PART I.

PLANS AND SPECIFICATIONS FOR WIRELESS TELEGRAPH SETS

COMPLETE AND DETAILED INSTRUCTIONS FOR MAKING
AN EXPERIMENTAL SET
ALSO A ONE TO FIVE MILE SET

BY

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PART 1

PLANS & SPECIFICATIONS FOR WIRELESS TELEGRAPH SETS

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PREFACE.

The purpose of this booklet is to describe and illustrate two different sized wireless telegraph sets, so that anyone having a little knowledge of electricity can successfully make them. The first set is intended for laboratory experiments, but will work under favorable conditions over a distance of a mile or so. The second set is designed to cover distances of from one to five miles, the chief conditions which govern the signalling distance of a set other than the power of the transmitter, and the sensitiveness of the receptor are (1) The height, length and type of aerial wire; (2) The size and kind of grounded terminal, and (3) The medium, namely land or water, over which the transmission takes place.

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CHAPTER I.

An Experimental Transmitter.

A wireless telegraph equipment comprises in any case two distinct pieces of apparatus, namely, a transmitter and a receptor and these are designed so that the former will operate the latter at a distance without connecting wires.

The Transmitter for an experimental set may be made up of the following parts:

(a) A ½ inch induction coil.
(b) An adjustable spark-gap.
(c) A battery.
(d) A strap key.
(e) An aerial wire, and
(f) An earthed terminal.

The Induction Coil is the principal piece of apparatus employed in the transmitter and upon the length and quality of the spark it gives, depends very largely the distance over which it is possible to signal. For this reason coils are rated by their spark-lengths and consequently, a ½ inch coil means that a maximum spark measuring ½ an inch in length may be obtained. A coil of this type is shown in Fig. 1 and is provided with a vibrating spring interruptor and having a paper condenser mounted in the base of the instrument.

Small induction coils seldom have spark-balls attached to the secondary terminals when pur-

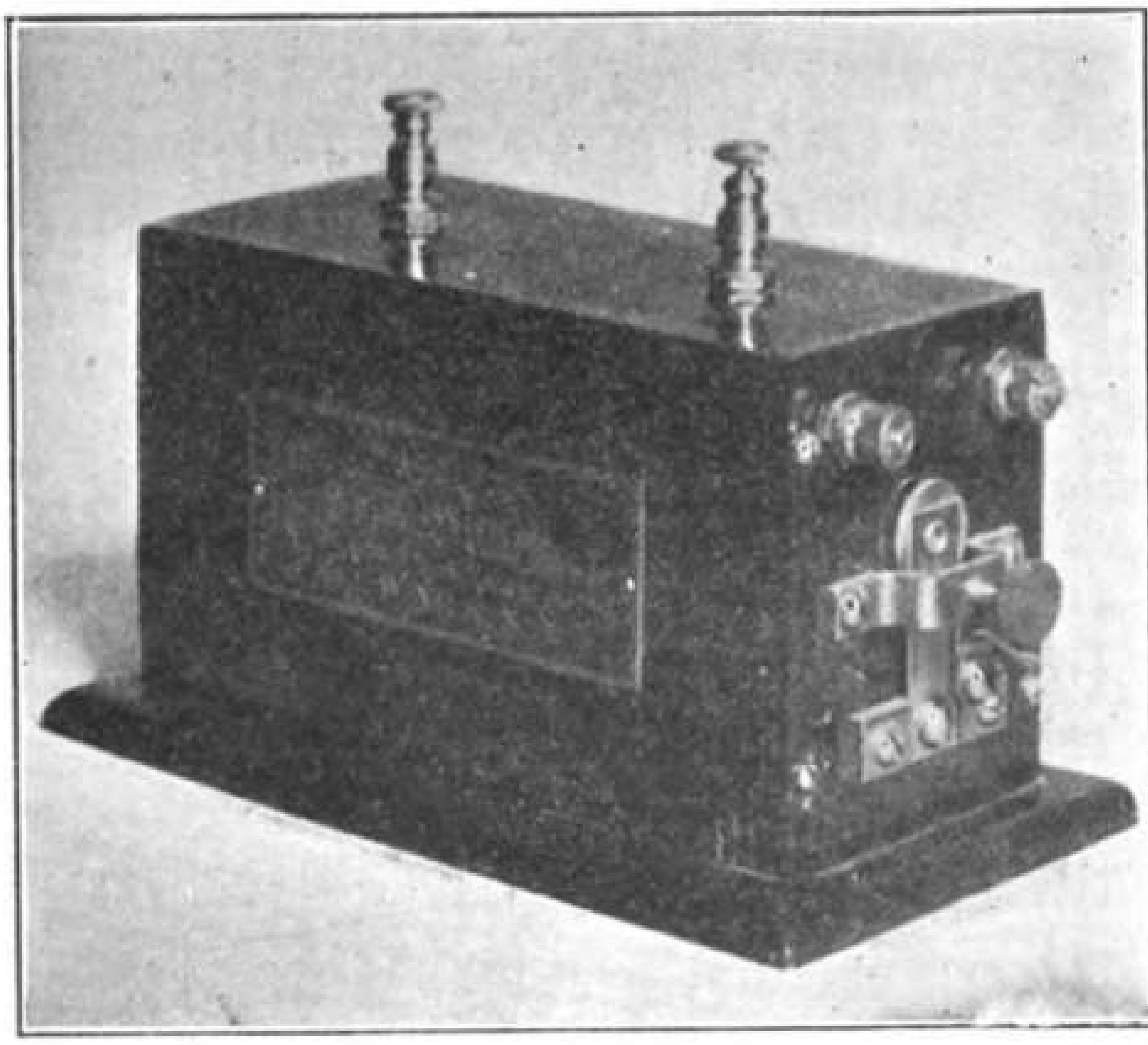

Fig. 1. Half Inch Induction Coil.

chased, and as these are necessary for wireless work the constructor must procure and put them on for himself.

The balls may be made of any kind of metal, should be ½ or ¾ inch in diameter, may be either hollow or solid and need not be absolutely round although they should have perfectly smooth surfaces.

Holes must be drilled in the balls and into each of these a wire 1/8 inch in diameter and 3½ inches in length should be inserted and soldered therein, or better, the holes may be tapped out and threads cut on the wires which are then screwed in. The wires should be bent as shown in Fig. 2 so that

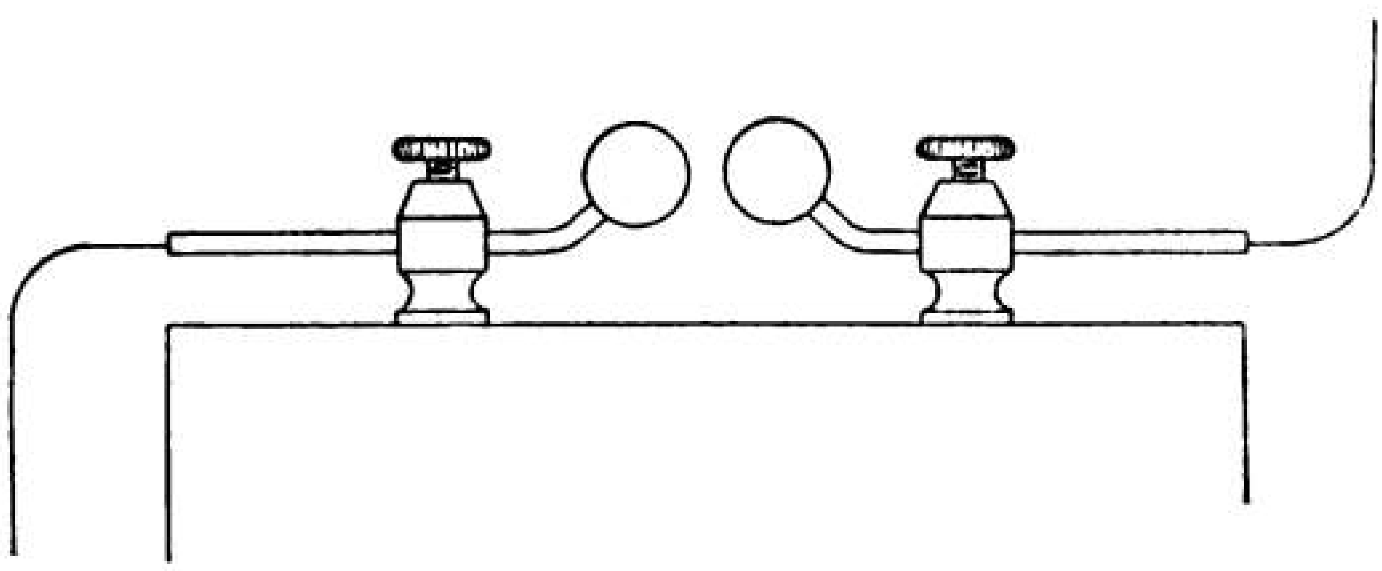

Fig. 2. The Spark-gap.

when the free ends are slipped through the small binding posts on top of the coil the adjustable spark-gap formed by the oppositely disposed balls will not be too close to the secondary of the coil.

If the transmitter is to be used indoors merely as an experimental set a battery of four dry cells will be sufficient to energize the coil, but if the apparatus is to be used to transmit signals through space in the open from six to eight dry cells will be required to supply the necessary electro-motive force.

The Key. For this small set a regular telegraph key is not necessary but a strap key shown in Fig. 3 may be made of a stiff piece of spring brass 3 inches in length and 3/8 inch in width at the fixed end, tapering to 1/4 inch at the free end as indicated; it is bent down near its fixed end. Two 1/8 inch holes are drilled near the

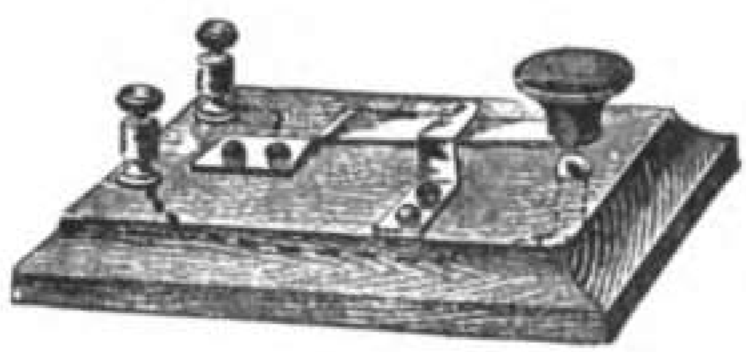

Fig. 3. A Simple Strap Key.

wide end and one 1/8 inch hole near the narrow end, and to the latter a button made of wood is screwed. The strap is screwed to a base of wood 4 1/4 inches long by 2 3/8 inches wide by 1/2 inch thick, and immediately under the button a screw is inserted through the base so that when the metal strap is pressed down it will make contact with the screw. Two binding posts are screwed to the rear of the base and to one of these the strap is connected while the contact screw is joined to the other as shown by the dotted lines.

The Wiring Diagram. Fig. 4 is a complete wiring diagram of the transmitter. The primary circuit is formed by connecting the large binding post 1 on the base of the coil to the zinc side of the battery 2; the carbon side of the battery 3

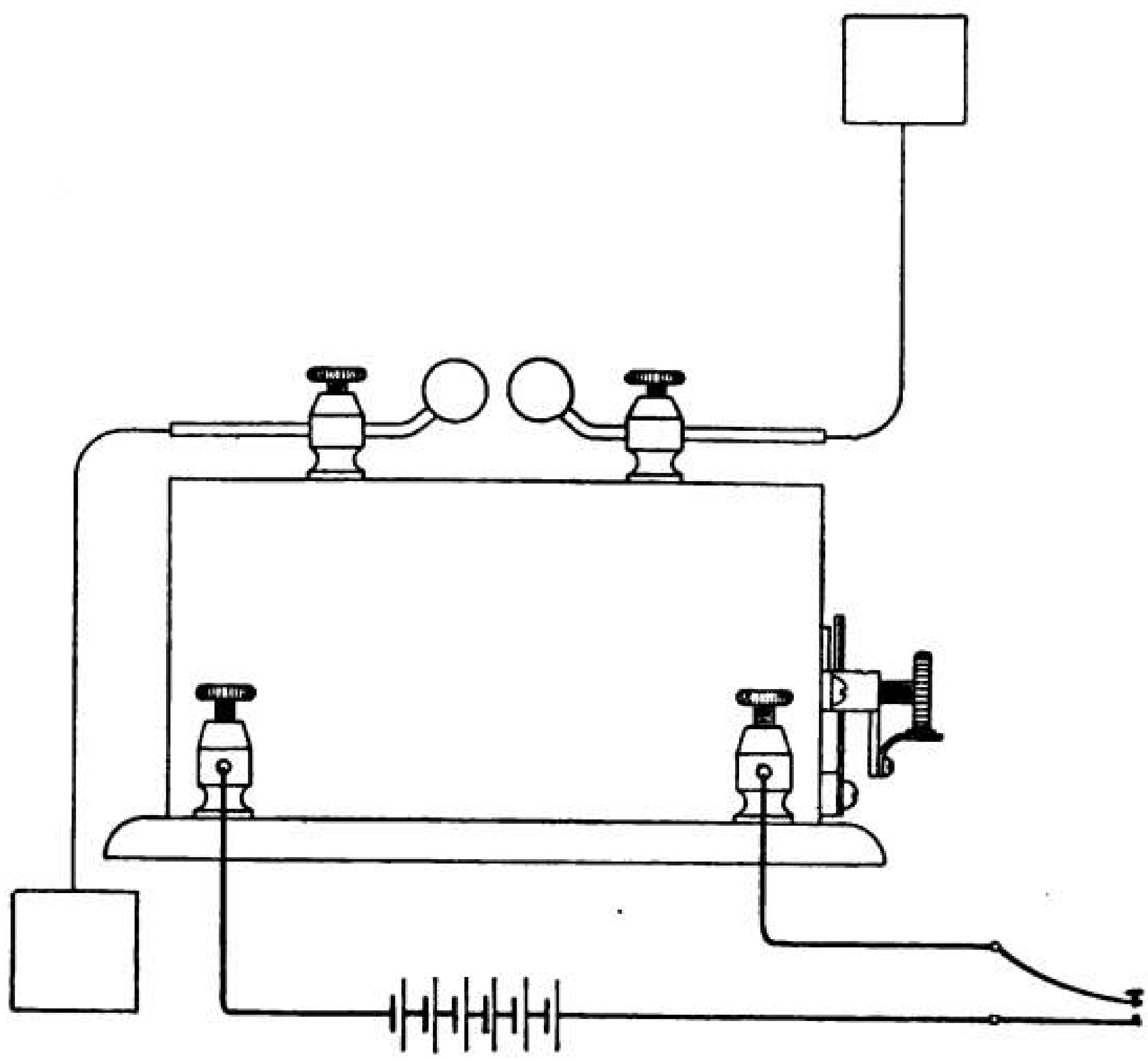

Fig. 4. Wiring Diagram of an Experimental Transmitter.

is coupled to the binding post 4 of the key while the opposite post 5 is connected to the remaining post 6 of the induction coil.

For interior signalling the aerial may be a stiff piece of wire two or three feet in length and set upright in a block of wood, or a wire suspended from a nail in the wall may be used, the lower end being connected to the terminal of the spark-gap; to the opposite spark-gap terminal a piece of flexible wire may hang over the side of the operating table. By attaching a copper plate 12 inches on the side to the top of the aerial wire, and a similar plate to the opposite wire and laying it on the floor a distance of 100 feet or more may be obtained indoors.

For out-of-door signalling the aerial wire should be at least 20 feet in height in order to insure transmission over a distance of 1 mile while the opposite terminal, designated the *ground-wire*, should have a copper or a zinc plate attached to it whose surface area is not less than 12 square feet and this should be buried deeply enough in the earth to insure its being constantly moist, or it may be immersed directly in the water if the signaling is to take place over a lake or river, or if the set is to be used in a city a *ground* may be made by connecting it to a water pipe.

To adjust the transmitter turn the screw of the interruptor so that the platinum point will just make contact with the platinum disk soldered to the vibrating member. Now when the primary circuit is closed through the key the vibrator should start itself. A partial turn of the screw, first in one direction and then in the other, will show the point best adapted for automatic start-

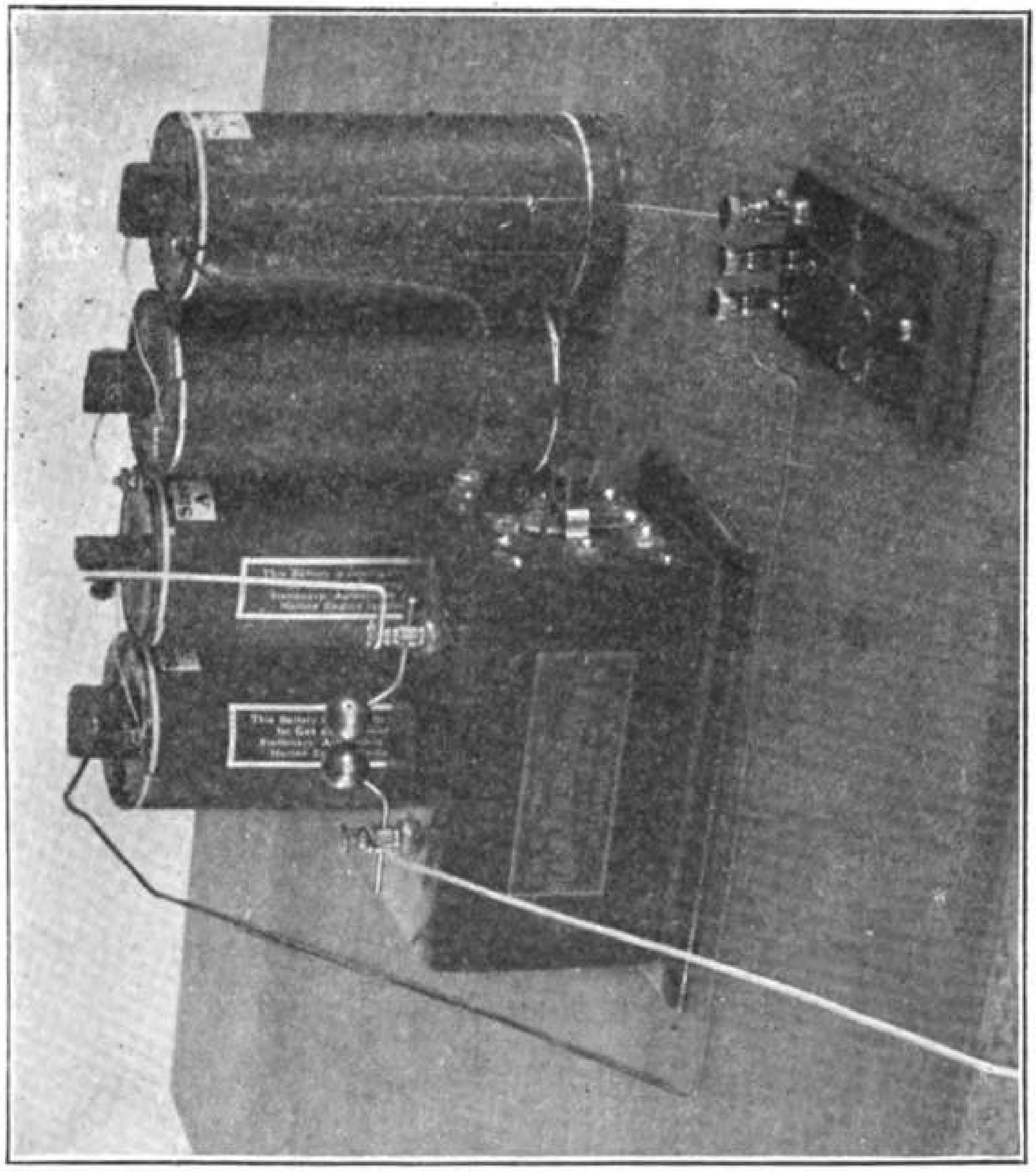

Fig. 5. The Experimental Transmitter, complete.

ing. The spark-gap should be cut down to about $1/16$ inch and should never be more than $1/8$ inch in length. The complete transmitter is illustrated in Fig. 5.

CHAPTER II.

Experimental Receptors.

There are two kinds of receptors used in wireless telegraphy, the older method employing a coherer to manifest the presence of the incoming electric waves and a Morse register to print the signals on a strip of paper, while the newer system utilizes a self-restoring detector and an ordinary telephone receiver to click off the dots and dashes in the ear of the operator. A simple type of both these receptors will be described and these will be designated, as:

(1) A coherer receptor.
(2) An auto-detector receptor.

The Coherer Receptor. A receptor of the coherer type includes the following parts:

(a) A nickel filings coherer.
(b) An electric bell.
(c) A 75 ohm relay, and
(d) A dry cell.

A coherer may be easily constructed by attaching two large sized ordinary binding posts to a block of wood 3½ inches in length and 2½ inches in width. The posts are screwed to the base 1½ inches apart, as shown in Fig. 6 and to each post a piece of bell-wire is secured. A brass conductor plug made of wire 1½ inches in length and ⅛ inch in diameter is inserted in the hole of each binding post. A glass tube about 1 inch

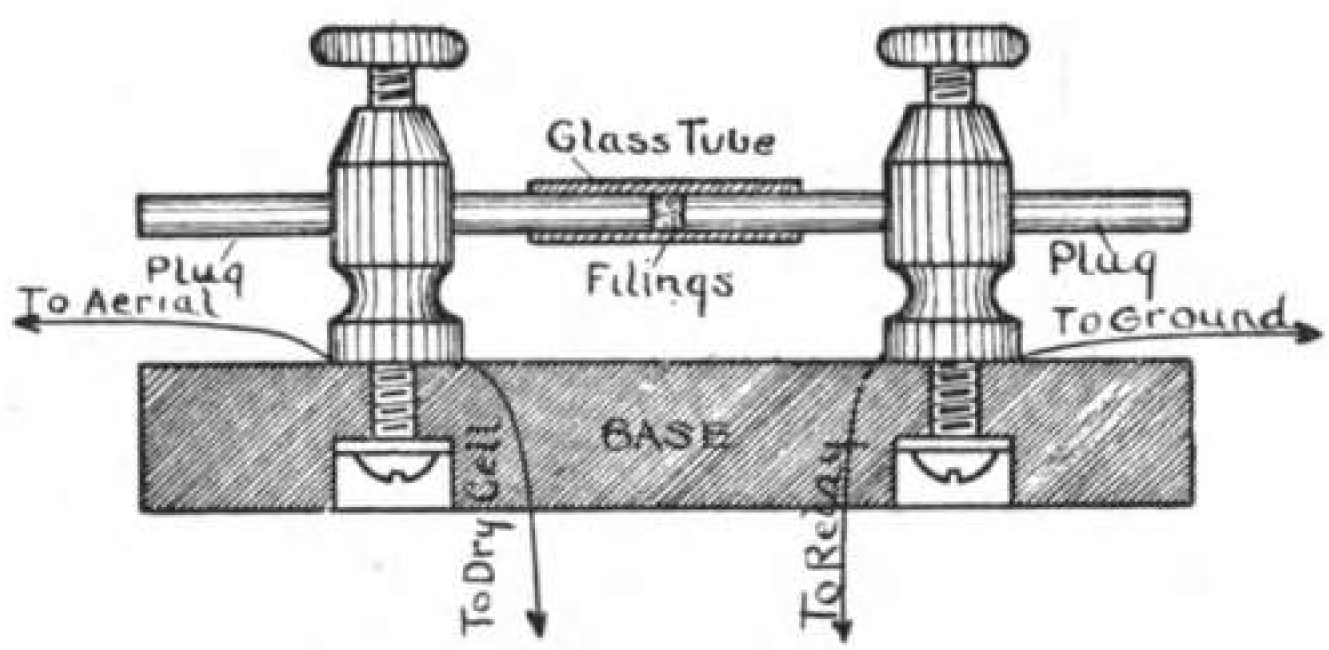

Fig. 6. Simplest Type of Coherer.

in length and having a bore just large enough for the plugs to fit in snugly, must be provided and in this is introduced a pinch of filings made by filing a nickel five-cent piece with a new file; the conductor plugs are now inserted and the coherer is complete.

The relay for this set is known as a *pony relay* and its magnets are wound with wire having a resistance of 75 ohms and the number of turns of wire on the magnets is sufficient to give it the sensitiveness required. On the base of the relay are four binding posts; the coils of the magnet are connected with the end posts while the stationary and movable platinum contacts are joined to the other two posts on the side of the base.

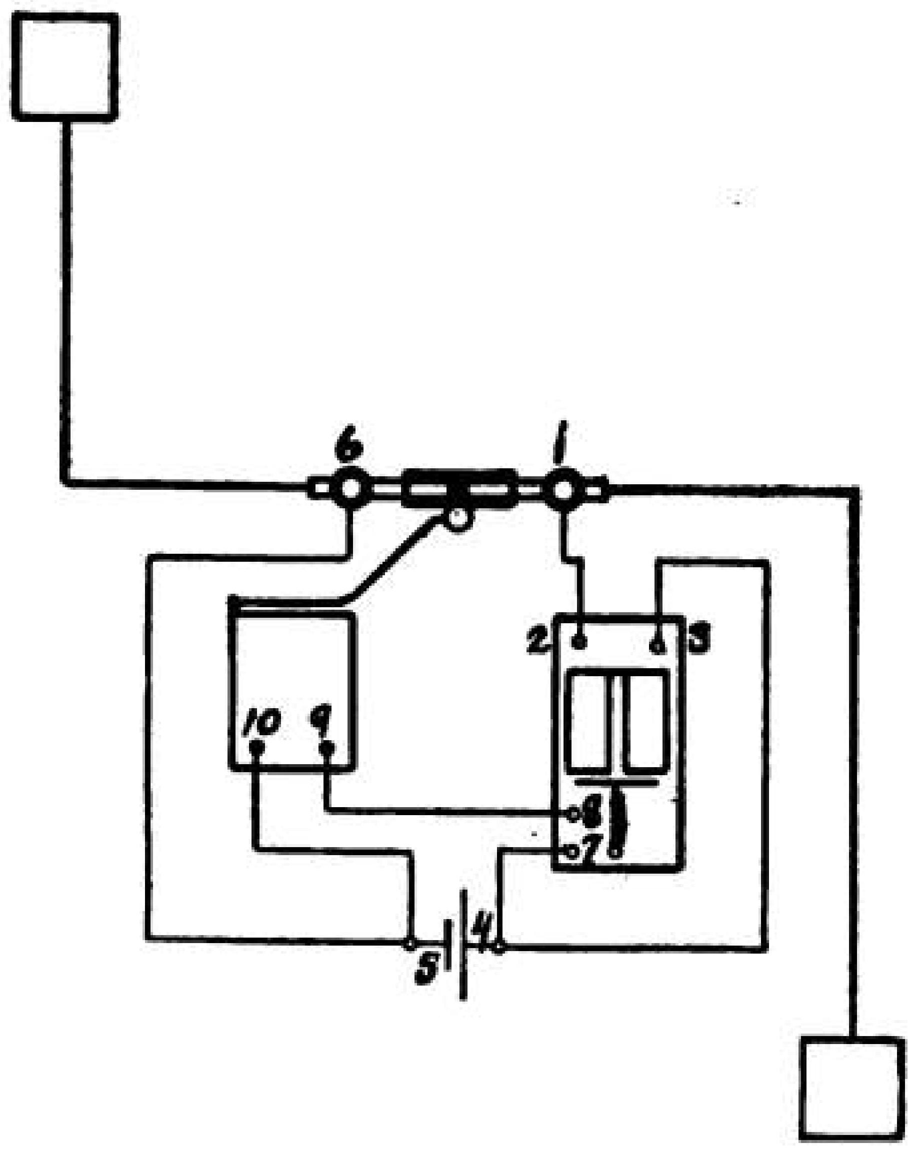

Fig. 7. Wiring Diagram of Experimental Coherer Receptor.

The tapper. An electric bell from which the gong has been removed serves in this case as a tapper to restore the filings, after the oscillations set up by the incoming waves have cohered them, to their normally high resistance; at the same time the vibrating hammer also acts, in virtue of its buzzing sound, as an indicator of the signals sent out by the transmitter. A single dry cell completes the receiving apparatus.

To wire the receptor the instruments are placed in the position shown in the plan, Fig. 7. The binding post 1 of the coherer is connected with post 2 of the relay; from the opposite relay post 3 a wire leads to the carbon 4 of the dry cell; the zinc 5 of the cell is connected with the post 6 of the coherer. A second circuit is formed by joining the cell carbon 4 with the post 7 of the relay; the circuit is completed by coupling the post of the relay 8 to the post of the buzzer 9, and finally the post 10 is connected with the zinc terminal of the dry cell 5. The aerial wire and compensating, or ground wire are of the same length as those attached to the transmitter previously described and these are secured to the opposite conductor plugs of the coherer, when the receptor is ready for use.

To adjust the receptor turn the adjusting screw of the relay so that the platinum point carried by the armature will just barely fail to make contact with the stationary platinum point. The coherer is adjusted by moving the conductor plugs closer together or farther apart until the current from the dry-cell flowing through the filings will be a trifle too weak to move the relay armature.

These two adjustments determine within its limitations the sensitivity of the receptor. Now if all the adjustments have been properly made,

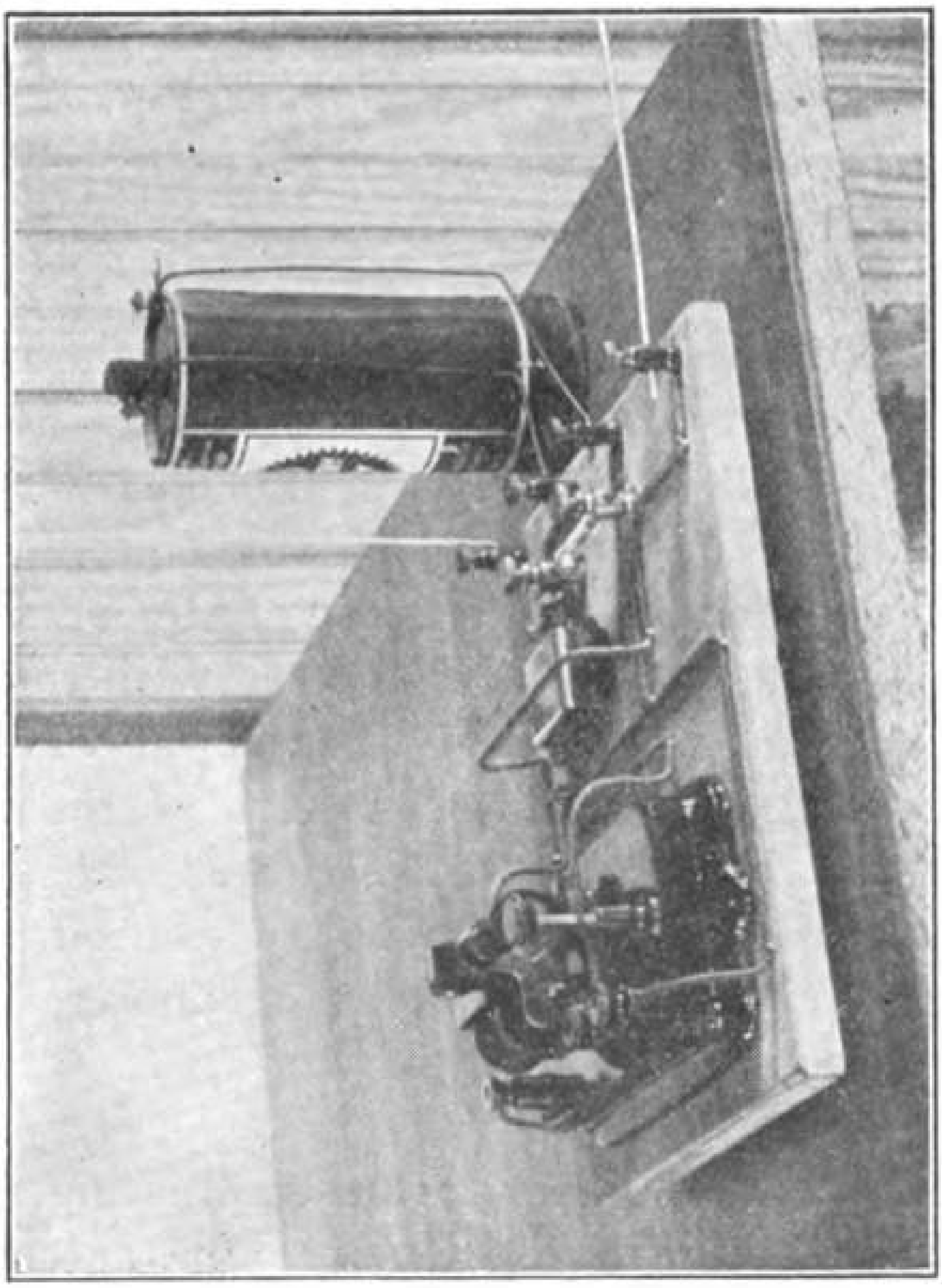

Fig. 8. Experimental Coherer Receptor, complete.

when the key at the sending station is closed, sparks will jump between the oscillator balls and electric waves will be radiated from the aerial wire. When these impinge on the receiving aerial wire the resistance of the coherer will drop to a few ohms, due to the oscillatory current flowing through them, and the local current, now free to pass through the coherer will set the relay into action, and finally when the relay contacts are brought together the buzzer circuit will also be closed and it will tap out the signals and tap back the filings at the same time, when it is ready for another impulse. Fig. 8 shows the receptor complete.

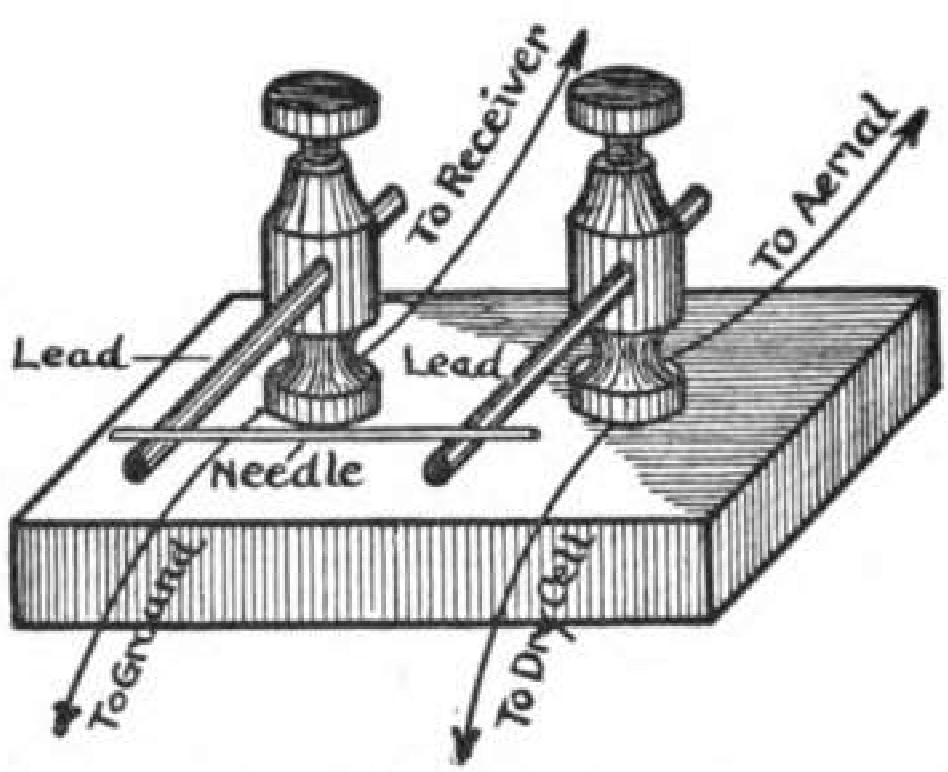

Fig. 9. The Simplest Auto-Detector.

An Auto-Detector Receptor. A receptor of the auto-detector type is exceedingly simple and has the advantage of receiving messages over longer distances and with greater rapidity than a receptor of the coherer type; moreover, it is less liable to get out of order, it is more accurate and considerably cheaper but is not nearly as spectacular when used for demonstrating purposes.

It consists of:—

(a) A microphone detector.
(b) A dry cell, and
(c) A telephone receiver.

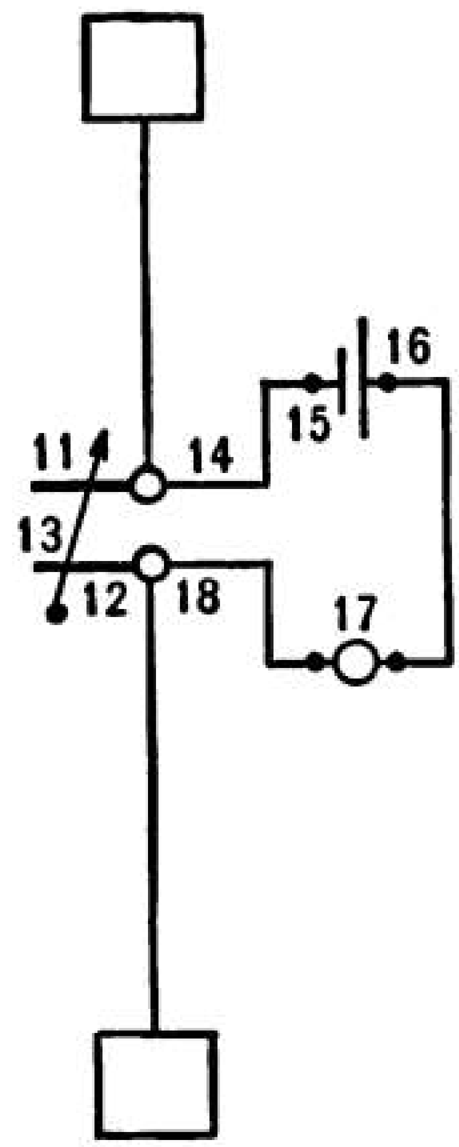

Fig. 10. Wiring Diagram of Auto-Detector Receptor.

The microphone detector may be made by screwing two binding posts to a base so that they are separated about an inch from each other. Wires to form the local and oscillation circuits, namely the telephone circuit and the aerial and ground wire circuit, are attached to the bottom of the posts as in the coherer previously described. In this detector the binding posts are turned so that the holes are parallel, instead of in alignment, as shown in Fig. 9. Into these

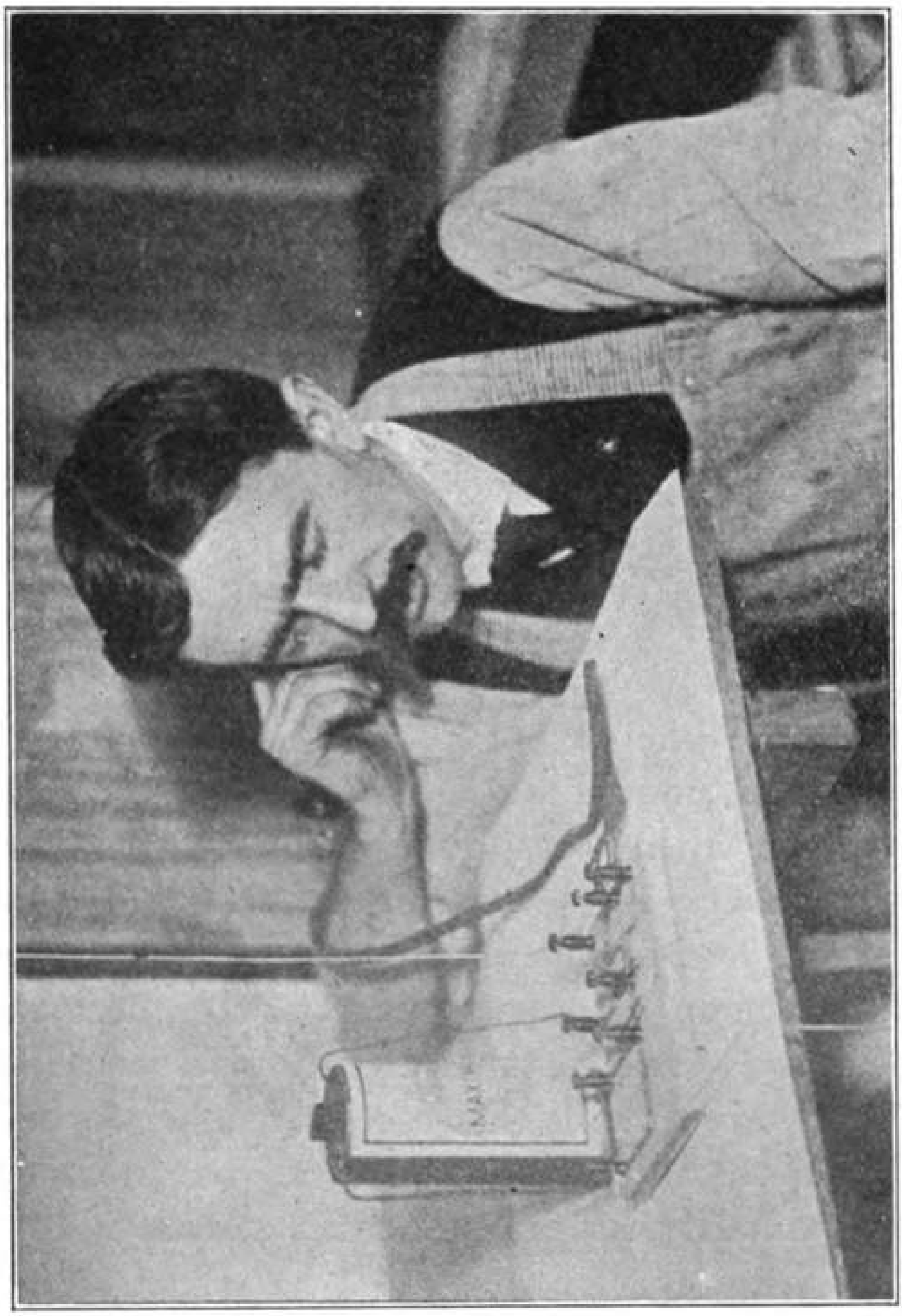

Fig. 11. Experimental Auto-Detector Receptor in Operation.

holes are inserted pencil leads or pieces of graphite. The leads may be obtained by splitting the wood from a medium hard lead pencil and cutting it into lengths of about 1½ inches. Across the graphite terminals is placed a steel sewing needle as shown.

Fig. 10 is a wiring diagram of the receptor. The leads are represented at 11 and 12 and the needle at 13. The binding post 14 of the detector is connected to the zinc of the cell 15; the carbon 16 of the cell is connected with one terminal of an ordinary telephone receiver 17; the opposite terminal of the receiver is connected with the remaining post of the detector 18. To the post 14 the aerial wire is attached and with the post 18 the ground wire is connected.

The detector is self-restoring, that is no tapping is necessary to restore its sensativeness as it possesses inherent properties which cause it to decohere immediately the oscillations have passed and without tapping. The only adjustment necessary is to occasionally shift the position of the needle over the lead terminals. Fig. 11 shows the auto-detector receptor complete and in operation. The distance over which messages may be received with this receptor depends very largely upon the aerial wire used, but it is designed primarily for experimental work.

CHAPTER III.

A One to Five Mile Transmitter.

The transmitter of a set capable of signalling upwards of five miles need not differ materially from the experimental one described in Chapter I, but there are certain improvements which can be made so that it will be very much more efficient.

Like the experimental transmitter this one is of the open circuit type, that is the aerial and ground wires are connected directly with the spark-gap terminals. The apparatus is however better made and it will serve all practical purposes for the distances named. The necessary parts for this transmitter are:

(a) A one-inch induction coil,
(b) An adjustable spark-gap,
(c) A high tension condenser,
(d) A battery,
(e) A key.
(f) A leading-in insulator.
(g) An aerial wire, and
(h) A ground wire.

The induction coil Fig. 12 is of the regular standard make and is fitted with a three-point switch so that the current can be reversed. Like the smaller coil it has a single spring interruptor and has an ordinary paper condenser secured in its base.

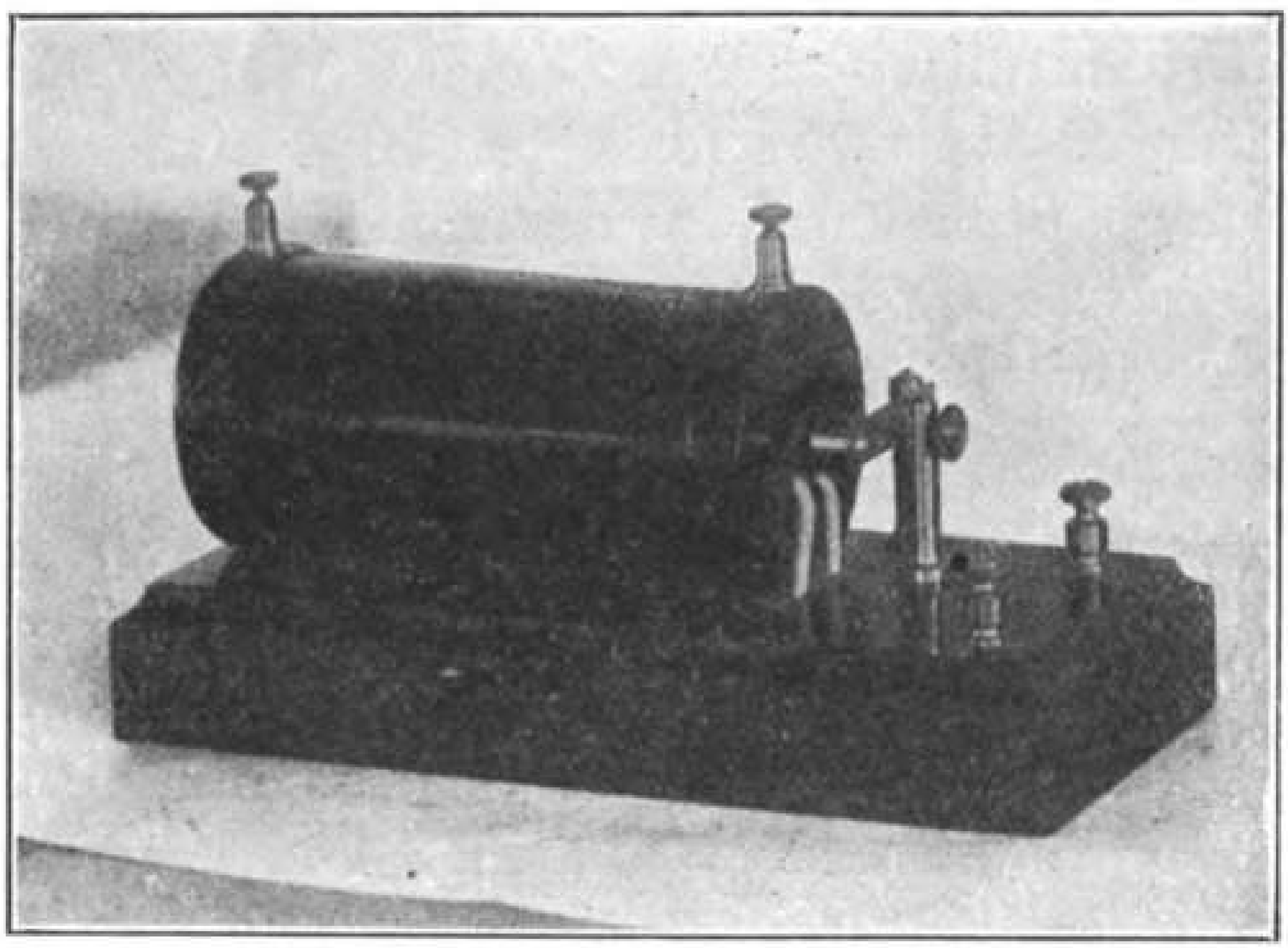

Fig. 12. Standard One Inch Induction Coil.

The spark-gap may be made by procuring two brass or zinc balls, ½ or ¾ inch in diameter, and after drilling and tapping them out with an 8/32 tap, screwing into each one a piece of brass rod 3 inches in length. Zinc is preferably used for spark-gap balls, since it adds materially to the efficiency of the disruptive discharge in setting up oscillations, and in this respect its value is quite as pronounced as that of copper in the conduction of electric currents, or as that of iron to the permeability of magnetic lines of force. Next to zinc, brass is the best metal for spark-gap electrodes.

Binding Posts. Since the binding posts, connected with the terminals of the secondary coils, are double, that is they have two holes for wires, there is no necessity for bending the wires as the spark-gap balls will be sufficiently distant from the surface of the coil to prevent straining by static charges.

Spark-gap Rods. The outer ends of the spark-gap rods are protected by handles turned of hard rubber or of hard black fibre, which, though not as good an insulator is much cheaper and can be polished to look like hard rubber. These handles may be 2½ inches in length and ⅜ inch in diameter, the ends of the spark-gap rods being screwed or otherwise tightly fitted in the handles.

To succeed with any wireless telegraph set the spark must be kept white and snappy—if the gap is too long the spark will be red and stringy, and if too short the voltage will be too low and an arc will be formed. It requires in the neighborhood of 50,000 volts to break down one inch of air, yet it has been found that from 20,000 to

25,000 volts are all that are required to set up the strongest oscillations in the radiating aerial however large the station may be; it has also been found that a large current is necessary for effective transmission.

For so short a distance as five miles the one-inch coil may be employed as it comes from the maker, but it will give much better results if the length of the spark is cut down, by shunting a high potential condenser across the spark-gap terminals as shown in Fig.13. This con-

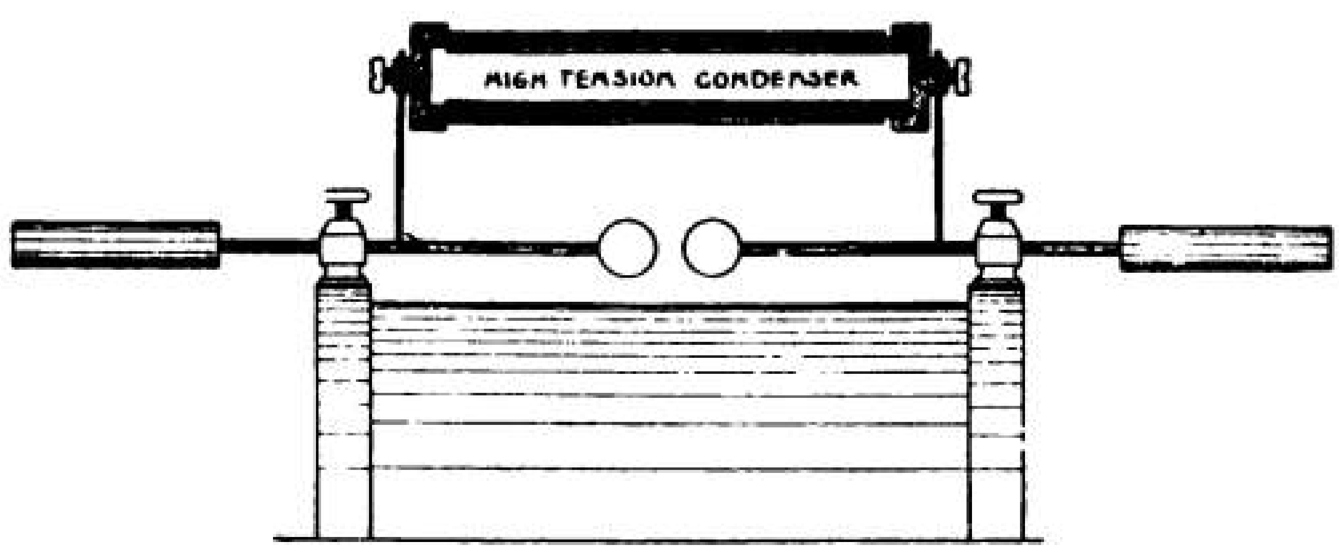

Fig. 13. Condenser Across Spark-gap.

denser may be a simple Leyden jar made by coating a flint glass bottle, say 4 inches high and 1 or 2 inches in diameter inside and out with tin-foil.

The Condenser. A more convenient and compact condenser may be made of two flint glass tubes each of which are 6 inches in length, the larger having an outside diameter of 1 inch and the smaller having an outside diameter a little less than the inside diameter of the large one. The smaller tube is coated inside and out with tin-foil and shellacked when it is placed inside the larger tube which serves to protect it. Brass caps or other terminals are fitted over the ends of the tube, one of the caps being connected with the inner coating of tin-foil and the other cap with the outer coating of tin-foil. This high tension condenser will have a capacity of ap-

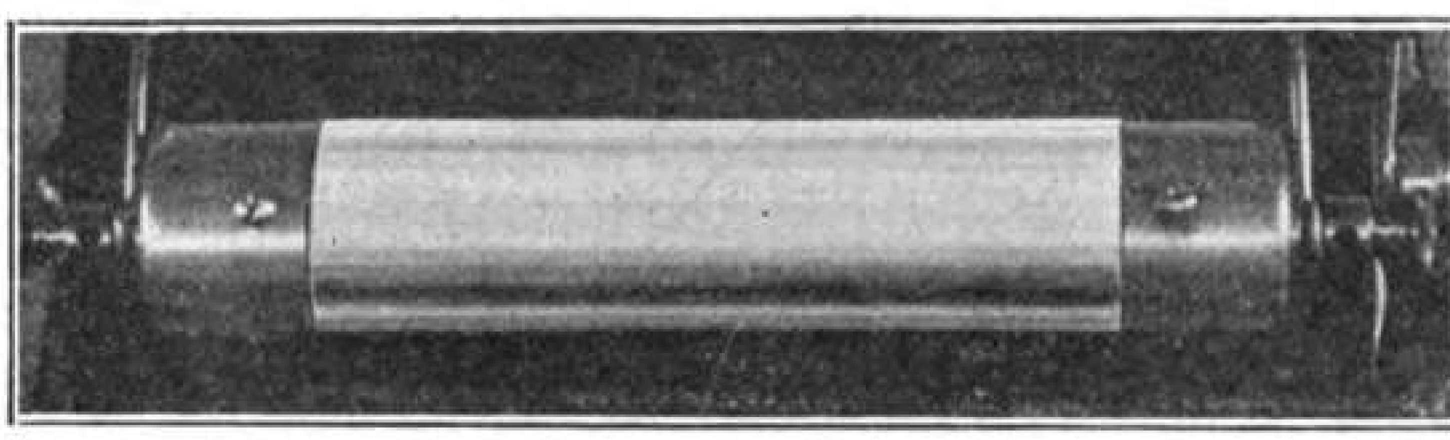

Fig. 14. High-Tension Condenser.

proximately 0.005 microfarad, and will cut down the length of the spark to about ⅛ inch when its efficiency will be greatest and send out signals which will ring sharp and clear in the receivers. This type of condenser is shown in Fig. 14.

A strap key, Fig. 15, with an adjustment screw on a cross bar set at right angles to and over the spring carrying the contact point, is sufficiently good for the purposes this set is intended for. A key may be easily fashioned by taking a strip of spring-brass 3½ inches in length, ½ inch in width at one end and cut so that it tapers to 5/16 inch at the opposite end; at a point ¾ inch from the widest end bend it up at an angle ¼ inch, and then down, as shown in Fig. 15, so that when the short and wide end is screwed to the base the long and narrow portion will stand parallel but free from the surface of the block.

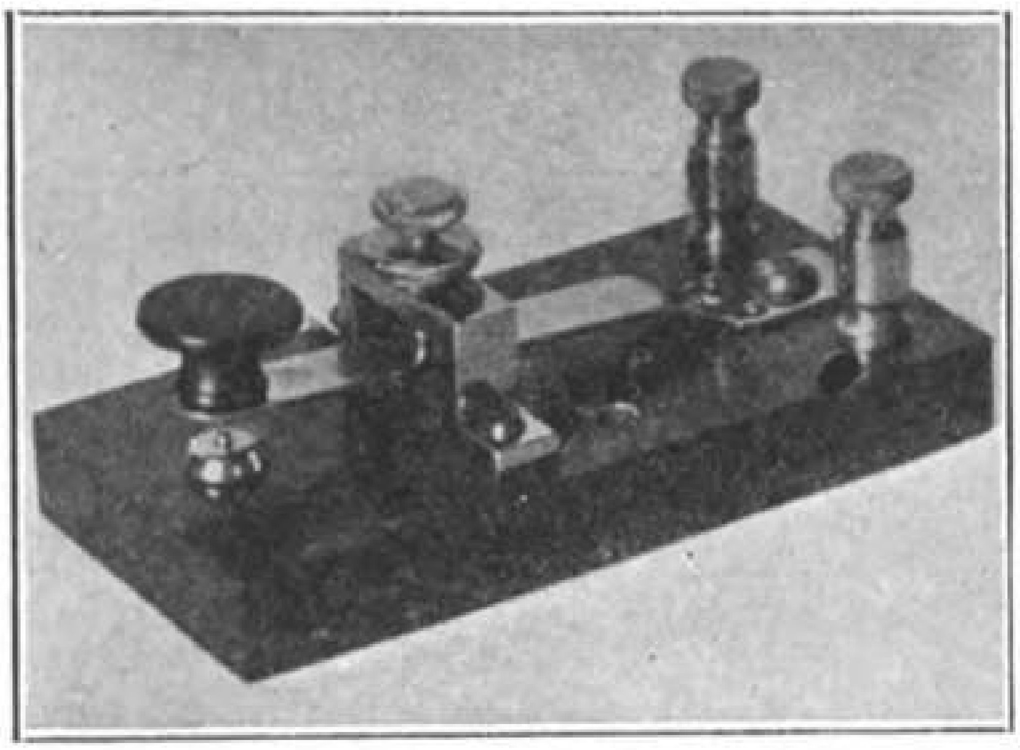

Fig. 15. A Good Strap Key.

To the free end a button is secured by means of a brass pin which serves to make contact with a stationary point immediately beneath it. The rear end of the spring is connected with one of the binding posts while the stationary point is coupled to the opposite post. About 1¼ inches from the free end an adjusting screw in a brass angle frame is placed in position when the latter is screwed to the base. The adjustment of the spring may be secured by means of a check-nut. The contact points are large enough to carry all the current the coil requires.

A battery of 12 or 14 dry cells connected in series parallel may be used to energize the coil, but greater satisfaction will be had if a battery of 5 or 6 Edison cells connected in series are used

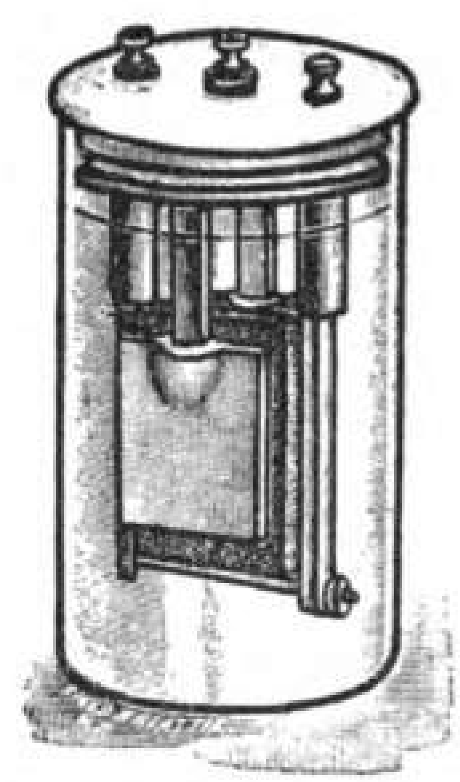

Fig. 16. Edison Primary Cell.

instead. The elements employed in these cells are zinc and black oxide of copper in a solution of caustic soda. A battery of these cells gives a practically constant current and when the elements are used up they can be easily and quickly renewed. There are a number of forms of these cells made and all develop an initial electro-motive force of practically one volt which drops to

$7/10$ of a volt when the circuit is closed. The smallest cell, known as **BB**, has a capacity of 100 ampere hours.

The **S** cell is the largest and has a capacity of 300 ampere hours. While a battery of these cells cost more than a battery of dry cells they are cheaper in the long run since, unlike dry cells, they need not be thrown away when exhausted.

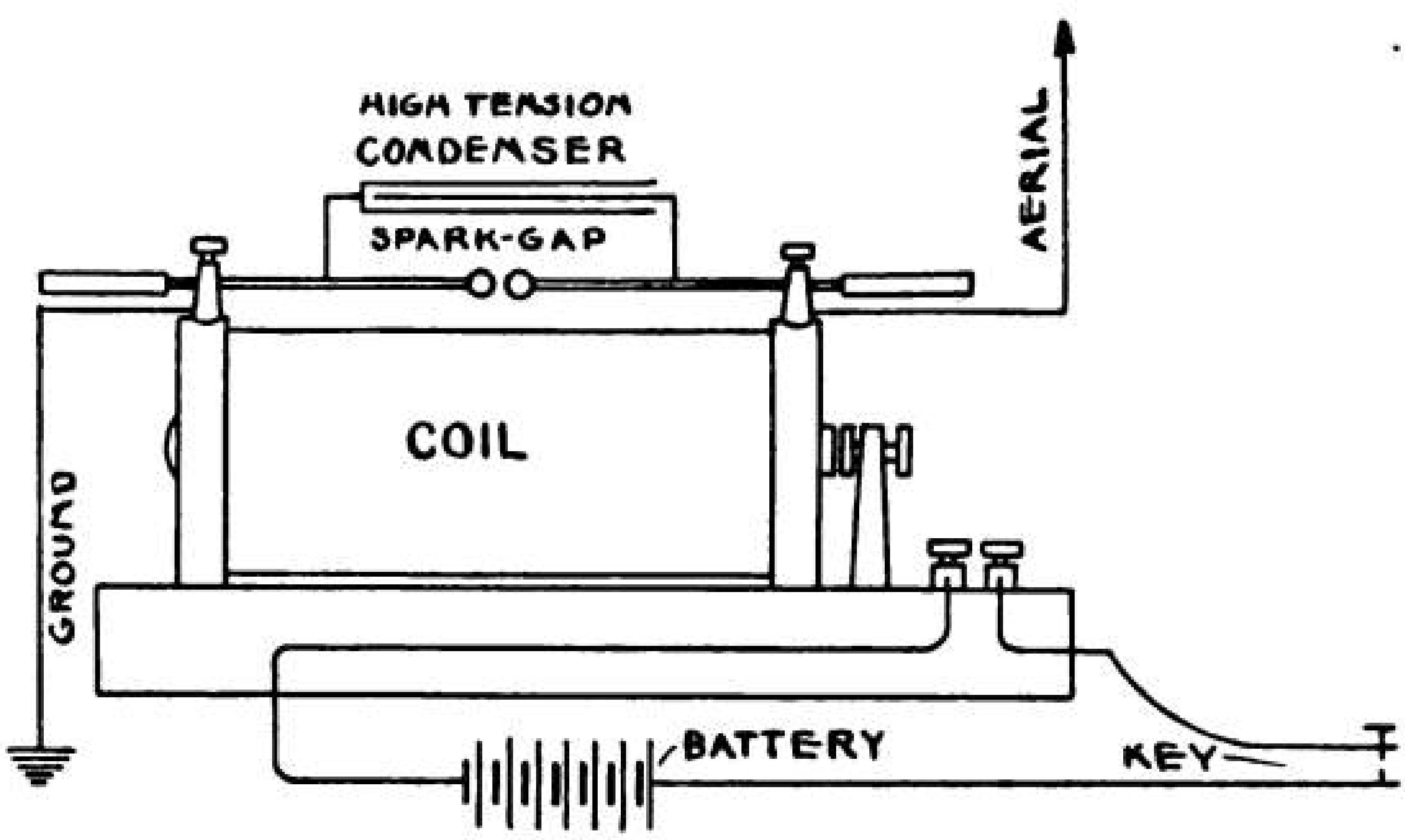

Fig. 17. Wiring Diagram of a One to Five Mile Transmitter.

The cell is shown in Fig. 16. These cells are connected in series with the key and the inductor, as the primary of the induction coil is called. These, together with the connections of the secondary coil, the condenser and aerial and ground wires, are graphically illustrated in the diagram Fig. 17.

The aerial wire is connected directly to one of the binding posts and the ground plate to the

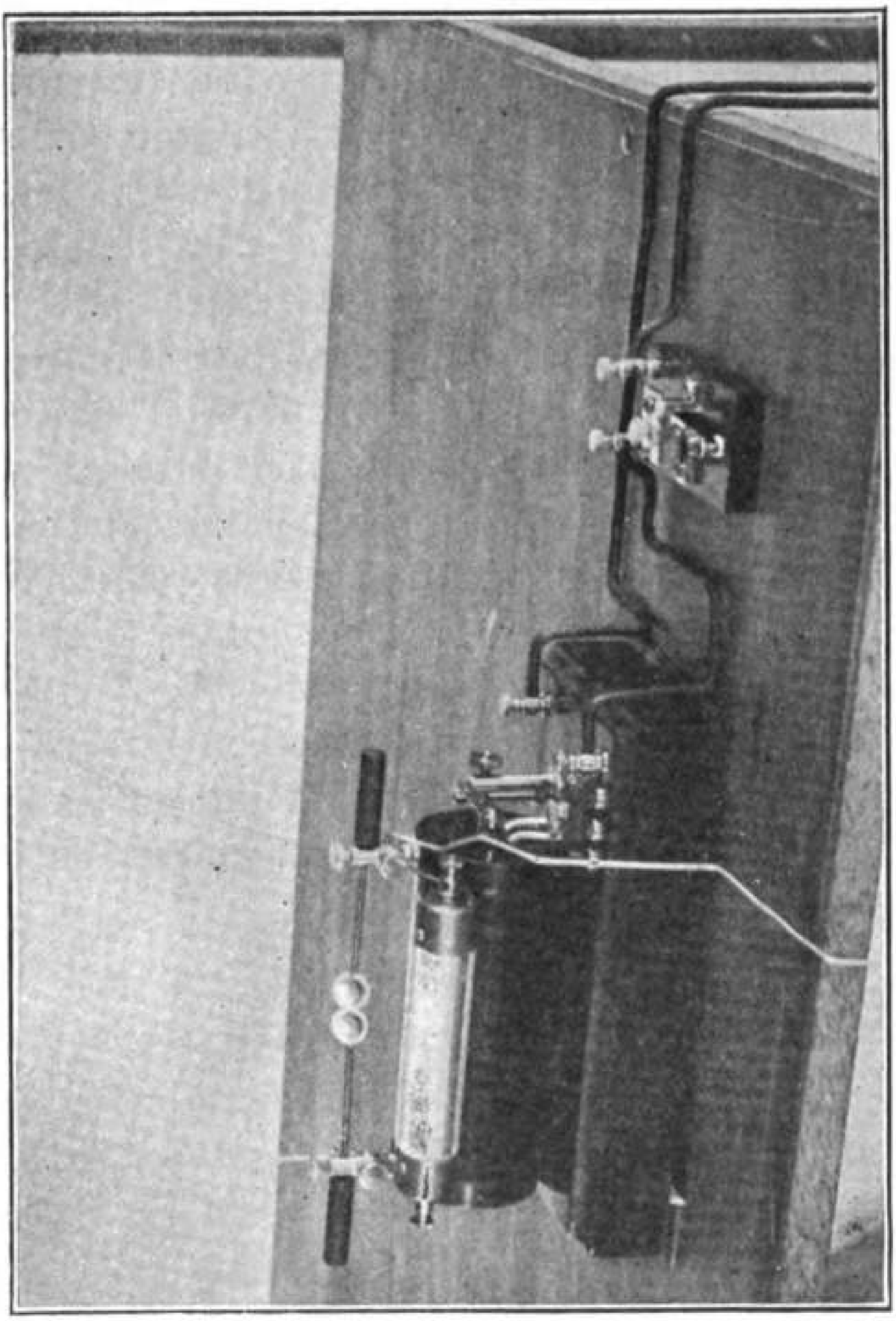

Fig. 18. One to Five Mile Transmitter, complete.

oppositely disposed post of the secondary, the condenser being shunted across the spark-gap as previously indicated. The complete transmitter is shown photographically in Fig. 18.

To cover a few miles with this transmitter is a very easy matter, but if the aerial is to be of the vertical type, that is one or more wires suspended from a spar or a yard of a mast or a pole directly to the operating room as was customary before the **T** aerial came into vogue, the wire should be at least 40 feet in length; if, however, the aerial is of the **T**, or flat-topped type, then it may be 20 feet high and formed of two parallel wires 30 feet long and separated from each other a distance of not less than 2 feet. A good ground must also be provided and a surface area of not less than 12 square feet of copper plate properly buried in good damp soil must be used. A simple leading-in insulator having a sufficiently high insulation to take care of the amount of energy supplied to the aerial by this transmitter should be used to obtain the best results.

CHAPTER IV.

A One to Five Mile Coherer Receptor.

The Receptor. To construct a receptor which will merely tap out signals by means of a buzzer or a bell is easy enough, but where it is desirable to employ a sounder for the reception of actual messages even though the distance is but a few miles, a very pretty and an exceedingly ingenious electro-mechanical combination will be required as will be seen presently.

For this receptor which may be designated as a coherer type to conform to the classification adopted in the preceding chapters the following devices are necessary:

(a) An adjustable coherer.
(b) An electro-mechanical tapper.
(c) A 100 ohm relay.
(d) A small switch.
(e) Five or six dry cells.
(f) An aerial, and
(g) A ground wire.

The coherer comprises two brass standards.

Fig. 19 each of which are $1^{11}/_{16}$ inches in height and turned to the form shown in the drawing. Through the horizontal line of the standards $1/8$ inch holes are drilled and these are filed out square. Holes $1/8$ inch in diameter are drilled and tapped out with an $8/32$ tap in the top and bottom of their longitudinal centers, and brass set screws $9/16$ inch in diameter and having

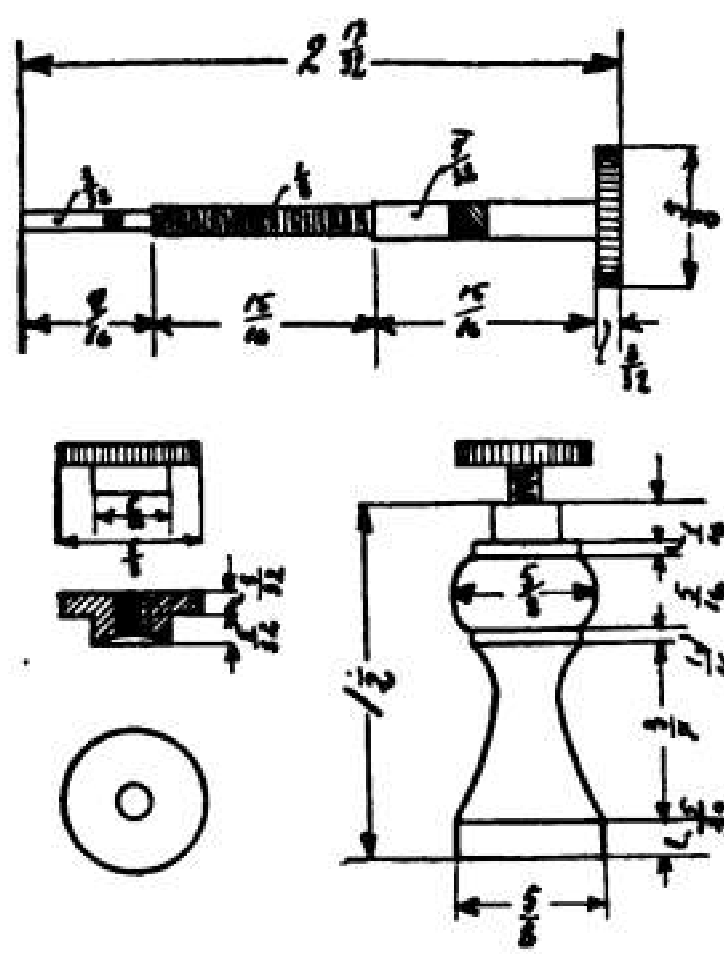

Fig. 19. Conductor Plugs, Adjusting Screws, Standards.

milled heads, and one inch machine screws are fitted into them, the latter for securing the standards to the base.

Two brass conductor plugs, Fig. 19, made of rectangular brass rod, each $1\frac{1}{2}$ inches in length and of a size so that they will slide nicely through the horizontal holes of the standards, are provided with milled heads 9/16 inch in diameter on one end. Before the plugs are inserted in the holes, spiral springs having five turns each, the distance between any two turns being about 1/16 inch, are placed over them. The opposite ends of the conductor plugs are tapped and adjusting

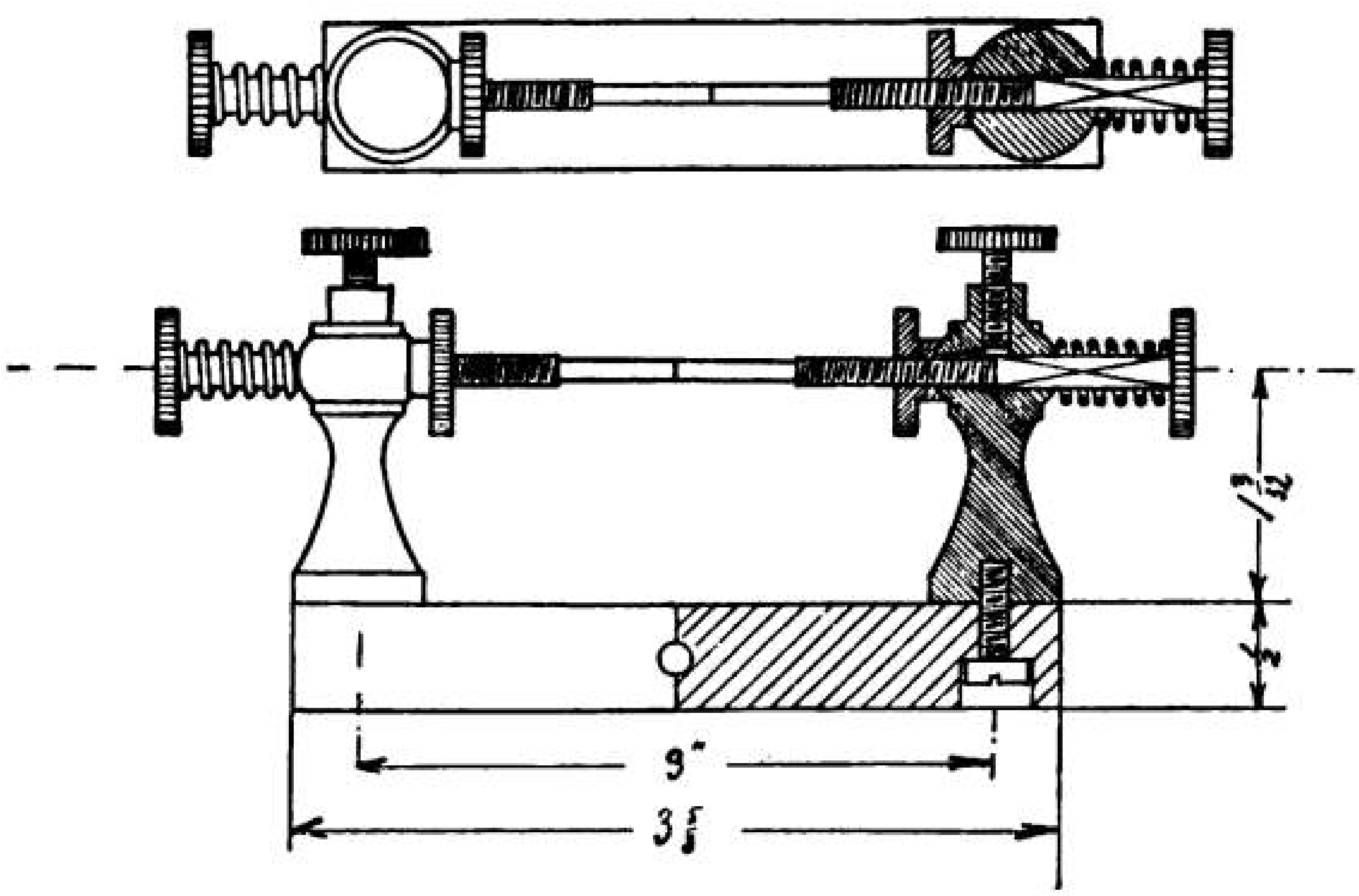

Fig. 20. Plan of Coherer: Top, Side and Sectional Views of Coherer.

screws having 3/32 inch shoulders turned on one side which serve as bearings, are tapped to screw thereon. To the extreme ends are screwed or soldered terminal conductor plugs 3/32 inch in diameter and 3/4 inch in length; these may be of brass or other metal.

The standards are now mounted on a base of wood or hard rubber 3⅝ inches long, Fig. 20, ¾ inch wide and ½ inch thick, and from the screws holding them in position four wires, to lead to the relay circuit, the aerial wire and to the earth, are connected. When these are in position the plugs are separated and a piece of glass tubing,

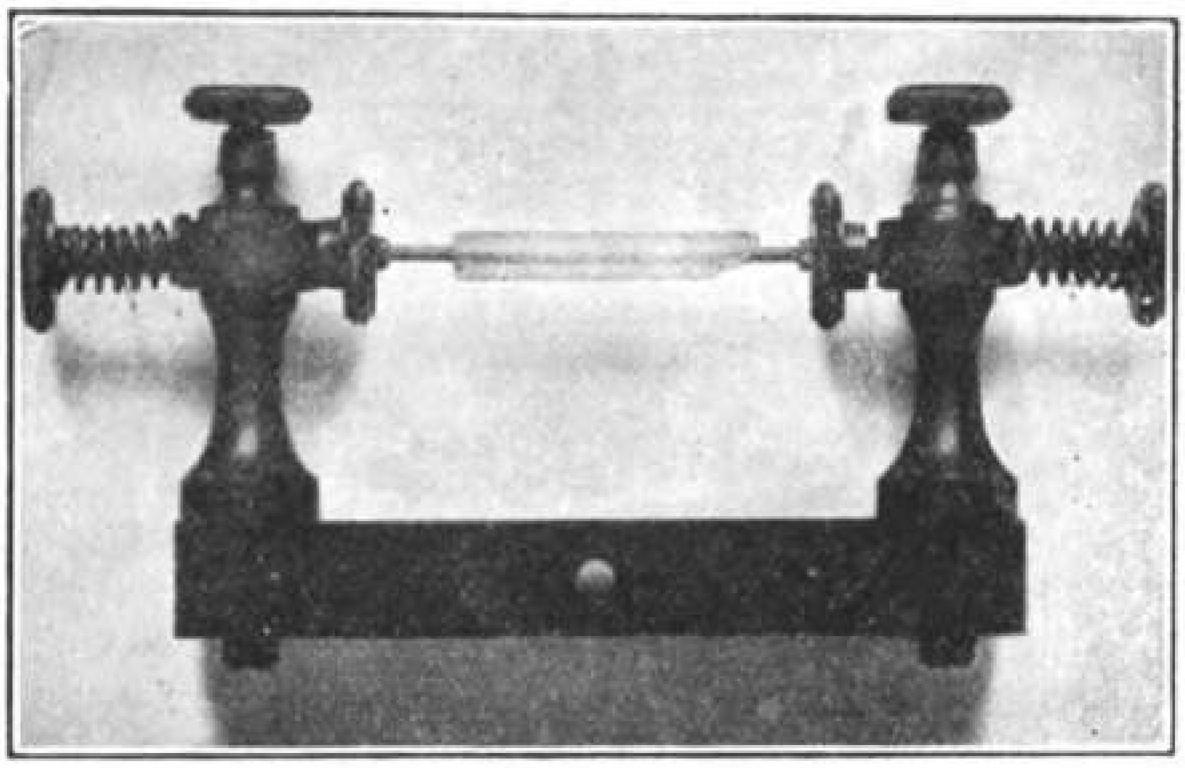

Fig. 21. The Coherer Assembled.

one inch in length, and into which has been placed a pinch of nickel and silver filings, is fitted over them. The filings should occupy a space of about $\frac{1}{16}$ inch. The plugs may be made to approach or recede from each other by the adjusting screws, the springs drawing the plugs apart.

The completed coherer is shown in Fig. 21.

The electro-mechanical tapper, or decoherer, for this receptor will have to be specially made, for the period of vibration of its armature must have a low time constant—that is the armatur must vibrate very rapidly while the armature of the relay must have a high time constant or in other words it must possess considerable inertia and so move very slowly.

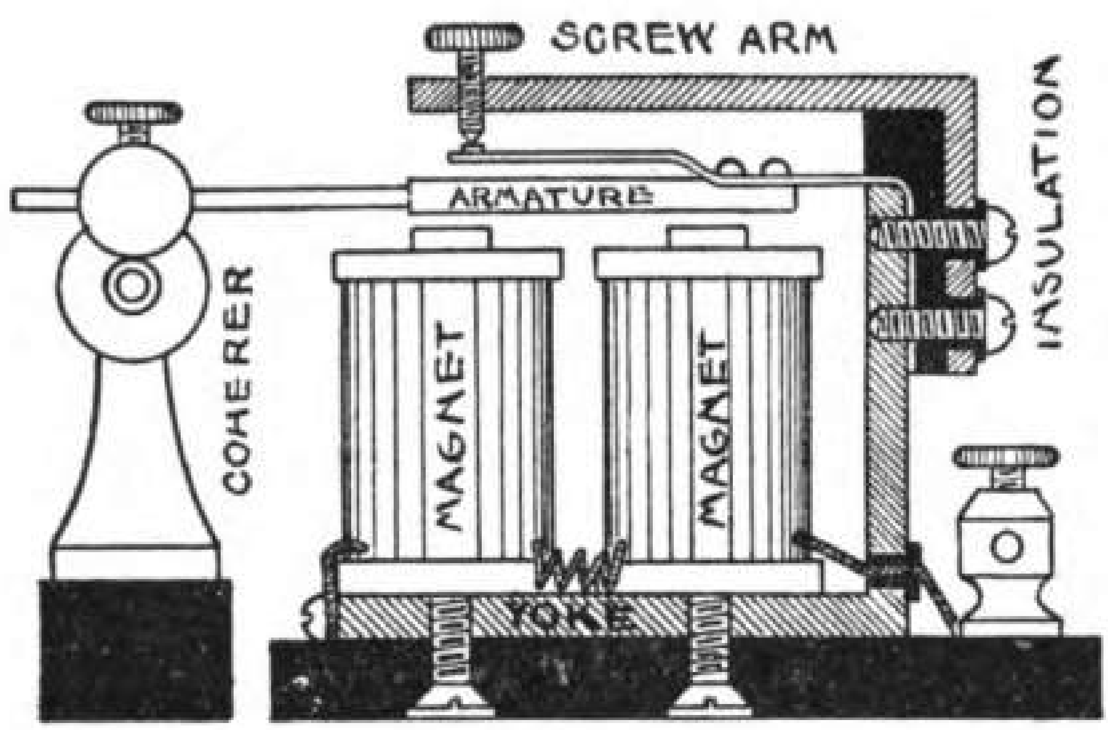

Fig. 22. Cross Sectional View of Tapper.

In order to make a simple electro-mechanical tapper that will conform to these requirements, an electro-magnet the cores of which are 1⅜ inches in length is wound with No. 30 single cotton covered wire until the bobbins are full and its resistance will be in the neighborhood of 250 ohms. For the yoke, a piece of very soft iron 3⅝ inches in length, ½ inch in width and ⅛ inch in thickness is used and this is bent at right angles 1⅞ inches from the end. Through the longer limb two holes are drilled and reamed out and the magnet coils are then secured to the yoke as shown in Fig. 22. To the standard is fitted the arm supporting the adjusting screw, but these are insulated from each other by an angle block of hard rubber and the screws for the standard by hard fibre bushings. The contact spring which is 2⅛ inches long and ½ inch wide and tapering to 5/16 inch is bent almost at right angles ½ inch from the widest end.

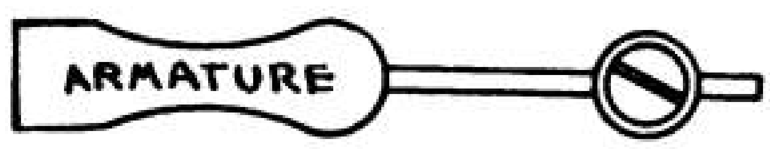

Fig. 23. The Armature.

Two holes are drilled in the spring for the screws and this is placed in position before the parts are screwed together. On the top of the spring a platinum disk ⅛ inch in diameter and 1/16 inch in thickness is soldered so that the platinum point of the adjusting screw will make contact with it. The armature, Fig. 23, consists of a piece of very soft iron 1½ inches long, ⅜ inch wide and 3/32 inch thick, cut away on the sides as shown. The contact spring is secured to the end of the armature by brass pins or screws. To the opposite end of the armature a brass wire 1/16 inch in diameter and 1¼ inches

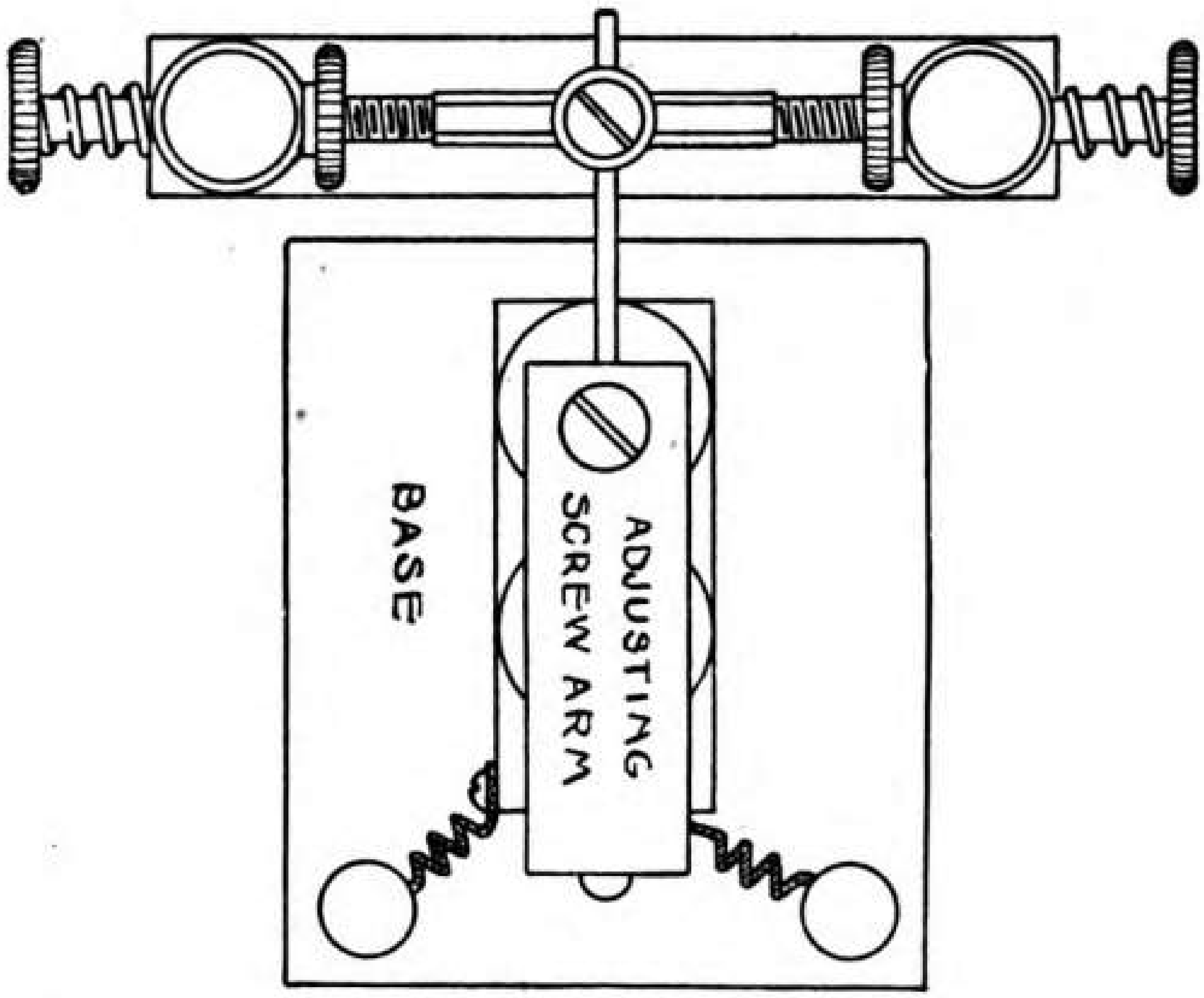

Fig. 24. Plan View of Tapper and Coherer.

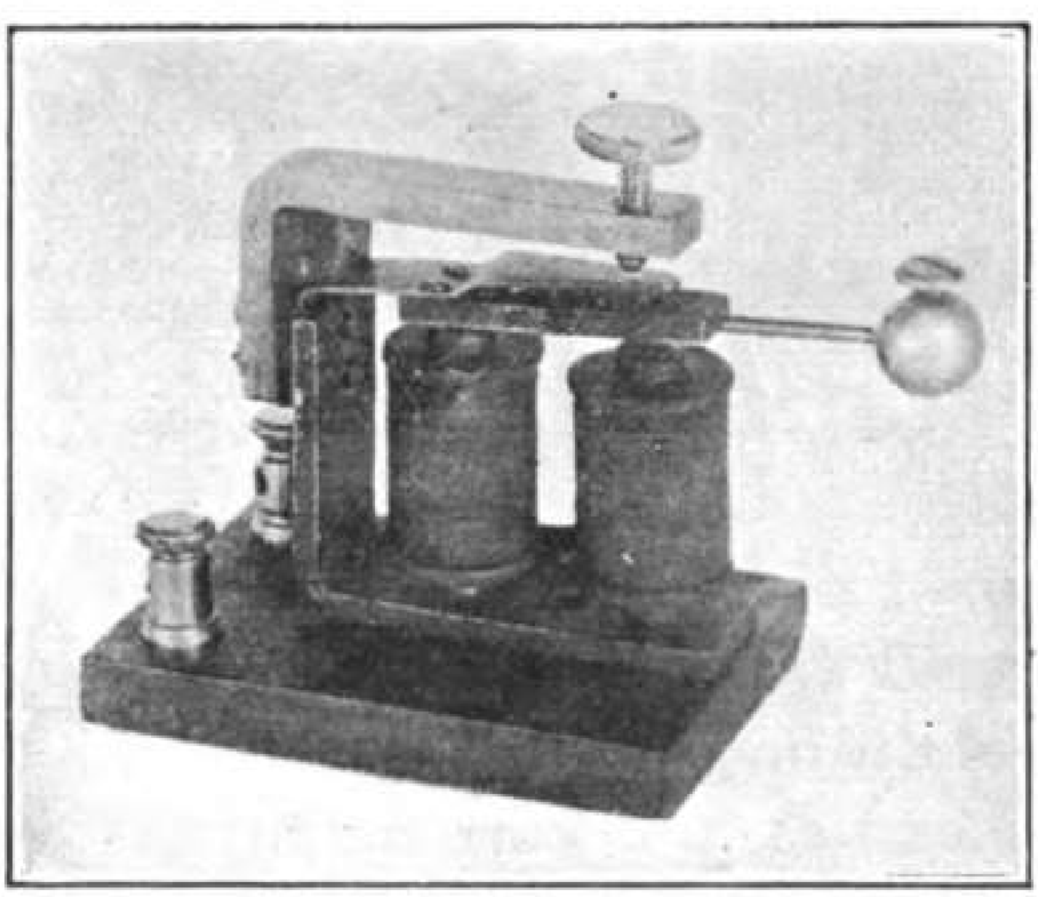

Fig. 25. The Tapper Assembled.

in length is secured and through a brass ball $\frac{5}{16}$ inch in diameter is drilled a $\frac{5}{64}$ inch hole so that it can slide freely on the wire while a screw set at right angles to the wire permits the ball to be adjusted.

The tapper is mounted on a hard rubber base, Fig. 24, 2 inches wide, ¾ inch long and ¼ inch thick. On one end of the base two small binding posts are mounted and the arm carrying the adjusting screw is connected with one of them and

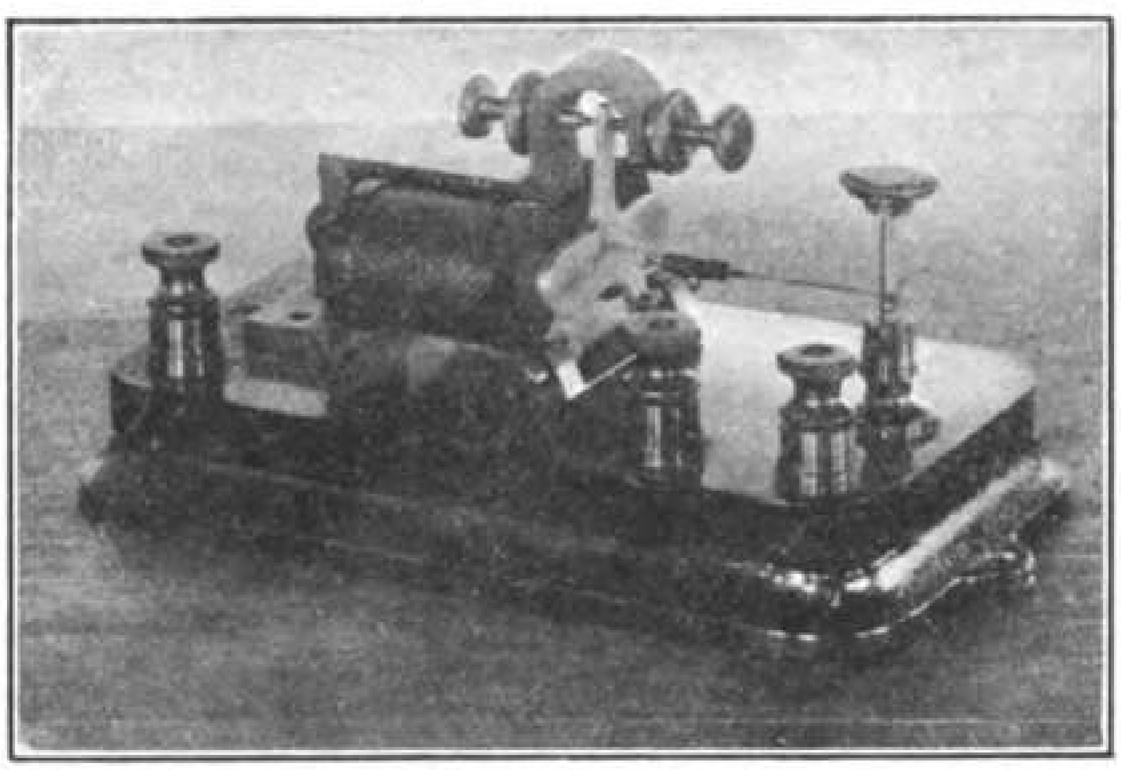

Fig. 26. The Relay, complete.

one terminal of the magnet with the other by silk covered insulated wire. The opposite terminal of the magnet is connected with the yoke and this carries the current to the vibrating spring. The tapper is shown in its completed form in Fig. 25.

The relay Fig. 26, may be of the pony type and should have a resistance of not less than 100

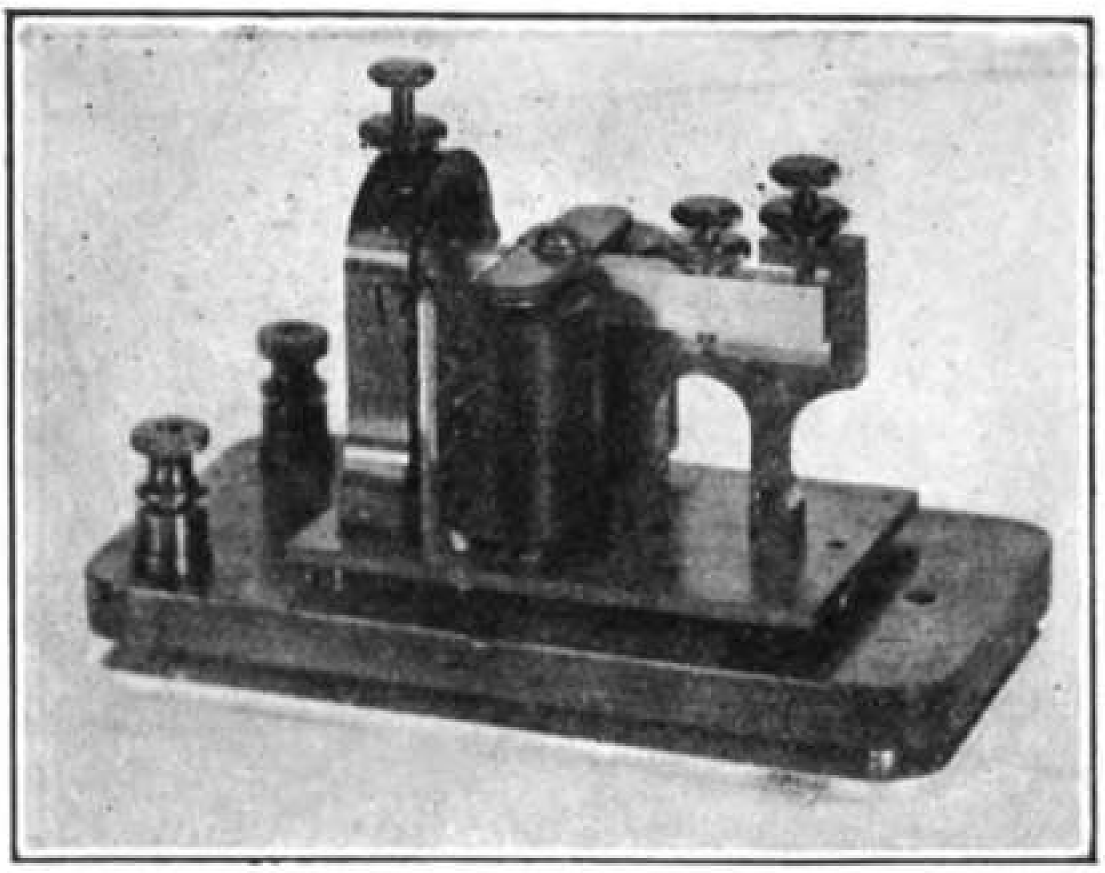

Fig. 27. The Sounder, complete.

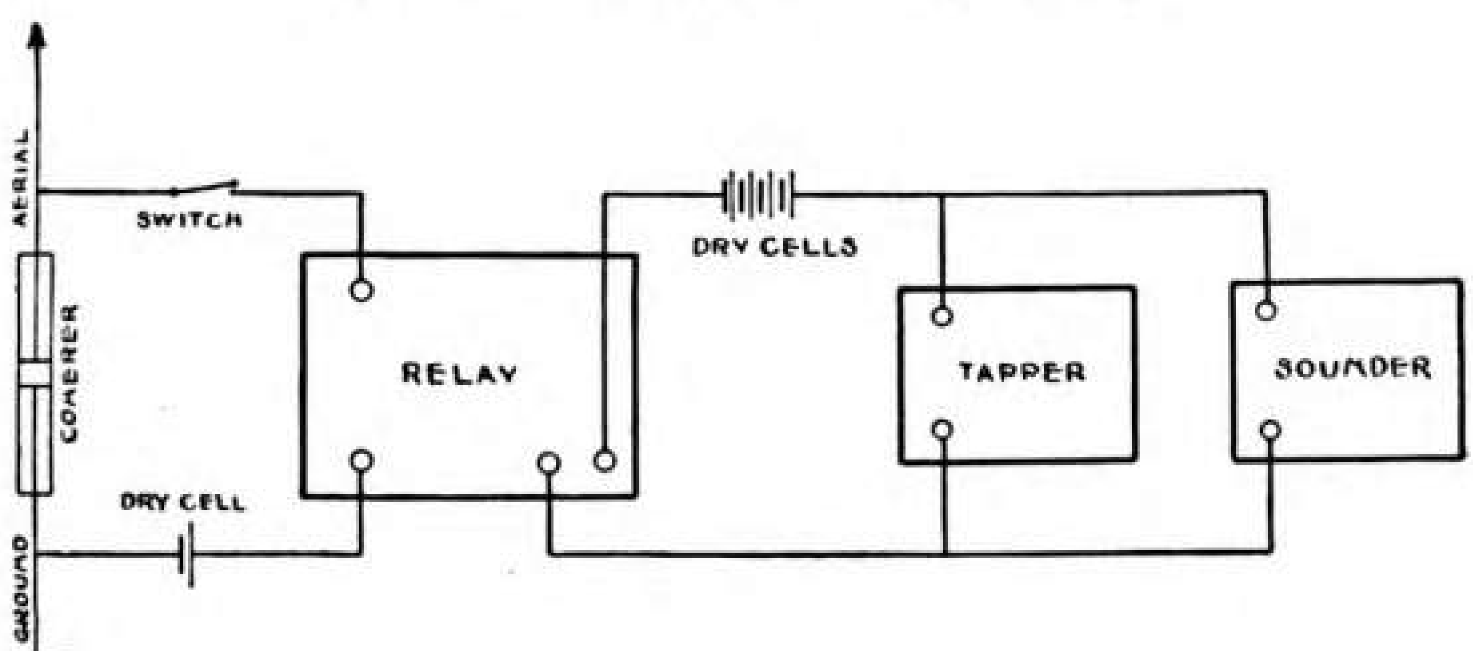

Fig. 28. Diagram of Connections for a One to Five Mile Coherer Receptor.

ohms. This may be purchased from dealers in electrical supplies.

A sounder Fig. 27, completes the parts for the receptor and this may be a standard giant Morse

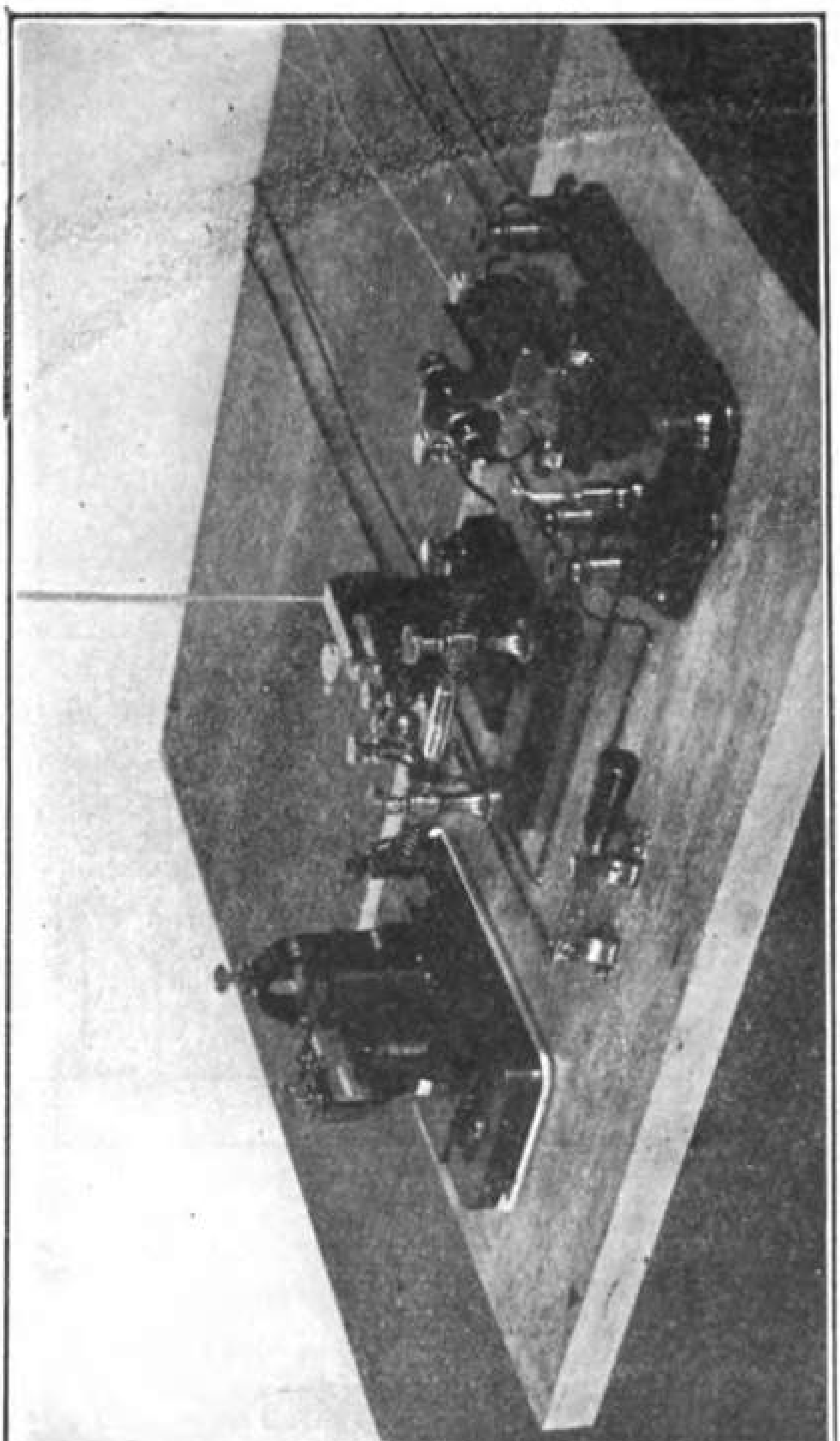

Fig. 29. The One to Five Mile Receptor, complete.

sounder which, like the relay, can be purchased much cheaper than it can be made by the con-

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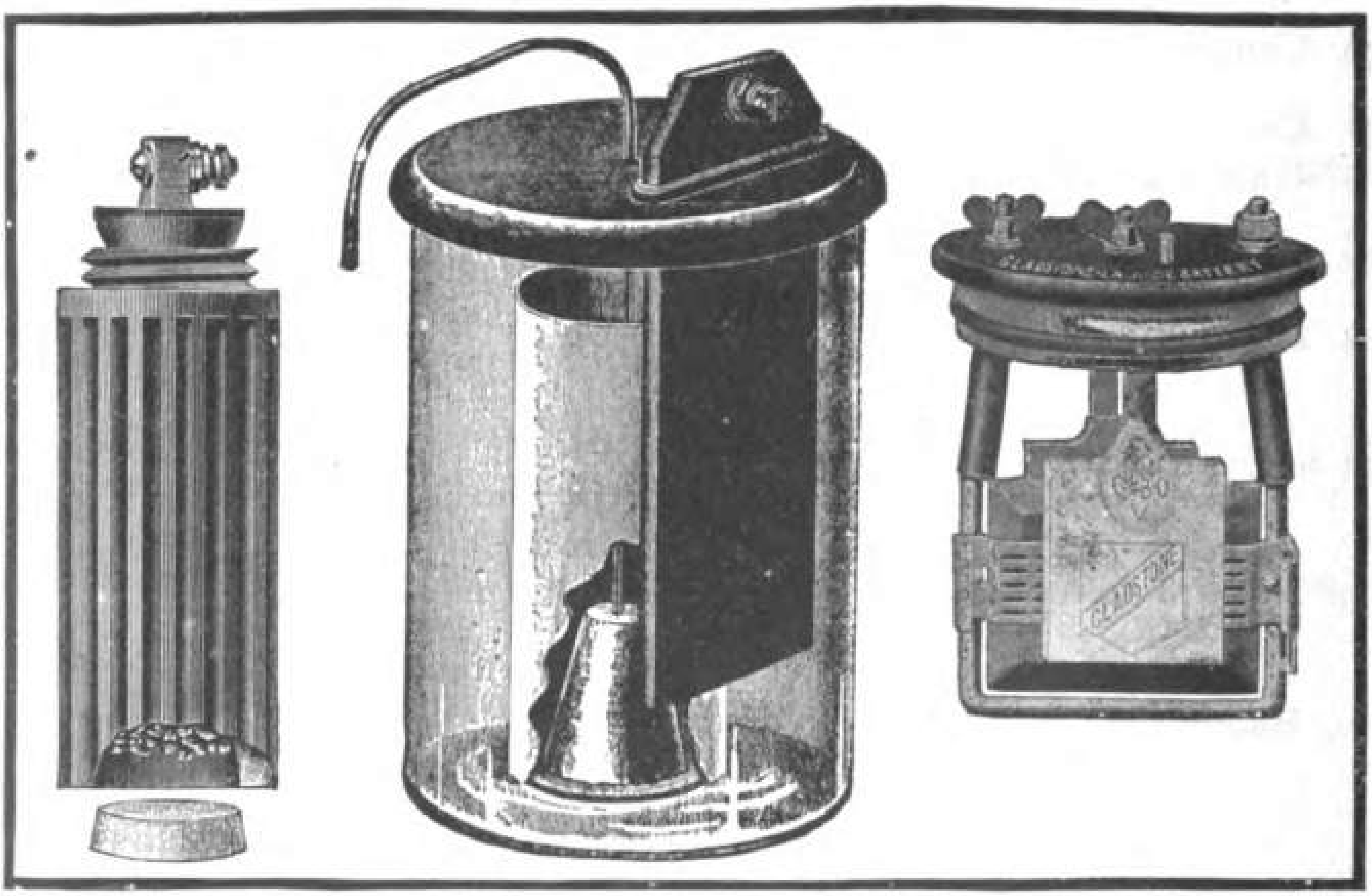

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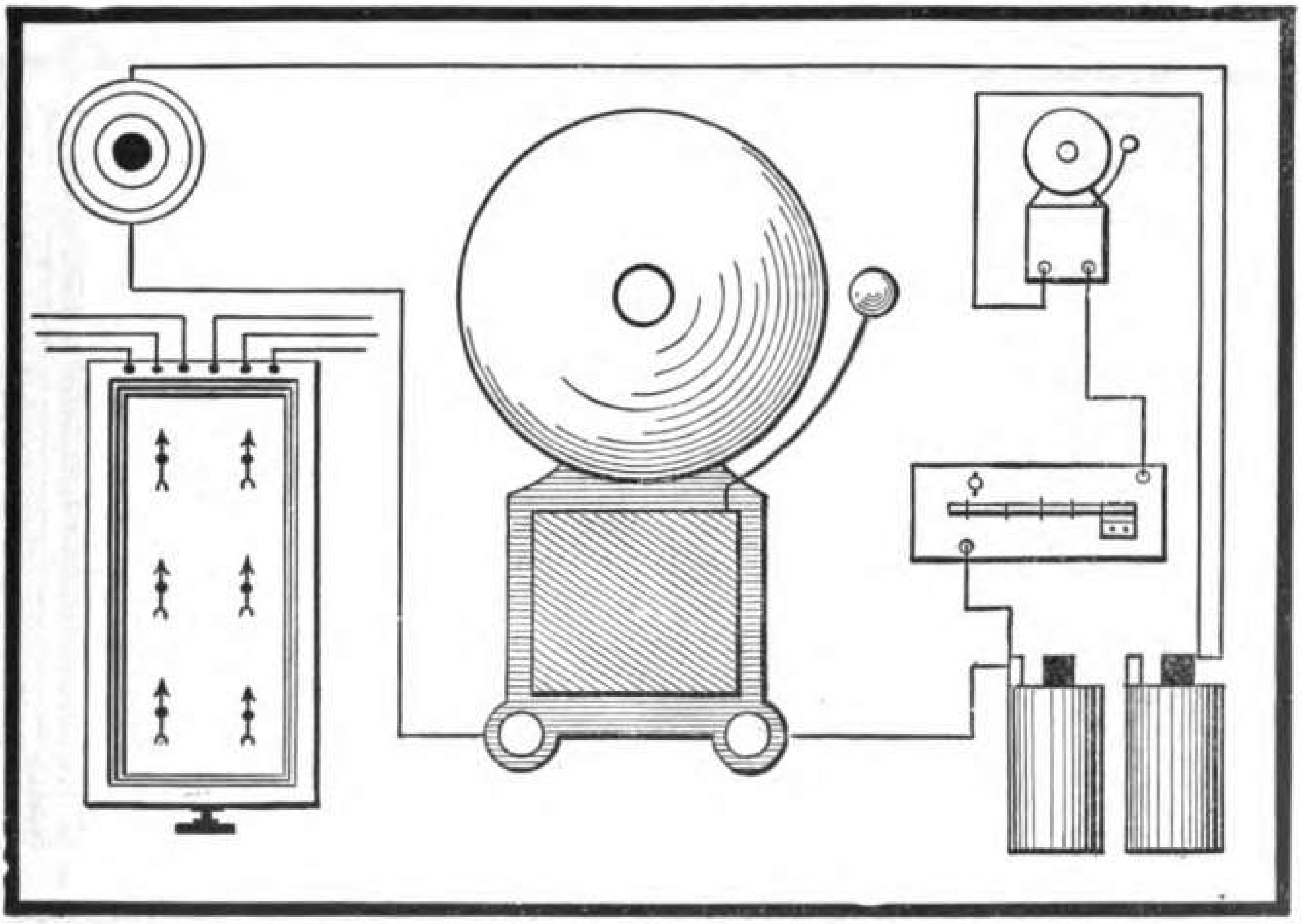

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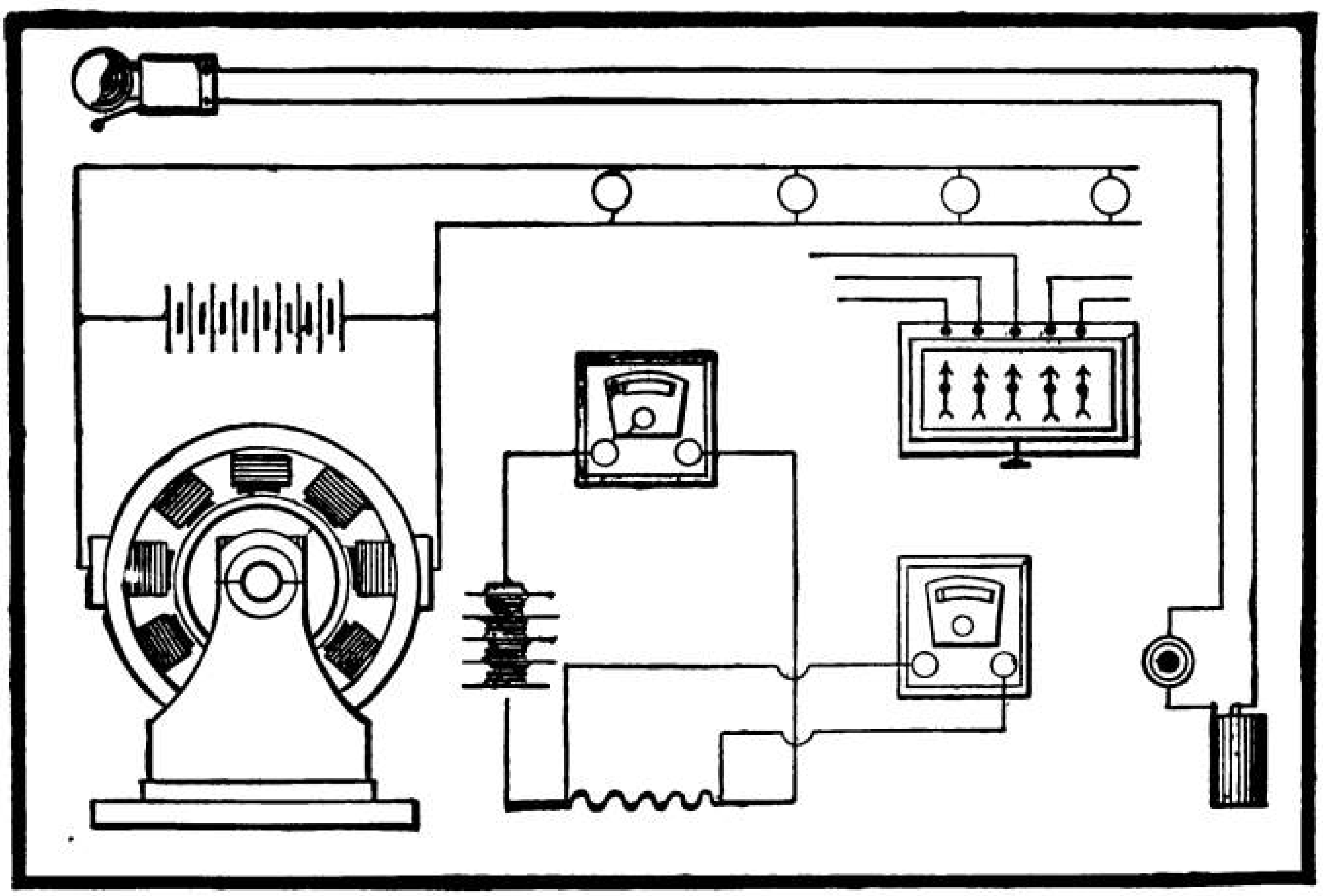

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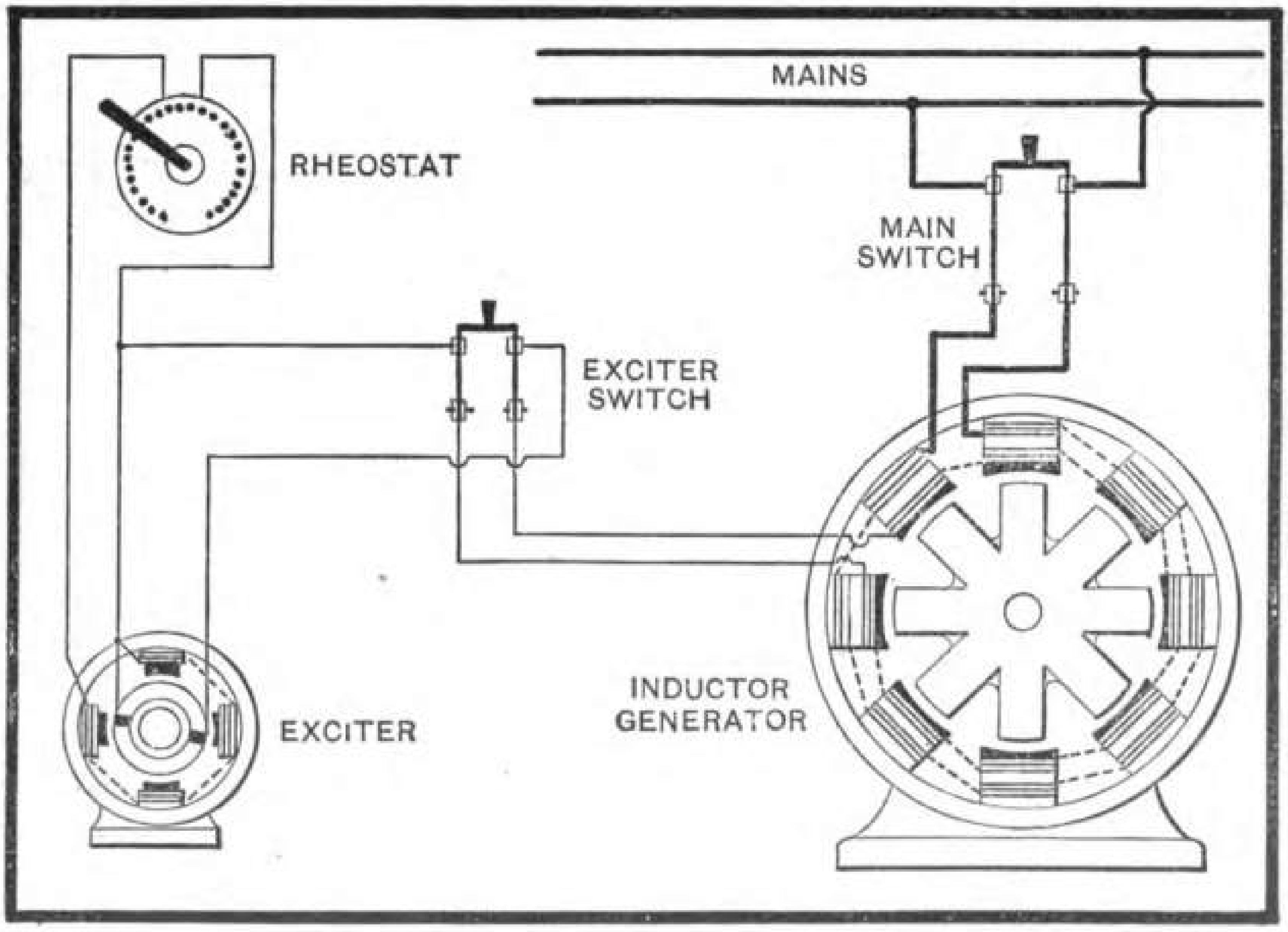

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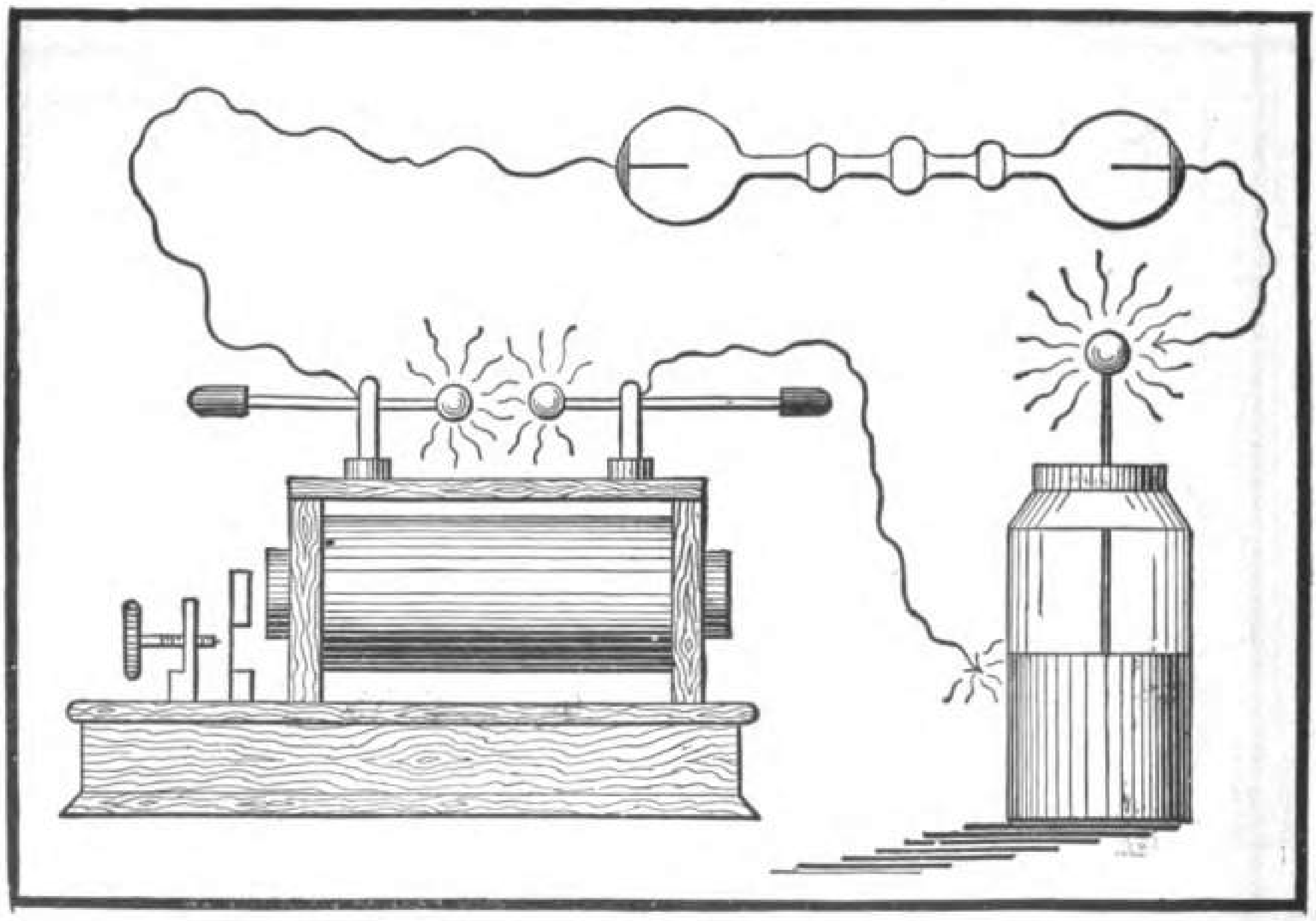

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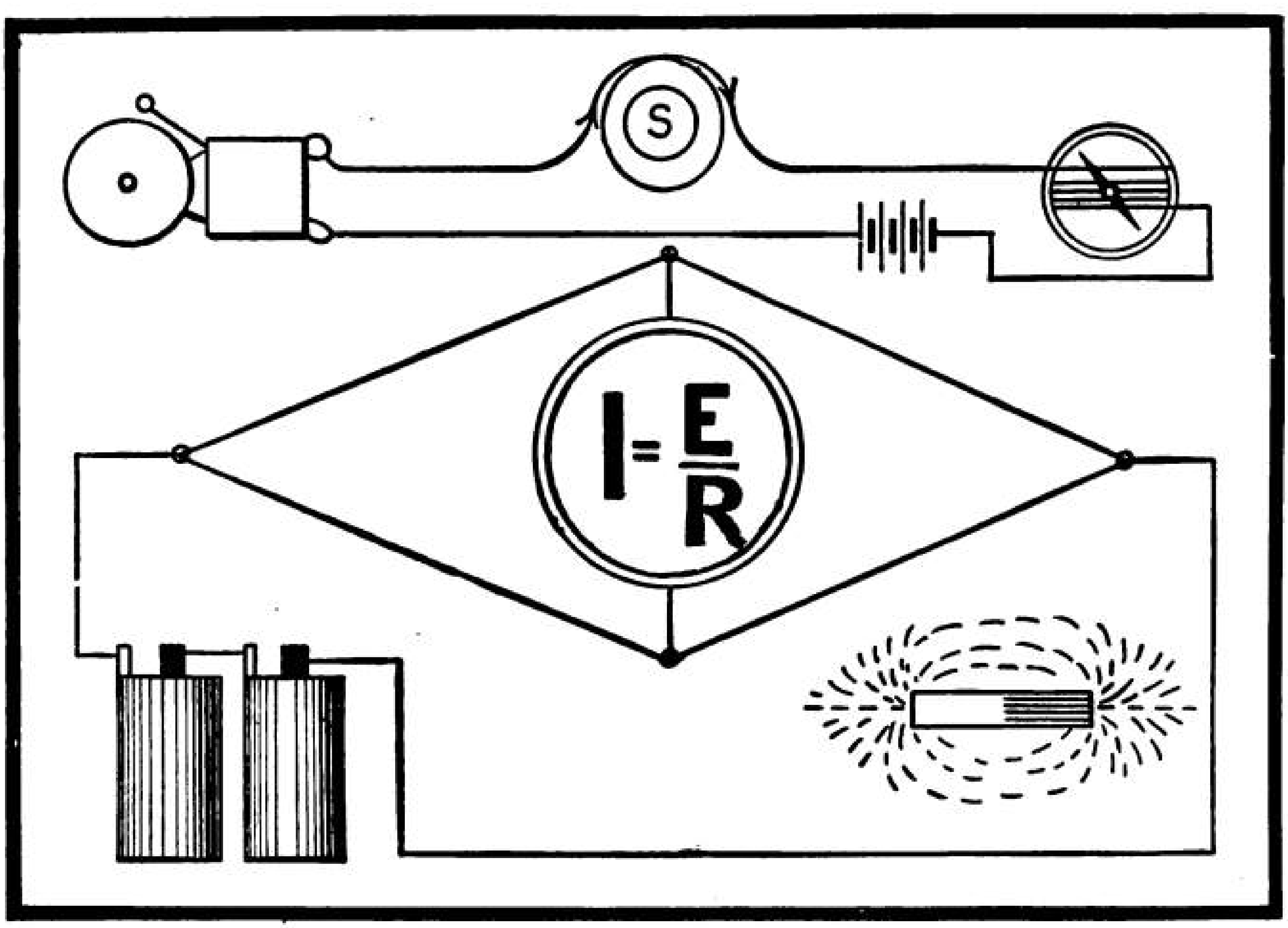

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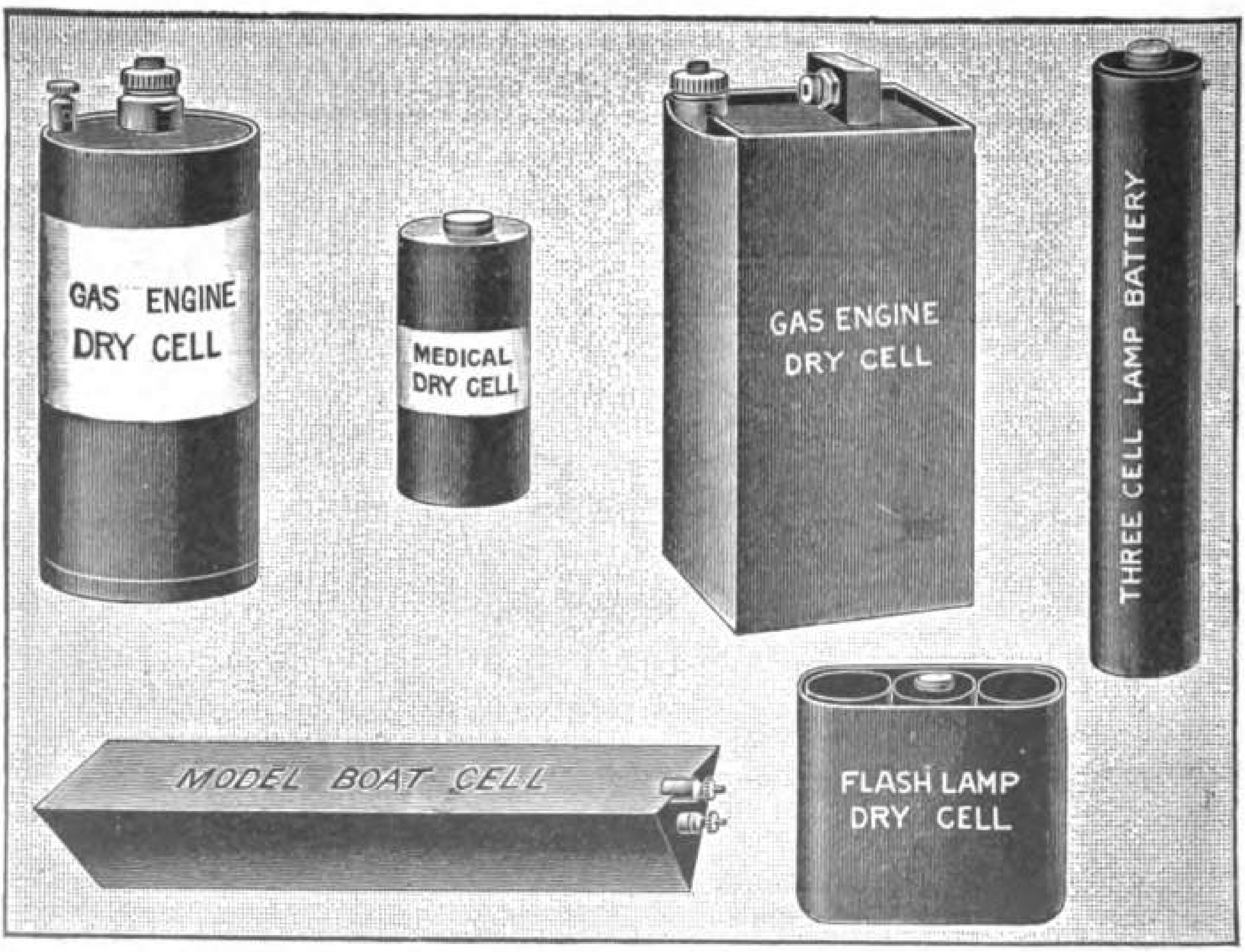

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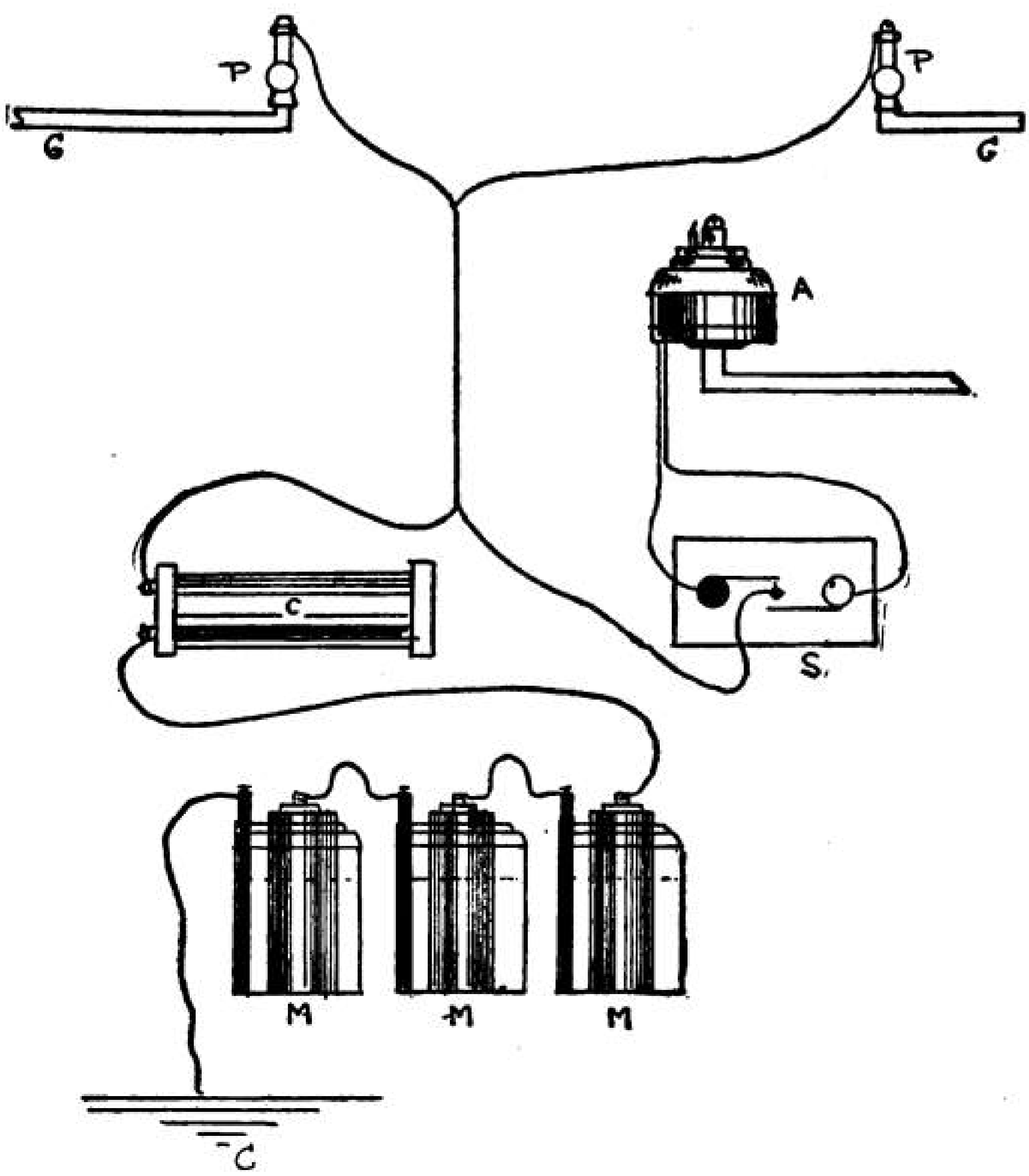

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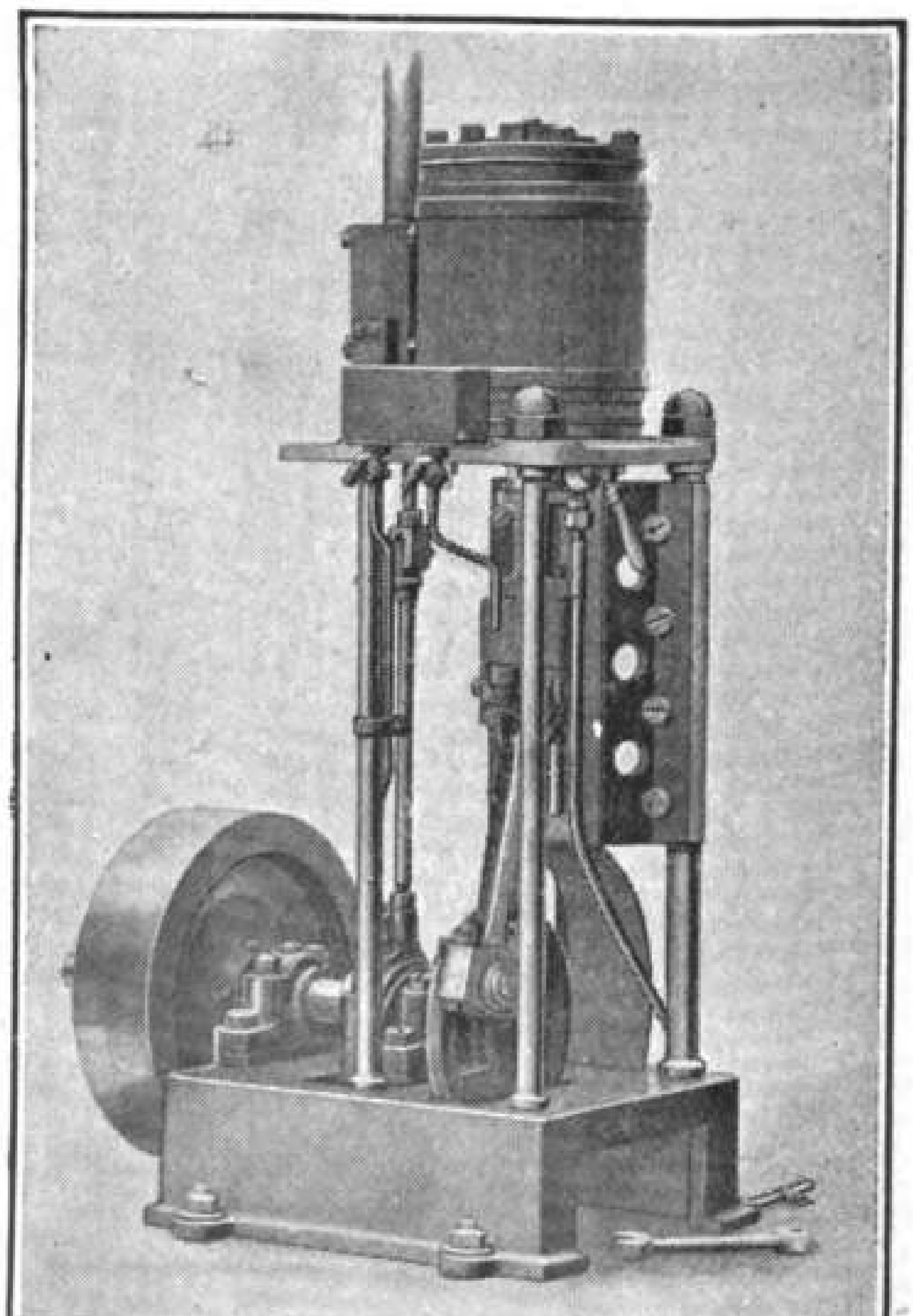

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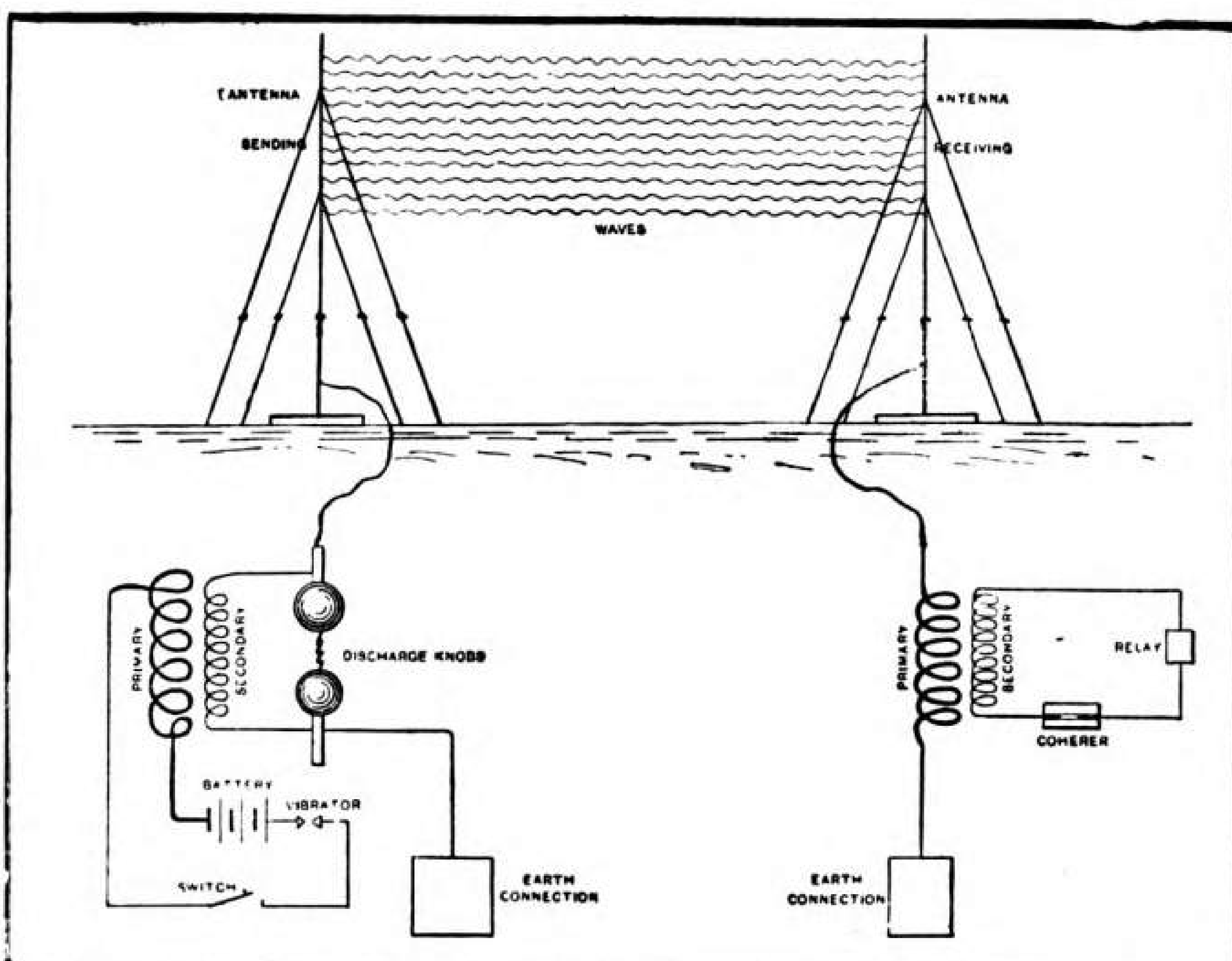

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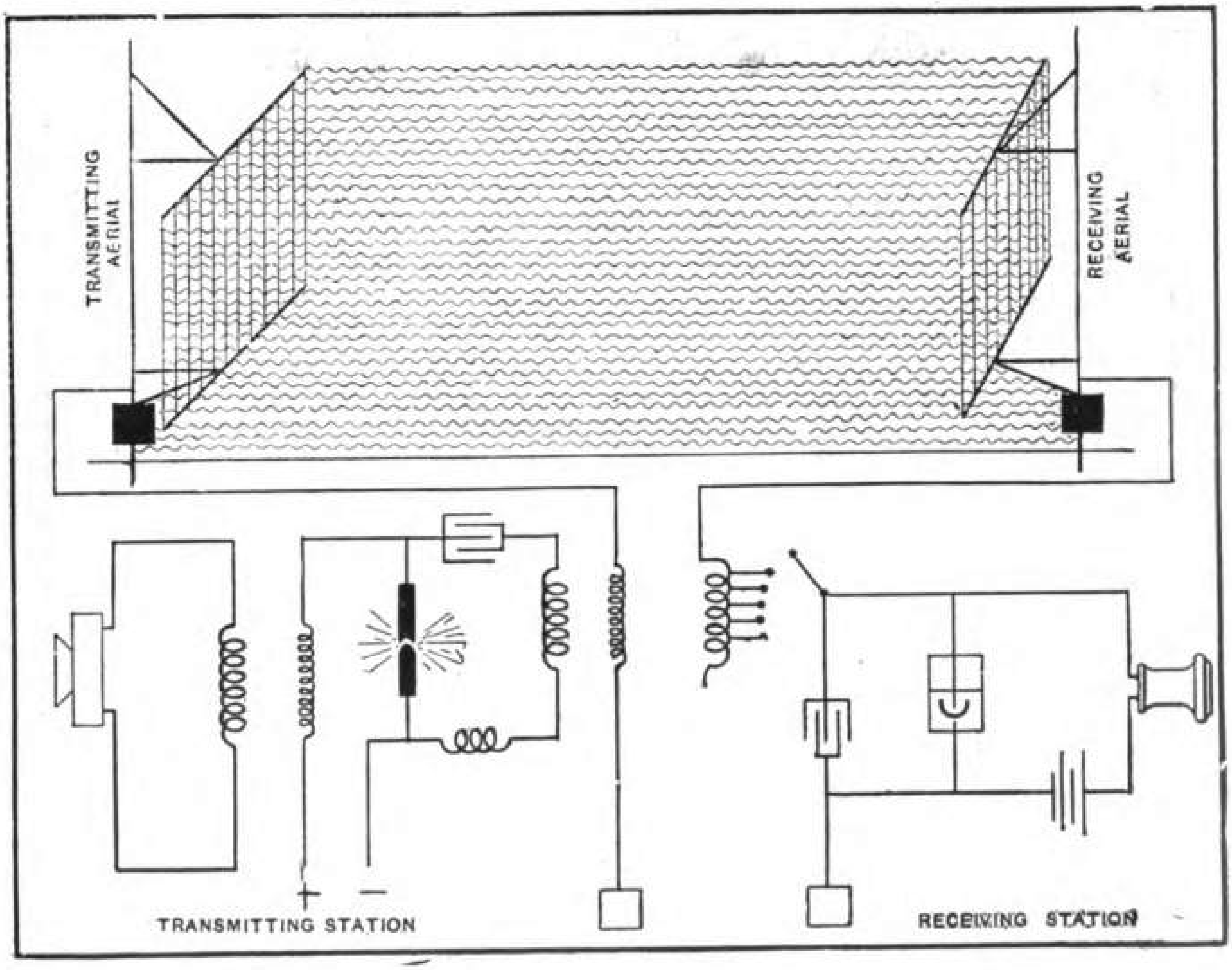

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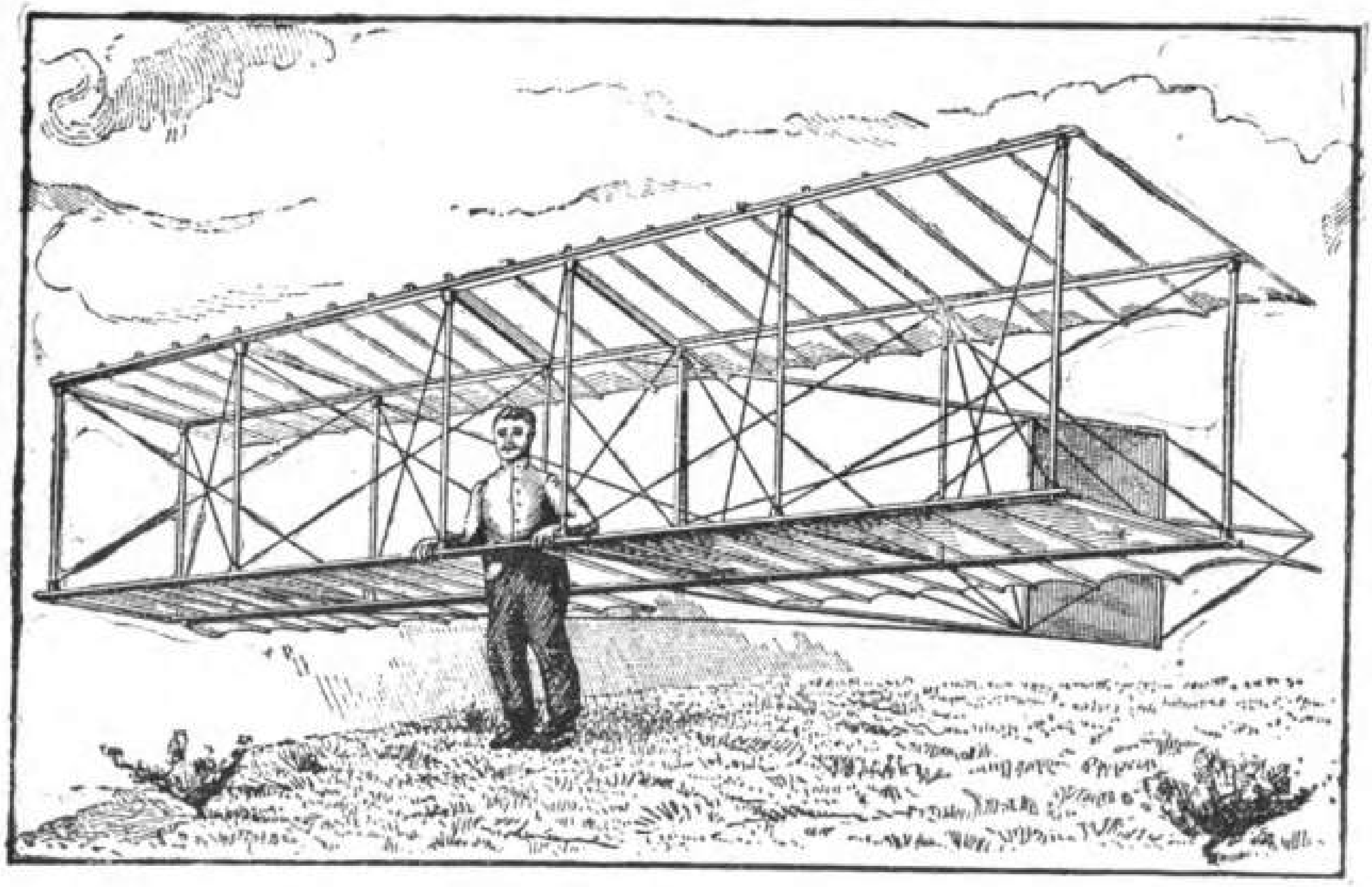

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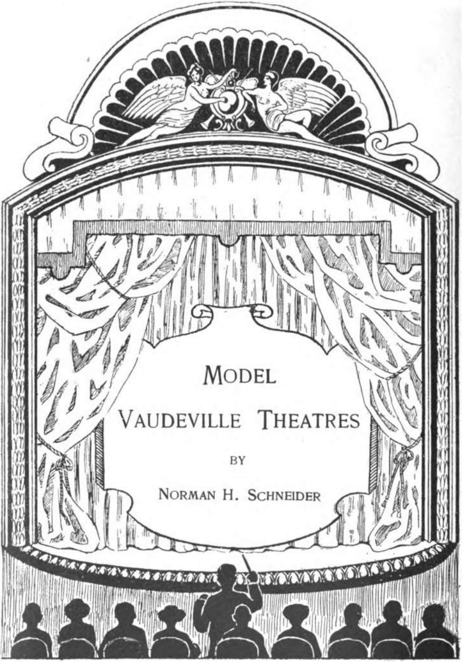

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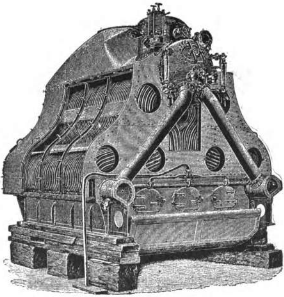

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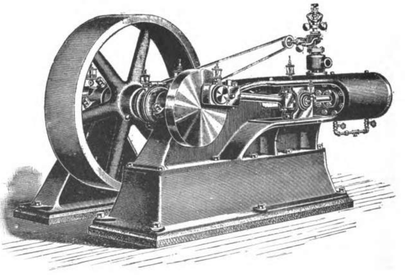

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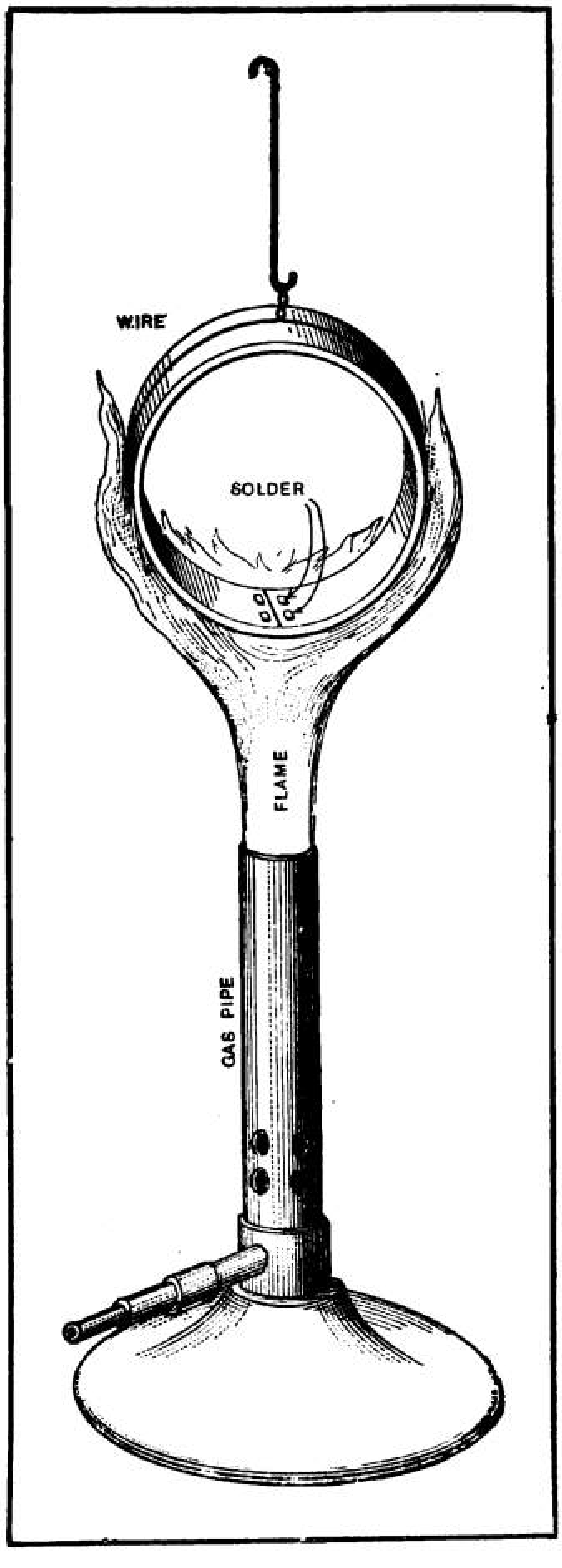

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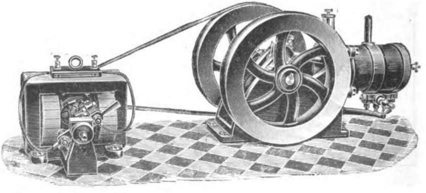

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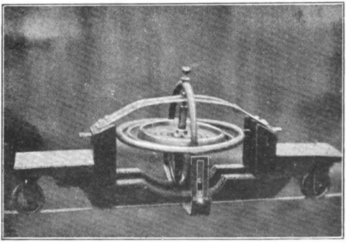

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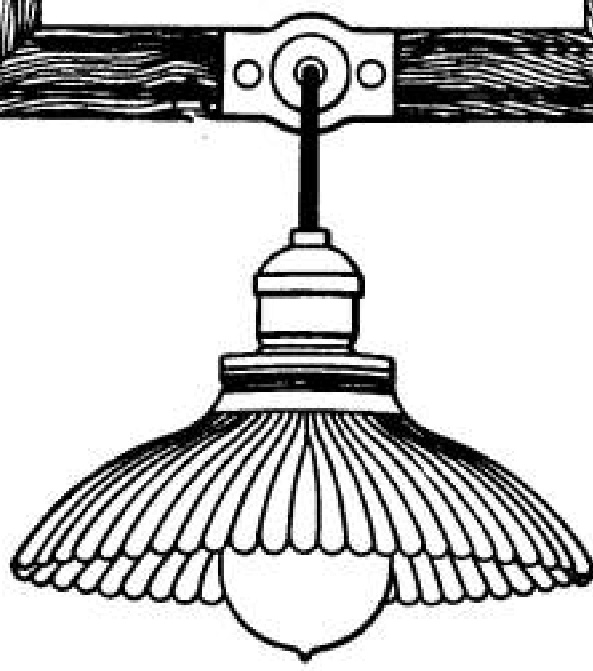

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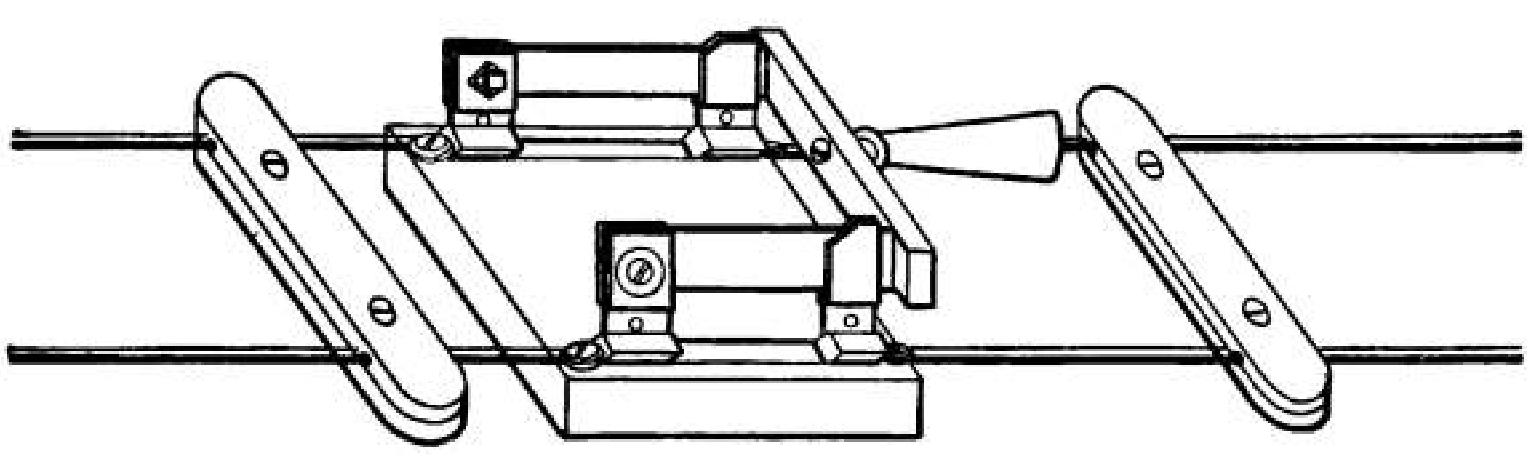

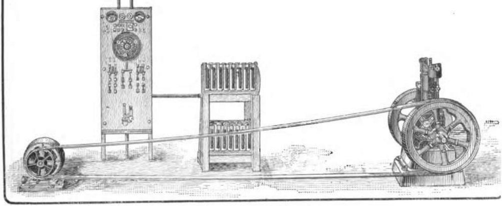

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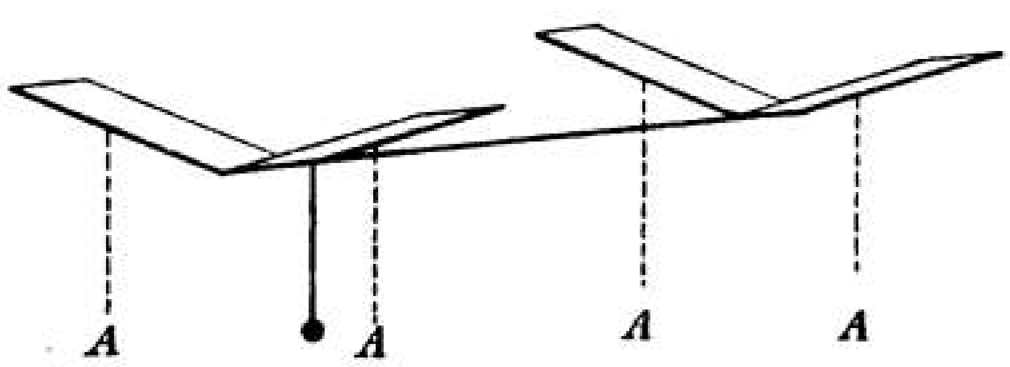
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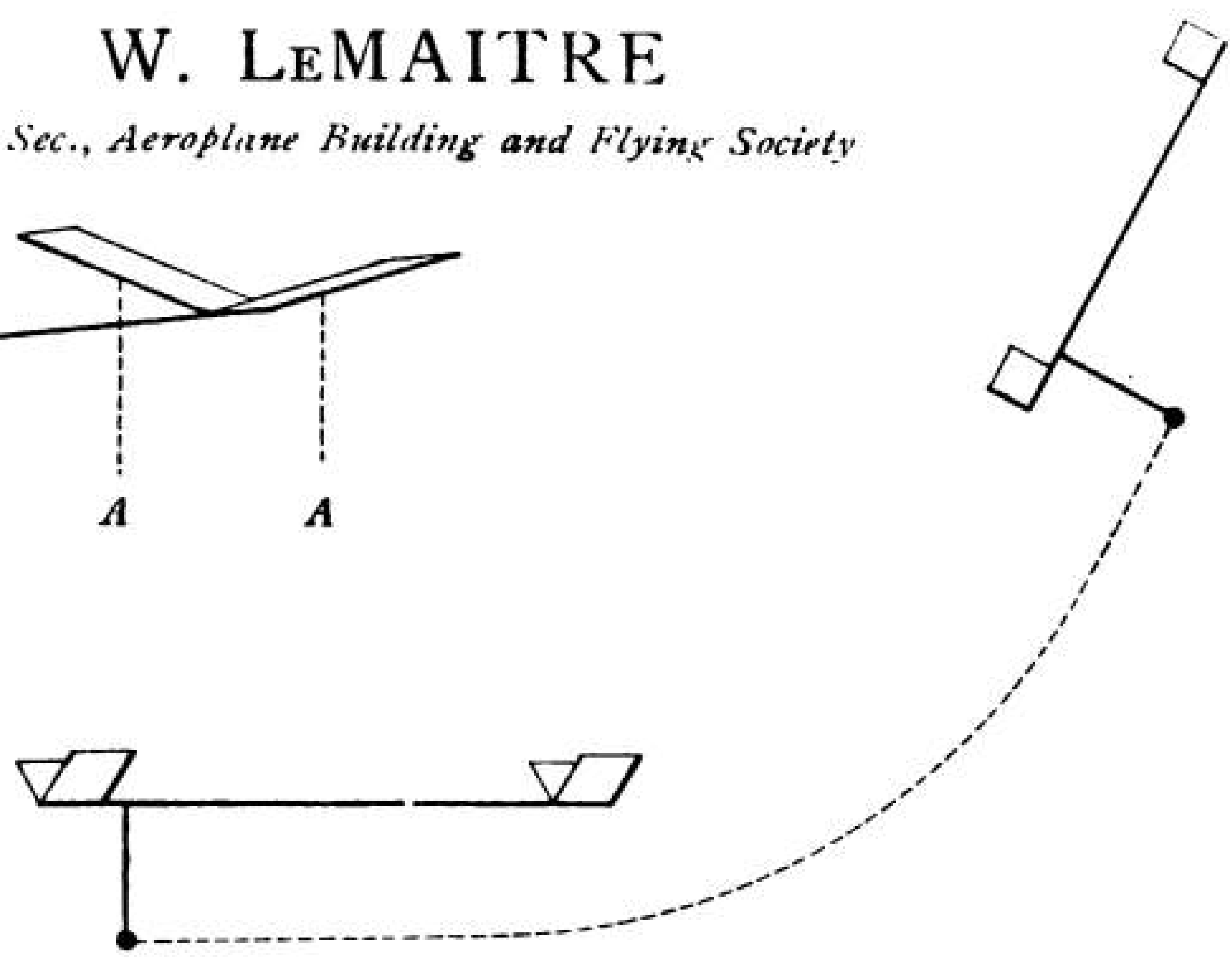

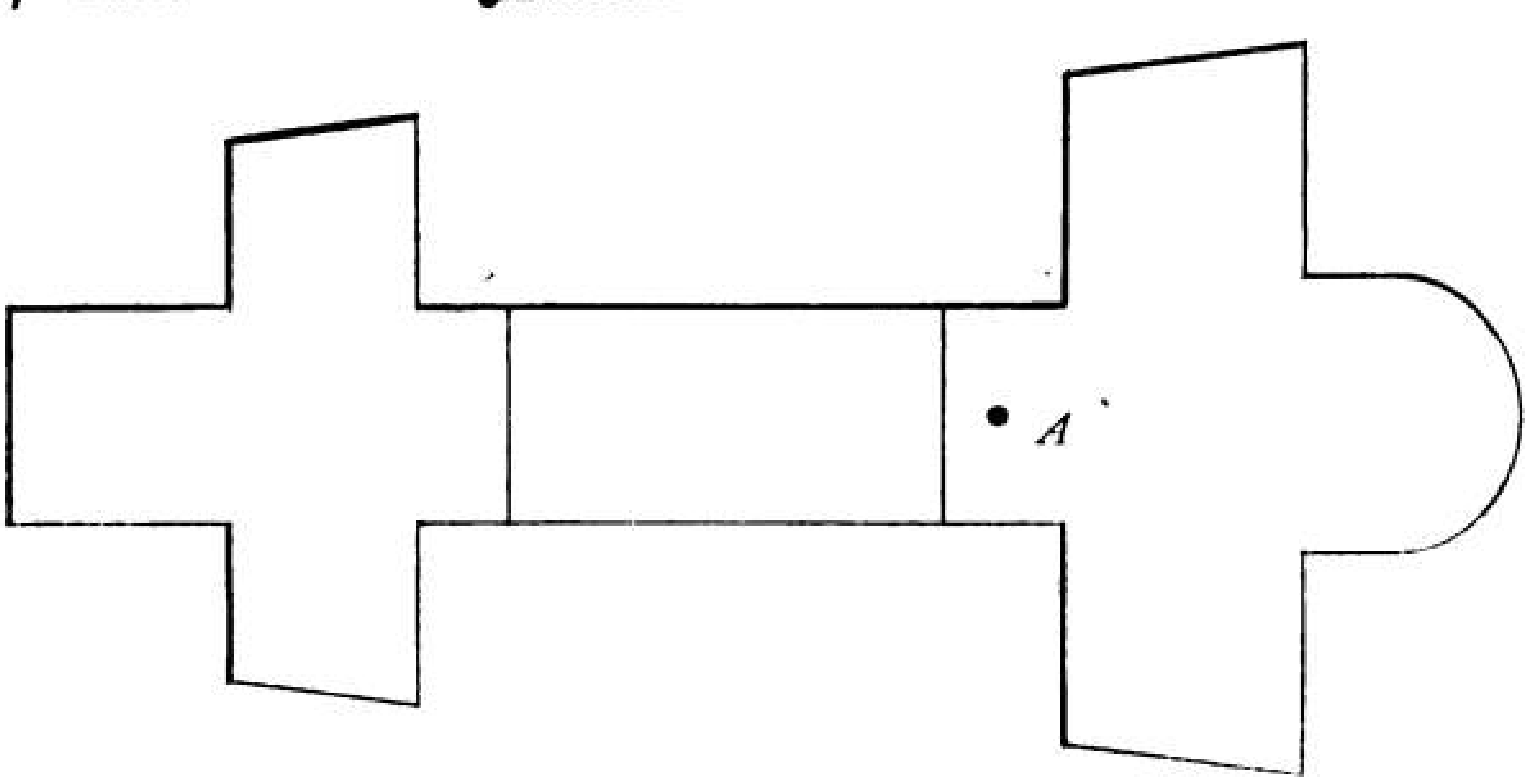
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BUILDERS' QUANTITIES

BY

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