THE WIRELESS AGE

FEBRUARY 1914

THE RADIO REVIEW

THE most striking feature of the wreck of the West Indian liner Cobequid, reports of which are just coming in as we go to press, is the fact that, while wireless telegraphy added another triumph to its credit, all other methods of distress signaling were proven absolutely valueless.

A Lesson in the Call of the Cobequid

Impaled on the treacherous rocks of the Trinity Ledges, with her back broken, and in the midst of a blinding snowstorm, this staunch liner was in imminent danger of being rapidly pounded to pieces by the mountainous seas and dashing her hundred odd passengers into the icy waters. Six minutes after the vessel struck, an S O S went hurtling through space, and sixteen minutes later the station at Cape Sable was in possession of the full details. Several vessels sped to the aid of the sinking ship, and another tragedy of the sea was averted.

No more remarkable or thrilling rescue than this has been recorded since wireless telegraphy first triumphed over the forces of nature. The rockets, fog horns and beacon lights that seamen depended upon up to a few years ago would have been useless in this case. For, even when the rescuing ships had rushed to her aid, they were forced to lay off for several hours, not more than a mile and a half from the Cobequid, because, to quote an officer: "I couldn't see much of anything; there was a heavy vapor lying close to the water and obscuring everything within a hundred feet. At times it became so bad that we couldn't see anything a boat's length off."

There was absolutely no chance for "flare-ups" to be seen, or sirens to be heard; it remained for the wireless alone to carry the insistent appeals for succor. And these distress calls were heard. How bravely they were heeded by the ships that were groping through mist and storm is known already. Soon we shall have the complete story of the heroic rescue, and may add to our elation fitting gratitude to the men who sacrificed all other interests to turn toward the ill-fated vessel.

ONE detail is known already, and once again THE WIRELESS AGE must take exception to the careless surmises of newspapers. A prominent New York daily observes in an editorial: "Its wireless apparatus worked feebly and uncertainly in the wild disorder of the atmosphere," and added that it was never able to give the ship's exact location.

A Misleading Report and the Actual Facts

In direct contradiction we have the statement of J. W. Hitchener, chief operator on the Cobequid, that he reported many times what the captain ordered, that the ship was on Trinity Rocks, or possibly Briar Island, and that the Partridge Island station acknowledged receipt of this intelligence. The communication difficulties were due to physical conditions other than the "wild disorder of the atmosphere." Less than an hour after the vessel struck, the heavy seas had flooded the engine room, putting the dynamo out of commission. The emergency set was then switched in and the S O S calls continued. Later the wireless room was swamped and the receiving apparatus flooded, but the transmitting set was worked most of the first day and the next morning. The interruptions were caused by the heavy seas smashing the boats and carrying the aerial away. Three times it was repaired, under increasing difficulties. Furthermore, communication had been established for several hours before the first of these occurrences.

Beside the inspiring knowledge that through wireless everyone aboard was saved, an erroneously reported detail seems trivial; but we have taken exception to this newspaper statement because it intimated that the efficiency of the ship's apparatus suffered under unfavorable atmospheric conditions. Marconi wireless has never failed in an emergency, nor will it fail in any that may arise.

A Panic Averted through Confidence

AN interesting illustration of how great is the confidence placed in wireless to-day was brought out at the Board of Trade investigation into the Volturno disaster.

In the course of his examination, the third officer was asked when he was informed that the Carmania had answered the Volturno's distress signals. He replied that he was on the bridge deck when the second Marconi operator brought him the news. The captain sent him aft to the unfortunate emigrants huddled together on the burning vessel to tell them that the Cunarder was coming full speed.

He was asked: "Did that have a good effect upon them?"

And he replied: "Yes, they quieted down quite straight."

Conferees Accept American Regulations

AN indication of how important a factor wireless has become in maritime affairs is witnessed in the dispatches from London reporting the work of the Revision Committee of the International Congress on Safety at Sea. As the conference draws to a close the wireless regulations are featured and other life-saving equipment is relegated to the background.

Late reports assert that the American wireless regulations were all agreed to by the European delegates. The main feature of these is that they give the control of the apparatus and the supervision over the operations of the employees to the United States Government; no matter what may be the nationality of the ships, whenever they are coming into or departing from American waters.

This agreement preserves intact the private code signals of any country reserved for war. Use is made of the commercial code, and only one code will be used for distress calls, assuring that the calls will be understood in any language.

Why Not an International Rescue Ship?

THE installation of wireless on harbor fireboats, reported in this issue, has suggested to a reader an Atlantic fire and life-saving service to handle just such accidents as the Republic, Titanic and Volturno. Supplementing the work of our revenue cutters, a special fire and life saving vessel could be posted at some port of Southern Newfoundland, such as St. Johns. It would there be kept in readiness to start out on short notice in answer to the first wireless appeal for aid.

During the iceberg season this vessel could patrol the neighboring waters for information on the iceberg drift, a task performed last year by a Government vessel. During other times of year she would lie in port awaiting an "alarm," and her ship's company would receive and transmit reports as to fog, storms and the relative positions of ships.

The type of vessel suggested for this service is one not over 1,000 tons. Her equipment would include oil tanks, speedy oil-burning engines and plenty of lifeboats. Carrying no cargo except food and fuel, she could provide in the neighborhood of 12,000 square feet of deck space, or reclining room for a thousand persons. The craft should be capable of twenty-two knots or so when hurrying to a call. Such a speed would carry her from St. Johns half way to Queenstown within forty-eight hours, and half way to New York harbor in a single day. The portion of the Atlantic which has claimed a greater tribute of lives than any other would lie within effective striking range.

In the case of a collision or storm-battered vessel sinking, a life saver of this type would be inestimably more effectual than an ordinary steamship. She would carry oil to smooth the seas, and because of her small dimensions and special design she could launch small boats when it would be suicidal to try it from a liner. Expert crews would enable these small boats to transfer human beings under weather conditions prohibitive to ordinary crews.

In case of fire at sea the wireless alarm would bring the rescue vessel quickly, and she could, under many conditions of weather and sea, play powerful streams through the side ports of the burning ship. She could put expert fire fighters aboard, and could take aboard a line that would keep the vessel the right way to the wind.

Expense, the only barrier to all these services, would be moderate, and could be shared by several governments.

The Trans-Ocean Stations

Some Details of the Power Equipment

AS RELATED BY A MARCONI ENGINEER

READERS of THE WIRELESS AGE are familiar with the fact that the Marconi Company is erecting trans-ocean wireless stations in different parts of the world. Descriptions have been given of the work under way in New Jersey, California and the Hawaiian Islands. At New Brunswick, N. J., the concrete and brick work for the power-house is completed, while the auxiliary operating building to the north is on the eve of completion. In California, the transmitting plant at Bolinas Point, eighteen miles northwest of San Francisco, and the receiving station near the town of Marshalls are still further advanced toward completion, while the large wireless duplex station on the Island of Oahu, of the Hawaiian group, will soon present another finished link in the wireless chain that is destined to girdle the globe. Transportation difficulties in this construction work have been great, and articles have been published concerning the various methods adopted in conveying building materials and necessary machinery to the sites.

A description is now presented of the equipment that will be installed in these stations—technical information that will surely be appreciated by the wireless expert and student alike.

The work of designing a wireless station such as the Marconi Company is erecting for trans-ocean work is essentially an enlargement of the work in connection with the sets used for ship and shore stations of only a few kilowatts. The engineer cannot, however, sit down with a slide rule and multiply the figures for his calculations relating to the small stations by a hundred or so, and have as a result a station that will work over a long range. Many problems present themselves in large radio installation which require much care and experimentation adequately to cope with the requirements of large stations, and which, in smaller sets, are of so little importance as to be practically negligible.

As in the small station, the principal circuits are simple, but it is easily seen that when about three hundred kilowatts are to be carried in the circuits and turned into high frequency currents, the problem must be handled with care. Some of the special arrangements made to use this large amount of current safely and efficiently may be of interest to our readers at this time.

The closed oscillating circuit is of interest because of the size and construction of its various elements. The discharger is of the rotating-disc type, and

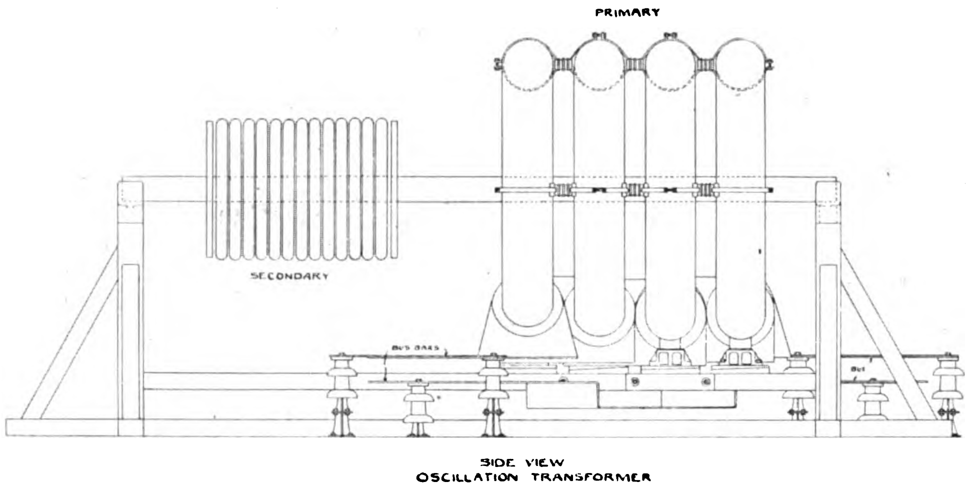


Fig. 1

is directly connected to the shaft of the alternator. The foundation upon which it rests is a solid block of concrete weighing about seven tons, supported by piles of insulating blocks and surrounded by an insulating compound in such a manner that the framework of the discharger is well protected. The coupling from the alternator is also insulated, the only live part being the discs which serve as the poles between which the studs pass. The spark discharge is well quenched by a blast of air under high pressure. In order that the phase relation between the alternator current and the spark may be varied to the most advantageous point, the alternator is built with the armature frame, the machine being of the rotating field type, mounted in a secondary outside frame, with a track machined in its inside circumference. On this track the armature frame may be rotated through an arc equal to the angle between the poles by means of a hand wheel. Thus the spark may be made to discharge the condensers at any desired point of the sine wave. The dischargers are set in sound muffling rooms and the leads run up through the ceiling to the oscillation transformers mounted on the floor above. These rooms are exhausted by motor-driven blowers of capacity sufficient to keep the air fresh and to draw out the air, which is admitted by the high-pressure blast used for quenching the spark.

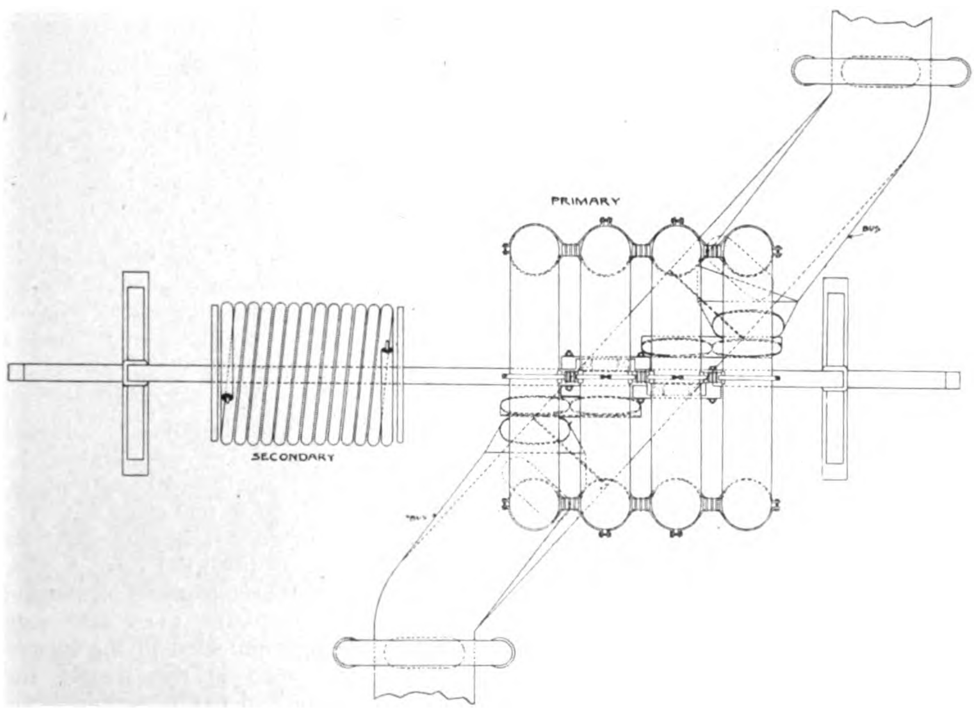
One of the precautions taken to provide an uninterrupted service is to duplicate any and all pieces of apparatus which are at all likely to be disabled. Thus, two generators and two disc dischargers are supplied for each station, and a ready means provided to connect either one to the bus and the oscillation transformer.

As the oscillation transformers are worthy of note, a sketch of them accompanies this article (Figs. 1 and 2). It will be seen that the coils are mounted on a horizontal axis and supported on a wooden frame. The primary coil is in series in the closed circuit. It consists of four turns, each turn being almost a complete ring of about 345 degrees. These turns are connected by heavy copper plates, making the equivalent of a helix of four turns. The helix is five feet in diameter and the section of the turns one foot in diameter. The turns are made of a wooden former, upon which the conductors are grouped. They follow along the length of the former, but have a long pitch spiral direction laid upon it in such a way that the length of each wire is the same, starting from one connecting plate to the next, that is, through the arc of 345 degrees. All the conductors are, in themselves, made up of stranded insulated copper wire.

The secondary coil of the oscillation transformer is wound on a wooden former, composed of two end plates with wooden rods, upon which are mounted porcelain spools. On these spools the conductor is wound; it consists of fourteen turns of a specially built high-frequency cable. The cable is made by winding thirty-six small conductors around a hemp center core, each conductor being made of seven double cotton-covered wires. There is a cotton cover over the whole cable, which is about three inches in diameter. In mounting this secondary coil on the frame, the barn-door type of roller bearings is employed. This makes a device that can be constructed totally of wood, and for close adjustment a wooden hand-screw is used, which will clamp the coil on the supporting bar of the frame, as well as furnish the means for adjustment.

From the oscillation transformer, the buses are led to the center of the condenser room, and as the transformer is on the second floor of the powerhouse, the main leads are carried horizontally about fourteen feet above the condenser room floor. The condenser bank is divided into four groups, each group being fed from the overhead buses. Each group is then subdivided into four sections of twenty-four tanks. They are connected in parallel series, three tanks being in each series and eight rows of three tanks each, parallel in each section.

From the central point of the room the overhead buses lead radially to points directly over the center of each section. Here the leads are carried down to a level with the condenser tops. From this point the sections are fed. The main bus is made of twenty-four-inch wide copper, bent in trough shape, the return lead being supported under the other. At every point where the leads divide, a smaller size conductor is used, and all the leads are so arranged that the distance between them can be adjusted, in order that the inductance of the leads can be varied as the requirements of the circuits demand. By using this system of distribution, the path of the current from the oscil-



PLAN VIEW
OSCILLATION TRANSFORMER

Fig. 2

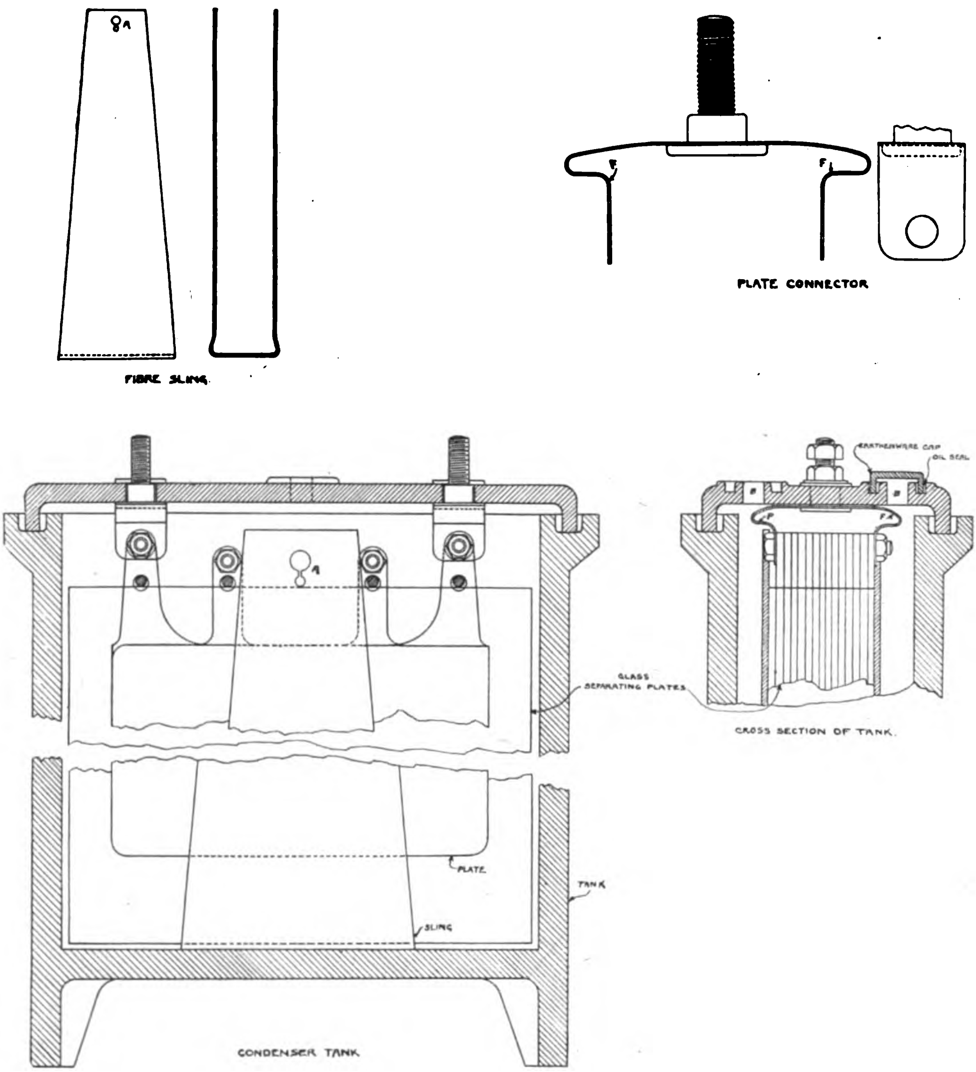
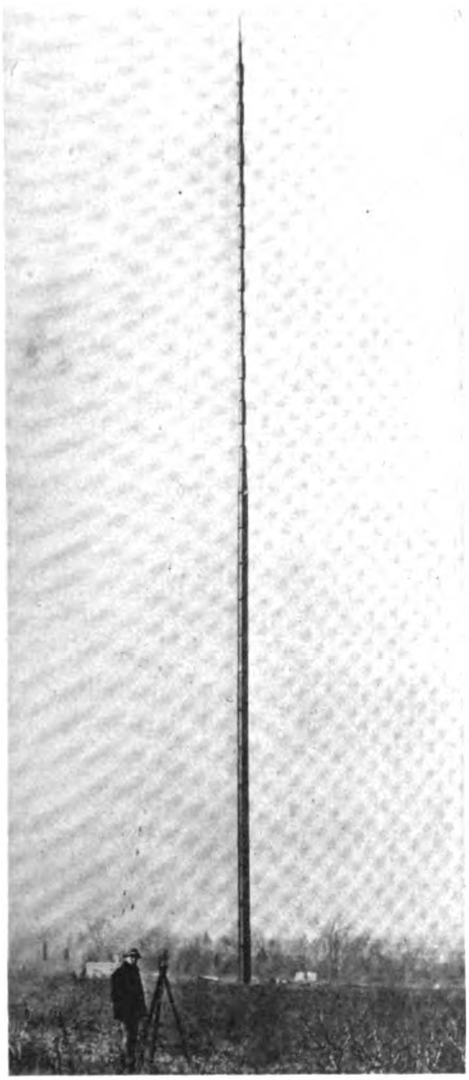


Fig. 3

lation transformer to any tank in the entire bank of three hundred and eighty-four is exactly the same. This is very important, in order that no one tank will be required to work on a greater current than any other. Each section of twenty-four tanks is set on a sloping floor, and from each section runs an oil drain, under the floor, to a single receiver.

The condenser tanks are a modification of the Poldhu type (Fig 3). They consist of stoneware tanks, thirty inches high by seventeen inches wide, by seven inches thick. The design was adopted for the purpose of keeping in view the necessity of the quick and easy replacement of plates. All the elements of a tank can be lifted out bodily and new plates of glass readily inserted. A fibre sling carries thirty-one glass plates and twenty-nine zinc plates, every alternate zinc plate being connected to the buses.

As will be seen in the sketch, the plates are connected to the terminals by flexible strips, which compensate for any inequalities in the depth of the tanks. The covers are thoroughly oil sealed, and the whole tank is filled with a high-grade mineral oil. As the slightest trace of moisture in the oil renders its insulating value inadequate, and as oil is highly hygroscopic, it is quite essential to use only very dry oil. To obtain this, a filter press is being installed in each station.



Completed Mast

If any tank fails or is broken down, the section of which it is a unit is cut out of the bank, and the spare section cut in. Then a portable derrick is run over the section, and by means of a block and tackle, which it carries, the contents of the tank are lifted out. To do this, a pair of tongs are run down through the small holes in the center of the cover, and the hooks inserted in the holes in the fibre sling. Thus the contents of the tank can be lifted out with the cover attached, and a new set of elements put in very quickly, without lifting the tank itself. After this, repairs can be made to the elements at leisure.

GOLD MEDAL FOR OPERATOR

Because of his excellent work at the key during the November hurricane in which so many vessels on the Great Lakes were lost, A. F. Moranty, wireless operator at the Marconi station at the Ashtabula (Ohio) plant of the Great Lakes Engineering Works, has been presented with a handsome gold medal by the Pickands-Mather Company.

During the storm the Pickands-Mather Company lost three ships, while the fate of many others of the same company was uncertain for many days. Moranty was able to render the company valuable service by keeping its Cleveland offices posted on the whereabouts of many of its ships. In fact, the Marconi wireless station was the only means Ashtabula had of communicating with the outside world for several days during the height of the storm.

The face of the medal is engraved with the letters "P. M. Company to A. F. M."

STATION WEATHERED STORM

The big masts and uncompleted buildings of the Marconi Wireless Station just outside of New Brunswick, N. J., successfully weathered a storm on January 12 and 13, although exposed on a towering bluff to all the force of the tremendous wind. Superintendent Rossi reported that no damage had been done to the station. The heavy wind and piercing cold did, however, interfere to some extent with the work.

Elementary Engineering Mathematics

As Applied to Radio Telegraphy

By Wm. H. Priess

ARTICLE IV

VARIABLES AND CONSTANTS

WHEN dealing with an equation representing a relationship among the various letters involved it is of prime importance to determine how one of the quantities—defined by the equation—varies when another of the quantities is varied. That quantity to which we ascribe various values is known as the *independent variable;* the other quantity, whose value we calculate from the equation in which the value of the independent variable has been substituted, is known as the *dependent variable.* Thus in the algebraic equation

$$y = ax + b,$$

y is expressed in terms of the *independent variable* x, and is therefore the *dependent* variable. All letters in an equation that are not variables are constants. Physicial constants, such as the electrical constants of a circuit, are often considered as variables, when it is desired to find the effect of their variation on the values of the dependent variables, like the current or voltage. It is apparent that the terms, independent and dependent, as applied to variables, are interchangeable and are descriptive of the viewpoint from which the relationships are regarded. Three important cases of the interdependence of variables will be considered.

(a) *Value of the Roots of a Quadratic.*

We have seen in the last issue that a quadratic equation falls in the general form

$$ax^2 + bx + c = 0,$$

and has two roots

$$x_1 = \frac{1}{2a}(-b + \sqrt{b^2 - 4ac}),$$

and

$$x_2 = \frac{1}{2a}(-b - \sqrt{b^2 - 4ac}).$$

The two roots x_1 and x_2 depend on the value of $\sqrt{b^2 - 4ac}$ in the following manner:

1. If b^2 is greater than 4ac, expressed symbolically

$$b^2 > 4ac,$$

both roots will be real and of different value.

2. If b^2 is equal to 4ac, expressed

$$b^2 = 4ac,$$

the radical reduces to zero. Both roots are real and equal to $-\frac{b}{2a}$.

3. If b^2 is less than 4ac, expressed symbolically

$$b^2 < 4ac,$$

the quantities under the radical will be negative. Since it is impossible to find a number which when squared is equal to a negative number, the radical quantity is called an imaginary number, and is equal to some constant K times the square root of minus one, or $K\sqrt{-1}$. The roots are therefore different and imaginary. Imaginary quantities will be further discussed in a later issue of THE WIRELESS AGE.

In a circuit containing resistance R, inductance L and capacity C, the conditions

$$R^2 > \frac{4L}{C}$$

for an aperiodic circuit, and

$$R^2 < \frac{4L}{C}$$

for an oscillating circuit, are obtained as the direct result of a similar form of reasoning, applied to the solution of the free discharge of a condenser circuit with respect to the current or voltage.

(b) *Resonance in a "Loosely" Coupled Circuit.* In Fig. 5, A is the primary circuit in which the current of constant effective value, I, is oscillating with frequency n. B is a circuit "loosely" coupled

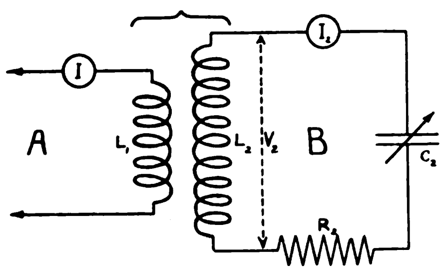


Fig. 5

to it, whose coupling coefficient, K, is a constant, and whose inductance, capacity and resistance are L_2, C_2 and R_2, respectively. L_2 and R_2 are to be maintained constant; C_2 is to be varied until the maximum effective current flows in circuit B. When this point is reached the circuits are then known as *resonating circuits*. It is desired to find the value of the capacity C_2 that will bring A and B to resonance, i. e., that will give the greatest effective current in B. Call the effective current in A, I. The effective flux through the coil, L_1, and the surrounding space depends on the effective value of the current, I_1, which is a constant. The effective voltage, V_2, across the terminals of the coil, L_2, depends entirely on the effective value of the flux from L_1 that cuts L_2, the number of turns in L_2 and the rate at which the flux varies expressed by n. Since I_1, L_1, L_2, K and n are constants, and since the voltage depends solely upon these quantities, the effective voltage is a constant and is applied periodically with a frequency n. Therefore in the equation connecting the current, the frequency and value of the applied voltage, and the electrical constants, L, C and R of a circuit

$$I_2 = \frac{V_2}{\sqrt{R_2^2 + \left(2\pi n L_2 - \frac{1}{2\pi n C_2}\right)^2}} \qquad (1)$$

V_2, R_2, n and L_2 are constants, I_2 and C_2 are variables. For I_2 to be a maximum the denominator of the right hand number must be a minimum.

Therefore

$$\sqrt{R_2^2 + \left(2\pi n L_2 - \frac{1}{2\pi n C_2}\right)^2} \qquad (2)$$

must be a minimum. Since R_2 is a constant and the square of any real number is positive, the radical (2) has its smallest value when

$$\left(2\pi n L_2 - \frac{1}{2\pi n C_2}\right) = 0 \qquad (3)$$

Solving for C_2 we get

$$C_2 = \frac{1}{L_2 (2\pi n)^2} \qquad (4)$$

When this value of C_2 is substituted in the circuit equation (1) becomes

$$I_2 = \frac{V_2}{R_2}, \qquad (5)$$

in which form it is the same as Ohm's law and represents the resonant value of I_2. The usual form of equation (4) is given in terms of n as follows:

$$n = \frac{1}{2\pi\sqrt{L_2 C_2}}, \qquad (6)$$

and is known as the Thomson Formula. Therefore if we wish to determine the capacity to be placed in circuit B to make it resonant with A, we must know the values of the frequency of A and the inductance of B.* If we wish to determine the frequency of A (B then acts as a wave meter) we vary the capacity in B

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* Note:—The strictly accurate formula for the frequency is:

$$m = \frac{1}{2\pi\sqrt{LC}\sqrt{1 + \left(\frac{\delta}{2\pi}\right)^2}}$$

where δ is the decrement. For values of decrement under 0.2 the error is less than .05 per cent when the correction is neglected.

until the ammeter registers the maximum current, then from equation (6), knowing the values of the capacity and inductance C_2 and L_2, respectively, the frequency may be calculated. For example, if A and B are loosely coupled, and C_2 is varied until the current in B is a maximum, then if $C_2 = 0.001\ \mu.$ f., and $L_2 =$ 11,200 cms,

$$n = \frac{1}{2\pi\sqrt{C_2 L_2}}$$

$$= \frac{1}{2\pi\sqrt{0.001 \times 10^{-6} \times 11{,}260 \times 10^{-9}}}$$

$$= \frac{1}{2\pi \times 10^{-7}\sqrt{1.126}}$$

$= 1.5 \times 10^{6}$ oscillations per second.

Since

$$\lambda = v\,T = \frac{v}{n} = \frac{3 \times 10^{8}}{n} \text{ meters.}$$

Where λ is the wave length in meters, v is the velocity of the wave in meters per second (= velocity of light or 3×10^8 meters per second), and n is the number of oscillations per second;

$$\lambda = \frac{3 \times 10^{8}}{1.5 \times 10^{6}} = 200 \text{ meters.}$$

(c) *Damping of a Circuit.*—The third important case is that of the damping of a circuit. When a condenser discharges through resistance and inductance, its energy surges back and forth in the circuit as electrostatic and electromagnetic energy. During each surge some of the energy is locally dissipated as heat by resistance of the conductors, hystersis and conductivity of the dielectric of the condenser, and eddy currents induced in conductors blocking the path of the magnetic flux; the remaining dissipated energy appears in the form of electromagnetic waves and is radiated. Therefore the maximum current or voltage amplitude is less than that of the previous surge. The ratio of two successive current amplitudes is expressed by the damping of the circuit,

$$\epsilon \frac{R}{2L} T \qquad (1)$$

Calling the maximum current of the m^{th} oscillation I_m, and the maximum current of the (m + 1) oscillations

I (m + 1)

$$I\,(m+1) = \frac{Im}{\epsilon \frac{R}{2L} T} \qquad (2)$$

The smaller value of $\epsilon \frac{R}{2L} T$ the greater the value of I (m + 1) and the more nearly sustained are the oscillations. But since $\epsilon \frac{R}{2L} T$ depends on the value of $\frac{R}{2L} T$, $\frac{R}{2L} T$ becomes the independent variable, I (m + 1) the dependent variable. When $\frac{R}{2L} T$ becomes 0, $\epsilon \frac{R}{2L} T = 1$, and

$$I\,(m+1) = Im \qquad (3)$$

When $\frac{R}{2L}$ T becomes very large $\epsilon \frac{R}{2L} T$ becomes extremely large, and

$$I\,(m+1) = \frac{1}{\text{extremely large number}}\ Im, \qquad (4)$$

or there is practically but one surge of energy.

Therefore I (m + 1) lies in value between Im and zero, as $\frac{R}{2L} T$ varies between 0 and a very large number.

Logarithms

Many students often wonder how engineers find time to perform the laborious calculation of product, quotients, powers and roots that are indicated in the various formulæ for design of apparatus. The invention of the Briggs tables has reduced all the operations to addition and subtraction. The Briggs tables are the tables of the logarithms of the number and decimals from 1 to 10. A consideration by the reader of the definition, meaning and application of the principles of logarithmic computation will be of benefit to him in the elimination of tiresome numerical labor.

Definition.—In the equation

$$a^{b} = c \qquad (1)$$

three possible problems may arise:

1. Given a and b, to find c. This is the process of involution or raising to a power.

2. Given b and c, find a. Solving for a, by taking the b root of both sides, equation (1) reduces to

$$a = c^{1/b} \qquad (2)$$

This is the process of evolution or finding the b root of a number.

2. Given a and c, find b. *This is the process of finding the logarithm of c to the base a.* Expressed symbolically,

$$b = \log_a c \qquad (3)$$

a is a constant, known as the base of the logarithm. It may be 10, as in the Briggs system, or 2.71828, as in the natural or *Napierian system,* or any other constant K. b is found in the tables by looking up the given number c. Since a positive number c can always be expressed as a constant raised to some power b, there is always a logarithm b, for a given positive number c. For example, if

$$10^x = 100,$$

then from equation (1),

$$x = \log^{10} 100,$$

but 10 squared is equal to one hundred, therefore,

$$x = 2.$$

That is, 2 is equal to the logarithm of 100 to the base 10. *The antilogarithm is the number corresponding to the given logarithm.* In the example given 100 is the antilogarithm of 2.

Properties of Logarithms.—1. If $\log_a n = x$, and $\log_a m = y$, since $n = a^x$ and $m = a^y$, then by the law of indices (¶ 26), $n \times m = a^{(x+y)}$, or

$$\log_a (n \times m) = x + y = \log_a n + \log_a m;$$

and by the second law of indices (¶ 33),

$$n \div m = a^{(x-y)}, \text{ or}$$

$$\log_a (n \div m) = x - y = \log_a n - \log_a m.$$

That is, the logarithm of a product is equal to the sum of the logarithms of the factors, and the logarithm of a quotient is found by subtracting the logarithm of the divisor from the logarithm of the dividend. To multiply two or more numbers together we find the logarithm of the factors, and then the antilogarithm of the sum of the logarithms. To divide one number by another we subtract the logarithm of the second number from the first, and find the antilogarithm of the difference of the logarithms.

$n \times m$ = antilogarithm of $(\log n + \log m)$.
$n \div m$ = antilogarithm of $(\log n - \log m)$.

2. If $\log_a n = x$, since $n = a^x$, then from the law of indices, $n^b = a^{bx}$, and therefore $\log_a (n^b) = bx = b \log_a n$; and since $n^{(1/b)} = a^{(x/b)}$, therefore

$$\log_a (n^{1/b}) = \frac{x}{b} = \frac{1}{b} \log_a n.$$

That is, the logarithm of a number raised to a power is equal to the power times the logarithm of the number, and the logarithm of the root of a number is equal to the logarithm of the number divided by the index of the root.

3. Since $a^0 = 1$, then

$$\log_a 1 = 0$$

The logarithm of unity is zero. Since $a^1 = a$, then

$$\log_a a = 1.$$

The logarithm of the base is equal to unity.

Change of Base. Most of the calculating is done by the Briggs tables, or to the base 10. Physical formulæ in which logarithms appear are usually to the base ϵ (2.71828). It is therefore essential for purposes of computation to express $\log_\epsilon n$ in terms of $\log_{10} n$. This is done by means of the easily derived form

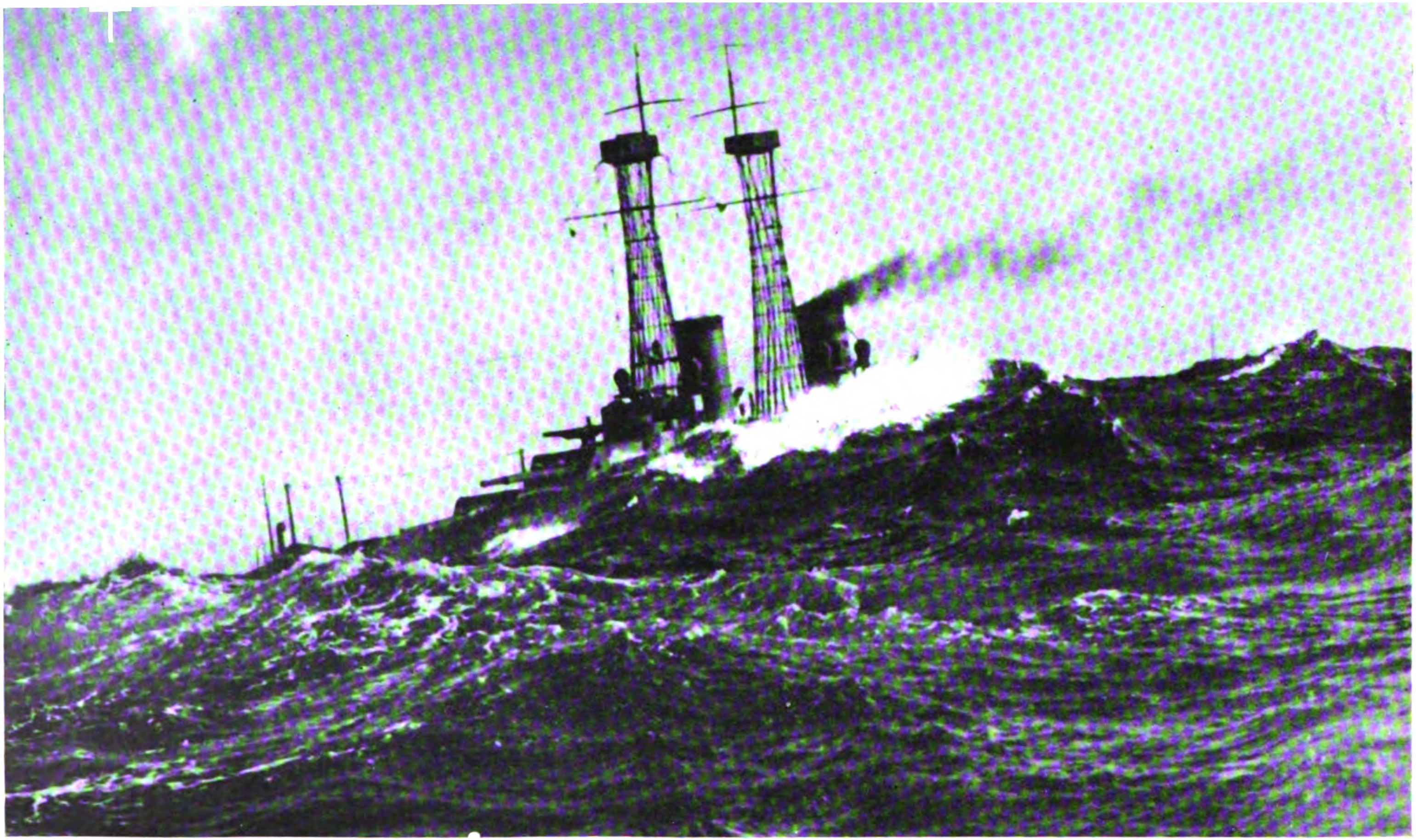
$$\log_\epsilon n = \log_{10} n \times \log_\epsilon 10 = K \log_{10} n,$$

where K = 2.3026.

The remainder of this installment, which is included in the fourth of a series of articles on mathematics by Mr. Priess, will appear in an early issue. This series will be followed by a simple explanation of the practical use of logarithms.

ARGENTINE CONTROLS SERVICE

A new law in the Argentine Republic provides that all wireless communication within the territory of the nation and for international messages up to a distance of 620 miles shall be conducted only by the state. The use of the government service is obligatory, according to the law, upon all vessels entering or leaving Argentine ports with fifty or more persons aboard, including passengers and crew.



Photo, Underwood & Underwood.

What wireless means in safety to our navy men strikingly illustrated in this photograph of one of Uncle Sam's greatest Dreadnaughts, the Delaware, fighting for her very life in the "cup" formed by the mountainous seas.

Directing Fire Boats by New Method

THE efficiency of wireless telegraphy when applied to use in the New York Fire Department was shown on December 23 last during a test of radio communication between Fire Headquarters in East Sixty-seventh street and the fireboat James Duane, steaming up the Hudson River to answer a false alarm. Following the test instructions were given to officials of the department to make further investigations with a view to installing wireless apparatus on each of the eleven fireboats in the service of the city.

"We are leaving now for Station 736 (West End avenue and Ninety-eighth street), out in river now," was the wireless message that came to Fire Headquarters from the Duane, at twenty-five minutes to four o'clock in the afternoon after an alarm had been sent in by the regular method. The wireless message followed five minutes after the alarm had been sent in.

Message Tells of False Alarm

This communication was answered as follows by the wireless operator in East Sixty-seventh street:

"Operator in charge fireboat James Duane: False alarm. Acknowledge and report by radio.

"Operator in Charge Headquarters
"(3.40 P. M.)"

From the Duane came the following reply:

"Operator in Charge Platform (Headquarters): O. K. We are now opposite Eightieth street (3:41 P. M.). Engine 85 returned to quarters at 3:56 P. M.
"Operator Martin."

When the wireless informing Lieutenant Heenan, in command of the Duane, that the alarm was false had been received, the fireboat headed about and steamed down the river to her berth at the foot of Thirty-fifth street. The message to the Duane, telling of the false alarm, showed the value of wireless as a time saver when employed in the Fire Department.

A message of congratulation to the fireboat brought the following response:

"The wireless idea is excellent and will save the burning of a vast amount of fuel in useless runs.

"Lieutenant Heenan, Commanding."

Joseph Johnson, who was Fire Commissioner at the time the test occurred, explained the advantages of wireless in directing the movements of fireboats. At present the department has no means of communicating with the craft on the water.

"We will suppose," he said, "that the first land company to reach the scene of the supposed fire—and invariably the land companies reach fires in advance of the boats—reports that it was merely a matter of a burning lace curtain and amounted to nothing.

"I want to stop the James Duane because I want her at her post in case a real fire occurs. Under the old plan I lost control of the boat the minute she put off from the wharf, but now I wireless her that the fire is out and she need not make the long run on which she has started. It means a much greater efficiency among our fireboats than we have heretofore known. In two instances fires have occurred on ships in the harbor while our fireboats have been away from their stations on long runs to waterfront fires that were out long before their arrival."

Wireless Summons for Ships Afire

Fire Department officials have considered the possibilities of receiving alarms of fire from vessels at sea by wireless and sending out fireboats to meet the craft as they entered port and fight the flames. A wireless installation would also prove of advantage in summoning the fire fighters to anchored craft ablaze. Even cargo steamships are now generally equipped with wireless and there would be little difficulty in getting assistance within a few minutes after the flames were discovered.

The apparatus used in the recent test included installations at Fire Headquarters and on the Duane rated at one-half kilowatt. The antenna in East Sixty-seventh street was located on the roof of Fire Headquarters and the set was placed in a small room on an upper floor. The set in the Duane was located in the pilot house.. The apparatus is of the quenched gap type, similar to that used on the United States torpedo boats.

If the Fire Department is equipped with wireless it is likely that the central radio station will be located in the building of the department in course of erection in Central Park at Seventy-ninth street.

THE LACKAWANNA EXPANDS ITS WIRELESS SERVICE

The success of the wireless service on the Lackawanna Railroad between one of its limited trains and fixed stations at Scranton, Pa., and Binghamton, N. Y., has induced the railroad company to arrange for the installation of additional radio equipments at points between Hoboken, N. J., and Buffalo, N. Y. Another limited train will also be equipped with wireless. Wireless operators will be assigned to duty on each train, and radio communication will be established between the trains and fixed stations over the entire length of the railroad.

Wireless telegraph on trains of the Lackawanna to transmit orders to the crews and news to the passengers recently proved its worth when it was used to summon an ambulance to remove a passenger who had been seized with a fit. It was at first supposed that the man was dead, and the message was sent while the train was running at full speed, but by the time the train reached Scranton the man had been revived and the hospital conveyance was not needed.

Another passenger aboard the train, which left New York at twenty minutes to one o'clock in the aftrnoon, was met at the station in Scranton by a friend, who had been summoned by wireless. The message was sent from Cresco to the Lackawanna's wireless station in Scranton, and relayed by telephone to the home of the passenger's friend. The reply, "I'll be there," was sent as the train passed through Tobyhanna. The distance from Cresco to Tobyhanna is thirteen miles. Another remarkable performance of the wireless was a conversation kept up between the Scranton station and the express as it sped through the Nayaug tunnel.

"Stentor" transmitters and reproducers (loud-speaking telephones) will be installed on the dispatchers' circuit of the Lackawanna between Hoboken and Franklin Furnace, N. J. This apparatus relieves the dispatcher of the necessity of wearing telephone head-gear, which is a source of danger and annoyance to him, particularly during electrical storms. The receiver is placed on the desk about six inches in front of the dispatcher, and the enunciation is described as being loud and distinct. The circuit between Hoboken and Franklin is 108 miles in length, and has thirty-two stations.

STATION SITE NEAR SAN DIEGO

The Navy Department has selected a site near San Diego, Cal., for the third of the giant wireless stations which are to form a chain extending from Washington to Panama on the Pacific coast, Hawaii, Guam and the Philippines.

A California site, suitable from an electric standpoint, was the prime requisite, but its adaptability for communication with Hawaii, Panama and Washington was also considered. The site is about four miles from San Diego and eleven miles from the seacoast. Arrangements are being made for a transfer of the title to the site, the cost of which is about $15,000. The construction of the radio station will be begun immediately after the transfer of title.

The Arlington station is already in operation and the one at Panama will soon be in commission.

Little Bonanza

A Serial Fiction Story

By WILLIAM WALLACE COOK

Begun in November—On the steamship Ostentacia, bound westward across the Atlantic, is John Maglory, of Ragged Edge, Ariz., his adopted daughter, Bonanza Denbigh, and his nephew, Jefferson Rance. Maglory is developing for Bonanza a gold mine, which has shown so little promise of yielding good returns that his attempt to sell it in London has met with no success. On the steamship he meets William Sidney, who buys an option on the sale of the mine. Rance, who has received a wireless message telling of a rich vein that has been uncovered in the mine, warns Maglory against Sidney. Maglory, however, is skeptical regarding the efficiency of wireless and pays no heed to Rance's statement that Sidney knows more than he appears to about the value of the property. Soon afterward Rance finds on the deck of the steamship a wireless message from Kennedy, superintendent of the mine, telling Sidney that the Burton-Slocum syndicate is prepared to offer Maglory $200,000 for the property. Maglory declines to credit Rance's statement.

CHAPTER VII

THE two-seated mountain wagon ground its way over the sandy trail between San Simone and Ragged Edge. It was an ineffective sort of trail and seemed rather aimless in its windings; but the Apaches had started it, and no Indian ever takes the longest way between two given points unless there is a very good reason for it.

In this particular case the reason was Lost Horse Cañon. That gash in the hills, with its precipitous sides and the treacherous ground adjacent to the rimrock made necessary a long détour in passing from San Simone to the town on the opposite brink of the cañon.

Old Joe Derry clucked to the lathered horses. It was almost derisive, that cluck in Old Joe's throat. For from the seat behind him John Maglory had remarked, in a voice husky with awe—and dust:

"God's country!"

A road-runner hustled across the road ahead of the team. At the side of the wagon a rattlesnake suddenly coiled and struck at Old Joe's whiplash.

The heat was blistering. A pall as of smoke hung low over the desert and almost obscured the dismal clumps of greasewood and the ragged growths of cactus. Old Joe coughed.

"This land must look a heap good to you, John," said he, "after crossin' the water and gettin' a bird's eye view of Yurrup."

"Out here, Joe," said Maglory, "either a man's the clear quill or he ain't—but you know it. Back East you never can tell what a man is, because surface indications don't count. Glad you're home, Bonnie?" and he turned to the girl at his side.

Bonanza's olive cheeks were flushed and her eyes were dancing. She was leaning forward over the back of the front seat, eager to catch her first glimpse of Ragged Edge through the clouds of dust.

"Oh, it's glorious to be back!" murmured the girl.

"That's you!" exclaimed the old man fondly. "Home never looked so plumb good to me as it does this minute, and I allow you feel the same."

"Well," observed Derry, taking lines and whip in one hand, while he pulled a plug of tobacco from his pocket with the other, "home ain't what it was when you left it, John. A few more has pulled up stakes and gone over to San Simone."

Maglory frowned. A sadness almost pathetic showed in his old face as he answered:

"Some people are never satisfied. Since San Simone got to cooking with gas and reading by electric light, the habit of moving over there has been growing on the Ragged Edgers. But it takes something more than gas stoves and incandescent bulbs to make a New Jerusalem, and I'm hoping to live and die on

"If that wireless of yours is any good, Ollie," the old man went on, hoarsely, "use it in getting a doctor out here."

the brink of Lost Horse Cañon without ever seeing a flying machine or—now, Bonnie, you hush!"

The girl had burst into laughter. Flinging an arm around Maglory's neck, she gave him a swift kiss. Then she turned to the driver.

"How's Silverheels, Joe?" she inquired.

"Big as life and twicet as ornery, Bonnie," chuckled Derry. "Ain't no one backed the critter since you-all went away. Gee, but he feels his oats! You'll have to be right keerful when you ride Silverheels for the first time."

"Oh," and the girl tossed her head confidently, "he wouldn't cut any capers with me."

"There's the town, Bonnie!" burst out Maglory; "there's home!"

Excitedly he fanned the dust from in front of him with his hat and pointed ahead with a finger none too steady. The girl drew a deep breath and again leaned over the front seat, fixing her dark eyes steadily on what was before her.

One by one the squalid, mud-walled houses took shape and form. There was no living person abroad in the street, and a funereal silence seemed to prevail everywhere.

"What's Ryckman been doing to the top of that 'dobe of his?" Maglory inquired, his eye keen for all changes that had transpired during his absence.

A pole rose high above the flat roof of the Ryckman dwelling. At its upper end was a cross-bar, and from one end of the bar hung a swinging wire.

"That pole thing?" guffawed Old Joe. "That there is Allie Ryckman's work, John. Ryck allows his boy Ollie is some progidy. Maybe you won't believe it, but that kid can telegraph without wires. He——"

John Maglory stiffened in his seat. The red ran into his face and he almost shouted:

"Do you mean to say that's one of these fool wireless outfits?"

Old Joe looked around, mildly curious at this outburst of temper.

"I reckon that's what they call it," he answered. "When I first heard of it, I allow it struck me a heap like it's strikin' you, John, but the more you get acquainted with the thing the more you believe in it. Plumb wonderful, and no mistake."

Maglory, fleeing from civilization and returning into his own primitive haunts, was rudely shocked by encountering that little wireless station right in his home town. So it had come to this! Ragged Edge, admittedly at its last gasp, could not die without having its final moments tortured by this wireless machine!

"Stop, Joe," growled Maglory, "stop in front of Ryckman's."

The moment the wagon stopped, Ollie, Ryckman's seventeen-year-old son, came running from the house.

"Hello, Mr. Maglory," he shouted. "Howdy, Miss Bonnie. Gee, but it's good to see you-all back home once more."

He ran up to the wagon and shook Bonanza by the hand. He would have shaken the hand of Maglory, too, but the latter gave him no chance to do so.

"No good will come of your fooling with that wireless layout, Ollie," said the old man, in a voice that trembled with indignation and anger. "Chop the pole down and smash the rest of the apparatus into junk. I'll bleed for the damage."

Ollie looked dazed.

"Chop the pole down?" he echoed; "smash the apparatus into junk? What for?"

"Because you're fooling away your time when you ought to be doing something else that's worth while," said Maglory sharply; "and because it glooms me all up to have anything like that in Ragged Edge."

"Why, I can talk with a fellow in San Simone who's got a station, and with another chap at Poco Tiempo, who has fitted up a wireless place. I can't send so very far, but"—and the boyish face glowed with delight and enthusiasm—"at night I can sometimes pick up signals from San Francisco, and once I caught an S O S from a boat somewhere off the coast. I got a Government license, too, and—and—say," he broke off, a puzzled light in his eyes, "you don't really mean I'm wasting my time, do you, Mr. Maglory?"

"When I say that," scowled Maglory, "I'm mild—mild as the babble of a Chinese cook. You stop this fool tinkering, Ollie, or you'll come to grief. Wireless never did anybody any good."

The boy's expression changed. He was no longer puzzled, but frankly hostile.

"That's where you're wide of your trail," said he stoutly, "and it's about as foolish a thing as any one ever put tongue to. Excuse me for breaking out at you that-a-way, Mr. Maglory, but when they had the big fire in San Simone and were short of men, didn't they call on my station for help? And when they had the cave-in, over at Poco Tiempo——"

"Drive on, Joe!" shouted Maglory.

And they drove on, leaving Ollie Ruckman staring after them, with face flushed and the light of rebellion in his young eyes.

From his own comfortable adobe, situated on a slight "rise," similar to the site of the Ryckman home, Maglory could look across the swale at any time of day and see that tall pole with its swinging aerial. It reminded him of many things that were not pleasant and was a source of constant annoyance.

For two or three days after reaching Ragged Edge the old man was going through a period of readjustment. It was a stormy period and he did not weather it very successfully.

His journey East, and across the water, had brought him face to face with some things that hammered hard upon his primitive barriers. He was obstinately shutting his eyes against facts which sooner or later would assert themselves in spite of him.

Kennedy, the dishonest foreman in charge of work at the Bonanza Mine, he must discharge. But he delayed. He remembered that his only proof of Kennedy's treachery had been developed by Rance through a wireless telegram. He prsuaded himself that he wanted other proof, and for the present he made no move to oust Kennedy.

Silverheels, Bonnie's pinto, abruptly leaped from idleness into the busiest days of his career. The mettlesome cayuse was taken out for many a long, hard ride, and gradually the spell of the East faded out of the girl's mind, and she settled comfortably back into the old Arizona life. The pinto had much to do with making Bonanza contented and keeping her hopeful.

On the afternoon of the fourth day after the return of Maglory and Bonanza, the hum of an automobile stirred the echoes of the town. Two men were in the machine, and they raced up to the Maglory adobe and came to a halt. One of the two got up and started for the front door, but it was opened before he reached it and Maglory appeared.

"What do you mean by slamming around this burg in an old pop-bottle like that?" shouted the old man, planting himself truculently on his porch.

"Eh?" gasped the visitor, astounded.

"A team and wagon ought to be good enough for any man," continued Maglory, "and I haven't a mite of patience with fellows who turn engines loose on the trails and scare the livestock. What's your business?"

"Are you John Maglory?"

"That's my label."

"You're Miss Bonanza Denbigh's guardian?"

At this question the old man shied like a restive horse. Vague suspicions began floating through his brain on the instant.

"If you've got anything to do with Jeff Rance," he cried, "I'll tell you flat he's out of the Maglory herd. I——"

"You're getting me wrong, Mr. Maglory," the motorist interrupted. "I have heard of Mr. Rance, but do not know him. He has nothing to do with my call here this afternoon. I happened to be in San Simone this morning, and, learning that you had returned from the East, motored over to see you on a matter of business. Is Miss Denbigh at home?"

"If your business is with me, why are you asking for her?" demanded Maglory.

The other laughed a little.

"I suppose," he went on, "that my business concerns her, in the main, rather more than it does you."

"Well, she's not around; she's away, horseback riding."

"My name is Hall, Mr. Maglory, and I represent the Burton-Slocum people. If you can spare me a few minutes, I'd like to make you a proposition in the matter of the Bonanza Mine, over Poco Tiempo way."

Maglory started and stared. A strange look crossed his face, and his eyes lost their fire and grew dull.

"Come up and sit down, Mr. Hall,"

said he in a subdued voice, pushing out a chair. "A proposition, you say? What do you know about the Bonanza property?"

"The Burton-Slocum people are willing to bank on what I know," was the smiling reply.

"Well, make your proposition," murmured the old man.

CHAPTER VIII

"I understand that Miss Denbigh's property is on the market." Hall did not sit down, but leaned over the back of the chair as he talked. "On behalf of the syndicate I represent, I am here to make a spot cash offer of $200,000 for the Bonanza Mine."

Maglory stool like a man chiseled from stone. Rance had not lied to him, after all. Rance had not shown him a spurious message. He had told the truth. Maglory, who would have cut off his right hand for Bonnie, had, through his obstinacy, cheated her out of $150,000—the difference between the price called for by the option and this cash offer by Hall. He had done even more than that, for this $150,000 he had taken from Bonnie and presented to William Sidney, the man against whom Rance had warned his uncle.

The old man crumpled up and dropped into a chair. His hands fell limply across his knees and his chin sank to his breast. How grievously he was hurt no one but himself would ever know.

Hall looked at Maglory curiously. Under his wondering glance the old man lifted his head.

"There's a thirty-day option out against the property," said he.

"Sidney?" returned Hall.

"How'd you know it was Bill Sidney?"

"He sent me a wire saying he had the property cornered, and that if my people wanted it they'd have to deal with him. Much obliged, Mr. Maglory. This is about all I want to know."

Hall started down the steps. Maglory halted him with a word.

"Don't you deal with Sidney!" he shouted. "He's a thief and a liar, and the Bonanza Mine isn't his! And it won't be his, if I can find the coyote and kill him before that option expires!"

"When does the option expire?"

"At 10 p. m. the 25th of this month."

"Suppose we buy his option?"

"You take my advice and hold off. Don't you buy the option, Hall. Buy the mine—and buy it from the person who happens to own it after the 25th."

There was something here which the Burton-Slocum representatives could not understand. It was one of those cases, however, in which it was best to take advice from a man who might be supposed to know.

"Very well, Mr. Maglory," said he, "we'll let the matter wait until after the 25th."

Maglory watched with narrowing eyes while Hall climbed into his machine and started along the back trail for San Simone. The motor car had not cleared the swale when Bonnie came galloping down the opposite rise on Silverheels. The machine was stuttering loudly on the up-grade, and the racket broke suddenly on the ears and eyes of the pinto.

Fright seized the cayuse, and, taking the bit between his teeth, he started to bolt. Bonnie set out to master her mount and seemed to be succeeding, when the riding gear failed her and the saddle turned.

John Maglory, with his eyes filming and the blood congealing about his heart, saw the girl cast to the ground. The white heels of the pinto twinkled across the rise, and a limp, draggled little figure was left lying unconscious in the dust.

A heavy groan was wrenched from Maglory's lips. He staggered, brushed a hand across his face, and then ran toward the scene of the accident.

The automobile had stopped. Hall and his driver had left the machine and were bending over Bonanza.

"It was your cursed machine that did this!" shouted the old man, flinging Hall roughly aside so that he might kneel in his place beside the girl. "Bonnie!" he cried, chokingly, gathering the crumpled form to his breast. "Speak to me, *mujercita!* You're not badly hurt!"

Bonanza did not answer. Her head fell back over Maglory's arm, and her closed eyes and white unconscious face struck at his heart like a dagger.

"Mr. Maglory," said Hall, "I'm enough of a doctor to see that the young woman is seriously injured. She should have medical attention without a moment's delay. Where is the nearest physician?"

The old man lifted an ashen face.

"San Simone—twenty mines away!"

"Charlie," and Hall turned quickly to his driver, "go after the doctor—and hit it up!"

"There's not enough gasoline for the trip," Charlie answered, hurrying toward the car.

"Find some," was the response.

Gently, Maglory laid down the form he was holding so tightly to his breast; then, getting to his feet, he stood for a moment, his eyes lowered and one hand smoothing the white hair back from his brow.

"You—you think, Hall," he asked stumblingly, "that this may be a case where—where minutes count in getting the doctor?"

"It may be such a case, Maglory. If Charley can find some gasoline he won't be long in getting a doctor out from town." The old man whirled and began running up the farther slope. As he neared the top, Ollie Ryckman could be seen walking along the trail and leading the pinto. As the boy drew close the look on Maglory's face alarmed him and brought him to a stop.

"Miss Bonnie hurt?" he asked.

"Yes," was the answer. "If that wireless of yours is any good, Ollie," the old man went on hoarsely, "use it in getting a doctor out here." He took the pinto's bridle from the boy's hands. "Hurry!" he added.

Ollie, filled with the idea of showing Maglory just what wireless could do in an emergency, cast one glance toward the foot of the hill, then whirled and dashed toward his station.

(*To be continued*)

OPERATOR'S STORY OF AN S O S CALL

George Uzmann, wireless operator, of 432 Forty-first street, Brooklyn, N. Y., who has returned from a three months' stay in Galveston, Tex., recently told an interesting story of how wireless brought help to a vessel in distress.

"I was one of the operators on the cable ship Relay, stationed at Galveston to await the outcome of the Mexican situation," he said. "I worked the third trick at the Galveston station on the morning of November 4 as a relief to the regular operator. It was about 4.30 o'clock in the morning and I had been working one of the battleships at Tampico when I heard some one calling and sending out S O S

"I found it to be the yacht Wakiva, belonging to the Heustica Petroleum Company. The operator reported that the yacht had run ashore in a heavy fog and high seas and was in only four feet of water. I stood by until a wrecking tug and revenue cutter went to the Wakiva's assistance. The yacht was floated on November 21."

RADIO INSTITUTE ELECTS OFFICERS

At the annual meeting of the Institute of Radio Engineers, held at Columbia University, January 7, the following officers were elected: President, Dr. L. W. Austin; vice-president, Dr. J. S. Stone; treasurer, J. H. Hammond, Jr.; secretary, E. J. Simons; R. H. Marriott, J. L. Hogan, Jr., R. A. Wiegant and G. Hill were elected members of the Board of Managers.

WARNING CONCERNING EXPLOSIVES

Experts of the United States Bureau of Navigation, Department of Commerce, say extreme care should be used aboard vessels carrying gasolene or similar substances which generate an explosive gas or any other explosive which might be ignited by electric sparks.

A. J. Tyrer, acting Commissioner of Navigation, has directed all radio inspectors to be rigid in their examination of wireless on tank vessels and others carrying material which might be set afire by sparks. "You will pay particular attention," said the order, "to the insulation of the antennæ to metallic rigging or equipment of the vessel in which currents may be induced from the action of the radio apparatus, and to the wiring and electrical equipment of the vessel in which currents may be induced so as to cause sparks to jump between wires or between small gaps."

Five Rescued Members of the Oklahoma's Crew, and a Last View of the Oil Tank Steamship, as Seen from the Deck of the Gregory

Wireless in the Oklahoma Rescue

REACHING out over miles of mountainous seas, wireless brought rescuing vessels to the oil tank steamship Oklahoma, which broke in two about seventy-five miles south of Sandy Hook on January 4. Twenty-seven of her crew were lost, but thirteen out of the forty aboard the wrecked vessel were saved. Captain Graalfs, of the Hamburg-American liner Bavaria, made the following report of the disaster in a wireless message:

"On January 5, at 6 A. M., we sighted the signals of distress of a vessel. Wind north to northeast. Velocity 48. High rough sea. At dawn we saw the fore part of a steamer floating on the water, tank steamer Oklahoma, from New York. At 8 A. M. we were close to the wreck and lowered a boat with six men, who succeeded after great effort in seizing a rope that was thrown to them. The men of the Oklahoma lowered themselves into the boat, quite exhausted from the experience of the last twenty-four hours.

"Captain Gunter, commander of the Oklahoma, states that last Sunday at 7:30 A. M., during heavy weather, without any previous warning the ship suddenly broke in two right behind the bridge. In about twenty-two minutes the after part of the ship, with the crew of thirty-two men, sank in the sea, the stern pointing upward, with the propeller running. The fore part kept afloat by the bulkheads, the stern up to the rear edge protruding from the water. The lifeboats either went down with the ship or were swamped by the waves. Immediately after the catastrophe on the morning of January 4 a Spanish steamer appeared, but was unable, owing to the bad weather, to approach them. Immediately after the Bavaria the United Fruit steamship Tenadores appeared on the scene of the disaster, but there was nothing left to be done, the boats from the Bavaria having taken off all the men. The life-saving work took place at latitude 39:07 north, longitude 73:45 west."

Chief Engineer John J. Fogh was drowned and so were First Assistant Engineer W. R. Dodd, Second Assistant Engineer Christopher Nelson and Third Assistant Engineer Walter Hanan. William Davis, Marconi operator on the wrecked vessel, was among the rescued. Edward Feline and Juan Siguier, the wireless operators on board the Manuel Calvo, of the Spanish line, told an interesting story of the disaster.

The Manuel Calvo first sighted the Oklahoma at 3:30 o'clock on the afternoon of January 4. The Spanish steamship slowed down until she was within three-quarters of a mile of the wreck before three men were seen aboard.

Feline said that the men did not wave their hands or do anything to attract attention. Then, as the Manuel Calvo swung in behind the wreck at a distance of about half a mile, the watchers could see eight men. Feline sent a message to Sea Gate and it was intercepted by the Caribbean, the Georgic and the revenue cutter Seneca.

Captain Juan Bonet, of the Manuel Calvo, then ordered a boat lowered. At the time the sea was running high and a heavy wind was blowing from the north. The boat was manned by the first officer, Jesus Marrogui, and six sailors. They were lowered from the starboard amidships, but the sea was too rough for them. First a sea broke the boat's rudder and quickly it was swept toward the bows, where, even quicker, it was hurled under as a sea lifted the steamship. The boat was smashed, spilling the crew into the water. Several managed to cling to the tanks of the lifeboat and two men caught the rings that were thrown from the steamship's deck. Those who held to the tanks managed to catch the lowering gear as it swung and finally all six men and the first officer were hauled over the side to safety.

Half an hour had passed while these attempts to launch the boat and its loss had occurred and the Manuel Calvo drew off a bit as dusk approached. At 6 o'clock she backed still further out of range of the possible radius of drift from the wreck and received wireless messages from the Georgic and the Caribbean, stating that both vessels were steaming under forced draught for the Oklahoma.

Captain Bonet said that his position became precarious as darkness came on, because he was not equipped with a searchlight and had no means of ascertaining his proximity to the wreck. So he sent out wireless messages to the Caribbean and the Georgic, warning them of the danger of the wreck and proceeded under just enough speed to make headway until 8 o'clock in the evening, when the Georgic was sighted.

The captain of the Georgic asked him for the Oklahoma's position, and then informed him that the White Star line freighter would go to the distressed vessel's assistance.

After this exchange of messages, Captain Bonet resumed his course and headed for New York.

During the night the Caribbean steamed toward the wreck, but she did not reach it because she received a wireless from Captain Graalfs, of the Bavaria, announcing his rescue of eight of the Oklahoma's survivors.

Five more survivors of the Oklahoma were picked up in the ocean early in the afternoon of January 4, after drifting in a lifeboat more than six hours. To rescue them three officers of the Booth Line steamer Gregory risked their lives repeatedly by leaping fully clad into the icy waters of the Atlantic. Third Officer Roberts did not even remove his shoes when the lifeboat in which cowered the half-frozen seamen capsized alongside the Gregory. His companions in rescue were R. H. Buck, the chief officer of the vessel, and Second Officer Sidney Williams.

Eleven men were in the lifeboat sighted by the Gregory. Two of them were swept overboard as the boat pitched about in the waves. Three others drowned when the lifeboat upset almost alongside of the Gregory, just when succor was at hand. The sixth was hauled half way up the ship's side by Third Officer Roberts, who nearly lost his life rescuing the man from the water, when it was discovered that the man was dead.

Dr. Kirby Basset, the ship's doctor, called to Roberts that his effort was useless. As the third officer's strength was ebbing fast, he let go of the limp form in his arms. It splashed back into the sea from which he had struggled to save it.

The stories told by the men rescued by the Gregory confirmed that sent by wireless from the Bavaria by Captain Gunter, of the Oklahoma, that the latter vessel broke in two amidships, and that the sections drifted away from each other.

In the stern of the ship, from which those rescued by the Gregory escaped, were the engines, which kept pounding away after the mishap. Smoke poured from her funnel, while her propeller, partly out of water, raced madly. When the rear of the broken vessel settled and sank, almost thirty minutes after she broke in two, the blades were still spinning.

According to the narrative of the seamen, the Oklahoma, which was running light from here to Port Arthur, Tex., was picked up at either end by giant waves. While she hung thus suspended, a third great comber washed high over her side and settled with a deadening crash on her deck. The strain was more than the vessel could bear. Like a frail wooden bridge beneath a heavily loaded truck the Oklahoma sagged, cracked and broke into two.

The Oklahoma was owned by the Gulf Refining Company, of New York City.

MESSAGE TO EXPLORER MACMILLAN IN THE FAR NORTH

Through the Arctic regions on the night of December 24 last, a wireless message from the sponsors of the Crocker Land expedition sped to its leader, Donald B. MacMillan, and his companions, at Etah, Greenland, 1,600 miles away. It was a Christmas message from the American Museum of Natural History, the American Geographical Society and the University of Illinois, and was signed by Dr. Edmund O. Hovey, of the Museum, director of the expedition.

It was looked on as a good gamble that it would reach its source, and though the wireless outfit of the party is expected to have caught it, it is not powerful enough to send an answer, which is tantalizing to those who want to know about the expedition.

The message to MacMillan was sent to G. J. Desbarats, Deputy Minister of the Naval Service at Ottawa, and then forwarded to the wireless station at Fogo, Newfoundland, for its leap of 1,600 miles to Etah. It reads as follows:

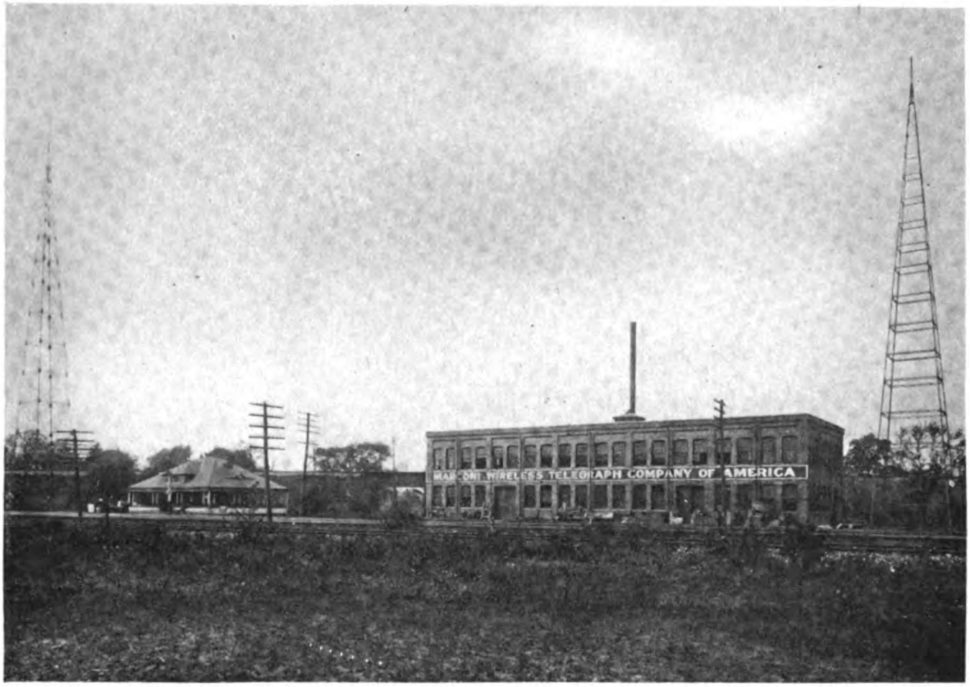
"Heartiest greetings and best wishes from Museum, Geographical Society and University of Illinois, and from family and personal friends of yourself and all your party. We are well and are confident of your success in spite of all difficulties, though no word from you has come through yet. "E. O. HOVEY."


Donald B. MacMillan

"We were encouraged by the reports of Roy Andrews, a Museum explorer," said Professor Henry Fairfield Osborn, president of the Museum, "to send a wireless message to the expedition, because Mr. Andrews, who was on the Adventuress in the Arctic last summer, was enabled to get even baseball scores by wireless, while not being able to send any long distance messages. We hope the message will reach its destination."

"We believe the wireless outfit at Etah is unable to get into communication," Dr. Hovey said, "but it will be able to take the message sent to it. The Canadian Government has arranged, however, to stand by every Tuesday evening from 10 to 11 p. m. for signals from Etah. When a station is established at Port Nelson, it will be possible, I am sure, for the Etah station to get in touch with us."

Another wireless communication containing messages from the members of Mr. MacMillan's family and personal friends was sent to the explorer on December 31.



Where the Wireless Sets are Made

A MOST interesting detail that strikes one who for the first time is surveying the manufacturing end of the wireless business is that practically all the American apparatus in commercial operation is made under one roof. This unique and enviable trade situation was brought about less than two years ago with the purchase by the Marconi Company of the assets of its only formidable rival and the establishment of a manufacturing plant at Aldene, N. J. At the time it was considered that generous allowance had been made for increased production as the business progressed, but so rapid has been the extension of commercial wireless telegraphy it has been necessary to run the factory continuously, day and night, for months at a time.

The location of the factory at Aldene was influenced by convenience to the New York headquarters, exceptional shipping facilities and ideal hygenic conditions. Its situation also permitted the erection of an aerial of no mean proportions, and the factory has been equipped to make exhaustive tests of new apparatus under actual working conditions, thus eliminating all chance of future breakdown. Perfect lighting arrangements were another important consideration, and no effort has been spared to provide sanitary and healthful quarters for the several hundred employees.

The building has been arranged with a view to greatest efficiency and economy of space; it is "L" shaped, with a floor area of 20,000 square feet. The testing department, transformer room, plating room, two large stock rooms and the power plant are located on the first floor.

The second floor contains the machine shop, tool rooms, research laboratory and the factory offices.

Ample protection is at hand in case of fire; the company maintains its own fire department with a full equipment of fire-fighting apparatus, and the two separate companies are given a fire drill twice a month.

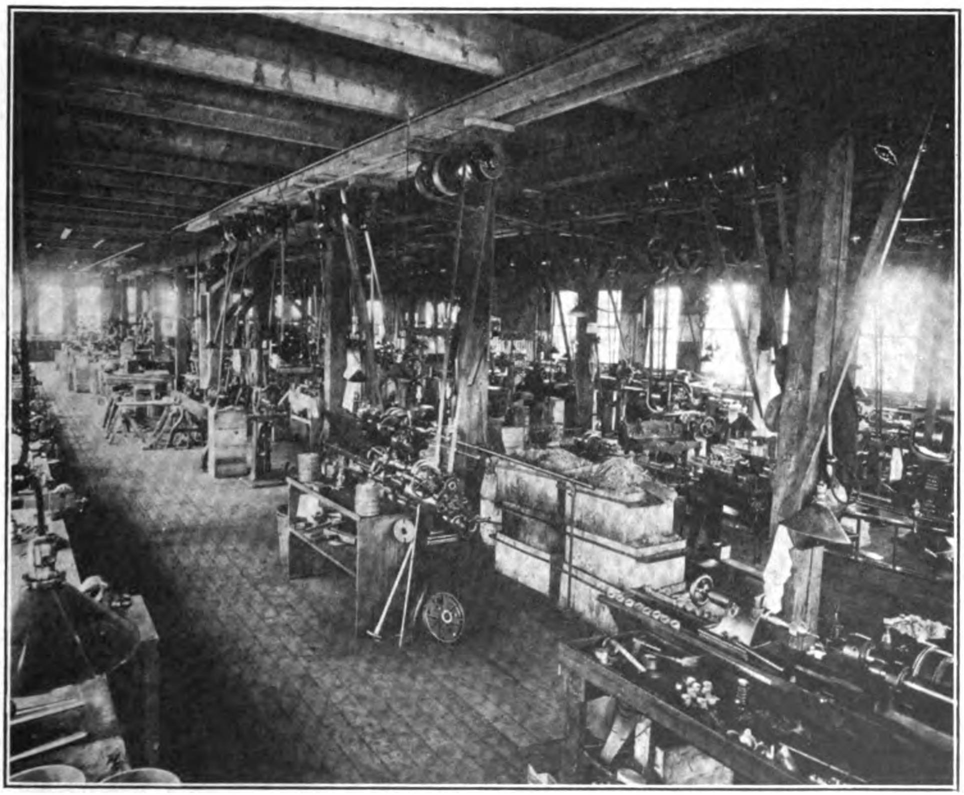
That the Marconi Company is engaged in the manufacture of wireless apparatus on a large scale is clearly indicated in the photograph showing a general view of a portion of the machine shop. Nearly a hundred different types and styles of machines are installed, and it is here that the numberless parts which go to make up the complete apparatus are machined and prepared for the various assembly departments.

The machine shop is in charge of a skilled foreman, whose extensive experience has given him an intimate acquaintance with the mechanical details of radio apparatus, and the specific work assigned to each man is closely followed to its completion under a new and comprehensive checking system.

Not all machine work is completed in this department. The more intricate parts of an equipment are turned out on milling machines, which cut, shape and form parts of irregular form and design. One of the photographs gives a general view of this department, and the trained mechanic will recognize it as being completely equipped and modern in every detail.

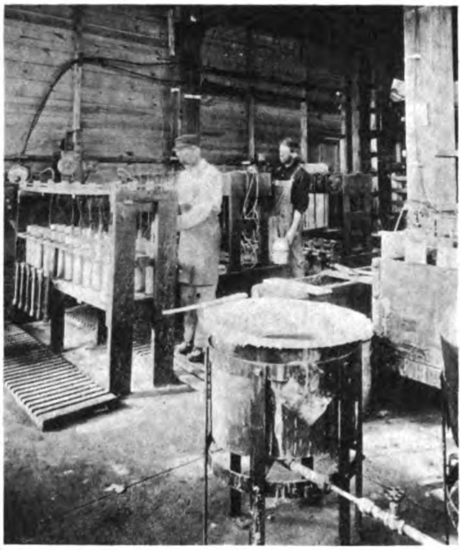
No manufacturing establishment would be complete without its precision department, and one of the rows of precision lathes is shown in a view of this department. It is here that those parts are made which require almost microscopically accurate machining, and are of too delicate a nature to be handled in the machine shop proper. The mechanics of this department are especially picked for their skill, and accuracy to the one thousandth part of an inch is part of their everyday work.

One of the most interesting features of the plant is its transformer department, in the photograph of which may be seen transformers in all stages of construction. Constituting a very important factor in wireless transmitting



A General View of the Machine Shop, Containing Nearly a Hundred Different Styles and Types of Machines apparatus, the windings of this device consist of many thousand feet of very fine wire, wound and formed into "pancake" coils. After winding they are stacked up in sections, taped with linen and impregnated with a high-insulating compound. This is done under vacuum requiring apparatus of special construction and manufacture, peculiar to the Marconi Company.

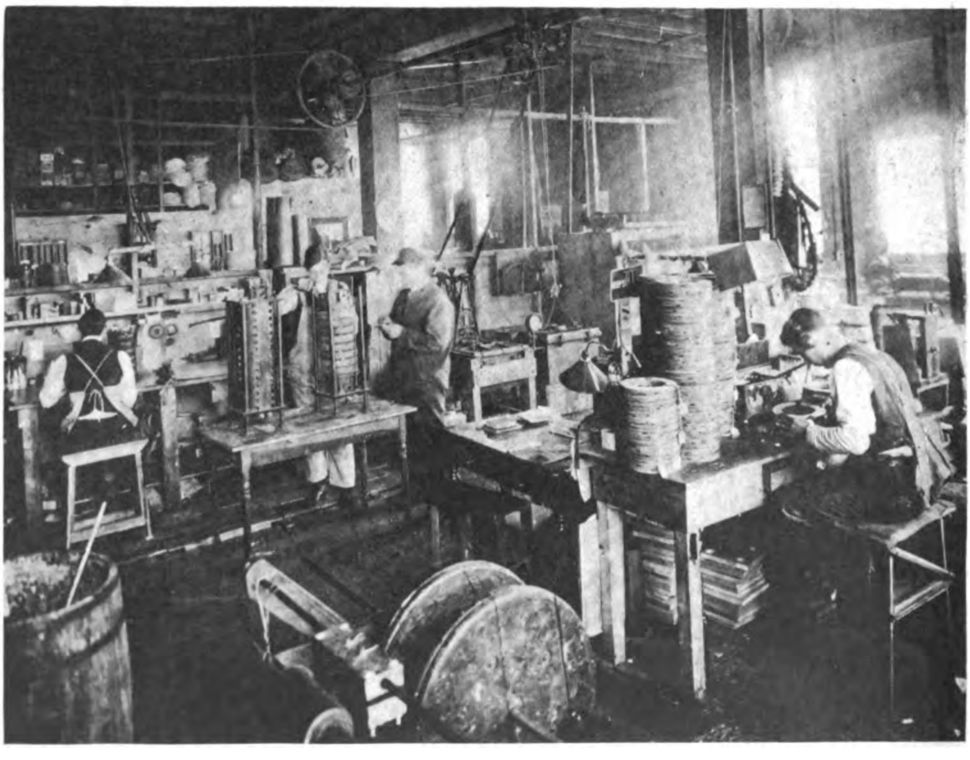
After the coils are passed through this process, they are baked in the special oven shown in the photograph for several hours at a very high temperature, making them strong electrically and mechanically.



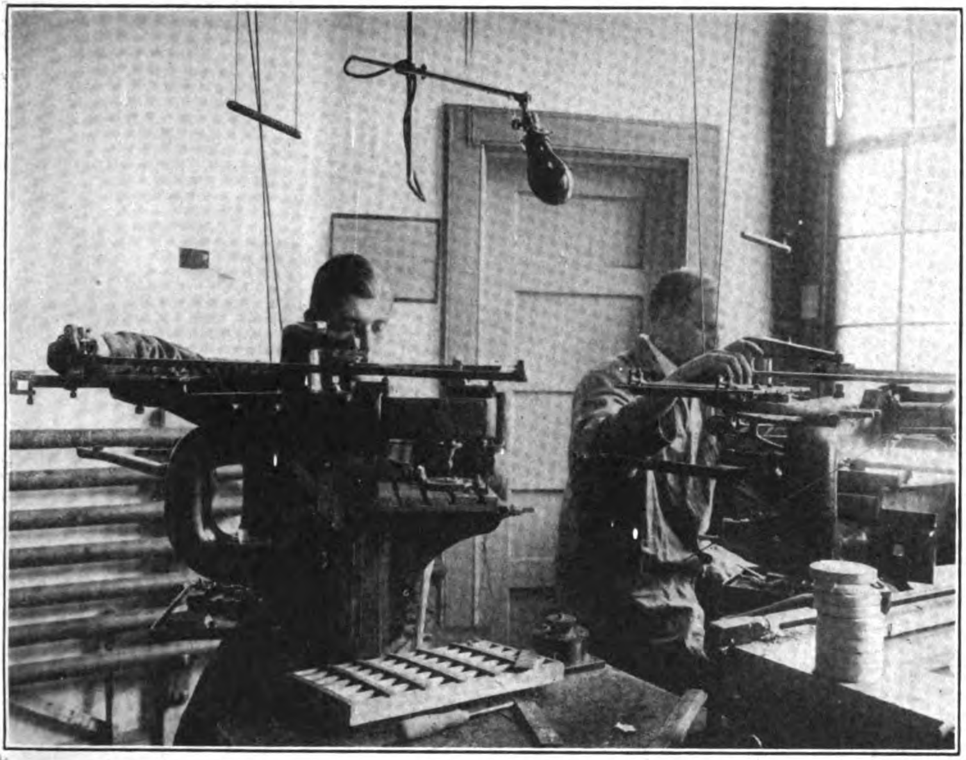
The Plating Room, where the Glass Condenser Jars are Copper-Plated Inside and Outside

The machine for winding the coils is also shown in the photograph (center), and to the right an employee is making an electrical test of one of the "pancakes" for any break which may have occurred. To the left of the picture is shown a transformer in process of assembly.

The power or electric light engineer will find many things of interest in this photograph, as the construction of these dry, high-po-



Where the transformers are built. In the center of the room may be seen the winding machines, on which are wound the small pancake coils. After being submerged in a tank of compound the coils are baked in a large oven, making them electrically and mechanically strong.

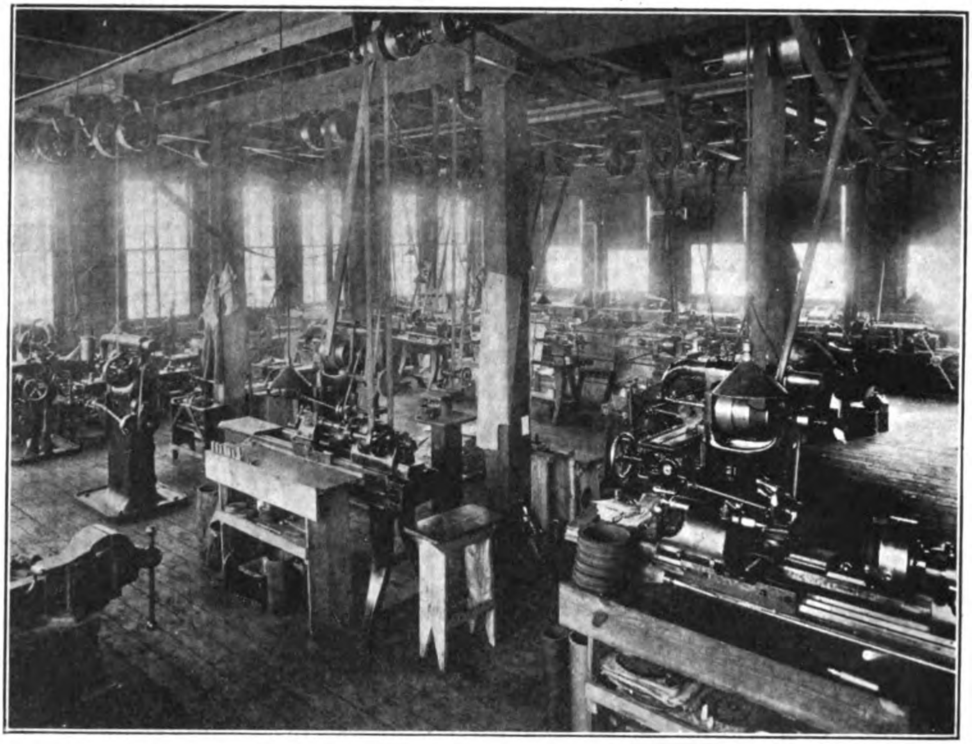


Many of the instruments require special markings, figures, letters and scales. Such work is done in the engraving department, on special machines of the pantograph type.

tential transformers has always been more or less a mystery.

In another view is shown the electroplating room, where glass jars are electrically coated inside and outside with copper to the thickness of one hundredth part of an inch. When completed, the jars are known in wireless telegraph language as condensers or leyden jars, and are one of the essential features in the production of wireless telegraph waves.

In this room all the apparatus is tested and inspected by a corps of experienced men.



Above, a general view of the milling department, showing the large and small-sized machines. Below, a row of small precision lathes on which the small parts of the instruments are made.

Many of the instruments comprising a wireless equipment require special markings, figures, letters and scales, which facilitate the operation of the apparatus in commercial practice. Such work is done in the engraving department, a portion of which is included in the picture, showing two of the engravers at work.

Special engraving machines of the pantograph type are employed, permitting the work to be done rapidly and with unfailing accuracy.

passed through all departments, it is placed in the various stock rooms. All orders for material to be shipped are turned over to the ever-active shipping and packing department. This department draws orders for equipment on the various stockrooms, and many thousands of dollars' worth of equipment material pass through it each month. The packing and shipping department is located adjacent to the private railroad siding, allowing material to be directly loaded on the cars.

Orders for material to be shipped are turned over to the shipping department, through which many thousands of dollars' worth of equipment material pass daily.

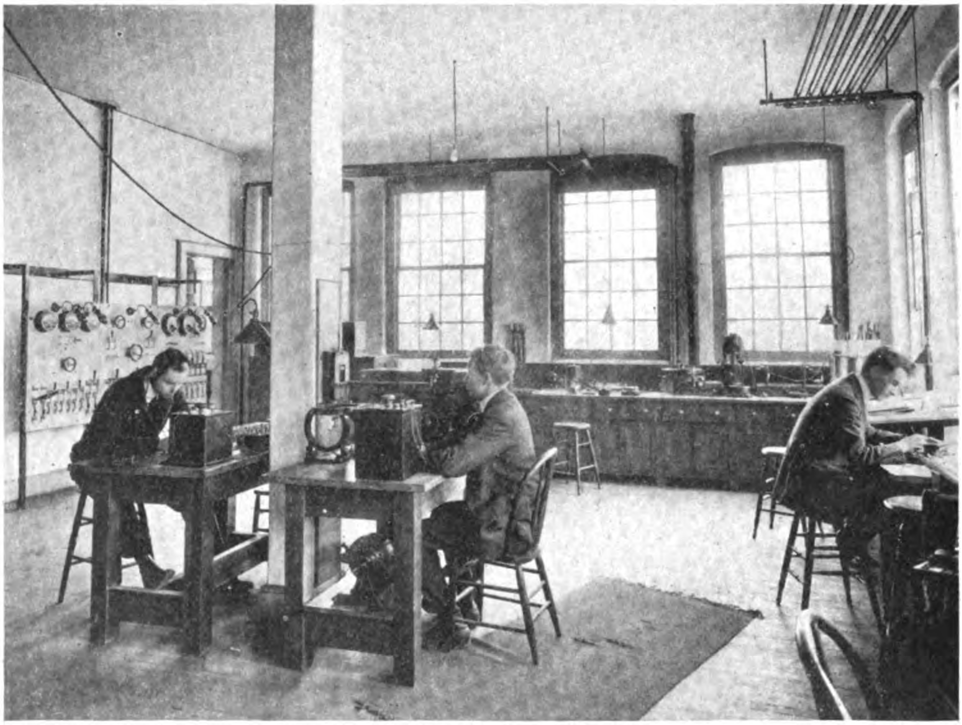
No apparatus is placed in stock or shipped until it has undergone thorough inspection at the hands of the corps of experienced men. A partial view of the testing department is represented, showing various types of radio equipment previous to the exhaustive tests for efficiency and possible flaws.

This photograph shows some of the higher power wireless equipments on the floor previous to subjection to a series of practical tests. The results are carefully noted, and should any defects appear the apparatus is returned to the shops for correction of faults.

After the radio equipment has

Of especial interest to our scientific readers, the photograph of the private research laboratory, operated under the guidance of the company's research engineer, shows where the original investigations are made, new ideas developed and new apparatus evolved. This laboratory is equipped with electrical instruments of such extreme precision that experiments may be conducted with absolute accuracy. Wave meters and special tuners are also calibrated in this department.

To the left of the photograph may be seen a large switch board, through which electricity is available at a pressure of 100 volts D. C., 100 volts, 60



The research laboratory, operated under the guidance of the company's research engineer, where the original investigations are made and new apparatus evolved.

cycle A. C., 500 volts D. C., 220 volts, 240 cycle A. C., 110 volts, 120 cycles A. C., and an extremely high frequency generator giving 300 volts at a frequency of 100,000 cycles. The department is thus fully equipped to carry on experiments with transmitting apparatus over a wide range of frequencies and voltages, insuring the efficiency of the factory's product.

THE SHARE MARKET

NEW YORK, January 22.

As predicted in the January issue, the upward turn in the stock market began a few days ago, and to-day securities have been carried forward with as much vigor as at any time since the beginning of the improvement now under way.

The advance, of course, has induced much profit taking with the professional traders, but this selling has not seemed to check the forward impulse. Many held the view that the rise had been proceeding at a too unusual pace, and its continuance could not confidently be looked upon, therefore the steadiness of the advance is all the more noteworthy.

The long-looked-for change in sentiment had its effect on Marconis, but for some reason unexplicable to the brokers, Canadians have not profited by the upward trend of the market, although English and American issues advanced several points.

Bid and asked prices to-day:

American, 5¼—5⅜; Canadian, 2—2⅜; English, common, 19—20½; English, preferred, 15—17½.

The Engineering Measurements of Radio Telegraphy

By ALFRED N. GOLDSMITH, Ph.D.
Instructor in Radio Engineering, the College of the City of New York

ARTICLE V

A recent classification of alternating currents as forced and free is explained by the author in the article published in this issue. The various types of discharges in arcs and spark gaps are considered, the types of discharge being properly classified. The conditions of production of each of these types of discharge and the efficiency obtained are given. The modern Poulsen arc is considered in detail, together with its conditions of highest efficiency and ease of manipulation. A novel method of obtaining a steady flow of energy at wave lengths between 250 and 1,000 meters wave length by means of the arc is shown, and the larger arcs are described in construction and operation. The measurement of capacity at radio frequencies and moderate voltages, using forced alternating currents, is then discussed by the author.

IN the measurements so far considered we have employed radio frequency oscillations which may be called "free alternating currents." These have been referred to as "damped oscillations," but the newer term is preferable because it conveys the correct impression, namely, that the electromagnetic energy stored in its circuit becomes transformed into heat, radiated waves, or other forms of energy. It is, accordingly, one which is left to decay *freely*. We have produced such free alternating currents by means of buzzer or spark excitation circuits.

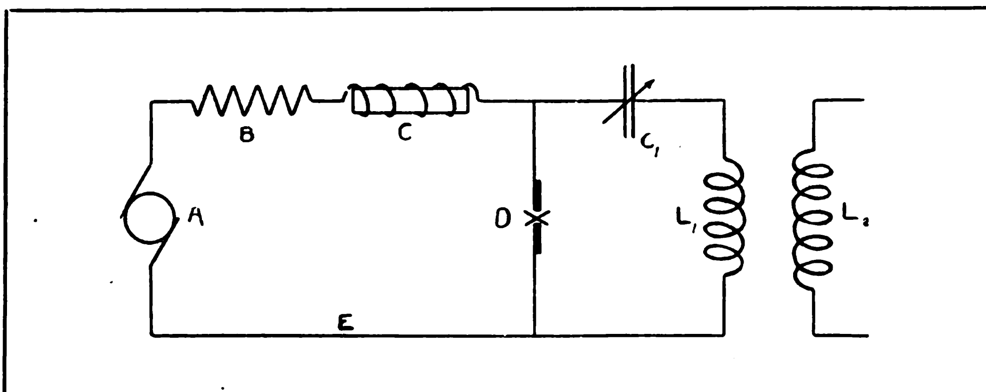


Fig. 23

we have an alternating current which is *not* being maintained by energy supplied from some other source, but one which is gradually diminishing in amplitude as

We propose now to employ an alternating current of constant amplitude. An alternating current of this description requires that energy shall be continually supplied to the circuit in which it flows to make up for the inevitable energy dissipation. We shall therefore call it a

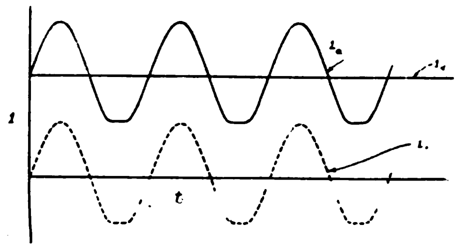


Fig. 24

"forced alternating current." It is quite easy to secure such forced alternating currents at audio frequencies, the ordinary alternator being an example of the appropriate form of generator. When radio frequencies of 20,000 cycles per second and beyond are required, the problem of obtaining such a current becomes difficult. It is hardly to be expected that such apparatus as the Alexanderson high-speed radio frequency alternator, or the Goldschmidt "reflector type" alternator, or the Arco audio frequency alternator with frequency transformers to bring the energy to radio frequencies, or any of the similar pieces of commercial apparatus, may be found in the laboratory equipment of the ordinary experimenter at the present time. We shall therefore confine ourselves in the detailed description of apparatus to the simplest available means of producing forced alternating currents of radio frequencies, namely, the Poulsen arc. Its construction, practical manipulation, and a valuable method of obtaining relatively short waves by its use will be considered.

We shall, however, first consider the phenomena produced by gap dischargers arranged as in Fig. 23. In this diagram, A is a direct current generator (generally of voltage between 200 and 1,000 volts), D the gap discharger, B a regulating resistance for controlling the flow of current through D, C a choke coil or reactor designed to steady the direct current flowing through D and also to prevent any radio frequency alternating current from flowing back into the generator, A. In some cases it is of advantage to place a second choke coil in the branch, E, of the supply circuit.

Shunted across the discharger is the circuit L_1 C_1. It is coupled inductively with L_2, thereby enabling any radio frequency energy to be transferred from L_1 C_1 to the energy absorbers connected to L_2. Following the usage recommended in the Preliminary Report of the Committee on Standardization, Proceedings of the Institute of Radio Engineers, Vol. 1, No. 4, December, 1913, we may call D an "arc converter," inasmuch as it is an arc used for converting direct to alternating or pulsating current. Arcs like this are divided into three classes, which we shall consider in order. The direct current referred to is that supplied by the generator, A, and the alternating current is that flowing in the circuit, L_1 C_1.

Type (1).—Those for which the amplitude of the (approximately) sinusoidal alternating current produced is less than that of the direct current. If we call the direct current i_d, and the current through the arc i_a. Fig. 24 shows the current curves plotted against time. It will be seen that i_a, the arc current, is the sum of the direct current supplied to the arc and the alternating (nearly sinusoidal) current flowing in the shunt circuit L_1 C_1. The arc current never reaches the value zero, as is also clear from the figure, because the amplitude of the alternating

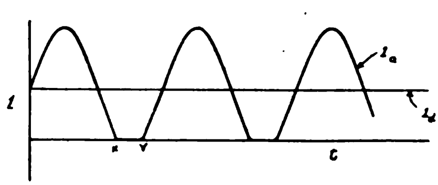


Fig. 25

current is less than that of the direct current. To produce currents of Type (1), the resistance and inductance in the direct current supply circuit must be large, the current through the arc small, and the effective resistance of the circuit, L_1 C_1, small. This last condition is in part equivalent to the statement that no circuit capable of absorbing *considerable* energy may be closely coupled to the circuit L_1 C_1.

The currents of this type being nearly sinusoidal are capable of giving very

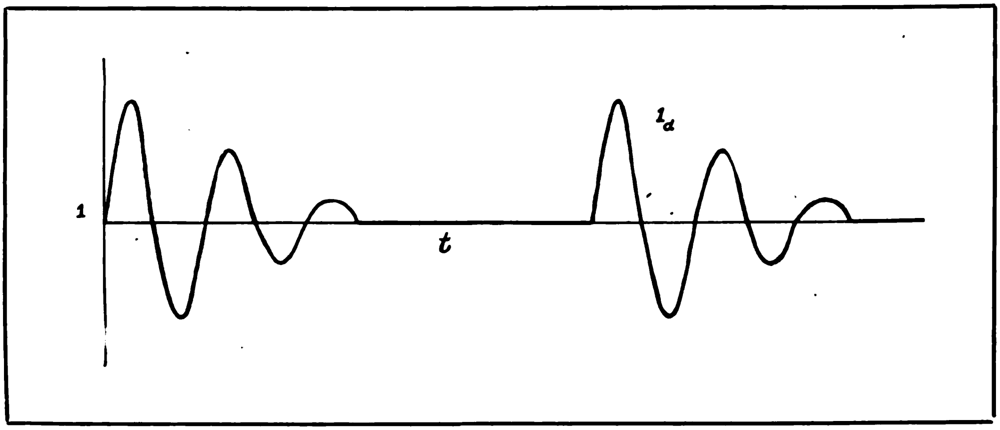


Fig. 26

sharp resonance effects, and may be useful in measuring work, and (rarely) for short range radio telephony. They are generally very steady and fairly constant in amplitude. However, as can be seen from the conditions of their production, only a very limited amount of energy can be thus obtained, and the efficiency of the whole arrangement may be as low as 5 or 10 per cent.

Type (2).—Those in which the amplitude of the (approximately) sinusoidal current is at least equal to that of the direct current, but in which the direction of the current is never reversed. These conditions are illustrated in Fig. 25. It is obvious that during the time represented by the space, XY, the arc is extinguished. During this time the voltage across the condenser, C_1, is gradually rising, until at Y its value is sufficient to cause the arc to start again. It is clear that, whereas in Type (1) the frequency of the alternating current produced is very approximately what would be expected in a circuit of the constants, L_1 and C_1, in the case of Type (2) this is not the case. For we must consider in this case that the supply circuit is capable of charging the condenser, C_1, at a limited rate, and that the period between successive pulses of current through the arc may be considerable. In fact, the period in question is very markedly affected by the length of the arc and the corresponding arc voltage.

In order to produce currents of Type (2), the supply current must be somewhat increased, and arrangements for absorbing a greater quantity of alternating current energy in the circuit connected to L_2 should be made. In addition, and this is a particularly important feature if considerable energy is to be drawn from the arc, special means are required to cool the arc powerfully, thus diminishing ionisation and consequent conductivity in the arc as much as possible. The means of cooling employed are very diverse. Some of them follow:

(a) The use of metallic electrodes, *e. g.*, copper, silver, aluminum.

(b) The use of an atmosphere of a gas of high cooling power, *e. g.*, hydrogen, alcohol, steam, moist hydrogen. Also rapid gas streams.

(c) The use of rotating electrodes.

(d) The use of powerful magnetic fields to quench the arc rapidly.

(e) Water or air cooling of the electrodes.

In addition, the arc discharge is sometimes divided so that several dischargers in series are employed, thus limiting the heating in each.

It may be immediately stated that the type of alternating currents used in practical radio telephony is almost always Type (2). This is because the energy which can thus be obtained is quite considerable. Ten or twenty kilowatts *actual output* seems to be somewhere near the upper limit at present. The efficiency of the arrangement is generally about 15 per cent, but under favorable conditions may rise to 20 per cent. or

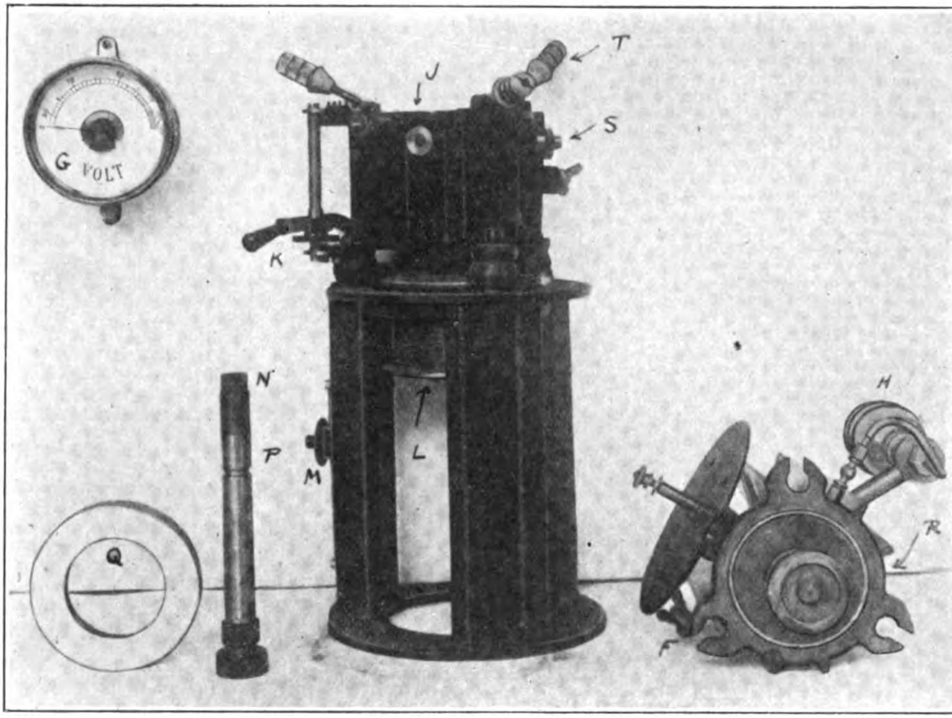


Fig. 27

even more. To realize the highest efficiency, it is desirable to reduce the control resistance, B, to a minimum, and this can be accomplished to a certain extent by the use of a generator, A, of proper characteristic, somewhat on the plan of the old Thomson-Houston arc light dynamos. The practical details and operation of these arcs are given further on in this article.

Type (3).—Those in which the amplitude of the initial portion of the free alternating current is greater than the direct current passing through the converter, and in which the direction of flow of the current is periodically reversed.

The arc current for this case is shown in Fig. 26. It will be seen that each train or group is separated from the next by a period during which no current passed through the gap. Generally speaking, alternating currents of this type are produced when the natural damping of the gap discharger (due to the rapidity of de-ionisation and loss of conductivity) is less than that required to produce alternating currents of Type (2). Discharges of this type are obtained in ordinary spark gaps, and usually in quenched spark gaps as well. The period of the current produced is very closely that to be expected in such a circuit as L_1 C_1, unless the damping of the gap is very high, in which case the frequency may be somewhat diminished. Currents of Type (2), and to a smaller extent those of Type (3) are capable of producing "impulse excitation" in the secondary circuit connected to L_2. That is, even if the period of the latter circuit is slightly different from that of the circuit, L_1 C_1, it is possible to excite in the latter circuit alternating currents of appreciably the period and damping which are natural to the latter circuit. This is a very valuable method for producing slightly damped free alternating currents for radio telegraphy, because by this method the reaction of the secondary circuit on the primary circuit, L_1 C_1, is, in effect, eliminated. Currents of very low damping, capable of yielding sharp resonance effects, can be thus obtained.

We pass now to a consideration of the

actual apparatus and methods of operation for the more important of these types of current, namely, Types (2) and (3).

Section 15.—THE POULSEN ARC. Essentially the Poulsen arc consists of an arc between a carbon electrode and a copper electrode, the copper electrode being connected to the positive side of a direct current line and the carbon to the negative side. It is usually not practical to run such an arc on 110 volts, because the drop across the arc (which may be from 70 to 120 volts in the smaller arcs with weak magnetic fields or no field at all) is too large a portion of the total voltage, and the regulating resistance cannot function properly to keep the arc current reasonably constant. The arc will flicker badly, and accurate work will be impossible. For arcs using up to about 2 kilowatts, supply energy of 220 to 250 volts may be used with satisfaction. For greater inputs, it is advisable to use 500 to 600 volts, or even 1,000 volts in the arcs absorbing 25 kilowatts or more. We shall consider first a small arc which is very useful for measuring purposes and radio telephony, being rather steadier in operation than the larger models. The arc in question, which is shown in Figs. 27, 28 and 30, is intended for an input of about 500 watts. The maximum steady output is from 30 to 50 watts.

Such an arc can be used at wave lengths from 1,000 meters *up* only, as it does not work at all well at lower wave lengths. However, by an ingenious arrangement which will be given, it is possible to draw a steady supply of energy at wave lengths as low as 250 meters from this type of arc. The regulating resistance, B, should be variable between about 30 and 150 ohms and capable of carrying about 5 amperes. It can be conveniently made of a lamp board rheostat, the resistance being readily varied by altering the number of lamps which are placed in *parallel* on the board. The choke coil, C, is of no great importance in the case of this small arc, the inductance of the line and generator being generally sufficiently high to prevent the radio frequency currents from "backing up" into the generator.

The arc itself is shown disassembled in Fig. 27. Here G is an 0-150 volt voltmeter, which is placed directly across the arc, and shows when the arc is burning steadily. P is the carbon electrode holder, consisting of an insulating (fiber) handle, an iron rod, P, and the copper springy holder of the carbon, N. P fits into the center of the coil, L, which produces a magnetic field, the lines of force of which run up the rod, P, and then spread outward radially to the iron ring surrounding the copper electrode, R. The coil, L, and the regulating resistance, M, are placed in series across the supply line. The radial magnetic field thus produced is not a powerful one, and its sole function is to cause the arc to rotate slowly to fresh points on the electrodes, thus causing even wearing. It does not act as a powerful "blow-out." K is the handle which, when lifted, raises P into contact with R, thereby starting the arc. The arc length may be conveniently regulated by the small fiber hand wheel just below K. J is a peep-hole covered with mica for viewing the arc in operation, and S is a poppet spring valve for releasing the excessive

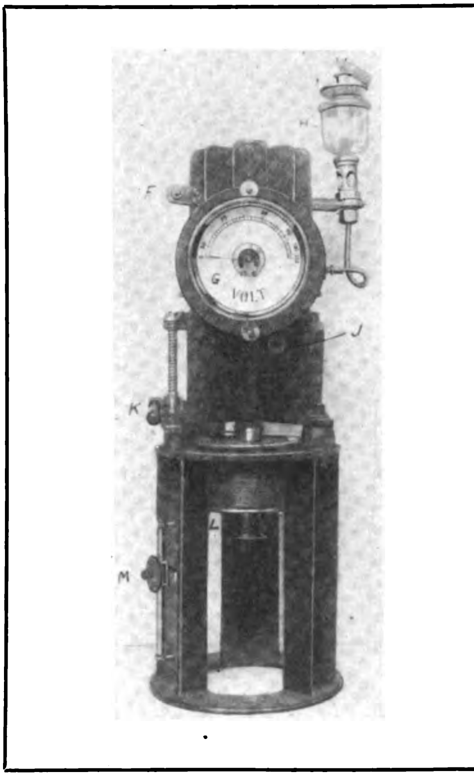


Fig. 28

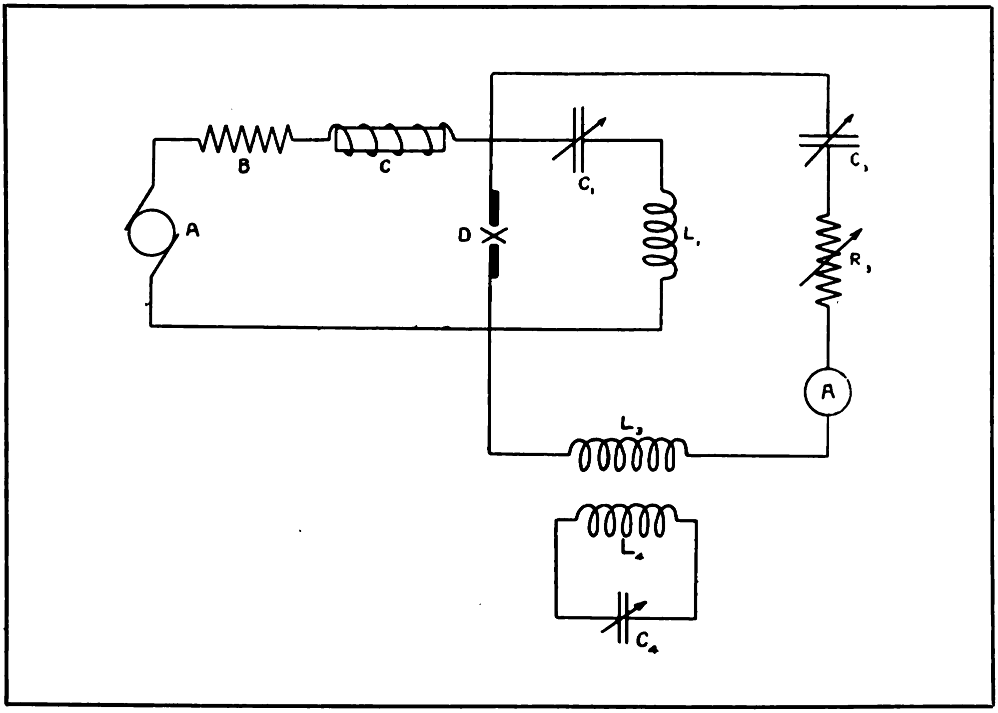


Fig. 29

pressure resulting from the explosion of the alcohol-air mixture when the arc is first struck. This valve is strictly necessary, and is provided in duplicate on each arc. T represents the screw clamps with lava insulating bushings, which hold the upper portion of the arc firmly in place on Q, a plaster of Paris separator faced with asbestos.

The upper part of the arc is shown to the right. H is the alcohol sight-feed cup, and a pipe which leads to a small hole in the center of the copper electrode, R. The iron rim of the copper electrode is visible. F, the binding post of the copper electrode, and the supporting face plate for the voltmeter can also be seen. The carbons used have a hollowed center with a small hole drilled outward and obliquely downward, thus providing for draining away excess alcohol. In Fig. 28 the arc is shown assembled. The cooling vanes on the arc will be seen. It may be mentioned that the carbons are about 0.5 inch (1.2 cm.) in diameter, and that the copper electrode is about 1.5 inch (4 cm.) in diameter to the iron rim. The arc operates in an atmosphere of alcohol vapor, about one drop being fed into the arc every 30 seconds. Denatured ("Pyro") alcohol is suitable, but the interior of the arc chamber requires cleaning less frequently if pure 95 per cent ethyl alcohol is used.

The capacity C_1 (Fig. 23) may appropriately be a variable oil condenser of range up to 0.002 or 0.003 microfarad. With an inductance of about 0.0009 henry for L_1, the usual range of wave lengths will be from about 1,500 to 2,200 meters. Inductances as small as 0.0003 henry can be used at L. Usually the direct current through the arc will be about 2 amperes and the current in L_1 C_1 from 1 to 2 amperes. The current in the circuit coupled to L_1 will, of course, depend on the resistance and other constants of that circuit as well as the closeness of coupling. In coupling it to L_1 it is convenient to start with a loose coupling and gradually make the coupling closer. It will be found that at a certain point the reaction of the secondary circuit on the primary circuit, L_1 C_1, and on the arc is sufficient to extinguish the arc, or at least to stop the production of alternating

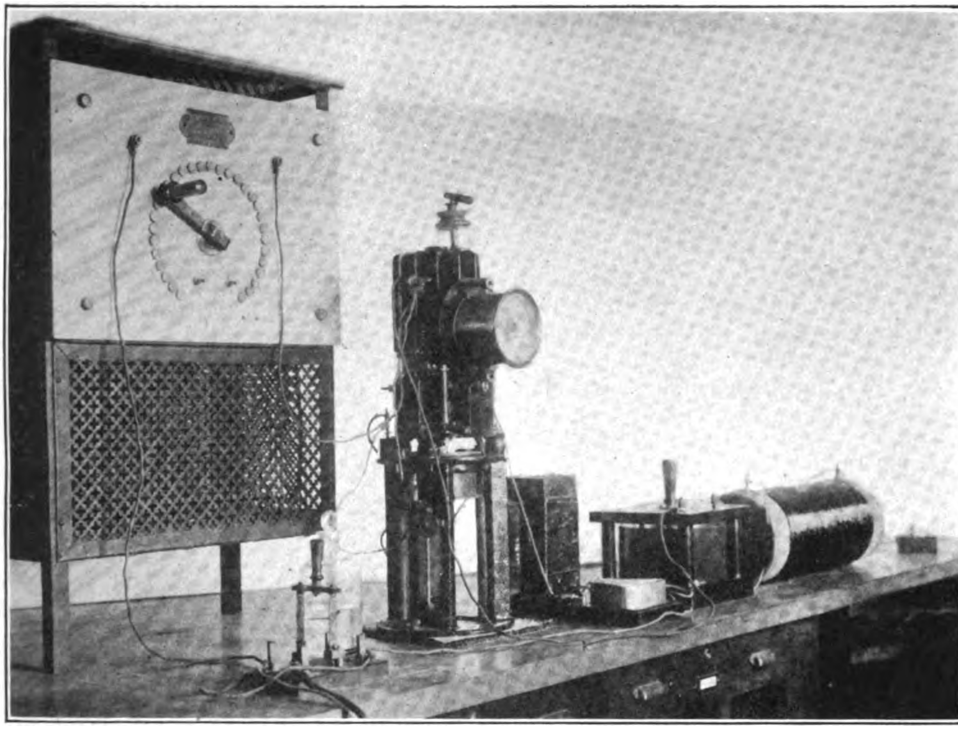


Fig. 30

current. This critical coupling marks the limit of available energy. It will also be noticed that as the coupling is increased, the voltage of the arc itself increases, rising as much as 50 or 60 volts at times.

Section 15A.—SHORT WAVE LENGTHS WITH THE POULSEN ARC. (Triple Frequency Method.) As Professor Zenneck pointed out some time ago, there is a tendency toward the formation of currents of three times the fundamental frequency in arc converters. Mr. Lester Israel has very kindly placed at my disposal his data obtained in the City College Radio Laboratory relative to the utilization of these triple frequency currents. The arrangement of circuits used is shown in Fig. 29. The arc, D, is shunted by two circuits, L_1 C_1 and L_3 C_3. The latter is to be adjusted to a wave length exactly one-third that of the former. That is, L_3 C_3 may be tuned to a range of wave lengths from 250 to 1,000 meters, and energy at those wave lengths drawn in the circuit, L_4 C_4, which must naturally be tuned to the corresponding frequency. It is found in practice that the best ratio of C_1 to C_3 is about 5 to 1. For purposes of observation, it is desirable to place an ammeter in the circuit L_3 C_3. The resistance R_3 *must* be inserted in the latter circuit for steady operation, and its value must be appropriate. A resistance of this description is best made of bare wire wound nearly non-inductively on ordinary porcelain knobs fastened to a supporting wooden base. The value of R_3 is from 3 to 5 ohms.

The effect of this resistance is to make the value of the alternating current in L_3 C_3 nearly independent of that in L_1 C_1. It is found that with the above-mentioned value of R_3, the current in L_3 C_3 is a *forced* current of triple frequency, and the tuning can be most readily accomplished by bringing L_1 C_1 to exactly the fundamental frequency. Variation of the wave length of L_3 C_3 within a range of about 10 per cent by tuning will merely change the current value in that circuit; beyond that change the triple frequency current disappears. If the resistance, R_3, be increased beyond 5 or 7 ohms, the circuit, L_3 C_3, draws too much energy, and the arc is extinguished. For best operation the circuit, L_1 C_1, should be so constructed as to have a minimum resistance, say not more than 1 or 2 ohms. Two alternative methods of procedure are suggested for manipulating this arrangement.

Method A.—(1) Tune the circuit, L_3 C_3, to the desired frequency, namely, that of the circuit, L_4 C_4. Place about 5 ohms in circuit L_3 C_3. (2) Tune circuit L_1 C_1 to a wave length three times that of the circuits mentioned. (3) In case the arc is extinguished (when the circuits are properly tuned), R_3 should be gradually reduced or the ratio of C_1 to C_3 increased.

Method B.—(1) Circuit L_3 C_3 is to be tuned to approximately the period of circuit L_4 C_4. (2) Tune circuit L_1 C_1 to approximately three times the wave length of circuit L_3 C_3, and continue this tuning until the current in circuit L_4 C_4 is a maximum. (3) Tune circuit L_3 C_3 further to increase the current in L_4 C_4 still more if possible.

It is of interest that, if the voltage across the Poulsen arc used in the ordinary and usual way were 60 volts, the best voltage across the arc when using this triple frequency method was found to be about 80 volts. Furthermore, when tuning to the triple frequency, the arc voltage tends to rise to about 90 or more. It is then generally of advantage to reduce the arc voltage to 80 by shortening the arc.

An entire assembly of the small Poulsen arc apparatus is shown in Fig. 30. The regulating resistance, B, is shown to the left, then the arc. Directly to the right of the arc are seen the choke coil, C, and an ammeter, which is in the direct current circuit. To the right, the variable oil condenser and the inductance, L_1, are visible. A useful adjunct is also shown, namely, a single turn of heavy copper wire bent into circular form, its terminals connected to a low voltage tungsten lamp. It is of great assistance in bringing the arc to proper adjustment. Tungsten lamps are preferable for this purpose because they begin to glow when only a small portion of their rated energy is supplied to them, and they will stand considerable momentary overloads without destruction.

In working with the Poulsen arc it must be admitted that the results obtained will depend very largely on the skill of the manipulator. Once the arc has been warmed up by the pasage of current through it for a few minutes and the alcohol has been vaporized, the adept operator will frequently start the alternating current very readily by adjusting B and C_1. The arc operates most steadily when no great amount of energy is drawn from it, a condition readily fulfilled in measuring work.

In Fig. 31 is shown a larger type of arc, capable of developing about 600

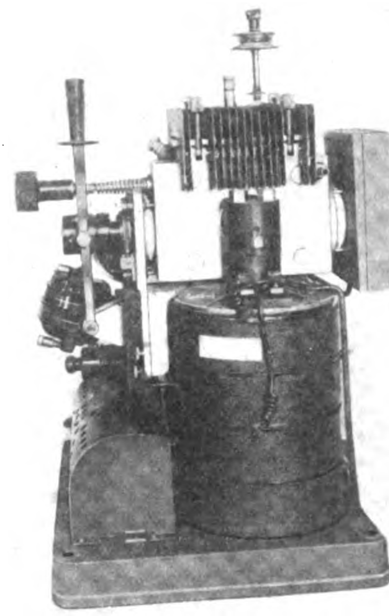


Fig. 31

watts radio frequency energy. It is characterized by an extremely powerful magnetic field across the arc, which may raise the arc voltage itself from 200 to 400 volts. The carbon electrode rotates by motor power. An arc of this type is intended for use on about 500 volts and 7 or 8 amperes. The field magnets are placed directly in series with the arc itself, thereby acting partly as resistance and partly as choke coils as well. Their ohmic resistance is 33 ohms in the arc shown. Two small supplementary *air-*

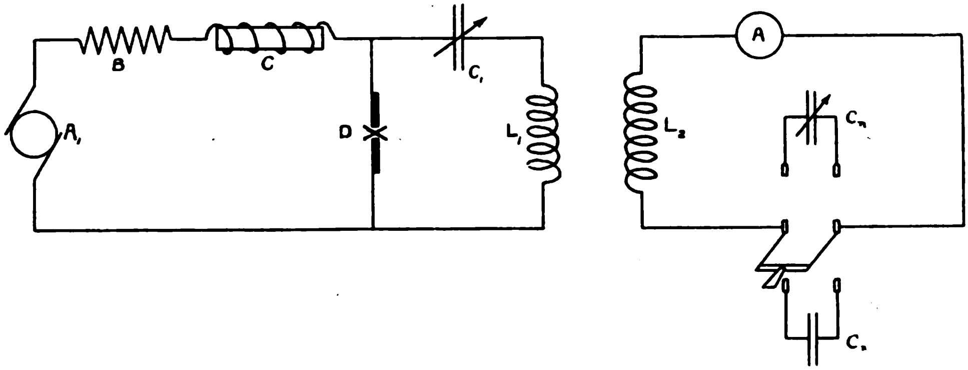


Fig. 32

core choke coils are provided in the direct current line. The distributed capacity of the bulky field magnet windings might permit the passage of some of the radio frequency energy were these air-core single layer choke coils not provided and the high voltage developed might then pierce the field magnet windings. The arc shown in Fig. 28 weighs about 15 kg. (35 lbs.); that of Fig. 31 about 150 kg. (350 lbs.). The larger arcs, because of the intense magnetic field in which they operate, never give quite as steady a flow of energy as the smaller arcs, and there are continued slight changes of wave length in the emitted energy which, in effect, introduce a small damping and diminution of the resonance effects as compared with a true forced alternating current of single frequency.

The condenser, C_1, must be designed for this work. It is to be noted that the voltage across the condenser may easily rise to two or three times the direct current line voltage. If the circuits are touched, the shock obtained is not particularly severe, but a disagreeable burn is produced unless the current-carrying wire is *firmly* grasped. The usual Tesla coil resonance effects and single wire lighting can be shown very beautifully on the larger arcs.

We shall defer the consideration of the Moretti arc, the Chaffee arc and the Scheller quenched spark gap for the present.

Section 16.—MEASUREMENT OF CAPACITY AT RADIO FREQUENCIES AND MODERATE VOLTAGES, USING THE UNDAMPED ALTERNATING CURRENTS. The method is identical in theory with that given in Section 9 of Article 2 of this series, with the exception that the "undamped" currents are used. Consider Fig. 32, which gives the circuit diagram for this method. As will be seen, the secondary circuit contains either the unknown condenser, C_x, or a variable known as condenser, C_n. In each case the circuit is brought to resonance, as indicated by the ammeter, A. To bring the circuits to resonance, it is convenient to vary L_2, C_1, or L_1. Obviously, under the conditions mentioned above, $C_x = C_n$.

If a telephone receiver is to be used as an indicator, a tikker must be added. The tikker is merely a make-and-break contact which intermittently connects the telephone to a large "storage" condenser placed in the circuit. The tikker contact is best made of gold wires, though a rotating wheel with a wire contact across it has also been successfully used by Dr. Austin. The coupling to the circuit, L_1 C_1, must naturally be very loose if the telephone is used, or the sound obtained will be excessively loud. The tikker is not recommended for this method because the ammeter far exceeds it in operating simplicity under these conditions, and practically equals it in accuracy. The accuracy of the experiment will be found to be 0.5 per cent without any unusual precautions. In fact, these "undamped" currents naturally lead to very accurate results, because of the sharpness of the resonance effects.

This is the fifth article by Dr. Goldsmith, in a series on the engineering measurements of radio telegraphy. The sixth will appear in an early issue.

French Radio-Phone Apparatus

By H. WINFIELD SECOR

THE accompanying illustrations show ingeniously constructed wireless telephone apparatus of French manufacture.

In Fig. 1 is pictured a novel form of arc generator for producing the undamped oscillaions. The power of this unit is sufficient to send radiophonic speech over a distance of 18 to 30 miles, depending upon the size of aerial may be utilized. Water is circulated about the positive electrodes, assisting cooling. The arc takes place under a powerful magnetic field, supplied by the electromagnet coils E, Fig. 2. The magnet coils are excited by an independent circuit taken from the potentiometer resistance R, at points R and C′. Hence the strength of current supplied the magnet coils is readily adjustable.

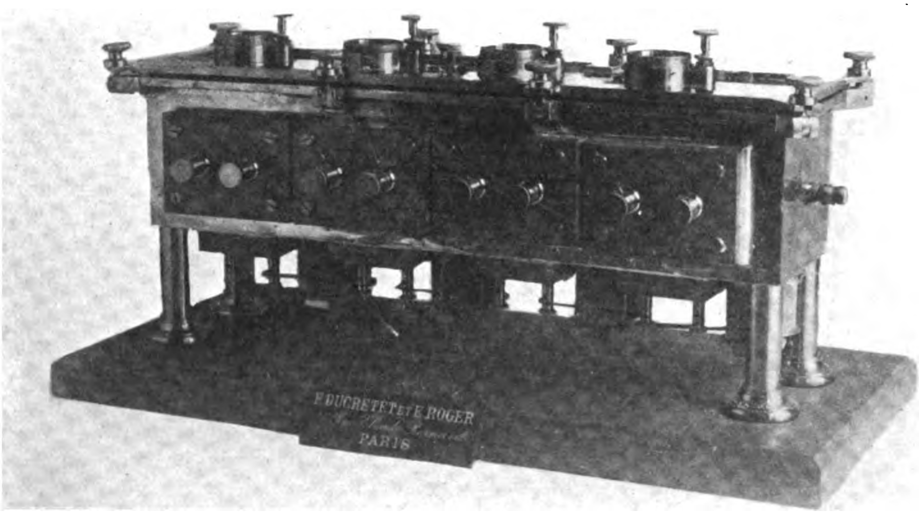


Fig. 1

employed and other physical conditions.

The arc is unique in several ways. It is composed of 4 individual arcs connected in series and is designed to be excited from 350 to 450 volts direct current circuit. The connections are clearly shown in the diagram, Fig. 2. The arcs are surrounded by gas chambers and hydrogen or illuminating gas

The arcs are provided with glass peep holes and safety valves to relieve the pressure, which sometimes reaches a high value in a short period of time. The ammeter A′ measures the quantity of current taken by the arcs. The amount of current may be varied by moving the slider C, on resistance coil R. Two choke coils are inserted in

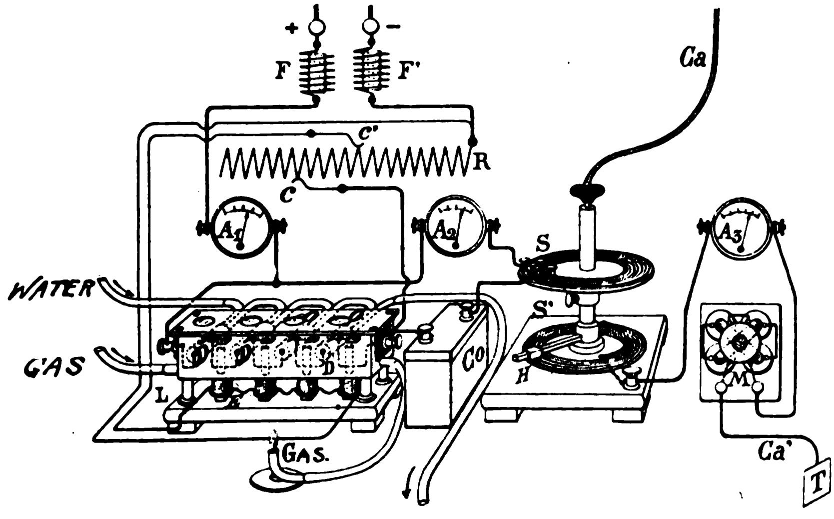


Fig. 2

series with the supply mains at F and F'. These prevent the high-frequency oscillations produced by the arc from surging back through the feed wires. A gas flame is lighted on an exhaust pipe taken from the arc chambers, tending to promote a good circulation of gas through and around the arcs.

The closed oscillating circuit shunted around the 4 arcs includes the high-potential condenser Co, hot wire ammeter A2, and the primary coil of an oscillation transformer S. Various numbers of primary turns may be used by attaching the lead wires to the different binding posts provided, as shown in Fig. 2. The co-efficient of coupling between the primary and secondary S' of the oscillation transformer is variable by raising or lowering the primary coil. It may be clamped in any desired position by a thumb screw. The coils or spirals of this transformer are of copper strip; a rotating arm is provided which permits of gradual variation of the inductance in use. The aerial is connected through the lead wire Ga to the upright metal standard of the oscillation transformer, which in turn is connected to the secondary contact arm already mentioned.

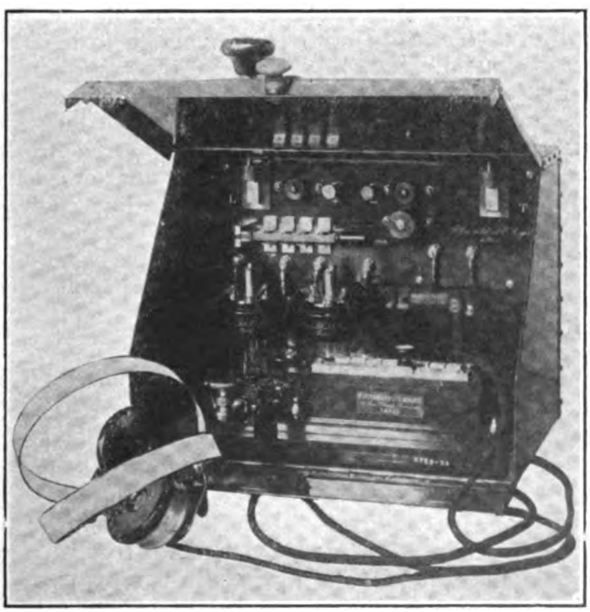


Fig. 3

The secondary of the transformer is connected in the aerial circuit; also the hot-wire ammeter A3, and the radiophone transmitter M, which consists of 4 microphones. The four separate transmitters are mounted horizontally on a wooden upright or frame, and their sound chambers joined together by equal lengths of metal tubing. A single mouth-piece terminates the four connecting tubes, and thus they are actuated simultaneously by the air-vibrations of the voice. The four microphones are usually connected in multiple, but are readily connected in series for other experiments.

The receiving apparatus is of the portable type (Fig. 3), and consists of two adjustable electrolytic detectors, aerial switch, potentiometer, switches and telephone receivers.

LOUISBURG STATION ON HISTORIC SITE

In order to handle the wireless traffic across the Atlantic, the Canadian Marconi Company has erected a new high-power station at Louisburg, N. S. This station, which is intended to work the duplex system in conjunction with those of the English Marconi Company at Letterfrack and Clifden, Ireland, is now in full operation.

Louisburg, which has a population of about 2,000, was at one time of little commercial importance except as a cod-fishing centre. In recent years, however, it has been developed to some extent by the Dominion Coal Company, which uses it as a winter port. The people of Louisburg assert that this port is the nearest harbor to Great Britain on the American continent, and are anxiously waiting for it to come into its own. The Sydney and Louisburg Railway, which serves the town, is a private line connecting with the Intercolonial and furnishing transportation facilities between the Louisburg wireless station and its power plant at Glace Bay.

The town was founded in 1715, receiving its name from Louis XIV. Under the French régime it was second only to Quebec and shares the distinction with that city of being a birthplace of French influence in Canada. In those days Louisburg was a place of gaiety, being the mecca of the elite in the French settlements. These conditions were, however, speedily changed when the town was lost to the French and the citizens were exposed to the attacks of their jealous neighbors in the British stronghold, Halifax.

The Louisburg fortress, which was built by the French, had great strength, and during the struggle for supremacy on the American continent between France and England it was the object of repeated attacks, resulting in frequent change of ownership. In 1745 it was captured by the American Colonists assisted by the English fleet, only to be surrendered again when peace was declared. The war was renewed, however, and Louisburg was lost by the French in 1758, when it was recaptured by a British land and sea force under General Amherst and Admiral Boscawen.

The only relics of the town's former greatness are in the ruins of the fortress. These make a striking contrast to that wonderful product of modern invention and industry—the wireless station—which has been erected within a stone's throw.

The station represents the last word in wireless high-power land equipment, embodying all the latest improvements in that branch of the art. It is the first station in the world to work with the duplex system, which permits the simultaneous transmission and reception of messages at the same operating house. An equally important invention utilized in the station is the automatic transmission device, by means of which it is possible to handle messages at the rate of 100 words a minute.

All the members of the operating staff of the Glace Bay Station have been transferred to Louisburg, where excellent quarters have been provided for them. The engineers, however, remained at Glace Bay, where the transmitting apparatus, which is operated from the Louisburg station, is located.

WIRELESS FOR HUERTA, SAYS A REPORT

It is reported that a wireless telegraph station will be erected in Mexico City to enable Provisional President Huerta to maintain communication with the Federal troops operating against the rebels in various parts of Mexico. General Huerta finds it necessary to use wireless telegraphy, as the ordinary telegraph wires are so frequently cut.

INSTRUCTION TO BOY SCOUTS

By A. B. COLE

CHAPTER VIII

Electromagnetic Oscillations and Waves

SINCE all modern wireless telegraph apparatus depends on the generation and propagation of electromagnetic waves, it is essential that the operator be at least familiar with the elementary principles governing them.

In practice, electric oscillations are set up in a circuit by means of the peculiar discharge of a condenser. From this circuit they may be transferred to another by electromagnetic induction, and from the second circuit the electromagnetic waves generated by them are radiated into space.

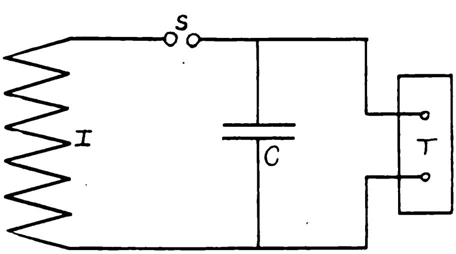


Fig. 40—Simple Oscillation Circuit

A simple circuit for the production of the oscillations is shown in Fig. 40, where (C) is a condenser, (S) is a spark gap, and (I) is a coil of wire. All coils of wire in which adjacent turns are insulated from each other possess a quality known as inductance when alternating or varying currents are caused to flow through them, and they are termed inductance coils, or inductances.

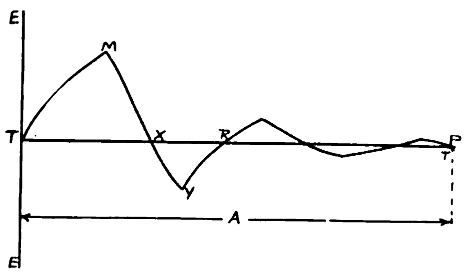


Fig. 41.—Condenser Discharge

In Fig. 40 the condenser (C) is connected to a transformer or spark coil (T), whose purpose is to charge it to a high potential. When (T) is set in operation, a discharge passes across the gap, which seems to the eye to be a continuous spark, but this is not the case.

The actual condition is shown by the diagram in Fig. 41, where the line TT represents time, and the line EE represents the potential of the condenser, the curve above the line indicating positive potentials, and that below representing negative potentials.

As the coil begins to charge the condenser, the potential of the latter rises from (T) to point (M). As soon as the potential has reached this point, however, it is sufficient to break down the resistance of the spark gap, and the condenser discharges across the gap, which act is shown by the curve falling

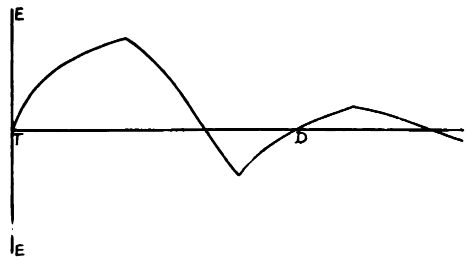


Fig. 42.—Increased Wave Length

to the point (X), which indicates zero potential. But this is not the stopping point, for the potential, as shown, falls below zero; in other words, the polarity of the condenser reverses and the potential increases in the opposite polarity untll it reaches point (Y). From this point it again falls to zero, and continues this change of potential and polarity until the action comes entirely to rest at point (P). These reversals of polarity and potential are called oscillations.

As soon as the coil again charges the condenser, the same series of oscillations also occurs again. Each spark discharge therefore is represented by the part (A) of the diagram.

So many spark discharges occur per second that the eye cannot follow them and they seem like one continuous spark, and for each spark there are many oscillations. A semi-oscillation is represented by the curve from (T) to (M) to (X).

When the oscillations are caused to flow along the aerial wires, they result in the radiation of electromagnetic waves by the wires, and the waves may also be represented by the same kind of diagram or curve as the oscillations.

The distance traversed by an electromagnetic wave in the time in seconds represented by line TR is the length of the wave, or the wave length. If a condenser having a greater capacity were substituted for (C) in Fig. 40, or if an inductance coil having more turns, or a greater inductance were substiuted for (I), the wave length of the circuit CSI would be increased, and its occillation diagram would be somewhat like that shown in Fig. 42, where the time of a complete oscillation is shown by the line TD.

Thus the wave length may be increased by increasing the capacity or the inductance of a circuit, or both. If all stations had the same wave length it would be practically impossible for one to hear signals of any other one if all were transmitting at one time within a limited radius, and the method of changing wave lengths provides a means whereby a number of stations can all work at the same time with little or no interference, providing that they all send out a wave of one particular wave length only, which would be termed a pure wave. In many stations, however, two or more different wave lengths are transmitted, and this is the cause of the difficulty often observed in trying to "tune" such a station out. This fact was the cause of the wireless law which provides that stations use a fairly pure wave for transmitting.

When the oscillations last for only a short time, as in Fig. 41, and die away rapidly, they are said to be highly

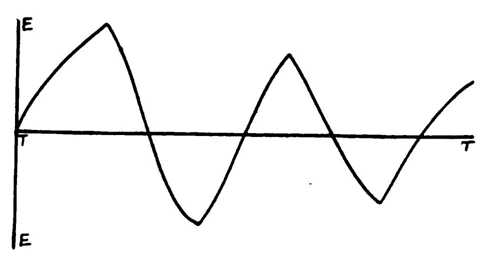


Fig. 43.—Slightly Damped Oscillations

damped, and when they continue for some time, as in Fig. 43, they are said to be slightly damped. A series of oscillations which would continue for practically an indefinite period of time would be called undamped.

The damping effect is due largely to the rapid radiation of the energy of the oscillations by the aerial. This effect is most apparent where the aerial and ground are connected directly across the spark gap, as shown in Fig. 44, where no helix or condenser is used. A station thus arranged would transmit a highly damped wave, which would be extremely difficult to "tune out," and this type of wave is no longer permitted by law where the station is capable of sending beyond the State border. This

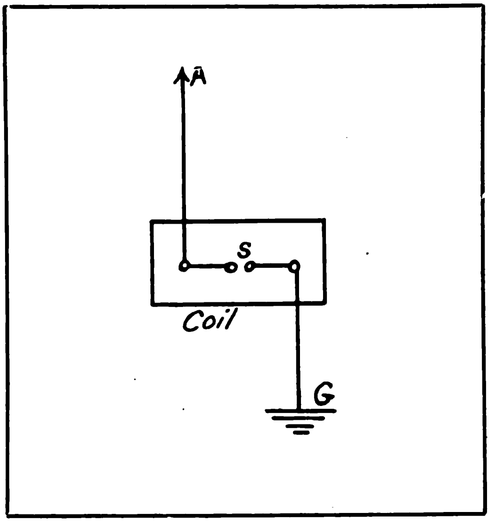


Fig. 44.—Untuned Transmitter

connection gives best results, however, in portable sets, as the transmitting range is greater and there is less adjustment than where a tuned set is used, unless the latter set is carefully tuned, which requires considerable time and patience. For this reason it is recommended that untuned sets be used for the field work of our readers, and in the following descriptions of sets we have arranged them in this way.

The Transmitting Set

Referring to Fig. 40, we may now complete the transmitting set, which is of the tuned variety, by arranging to transfer the energy of the oscillations from the inductance coil (I) to the aerial. This is done by placing another or secondary winding around (I), but separated from it. The method of connecting this coil to aerial and ground is illustrated in Fig. 45, which shows a complete transmitting set. The circuit CSI is known as the closed oscillation circuit, and the circuit ABG is the open oscillation circuit. The necessary capacity for the open circuit is provided by the aerial, which acts as a condenser.

When the open circuit has been adjusted to the same wave length as the closed circuit, by varying the inductance of (B) the two circuits will be in "tune," and the greatest possible transfer of energy from (I) to (B) will result. This variation is accomplished by using more or less turns of wire of the coils, and is generally done by the use of clips, which will make contact with any part of the wire.

The Receiving Set

In Fig. 46 we illustrate the method of connection of a complete receiving set, and would call attention to the similarity between this and the tuned transmitting set shown in Fig. 45. In each case we have an inductance coil with two windings. In the transmitting set this is called an oscillation transformer, and in the receiving set a receiving transformer. The open oscillation circuit of the receiving transformer is ABCG, and

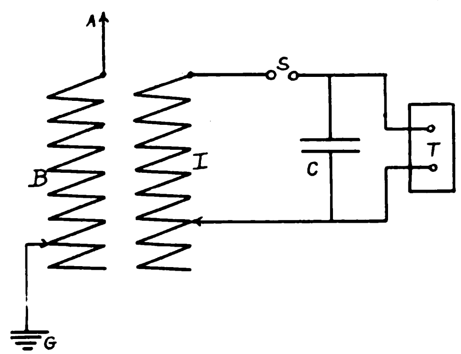


Fig. 45.—Complete Tuned Receiver

the closed circuit is EFC. Each set has a condenser (C). In place of the transformer or coil of the transmitting set we have a detector (D) in series with a small condenser (H), and across the detector a telephone receiver, or better, a pair of receivers (T) are connected.

Any electromagnetic waves impinging upon the aerial of the receiving station are converted into oscillations which travel up and down the circuit ABCG, and set up similar oscillations in the secondary of the receiving transformer by magnetic induction. These oscillations affect the detector (D), which in turn causes currents corresponding to the oscillations to flow through the receivers (T).

The open circuit is adjusted to the length of the incoming wave by changing the inductance of the primary through the aid of the movable contacts or clips (B) and (C). The closed circuit is placed in tune with this circuit by means of the sliding contact or switch (F) and by variation of the capacity of the condenser (C).

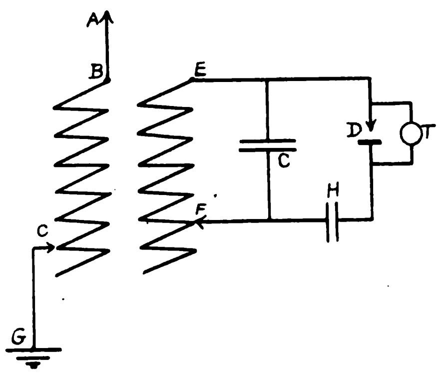


Fig. 46.—Tuned Receiving Set

Generally in large stations this condenser is so built that its capacity may be varied gradually from zero to maximum at will, and for this reason it is called a variable condenser. A condenser whose capacity cannot be changed is known as a fixed condenser. A variable condenser is, of course, desirable, but in many cases its increased cost over that of a fixed or adjustable condenser prohibits its use by beginners. Good results can be obtained by the use of an adjustable condenser, which is built in sections, so that several steps of capacity may be available.

NOTE.—Referring to the diagram Fig. 46 —— members of Boy Scout Wireless Divisions will secure much better results if the telephones (T) are connected around the fixed condenser (H), rather than around the detector.—*Technical Editor.*

This is the fifth installment of instruction for Boy Scouts. The fifth lesson by Mr. Cole will appear in an early issue.

NEW YEAR'S DINNER ATOP OF A MAST

"Boys, finish this mast by Wednesday and you eat your New Year's turkey off the last diaphragm plate," was the promise made in December last by Foreman Holliday to the expert riggers of crew No. 1, who are erecting the masts at the Marconi Trans-Atlantic Wireless Station, New Brunswick, N. J.

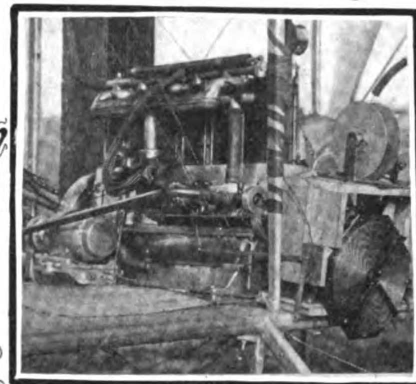
Three crews of riggers in the employ of the J. G. White Engineering Corporation had been fighting for several weeks to demonstrate their prowess in the air. Each crew began work on the same day, and the contest to gain the height of 400 feet began. These masts are not like the large frames of the modern skyscrapers. They consist of a hollow cylinder 42 inches in diameter, made up of half sections fifteen feet long for an elevation of 195 feet; the remaining 205 feet are 30 inches in diameter, made up of half sections ten feet long. All the flanges are bolted, and high-grade work is essential.

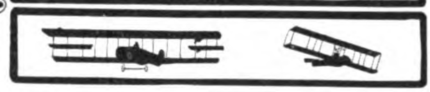
One crew gained a section, only to lose it in the next hour. Crew No. 2 finished the first mast with a lead of one section, and crew No. 1 stopped but a moment, as the flag was hoisted on timber top-mast of their rival's mast. Each crew started a second mast with crew No. 1 one section behind. Three days before New Years, crew No. 1 had 170 feet to go; to work faster at such a dangerous height seemed impossible. Then Holliday announced his turkey-dinner plan, and the men renewed their efforts.

On Monday they raised sixty feet and gained half a section on crew No. 2. On Tuesday seventy feet and no gain was the result. On Wednesday morning, December 31, at 11 o'clock the crews were even, and had one section to go. At half past twelve o'clock a shout was heard from the erection cage of crew No. 1—the mast was completed.

At 1 o'clock sharp an automobile pulled up to the foot of the mast and unloaded three large market baskets, which were hoisted to the top of the mast. There, upon the thin thirty-inch shelf, the four riggers and their foreman spread their New Year's dinner.

Apparatus for Army Air Craft





PORTABLE wireless equipments are among the latest devices to aid signal work in the United States aviation squad. Before the field wireless set became a reality, messages could be exchanged with aeroplanes in flight only when the machines were in sight of the observer. It is now possible, however, to communicate with an aeroplane in motion even when it is out of sight and as far away as fifteen miles.

The outfit operates on the quenched-spark system, with a transmitting range under ordinary conditions of thirty miles. The generator is geared to a double hand crank and with two operators can be run at very high speed, giving an output of 1/8 of a kilowatt.

The transmitting apparatus is mounted in a reinforced trunk for convenient transportation, with suitable means for making the outside connections. The outfit may be set up in a few minutes.

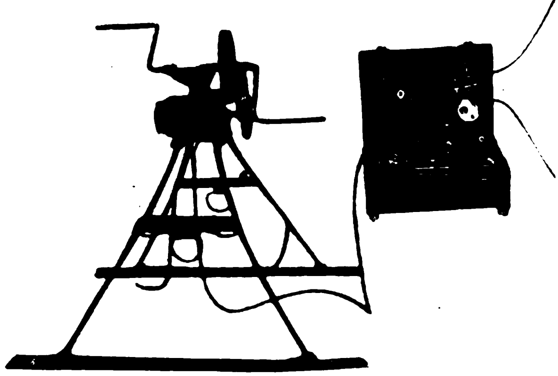
The radio apparatus used on the signal aeroplanes is a modified form of the field outfit. The generator is friction-driven from the flywheel of the engine, and the antenna is of the hanging wire type contained on a reel so that it can be let out or taken in at will.

As far as is practicable, the set is made interchangeable part for part with the field apparatus. This enables an operator of the field signal corps to operate the aeroplane outfit when carried as a passenger in a machine. The machines are of the double control type and a message can be sent by either operator. When the ajustments are once made it is not necessary to disturb them except in case of accident. The total equipment for an aeroplane weighs about seventy-five pounds. It has a radius of action of thirty miles.

During recent tests by the signal corps the radio set illustrated in this article was used as a constant means of communication between the aeroplane and the ground for periods of time varying from fifteen to seventy-five minutes. Not the slightest difficulty was encountered in receiving messages at a height of half a mile, and messages were sent from a machine to the ground from an altitude of 1,500 feet. These figures are the results of tests extending over a period of several days, and are not merely the reports of special extraordinary performances.

That the person ambitious to become an aviator in the service of the United States has to have a considerable knowledge of air craft and how to manage them is shown by the test which it is necessary for him to undergo before he is able to obtain an aviator's certificate. The test is as follows:

Cross country flight of at least twenty miles at a minimum height of 1,000 feet. Make a flight of at least five minutes' duration with the wind blowing at the rate of at least fifteen miles per hour. Carry a passenger to a height of at least 500 feet and, on landing, come to rest within 150 feet of a previously designated point, the engine being completely cut off prior to touching the ground. The combined weight of the passenger and pilot must be at least 250 pounds. Execute a volplane from an altitude of at least 500 feet with the engine completely cut off, and cause the aeroplane to come to rest within 300 feet of a previously designated point on the ground. Make a military reconnaissance flight of at least twenty miles for the purpose of observing and bringing back information concerning features of the ground or other matter which the applic nt is instructed to report upon. This flight must be made at an average altitude of 1,500 feet.



Field Radio Pack Set and Generator

If the applicant passes this test, he is given a certificate signed by the secretary of war, chief signal officer commanding and the adjutant general.

Captain J. H. Worden, of the Federal Mexican army, is said to be the first aviator to take part in actual warfare on the Western hemisphere. He has positive ideas regarding the character of the men to be chosen for military aviators. He advocates detailing men "of an age to warrant mature judgment and self-reliance at critical moments." They should not be men who are "attracted by the temporary glory and publicity of being an aviator," in his opinion.

Buzzer Outfit

In pointing out the utility of the aeroplane as a director and observer of artillery fire, he said: "When the artillery fire is directed upon a point directly within sight of the gunners, the aeroplane would be of very little service, but where there is a mountain intercepting the aeroplane will prove indispensible. He calls attention to a battle fought in Mexico at Bachimba, between Chiuahua and Torreon, and declares that "the rebels were entrenched upon all the really strategic points, so that the attacking Federal forces were at a disadvantage; the artillery used up over $100,000 worth of ammunition, yet at the termination of the battle there were less than 300 men killed, and most of these were victims of close infantry fire." He asserted that the Mexican gunners in the battle were not poor marksmen, but that "the topography of the country made it necessary to place the artillery at a point where a view of the enemy's batteries was intercepted by a big hill upon which the infantry fighting took place."

He says in conclusion: "It is easy to understand the difficulties attending the directing of the firing and the consequent small damage done; but add to the moral effect these guns did have, the effect they would have had if the firing had been accurate, as it could have been by the aid of a well-trained observer directing the fire from overhead, and the battle would have been quick, decisive and probably final."

The militia, too, has adopted the use of portable wireless outfits in aviation work, having employed them to advantage in manoeuvres.

From and For those who help themselves

Experimenters' Experiences.

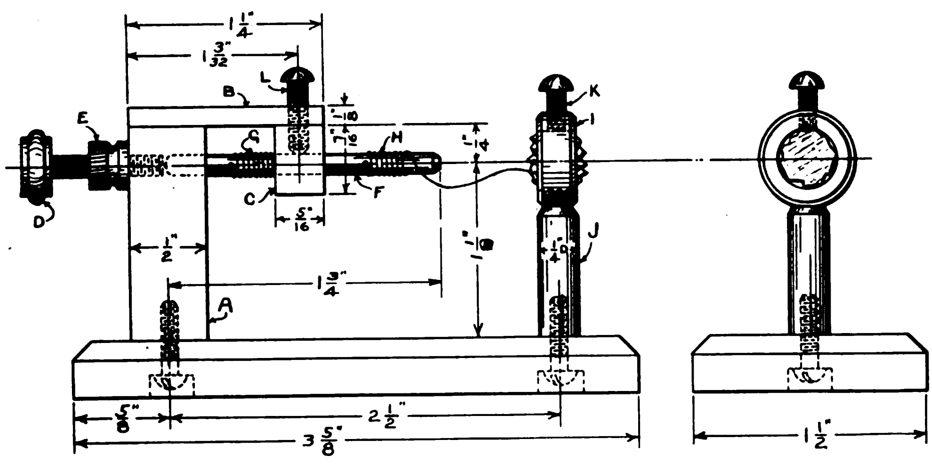
FIRST PRIZE TEN DOLLARS

A Galena Detector Which Has Given Excellent Results

I have found that the Galena detector, which I am about to describe, has given better results than any I have used.

As shown in the accompanying diagram, the base is made of oak, or other hard wood, and can be constructed to suit the size of cabinet. Brass upright A, having dimensions ½" by ¼" by 1⅜", is drilled to receive adjustment screw D. Nut E is taken from a dry battery and is soldered in line with hole. B is a piece of brass ¼" by ⅛" by 1¼", and is tapped at one end to receive set screw L. This is soldered to top of A, as shown in the sketch.

C is a piece of brass 7/16" by ¼" by ¼", drilled at the center to receive pin F. Another hole is drilled in the top of the pin hole to receive the set screw, and is soldered to piece C. F is a pin 2 by ½ inches, which slides back and forth and is kept in tension by spring G and set screw L. G is a small spring which keeps a pressure on the pin. H is a piece of No. 36 B and S copper wire used to make contact with the galena. I is a round brass nut screwed onto brass stud H, and is tapped on top to receive set screw. The set screw is used to hold the detector mineral in place. J is a piece of brass ½" by ¼" by ¾", to hold the galena holder.



Screws and parts can be made according to the supply of material on hand in the shop.

Edw. Dorst, New York.

SECOND PRIZE FIVE DOLLARS

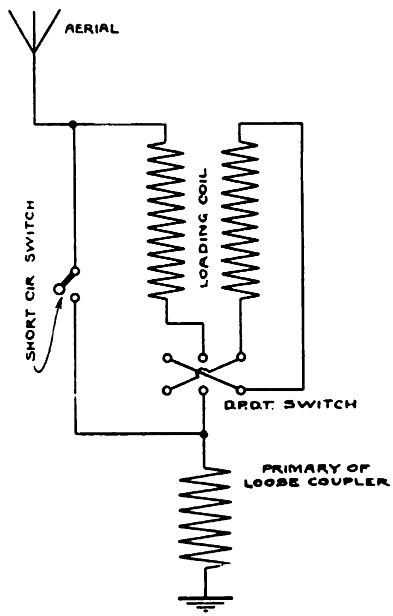
A Loading Coil without Taps or Dead Ends

Loading coils, or adjustable inductances without taps, slides, or dead ends, are not new. Most experimenters are familiar with the "variometer," which consists of two coils connected in series, with the inner coil mounted on an axis so it can be turned at any angle with the outer coil. As many experimenters have not a clear idea of the action of this "variometer" type of inductance, a few words may not be amiss. With the turns of the inner coil going in an opposite direction to those of the outer coil, and the planes of the two coils parallel, the effective inductance is a minimum. This is due to the fact that in this position the magnet field of the inner coil opposes the magnetic field of the outer coil. As the angle between the coils is increased by rotating the inner coil on its axis the effective inductance increases, and at 90° the magnetic fields are perpendicular, and have no effect on each other. In this position the effective inductance is the same as the inductance of the inner coil plus the inductance of the outer coil.

As the inner coil is rotated from 90° to 180° the turns of both coils run in the same direction, the magnetic fields assist each other, and the effective inductance increases. At 180° the two coils are parallel, their turns run in the same direction, and the effective inductance of the "variometer" is the maximum.

The adjustable inductance, which I am about to describe, is identical in principle with the "variometer" referred to, but it is built like an ordinary loose coupler without any taps or slides on either of the windings. The advantages of this construction over the "variometer" type of inductance are, (a) simplicity, (b) cheapness, and (c) great range of inductance.

To build this type of loading coil procure two cardboard tubes, one of slightly smaller diameter, so that it will slide within the other. Wind the larger tube with several turns of insulated wire, and wind the smaller tube with slightly smaller wire, so as to get more turns in the same winding space. For the best results the writer recommends that each coil have the same value of inductance, so that with tight coupling, and the turns of the inner coil running in an opposite direction to those of the



outer coil, the effective inductance of the loading coil will be zero. The ends of the two coils are then connected up as per the diagram. The short-circuiting switch does not necessarily have to be used if the loading coil is properly designed, but some prefer not to have the resistance of the two windings in the aerial circuit when the loading coil is not needed.

The explanation of the action of this loading coil is as follows: If the inner coil has the same inductance as the outer coil, and the turns run in opposite directions, the effective inductance of the loading coil is zero with tight coupling. The effective inductance increases as the inner coil is pulled out from the field of the outer coil, and the total inductance is the same as the inductance of the inner coil plus the inductance of the outer coil when the coupling is very weak; that is, when the inner coil is pulled out far enough to be entirely out of the field of the outer coil. If the turns of the inner coil are reversed by the D. P. D. T. switch, the turns will all be running in the same direction. As the coupling between the two coils is tightened the effective inductance increases. The maximum effective inductance is reached when the coupling is tightest, that is, when the turns of the inner coil are directly beneath those of the outer coil.

A practical example and the formula necessary to calculate the inductance of each coil follow:

$$L = \frac{(5 \times D \times T)^2}{\frac{M + D}{3}} \qquad (1)$$

In which L = inductance in centimeters.

D = diameter of the coil in inches.

T = the number of turns of wire on the coil.

M = the length of the coil in inches; that is, the number of inches of winding space.

Let us suppose the outer coil is to have 100 turns of wire in a winding space of 4 inches, and suppose the diameter of the coil is 4 inches. Then D = 4 inches, T = 100, M = 4 inches. Substituting in the formula

$$L = \frac{(5 \times 4 \times 100)^2}{\frac{4 + 4}{3}}$$

= 750,000. centimeters.

Now, suppose the inner coil is 3½ inches in diameter. The winding space (M) should be the same in both coils, and the inductance should be the same.

Therefore, L = 750,000., D = 3½ inches, T is unknown, M = 4 inches.

Substituting in (1)

$$750{,}000. = \frac{(5 \times 3\tfrac{1}{2} \times T)^2}{\frac{4 + 3.5}{3}}$$

Or T = 113. turns.

From an examination of the wire tables we find that No. 20 S. C. C. magnet wire is the proper diameter to give 100 turns in 4" of winding space. Likewise, No. 21 S. C. C. magnet wire is seen to be the proper diameter to give 113 turns in 4" of winding space. Therefore, the larger tube is wound with 100 turns of No. 20 S. C. C. magnet wire, and the smaller tube is wound with 113 turns of No. 21 S. C. C. nagnet wire. The writer recommends the sizes and dimensions given in the practical example as being most suitable for the experimenter. The maximum effective inductance of the loading côil described in the practical example is about 2,225,000 centimeters, or 2.25 Milli-Henrys. For very long wave lengths, over 2,000 meters, it is entirely practical to use two or more of the loading coils described.

HARRY V. ROOME, California.

NOTE.—While the method described for obtaining variations of inductance is not distinctly new, it should be of interest to amateurs who have a hazy conception of a variometer. The great objection to the method is, as the writer hints, that the ohmic resistance of the wire is present at all wave lengths and, unless the wire has a high degree of conductivity, the energy losses may be objectionable.

The formulæ given for the calculation of inductance, while somewhat crude for precision work, is sufficiently accurate for amateur needs.—*Contest Editor.*

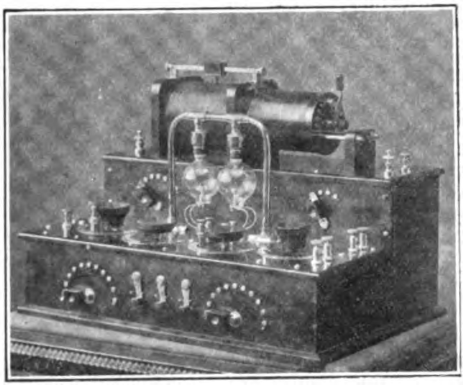
THIRD PRIZE THREE DOLLARS

A Description of an Audion Amplifier

This is a description of an audion amplifier. I constructed the device, a photograph of which is published herewith, after reading How to Conduct a Radio Club in the January issue of THE WIRELESS AGE. Since the apparatus has found favor among amateurs who have seen it I thought it would be well to place a description of it before all wireless enthusiasts, for it may be of assistance to them in making a similar device.

It is not necessary for me to go into details, as all points were fully covered in the January article, the hook-up appearing in that issue being used. Referring to the photograph accompanying this article, the right and left-hand knobs are connected to the variable condensers, while the two middle ones operate the filament rheostats. The four binding posts on the right allow connections to the small storage cells, which light the filament. The two binding posts to the extreme left are the terminals for the head-phones.

I am using the secondary of an 8-inch spark coil as an auto-transformer, connections for which are located at the right of the secondary of the "loose coupler." Two binding posts are located to the left of the primary of the receiving transformer, allowing connection to the earth and antenna.



Directly underneath the "loose coupler" are placed two distinct sets of flashlight batteries, each set consisting of 36 cells. Connections from the audions to each set of cells are made through the multiple point switches on the front of the cabinet. The connections are so arranged that 12 cells are always in the circuit, the remaining number in use being determined by the multiple point switches. Three switches are mounted on the front of the case; the one on the right is connected in series with the filament of the No. 1 audion; the one on the left closes the circuit with the filament of audion No. 2. The middle switch makes connection to a fixed condenser in shunt with the head-phones.

My aerial consists of a single wire from the top of a chimney 200 feet in height. I can hear the time signals from Arlington 10 to 20 feet behind the closed doors of my station. I can read the signals from Cape Cod when standing 12 feet distant from the head-phones.

As I stated before, I am using the secondary of an 8-inch spark coil as an auto-transformer. Of course, it has a primary winding, and as a matter of experiment I connected a microphone transmitter in series with 3 dry cells to the primary winding. I was certainly surprised at the result. I placed an alarm-clock some 20 feet from the microphone, and the ticks produced in the receiver reminded me of a blacksmith shop. The sounds from the whistle of a ferry-boat about 500 feet from my station were intensified to such an extent that they made my ears ring. I also heard plainly conversation taking place next door through the walls. All this was heard while receiving wireless messages.

Amateurs should experience no difficulty in constructing this device, and if the work is properly done they may expect exceptional results.

F. J. SUCHANEK, New York.

NOTE.—The apparatus shown in the photograph accompanying this article is entirely of amateur construction, and should be an incentive to students of wireless telegraphy to produce work of equal merit. The results obtained from the microphone are particularly interesting, and it would sometimes seem that audions are more responsive to audible frequencies than to the very high frequencies generally employed in radio work.—*Contest Editor.*

FOURTH PRIZE SUBSCRIPTION TO THE WIRELESS AGE

An efficient Loose Coupler

This is a description of a loose-coupler which entirely eliminates the "dead-end" effect and allows accurate tuning without the use of sliders.

The following materials are necessary:

One square brass rod 21½ by ⅜ inches; 2 round brass rods 14¾ inches long and 3/16 inches in diameter; ½ pound No. 22 S.C. copper wire; ¼ pound No. 28 S.C. copper wire; 4 binding posts; 3 helix clips; 1 cardboard tube 6¼ inches long and 4½ inches in diameter; 1 cardboard tube 6 inches long and 3⅞ inches in diameter; 42 brass machine screws and nuts; 15 brass washers; 1 board 16 by 6½ by 3 inches (base); 2 boards 6½ by 5½ by ½ inches (front and back of primary box); 2 boards 5½ by 5 by ½ inches

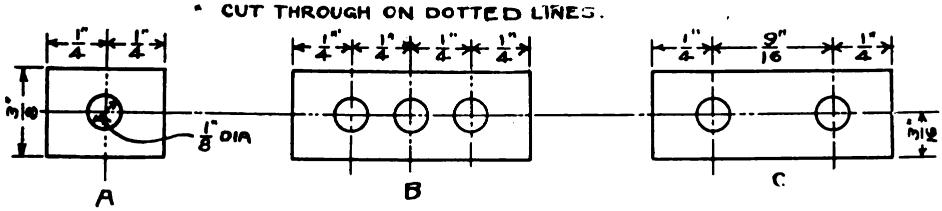


Fig. 1

(sides of primary box); 1 board 6½ by 6 by ½ inches (top of primary box); 1 board 6 by 3 by ½ inches (support of sliding rods); 2 round boards 3¾ inches in diameter, ½ inch thick (ends of secondary tube).

The boards are preferably made of mahogany. A 4½-inch hole ¼ inch from the bottom and from either side is cut in one of the 5½ by 5 by ½-inch boards, and a corresponding groove, ⅛ inch wide and ¼ inch deep, is cut in the other board to receive the primary tube. When the boards are cut to the required dimensions they should be sandpapered and given two or three coats of a suitable stain.

The primary should be wound in the following manner: Begin winding the No. 22 wire around the larger tube

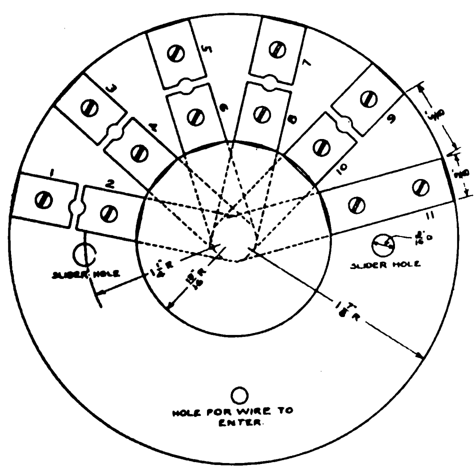


Fig. 2

about ⅜ of an inch from one end. Leave six inches for connection, wind 16 turns and again leave six inches. A good method to prevent the wire from unwinding is to punch two holes in the cardboard with a pin and push the wire in one hole and out the other. Wind 8 divisions of 16 turns each, and then wind 7 divisions of 2 turns each, making a total of 142 turns.

From the square brass rod cut off 19 pieces one inch long, drill three ⅛-inch holes in each, and then cut each in half, as shown in B, Fig. 1. Cut and drill two pieces like A and one like C. The primary plates are arranged as in Fig. 3, and are fastened to the top of the primary box with machine screws and nuts. A washer is placed under the head of a screw in every other plate to aid in tuning, as will be shown later. Plate No. 1 is connected to the beginning of the first division, No. 2 to the

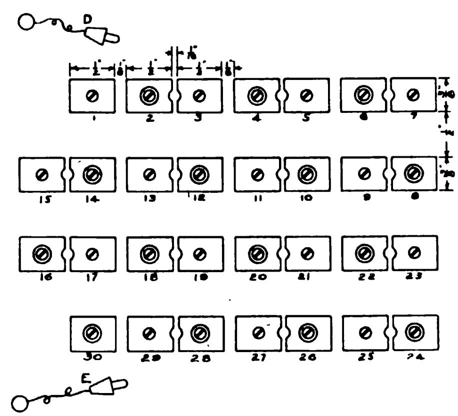


Fig. 3

end of that division, No. 3 to the beginning of the next division, etc.

When winding the secondary arrange the brass plates on one of the 3¾ inch in diameter boards, as shown in Fig. 2, and fasten them to the board with machine screws and nuts. Slip this end just inside the secondary tube, and tack the tube to it. Leave about 16 inches of the No. 28 wire to run through the hole in the end, attach to the binding post and wind 37 turns around the tube. Push the end of this division through a pin hole in the tube and connect it to plate No. 1. Wind the wire in six divisions of 37 turns each, as shown in Fig. 5, making a total of 222 turns.

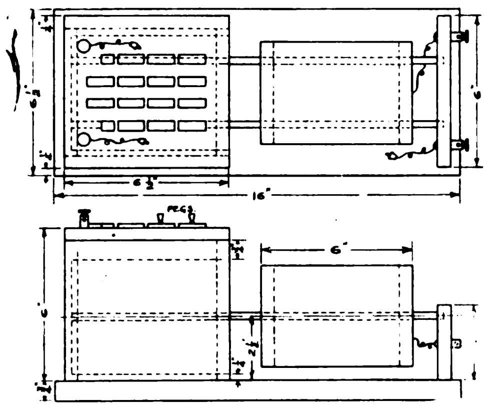


Fig. 4

Be careful to wind the wire in the same direction around the tube. When the wiring is finished, slip the other round board into the open end of the secondary, and tack the tube to it.

Next assemble the parts as shown in Fig. 4. Make 19 pegs out of brass rod. Each peg should be one inch long and 3/16 of an inch in diameter. Beginning at the middle, it should taper down at one end almost to a point. These pegs are to make connections between the brass plates.

When tuning the primary the clip D (see Fig. 3) is attached only to the plates which have no washer and are in the two rows nearest the clip D, while the clip E is attached to the plates which have a washer and are in the other two rows. All intervening holes between the plates are filled by pegs. For instance, if clip D is on plate No. 11 and clip E on No. 18, the holes between 12 and 13, 14 and 15, and 16 and 17 are filled by pegs. Clip D controls the primary in steps of 16 turns each, E in steps of 2 turns each. In this manner any even number of turns from 2 to 142 may be used. In the secondary the clip is attached to the plates on the outside circle only and the holes to the left filled by pegs, thus controlling the secondary in steps of 37 turns each. For instance, if the clip is on No. 7 the holes between 6 and 5, 4 and 3 and 2 and 1 are filled by pegs.

Fig. 5 gives the diagram of connections. When the D.P.D.T. switch is to the left, the set is more responsive to long wave lengths; and when it is to the right, the set is more responsive to

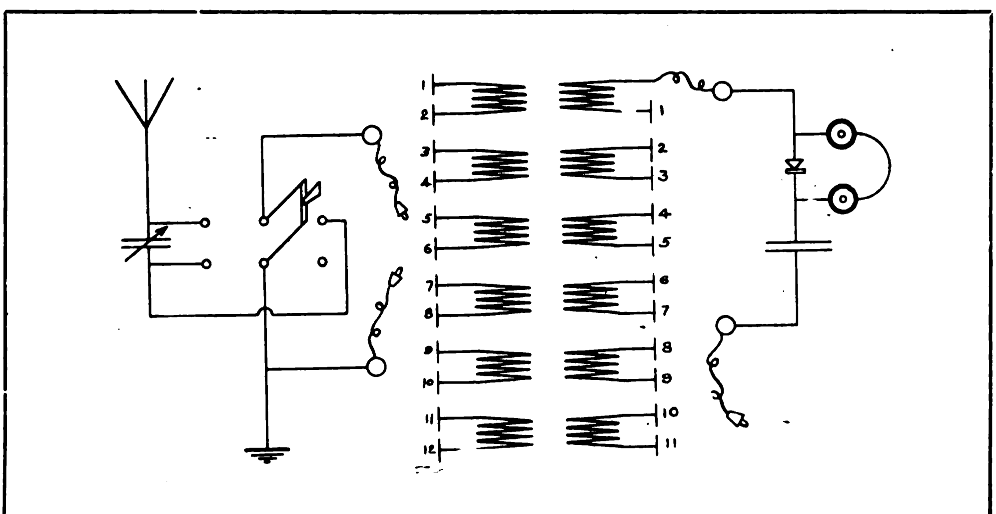


Fig. 5

short wave lengths. This arrangement coupled with the selectivity of the loose-coupler will allow the operator to tune to almost any desired wave length.

GRANVILLE B. SMITH, New York.

NOTE.—It is evident from amateurs' communications that they are much concerned with the dead end losses in receiving tuners. We have therefore printed this article. We must, however, take exception to the statements that the "dead end" losses are "entirely" eliminated, for the very reason that these losses are present to a certain extent, even when the unusual turns are metallically disconnected from the remainder of the turns. The construction of the tuner in question assists in doing away with the "dead end" effect and undoubtedly will give sharper tuning than the average amateur tuner.—*Contest Editor.*

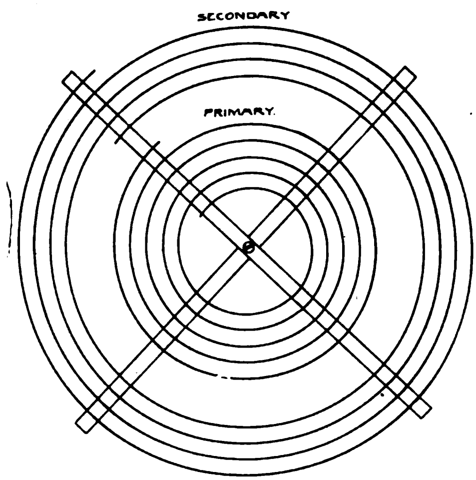


Fig. 2

HONORABLE MENTION

An Oscillation Transformer

The new wireless law says that the

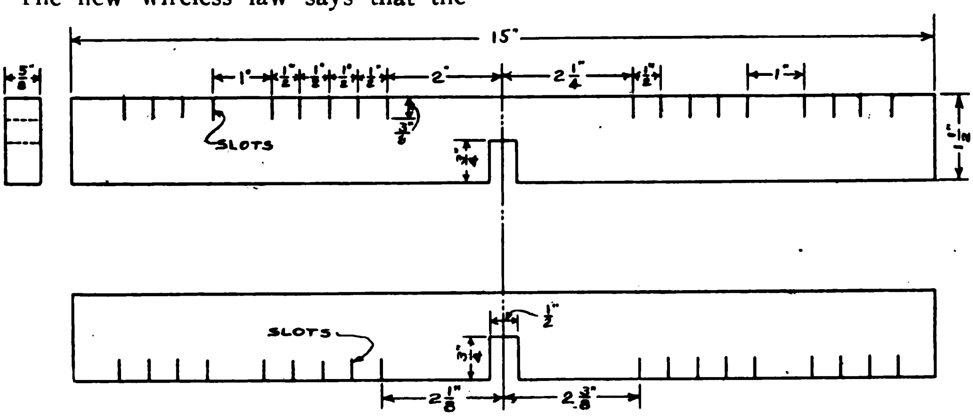


Fig. 1

wave emitted must be pure and sharp. To accomplish this an inductive helix, or oscillation, transformer must be employed. A very simple and efficient one can easily be constructed in the following manner:

Procure two pieces of hardwood 15 by ⅝ by 1½ inches, and with a fine back saw, saw slats as shown in Fig. 1. Make a joint at the center and glue the pieces together as in Fig. 2. Fill in the slots with brass ribbon ½ inch wide, as shown in Fig. 2, until there are five turns. This is the primary.

Spacing off as in the diagram, put on four more turns. This is the secondary. If the slots are cut with a good back saw, the brass ribbon will be held tightly without any other fastening than that of the wood itself.

The transformer is designed to be mounted directly on the wall. Connections are made by ordinary helix clips. The writer has used this oscillation transformer, and has found it will limit a wave complying with the Government regulations.

I. RABI, New York.

HONORABLE MENTION

The Best Form of Crystal Detector

The best form of crystal detector is the "Catwhisker Type." Any mineral may be used in it with equal advantage.

Figs. 1 and 2 show a detector of this type.

A and A¹ = a couple of double binding posts.

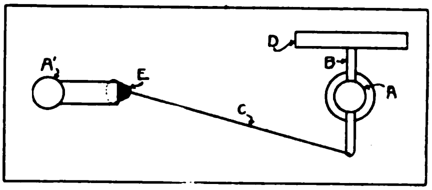


Fig. 1

B = piece of No. 12 copper wire 3 inches long.

C = a piece of No. 22 copper wire 6 inches long.

D = rubber knob.

E = crystal to be used.

F = a piece of spring brass 6 by ½ inches, bent double and held under A¹.

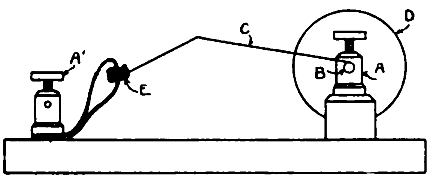


Fig. 2

By turning D the wire C may be moved upward or downward. No 22 wire is about right for silicon, but different sizes of wire should be used with different minerals.

F should be notched at each end to hold the mineral firmly. My experiences have proven one of these detectors to be the best obtainable.

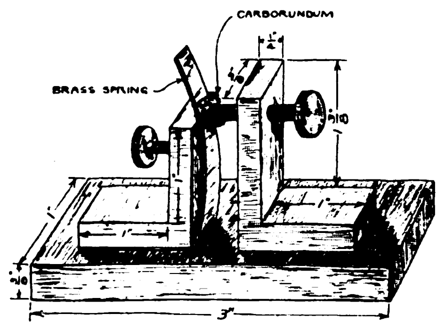
MAURICE WINGLEMERE, Michigan.

HONORABLE MENTION

Mineral Detector Stand

In the accompanying illustration, a simple detector stand which can be made at a very small cost is shown. It consists of but four pieces as shown: a hardwood or fiber base; two brass or copper standards, and a piece of spring brass.

The base is 1 inch wide, 3 inches long and ⅜ of an inch thick. The brass standards are each ¼ of an inch thick and ⅜ of an inch wide; the legs of one are 1 by 1 inch; the legs of the other are 1 by 1⅜ inches. A hole is drilled ¼ of an inch below the top, and in the center of each standard with a No. 31 twist-drill, and tapped with a No. 8, 32 thread tap and a brass screw, ¾ of an inch in length, fitted therein. Two holes are drilled in the bottom legs of each standard, with a No. 10 twist-drill and countersunk to admit brass screws, with which the standards are fastend to the base.



A piece of thin spring brass ⅜ of an inch wide and 3 inches long is bent at right angles at a point 1 inch from one end. It is placed under the short standard and scribed for the two holes through which the holding down screws pass, and which are drilled with a No. 10 twist-drill.

The stand is now ready for mounting and the standards are placed on the base, facing each other, ⅜ of an inch apart. A piece of carborundum or silicon is placed between the spring and the upper screw. The tension is adjusted by the lower screw. One of the holding-down screws in each standard can be replaced with a threaded or screw point binding post, insuing a better connection.

This detector is very sensitive, and I have obtained excellent results with it.

WILLIAM ROSENFELD, New York.

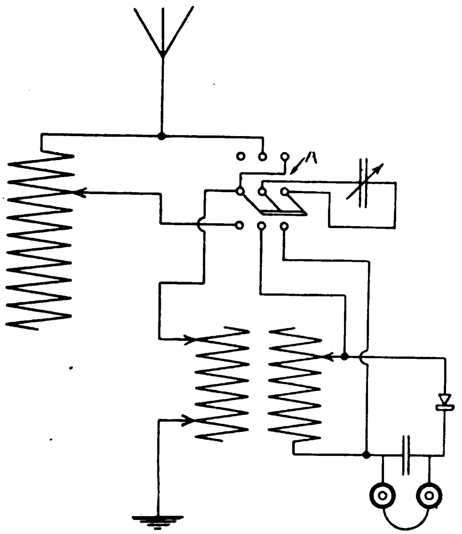
Note.—A detector stand of this type is cheap and easy of construction. It is, however, more suited to carborundum crystals than to silicon perikons, etc., requiring lighter adjustment.—*Contest Editor.*

HONORABLE MENTION

A Brand New Hookup

I have devised what I believe to be a new hookup for changing from long to short waves with a minimum amount of effort.

In receiving long waves, a loading coil in the primary and a variable con-



denser across the secondary is the accepted method, while short waves require the condenser in series with the primary and the "loader" is cut out of the circuit. With most switching arrangements two or more switches are operated to accomplish this change. My sketch shows that it can be done with a single "twist of the wrist."

By looking at the figure accompanying this article it is evident that when switch A is up the condenser is in series with the aerial and the loading coil entirely out of the circuit. If the switch is thrown downward the set is in a position to receive long wave lengths.

For best results, the condenser should be of fairly high capacity and the loading coil possess no dead ends. This will be appreciated by most amateurs, and by adopting it they may increase the flexibility of their sets.

THOMAS BENSON, Pennsylvania.

HINTS FOR IMPROVING RECEIVING STATIONS

A sensitive detector is a necessity in a first-class receiving station, and I intend to describe some methods of improving its efficiency.

The resistance of nickel is high. Therefore, nickel plating of parts of detectors should be avoided because the current tends to travel through the nickel rather than through the more conductive metal of which the detector is constructed.

The sensitive adjustment of the electrolytic detector can be increased by placing a small piece of cotton in the acid solution. Then, by adjusting the platinum point so as to have a fine thread adhere to it, a circuit from the point, through the wet thread to the solution will be formed.

I have noticed several cases in which detectors using battery current were wrongly connected. To get the best results the current must flow in a certain direction, which is found by experiment; the proper direction gives the best signals.

All detectors should be kept free from dust and other foreign matter. Crystals should be occasionally washed in gasolene. (Keep away from all flames while cleaning.)

The table published in this article is a list of common crystals used as detectors with their best contacts and points, as found in my experience. The tellurium-galena combination will be a surprise to some if they try it, because of its great sensitiveness. The table follows:

CRYSTAL DETECTORS

Mineral	*Contact*	*Point*
Carborundum	Very heavy	Large and blunt
Silicon	Light	Blunt and fine
Molybdenite	Heavy	Blunt
Galena	Very light	Blunt and fine
Iron pyrites	Light	Blunt and fine
Perikon	Light	
Tellurium-galena	Light	

Whenever possible dead ends should be eliminated in all tuning instruments. It is best to make connections of stranded wire, because of the "skin effect" of high-frequency currents.

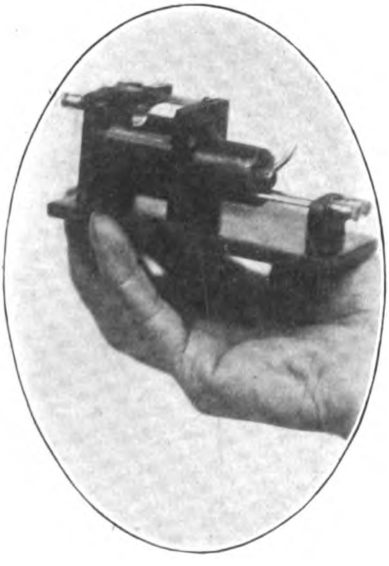
If the amateur intends to receive messages and not to send, it would pay him if possible to increase the size of his aerial. With a 6-wire aerial, about 120 or 150 feet long and 60 feet high and a sensitive receiving set it should be possible to receive messages from a distance of two thousand miles provided the conditions are right. For best working the "ground" should be copper or zinc plates surrounded by charcoal or moist earth.

A. R. RADOM, Connecticut.

NOTE.—Many inquiries from beginners as to the best contacts to use with various crystal detectors are received by THE WIRELESS AGE. In reply we herewith publish results obtained by one amateur. Beginners would do well to make similar observations.—*Contest Editor.*

SMALLEST RECEIVING TRANSFORMER

The accompanying photograph shows the smallest operative receiving transformer that has come to our notice. Its base is 4½ inches long by 2 inches wide. Its overall height is 2 inches. The primary winding, which is of No. 30 enameled wire, is 1½ inches long and 1⅛ inches in diameter. The single slider of the primary is made of hard rubber, and has a phosphor bronze contact spring. The secondary is 1½ inches long and ⅞ inch in diameter, and is wound with No. 32 single silk-covered wire.



The sections of the secondary winding are brought out to the contact points of a miniature switch, which have a diameter of 1/16 inch.

This miniature tuner is an exact model of the standard types on a very small scale. It was built by Mr. Joseph Stanley, of New York City, and he claims that with it the received signals are equally as strong as with a transformer of regular size. The range of wave length was not given.

WIRELESS TELEPHONE A FACT SOON—PROF. THOMSON

Declaring that the wireless telephone will soon be a fact, and that communication by this means between Europe and the United States may soon become practicable, Professor Elihu Thomson, inventor of electrical devices in use all over the world, addressed an audience upon the subject, "The Wireless Transmission of Electrical Energy," in the Edison Auditorium, No. 44 West Twenty-seventh street, on the evening of January 20.

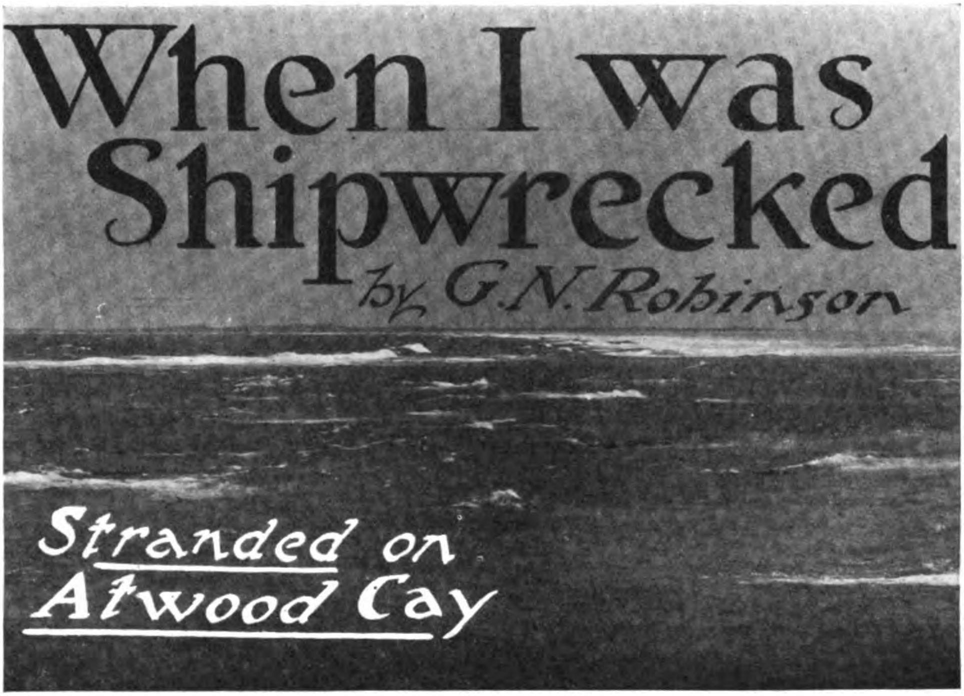
"The success of the wireless telephone," said Professor Thomson, "depends upon our ability to control the voice waves and to vary in accordance therewith the energy given out by the transmitting antennæ, and to do this with a fairly good output of energy. Much progress has been made in this department of wireless work, and such telephony between Europe and America may yet become practicable.

"Methods are being worked out whereby it may be possible to mould outputs of many kilowatts of energy so as to have them vary with the voice waves, and when this is done many problems the solution of which now seems remote may be solved and the results prove of great practical value to the world."

Professor Thomson told of his experiments with the transmission of wireless energy when, with E. J. Houston, he taught in the Central High School in Philadelphia in 1875. He used an induction coil with automatic interrupter for the primary circuit, and then gave a technical description of the results, one of which was the discovery that at a distance of several stories from the coil sparks were emitted by placing two points of carbon together near a doorknob. This proved that waves were in ether and demonstrated a principle which ultimately was developed in a highly satisfactory manner.

WIRELESS AGE WORRIES:

THE EFFICIENCY OF THE POLICE WOULD BE INCREASED 100% IF EACH PATROLMAN WAS EQUIPPED WITH WIRELESS



HOW'D you like to be shipwrecked on the shores of an island in the West Indies, have an adventure with pirates and spend Christmas and New Year's on a vessel that was stranded more than a thousand miles away from home? That's what happened to me.

This experience, it seems to me, belongs in a chapter of "Robinson Crusoe," or one of Robert Louis Stevenson's books, instead of in the life story of a wireless operator. A conversation overheard a short time ago while I was turning in my reports at the Cliff street headquarters in New York recalled my adventures, my attention being caught by remarks from a group of operators lounging in the static room—so called because static means a disturbance in the atmosphere, making a considerable noise, interfering with business and acknowledged a general nuisance.

Discussions in the static room may range from a review of a captain's characteristics, merit and disposition to the value of a passenger's pet dog. On this occasion the talk had turned to shipwrecks. None of the members of the group had figured in marine mishaps, and they speculated on what they would do if they were aboard a vessel in distress. To set down on paper their opinions of how a wireless operator should act when Neptune is clamoring for the destruction of lives and craft would add little to the interest of my story. It is enough to say that I was sufficiently moved by the conversation to isolate myself in my lodgings during part of my sojourn ashore and scratch off the narrative of how the steamship Prinz Joachim was wrecked off Samama Island, better known as Atwood Cay.

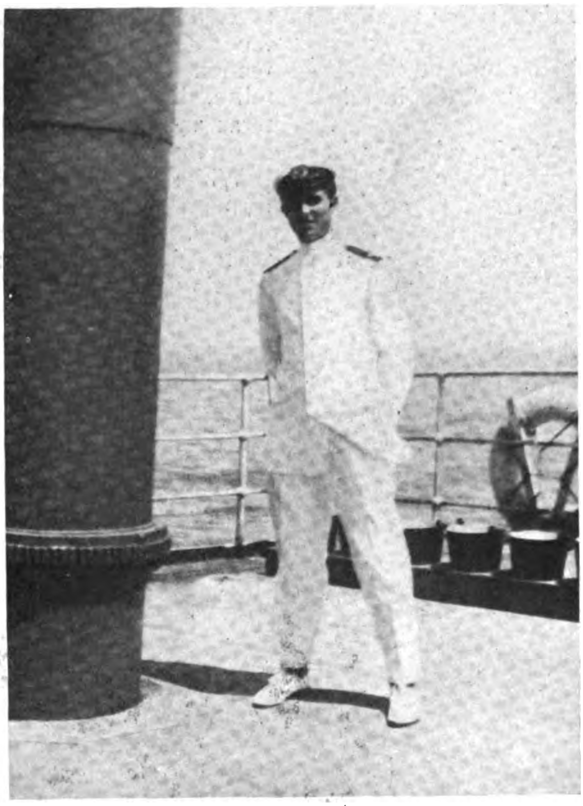
The voyage which was to prove so eventful began on November 18, 1911. When the Joachim, owned by the Hamburg-American line, left her pier in New York on that date she had among the passengers on board William Jennings Bryan, now Secretary of State. He was bound for Panama. Because this always active figure was a passenger, I anticipated that I would be kept busy during the trip, and I carefully tested the wireless apparatus aboard the Joachim before she left port.

It was perhaps an omen of the ill-fortune to follow that my aerial was carried away by the wind while we were making our way out of the harbor. The big spreader, with its four wires, came to the deck with a loud crash, barely missing one of the passengers.

The accident disturbed me not a little, because I had planned to make a good showing on long distance work. For two hours the chief officer, ten deck hands and myself worked until we succeeded in untangling the wires. We spliced the leads in several places and improvised a bridle, and I was finally able to work the set again.

During the early days of the voyage I handled considerable press matter, although I did not accomplish any results worth mentioning in long distance work. In the days of which I am writing the greater part of wireless communication took place between the land stations and the ships off shore. Yet it was customary for the old station at 42 Broadway to communicate with craft one or two thousand miles away.

But communication of this description was somewhat of a hazard, and on this voyage the nearest communicating station, after leaving the wireless zone of Cape Hatteras, was more or less a matter of good fortune until we reached a point south of Cuba, in the radio region of Guantanamo and Kingston. It was impossible to work the stations at the latter places while north of Cuba, because of the hills; consequently it was necessary for the ship operators to make arrangements with stations in the north to work with them at specified times in the early morning hours. I had arranged with Charley Hahnes, working the night trick in New York, to take my business every morning at four o'clock.



An unconventional portrait of Operator Robinson, whose unusual experiences told here are epitomized in his opening remark: "How'd you like to be shipwrecked on the shores of an island in the West Indies; have an adventure with pirates and spend Christmas and New Year's on a vessel that was stranded more than a thousand miles away from home? That's what happened to me."

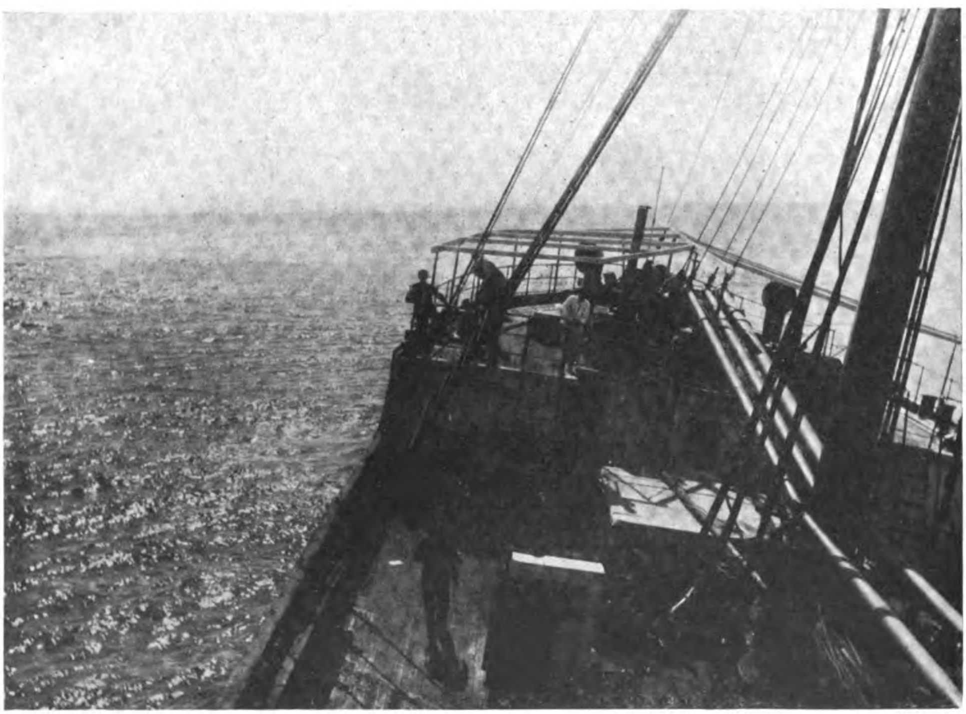
Tumbling out of bed at four o'clock on the third morning of the voyage to keep my schedule with New York, I found that the static was so bad that I could not even hear the high-power station at Key West, Fla. Despairing of establishing communication, I turned in again. Later in the morning I succeeded in working with the steamship Zacapa, one of the United Fruit Company's line, bound north, and giving her most of my traffic because I believed that I would be unable to communicate directly with New York. I also worked the steamship Panama, bound south. We were due to sight Watling Island (San Salvador) that night, the 21st. The Watling Island light failed to make its appearance at the time it was looked for, however, and Captain Fey, our commander, ordered that the vessel steam at half speed and directed that a sharp lookout be kept.

When I turned in at midnight he was on the bridge in his oilskins, for it was drizzling. Perhaps if I had known what was before me my slumber would not have been so peaceful. As it was, I enjoyed an excellent rest till fifteen minutes to four o'clock in the morning. At that time I was awakened by a slight jar. I had set my alarm clock for four o'clock and at first believed that the ringing of the bell had aroused me.

I started to get out of my berth, when the ship trembled as if she had been struck a terrific blow, slid along for a short distance and then came to an abrupt stop. Partly dazed by what I dimly realized had happened—that some sort of a mishap to the vessel had occurred, I was sure—I leaped to the floor of the cabin. As I did so I heard a loud pounding on my door and opened it to find the captain facing me.

He was somewhat excited, and told me in a quick, snappy way that the vessel was aground; that he wanted me to stand by and call for help. I made haste to carry out his orders, although at the hour and the position we were in I thought the possibility of picking up any one was slight indeed. The nearest station was Guantanamo, almost five hundred miles away, back of the Cuban hills, and in the other direction was Key West, eight hundred miles distant. I reckoned Cape Hatteras and New York as possibilities almost too remote to be considered.

While these thoughts were racing through my brain, I picked up my phones. For thirty seconds at least I "listened in"; I could not hear a sound. Starting my motor, I then sent out the S O S call for about two minutes, sign-



I was deeply impressed with the calm bearing of Mr. Bryan in the midst of the possible peril. Daylight was just breaking, and in the distance could be seen the dim outlines of Samana Island. The Secretary of State jokingly remarked that if the worst came to the worst we could land on the island, start a republic of our own, and he would run for President.

The seas ran higher than ever the following day, and at daybreak the Joachim was pounding hard. The waves would lift her up a few feet and then she would settle with a crash that was alarming.

ing S P, the call of the ship, at frequent intervals. The crystal of my set, I suspected, was out of adjustment from the shock when the vessel went aground, and then, too, I had a patched-up aerial. The outlook for receiving a response to my call appeared decidedly unfavorable.

Behind me stood Captain Fey and Mr. Stege, the chief officer. The captain was writing on a pad and he gave me the following message to send:

ASHORE SAMAMA ISLAND, 60 MILES SSE., WATLING ISLAND. WANT IMMEDIATE ASSISTANCE.

I repeated this message several times and then signed off. Great was my astonishment and unrestrained my delight when, my motor having stopped, I heard Charley Hahnes at 42 Broadway, in far away New York, giving me O.K. It was as if we were in the shadow of the Statue of Liberty instead of 1,100 miles away.

Hahnes' O.K. obviously brought relief to the captain and chief officer. They realized as well as I did that if New York could hear me, I would be able to get into communication with other stations. Soon afterward Hahnes said that he had telephoned the news of the accident to Captain Jarka, superintendent of the Hamburg-American line. The superintendent expressed a wish for more details and Captain Fey dictated another message to me, in which he said that he didn't know whether or not the vessel was safe for the time being, and that he wanted help immediately.

Following this message, Hahnes worked his set to some purpose, and, as I afterward learned, the Revenue Cutter Service and the Navy Department soon knew of our plight. By this time I was in touch with all the stations from New York to Key West. I worked Key West and sent an official message to New York, signed by Captain Fey, in which Key West was told to rout out Guantanamo. I had been unable to obtain a response from Guantanamo, but I afterward found out that the operator there heard me, but he could not answer because of a balky gasolene motor. However, he sent a tug to our aid ten minutes after he received my distress call.

While I had been working my set, many of the passengers were running here and there about the vessel like frightened sheep. Everything was in confusion. One man attempted to lower a life boat without assistance and lost control of one end when the craft was suspended in the air. A junior officer and one of the stewards were in the boat, and they were thrown into the water. They were rescued without much difficulty, and, in the meantime, the second officer and a boat's crew had taken soundings and reported that we were well up on a reef. The forward holds were found to be full of water.

The captain decided, however, that there was no immediate danger and determined to keep the passengers on board until help arrived.

I was deeply impressed with the calm bearing of Mr. Bryan in the midst of the possible peril. He came to my room, apparently unmoved and cheerful, to ask what I had done to bring aid. Then he wrote a message to his brother in Nebraska, which I managed to transmit to Key West; then he went to join the other passengers on deck. Coffee was being served, and he tried to cheer them by talking. Daylight was just breaking, and in the distance could be seen the dim outlines of Samama Island. The Secretary of State told several anecdotes and jokingly remarked that if the worst came to the worst we could land on the island and start a republic of our own. He added that he knew something of politics and would run for President. Mr. Bryan's efforts to entertain put every one in good humor, and the most fearful among the passengers began to take a more optimistic view of our predicament.

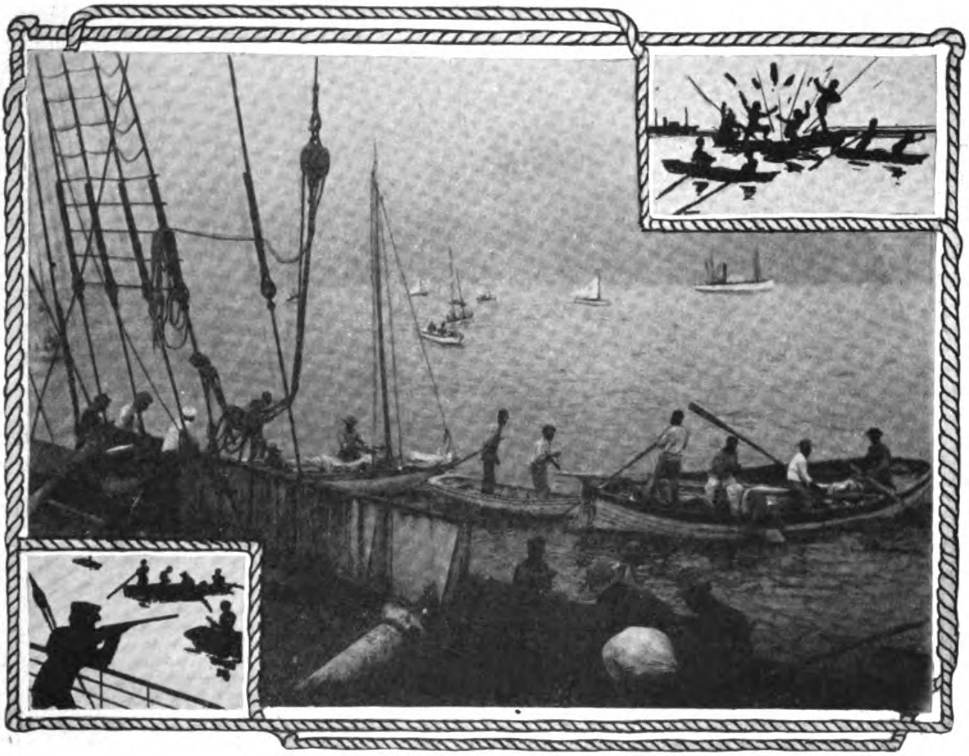
My endeavors to get into communication with other ships met with success a few hours afterward. About seven o'clock my calls were answered by the steamship Olinda, bound from New York to Antilla, Cuba. The captain of the Olinda answered that he would come to our aid, but asked us to try to reach some other craft nearer to us. While I was talking with the Olinda, the operator on the Seguranca, going from the south side of Cuba to Nassau, asked what the trouble was. Captain Fey sent a message to Captain Jones of the Seguranca, asking help, and the master of the Seguranca replied that he was on his way to the Joachim. The captain of the Olinda was then told that we had found a rescuing ship and he proceeded on his course.

The Seguranca was sighted at fifteen minutes to two o'clock in the afternoon, and the work of transferring the passengers began. I went in the first boat, Captain Fey having asked me to give the details of the wreck to Operator Bernstein on the Seguranca, so that the latter could make a full report when he arrived in New York. By the time I had finished telling my story to Bernstein the transfer of the passengers had been completed. and the crew and officers of the Joachim were ready to return to the stranded vessel.

The Seguranca was a considerable distance away from the Joachim, and when our boats started to return the men at the oars faced a long pull. It had started to rain and the boats made poor headway in the high seas. I was steering the boat in charge of the chief officer, the oars being in the hands of four stewards. None were skilled oarsmen, and it was only due, in my opinion, to the vigorous language the chief officer addressed to the stewards that we made any headway whatever. For my part, I had all I could do to keep the boat headed in the right direction.

At dusk we were still four miles away from the Joachim, and three of our boats were out of sight. Red lights were burning to guide us, and we finally managed to get near enough to the ship to catch a line. But even then our troubles were not at an end, for the waves were sweeping completely over the after part of the vessel. By waiting until we were lifted on top of a wave, and then jumping to the deck, we got aboard, one by one. Fortunately, all of us escaped injury, but within ten minutes after we had reached the deck our small boat was smashed to pieces. After I had recovered from my exhaustion, induced by the trip from the Seguranca to the Joachim, I found that it had taken us more than six hours to traverse the six miles between the two vessels.

Three other boats came straggling alongside the Joachim soon afterward, and at one o'clock the next morning all were accounted for except the three which we had lost sight of soon after leaving the Seguranca. We learned afterward that the men in these boats had been picked up by a Cuban steamship.



Then the pirates made their appearance. Although not of the Captain Kidd type, they were a source of much annoyance to us. The second officer was on guard, armed with a rifle, while the third officer had a shotgun. The pirates persisted in advancing. They were warned to halt, and several shots were fired from the deck.

The seas ran higher than ever the following day, and at daybreak the Joachim was pounding hard. The waves would lift her up for a few feet and then she would settle with a crash that was alarming. Early in the morning Captain Fey ordered me to send out the S O S call again. I received an answer from the Admiral Schley, saying that she was a few miles south of Fortune Island and would reach us about half past one o'clock in the afternoon. The Schley hove to within a few hundred feet of the Joachim fifteen minutes after the time she was expected to arrive, and forty-three of the crew from the grounded ship, including two stewardesses, were transferred to the former craft. Capt. Jensen, of the Schley offered to stand by to take off the rest of the ship's company if the weather became more threatening, but Captain Fey said that the barometer was rising and he had determined to remain aboard, as he believed there was a chance to salvage the vessel.

With the Joachim still at the mercy of the seas, the Schley steamed away. A great sense of depression seized me as I watched her disappear. The waves had subsided to a great extent, but there was little to induce high spirits in the prospect of remaining on the vessel.

I had little time to brood over my lot, however, for the next morning at eight o'clock the Vigilancia, of the Ward Line, called me. She said that she had the majority of our passengers aboard and was bound for Kingston; the plan of her captain was to stop en route and transfer the baggage of the passengers from the Joachim to the Ward liner. At the time the message was sent the Vigilancia was eighty-five miles north of Watling Island. I worked my set all day in communication with the United States cruiser North Carolina and received several dispatches from New York, one of which was a message of congratulation to Mr. Bryan on his rescue.

It was almost seven o'clock in the evening before we sighted the lights of the Vigilancia. Captain Curtis, commander of the Ward liner, hove to within three hundred yards of our stern and sent boats to get the baggage. This was transferred without incident until the last boat load left the side of the Joachim. The men had piled too much into the small craft, and when it reached the Vigilancia it overturned, throwing the occupants into the water. The men made a wild scramble for safety, their movements being hastened by the sight of several man-eating sharks.

And now I have arrived at the point in my story where the pirates made their appearance. Although not of the Captain Kidd type, they were a source of much annoyance to us. Known as Bahama pirates, it is the custom of these natives of the islands to watch for ships that pile up on the rocks, and steal as much of the cargo as they can carry away.

While the members of the Joachim's crew were jettisoning her cargo one day several schooners from the islands arrived. Immediately afterward the waters became alive with small boats manned by the islanders. Several of the craft approached the sides of the Joachim, and their occupants tried to board us.

The second officer was on guard armed with a rifle, while the third officer had a shot-gun. Undaunted by the threatening attitude of those aboard the vessel, the pirates persisted in advancing. They were warned to halt.

Even then, they did not stop pushing forward, and several shots were fired from the deck of the Joachim. At first the officers were careful to fire into the air, in order to avoid wounding the islanders, but it was later necessary to plug some of the boats full of bullet holes before their occupants decided that it would be wise for them to take covetous eyes from the cargo of the Joachim.

Notwithstanding our antagonistic attitude toward the natives, we were troubled from time to time by them during our stay on the shores of Samama. They received a well-deserved scare, however, when the United States cruiser North Carolina and the revenue cutter Algonquin arrived. The big cruiser loomed into view from the north almost simultaneously with the appearance of the revenue cutter to the south. The pirates saw the vessels as soon as we did, and made haste to scurry to their schooners and sail away.

Recovering from their fright a short time afterward, they returned to the scene of the wreck. Evidently the temptation to obtain what they could of the vessel's cargo overcame their fear of the North Carolina and the Algonquin. The wrecking tug Premier had arrived, and Captain Johnson, the wrecking master, threw considerable of the less valuable portion of the cargo over the side.

One case hurled overboard contained explosives, and the natives, eager to obtain possession of it, raced toward the floating object. The case was some distance away from the ship when they reached it, and a general scramble to obtain possession of the prize resulted.

One of the natives, evidently anxious to open the case, struck it with an axe. A terrific explosion rent the air, and a second later a few scraps of wood tossing on the disturbed waters were all that remained of the boats and men. The remainder of the pirates beat a hurried retreat from the vicinity, and we learned afterward that they believed the Algonquin had fired a shot at them.

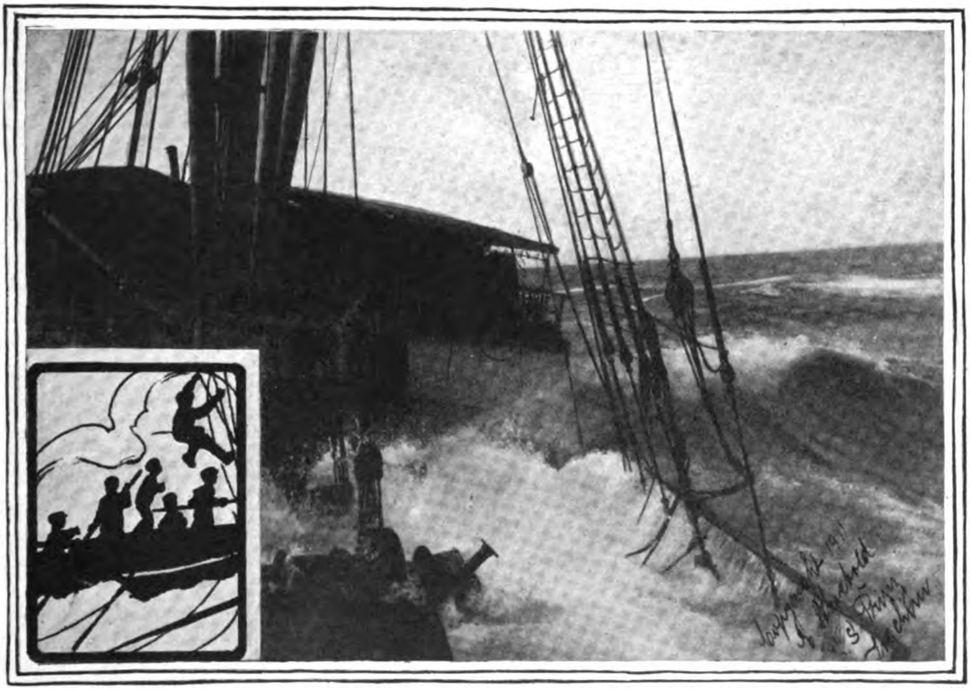
Strong winds kicked up a rough sea during the next three days, and the Algonquin and the Premier were compelled to remain under the lee of the island. On the third day the waters became calm enough for the vessels to approach us again, and the captain of the Algonquin announced that he intended to return to San Juan unless Captain Fey wished the revenue cutter to remain. Accordingly, the Algonquin steamed away from Samama; but not before her commander had left with us half a dozen rifles and as many revolvers.

To my mind, this narrative has quite enough of storms and blows in it, but it would not be complete if I did not mention that the gale kept up for two weeks following the departure of the Government vessels.

Christmas and New Years aboard the Joachim were made notable events. One of the stewards went ashore a few days before Christmas and obtained a fir tree; this he decorated and surrounded with a miniature snow village built on one of the dining tables in the saloon. Our tanks had been destroyed, and we had no fresh water, but there was a plentiful supply of beer and soda water aboard. Several of the men went ashore to shoot ducks, and were so successful that we had enough fowl for all the members of the ship's company, and a general jollification followed.

The Joachim was floated about the middle of January, and a few weeks later we started for New York. We encountered another storm en route, but proceeded under our own steam, although a line was made fast to the wrecking tug Relief, which had come from New York to convoy us.

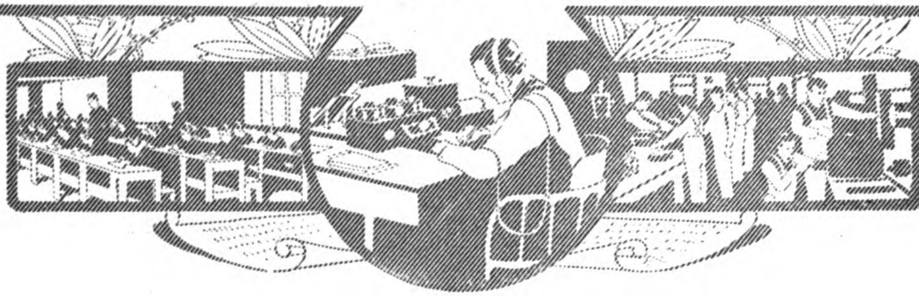
It was a very hard blow, but we came through it safely. I was mighty glad to see the good old New York skyscraper line and know that my adventures were ended.



The waves were sweeping completely over the after part of the vessel. By waiting until we were lifted on the top of a wave, and then jumping to the deck, we got aboard, one by one.

So far as I am concerned, the others who clamor for shipwreck experience are more than welcome to my future share, whatever that may be. Everything turned out all right in the incident I figured in, but there were a lot of close calls, hours of suspense, and excitement enough to last me for some time to come. I would not have missed it for anything on earth, but I am not exactly eager to repeat the experience. At least, not right away!

WIRELESS ENGINEERING COURSE



By H. SHOEMAKER
Research Engineer of the Marconi Wireless Telegraph Company of America

CHAPTER XIV

Electrical Oscillations

THE production of sustained oscillations or those having no decrement, is not so simple as the production of damped oscillations. They can, however, be produced by the discharge of the condenser through a direct-current arc, between carbon electrodes or between metallic and carbon electrodes.

The direct-current arc has a resistance which decreases with an increase of current, and is said to have a negative characteristic. This decrease of resistance with an increase of current is greatest for certain values of current through the arc, so that with a certain current value a slight variation of current will cause a great variation of resistance. If the supply of current to the arc is limited so that the current can not vary with this variation of resistance, the potential across the arc will vary if anything happens to disturb the resistance of the arc. In the diagram shown in Fig. 58 G is a direct-current generator, or any other source of direct current, R R′ are resistances, of such value as to maintain the proper current value through the arc S.

These resistances can be wound inductively to advantage, as they will then tend to prevent any sudden variation of current through the generator. The arc S is connected to condenser K and inductance L. Another inductance L′ has one of its terminals connected to the aerial A, and the other terminal to the ground E. This figure is an elementary diagram of a complete wireless telegraph transmitter, providing a key is inserted in either the open oscillating circuit or the closed oscillating circuit for the purpose of signaling.

The operation of this circuit is as follows:

An arc is started between the carbons by bringing them together and then separating them slowly. As soon as this arc is of proper length the condenser K starts to charge; this robs the arc of some of its current, which in turn increases its resistance. The increase of resistance causes the potential across the arc to rise, and the rise of potential causes the condenser to take more current. As the current flowing out of the generator through the arc is limited by the resistances R and R′, this increase of potential and increase of resistance of the arc continues until the potential across the arc is the same as that across the generator, or nearly so.

The condenser now starts to discharge back through the arc. This increases the current through the arc, and consequently lowers its resistance, and also its potential, until the condenser ceases to discharge any more current through the arc. The condenser discharge through the arc has increased the current through the arc and lowered its resistance to a much lower extent than it could be lowered from the current flowing from the generator. The condenser now begins to charge again, robbing the arc of its current and increasing its potential; this process is repeated continuously as long as the arc has a proper length. The inductance in series with the condenser has the effect of giving this circuit inertia or a definite time period.

The time period of the oscillation produced by this method is not, however, solely dependent on the $\sqrt{LK}$, as is the case with damped oscillations. The length of the arc and the current flowing through the arc have a slight effect on the period of the oscillations.

When an open arc is used it is impossible to produce oscillations having a frequency over fifteen or twenty thousand. But when this arc takes place in an atmosphere of hydrogen or a gas containing hydrogen frequencies as high as 1,000,000 can be produced. This is probably because hydrogen has a greater heat-conducting power than air.

This form of producing sustained oscillations has not come into commercial use to any great extent at present. This is due to the limited amount of energy which can be used and also the critical adjustment necessary to maintain its operation.

Alternating-current generators which give a frequency as high as 100,000 cycles with an output of 2 K. W. have been constructed and used. These generators have 600 poles and opérate at a speed of 20,000 R. P. M. They are troublesome to operate, and for this reason have not as yet come into commercial use.

The superiority of sustained or continuous oscillations over damped oscillations has been given sufficient proof to warrant further investigation and development along this line. With this type of oscillations, resonant phenomena are much more marked than with damped oscillations. The problem of tuning the receiver and transmitter together is considerably simplified by their use.

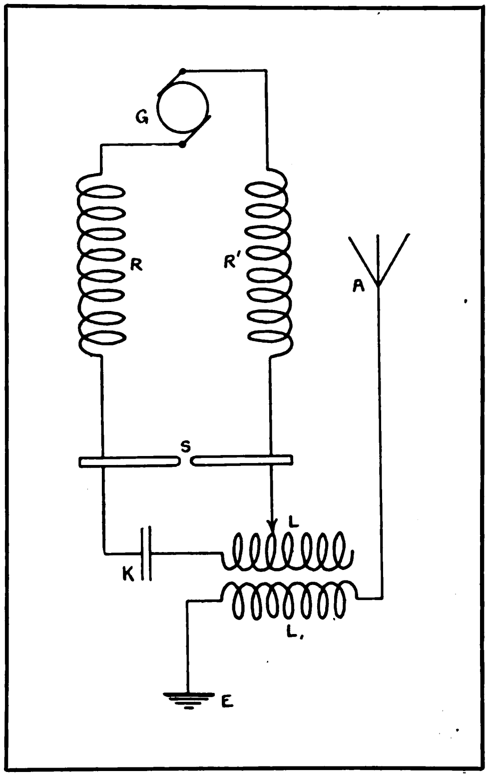


Fig. 58

The electro magnetic waves radiated from the antenna are also continuous, and when audible receiving apparatus is used no audible sound will be heard, unless one of the oscillating circuits or the telephone circuit is interrupted. In that case, the note, or sound in the telephone, will be due to the interrupting device. The sustained oscillations produce a continuous flow of energy, and consequently a continuous effect on the detector.

This fact has been taken advantage of for telephoning, in which case a telephone transmitter is inserted in the radiating circuit of the transmitter, which varies the intensity of the radiated waves in accordance with the sound waves produced when the transmitter is spoken into. This, in turn, causes the detector at the receiver to vary the current in the same manner, thus reproducing speech or sounds.

Receiving Aparatus

In Fig. 50, Chapter 12 (a preceding article), I have shown an elementary diagram of the simplest form of receiving circuit. This form of circuit is not used in practice at the present time. Instead of inserting the detector in series in the open oscillating circuit, as shown in Fig. 50, the general practice is to use an open circuit, as shown in Fig. 59, where A is the antenna, L a variable inductance, and E the ground. K is a variable condenser connected in series between L and E, for the purpose of reducing the natural period of the open circuit. The condenser is not necessary except where the wave length of the received waves is shorter than the wave length of the circuit. This shortens the wave length of the circuit because it puts a capacity in series with the capacity of the aerial, thus lowering the total capacity of the circuit.

The variable inductance L' is inductively related to L, and has its terminals connected to the detector D through condenser k. To the terminals of condenser k is connected the telephones T, potentiometer P and battery B. If the detector used does not require batteries for its operation, then the potentiometer and battery may be eliminated.

As the open circuit can be constructed with a small amount of resistance, the damping in that circuit can be kept low. When oscillations are taking place through the inductance L, they induce oscillations in the inductance L'. If the resistance of the detector D is low enough and the inductance L and capacity k are adjusted for resonance with the open circuit, then a maximum response will be obtained in the telephones T. If, however, the detector D is of high resistance, that is, 1,000 ohms or more, then the closed circuit will not resonate, but there will be a maximum current flowing through the detector when L' and k have the proper values. In that case the current flow will depend on the resistance, and not on the capacity and inductance. The circuit is still tuned, although it is not a resonant circuit. The maximum tuning effect can then be obtained by proper adjustment of the open circuit.

Fig. 60 is a diagram of the circuits generally used in wireless receiving apparatus at present. A is the antenna, L^2 is a variable inductance, and L is another variable inductance, which is also the primary of an oscillation transformer. K is a variable condenser and E the ground connection. These elements are all in series and constitute the open oscillating circuit. L^2 is used to increase the natural period of the open oscillating circuit without increasing L. K is used to decrease the natural period of the open oscillating circuit. The open oscillating circuit is adjusted to resonance with the received waves; then the closed oscillating circuit comprising the inductance L', which is in inductive

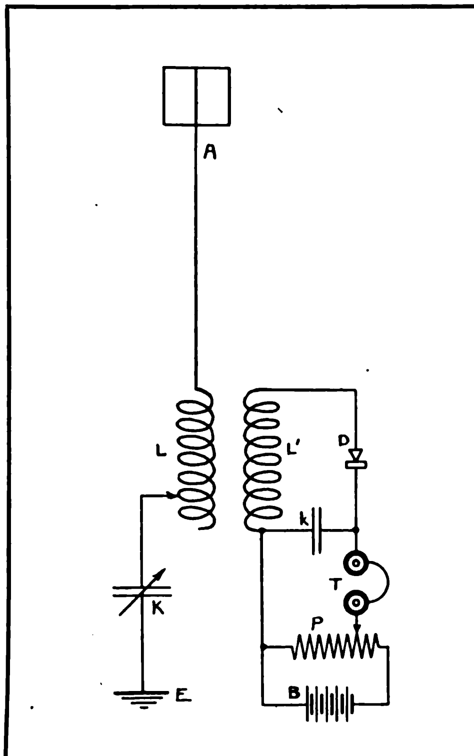


Fig. 59

relation to L, and the variable condenser K' is adjusted to have the same time period as the received waves.

The latter circuit is of low resistance

and consequently small damping. By adjusting the inductive relation of L and L′ the reaction of one circuit on

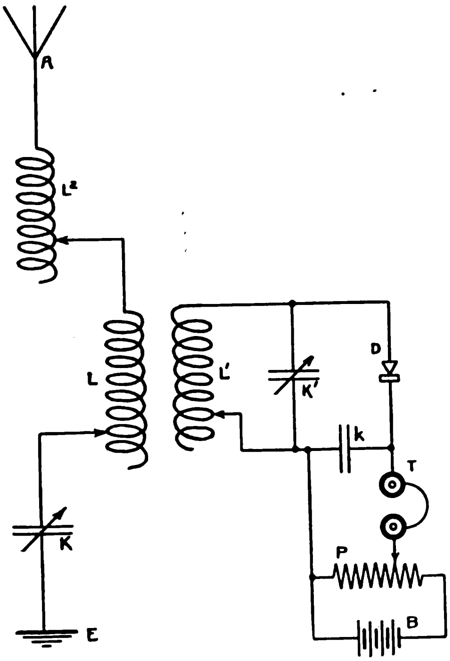


Fig. 60

the other is reduced to a minimum, so that sharp resonance is obtained in the closed circuit. This causes an excessive rise of potential at the terminals of the condenser K′. To the terminals of condenser K′, and in series with each other, are connected the detector D and the condenser k. To the terminals of the condenser k are connected the telephones T and the potentiometer P and battery B. When oscillations are taking place in the closed circuit the detector D is subjected to an oscillating potentional across K′.

This causes current to flow through the detector and condenser, which either varies its resistance and causes the battery current to fluctuate through T, or is rectified by the detector D; in the latter case the oscillating current itself is used to operate the telephones. It can be readily seen that the high frequency current itself, even if it were able to pass through the telephones, could not cause an audible response. If it is quickly rectified, however, we get a number of small impulses in the same direction, which affect the telephones. The detector should be of high resistance, so that it will not take energy from the closed oscillating circuit too rapidly.

The value of the inductance and capacity used in the different circuits depends entirely on the range of wave length which it is desired to operate with, and also on the resistance of the detector used. These values, in practice, are generally determined by experiment. In fact, it can be said that the higher the resistance of the detector the smaller should be the capacity of the condenser K′ and the larger should be the inductance L′. The effect of this is to increase the potential across the detector D.

I shall not attempt to describe the numerous kinds of detectors in general use at the present time, but will refer the reader to "Principles of Wireless Telegraphy," by G. W. Pierce, in which these detectors and their characteristics are fully described. For those desiring to go into the question of wave propagation, the reader is referred to Chapter 5, "Principles of Electrical Wave Telegraphy," by J. A. Fleming.

THE END

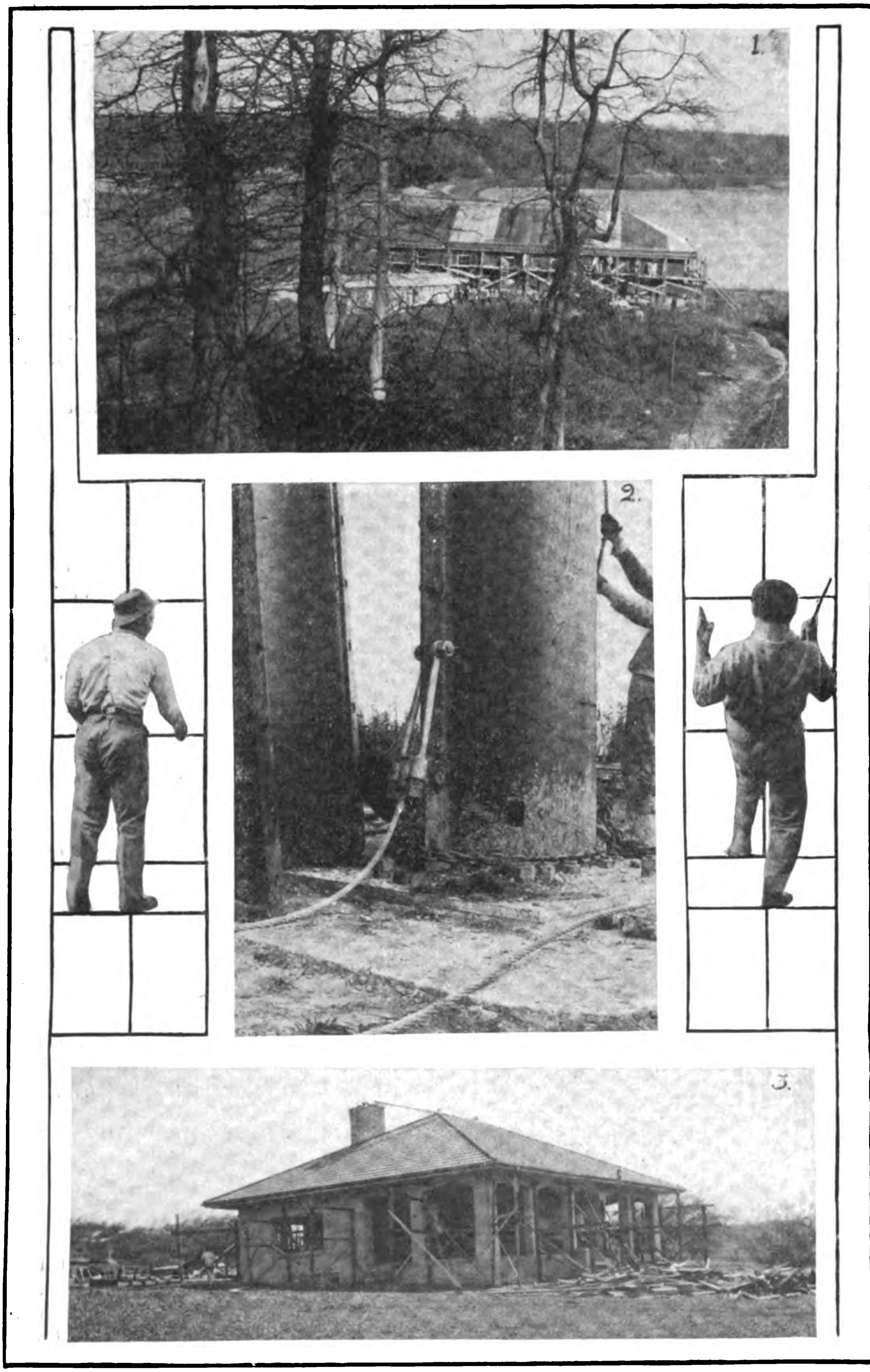
This course commenced in The Marconigraph, issue of December, 1912. Copies of previous lessons may be secured. Address Technical Department, THE WIRELESS AGE.

U. S. STATIONS IN ALASKA

Lieutenant Edwin H. Dodd, of the United States Navy, radio officer in charge of the expedition which established permanent wireless telegraph stations in Alaska, has made a report which is in part as follows:

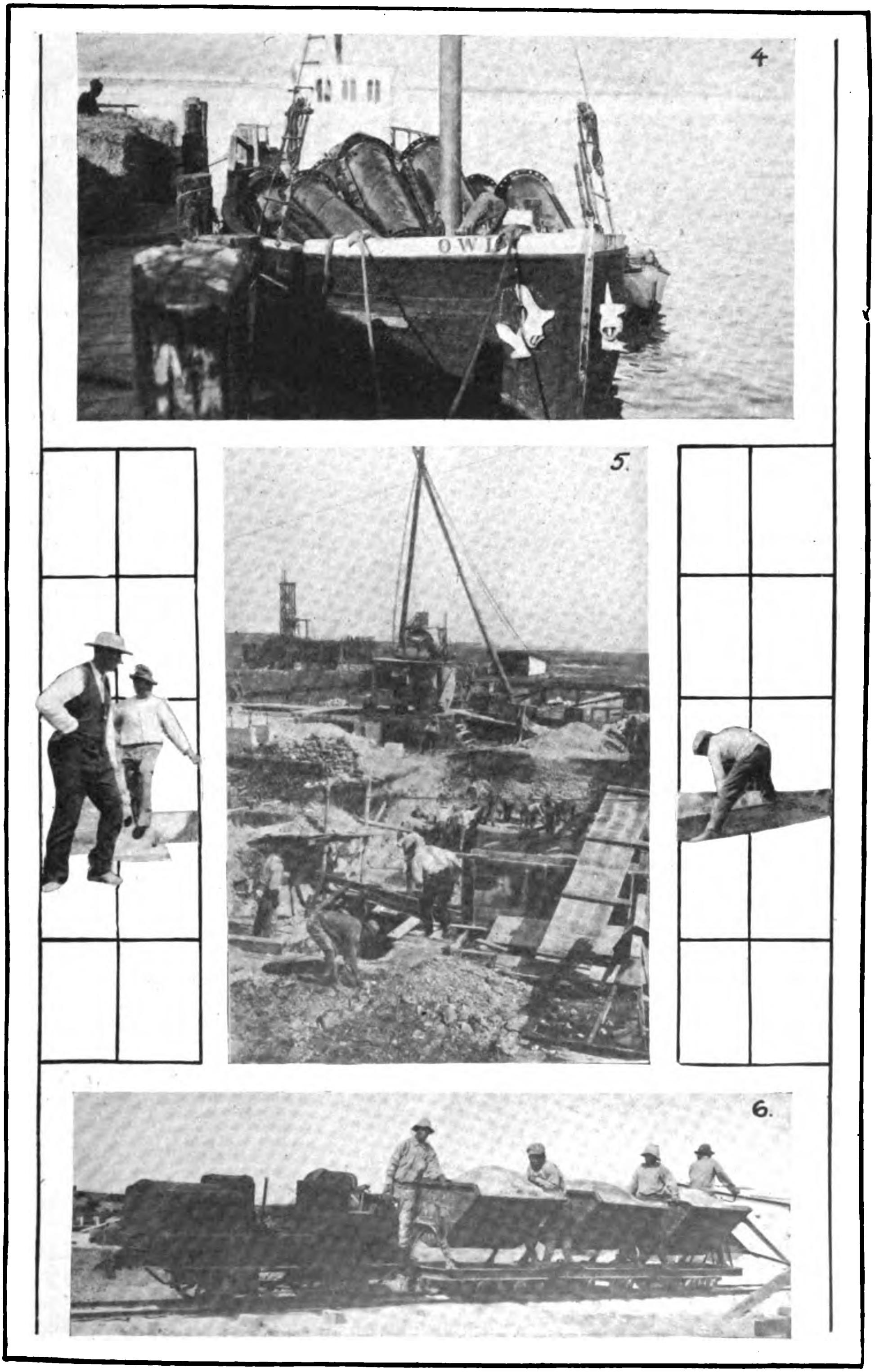
"The importance of the Alaska stations will increase from year to year. Unalaga can be a relay station from the United States to Japan and Siberia. Communication with the former has already been established via Otchisi. Dutch Harbor is the farthest point to the westward at which a weather observer is stationed, and the daily reports from that station are of great assistance to forecasters in making weather predictions for the Pacific coast."

Latest Pictorial Reports



(1) The operating building at the Belmar receiving site is now awaiting the roof tiling, as may be seen in this view taken from the hotel. (2) An illustration of the simple and effective way the mast stays are secured. (3) A typical residence as it nears completion.

on the High Power Chain



(4) *One of the methods of transportation employed in delivering mast sections to the Honolulu sites.* (5) *Condenser pit excavations made under difficulties.* (6) *An illustration of the ingenuity of the Marconi engineers: the chassis of an automobile transformed into*

OPERATORS' INSTRUCTION

CHAPTER VII

DETERMINING THE WAVE LENGTH OF THE RECEIVING CIRCUIT

THE method for obtaining the wave length of a distant transmitting station at a receiving station is shown clearly in Fig. 21. An inductively coupled tuner is represented by its primary and secondary windings and it will be noted that in reality the secondary

Inasmuch as the circuit contains a variable condenser and a variable inductance it is comparatively easy to construct a table giving the wave length of the receiving circuit at any given adjustment of either the variable condenser or the variable inductance.

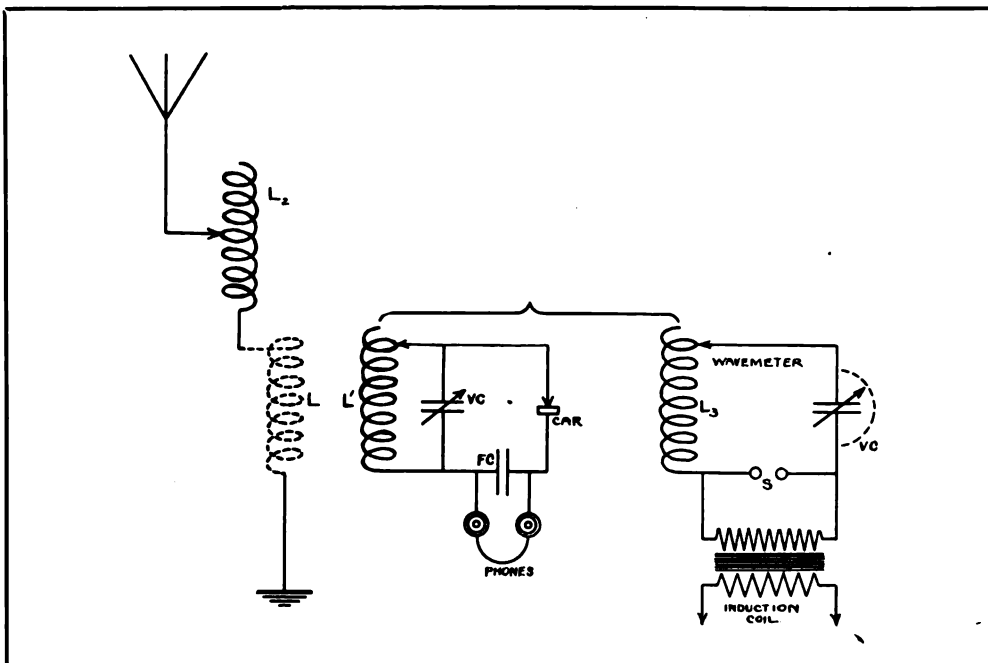


Fig. 21

circuits of a receiving tuner are not unlike the circuits of a wavemeter, i. e., consisting of a variable condenser in shunt to an inductance coil.

When this reading is taken the coupling between the primary and secondary of the receiving tuner must be "loosened" up as far as possible for the

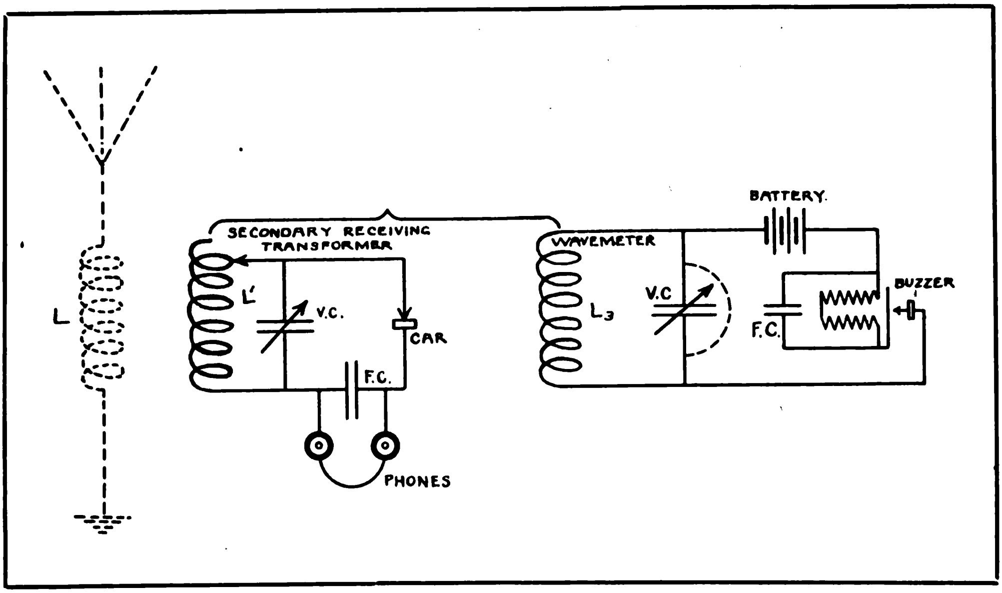


Fig. 22

signals still to be read. By reference to the table the wave length of the distant transmitting station is obtained, it being understood that the antenna and the inductance included in the open circuit are of such combined value as to be within the limits of the wave lengths it is desired to receive.

As before stated, the coupling between the primary and secondary circuits of the tuner must be made as loose as possible, for if this is not complied with, the degree of coupling between the primary and secondary circuits will influence the effective self-induction of the local circuit to the extent that the wave length readings are not apt to be accurate. The smaller the degree of coupling when taking the readings, the more accurate will be the determination of the distant transmitting station's wave length.

To present a typical case showing the calibration of the secondary circuit of a receiving transformer, herewith is furnished a table showing the wave length adjustments possible in the closed circuit of the Marconi Type "E" tuner. Calibrations are not given for all the points on the scale of the variable condenser, but are sufficient for general commercial work.

CONDENSER SCALE

Points on Inductance Switch	C_0	C_1	C_3	C_5	C_8	C_{10}
1	300	350	390	400	440	500
2	425	460	575	650	750	1000
3	600	700	850	1025	1100	1340
4	790	900	1100	1285	1400	1590
5	950	1035	1275	1460	1650	1920
6	1100	1150	1425	1625	1875	2175
7	1240	1395	1550	1790	2095	2475
8	1330	1450	1675	1925	2300	2660
9	1425	1600	1825	2090	2490	2825
10	1490	1720	1820	2275	2650	3000

It will be evident from the table that a given wave length adjustment may be obtained with two or more values of inductance and capacity.

For example—the 1,100-meter adjustment may be secured with:

(1) Six points in use on the inductance coil and the variable condenser at zero.

(2) With four points on the inductance and the third division on the condenser scale.

(3) With three points on the inductance coil and the variable condenser at division 8.

The arrangement to be used (1, 2 or 3) depends upon the degree of coupling. If "loose coupling" (to prevent interference) is desired use arrangement (3). For a tighter coupling (2) or (1) may be employed.

Operators at present in the employ of the Marconi Wireless Telegraph Company of America can make use of the foregoing table in adjusting the Type E tuner to a definite wave length.

Receiving sets are for the present rarely calibrated directly in wave lengths and if no table is furnished, adjustments of the tuner for resonance are best obtained by practice; this, however, is not difficult, as all coast stations communicating with ships carry on correspondence at a wave length of 600 meters and, after an operator has once determined the adjustments on the tuner for the 600 meter wave, it is easy to judge the values of inductance and capacity to use in either circuit for longer or shorter wave lengths.

If a wavemeter is at hand it may be used to determine the wave length of a distant station from the adjustments at

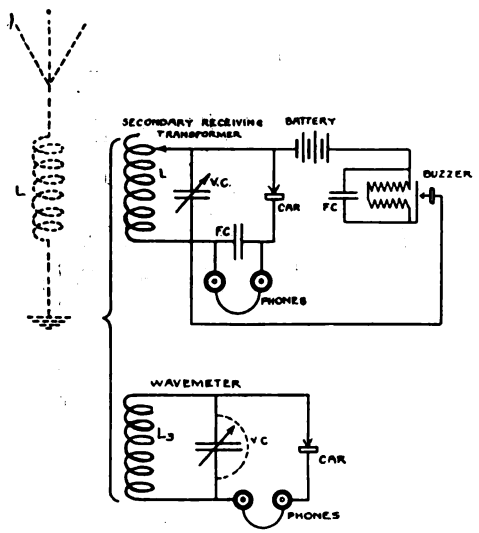


Fig. 23

the receiving station, as shown in Figs. 21 and 22.

The secondary of the receiving tuner circuit is adjusted to the highest point of intensity of signals from the distant transmitting station by means of the variable condenser, *VC*, and the variable inductance, *L'*. To the right of the secondary is shown the circuits of a standard wavemeter in series with which is placed a micrometer spark-gap, *S*. The wavemeter is energized by means of a

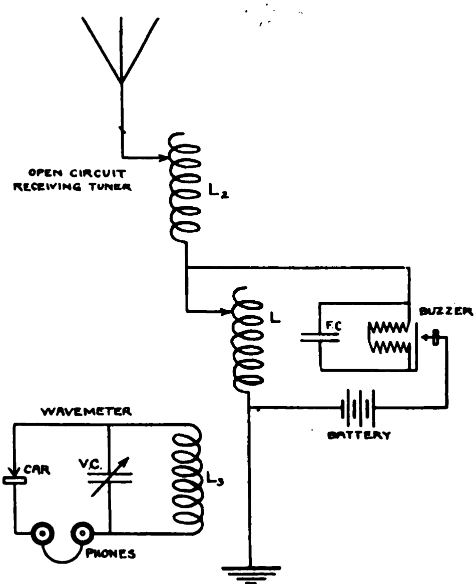


Fig. 24

small induction coil, the secondary of which is connected to the spark-gap, *S*. When the coil is in operation, high frequency oscillations are set up in the wavemeter circuit and are to some extent radiated. The wavemeter is then placed near enough to the secondary circuit to act upon it inductively and the variable condenser of the wavemeter altered until a maximum of sound is obtained in the headphones of the receiving set.

At the point where the maximum sound is obtained, resonance between the wavemeter and the local circuit of the receiving set is indicated, and therefore it is only necessary to note that wave length reading in meters on the wavemeter to determine the wave length to which the receiving set is adjusted. The wavemeter may be used in this manner to test the sensitiveness of the detector. It should be placed some distance from the tuning circuits.

The presence of the spark-gap in series with the wavemeter introduces damping in the circuit and does not allow the accuracy of reading which otherwise might be obtained. More accurate readings are secured by the method shown in Fig. 22, where it will be noted that the wavemeter is excited by a buzzer and battery cells, rather than by an induction coil.

It should be observed that the circuit of the buzzer is made through the wavemeter, and when the buzzer is in operation a change of lines of force takes place through the wavemeter coil, causing the condenser of the wavemeter to be charged and then discharged through the circuit. Thus, high frequency oscillations are set up in the wavemeter and may be recorded on the receiving tuner detector, as previously described. Accurate readings may be taken by this method, provided all is in proper adjustment.

In making tests of the wave length received, the latter method may be reversed; the circuits for this are indicated in Fig. 23. The receiving tuner is adjusted to the greatest intensity of signals and then the buzzer circuit is used to excite the receiving tuner circuit. The carborundum crystal and head phones are now connected to the wavemeter in the regular manner. The local circuit of the receiving tuner now becomes the transmitter and the wave length may be read directly upon the wavemeter.

The wave length of the open oscillatory circuit of the receiving tuner can be read in the same manner as shown in Fig. 24. The buzzer circuit is connected to the coil of inductance (whatever amount of inductance is in use in the open circuit) and when the buzzer is in operation high frequency oscillations traverse the antenna, which may be read directly upon the wavemeter.

Test Buzzers—Test buzzers are often used to determine the adjustment of a receiving outfit for the most sensitive adjustment without necessarily receiving signals from a distant transmitting station. The device is shown in Fig. 25, near to the tuning circuits, and consists of an ordinary buzzer with a condenser shunted around the vibrator. It is in reality a miniature transmitting set, sending out highly damped waves, which, in turn, induce currents in the receiving tuner circuits, enabling the operator to secure a maximum degree of sensitiveness in the detector adjustment. Sometimes a small coil of wire is connected in series with the condenser, and this coil is placed in inductive relation to some part of the receiving circuit.

In General—In the general operation of all receiving tuners, operators will find it of great value to take note of the best adjustment for any given land or ship station. This is easily possible, for all receiving tuners have empirical scales on the variable inductance and the variable capacity. By reference to this table the apparatus may be adjusted in advance to the particular wave length of a distant radio station.

The importance of this is obvious; suppose after the operator had finished communication with some ship or land

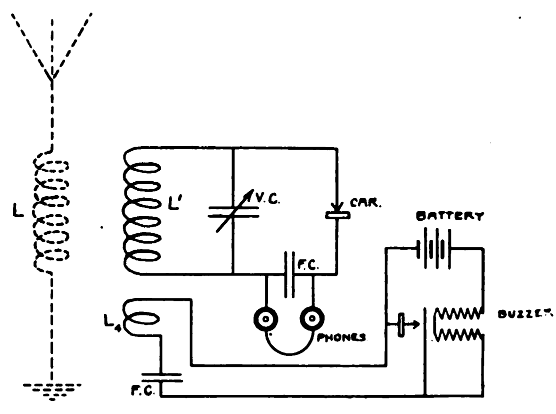


Fig. 25

stations at 600 meters and then desired to tune the receiving apparatus to the 1,650-meter wave of Cape Cod, it would certainly tend to greater efficiency to be able to preadjust the apparatus rather than simply "feel around" for the particular receiving tune.

(*To be continued*)

SUSPENSION FOR OPERATOR

The United States Department of Commerce recently suspended for a period of thirty days the license of a wireless operator who had been found asleep at his post three times during the voyage of the steamship on which he was detailed.

A Unique English Relay

By FRANK C. PERKINS

A MOST interesting type of telephone relay, which it is claimed may be applied to wireless, has been devised by S. G. Brown, of London, an American whose native city is Chicago. The relay has been developed along quite new lines. It takes as its basis the researches of J. J. Thomson, Earhart, Kinsley and others, with regard to the flow of electrons across a microscopic air gap between two conducting surfaces at different potentials.

This English telephone relay has been used on the electrophone system, and by its aid, and on damping the reed with a piece of rubber, the speaking and music from the theaters are rendered with loudness and greater clearness than it is possible to obtain with the telephones supplied by the Electrophone Company. By adding a loud-speaking device with trumpet the sounds may be heard at some distance in the room.

Fig. 1

The accompanying illustration (Fig. 1) and drawing (Fig. 2) show the construction of the instrument with the brass cover removed. It will be noted that N is a permanent magnet, continued by soft iron poles right up to but not touching, the steel reed P. Two sets of coil windings are wound around the soft iron pole extensions H and K. The telephone currents to be magnified circulate round the winding H, and by thus varying the magnetism set the reed P on variation. M O are the top and bottom metal contact pieces, which are opened to an infinitesimal degree to form a microphone by the fine adjusting screw W, and the action of the local current passing through the contact and round the winding K. It is by the action of the local current operating through this winding that the conduction space is formed, and afterwards the microphonic adjustment maintained.

It is claimed that so good is the automatic adjustment that the instrument may be turned upside down without scarcely any noticeable alteration in the value of the local current and without any effect on the working of the relay. The regulating winding K must not act when H is traversed by the rapidly varying telephonic current; this is brought about by surrounding the iron under the coil by a closed circuited copper sheathing. Eddy currents set up in this sheathing circuit by mutual induction destroy the self-induction of the coil.

It is stated that in earlier instruments the lower contact O was carried by a thin iron disc; the relay was then very susceptible to outside noises. For this reason a reed is now used, for it exposes such a small surface to the air that it is practically unaffected by extraneous sounds.

It is claimed that this relay will magnify the very feeblest telephone currents. Speech or signals that are too faint to be heard in the ordinary bell receiver may be heard clearly when employing the relay. If a watch be held against the ear-piece of a Bell telephone the inducted currents produced will reproduce when passed through the instrument, the ticking in the receiver attached. This is a severe test.

This property of magnifying feeble telephone currents has made this new relay useful in wireless telegraphy. On replacing the telephone by the relay and telephone used, the increased sensitiveness thus obtained doubles the distance over which it is possible to receive signals. Its utility in this direction has been tested by the Admiralty and Post Office. In a wireless receiving station messages too weak to be heard when listened for with the relay in circuit, were easily read. At the invitation of Mr. Marconi, Mr. S. G. Brown took two instruments to the Haven Hotel, Poole. In one of the tests (Clifden, in Ireland, sending with the Marconi musical spark) the signals were heard in the telephone directly connected to the wireless receiver, as a faint, but clear and pleasing, series of musical notes. But, with two relays working joined to the system in series, the signals were rendered loud enough to be heard clearly by every person in the room, and an operator listening at a distance of several yyards from the instrument could have deciphered the message. The relay is not easily affected by extraneous noises and vibration. It can thus be carried on board ship and worked in all weathers.

In reference to its utility on ordinary telephone lines, speech may be magnified many times in loudness without preceptible loss in the articulation, and it will work with large currents to a point at which the Bell receiver in its local circuit is responding with uncomfortable loudness. In experimenting over a 20-pound standard cable under water and speaking but one way, it has been proved that when the relay is applied 30 miles may be added to any length through which it is possible now to speak direct. For instance, supposing the length of the core for direct speaking to be 20 miles, this may be increased to 50 miles for the same loudness and approximate clearness when the relay is in circuit either as a single

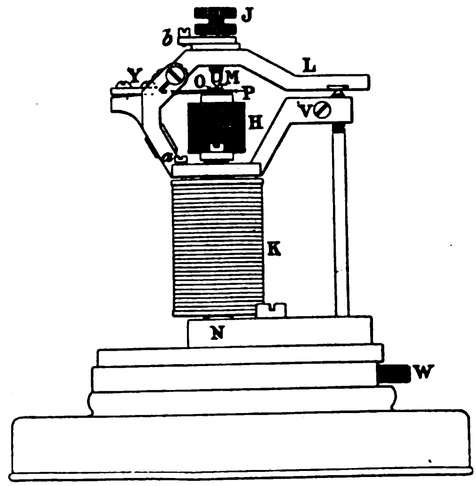


Fig. 2

repeater at the end of the first 20 miles, or as a receiver at the end of the 50 miles.

It is stated that these tests prove that the telephone currents are increased by the relay in strength to the extent of something like twenty times. If greater magnification than can be obtained with one relay is required the simplest method would seem to be to employ two relays working in tandem. Their combined power would then be 400 times. In the majority of cases it is not necessary to add to the natural electrical damping of the reed, but if a piece of soft rubber be made to touch it the voice can be transmitted with greater clearness even than if the conversation were taking place ordinarily in a room. This may be due to the complete absence of echoes.

Advocating Wireless for All Lake Boats

WIRELESS for every steamer on the Great Lakes, passenger and freight, now seems to be the idea of the House Committee on Merchant Marine and Fisheries, before which the passenger steamboat men of the Great Lakes, the bays and sounds are laying their protests against the La Follette seamen's bill. This is indicated by the well-evidenced inclination of the committee so to amend the seamen's bill for all classes of steamers, saving, of course, river and harbor steamers, as to require a wireless outfit.

The questions asked generally by the committeemen show them to be in serious doubt as to the real value of the La Follette bill as a provision for the greater protection of life at sea. The committee is laying great stress on the danger of fire, and is permitting the vesselmen to bring out the fact that the measure championed by Senator La Follette and passed by the Senate makes no mention of fire protection or wireless.

The vesselmen are being questioned closely on both these matters, and it is a general observation by the witnesses that fire is the thing most feared at sea. The vesselmen are unanimous that wireless is the thing imperatively needed on all ships. They put it: "What good is wireless on one ship if she is unable to use it for communicating with other ships from which she might need aid?"

Several of the witnesses have declared that a general provision for wireless would be of far more effectiveness for the safety of life than any provision calling for "100 per cent life boatage."

The passenger steamboat men of the Great Lakes have shown some reluctance to emphasize this subject. They have stated to the committee that they are passenger steamboat men, and not freight-boat men. They have insisted that they preferred to confine the discussion to their own boats, especially as the subject of protest has been limited to the safety provisions of the seamen's bill.

Full credit has been given the lake freighters for carrying 100 per cent lifeboats at the present time. The passenger steamboat men insist they have played more than fairly by the freighters and their operators, and they have insisted that as things stand the freighters will not have to make any changes in their equipment, even though the seamen's bill passes in its present form.

The committee holding the hearings seems to take the view that when it comes down to a question of real safety fire should be given consideration, and the Congressmen seem inclined to act along this line, excluding the lakes, at least, from the lifeboat requirements on the 100 per cent basis and amending the bill further to take precautions against fire and to insist on wireless for all ships.

Testimony was given by A. A. Schantz, general manager of the Detroit & Cleveland Navigation Company.

Schantz stated that all of the ten boats of his line have carried wireless from the outset without having been required to install it by the Government.

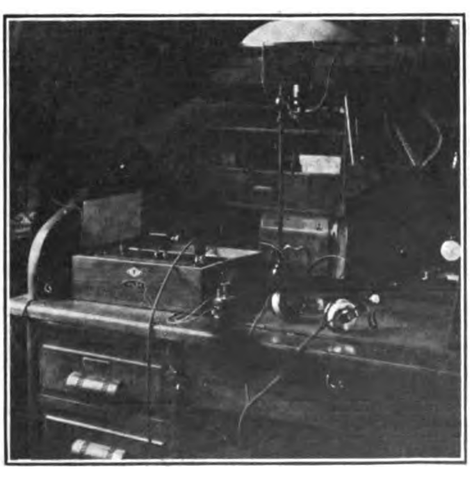
In conclusion he stated that the only things feared on the lakes are fire, fog and snow. The passenger boats do not run in winter, and so are free from the perils of snow. Fog is met by slowing down and by constant fog whistling. Fire, he explained, is guarded against by the best fire preventive and fire-fighting apparatus possible to install, adding that "for further protection we believe that wireless for all steamers will give us greater protection than any other measure."

Time Signal Station at the Hamburg Observatory, Bergedorf

German Wireless Time Signal Stations

THE first wireless astronomical time signals were tried in 1906, and the first regular wireless time signal service was established in 1907 at Camperdown wireless station, near Halifax. In 1910 wireless time signal service was placed in operation between Paris, German Norddeich wireless stations and the Imperial Marine Observatory at Wilhelmshaven.

The wireless time signal equipment of the Hamburg Observatory at Bergedorf, Germany, seen in the accompanying illustrations, is under the direction of Dr. R. Schorr, who established this wireless installation in August, 1911. The antennæ consist of copper conductors of two millimeters stretched in a horizontal position, the total length of these aerial wires being 320 meters. They are located at a height of from 8 to 15 meters from the earth.

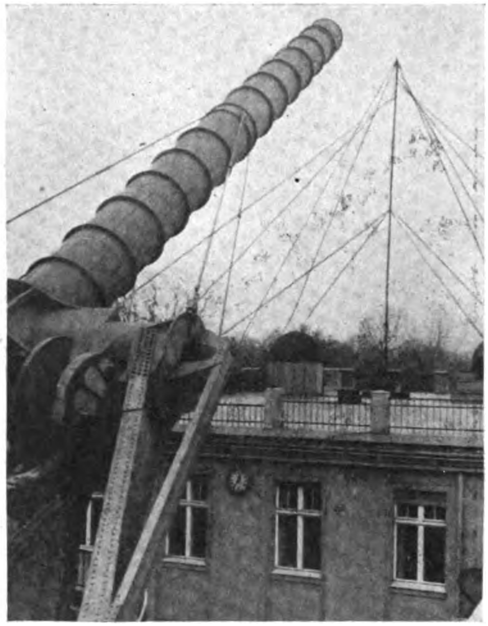


Receiving Apparatus of the Signal Station at Mülhausen, in Elsass

The wireless receiving equipment used is that of Mr. Erich F. Huth, of Berlin. This apparatus measures 180 mm in length and 170 mm in width, with a height of 260 mm; and includes a thermodetector and double-head telephone receivers of high resistance. A small transmitting equipment of 2,000 meter wave length is utilized at Norddeich and Paris. The total weight of the apparatus is only 5.5 kilograms. The distance between Norddeich and Bergedorf is about 200 kilometers, while the distance between Bergedorf and Paris is fully 730 kilometers.

The Berlin wireless signal installation at the Treptos Observatory includes a mast 18 meters high carrying the antennæ with wireless instruments of the Normalzeit Gesellschaft. At the municipal Technical School at Mülhausen, in Elsass, Germany, there is a wireless time signal station under the direction of Dr. Hans Zickerdraht. This wireless is so arranged that any wave length may be used from 200 to 2,500 meters. Time signals are sent at intervals day and night, although usually not more than four signals are transmitted in 24 hours.

Wireless Equipment of the Hamburg Observatory



Time Signal Station of the Treptos Observatory

WIRELESS LAWS IN NEW ZEALAND

The Governor of New Zealand has been empowered to require that ships registered within his jurisdiction and carrying passengers shall be equipped with apparatus for transmitting messages by wireless telegraphy. The regulations specify that every steamship registered in New Zealand and carrying passengers, engaged in foreign or intercolonial trade, except steamships trading to the Auckland, Chatham or Campbell Islands, and every home-trade steamship which is authorized by her ordinary survey certificate to carry not less than 150 passengers at sea, shall not attempt to leave any New Zealand port unless she is equipped with an efficient apparatus for radio communication in good working condition.

The range of the apparatus, it is specified, must not be less than 100 miles, day or night. The regulations stipulate that the power necessary to transmit signals shall be at all times available for the use of the wireless operators.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with india ink. Not more than five questions of an individual can be answered. To receive attention these rules must be rigidly observed.

A. L., Bar Harbor, Me., writes:

Ques. (1) I have an aerial 90 feet long, 85 feet high, 7 wires 2 feet apart; Clapp Eastham receiving set, consisting of loose coupler, 2 variable condensers and a Perikon detector. I hear nearly all stations between here and Key West, Fla., and have heard Colon, Panama, once. Could I do as good or better work with the aerial 180 feet long, 4 wires 4 feet apart, same height?

Ans. (1) Undoubtedly you will be able to do better work with longer antenna. It will enable you to receive the longer wave lengths more readily. It will, however, decrease your range when receiving 200-meter amateur wave lengths.

Ques. (2) My sending set consists of a 250-watt transformer, oscillation transformer, Clapp Eastham 2-section condenser, rotary spark gap; length of the lead-in, 54 feet; length of ground wire, 6 feet. I use 110 volts alternating current with the transformer. Will you please give me the total sending distance with the aerial?

Ans. (2) Your query is not plain and you have not given us the full dimensions of your antenna. Do you intend to use this set with the 180-foot flat top aerial? If so, your transmitting set will not comply with the law, having a wave length greater than 200 meters. Your sending range is approximately 45 miles (with the 90-foot aerial).

Ques. (3) Will you please give me the size of aerial to reduce to 200-meter wave length?

Ans. (3) If you desire to emit a wave length of not more than 200 meters, the natural wave length of your antenna should be less than 200 meters—roughly, 160 meters. An aerial of such dimensions will allow a few turns to be connected in series for the transference of energy from the condenser circuit. An aerial 56 feet in length and 40 feet in height, consisting of 4 wires 2 feet apart, will have a neutral wave length of approximately 160 meters.

Ques. (4) Are Key West, Fla., and Colon, Panama, good amateur working results for this location?

Ans. (4) The average amateur working at night during the winter months does not do any better.

Ques. (5) Has the apparatus or the spark at WCC been changed? The spark sounds more "cracky" than usual.

Ans. (5) The pitch of the note has been lowered.

* * *

H. M. R., Jasper, Mo., writes:

I understand that 4 watts per mile (overland in day time) are allowed in transmission with an open core transformer and about 8 watts per mile for a closed core transformer. In other words a half K.W. open core transformer is supposed to transmit about as far as a 1 K. W. closed core transformer. If this is the case, why does the condition described exist? Which is the better for the use of an amateur limited to 1 K. W.?

Ans.—You have been misinformed. While the transformer is a dominant feature in a transmitting set there are other conditions in the case, external to the transformer, which determine the distance covered. The two types of transformers, provided they were properly designed, should be equally efficient. For complete data as to the distance you may expect to cover with a given amount of antennæ current, we refer you to the appendix in the Naval Manual of Wireless Telegraphy for 1913 by Commander Robison. Replying to the latter portion of your query, we have not yet seen a set operating on a wave length of 200 meters consuming 1 K. W., even with the set operating at a spark frequency of 1,000 per second. A watt meter in the primary circuit indicated but 750 watts.

* * *

E. B. K., Tutuila, Samoa, asks:

Ques. (1) How many points does a 10-inch wheel on a rotary gap require, operating on 60-cycle alternating current? I have a wheel that has 12 electrodes and a speed of 2800 or 3000 R.P.M. The spark seems to take place before the moving electrode gets even with the stationary electrode, and as my wheel was constructed of hard rubber, it did not take long for the spark to pierce the rubber. Can you explain this?

Ans. (1) If you will make the brass points in the disc project at least 1½ inches on either side of the disc, you will remove the discharge to a point where it will not pierce the hard rubber. When using a rotary gap the spark discharge invariably takes place before the points are opposite one another, due to the fact that the spark breaks down at the maximum potential of the condenser. In other words the potential of the condenser is so high that it is not necessary for the electrodes to be opposite each other for discharge. Ten points equally spaced around the disc should be quite sufficient at a speed of 3000 R.P.M. You will find it much to your advantage to have some means at hand for increasing or decreasing the speed of the motor.

Ques. (2) At present my set is direct coupled, but I am constructing a loose coupled oscillation transformer, the closed circuit of which is wound with No. 6 wire and the open circuit with No. 3 wire. I shall also have a loading coil in the aerial circuits. The ship is equipped with a loop aerial which I intend to change to the inverted "L" type. Do you think that the arrangement described will help my set, and have you any suggestions to make? The set is of 2 K. W. capacity.

Ans. (2) There will be no great advantage in constructing an inductively coupled oscillation transformer. You can secure loose coupling with the ordinary direct coupled helix. We do not understand your query about the looped aerial. You, of course, understand that an aerial may be of the looped type whether it is of the inverted "L" type or any other type.

* * *

J. A. W., Waterbury, Conn., asks:

Ques. (1) Did the Titanic communicate without relaying directly with Cape Race when signalling for help?

Ans. (1) Yes.

Ques. (2) What is the longest distance the station at Arlington, Va., has communicated?

Ans. (2) We understand that the signals have been read at a distance of 4,000 miles, but the everyday range is not more than 1/3 of this.

Ques. (3) At what rate of speed does Sayville send?

Ans. (3) About 15 words per minute.

Ques. (4) How many words per minute does Cape Cod send?

Ans. (4) Eighteen to 20 words per minute.

* * *

H. E. W., Bay City, Mich.:

The data for the transformer you desire to obtain will appear in an early issue of THE WIRELESS AGE, in the series of Instructions for Boy Scouts. Referring further to the Thordarson transformer, you should communicate directly with the concern making that apparatus.

Answer to Query No. 2: There is no distinct advantage to the "doughnut" type of oscillation transformer, except that it allows a loose coupling to be easily obtained.

Answer to Query No. 3: The natural wave length of your antennæ is approximately 250 meters.

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H. H. H., Medical Springs, Ore.:

Ques. (1) I have a 6-inch induction coil made for X-ray work; it has but one secondary terminal. How can I adjust it to use it for wireless?

Ans. (1) Why not communicate with the makers of the coil? The majority of X-ray coils are furnished with two secondary terminals. Automobile ignition coils that are very often furnished have but one secondary terminal, the other high potential terminal being connected to the primary circuit, which is in turn connected to the frame of the machine. Since, however, this is a 6-inch coil, it is likely that our explanation is incorrect.

Ques. (2) Is a 325-foot lead-in too long for a 150-foot aerial having 6 wires and 2 lead-in wires?

Ans. (2) Yes. This is decidedly abnormal construction for wireless telegraph antennæ.

Ques. (3) As I have only direct current source of supply, where can I obtain a 1 K. W. open core transformer with an interrupter of some kind?

Ans. (3) We never heard of a 1 K. W. transformer with an interrupter. Transformers having interrupters are known as induction coils. There is considerable difference in the proportionment of windings (primary and secondary) between a transformer and an induction coil. If you desire to handle 1 K. W. through an induction coil, you will require a water-cooled electrolytic interrupter.

Ques. (4) Can I take alternating current from a direct current generator?

Ans. (4) Certainly. If you tap off a pair of leads from the commutator segments directly under two brushes of opposite polarity and then connect these two wires to a pair of slip rings on the other end of the armature, you will secure alternating current of a lower potential than that of a current generated on the D. C. side. You will then have a self-excited alternating current generator. Since D. C. generator windings differ, you should have this work done by some reputable electric company.

Ques. (5) Would this 6-inch X-ray coil be as efficient as a regular wireless coil?

Ans. (5) It is not likely. The potential is rather too high.

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E. W. S., Aurora, Ind., writes:

We hear a station at night sending press to Sayville, seeming to sign "BIT." Where is this station, if there is such a station working with Sayville?

Ans.—We are not aware that Sayville is in communication with such a station, although some long distance experimental work is being done at that point. "BIT." is the H. M. S. S. S. Christopher, of the British Admiralty.

* * *

N. S., Ithaca, N. Y., writes:

Ques. (1) Does a long ground lead increase or decrease the wave length of a receiving station?

Ans. (1) It increases the wave length.

Ques. (2) What transatlantic steamships use Marconi apparatus, and what companies use Telefunken apparatus?

Ans. (2). We cannot answer this question fully, as it will require too much space. The Telefunken system is employed on ships flying the German flag. The Marconi apparatus is used on ships of all other nations.

Answer to Query No. 3: We are not familiar with the conditions surrounding the Federal Company's San Francisco-Honolulu long-listance work. You should communicate with the company.

The information requested in Query No. 4 is not available for publication.

Answer to Query No. 5: Operators must be 18 years of age before they can obtain employment with the Marconi Company.

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A. B., Seattle, Wash.:

The information you request concerning the Marconi multiple tuner is not available for publication.

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V. R. P., New York City, writes:

Please give formula for calculating inductance and wave length of a loose coupler.

Ans.—The wave length of an oscillatory circuit is equal to $59.6 \sqrt{L.C.}$

Where L = the inductance in cms.

And C = capacity in mfds.

A simple formula for calculation of capacity has been given in previous issues of THE WIRELESS AGE. A simple formula for calculation of inductance suitable for amateur needs is given in the experimental department in this issue. All told, however, you will find it far more desirable to purchase a wave meter than to make these calculations.

Ques. (2) Is it practicable and desirable to use one or two turns on the primary of the receiving tuner for minimum wave length? How many turns should be used in the secondary for the same minimum wave length?

Ans. (2) It is possible to transfer energy with two turns in a primary circuit, provided the turns of the secondary are not too far off. Approximately, the minimum amount of turns in the secondary using receiving tuners of the average size should not be less than six or eight.

Ques. (3) What would be the probable capacity of an inverted type of aerial composed of four No. 14 B. & S. gauge galvanized iron wires, spaced two feet apart, length of flap top, 80 feet; length of lead-in, 70 feet. What would be the probable inductance and the resistance?

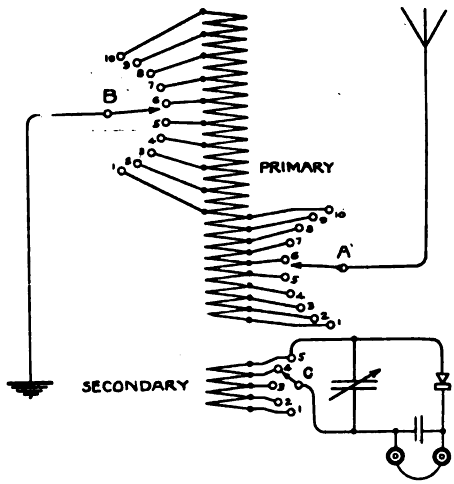
Ans. (3) We do not advise the use of galvanized iron wire for aerials. The capacity of an aerial such as you describe will be approximately 0.000349 mfds., the inductance 62390 cms. If your antenna was constructed of copper wire the effective ohmic resistance would be approximately about 9 ohms.

Answer to Query No. 4: A ground lead 40 feet in length will have the effect of decreasing the transmitting range, but will not so seriously affect the signals being received.

J. W. S., Ivoryton, Conn., writes:

I am building a "loose coupler" for receiving transformer; primary has a tube 4½ inches long and 5¼ inches in diameter, and is to be wound with No. 20 enameled wire; secondary tube 4½ inches long, 4¾ inches in diameter, to be wound with No. 28 wire; secondary to slide inside of primary. How would you advise me to wind them so as to use switches, that is, how many points should I use on the secondary and primary? What is this so-called "dead-end" effect? Would you advise me to use this method, or would it work equally well with taps taken off wire without cutting off complete sections of the windings not in use? I myself believe switches are preferable to sliders.

Ans.—When using a receiving tuner with such small dimensions you need not take into



account the "dead-end effects." While they are probably present, the loss occasioned is of such small value that it need not be taken into account.

Switches are undoubtedly better than sliders. but a switch designed to simply throw into use the turns desired is unnecessarily complicated and expensive to construct.

For the primary coil you should use a switch allowing one turn to be cut in at a time. The windings on the secondary may be divided between the 5-point switch, particularly if you use a variable condenser in shunt with the receiving transformer. Arrangement of the switches is shown in the accompanying diagram.

In the primary circuit switch A has ten points, each of which are connected to the first ten turns of the primary. Switch B has ten points, each point adding ten turns to the circuit, or whatever number fits your particular case. Switch C has five points which, as before stated, may be equally divided between all the turns of the secondary.

As regards the dead-end effect, see the article in the November issue entitled Kolster Addresses Radio Men.