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to red heat in a vacuum which does away with oxidation and makes towards a better product.

A straight soft iron rod is usually insulated by means of paper, shellac or varnished cloth, fibre, rubber, etc., and on top of this the wire convolutions are wound. It is necessary that the wire be well insulated or else short circuits between layers or turns may easily occur. If there are a great many layers it becomes necessary to use a spool on which to wind the wire or else there would be nothing to hold the sides of the completed winding. These spool heads as they are called may be made of most any insulating material such as wood, fibre, hard rubber, glass, porcelain, etc., all depending on the use and purpose of the electromagnet.

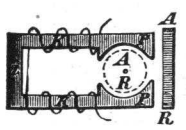


FIG. 186

It is the custom to let the iron rod project some fraction of an inch through the spool heads. Most electromagnets are bipolar, or of the so-called horseshoe type. It is unusual to make a horseshoe electromagnet in one piece, as it is easier to wind the two cores separately and then the cores are either screwed or riveted to a common iron plate which for all practical purposes is as good as making the core in one piece.

127. Forms of Electromagnets

In the usual electromagnet we distinguish its important parts as follows:

In Fig. 186, *i* is the connecting piece, K represents the legs or core, while in a dynamo or motor they are usually called the field cores. Around these, the field windings or coils are placed or wound. The two poles are shown at P.

In the case of the dynamo, as in the illustration, AR represents the armature which rotates between the two pole pieces and in the usual electromagnet the

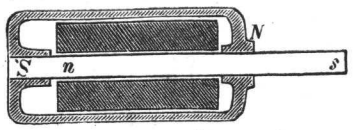


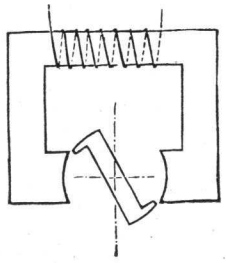
FIG. 187

straight piece, AR, is also termed the armature.

The armature is usually an iron mass which may carry wire or not and the purpose of the armature is to absorb in itself the magnetism which passes between the poles of the electromagnet. In dynamos the armature is made to rotate between the poles and thereby generate the current of the machine.

The mission of the electromagnet is either to pull an armature towards the pole pieces, the power being used for pulling weights, or to close contacts, etc., while in a dynamo the rotating armature produces electric currents. The electromagnets find use in thousands of different industries and arts, mainly in dynamos and motors, in telegraphy, registering apparatus, signaling apparatus, electric clocks, etc.

Fig. 187 shows the so-called bell magnet, mantle magnet, or plunger magnet, and it will be seen that the windings are located in the inside of the iron bell. This form of electromagnet is very efficient as no magnetism is lost through leakage. These electromagnets are usually very powerful.


FIG. 188

In Fig. 188 we have a rotating armature and if this armature is a magnet itself it will produce a current in the winding. On the other hand we may put the winding on the armature which may be of soft iron and if the field is itself magnetic, a current will also be produced.

(To be Continued.)

HERE AND THERE

Telephone operators in Egypt are required to speak English, French, Italian, Greek and Arabic.

The British post office has adopted the night letter-telegram service for telegraph lines in the British Isles.

The busiest time in all the year in the telephone exchange is the tenth or eleventh day before Christmas.

A wireless station is being built at London which is expected to provide direct communication with New York.

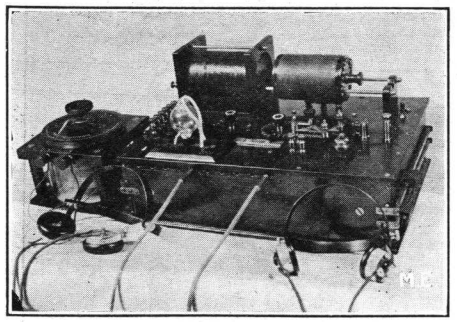
Electricity will be the only power used at a lock large enough for vessels 1,000 feet long that will be built at the Pacific end of the Panama Canal.

Wireless Station at the University of Michigan

By B. N. Burglund

THE transmitting set is composed of a large condenser which is variable and composed of copper coated flat glass plates, 30″ x 30″ and fifty-six of these plates can be used in series or multiple as different experiments require. These plates are coated and insulated in such a manner that there is practically no loss due to brush discharge. Each plate is connected to a switch, so as to be cut in or out as the occasion requires. All plates are connected with cable, very heavy but finely divided. Fig. 4 shows how these leads are fanned out and soldered to the copper coatings, also the condenser frame and the switches "Bus Bars" and connecting leads and the primary and secondary of the oscillation transformer.

The square case back of the oscillation transformer contains the rotary spark gap and motor. This spark gap is rather unique and will be described in detail later. The transformer is of the open core type, and in connection with an auto-transformer is variable from ½ to 15 kw. The transformer is not shown in the picture.


FIG. 1

The oscillation transformer is made like a large loose coupler. The secondary slides on the brass tube shown in the center. Fig. 2 shows the secondary of the oscillation transformer set for loose coupling.

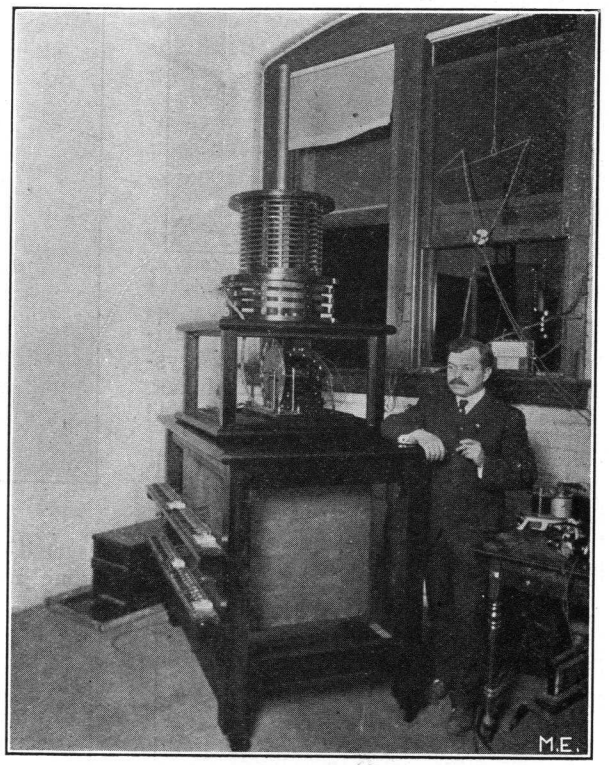


FIG. 2

Figs. 2 and 3 give a very good idea of the size of the set. Fig. 3 was taken by the light from the spark gap. The spark wheel was running about 3,000 R.P.M. and a spark was made that lasted about 0.1 part of a second. Note the strong actinic light. An ammeter placed in the oscillating circuit shows more than 150 amperes circulating through the gap.

The round white spot under my chin is caused by the spark reflecting back from the surface of the camera lens and gives a fair idea of the size or the volume of the spark as viewed through a smoked glass. (The picture is of yours truly standing at the edge of the transmitter case.)

Figure 1 shows one of the receiving

sets used for long distance work. This is a combination set arranged so as to be used as single or double slide tuning coil or loose coupler and a combination of both. We also can use most any de-

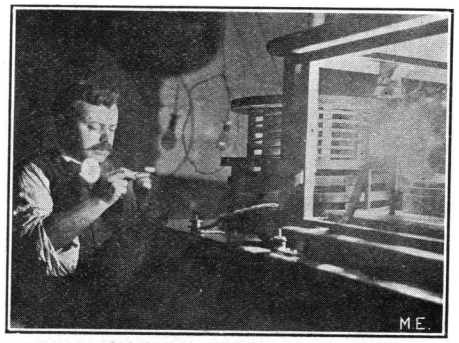


FIG. 3

tector, for instance, carborundum, perikon or audion, in fact, any type of crystal can be used and tested with this set. On the loose coupler, it will be noticed

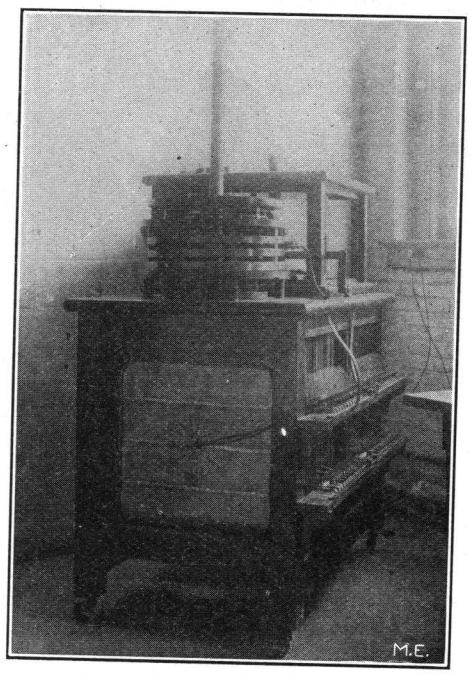


FIG. 4

that no sliding contacts are used. (We don't believe in them.) All taps are made on switches that have positive contact. This set can also be used to measure the wave length of incoming signals as well as to measure their strength. Ten sets of telephones can be used on this set at once. Note how the telephones are attached. When the plug is

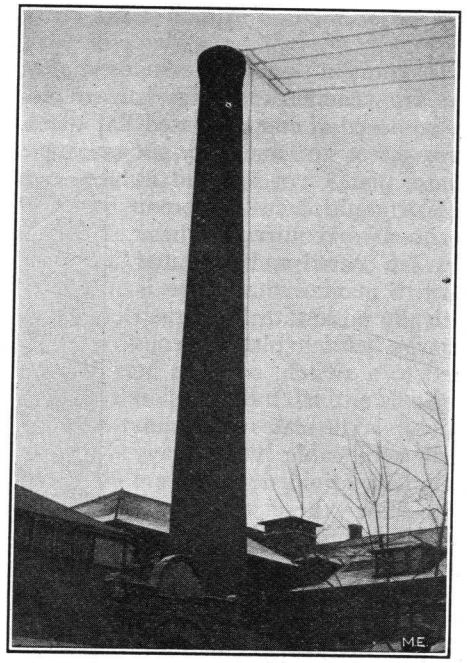


FIG. 5

inserted it cuts in that particular telephone automatically and when the plug

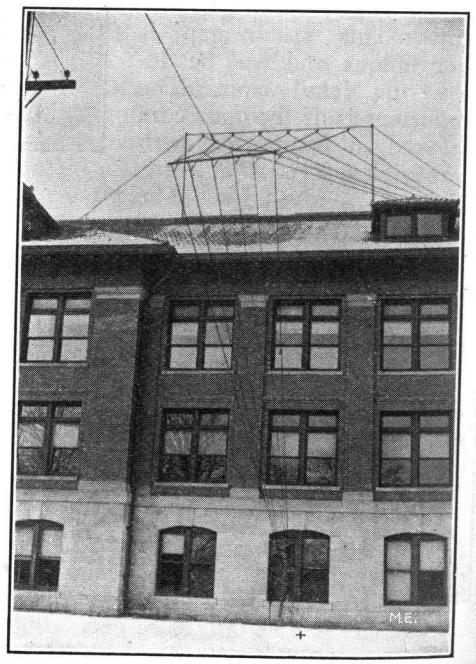


FIG. 6

is taken out it closes the circuit again.

(*Continued on page 1262.*)

Measurement of Antenna Insulation and Earth Plate Resistance

By Stanley E. Hyde

Antenna Insulation

IN the construction of aerials for radio transmission it is of the utmost importance that the antenna possess a high-insulation resistance, so that the leakage of the current from the antenna wires will be reduced to a minimum. To measure the insulation resistance of the antenna proceed as follows: the antenna is disconnected from the sending inductance and also the ground wire. Connect the ground wire to one side of a supply of direct current capable of giving an E. M. F. of 200 to 500 volts. The other side, preferably the positive pole if the system is grounded, is connected to the antenna lead through a sensitive galvanometer which has been previously calibrated as a micro-ammeter, i. e., one that will register a current of one millionth ampere, see Fig. 1. For example, suppose the galvanometer reading was 10 micro-amperes and the voltage of the dynamo or other source of current, was 500. Then by Ohm's Law

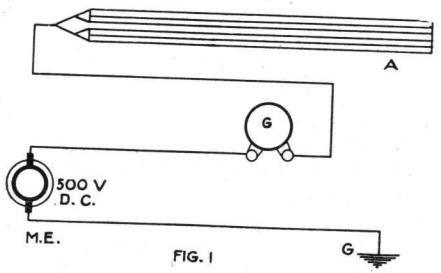


FIG. 1

$R = E \div I$; and substituting the above values, we have $R = \frac{500}{0.000010} = 50{,}000{,}000$ ohms, or 50 megohms (1 megohm = 1 million ohms).

This means that 10 one-millionths of an ampere is making its way to the earth through a resistance of 50,000,000 ohms. It does this by way of the wooden pole, guy wires and other supports that hold up or insulate the aerial. The insulation resistance will be found to vary a great deal according to the moisture present in the atmosphere, thus on rainy or foggy days the resistance will be low, while on dry days it will be found to be very high. For this reason rubber insulated wire would make a better antenna than bare wire, but the cost of the rubber covered wire would offset the advantage of having greater antenna insulation. It must also be remembered that although the aerial may possess a good insulation resistance it may not be in-

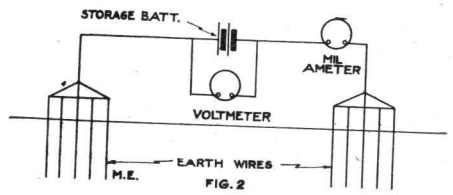


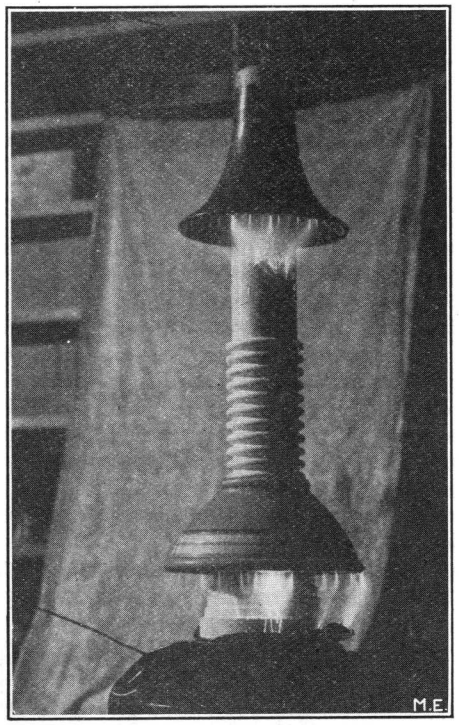
FIG. 2

sulated well for high frequency oscillations, for if the lead to the antenna runs parallel to other wires or metallic work that is grounded, oscillations will be set up in these by electro-magnetic and electrostatic induction and energy absorbed as effectually as if they were in actual metallic contact. For this reason the guy wires supporting the masts of radio stations should be cut up into short lengths by means of insulators so that but little of the induced current will escape into the earth.

Another factor in high powered stations where large quantities of current are oscillating in the antenna is a loss of energy from brushing, and this usually occurs at the end of the aerial away from the instruments. If sharp points are left, when soldering the wires, these act the same as a lightning rod, in that they let energy escape from the sharp point out into the surrounding air. No matter what system is being used, the wires at the far end of the antenna should invariably all be soldered together for the reason that if two sets of wires are used they may not be of the same capacity or wave length.

TESTING 100,000-VOLT INSULATORS

On high voltage transmission lines the insulators are of great importance and must have a high factor of safety. Before installing, each is tested to a somewhat greater voltage than that



with which it is to be used. The illustration shows a test where the voltage has just passed the insulation limit and the current can be seen beginning to break across.

BARBED WIRE FENCE TELEGRAPH

(*Continued from page* 1253.)

coil and its interrupter. The interrupter continually "interrupts," or makes and breaks, this circuit as long as the key is depressed, and the current of self-induction is forced to go out on the line at each interruption and operates the diaphragm of the distant telephone receiver as just described. The interruptions are very rapid, hence the impulses that go to line follow one another at very minute intervals and produce a buzz rather than a series of clicks in the distant receiver.

Hence the theories of operation of the induction telegraph and the field buzzer are somewhat analogous, the former operating on an induced current, the latter on a self-induced current.

An amateur buzzer line is very easy to construct and can be made to operate over a barbed-wire fence "line" to perfection.

All that is needed for one station are: One ordinary iron kitchen buzzer or vibrating bell with the tapper removed; one inexpensive telephone head receiver; one key with closing switch lever removed, and three dry cells.

Connect the buzzer, key and dry cells in series so that when the key is depressed the buzzer will "buzz." Now solder a piece of wire to the small adjustable post against which the spring of the interrupter strikes. This will be the "line" wire. Put the telephone receiver for that station in series with the line.

Attach a "ground" wire to that binding post of the buzzer which leads to the buzzer coils, not the interrupter. Connect the distant station in the same manner and the line is ready for operation.

If the line is a very short one, as, for instance, one room to another, insert some resistance in the line. A 16 c. p. lamp would do, an 8 c. p. lamp would be better.

The more rapidly the interrupter vibrates the higher and better will be the note in the head receiver, consequently a high pitched buzzer is better than a low one. The little nickel-plated buzzers (about 1½ inches long and ¾ inch wide) are the best for this purpose.

In using a barbed-wire fence for a line, merely see that the "line" is continuous; insulation does not matter, nor does the resistance of the iron wire.

WIRELESS STATION AT UNIVERSITY OF MICHIGAN

(*Continued from page* 1246.)

No switches are needed.

Fig. 5 gives some idea of the antenna. This is fastened to the top of a 150-foot brick stack. The spreader is 20 feet of 1½" steel conduit pipe.

The insulation is tarred hemp rope in the bridles and electrose 11" insulators in the wires. Four wires are used part way and then six wires are used, this is a very peculiar construction. All wires are 7 strand No. 20 phosphor bronze. The "leads" leading into the instrument are two No. 4 very finely stranded copper cables. Plate glass "lead in" insulators are used. The ground is equivalent to No. 0000 finely stranded copper cable and bolted to the steel frame work of the building also a No. 0000 cable running out to a 6" water main.

When transmitting on full power the antenna is *blue* from end to end, and emits a tone that can be heard four or five blocks away. It requires about 25 amperes in the antenna circuit to produce this effect. Fig. 6 gives an idea how the wires are brought over the building and into the operating room. The + shows the operating room. The high end of the antenna is located about 350 feet back of the operating room, and the top of the chimney, to which antenna is fastened, cannot be seen from this view. (In a later issue I will publish an article on antennas in which I will describe the reason for beginning with six wires and ending up with four or two wires.)

ELECTRICAL MOUNTAINS TO PROVIDE ENERGY FOR THE WORLD?

It is reported that the Chilean Government, acting with those of Bolivia and Feru, have appointed a commission of scientists to investigate a strange light which is flashing from the Andes in Chile. The light is visible within a radius of 500 miles from the main ridges of the range and is believed to be electrical in origin. It emanates directly from the mountains themselves. The three governments are anxious to see whether the enormous energy which is manifested can be harnessed and be made a source of power to irrigate the deserts on the Pacific slopes of the Andes and tame the wilderness west of the Cordilleras.

A suggestion has been made that the light may not be electrical at all; that it may be emanations from gigantic beds of radio-active substances, perhaps radium itself, which become visible under certain atmospheric conditions. If this latter theory is correct the Chilean Cordilleras hold a hoard which will change the destinies of the world.

Dr. Pedro Santinez, one of the commission selected, writing of the extraordinary phenomenon, says:

"The light is ordinarily of a glistening appearance and has the shape of a bold curve. It appears to have fixed points of issue and changes only in the frequency of its discharge and in its extent. The most vivid flashes come from a very definite point, and the radiation sometimes reaches far above the zenith and away to sea. The extraordinary phenomenon can be seen with greatest ease when the sky is clear.

"The flashing begins late in Spring and lasts until early Winter. Toward the south then the light ceases almost altogether. But in northern and central Chile, in Peru and Bolivia the flashes are intermittent throughout the Winter.

"We owe all of our present knowledge of the light to a distinguished naturalist, who recently, during a journey through a valley of the main Cordillera, observed this phenomenon with exactness. One evening about 9 o'clock, while studying an unusual and frequent discharge, he was able to ascertain that its point of issue was an elevation of the Cordilleras along which he was roaming. Moving constantly around this peak was a band shaped like a segment of one or two degrees in height and somewhat similar to the zodiacal light in brightness.

"During the present season the light has glistened as usual, but with much greater strength, and especially above the discharge, into which the glistening has disappeared after a moderate interval. The naturalist believes that this flashing of the Andes is due to profuse electric discharges in certain districts of their Chilean section, and particularly among the greater peaks. The predominating popular view is that this light is a reflection of the molten lava in volcanic craters. Such a view is erroneous, however. It is not improbable that the number of the points at which these discharges occur changes; and it is possible, too, that during the great earthquake of August, 1906, discharges occurred along the whole crest, for, if we may accept authoritative statement, the sky everywhere in Central Chile then flashed with a