohms or more.

867. **Wireless Telegraphy.** H. O. J., Somerville, Mass., asks (1) Will you please explain: If I connect aerial wire to one terminal of telephone receiver and the other terminal of receiver to ground wire, a continuous buzzing sound is heard, as though some one was holding their key down. This happens only at night and without detector or other instrument in circuit. If either ground or aerial wire is disconnected the noise ceases, but starts again as soon as reconnected. Can you account for this? (2) Referring to the tuning coil described by Mr. W. C. Getz, in the April and July issues, would it work as well, if,

instead of using bare wire and a thread between each turn, single cotton-covered wire of same size was used? Ans. — (1) We should say you were getting the induction from the electric lighting mains. (2) Yes.

868. **Wireless Telegraphy.** C. C., Flushing, L. I., N. Y., asks, Would you kindly tell me through your "Questions and Answers" column where I could get a complete list of the Wireless Stations of the world? Ans. — The Navy Department, Washington, D. C., publishes such a list, corrected to August 1, 1907.

869. **Induction Coil.** R. W., Emerson, Texas, asks (1) What is the size of copper wire sent? (2) Will three layers of it for primary and $\frac{1}{4}$ pound of No. 36 for secondary and twelve sheets of tin-foil for condenser make a proper combination for small wireless telegraph use? (3) How are induction coils wound in sections? Ans. — (1) No. 16. (2) You have not stated the length proposed. Perhaps 6 inches would do, but we think two layers are better than three. The other proportions are good, but you must realize that fine adjustments and infinite patience are needed in this kind of fun. (2) See our magazine for April, 1908.

870. **Induction Coil Construction.** R. H., Farmdale, Ill., asks (1) How to proportion spark coils, — for instance, how, from use of Nos. 18 and 34 wire, to make one for a motor-cycle? (2) What voltage is best for a private lighting plant? Ans. — (1) Such work requires experience and care. We have published several good articles on the construction of these coils, and all we can say to you is to make one, and then improve on it. (2) 110 volts; that being the potential for which most electrical apparatus is designed.

871. **Induction Motors.** O. A. R., Northville, Mich., refers to the designs in the *American Electrician* for 1903 for $\frac{1}{2}$, 1, and 2 h. p. induction motors, adapted for 110-volt, 120-cycle, single-phase circuits. He asks what changes should be made in the windings to fit 60-cycle circuits, admitting that the speed will be reduced to one half? Ans. — In general, you should get about fifty per cent more turns in the stator windings. Of course this will mean smaller sizes of wire, and this fact, coupled with the lower speed, will reduce the output of power to about three quarters of the former ratings.

872. **Meter Wiring.** F. O. S., Morgantown, W. Va., sends sketches showing two methods of wiring wattmeters for two-phase motors. In one case there is only one meter, the wires for one phase connecting directly with motor without attempt at measurement of power. In the other case one wire of each phase passes through the meter, while the other two lead directly to the motor. In both cases the meters are stated as recording one half the current. Can we explain the discrepancy? Ans. — Perhaps the descriptions on the two meters will assist you. It would appear that the two were of different types, — the one a single-phase meter, the other for two phases. There is a difference in the winding for the two conditions. In the first case the meter record is for only one half the power that enters the motor; so, very properly, in making out the bill, the reading is doubled. In the second case the motor supplied is apparently of

larger size, and in the regular method of operating meters there is a "constant" to multiply by, in this case the number being 2.

873. **Wireless.** G. W. S., Chambersburg, Pa., asks (1) I have just completed an induction coil primary 2 feet long, two layers of No. 11 on core of No. 20 wire — which is 2 inches diameter. Secondary is in two sections, 10 pounds each, No. 34, d.c.c. wire (20 pounds). Each layer is insulated with buckskin paper shellacked on both sides. What size spark coil is this, and what distance? (2) Can I be heard having a 90-foot pole aerial same length having 6 wires? I use 110 A. C. Ans. — (1) Your coil should give about a 3-inch spark on A. C., with condenser across secondary. With the electrolytic interrupter the spark may be increased to 6 inches. However, for wireless work, the A. C. is best without the electrolytic interrupter. You should have built your coil in more than two sections. For that size coil use sections $\frac{1}{4}$ inch thick, each having insulation between them, forty sections or more being required. This will give the best results. (2) With a 90-foot aerial, your transmitting distance should be about two hundred miles under favorable conditions, using tuned transmitting circuits, with above coil.

874. **Potentiometer.** A. B., Los Angeles, Cal., asks (1) What is the price of a kilowatt transformer? (2) Please tell me how to make a 1000-ohm potentiometer. (3) Give dimensions of an adjustable condenser. (4) What size is the wire enclosed? Ans. — (1) You are not definite in your inquiry. What size transformer do you want? If you mean a 1-kilowatt Step-up Transformer, to run on 110 volts, 60-cycle, A. C. on primary, with secondary e.m.f. of 15,000 volts, the cost will be between \$75 and \$100 for the best types. (2) Use a core made of wood, 3 inches in diameter by 12 inches long and wind it with No. 30 German silver wire, as described in July, 1908, issue, article on "Tuned Circuit Receiving Instruments," by W. C. Getz. (3) See above-mentioned article, by W. C. Getz, for information regarding construction of adjustable condenser. (4) Wire size No. 36, B. and S. Gauge.

875. **Burning of Lead Joints.** J. J. K., Grafton, Ill., writes: I notice question No. 579, in *ELECTRICIAN AND MECHANIC*, for April, 1908. In making joints of this kind on light lead, the trouble can be overcome by using a wet board or wet waste against the lead on the opposite side from that which you are burning. I have been at this kind of work for seventeen years.

876. **Substitute for Platinum.** J. E. T., Cleveland, Ohio, writes: In your January number I note Y. K.'s question No. 464, asking if there is any metal substitute for platinum for induction coil contacts. Permit me to advise that thirty-five per cent nickel steel is very much used for this purpose in automobiles. It can be furnished by the Carpenter Steel Co., Cleveland, Ohio, at 50 to 75 cents per pound, according to size.

877. **Hard Rubber Tubing.** N. H., Chicago, Ill., asks: Where can I obtain some ebonite? By that I mean a piece of tubing, made of hard rubber, about 2 feet long and about $2\frac{1}{2}$ inches in diameter, and $\frac{1}{4}$ inch thick? How much will it

cost? I want it to insulate the primary from the secondary in a coil. Ans.—J. H. Bunnell & Co., 20 Park Place, New York City, can furnish hard rubber tubing, and the Mica Insulator Company, of New York, can furnish micanite tubes.

878. **Wireless Telegraphy.** Brother Avila, Canada, asks: Could message be received for a distance of three hundred to four hundred miles with an electrolytic detector, tuning coil (wound with No. 28 copper wire), potentiometer, 75-ohm receiver, 110-foot aerial? Four wires 20 feet long are strung 8 inches apart, composed of eight wires, No. 28, twisted. For the lead into the instruments, No. 14 weather-proof wire is used. Ans.—Using a 110-foot vertical aerial, electrolytic detector, tuning coil, potentiometer, and adjustable condenser, with a 75-ohm receiver, the receiving distance would be about twenty-five miles. With a 1500-ohm receiver this may be increased to about five hundred miles. It is assumed that the electrolytic detector is of a reliable make, and has very fine silver platinum wire, such as the .0001/.00002-inch size now sold. Aerial should give better results if wired, as shown in article in June, 1908, issue of this magazine, on construction of aeriels.

879. **Lifting Magnet.** R. A. B., Randolph, Mass., asks (1) What size and amount of wire to use in rewinding the coils when the diameter of cores is 1 inch and the length 4 inches, enlarged ends, $1\frac{1}{2}$ inches in diameter? The current is to be taken from six dry cells. (2) How is the armature winding for a dynamo calculated? (3) Is there any place in Boston where small, second-hand dynamos can be obtained? Ans.—(1) No. 20 wire, about $\frac{1}{2}$ pound on each core, will suffice. (2) There are plenty of large books on this subject, but they are of the designing engineer's grade. In the final chapter of Watson's new book, "How to build a 1 Kilowatt Dynamo," you will find some simple and concise directions. (3) Yes; at Frank Ridlon Co., 200 Summer Street.

880. **Power Transmission.** A. D. P., Island Falls, Me., asks (1) With 100 h. p. driving a generator, how much power can be returned by an electric motor supplied from it? (2) Is a storage battery practical for driving an automobile? (3) Can storage batteries be charged at an ordinary electric light station? Ans.—(1) About 75 to 80 h. p. would be a fair result, but the answer is concerned in the distance over which the transmission takes place. (2) Not practicable except in level cities with smooth pavements. (3) Small stations usually supply alternating current only, or, if there was any of the direct sort, it might be for series arc lighting, — rather inconvenient and dangerous for battery charging. Added to this is the fact that a long wait is necessary for the charge, and so the future of the electric automobile is not regarded as very promising.

881. **Arc Lamp.** G. S., Bowie, Texas, asks (1) How much energy is required to light a lamp of 500 c. p.? (2) How much for a moving picture machine? Ans.—(1) The candle-power of an arc lamp is a matter that has called forth much discussion and not a few law-suits. The general conclusion is that what was formerly called 2000 c. p. really gave in any one direction about 500. Such a light was produced in an

open arc, when 45 to 50 volts and 9.5 to 10 amperes of current were expended. This means that the engine must supply about 1 h. p. per lamp; 80 volts and 6.5 amperes, in an enclosed lamp, will give about the same illumination. (2) These lamps take from 30 to 50 amperes at 50 volts. In consequence of the supply circuits being usually operated at 100 to 110 volts, rheostats must be put in circuit, but the user has to pay for the wasted volts as well as those desired.

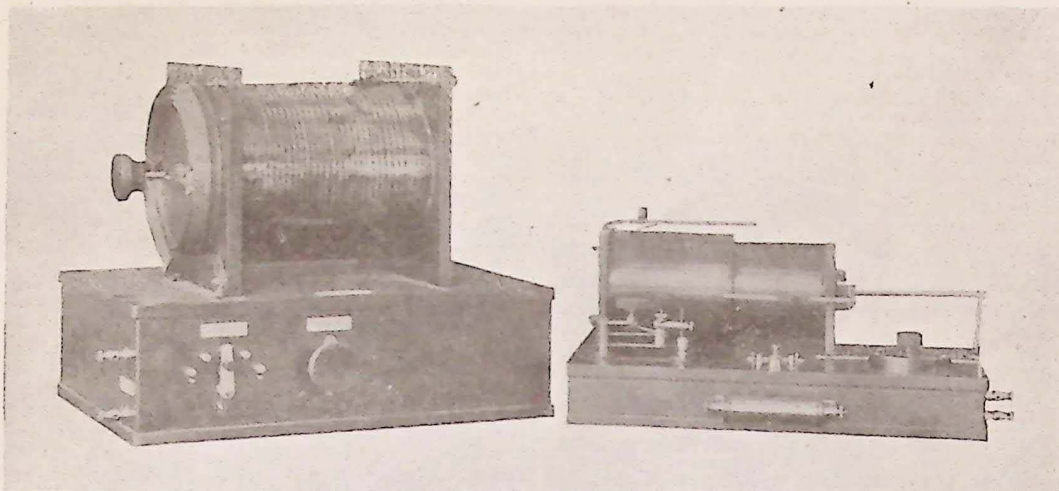
882. **Field-magnet Calculation.** A. E. N., Britt, Iowa, asks (1) If 990 ampere turns will suffice to produce a magnetic flux of 123,000 lines in a steel field-magnet having cores 1.5 inches diameter, and total length of circuit 11 inches? Polar faces are of 6.25 square inches in area, air-gap .125 inches in length, and armature being $2 \times 2.5 \times 5$ inches minimum area. (2) Is it possible to find the resistance of the average person, from hand to hand? (3) Is the resistance of the various bells added together, on a bridging line, when it is stated that a magnet will ring through 3500 ohms? Ans.—(1) Yes, your figures are as near correct as we can judge by your description. Why did you not make a sketch of the magnet? We are at loss to comprehend the shape of your armature, but we think it is out of all proportion to the size of the field-magnet. Better make the cores 2.5 inches in diameter, and much shorter, and use larger polar areas. (2) Yes; about 5000 ohms. (3) If each bell on the bridging circuit has a resistance of 1200 ohms, their combined resistance, as arranged, is less than that. Two in circuit will bring the resistance to 600 ohms, four to 300 ohms, and so on. The rating referred to is a shop test, when one bell is connected in series with a large non-inductive resistance. The 3500-ohm test is a very low one; 20,000 ohms is a common stipulation.

883. **Burned-out Incandescent Lamps.** C. P., Ridgewood, N. J., asks (1) What is the size, material, and resistance of the sample of wire sent? (2) Are burned-out incandescent lamps of any value? Ans.—(1) No. 24 size, eighteen per cent German silver, 480 ohms per 1000 feet. (2) If delivered at lamp works, you can get about one cent each for them. The only value is in the platinum leading wires.

884. **Dynamo Construction.** E. K., Rushville, Ind., is building a dynamo with cast iron field-magnet, cores being 2 inches in diameter; armature is 3 inches in diameter, and wound in six coils of No. 24 wire, each of eighty-eight turns. He asks (1) Why we did not answer his previous inquiry on the same matter? (2) What winding should be put on the field-magnet, and how fast should armature run to give 60 volts and 2 amperes? (3) How fast for charging a 2-volt storage cell? (4) Would a balloon rise in the air if inflated with natural gas? Ans.—(1) Your data was insufficient, as also in this case. You should be willing to make a fairly accurate drawing, else our estimate is worthless. You have not stated the length of armature, area of polar faces, nor dimension of air-gap. (2) We suggest 1 pound of No. 26 wire for each of the field cores, but we do not know how many cores of them you have. (3) If the winding is for 60 volts, you cannot run machine at 2 or 3 volts. (4) Yes, if not too much loaded.

WIRELESS CLUB

This department is devoted to the Club members and those interested in Wireless Telegraphy. We will publish experiences, discoveries, and suggestions, which may be helpful to all interested.



WE present above a photograph of the \$175 wireless set which we are to present to one of our readers. Full information will be found on another page. The details of the set are as follows:—

This installation is a complete model of a modern commercial station, and is thoroughly up to date, having tuned sending and receiving sets. The entire outfit is mounted in two solid mahogany cabinets, one containing the receiving and the other the transmitting apparatus, all finished in the best possible manner. The set is designed to operate on 110-volt alternating current, and takes about $2\frac{1}{2}$ amperes at its maximum point, having a multiple switch so that the current may be varied in several steps downwards from this point. If desired, it will be furnished wound for 220 volts. Where direct current only is available, a $\frac{1}{2}$ h. p. rotary converter may be installed at small cost, to change the current from direct to alternating. If it is desired to operate the set from batteries, an independent interrupter may be used.

The receiving set consists of a receiving transformer, "Ferron" detector, tubular condenser, pair of telephone head receivers wound to 1000 ohms resistance to each ear, potentiometer, and dry battery. As previously stated, these are mounted complete in a mahogany cabinet, and are equal in appearance and sensitiveness and permit of as fine tuning as most commercial stations. Using a 100-foot aerial, messages should be readily received from high-power stations at distances of several hundred to a thousand miles.

The sending set consists of a 250-watt transformer, glass plate condenser, adjustable spark-gap (composed of Ceco alloy, which will not corrode and wear down, as do the usual zinc or brass gaps), oscillation transformer, having variable inductance in primary and secondary, and key.

Used with a suitable aerial 80 or 100 feet in

height, this sending set will operate for 20 miles under average conditions, and under the best conditions, such as over water at night, this distance should be materially increased up to 100 or 150 miles.

Don't be afraid to try. NO ONE HAS YET SENT IN MORE THAN TEN SUBSCRIPTIONS. You could beat this in a day. Would you like to get a \$175 wireless set for getting only a few more subscriptions than the next fellow? Think it over. Then WORK.

F. R. FRAPPIE, ESQ., M. SC.

Dear Sir,—Your letter of the 14th instant, with reference to the article which recently appeared in the *ELECTRICIAN AND MECHANIC*, came duly to hand. I delayed replying thereto until I could procure some data from our ships in port as to communications, etc.

It was rather unfortunate that your experience with the Marconi System should have been, in the first instance, on board the Austro-Americana liner "Alice." These vessels immediately after leaving New York take a very southerly course, and Sagaponack, our station on Long Island, is the last one they generally communicate with. These vessels, by taking this course, are also out of touch with the general run of transatlantic liners, and are also out of touch with vessels coming from the Mediterranean, as the courses to and from the latter are very far apart.

Then, again, the operators on the Italian liners are now, in accordance with the rules of the Convention, natives of Italy, and as such are not perfectly acquainted with the American language; hence their work is not so good as that on the other ships; but this matter is receiving the earnest attention of the Italian Marconi Company, which controls these boats.

The "Republic," on which you returned, sails to and from Boston. The White Star Line is only

willing to pay for one transmission of news, and this was the one which was received when you were on board the boat. I think that you are mistaken as to the communications which that vessel had with others, as, in our experience, we find that such boats as the "Republic" are in communication daily with at least two or three boats.

I have taken two boats, one of the American Line and the other of the White Star Line; viz.: the "Philadelphia" and the "Celtic," have requested the operators to give me a note of the communications had by these vessels with others on one trip, and enclose same to you for your information. These are fair averages.

If, after reading the reports from the boats, which I now enclose, you wish to make any statement in your paper, I feel sure that you will be able to contradict, to a certain extent, the little article which has already appeared.

We thank you for having brought this matter to our attention. We also thank you for your publication of November, 1908, which came duly to hand, and which contains a great deal of interesting matter.

Yours very truly,
MARCONI WIRELESS TELEGRAPH
COMPANY OF AMERICA.

By J. BOTTOMLEY,
General Manager.

MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA

Summary of communications, week ending October 31, 1908, SS. Philadelphia, Eastward bound:—

SUNDAY, OCTOBER 25

11.01 A.M. SS. Minnetonka.
11.21 A.M. " Chicago.
5.20 P.M. " Ryndam.

MONDAY, OCTOBER 26

11.32 A.M. SS. Kronprinz Wilhelm.
5.00 P.M. " Pretoria.
6.10 P.M. " Adriatic.
6.10 P.M. " Ivernia.
7.30 P.M. " Republic.

TUESDAY, OCTOBER 27

5.15 P.M. SS. Lusitania.
5.25 P.M. " Narragansett.
7.16 P.M. " La Lorraine.

WEDNESDAY, OCTOBER 28

7.45 A.M. SS. New York.
3.40 P.M. " Finland.
4.00 P.M. " Cymric.
4.10 P.M. " Prinz Friedrich Wilhelm.

THURSDAY, OCTOBER 29

FRIDAY, OCTOBER 30

12.45 A.M. SS. Kaiser Wilhelm II.
7.55 A.M. " Majestic.
8.55 P.M. " Montezuma.

SATURDAY, OCTOBER 31

12.45 A.M. SS. Kaiserin Augusta Victoria.
2.45 P.M. " St. Louis.
3.45 P.M. " La Touraine.
8.51 P.M. " Vaderland.

On board SS. "Celtic," New York
November 16, 1908.

J. BOTTOMLEY, Esq.,
Marconi Wireless Telegraph Co.
of America, New York.

Sir,—Herewith is a list of stations, land and steamers, that I communicated with on our outward passage, November 6 to 14, from Liverpool to New York, which I am sending, as requested.

Left Liverpool on the 6th inst.; communicated with Liverpool and Rosslare (Ireland) land stations.

Saturday, 7th, communicated with Rosslare and Crookhaven land stations until midnight, also the steamers "Baltic," "La Savoie," and "Minnetonka."

Sunday, 8th, communicated with "Kronprinz Wilhelm," "Montreal," "Patricia," "Lusitania," and "La Savoie."

Monday, 9th, communicated with "La Savoie," "Adriatic," "La Lorraine," "Montreal," and "Mount Royal."

Tuesday, 10th, "La Savoie," "Montreal," "Cedric," "New York," "Cymric," and "Chicago."

Wednesday, 11th, "Philadelphia," "Pretoria," "La Savoie," and land station Cape Race, N. F.

Thursday, 12th, land stations Cape Race and Sable Island, steamers "Kaiser Wilhelm II," "Statendam," "Narragansett," and "Majestic."

Friday, 13th, land stations Sable Island, Cape Sable and Siasconset (Nantucket Island).

Steamers "Lucania," "Prinz Frederick Wilhelm," "Finland," "Kaiserin Augusta Victoria," "La Touraine," and "Slavonia."

Saturday, 14th, land stations Siasconset, Sagaponack, L. I., and Seagate.

Steamers "President Lincoln," "St. Louis," "Arabic," "Minnehaha," and "Bluecher."

I connected with forty-one stations, was in constant communication with one or more stations the whole time, from departure to arrival, and in touch with land for six days out of nine.

I am,

Yours faithfully,

GODFREY D. HENCHMAN,

Operator "Celtic."

* * *

CHICAGO, as far as wireless is concerned, is a busy center. The station of John Erwood is as complete as any station on some boats.

Earl Pierce, another successful experimenter, is remodeling his station. He is going to use a 400 watt transformer.

W. J. McGuffage is building his station, and is going to use a one fourth kilowatt transformer when complete.

The writer has looked all of these stations over, and finds that there are others that are having just as much luck in experimenting. A station on the top of the Lewis Institute is going to use a 12-inch coil for the students to experiment with.

J. E. E., Jr.

* * *

OUR two stations will be ready when the stormy season is over, which will be about April or May. I am not quite sure how far Wright's station will be able to send, but I shall be able to send from six to ten miles, as I made a little change in my apparatus. Both stations will have 75 meters wave length. Wright's call letters will be W.W. and mine will be C.M., and we shall use the Continental code. I

would like the names and addresses of some of the members of the club in my vicinity who have already got stations. I have already the names of two members who have stations, but they are too far out. I have read so much about the wireless jokers who call up a big station and send some fake message, stating that their boat is in the middle of the lake with the machinery out of order, and then give the name of some big boat, etc. They are trying to stop all experimental and amateur stations. I do hope that the jokers will be found out and heavily fined or punished, so those who wish to experiment will be left in peace.

C. M.

* * *

AN enthusiastic gathering of the local members of the "E. & M." Wireless Club was held at a prominent down-town restaurant in Chicago, Friday evening, December 11. After dinner and an informal talk the members present took steps toward the organization of a local branch. Mr. R. C. Dickson was made temporary chairman, and W. J. McGuffage, secretary. After some preliminary arrangements had been made, the meeting adjourned to meet again the second Friday in January. Those present were: R. C. Dickson, George E. S. Carlson, K. B. Sheldon, J. Maypole, F. Richards, J. Erwood, Jr., Carson Schaffner, D. J. Stump, W. J. McGuffage.

W. J. MCGUFFAGE, *Secretary.*

* * *

YOUR editorial about forming local clubs in each city has interested me greatly. However, I would like to add a little more to the idea, and say, that by means of such a club possessing a few stations, a message could be relayed from one to another for a good distance. At present an owner of a small outfit that works to five miles can only send a message this distance. Now, if within his radius was another station of a similar nature, the owners could agree to relay each other's message. Regular hours could be appointed for all the stations, to avoid a break in the transmission. Each member could also be restricted to a certain number of messages, so that a fair exchange would be had. I have no doubt that with such an enterprise as this the wireless experimenters who now cannot reach far would be capable of transmitting over 30 miles by this means. It would not be practical to have units of less range than 4 miles up, as the more stations there are, the longer the message takes to travel, and more errors are likely to be encountered. The stations would also be so arranged that even were there one operator "off the job," the stations wishing to communicate could do so direct, though of course less powerful. I hope you will call attention to this letter through the columns of the ELECTRICIAN AND MECHANIC, so that other experimenters can express their opinion on the question.

A. L.

TRADE NOTES

A SPECIAL certificate for inventors, called "Inventor's Protective Certificate," giving information how to protect their inventions before filing caveats or making application for Letters Patent, has just been issued by the firm of Smith & Frisbie, Patent Attorneys and Corporation Organizers with offices at 49 Federal Street, Boston, Mass. This certificate is of great value to inventors, and every inventor

should procure a copy of same, which will be mailed free on request.

This firm has also issued for free distribution to those who have already procured their patent and desire to organize a corporation, a printed pamphlet entitled "Letter of Instructions for the Organization of Massachusetts Corporations."

* * *

Messrs. Mathias Klein & Sons request all their friends to visit their exhibit at the Chicago Electrical Show, January 16 to 30, 1909.

THINGS RECEIVED

Peter's Miniature Motor Works, 61 Terrace, Buffalo, N. Y. Catalogue B — 1909, of Miniature Motors and Model Generators.

Seth W. Fuller Co., 100 Bedford Street, Boston, Mass. Catalogue of Electrical Novelties, Dynamos, Motors, Experimental Apparatus, and Gas Engines.

School of Applied Art, N. 71, Gallery of Fine Arts, Battle Creek, Mich. Year Book for 1908-9. Write for a copy. Some fine illustrations.

American Motor Co., Brockton, Mass. Catalogue of M. M. Motorcycles.

Boston School of Telegraphy, 18 Boylston Street, Boston, Mass. Catalogue. The only school which teaches wireless.

Thomas M. St. John, 848 Ninth Avenue, New York City. Educational Amusements.

Electro Importing Company, 84 W. Broadway, N. Y. 1908 Catalogue of electrical goods.

Kolesch & Co., 138 Fulton Street, New York. Holiday Hints, a condensed catalogue.

General Electric Co., Schenectady, N. Y. Bulletin 4629, Automobile Accessories; 4630, D. C. portable testing instruments, Type D.P.

BOOK REVIEWS

THE BOYS' BOOK OF STEAMSHIPS. By J. R. Howden. Illustrated. New York, The McClure Company, 1908. Price, \$2.

This book, although its name indicates that it is for boys, will be of the most absorbing interest to every person interested in navigation or mechanics, for the information it contains is absorbingly interesting and astonishingly complete.

The book gives a short history of the development of the steamship, and a very full account of the principles on which ships are designed and built, with special reference to devices adopted to insure stability, one of the most important features in modern ship building. It then passes to a detailed description of every portion and department of a steamship, describing with great thoroughness the operation of the boilers, engines, and other machinery, and then the work of the ship from the engineers' department to the navigation.

The last third of the book gives full accounts of the principal steamboats and steamboat lines of the world, both inland and ocean. The book is profusely illustrated with most attractive photographs and reproductions of old prints. It is the first popular book on the subject and collects material from many inaccessible sources.

* * *

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No. 172, Flemish Oak
No. 121, Moss Green
No. 180, Silver Gray
No. 110, Bog Green

No. 130, Weathered Oak
No. 140, Manilla Oak
No. 125, Mission Oak
No. 126, Light Oak
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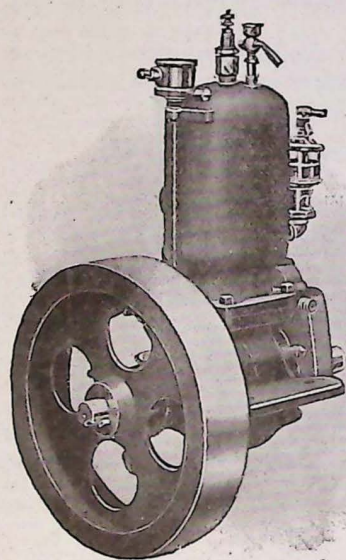
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This is a small professional set and is the best in the market for the price. The transmitting wave lengths range from 150 to 450 meters, and the receiving from 150 to 1500 meters, which is about the wave length of the Marconi Station on Cape Cod. The range of the transmitter depends on the battery and antenna. Made from carefully selected stock, adjusted and calibrated before leaving the factory and guaranteed in every respect.

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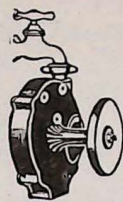
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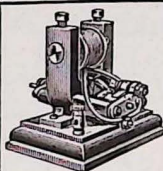
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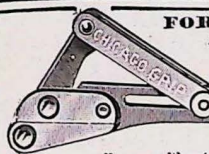
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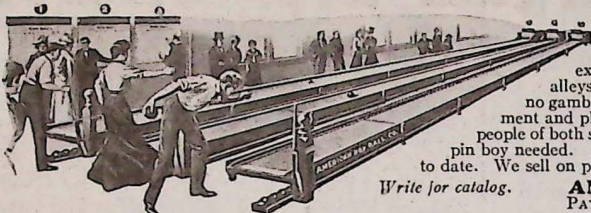


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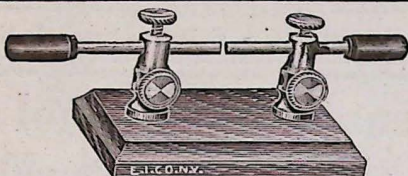
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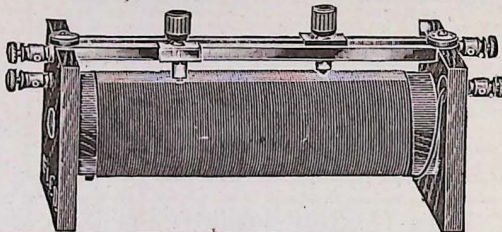
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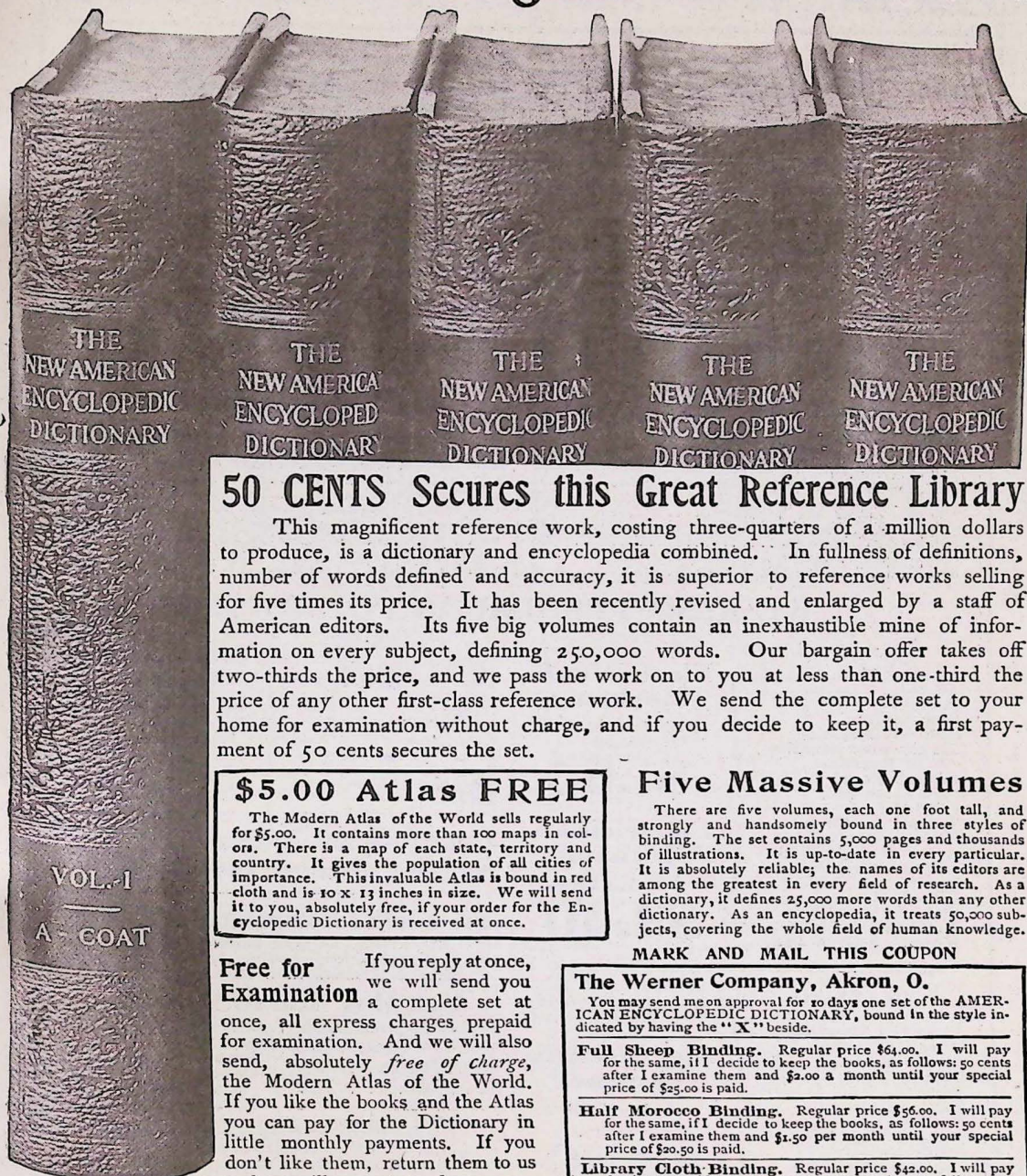
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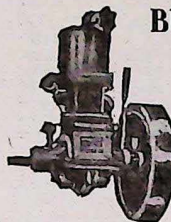
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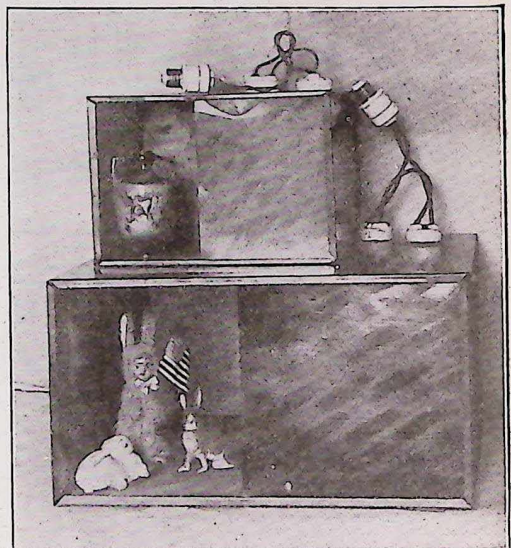


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Q Owing to the large number of inquiries we are constantly receiving from inventors, we have decided to establish a bureau for the convenience of our readers, through which they will be enabled to secure patents on their inventions at the lowest cost, consistent with the work performed. We have retained a firm of skilful patent attorneys of Washington, D. C., with a branch office in Boston, who will have charge of this bureau, and who will pay special attention to the legality of patents secured. Advice in patent law and opinions as to patentability will be given without charge. If you desire to secure a patent on your invention, fill out the coupon below, forward a rough sketch together with complete description of what you have, addressed as directed below, and our attorneys will immediately inform you as to its patentability and cost of patent. Appointments may be made for conference with attorneys in charge of Bureau, at Boston office.

Inventor (Name in full).....

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

City or Town.....

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

Electrician and Mechanic Patent Bureau

6 BEACON STREET

BOSTON, MASSACHUSETTS

A \$175 Wireless Set Free

¶ The publishers of ELECTRICIAN AND MECHANIC will give absolutely FREE, on February 1, 1909, a set of Wireless Telegraph Sending and Receiving Instruments worth \$175 to the reader who obtains the largest number of subscriptions to the magazine before that time. As we will pay a liberal commission on all subscriptions obtained by those who do not win this valuable outfit, we hope every reader will try for the prize. ¶ This set is made on up-to-date lines, and the specifications are as follows:

¶ This installation is a complete model of a modern commercial station, and is thoroughly up to date, having tuned sending and receiving sets. The entire outfit is mounted in two solid mahogany cabinets, one containing the receiving and the other the transmitting apparatus, all finished in the best possible manner. The set is designed to operate on 110 volt alternating current, and takes about 2½ amperes at its maximum point, having a multiple switch so that the current may be varied in several steps downwards from this point. If desired, it will be furnished wound for 220 volts. Where direct current only is available, a one-half horse power rotary converter may be installed at small cost, to change the current from direct to alternating. If it is desired to operate the set from batteries an independent interrupter may be used.

¶ The receiving set consists of a receiving transformer, "Ferron" detector, tubular condenser, pair of telephone head receivers wound to 1000 ohms resistance to each ear, potentiometer and dry battery. As previously stated, these are mounted complete in a mahogany cabinet and are equal in appearance and sensitiveness and permit of as fine tuning as most commercial stations. Using a 100 ft. aerial, messages should be readily received from high power stations at distances of several hundred to a thousand miles.

¶ The sending set consists of a 250 Watt transformer, glass plate condenser, adjustable spark-gap (composed of Ceco alloy, which will not corrode and wear down, as do the usual zinc or brass gaps), oscillation transformer, having variable inductance in primary and secondary, and key.

¶ Used with a suitable aerial 80 or 100 ft. in height, this sending set will operate for twenty miles under average conditions, and under the best conditions, such as over water at night, this distance should be materially increased up to 100 or 150 miles.

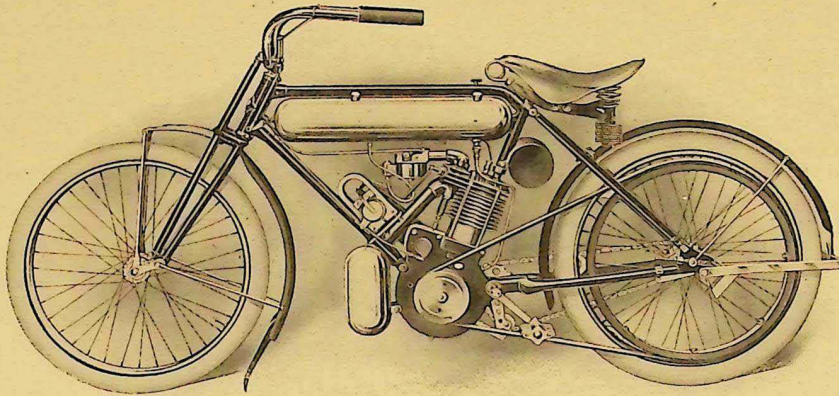
¶ Every reader of ELECTRICIAN AND MECHANIC may try for the prize. Your own subscription for any period up to five years may be reckoned, and every year's subscription at \$1.00 which you send in will count as one toward the prize. Full particulars of the commission we will pay you will be sent on application. Write us to-day. You will find it easy to get subscriptions, and if you win the set you will get a valuable prize indeed.

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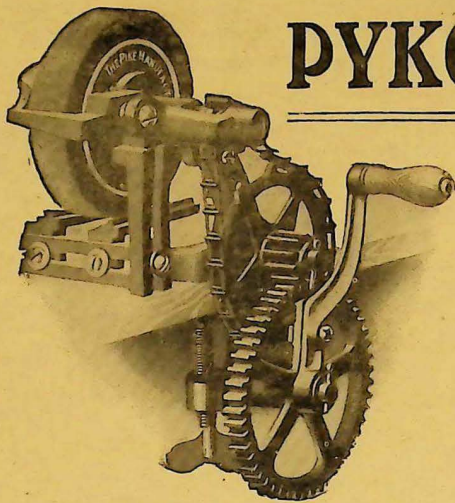
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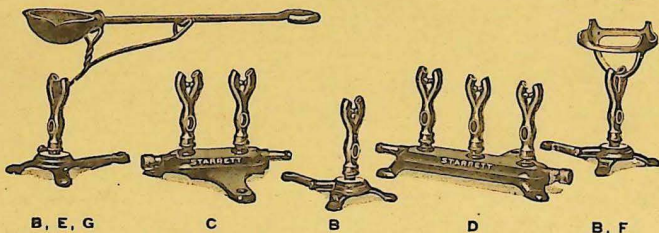
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