ELECTRIC FLASHES

OR

THE SYSTEMS OF WIRELESS TELEGRAPHY AND TELEPHONY

BY

A. T. M. JOHNSON, A.M.M.C.I.E.

Inventor of the Johnson-Guyott system of Wireless Secret Telegraphy and Telephony

With an Introduction by Dr RICHARDSON

LONDON:
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1904.

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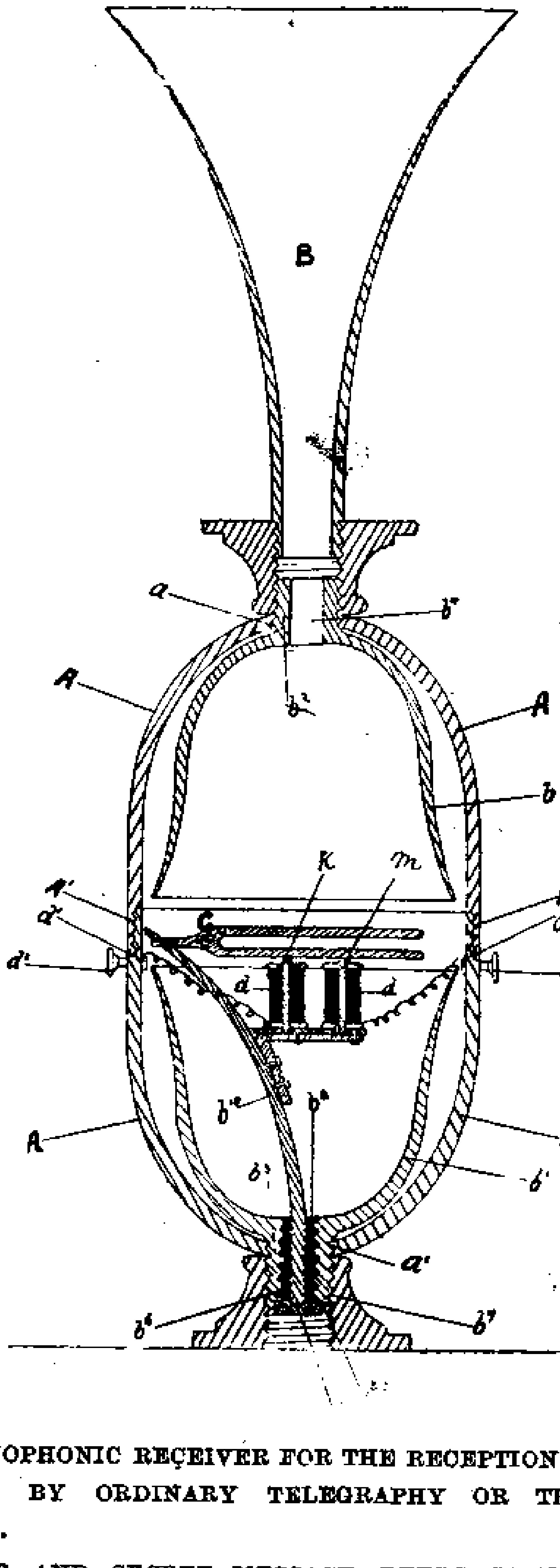
AN EXPOSITION OF

THE SYSTEMS OF WIRELESS TELEGRAPHY
AND TELEPHONY

FIG. I



A MULTITONOPHONIC REÇEIVER FOR THE RECEPTION OF MESSAGES EITHER BY ORDINARY TELEGRAPHY OR THE WIRELESS SYSTEM.

THE MASTER AND SECRET MESSAGE REEDS BEING SHOWN AT K AND M RESPECTIVELY.

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PREFACE

DURING the latter part of the past century, various systems have been devised by which messages can be transmitted and received, electrically, between two or more stations without the aid of connecting wires, thereby constituting what is commonly known as wireless telegraphy; and with reference thereto certain theories have been propounded and influentially supported by prominent scientists and electrical experts. And it seems strange that, in spite of ocular demonstrations which have produced tangible proofs that their theories are erroneous, nevertheless, many of our leading electricians are still found to favour the mistaken but popular belief that electrical impulses are transmitted through air by means of the Hertzian system of Etheric Waves projected through space, thereby setting up electrical oscillations in the vicinity of the receiving station.

Therefore, the object I have in view in compiling this little work, is to place those who feel sufficiently interested in the subject and its early development, but, at the same time, would like to avoid the perplexing study of abstruse theories, in possession of indisputable facts relative to the erroneous opinions that exist with reference to the conflicting methods. And, furthermore, to lay before the reader, in as simple a form as possible, a concise summary of my new system of "Syntonized Synchronism," which was lately demonstrated by me, for a period of four months, at Earl's Court Exhibition, Kensington, London, W., before officials from the British Admiralty, Trinity Brethren, General Post Office, Members of the Institute of Electrical Engineers, and the general public. In order to assist the reader to form an unbiassed opinion as to the novelty and intrinsic values of the various methods that have been placed before the public of late, I have briefly traced the leading events that have transpired since the inception of electricity to the present day, in which it will easily be observed that, in many cases, the first and true inventors of invaluable additions to our electrical appliances have been robbed of the honour they so rightly deserved by experimenters of far later date, who unjustly lay claim to the distinction.

For simplification and explicitness I have arranged the subject-matter in four parts:—Ancient and Modern Opinions on the Properties of Electricity; Electric Conduction, and its Application to Telegraphy; Electro-Magnetic Induction; Ancient and Modern Systems of Wireless Telegraphy and Telephony.

The information given in this volume has been carefully selected from the most reliable sources, and the quotations from eminent writers of undoubted authority; and will be found descriptive of the rise and progress of electrical science through ancient and modern times.

In conclusion, I desire to acknowledge my obligations to my friends (especially Mr. G. C. B. Duncan) for their consistent support, the press, the various scientists, and members of the electrical profession in general, for the valuable assistance I have had the honour to receive at their hands.

A. T. M. JOHNSON.

CARLTON HOUSE, LONDON, W.
March 1904.

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INTRODUCTION

Undoubtedly the greatest boon that has been bestowed upon mankind is the facility now afforded individuals, of all nationalities, in diplomatic, public, commercial, and private life, by telegraphy, for the transmission of intelligence throughout the length and breadth of the civilized world. But in order that the information may be of service, and possess intrinsic value, speed, reliability, and secrecy are indispensable; otherwise the correspondence would be almost worthless, and consequently despised by the persons concerned.

At the present time all these important attributes are available and provided by the ordinary systems of Wire Telegaphy that are now in vogue, but, unfortunately, at such in enormous expense that in some cases it proves almost prohibitive. Therefore it is very apparent that any innovation that would ensure these benefits at an exceedingly reduced outlay, would be hailed with delight by the world at large. Accordingly, it was to try and accomplish this task that Professor Popoff, of the Russian Torpedo School at Cronstadt, following up the renowned researches of Clerk Maxwell, and Heinrich Hertz, instituted the idea of Electric Transmission by means of the aerial system of Hertzian Waves. After a series of exhaustive trials, this indefatigable experimentalist succeeded in inaugurating the *principle of Wireless Telegraphy, and establishing, as he thought, a method of intercommunication through the ever-present and surrounding ether.*

As may easily be imagined, the efforts of this rising genius speedily called forth a multitude of inventors, who have from time to time flooded the world with all sorts of substitutions and imitations, every one of which has been declared to be a panacea for every kind of telegraphic and telephonic evil. The public have been rapidly and carefully educated into the belief that metallic connections for electric conduction were non-essentialities, and were to be forthwith and for ever dispensed with; and that distance, whether to America, round the world, to the planet Mars, or the moon, was immaterial.

But these zealous labourers in the field of science were doomed to disappointment, as, unfortunately for others as well as themselves, they had reckoned without their host, and were suddenly confronted with what, to them, has proved to be an insurmountable difficulty, viz., the syntonization of the electric current. It is therefore to overcome this obstacle to the development of what will most assuredly prove an invaluable addition to our electrical system of social and commercial intercourse that Mr. A. T. M. Johnson, by an invention of his own, has introduced his Multitonophonic System of Wireless Telegraphy, which is founded on the unerring principle of "Syntonized Synchronism," and provides rapidity of transmission, thorough reliability, and absolute secrecy (all of which are impossible achievements by any other wireless method) at a minimum expenditure; and has compiled the present treatise, which will be found to comprise clear and concise explanations regarding Mr. Johnson's invention, and most astonishing comparisons between his and the other systems of Wireless Telegraphy

In conclusion, I earnestly recommend all persons who feel sufficiently interested in the above subject, to carefully peruse this little work, and as it has, as far as possible, been denuded of negligible technicalities, endeavour to form an unbiassed opinion on its merits, and the nature of the information it contains.

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ELECTRIC FLASHES

᾿ART I.—Ancient and Modern Opinions on the Properties of Electricity

CHAPTER I

DISCOVERY OF FRICTIONAL ELECTRICITY

the year B.C. 600, Thales, a Greek sage, discovered the ctrical properties of amber, and found that when it s highly excited by friction it behaved in a peculiar y, and if worn as an article of jewellery the friction oduced by contact with the garments caused the amber attract lint and such like particles, which adhered ereto, and consequently materially impaired its lustre.

Three centuries later Theophrastus, a Grecian philoso- ıer, stated that lyncurium, which has the appearance amber, possessed similar qualities; and Pliny, a Roman ıthor, two hundred and thirty years afterwards re- erred likewise to this singular phenomenon. These eculiarities, which the ancients considered inexplicable, ut are thoroughly understood by modern scientists, were not deemed of sufficient importance to call for pecial efforts to elucidate the mystery; consequently, or a further period of sixteen hundred years the un- olved problem remained in abeyance.

However, in A.D. 1531, *Lib di. Simplicibus Medicinis* was published, in which it was asserted that Kager Albuzedi, the geologist, had discovered a red stone, which, if rubbed against the hair of the head, would attrac chaff: but in this age of ignorance and superstitio scientific inquiry was deprecated, and desires for solvin hidden mysteries considered impious, and declared t be temptations presented by the King of Darkne Accordingly, the subject was so ridiculed and conten tuously treated by the superstitious, that the matter v discarded by persons of position and intelligence fear of incurring the wrath of an enraged popula But, in the year 1600, Dr. William Gilbert, med attendant to Queen Elizabeth, came to the rescue, published his scientific treatise entitled *De Magn* wherein he declared that precious stones, glass, seal wax, sulphur, and resin possessed attractive proper equal to amber; he therefore designated them electr a term derived from the Greek word "elektron," wh signifies amber.

This excellent work was in turn severely critic and subsequently condemned by Bacon in the *Nov Organum* as "an instance of inconclusive reasoni distorted by preconceived fancies"; and in another p of this invective diatribe he denominated it "electr energy, concerning which Gilbert has told so ma fables." Nevertheless, one hundred and fifty ye later, the assumptions of this man of letters we found to be erroneous, as Gilbert's fables had becor astounding realities.

CHAPTER II

POSITIVE AND NEGATIVE ELECTRICITY

BOUT A.D. 1625, an Italian Jesuit, named Cabæus, creased Gilbert's category of electrics by adding thereto ıms, white wax, and gypsum.

After this, Boyle discovered that a diamond, if suffintly excited by friction, became luminous in the dark. bsequently, Otto von Guericke, Burgomaster of

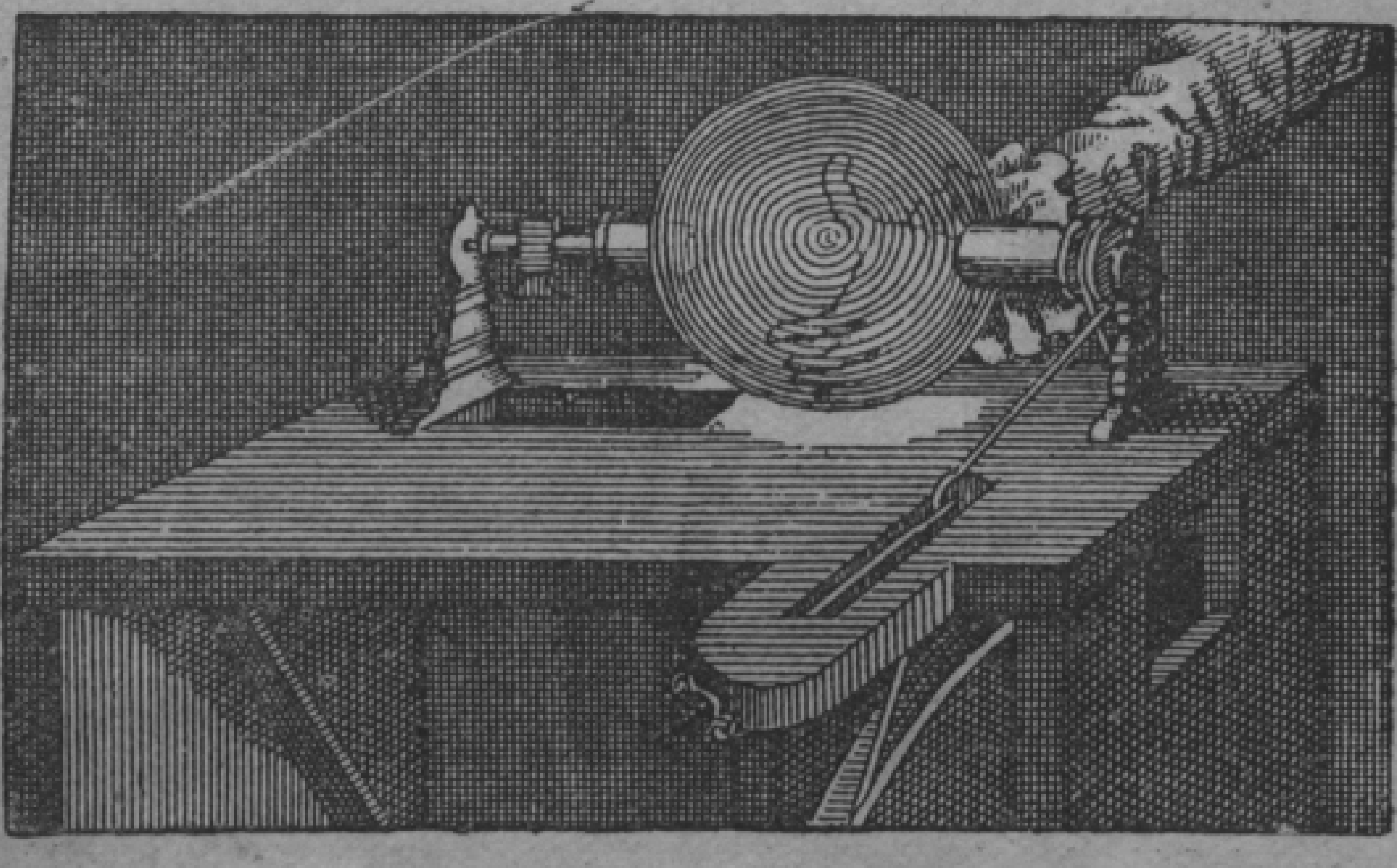


FIG. 1.—FROM GRAVESANDE'S "MATHEMATICAL ELEMENTS OF NATURAL PHILOSOPHY" (1731).

gdeburg (who, by the way, was the favoured person who obtained the first glimpse of the electric light the aid of a crude contrivance, a drawing of which shown in fig. 1), asserted that electricity was manied as much by repulsion as attraction; he accordingly, although unwittingly, was the true discoverer of Positive and Negative Electricity. Boyle, howeve maintained the opinion that this effect was produced b an invisible glutinous substance which emanated fro electrified bodies: but this fallacy was speedily di pelled by Sir Isaac Newton's discovery of the fact tha by rubbing a piece of flat glass on the upper side, lig bodies were caused to jump about between the und side of the glass and the surface of the table, thus provi that electrical attraction was transmitted through t plate of glass. In 1708 Dr. Wall succeeded in pr ducing an innumerable quantity of flashes by means amber excited by wool; each flash being accompan by a crackling noise, which seemed to represent thund

Up to 1730 the electrical apparatus was remarka crude, as, under the circumstances, the reader may ea imagine; and the appended drawing, which is a production of the one given by Dr. Gravesande in valuable treatise on the subject, is a true representat of the machine constructed by Hawksbee and Wink as an improvement on Otto von Guericke's.

It consists of a glass globe, *G*, supported on tubes, *H* which are revolved by a belt, *F*, from the pulley, which is rotated by the handle, *M*. One of the tu has an open end, into which is fitted the stop-cock, Through this tube the air contained within the gl can be exhausted. Over the globe is an arch of bi wire, *D*, from which threads are suspended.

The hand is used as a rubber, and the machine shown, is intended to demonstrate the follov experiment :—

Whirl the globe, and apply the hand to the centr it. At first the threads will be moved irregularly by agitation of the air, but as soon as the globe beco heated by the attrition, all the threads will be dire towards that part of the globe which lies beneath the

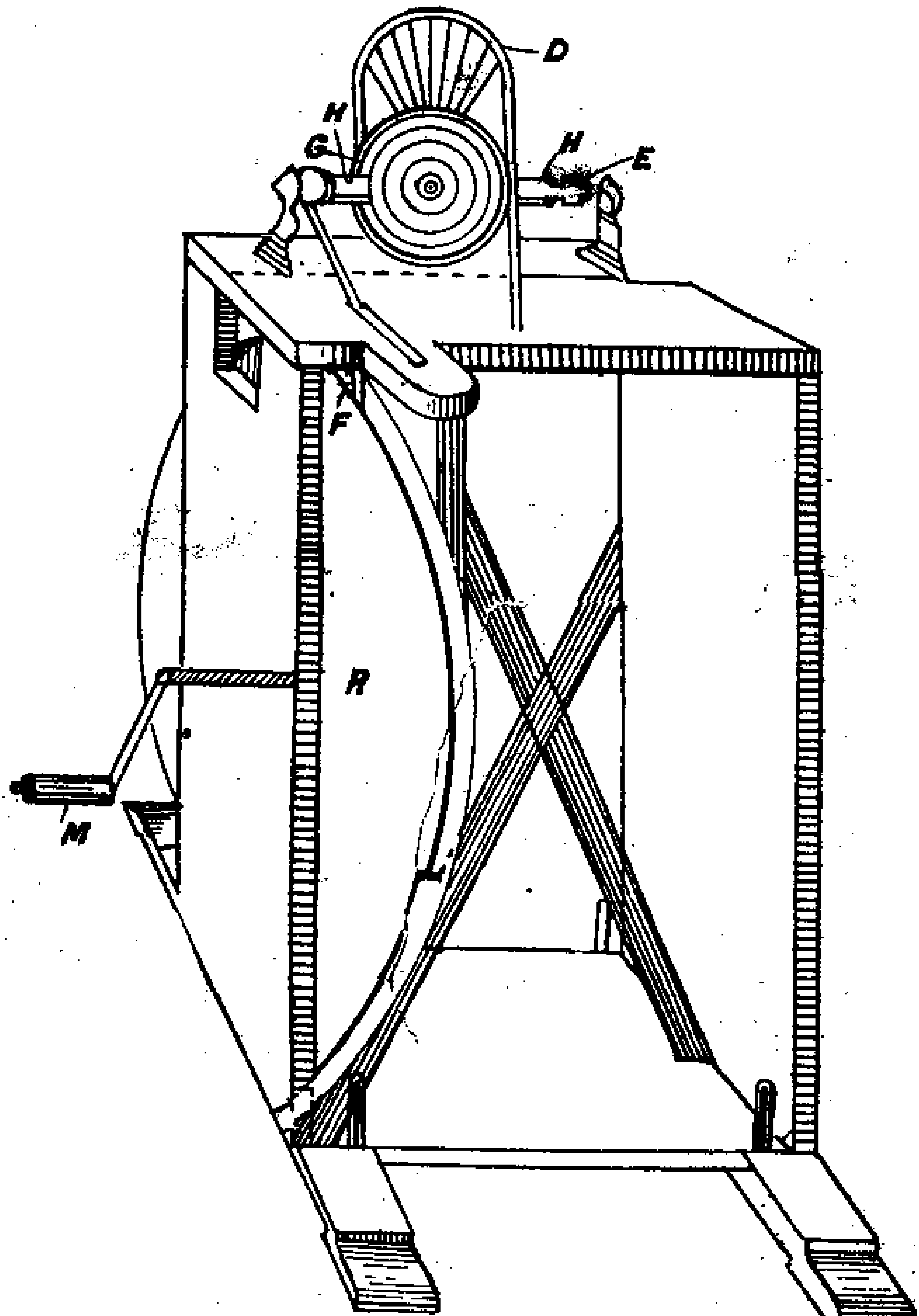


FIG. 2.—ELECTRICAL MACHINE OF 1730.

hand, as shown in the figure. But if the hand be applied a little on one side or the other of the centre, and nearer to one of the poles than the other, the threads will immediately be rearranged and attracted towards that point of the axis immediately underneath the hand. Provided the air in the globe be withdrawn, the effect ceases. Unfortunately, this operation frequently entailed unpleasant, if not serious, consequences, caused by the expansion of the air contained within the globe exploding the vessel, and thereby producing an undesirable ending to an otherwise most interesting experiment. Three years later, a French physicist, named Dufay, discovered that a gold leaf suspended in air was repelled if held in proximity to a piece of excited glass; but was attracted, provided the substance were resin.

Hence, for a considerable time the two kinds of electricity were denominated vitreous (from Lat. *vitrum*, glass) and resinous.

This erroneous opinion was subsequently disproved, as no such distinction exists: and the truth of the assertion can be easily verified by changing the material constituting the rubber, when the opposite effect is obtained.

However, the result of this simple experiment some years later led to the important discovery of Positive and Negative Electricity; the former being similar to that produced by rubbing glass with silk, and the latter by exciting resin with flannel.

In 1742 Winkler used the cushion rubber as a substitute for the human hand. After this, Gordon of Erfurt invented a glass cylinder, which was eventually superseded by Planta's circular plate, which is still in use.

For many years it was thought that only a certain number of substances, which were designated electrics, were capable of being electrified; other bodies which did not exhibit signs of electrification after frictionization were called non-electrics.

But this appellation proved to be a misnomer, as all bodies are found to possess electrical properties, more or less, if the necessary precautions be adopted: the difference in the action of the various substances being caused by the ignorance of the operators at that time, who were unaware of the fact that the electricity contained in the so-called non-electrics was discharged to earth by means of the hand and body of the persons making the experiment, as the human form in such instances provided a suitable conductor; whereas, in the case of the electrics, it was not so. This phenomenon is fully explained in Chapter III.

PART II.—ELECTRIC CONDUCTION AND ITS APPLICATION TO TELEGRAPHY

CHAPTER III

EXPERIMENTS IN ELECTRIC CONDUCTION

IN the year 1720, Stephen Gray, who, although a Charterhouse pensioner, was called by Professor Tyndall a "most meritorious philosopher," began a series of experiments which lasted for a period of sixteen years, when, unfortunately, they were brought to an abrupt termination by the decease of this indefatigable inventor. In the year 1729 he made the following remarkable experiment:—

He suspended a hempen line for a long distance in a horizontal position by loops of packing-thread; but this arrangement failed to convey the electric power.

The line was then supported by loops of silk, which proved effectual, the attractive influence being transmitted for a distance of 255 yards by the hempen line. Gray imagined that the success of the latter test was due to the thinness of the silk, and consequently replaced a broken loop by a thinner one made of wire, which was a failure. This circumstance convinced Gray that the success of the previous experiment was owing to the nature of the material, and not its dimensions. By this novel arrangement two most important facts were demonstrated, and, as Tyndall truthfully remarked, "was the starting-point of our knowledge of Electric Conduction and Insulation." This praiseworthy man dictated the result of his last trials to the Secretary of the Royal Society while lying on his death-bed.

Nine years after Gray's death, Von Kleist, Dean of Camin Cathedral, made the following startling announcement, which he graphically described in a letter he wrote to his intimate friend, Dr. Lieberkuhn of Berlin, wherein he states :—

"When a nail or piece of brass wire is put into a small apothecaries' phial and electrified, remarkable effects follow: but the phial must be dry and warm. I commonly rub it over beforehand with a finger on which I put some powdered chalk. If a little mercury or a few drops of spirits of wine be put into it, the experiment succeeds the better. As soon as the phial and nail are removed from the electrifying glass, or the prime conductor to which it has been exposed is taken away, it throws out a pencil of flame so long, that with this burning machine in my hand I have taken about sixty steps in walking about my room: when it is very strongly electrified I can take it into another room, and then fire spirits of wine with it. If, while it is electrifying, I put my finger, or a piece of gold which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders." This was the origin of the accumulator, and proved the possibility of electrical storage. During the following year, Cunæus made a similar discovery, and succeeded in delivering a shock to Musschenbroek, the Dutch physicist, who declared that he would not experience a repetition, if, even, as a reward for undergoing the ordeal, he were to receive the crown of France. Boze, on the other hand, expressed an ardent desire to die by means of the Electric Current, in order that his electrocution might furnish information for the Academy of Science. Winkler and his wife also suffered severely from convulsions produced by this machine, and the latter only ceased her experiments when she became so physically incapacitated that she could not walk. Kleist failed to account for the effects produced by this simple contrivance; but Cunæus and other Leyden philosophers succeeded in solving the problem, and hence the introduction of the apparatus known as the Leyden Jar. Dr. Bevis eventually constructed one on the model as shown in fig. 3, the form, in reality, it has ever since retained (see fig. 4).

LEYDEN JARS

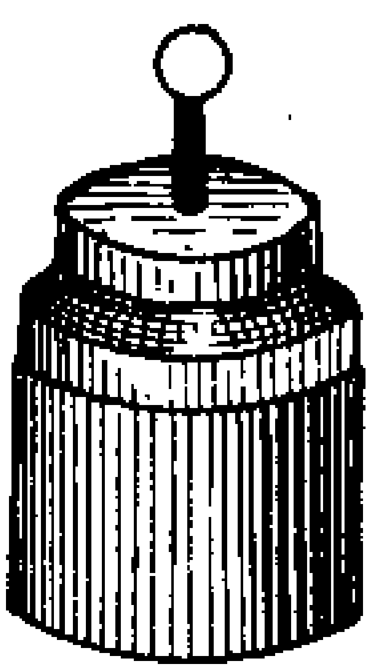


FIG. 3.—THE BEVIS.

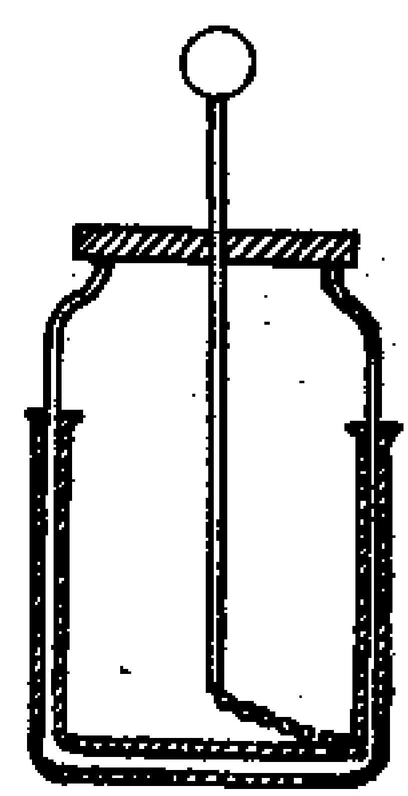


FIG. 4.—THE MODERN.

Von Kleist's invention was exceedingly simple in construction, and consisted of a glass bottle, through the cork of which was inserted a nail or brass wire of sufficient length to dip into water, spirits, or mercury contained within. Dr. Bevis's contrivance differed somewhat in its arrangement, but, nevertheless, was not at all complicated. In this instance, however, the liquid was dispensed with, and a thin coating of tinfoil, pasted or gummed round the inside and on the bottom, used instead. Over the exterior surface of the jar a covering of a similar material was suitably adjusted as a substitute for the human hand. Both inside and out a margin of about an inch and a half was left round the top (see fig. 3), which was coated with Shellac varnish for the purpose of insulation. A brass nob was soldered on to one end of a piece of brass wire, the other end being attached to a short chain. A wooden or cork stopper, provided with a hole in the centre of sufficient dimensions to admit of the chain and wire being passed through it, was cut to fit the neck of the jar. The stopper was then inserted in such a manner that the lower part of the chain lay on the bottom of the vessel. The jar was then complete.

In Von Kleist's appliance the liquid formed the inner conducting coating, and the hand grasping the bottle, the outer one, which was thus connected to earth through the medium of the human body.

But in Bevis's vessel the electricity was conveyed by means of the prime conductor, rod, and chain, to the inner coating of the jar, and there accumulated; the outer coating being connected to earth by suitable means.

The Kleist apparatus could only be charged with one kind of electricity, as operators up to that time were not sufficiently acquainted with insulation and the proper management of electric currents. Dr. Bevis, however, successfully inaugurated a system by which the jar could be charged as required, and asserted that it was positively or negatively charged according to the kind of electricity that was accumulated on its inner coating. To charge the jar positively, he held the outer coating in his hand, and presented the nob to the prime conductor of an electrical machine while in motion. To charge it negatively, he held the nob in his hand, and connected the outer coating of the jar to the prime conductor.

CHAPTER IV

NOVEL EXPERIMENTS IN CONDUCTION AND ELECTRIC DISCHARGES

By this time the attention of the leading scientists of the world had been so thoroughly aroused that they delayed no longer, but forthwith commenced a searching investigation of this interesting, yet mysterious subject.

To test the power of the electric shock, and the distance to which it could be transmitted, Graham caused a number of persons to join hands, the first and last laying hold of the outer coating of a charged Leyden jar, and a brass rod by which the vessel was discharged, respectively, and found that all experienced a similar effect.

This was followed by an experiment conducted by Abbé Nollet, who stood 180 soldiers in a line and sent shocks through the entire company.

But this endeavour was surpassed by the monks, who formed a human chain, 5400 feet in length, composed of 750 persons, with distance wires between each two. When the discharge occurred, the whole body of ecclesiastics involuntarily uttered a piercing yell and simultaneously sprang forward. "In 1745, Peter Collinson, of the Royal Society, sent a jar to the Library Society of Philadelphia, with the necessary directions for use. The apparatus fell into the hands of Benjamin Franklin, an American philosopher, who at once began a series of electrical experiments," and subsequently commenced his famous "Letters to Collinson," with regard to which Priestly remarked: "Nothing was ever written upon the subject of electricity which was more generally read and admired in all parts of Europe."

Up to this time four most important things relative to electricity had been discovered, namely:—Tangible proof of its existence, a system of Electric Conduction, the opposing influences of Positive and Negative Electricity, and lastly, the possibility of Electrical Accumulation. In May 1752, three prominent scientists, viz., D'Alibard, de Lor, and Buffon, erected apparatus in various localities for attracting the lightning; and, at the urgent request of Louis XV., king of France, who, by the way, had been informed of the wonderful results that had been achieved, further and far more elaborate experiments were undertaken.

D'Alibard, who was making strenuous efforts to try and secure the favour of His Majesty, employed an ex-soldier, by the name of Coiffier, to assist him in erecting the apparatus, and to subsequently attend to it.

One day, during D'Alibard's absence, the long-looked-for thunderstorm arrived, and Coiffier, who was utterly unacquainted with the danger attending experiments of this description, decided to embrace the opportunity thus afforded him of making a trial on his own account.

Accordingly, mounting a stool that had been insulated by D'Alibard, he presented a wire to the vertical rod of the contrivance, and was successful in obtaining spark after spark therefrom.

Being highly elated at the excellent results which had attended his efforts, he hurriedly invited his neighbours to witness the startling manifestations. These, in turn, informed the parish priest, who, anticipating that some impious wretch had fallen a victim to Divine wrath, made his way in a very undignified manner to the locality in question. But, on arrival, the reverend gentleman found himself the leader of a crowd of villagers, who, regardless of the pelting hail and pouring rain, stood round the machine watching with amazement the performances of Coiffier in drawing the electric fire from this simple contrivance. At Coiffier's earnest solicitation, the clergyman was reluctantly persuaded to perform the operation, and so great was the wonder and excitement displayed by all present, that both clergyman and soldier were unaware that they had been lightly struck by the electric current, until they were made acquainted with the fact by smarting sensations in their arms, and, searching for the cause, found the flesh covered with bright red stripes, presenting the appearance of recipients of sound lashings. When the mob perceived the effects of what they deemed "supernatural manifestations," they imagined that the powers of the Evil One had been "invoked." One month later, Franklin performed his wonderful experiment with a kite constructed of two crosssticks, on which was fastened a silk handkerchief.

To the upright stick he fixed a piece of pointed iron. The string that held the kite was composed of hemp, with the exception of the lower extremity, which was constructed of silk. Within a few inches of the termination of the hempen portion of the string he attached a key. All being ready, he had to quietly await the arrival of a thunderstorm, in order to demonstrate the possibility or otherwise of conducting electricity from the region of the clouds, and prove or disprove his theory that electricity and lightning were identical.

At last the eventful time was approaching, and, kite and other materials in hand, he sallied forth to the town common, accompanied by his son, and, despite the ridicule of a jeering populace, raised his kite, and then, attended by his first-born, retired to a shed to avoid the storm. To one of the supports of the building he fastened the restraining string by the silken portion, and then contented himself by watching for the desired demonstration. Clouds heavily charged with electricity passed over his kite, but no signs of electricity appeared in connection with the arrangement, and disappointment seemed looming in the distance. Just then, however, the rain began to descend in torrents, the heavy downpour being accompanied by vivid flashes of lightning and terrific peals of thunder. The rain had wetted the string and "made it a good conductor."

Franklin presented his knuckles to the key, and then—oh, with what rapturous feelings no soul can tell!—did he for the first time behold the passage of the electric spark. Over and over again he repeated the pleasing experiment, and concluded the demonstration by charging a Leyden jar sufficiently to administer powerful shocks to some of the astounded onlookers.

Prior to these trials, Franklin informed Collinson of his proposed scheme, and even went so far as to outline the method he had formulated.

It is therefore believed by many that although D'Alibard is supposed by the French nation to be the first experimenter in this branch of the science, it was owing to the information Franklin had previously given to Collinson that he was deprived of the credit of this valuable discovery.

About 10th May 1752 "Collinson offered Franklin's letters to the President of the Royal Society for publication," but his declaration, that he could draw electric fire from a cloud, and consequently secure protection from terrible mischief, was received by the Society with open derision, and the solicited publication met with a positive and contemptuous refusal.

Subsequently, however, Dr. Fothergill undertook to publish them, and was doubly rewarded for his pains, as the work was so highly appreciated that it reached a fifth edition in London, and attracted the attention of the whole civilized world. After this, the Royal Society admitted their error of judgment in relation to this matter by awarding Franklin the "Copley medal," the highest honour that was within their province to confer. After the success of Franklin's experiment, Professor Richmann, of St. Petersburg, constructed an "Electrical Gnomon," for the purpose of measuring the strength of the lightning discharge.

Accordingly, he arranged an iron rod in the roof of his house, which he insulated from the surrounding portions of the building. To this rod a chain was connected, which extended from the rod to his laboratory, and there fastened to an insulated support, from which a thread was suspended over a dial on his Electrical Gnomon.

One tempestuous afternoon Richmann invited Solokow, an engraver, to witness his experiment. Suddenly a fearful peal of thunder was heard. Richmann approached the thread for closer observation, when instantly a flash of bluish fire appeared between the rod and his hand, accompanied by a dense vapour which benumbed the engraver's limbs, and caused him to fall to the ground. "The apparatus was torn to pieces, the doors of the room thrown down, and the house violently shaken." Richmann's wife, on rushing into the room, discovered her husband dead, with a red spot on his forehead, his shoe ripped open, and waistcoat burnt, indicating very clearly the direction taken by the deadly current. Solokow was removed in an insensible condition, but slowly recovered consciousness. The cause of the catastrophe was Richmann's neglectfulness in not providing an earth connection, "whereby the electric charge might have passed harmlessly to the ground."

Richmann's fate was considered by the ignorant and superstitious as a direct warning from the Almighty to refrain from further temptations of Providence, and maintained that it was "as impious to ward off Heaven's lightnings, as for a child to evade the chastening rod of its father." Nevertheless, the opinion of the intelligent classes of society prevailed, and Franklin's idea to erect pointed lightning rods for the protection of buildings, by conveying the electric charge harmlessly to earth, found numerous friends and lasting favour. But "that wise monarch, whose scientific acumen stood nonplussed before the problem of how apples got into dumplings, graciously considered the question, because it affected his royal abode, Buckingham Palace, and came to the sage conclusion that pointed conductors were a republican device calculated to injure His Majesty, and ordered ball ones to be erected instead." The king's decision was treated with contempt by Franklin, who wrote: "The King's changing his pointed conductors for blunt ones is a small matter to me. If I had my wish about them, it would be that he would reject them altogether as ineffectual. For it is only since he thought himself and his family safe from the thunder of Heaven, that he has dared to use his own thunder in destroying his innocent subjects."

Thus briefly has been traced the crude and early development of a science which for thousands of years remained hidden from the minds of the ancients, and subsequently baffled the men of science for a further period of over two thousand, before the mighty force, which had aroused only feelings of religious awe and bodily fear, could be confined, conducted, directed, examined, accumulated, or, when required, diverted "from its path of destruction."

By scientists of the eighteenth century the Electrical Pegasus was discovered and captured, but it was owing to the energies and perseverance of those of the nineteenth that he was tamed, broken in, and harnessed to the plough. But even now, who would presume to predict, or even attempt to imagine, the extent of those vast fields of electrical science still unexplored and hidden in the womb of futurity?

CHAPTER V

GALVANIC AND VOLTAIC ELECTRICITY

In many cases most important discoveries have been passed over and, in some instances, almost ignored by the very men that unknowingly discovered them, for the simple reason that the lucky individual who first witnessed the effects produced, was unable to account for the phenomenon, and consequently could not comprehend the vastness of its importance. The force of the above remarks is exemplified in the case of Sulzer, a German by birth, who, in 1763, applied two different kinds of metals simultaneously to the tongue, one being placed above, the other below, that organ. On bringing them in contact with each other, he observed a sour taste, which he attributed to the vibratory action of the metals which was conveyed to the palate by the nerves of the tongue. Four years later he disclosed this novel experience in his work entitled *The General Theory of Pleasures*, but, as the subject was not deemed worthy of further consideration, it remained unnoticed by scientific men until some time subsequent to Aloisio Galvani's wonderful discovery of that species of electricity which is developed by chemical action on different metals and various other substances, which had aroused the admiration of the civilized world.

About the same time, Cotugno, a professor of anatomy in Neapolis, published a statement that one of his pupils, feeling a stinging sensation in his leg, applied his hand to the part affected, and in doing so killed the mouse that had bitten him. Cotugno subjected the animal to dissection, and, during the operation, he accidentally touched the diaphragmatic nerve with the instrument he was using. Instantly he received a shock which made him quickly remove his hand. Subsequently, Vassalli formulated the theory that electricity was accumulated in certain parts of an animal's system, and that the

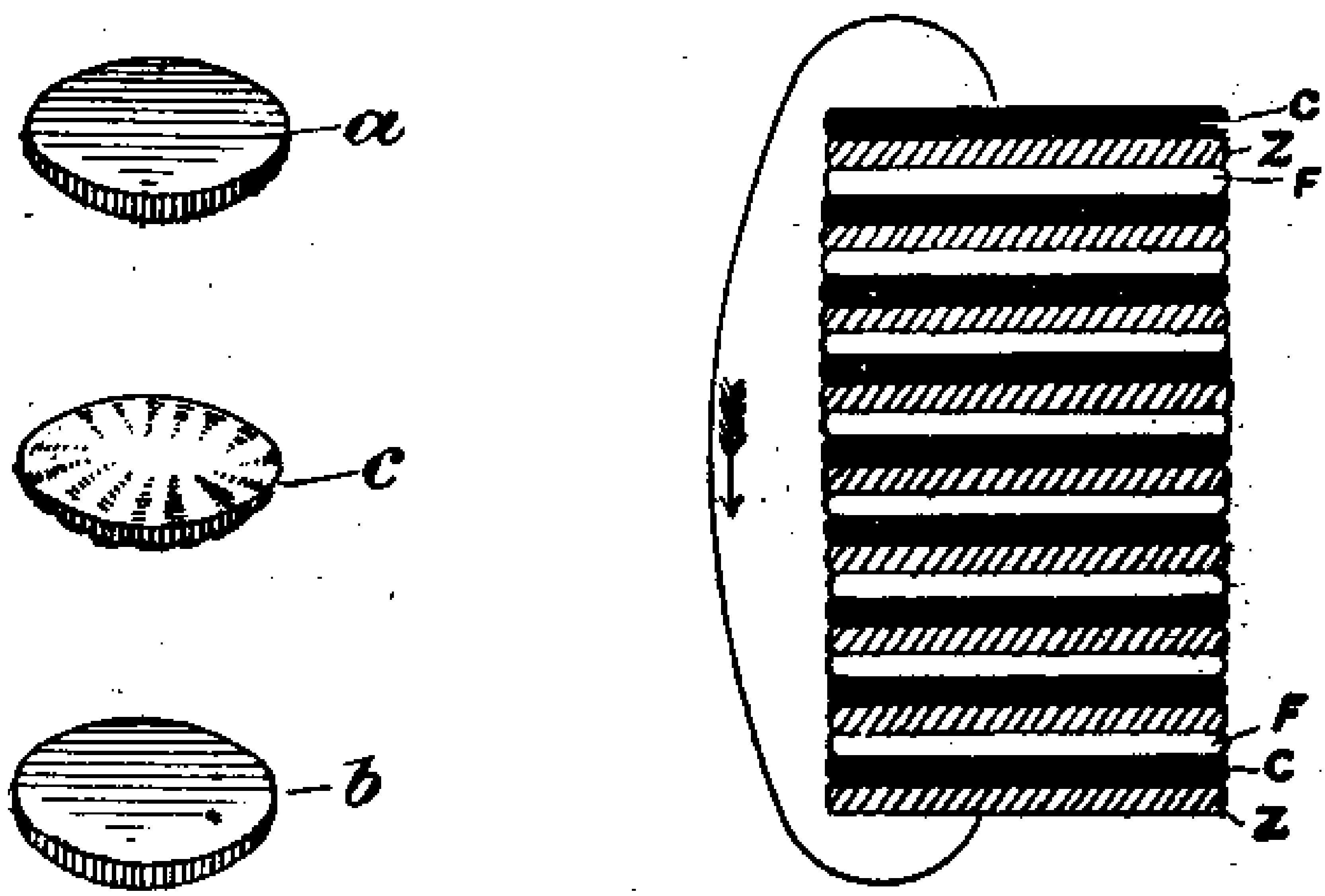


Fig. 5.

supply was capable of being drawn upon at will. But it is certain that both of the latter discoveries had been almost, if not quite, forgotten, when in A.D. 1786 Luigi Galvani commenced a series of interesting and valuable experiments. This zealous scientist believed that atmospheric electricity was capable of producing certain effects upon the human body and all kinds of animal matter. In order to try and solve the mystery, he procured some frogs, which he killed and prepared for the purpose of investigation; and was rewarded for his trouble by ascertaining the fact that, by forming a metallic arc of two pieces of copper and iron respectively, placing one end thereof in contact with the leg of the animal, while the other was made to touch its spine, muscular contractions were immediately produced. This tangible demonstration caused physiologists to entertain the belief that at last their ideas of a vital power would speedily be realized, and the medical fraternity were thoroughly of opinion that the electric shock would prove a panacea for all kinds of nervous diseases. But these over-credulous individuals were doomed to bitter disappointment by the marvellous discoveries of Alessandro Volta, an Italian electrician, who proved that the so-called animal electricity was simply the production of metallic contact only, and not due to any organic formation of animal substances.

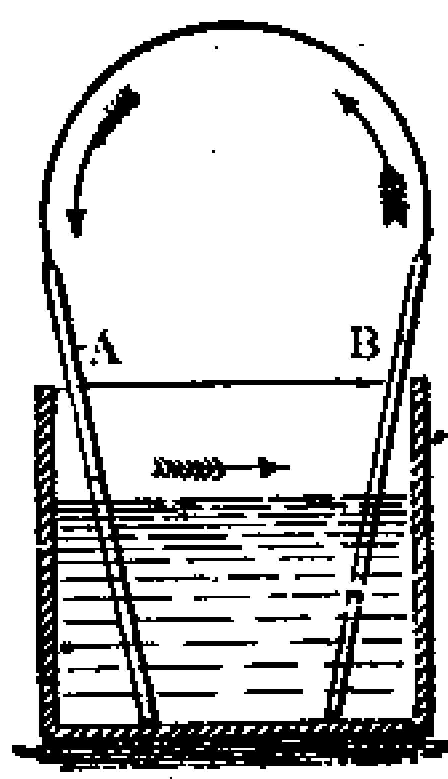


FIG. 6.

For the purpose of effectually demonstrating this theory, he invented the world-renowned Voltaic Pile as shown in fig. 5, which was composed of discs of zinc, *a*, and copper, *b*, which were soldered together in pairs, each pair being separated by a layer of flannel, *c*, moistened with salt and water, or diluted sulphuric acid. Soon afterwards, Volta constructed his battery cell (fig. 6), which is in reality the Voltaic Cell of the present day.

By this important invention, electricity was made controllable, and the possibility of creating electric currents of enormous power proved beyond question. As a reward for his perseverance, Napoleon Bonaparte called Volta to Paris to demonstrate the principle before him, and at its termination ordered the suspension of the academic rules in order to present him with the Gold Medal of the Institute of Science, accompanied by

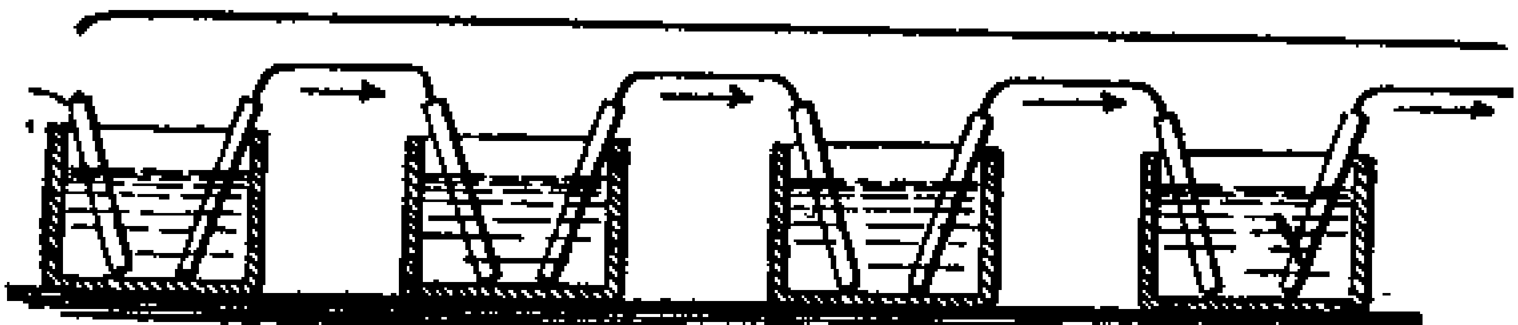


FIG. 7.

a purse of two thousand crowns from the National Treasury. A number of Voltaic cells connected together in series, as shown in fig. 7, form a Voltaic Electric Battery.

CHAPTER VI

ELECTRICAL MECHANICAL MOTION

On the morning of 21st July 1820 it was publicly announced that Oersted had discovered that, provided a wire through which an electric current was flowing be placed parallel to, and above, a magnetic needle, the latter was caused to sway towards the east or west in accordance with the direction in which the current was passing through the wire—a fact which, he declared, proved conclusively that electrical energy was capable of producing and directing mechanical motion. The inestimable value of Oersted's glorious discovery was graphically described in the following quotation, which is taken from the report of the Smithsonian Institute: "Fortune, it might be said, ceased to be blind at the moment when to Oersted was allotted the privilege of first divining that it was not electricity in repose accumulated at the two poles of a highly charged battery, but electricity in movement along the conductor by which one of the poles is discharged into the other, which would exert an action on the magnetic needle." It was "while thinking of this," and "during the animation of a lecture before the assembled pupils, that Oersted announced to them what he was about to try. Taking a magnetic needle, he places it near the electric battery, waits till the needle has arrived at a state of rest; then, seizing the conjunctive wire traversed by the current of the battery, he places it above the magnetic needle (fig. 8)," at the same time "carefully avoiding any manner of collision." "The needle—everyone plainly sees it—is at once in motion. The question is resolved, and

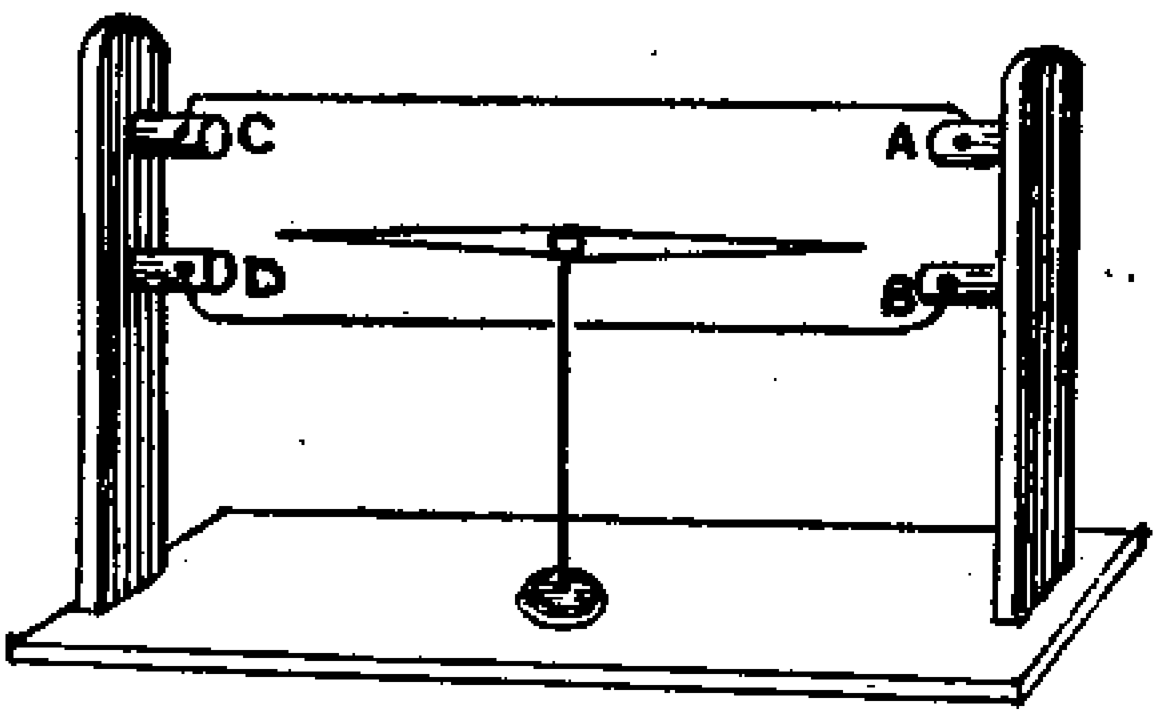


FIG. 8.

Oersted has crowned by a great discovery the labours of his whole precious life." Thus it was that this noteworthy electrician once and for all solved two of the most important problems in electrical science, viz.:—

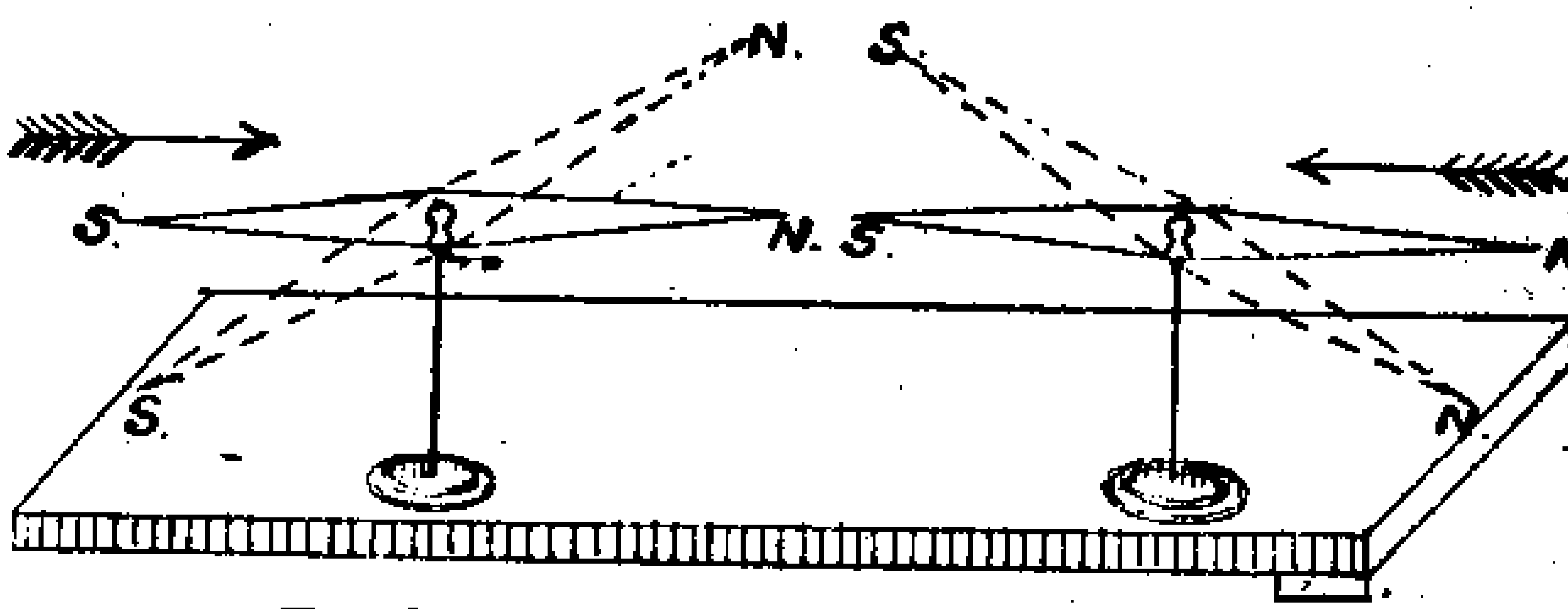


FIG. 9. FIG. 10.

SHOWING THE NEEDLE IN ACTION.

The arrows in each case indicating the direction of the current in a wire situated above the line.

The possibility of its adaptation to mechanical motion, and the existence of electric induction.

When the current passes beneath the needle in either direction, the reverse action takes place.

Before passing on to the next chapter, it may be as well, for the benefit of the general reader, to briefly outline what at the present time is understood by the scientific world by the term "electrical energy." As to what electricity really is, its origin, composition, and the qualities of its constituent parts, no one can say; but, by our leading scientists, it is supposed to be the ruling or governing force of the entire universe—the generator of the Celestial, Terrestrial, and Mechanical Motions, and the originator of light, heat, sound, and climatic influences. By its almighty power, our earth, and the myriads of orbs which surround it, are guided in their various revolutions, and their specific and relative positions to each other properly and accurately defined and maintained. To it the attractive and overpowering influences of Chemical Affinity, Gravitation, and Terrestrial Magnetism owe their being, and from hence human, animal, and vegetable life derive their marvellous and mysterious existence.

CHAPTER VII

THE ELECTRIC TELEGRAPH

As early as 1617 the "instantaneous transmission of thoughts and words between two individuals over an indefinite space" was recorded in the *Prolusiones Academicæ* of Strada. The messages were transmitted by the electrical influence of a loadstone, in proximity to which two needles were pivoted on a dial round which the letters of the alphabet were arranged. Ninety-five years subsequently, a letter was written by Joseph Addison, the Essayist, and published in the *Spectator*, wherein he proposed to send love-letters by this means; and, strange to say, the *New York Tribune*, in 1876, on the introduction of the Speaking Telephone, made use of similar remarks, relative to that invention, by calling attention to the fact that the principal use of that contrivance was the possibility that existed of lovers and diplomatists holding secret converse. In the year 1729 Gray and Wheeler caused light bodies to be electrically influenced at a distance of 222 yards, and in 1747 Dr. Watson transmitted the electric current through a wire more than half a mile in length. But it was not till the year 1753 that a practicable method of telegraphing electrically was introduced.

A description of this novel invention was given in an anonymous article which appeared in the *Scot's Maga-*

zine under the heading of "An Expeditious Method of Conveying Intelligence."

The idea of the inventor, who Sir David Brewster asserts was Charles Morrison, was to construct an installation with twenty-six wires, each one representing a different letter of the alphabet, and supported on a glass insulator fixed to a solid substance.

At the termination of each wire a metallic ball was to be adjusted, and under it a piece of paper with a corresponding letter of the alphabet printed thereon. To work the apparatus, all that was necessary was to bring the farther end of the wire intended to be operated upon, in contact with an excited glass tube, when the paper lying beneath the ball would instantly rise by the force of attraction.

With reference to the inventor of the above system, a most amusing anecdote is related by Park Benjamin, Ph.D., in his highly interesting work entitled *The Age of Electricity*, wherein he states: "In fact, about the only definite information ever obtained regarding this inventor was from a very old Scotch lady, who remembered a very clever man, of obscure position, 'who could make lichtnin' write an' speak, an' could licht a room wi' coal reek'" (coal smoke).

At the decease of Morrison (or Marshall, as he was christened by some), there is not the slightest doubt that an able and highly intelligent man, yea, a perfect genius, became lost to the world of science.

But his fate is only another exemplification of professional jealousy, and which, by those unfortunate individuals who have experienced similar treatment, can be easily imagined.

By the efforts of a masterly brain, he had succeeded in devising and working out an invention that far surpassed the endeavours of his puny rivals, and by which even the striking discoveries of the renowned Franklin had been outdone. Nevertheless, Morrison's hopes were doomed to disappointment for his audacity in holding opinions at variance with those of the leading scientists of his day, and his invention was scoffed at, and relegated to the backwoods of ignorance and opposition, because it was a vexatious source of conflicting evidence, and tangible proof of the absurdity of his opponents' theories. Furthermore, these scientific butterflies, in order to complete his downfall, and consummate their most uncharitable desires, designated him " a visionary—a madman," thereby not only proving the truthfulness of the adage, that a prophet is without honour in his own country, but intensifying the punishment by making the poor fellow the recipient of a violent tirade of dishonour and abuse.

With regard to this affair, Benjamin very pungently remarks: " There is more true pathos in the stories of the many stout hearts thus broken, than in all the romantic vicissitudes of the Abelards and Heloises since the flood."

In 1787 Lomond introduced the pith-ball electrometer, the movements of which were actuated by a current conveyed by one wire, instead of Morrison's twenty-six. Seven years later Reizen constructed an apparatus which was an adaptation of Morrison's, the only difference in the mechanism being the substitution of tinfoil for paper, and the illumination thereof by electric sparks.

Subsequently, Cavallo reverted to Lomond's single-wire system, but adhered to Reizen's method of illumination; the improvement in this instance being the utilization of a miniature gas explosion as an alarm bell to indicate the transmission of a message.

After this, a further lapse of fifteen years took place, during which time Volta invented his electric pile. In

1813 the Lords of the Admiralty were interviewed relative to the use of electricity on board the ships in the British Navy; but, after giving the subject due consideration, arrived at the conclusion that, owing to the scarcity of money and the enormous cost of the war then proceeding, they deemed it advisable to refrain from incurring further liabilities.

However, in 1820, as previously observed, Oersted made known to the world the nature of his grand discovery, which was followed in the same year by the completion of Ampère's Galvanometer, and Arago's Electro Magnet. But, although the electrical fraternity were, at the above date, actually in possession of the elements that are used in the electrical apparatus of the present day, they were still in absolute ignorance of the necessary means of application to ensure success. "They were all groping in the dark," and continued to do so for a further period of five years, at the expiration of which time the subject received a serious shock when Mr. Peter Barlow, a Fellow of the Royal Society, who was requested to examine the existing scheme of Electrical Transmission and report thereon, positively affirmed that the system was impracticable, and unworthy of serious consideration.

The following year a young academician, named Joseph Henry, was appointed professor of mathematics at the Albany Academy, New York. Soon after his installation he began his world-renowned series of electrical experiments, which, on conclusion, placed him leader of the van of American scientists.

By conducting various trials over long distances, this able electrician speedily discovered that the chief obstacle that had to be contended with was the excessive weakening of the current at the receiving station, owing to the resistance presented to the electric flow by the metallic conductors, and the leakage of power caused by their bad insulation. To overcome this difficulty, he conceived the idea of assisting the remnant of electric power by the addition of a local battery, which he placed in series with an electro-magnetic device termed a relay. "And thus," remarks Benjamin, "the Electro-Magnetic Telegraph was completely invented and demonstrated. There was nothing left to do but to put up the posts, string the lines, and attach the instruments."* The question asked thousands of years before by the prophet, "Canst thou send lightnings, that they may go, and say unto thee, here we are ?" Henry had answered in the affirmative. It remained for other men, following his example, to go and do likewise.

This statement is fully substantiated by Henry's own assertions, wherein he reminded the members of the Franklin Institute, in 1832, "that nothing remained to be discovered in order to reduce the proposition of the Electro-Magnetic Telegraph to practice. I had shown that the attraction of the armature could be produced at any distance, and had designed the kind of a battery and coil around the magnet to be used for this purpose.* I had also pointed out the fact of the applicability of my experiments to the Electro-Magnetic Telegraph." Nevertheless, another period of five years elapsed before the leading spirits of the Franklin Institute were able to exercise sufficient confidence to offer their services to the Government, relative to the erection of semaphores only, as they were still dubious of the results in connection with telegraphy. The secretary of the Treasury, after duly considering the matter, ventured to reply by circular, in which he solicited their opinions. Various members of the Institute responded to the invitation that he had given, and among the replies that were forwarded were three letters from Samuel Finley Breeze Morse, an American inventor, in all of which he advocated the establishment of the Electro-Magnetic Telegraphic system.

In 1838 Morse's apparatus was demonstrated before the Congress; but, in spite of the urgent recommendations made by the committee appointed by them to inquire into the matter, they refused to take action, and another period of four years elapsed ere the subject received recognition. During this time Morse made numbers of appeals, but they paid little or no attention to his solicitations.

But at last his importunity prevailed, and in 1843 his Bill authorizing the construction of an electric telegraph between Washington and Baltimore, at a cost of thirty thousand dollars, passed the House of Representatives. In 1844 the line was completed, and, during the ensuing year, a further grant of eight thousand dollars was sanctioned by Congress for the express purpose of keeping the line in working order for twelve months. To assist in defraying the cost of maintenance, and test the profitableness of the undertaking, a tariff of charges was inaugurated at the rate of one cent for every four letters which a message contained.

During the first three days that followed the opening ceremony a very large number visited the premises as sightseers, but no business was transacted. On the fourth day, however, the operator was the happy recipient of one cent. The next day, twelve and a half cents. Sixth day, Sunday, nothing was taken; but on the seventh, eighth, and ninth days the receipts reached sixty, one hundred and thirty-two, and one hundred and four cents respectively. In consequence of the success which attended Morse's efforts in the introduction of the Electro-Magnetic Telegraph, he is by many electricians and scientists erroneously regarded as its inventor. "The true inventor was Joseph Henry," with whom

Morse never attempted to dispute the claim: moreover, "Morse is not entitled to the credit of having devised the mechanism of the telegraphic instrument attributed to him, nor of the dot and dash alphabet that bears his name," as that valuable addition to electrical apparatus was the production of "Alfred Vail," a young man that Morse employed to assist him in the improvement and completion of the instrument. By many English writers on electricity the honour of the invention of the Electro-Magnetic Telegraph is ascribed to "Professors Cooke and Wheatstone"; but this is absolutely incorrect, as Henry had worked out and demonstrated the principle in 1835, at Princetown, two years prior to the date that Wheatstone conducted his trials at King's College, London, when he declared that the difficulty attendant on working the Electro-Magnetic system over long distances "was insurmountable." Notwithstanding this bold assertion, he subsequently, in conjunction with Cooke, applied for an English patent for it.

Thirty-three years afterwards the following descriptive account of the glorious success which attended their combined efforts was published in *Chambers' Journal*, and ran as follows: "In July 1837 wires were laid down from Euston Square to Camden Town stations by the sanction of the North-Western Railway, and Professor Wheatstone sent the first message to Mr. Cooke between the two stations. The Professor says, 'Never did I feel such tumultuous sensations before, as when, all alone in the still room, I heard the needles click; and as I spelled the words, I felt all the magnitude of the invention, now proved to be practical, and beyond cavil or dispute.' The form of telegraph now in use was substituted because of the economy of its construction, not more than two wires (sometimes only one) being required. Of course several persons claimed to have invented the telegraph before Professor Wheatstone. In the same month that the professor was working upon the North-Western Railway, there was one in operation invented by Steinheil of Munich, but Wheatstone's patent had been taken out in the month before. An American named Morse claims to have invented it in 1832, but did not put it into operation till 1837. After this his system was generally adopted in the United States. It is a recording one." From that time to the present day science has made enormous strides in the subject of electricity. The mechanical skill that has been exhibited in the construction of telegraphic instruments during the period is perfectly marvellous, and the efficiency of the various contrivances that have been devised also passes comprehension, as the following article, which appeared in the London *Telegraphist* some years ago, conclusively proves.

"In the basement of an unpretentious building in Old Broad Street we were shown the Morse printer in connection with the main line from London to Teheran.

"We were informed that we were through to Emden; and with the same ease with which one 'wires' from the City to the West End, we asked a few questions of the telegraphist in the German town. When we had finished with Emden, we spoke with the same facility to the gentleman on duty at Odessa. This did not satisfy us, and in a few seconds we were through to the Persian capital (Teheran).

"There were no messages about, the time was favourable, and the employees of the various countries seemed anxious to give us an opportunity of testing the capacity of this wonderful line. T.H.N. (Teheran) said, 'Call Kurrachee,' and in less time than it takes to write these words we gained the attention of the Indian town. The signals were good, and our speed must have equalled fifteen words a minute. The operator at Kurrachee, when he learnt that London was speaking to him, thought it would be a good opportunity to put us through to Agra; and to our astonishment the signals did not fail, and we chatted pleasantly for a few minutes with Mr Malcom Khan, the clerk on duty.

"To make this triumph of telegraphy complete, Agra switched us on to another line, and we soon were talking to a native telegraphist at the Indian Government Cable

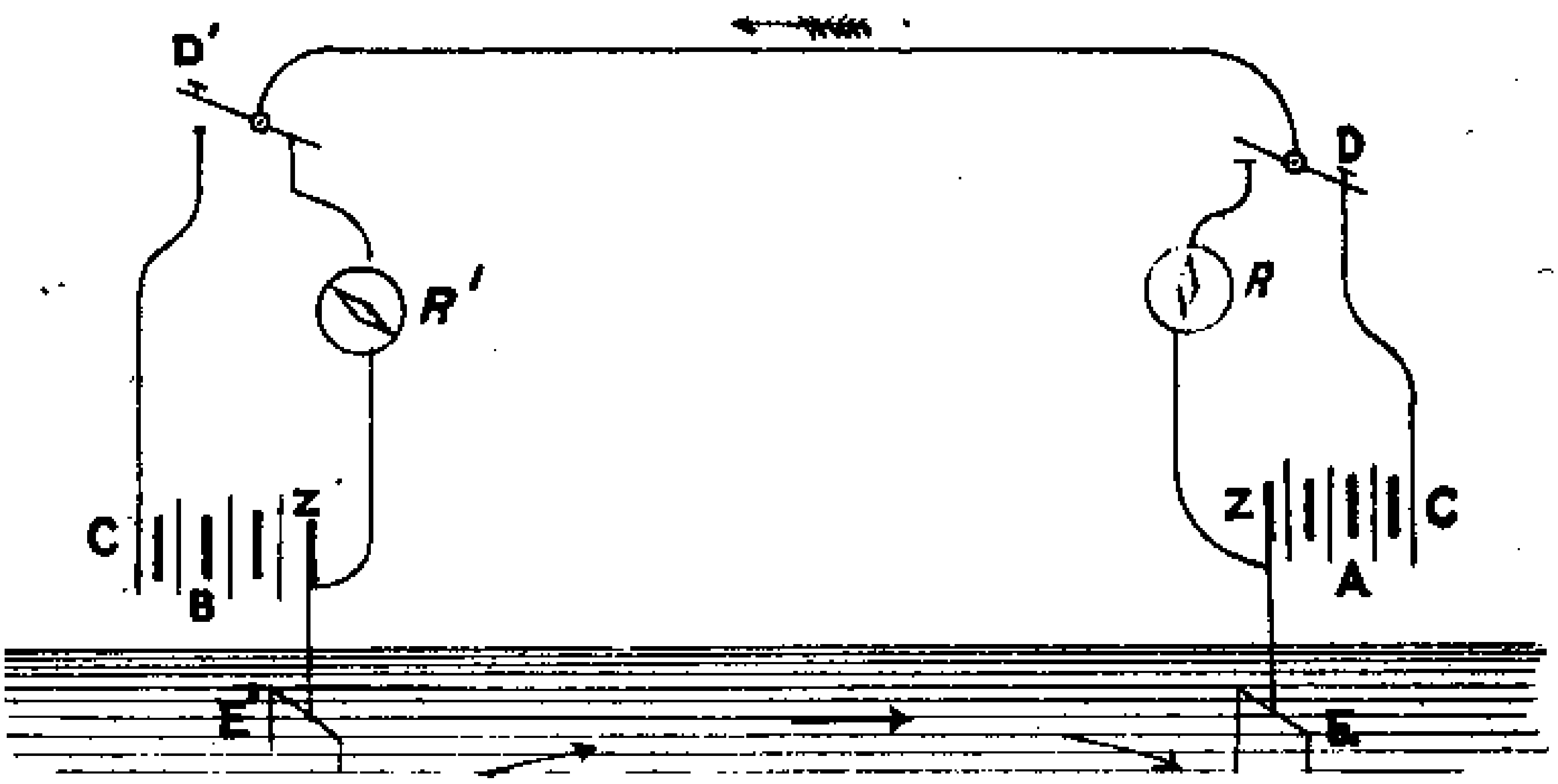


FIG. 11.—TELEGRAPHIC APPARATUS.

Showing an arrangement for the transmission of a Telegraphic Message. *D* and *D′* being Morse Keys, or the transmitting parts of the instruments; and *R* and *R′* the receiving portions, which may be either needle instruments, as shown in the figure, or Morse Sounders. The electric force being supplied by the batteries, *A*, *B*; while the earth connections are made by the plates, *E* and *E′*.

station at Calcutta. At first the gentleman 'at the other end of the wire' could not believe that he was really in direct communication with the English capital, and he exclaimed in Morse language, 'Are you really London?' Truly this was a great achievement. Metallic communication without a break from London to the telegraph office in Calcutta! Seven thousand miles of wire! The signals were excellent, and the speed attained was not less than twelve, perhaps fourteen, words per minute."

Part III.—Electro-Magnetic Induction

CHAPTER VIII

ITS ORIGIN AND GENERATION

Before proceeding with this intricate subject, it is highly essential that the attention of the reader should be called to the striking anomaly that exists between the ordinary meaning of the term Induction, as etymologically expressed in the English language, and the technical definition of Electro-Magnetic Induction, as understood by electricians.

Induction, simply, is the principle that, under similar circumstances and in similar substances, similar causes produce similar effects.

But this logical reasoning is not applicable in the case of Electro-Magnetic Induction; inasmuch as the circumstances are different, the substances are dissimilar, the causes do not agree, while the effects produced contravene each other. That is to say: Firstly, With regard to the circumstances, the primary current is produced by the action of an electric battery, or some other kind of generative force; while the secondary, or induced current, is created solely and compulsorily by the independent activity of the primary flow consequent on the latter's perfect insulation.

Secondly, With reference to the dissimilarity that exists between the various substances, or kinds of matter, employed in the construction of the primary and secondary circuits, it is of no consequence, provided suitable materials be used.

Sometimes the conducting media are purely metallic in both cases; at other times, partly so, and partly either terrestrial, aqueous, gaseous, or aerial. But a secondary current of high electro-motive force (or high E.M.F. as it is technically designated) can only be induced by a primary current flowing through an absolutely metallic circuit. Thirdly, The cause of the electric flow in the

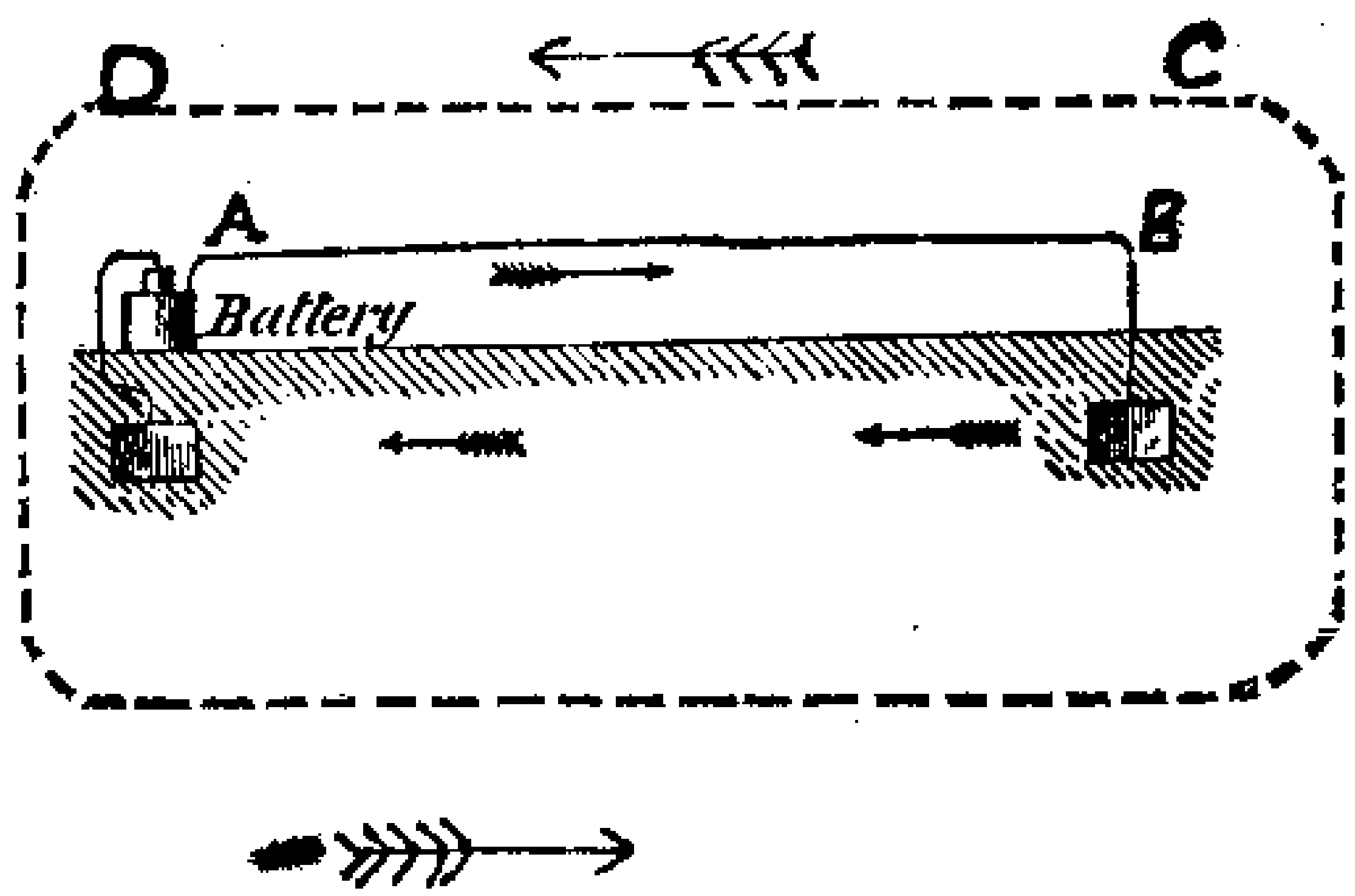


FIG. 12.—SHOWING THE DIRECTIONS OF THE CONDUCED AND INDUCED CURRENTS.

primary circuit is the difference in potentiality, or electric condition, of the positive and negative elements of the electrical generator. But the electrical discharge, which takes place in the secondary, or induced circuit, is the result of a natural and instantaneous production of a dependent current, created and maintained solely by the influence exerted by the primary flow, without weakening the latter of any portion of its force. Lastly, The effects produced by the primary and secondary discharges are diametrically opposed to each other; that is to say, provided the primary current be travelling from the point A towards the point B (fig. 12), the secondary current would be flowing in the reverse direction, namely, from C to D. Sprague's definition of Electro-Magnetic Induction is not sufficiently determined; he says that it is "the name given to effects produced outside of the body exerting a force, or out of a circuit to which the force is directly applied." G. E. Bonney, although disagreeing with Sprague's description, does not provide a correct definition, as he states that "Induction is the name given to the attracting or repelling influence exerted by a current of electricity on all material lying in or near to its path," which is obviously incorrect, as it does not exert an influence on everything in proximity to its flow; if so, what is the use of insulation? But Faraday's explanation, though very concise, is beautifully explicit. He asserts that it is "the influence which an electrified body, without the transfer of any portion of its charge, exerts through a non-conducting medium upon an adjacent body, whereby the latter, if insulated, is rendered electro-polar; the nearer part becoming, in respect to the electrified body, oppositely, and the remoter parts similarly, electrified. If the adjacent body be uninsulated, the nearer part only is electrified."

With reference to a former observation relative to the reversed directions of the primary and induced currents, Professor Poyser gives an admirable opinion, and affirms that "in all cases of electro-magnetic induction the induced currents have such a direction that they tend to stop the movement which produces them." This, he states, is known as Lenz's Law.

By the above definitions, the reader will readily perceive the feasibility of the introductory remarks to this chapter, wherein it is declared that the terms Induction and Electro-Magnetic Induction are not analogous.

CHAPTER IX

THE MARVELLOUS UTILITY OF ELECTRO-MAGNETIC INDUCTION

BEFORE expatiating upon the extraordinary powers and marvellous utility of Induction, it is highly essential that the reader should be made acquainted with one of the principal instruments employed in its production, and an extremely simple apparatus used in its detection. The former is denominated an "Induction Coil," and the latter an "Induction Balance," and with regard to both of which the reader is advised that it will materially assist him in his comprehension of the subject-matter that must of necessity be employed in dealing with this branch of the science, and which it is compulsory to sufficiently elucidate, provided he carefully study the various figures, and, by the aid of the index letters, quietly compare the diagrams with the explanations in connection therewith.

In 1832 Joseph Henry discovered the principle of Electro-Magnetic Induction; for, although Faraday in 1831 conducted some startling experiments relative to the matter, nevertheless, it was not until 1835 that his researches were so far completed as to justify his opinions.

Therefore to Henry has been attributed the distinguishing honour and undisputed title of being the independent and original discoverer thereof. He, like Faraday, however, did little in devising the mechanical construction of a suitable apparatus for demonstrative purposes. During 1836 Professor C. G. Page and Mr. Sturgeon individually carried out numerous experiments with reference to the subject, and in the year 1850 the former was instrumental in designing and constructing an induction coil capable of producing a spark eight inches in length.

But the efforts of the latter were superseded by Dr. Callan, a professor at Maynouth College, Dublin, who in 1863 constructed an induction coil (fig. 13) that would give a fifteen-inch spark. The secondary winding of this coil contained 150,000 feet of insulated copper wire of No. 34 gauge.

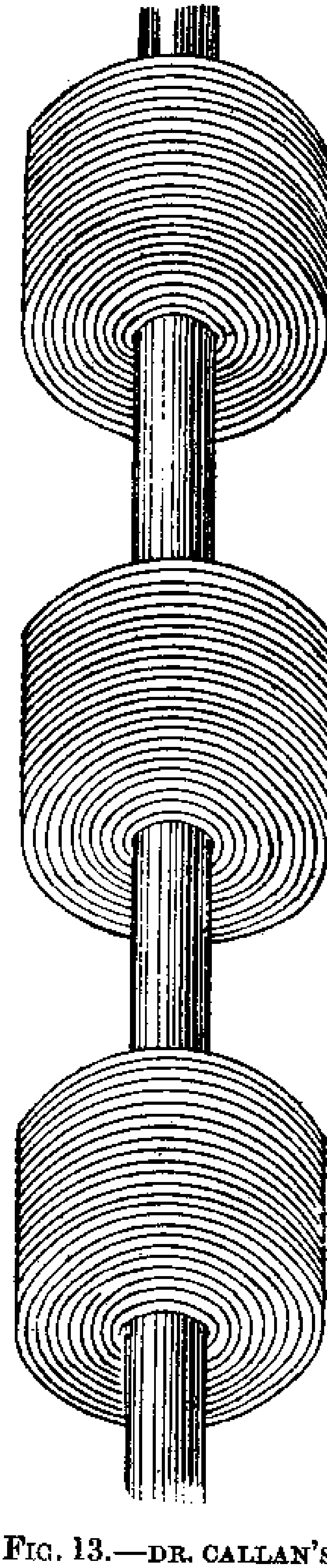


FIG. 13.—DR. CALLAN'S INDUCTION COIL.

But the climax was reached on the introduction of Ruhmkorff's astounding apparatus, and although the mechanism, as may be readily imagined, has been vastly improved and somewhat altered in design by such celebrated manufacturers as Apps, Newton, Isenthall, Voss and Wimshurst, and others (who, for want of space, must be omitted in a work of this description), nevertheless, this most remarkable appliance, no matter by whom built, still bears the renowned inventor's name, and is known throughout the length and breadth of the civilized world as the "Ruhmkorff Induction Coil."

The method adopted in the construction of this invaluable instrument will be perfectly understood by reference to the following illustrations and explanations, wherein

Fig. 14 is a side elevation of a complete Ruhmkorff Coil, and fig. 15 a longitudinal view of a dissected coil, having, for the sake of convenience and explicitness, its

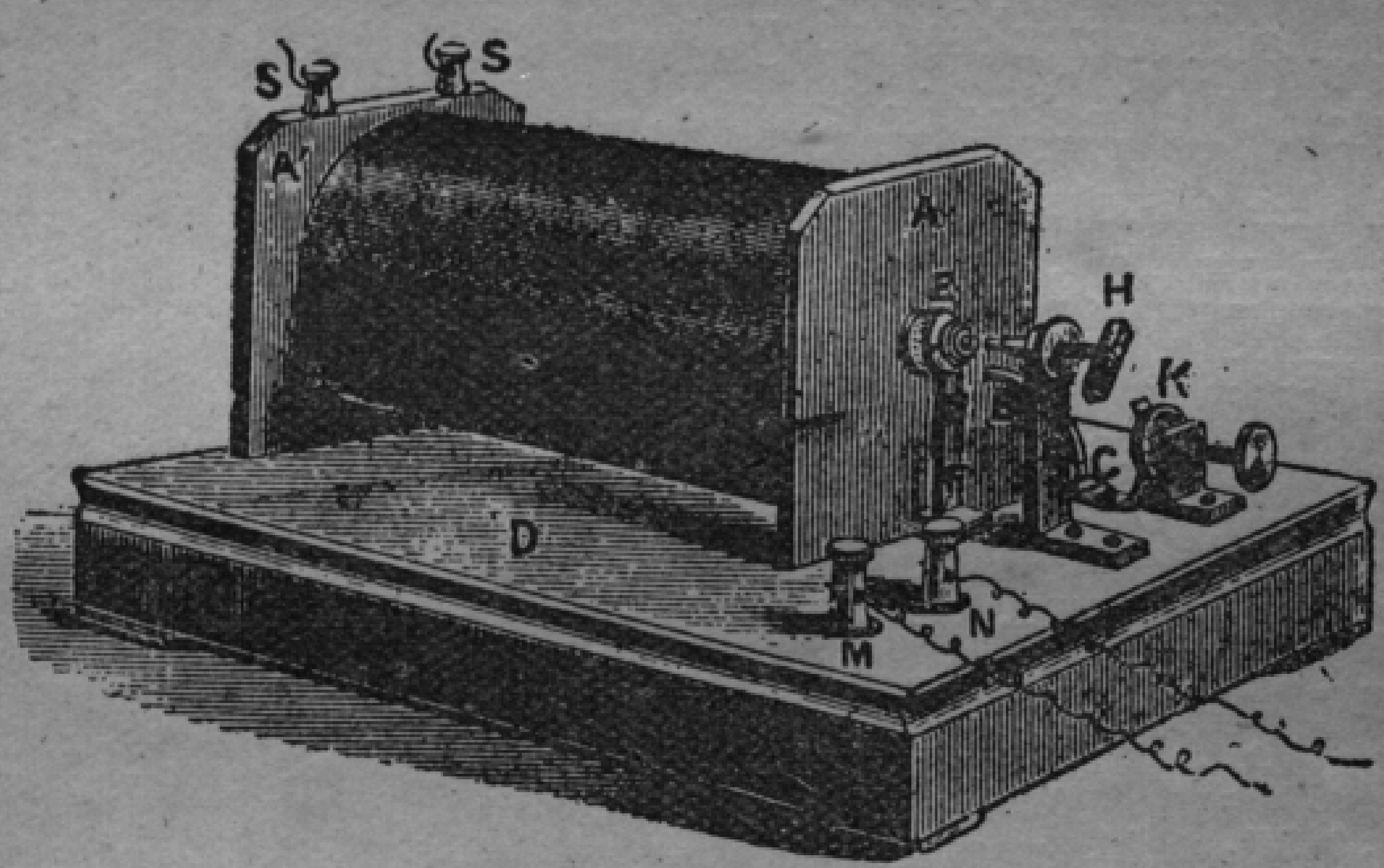


FIG. 14.—A SIDE ELEVATION OF A COMPLETE RUHMKORFF INDUCTION COIL.

exterior parts removed. Fig. 16 is a front elevation of condenser plates, with containing box removed. The essential parts, which will be dealt with separately, are :—

1. Core.
2. Reel.
3. Primary coil.
4. Secondary coil.
5. Contact-breaker.
6. Contact-screw and pillar.
7. Commutator or current reverser.
8. Primary terminals.

9. Secondary terminals.
10. Condenser.
11. Base-board and condenser box.

In fig. 14, *D* represents the base-board, upon which the coil is erected. In the centre of the coil the core, *C* (fig. 15), consisting of a bundle of soft iron wires, is placed inside a tube, *R* (fig. 15), composed of vulcanite or stout paper, called the reel, which is supported in its position by passing through holes bored in the end pieces, *A*, *A′* (fig. 14). Over the reel, which is thoroughly insulated with a thick layer of paraffin wax, the primary coil, *P*, of two layers of thick insulated copper wire, No. 12 or 14 B.W.G.* is wound, and the loose ends passed through the hole, *A*, one being connected to the switch, *K*, and the other to the terminal or binding screw, *M*. Over the primary winding a thick coating of insulating material, viz., vulcanite, paraffin wax, or shellac, is deposited, thereby entirely isolating the secondary coil, *T* (fig. 15), which consists of an enormous number of turns of very fine silk-covered wire (No. 32, 34, or 36 B.W.G.), drawn through a bath of molten paraffin wax, and wound in layers, insulated from each other with sheets of paraffin paper, or such like material; the ends of the coil being connected to the secondary terminals or binding screws, *S*, *S′* (fig. 15). Round the outer layer of the secondary winding another thick coating of insulation is placed, over which a thin sheeting of vulcanite or velvet is laced between the base-board and underneath part of the coil.

The commutator is an arrangement for the purpose of starting, stopping, or reversing the current. In this instance, however, the commutator is replaced by the switch, *K*, which is capable of starting or stopping the current only.

* Birmingham Wire Gauge.

The contact-breaker consists of a head of soft iron, *E*, mounted on a spring, *F*, attached to a vertical or horizontal metallic substance, *O*; and, in combination with the contact-screw, *H*, which is provided with the platinum point, *V*, and adjusted in the upper part of the pillar, *G*, is expressly contrived for making and breaking contact, or, in other words, closing and opening the electric circuit.

The last, but not the least, part of the apparatus to be

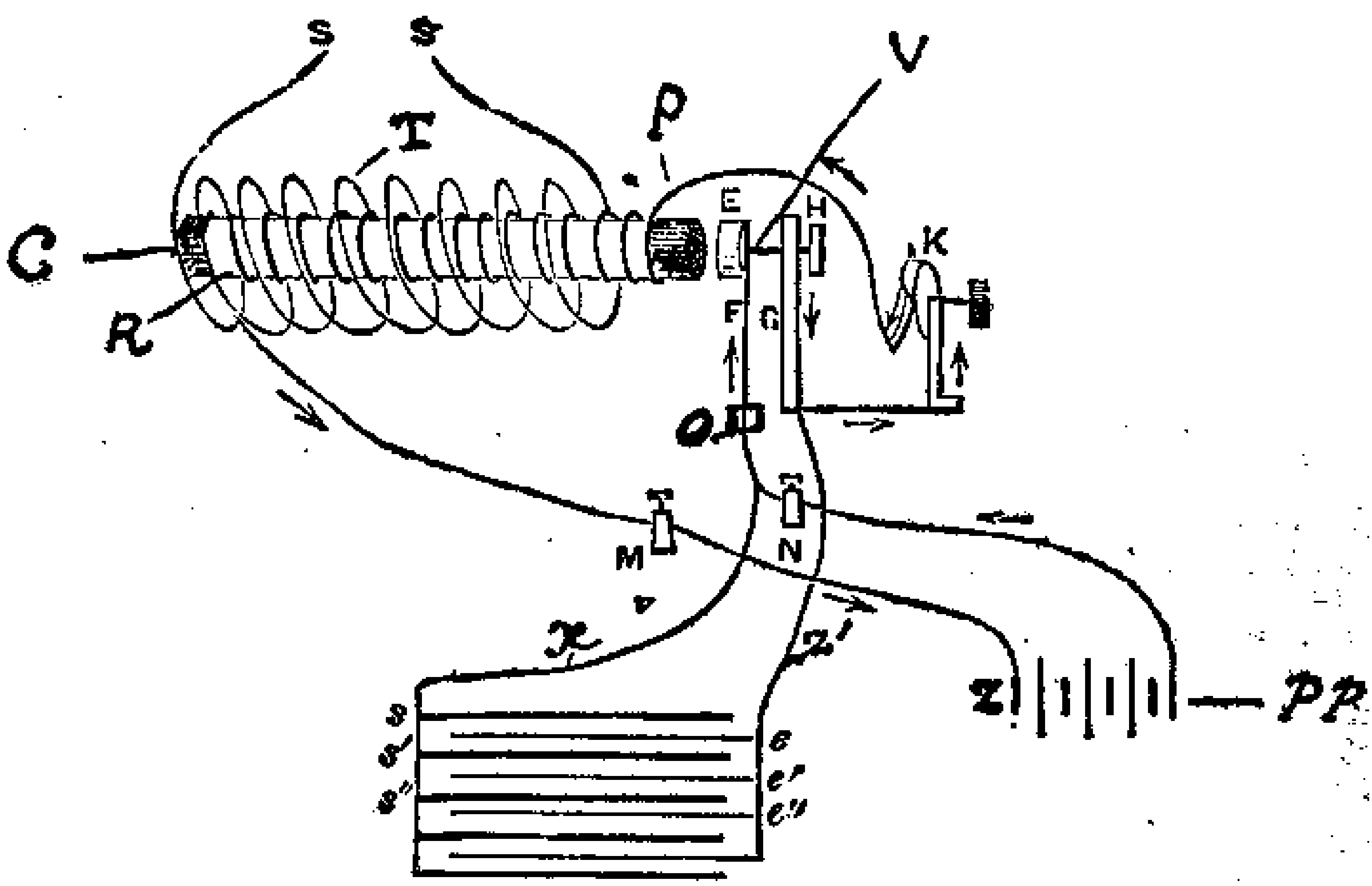


FIG. 15.—A LONGITUDINAL VIEW OF A DISSECTED RUHMKORFF INDUCTION COIL, WITH OUTER PARTS REMOVED.

explained is the condenser (fig. 16), the formation and use of which will be made apparent by the following descriptions.

It is constructed of sheets of tinfoil, which are separated by layers of paraffin paper, *V*. The sheets, which, for the sake of insulation, are less in width than the layers of paper (see fig. 16), are arranged in two sets, all the odd numbers constituting one, and the even numbers the other ; one end of each sheet, in each case, projecting in the manner shown at *S* and *E*. The odd ends at *s*, *s′*, *s″* are collected and folded together, and securely fastened, by soldering or other suitable means, to the wire *X* (fig. 15) ; likewise the even ones at *e* to the wire *Z′*.

The condenser is a very important part of the apparatus, as on breaking the primary current an extra and induced current is created in the primary coil, which, supposing the condenser were absent, would discharge itself in the form of a spark between *E* and the platinum point *V* (fig. 15). But with the condenser the action of the coil is totally different, for before a spark can be

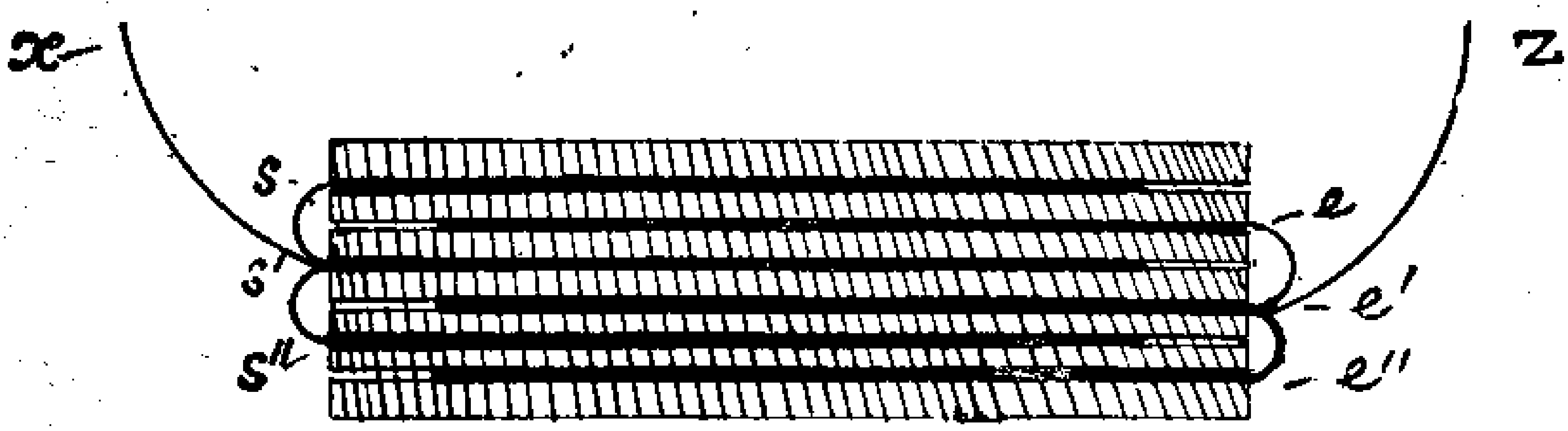


FIG. 16.—A CONDENSER, OR SHEETS OF TINFOIL SEPARATED BY SHEETS OF PARAFFIN PAPER AS INSULATING MATERIAL.

emitted, the surfaces of the condenser must be raised to the requisite potentiality ; therefore the extra current is employed in charging the condenser, instead of producing the electric spark, until such time as the charging operation is completed, when the condenser, whose surfaces are connected through the primary coil and battery, instantly discharges itself, thereby sending a reverse current through the primary winding, which neutralizes the residual magnetism, and, at the same time, effectually increases the rapidity of the disruption. To complete the mechanism of the apparatus, connect the terminal, *N* (fig. 15), to *O*, at the foot of the contact-breaker, *EF*; and the pillar, *G*, to the switch, *K*. Insert the condenser (fig. 16) in the box situated beneath the base-board, and connect the wires *X* and *Z′* to *O* and *G* respectively. Finally screw down the bottom of the condenser box, when the coil will be ready for use. The action of the coil may be briefly described as follows:—

Supposing the battery to be in circuit, then the current will flow from the positive pole, *PP* (fig. 15), to the terminal, *N*, up the contact-breaker, *FE*, through the contact-screw, and the pillar, *G*, through the switch, *K*, thence through the primary coil to the terminal, *M*, and the battery. Every time the current flows through the above circuit two most important effects are produced.

1st. At each rupture of the primary current an inversely induced discharge of enormous electro-motive force is generated in the secondary. 2nd. The iron core is magnetized, and consequently attracts the hammer-head, which causes the primary current to cease, when the hammer-head immediately resumes its normal position, re-establishes the current, and the action is repeated.

The most powerful induction coil ever constructed was manufactured by Apps, of the Strand, London, for the late Mr. Spottiswoode, the secondary winding of which contained 280 miles of wire and 341,850 turns; and with 30 Grove cells is still capable of yielding an electric spark, or, more correctly speaking, flash, forty-two inches in length. The electro-motive force of this coil is prodigious, and stated by various writers to be from 450,000 to 1,000,000 volts, and capable of piercing a plate of glass six inches thick.

The Induction Balance, as illustrated in fig. 18, is a beautiful application by Professor Hughes, who subsequently invented the microphone, of a telephonic

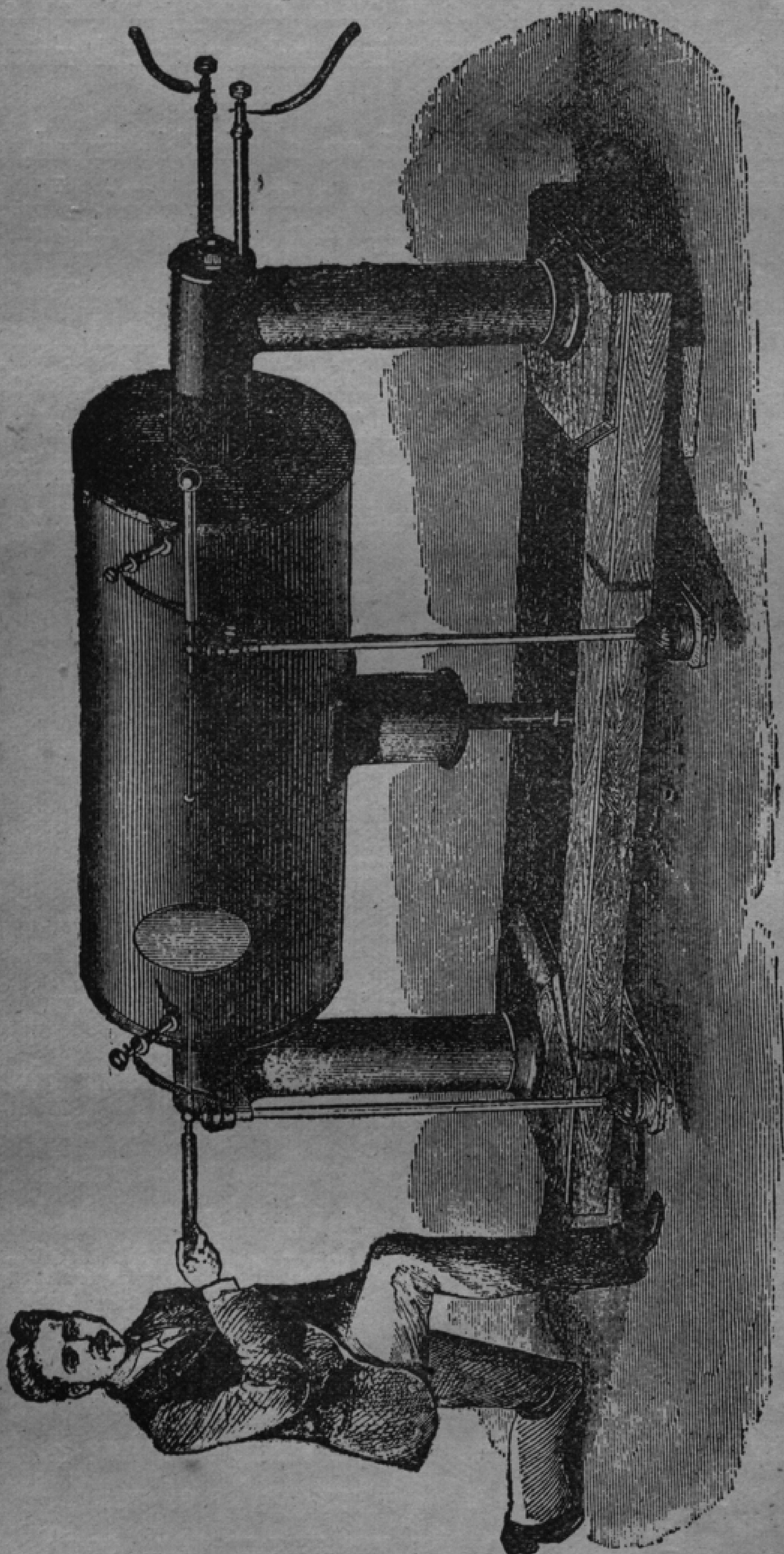


FIG. 17.—MR. SPOTTISWOODE'S RUHMKORFF INDUCTION COIL.

receiver. It consists of four coils of copper wire, each coil having the same sized wire and an equal number of turns.

The coils, P^1, P^2, are erected on a suitable stand, and connected to a battery, *B*, with a microphone, *M*, and key, *K*, in circuit. The other coils, S^1, S^2, which are wound in opposite directions, are placed above the primary coils: S^1 over P^1, and S^2 over P^2, and likewise connected to each other with a telephone, *T*, in circuit—thus forming two distinct paths for the flow of the electric current, with an airway between them as an insulator. The effect of this combination is that, on depressing the

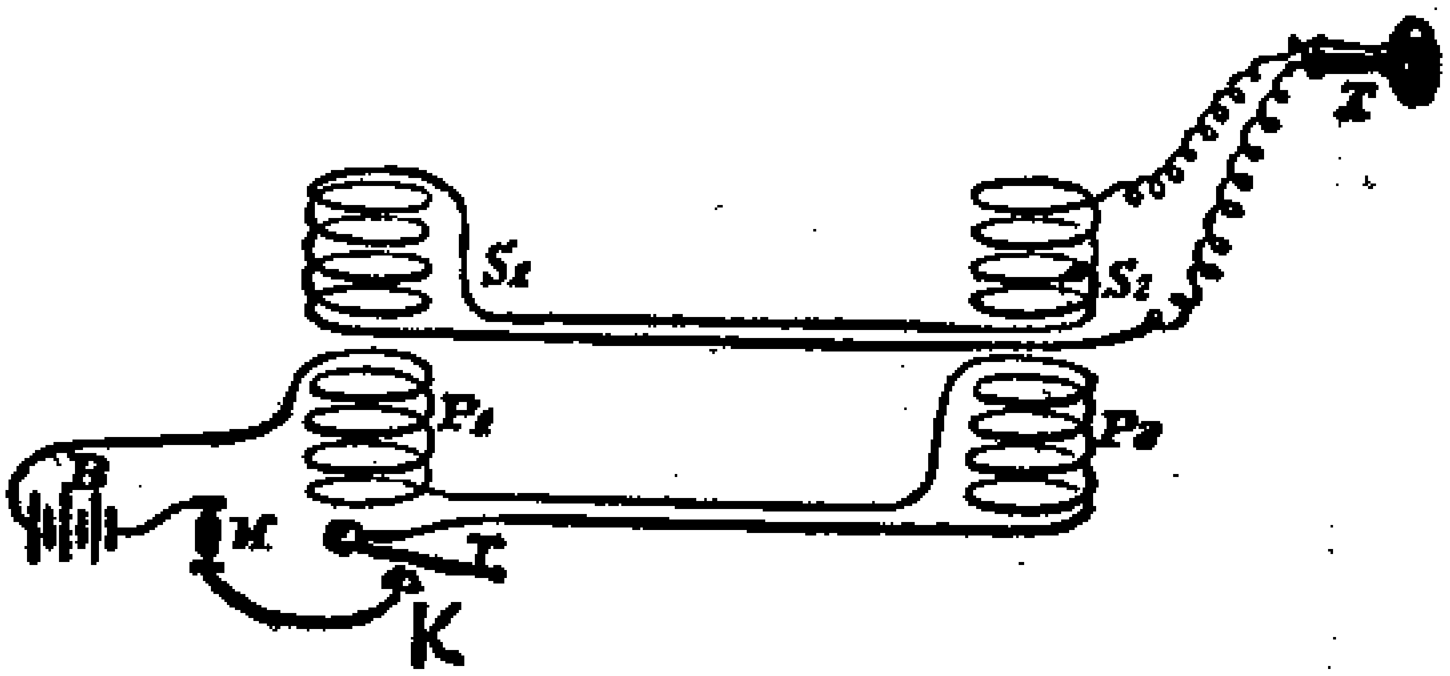


FIG. 18.—PROFESSOR HUGHES' INDUCTION BALANCE.

key, *K*, a current flows through the primary circuit, *B*, P^1, P^2, *K*, and *M*, thereby inducing a secondary current in the circuit, *T*, S^1, S^2, when the sounds generated in the primary would be plainly audible in the telephone, provided the secondary coils, S^1, S^2, were wound in the same direction.

But, as they are not so, S^1 and S^2 neutralize each other, and no sound is discernible. The balance, however, can be easily disturbed by inserting a coin, or other metallic substance, between one of the two pairs of coils, P^1 and S^1, or P^2 and S^2, when the resistance and coefficients of the two pairs would not be equal as part of the inductive influence in P^1 or P^2, as the case may be, and would be utilized in creating currents in the additional mass of metal, during which time the sounds generated in the primary, by the action of the microphone, would be clearly heard in the receiver, T. The two telephonic instruments before mentioned—namely, the telephone receiver and telephone transmitter, or microphone—are fully explained hereafter in Chapter XV.

And now we come to the consideration of the marvellous utility of electro-magnetic induction; but, as a careful examination of its varied uses would require a work of far greater proportions than the present one, it is only possible under the circumstances to make cursory allusions to the subject, and briefly notice some of the leading facts that can be adduced in its favour.

The most important and practical employment of its mysterious and almighty power is in connection with the telephonic transmission and reception of oral messages over long distances. By its aid a very weak primary current from a galvanic battery or accumulator is sufficient to produce a secondary or induced current of immense electro-motive force (pressure), thereby rendering spoken messages distinctly audible at vast distances.

Without its powerful assistance, the world-wide systems of electric telegraphy would be seriously handicapped, and, in some cases, jeopardized, or, even worse still, might become inoperative. By its help a perfect knowledge of the behaviour of electrical currents, in rarefied media, has been obtained; whereas, divested of its inestimable instrumentality, wireless telegraphy would be rendered impracticable, as the high potentiality, so absolutely necessary for its accomplishment, would be almost unobtainable, and, even provided it were secured by the use of high-tension machinery, not only would the cost of production prove prohibitive, but the adaptation of such violent and voluminous discharges would most assuredly end in failure. In concluding this branch of the subject, it may be truthfully stated that "wherever discharges of high potential electricity are required, the same can be much more

PART IV.—ANCIENT AND MODERN SYSTEMS OF WIRELESS TELEGRAPHY AND TELEPHONY

CHAPTER X

FRANKLIN'S HUMOROUS INTRODUCTION OF WIRELESS TELEGRAPHY, AND SUNDRY ENDEAVOURS BY VARIOUS EXPERIMENTERS

DURING the year 1747 Benjamin Franklin performed a number of interesting and valuable experiments in electricity by means of the wireless system, and concluded his demonstrations with a novel entertainment which, in one of his letters to his most intimate friend Collinson, he describes as an "electric feast."

The following programme of events that took place on that memorable occasion is given in his own phraseology. He says :—

"The hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them, for this season, somewhat humorously, in a party of pleasure on the banks of the Schuylkill. Spirits are to be fired, at the same time, by a spark sent from side to side through the river, without any other conductor than the water: an experiment which we some time since performed to the amazement of many. A turkey is to be killed for our dinner by the electric shock, and roasted, by the electric jack, before a fire kindled by the electric bottle; when the healths of all the famous electricians of England, Holland, France, and Germany are to be drunk in electrified bumpers, under a discharge of guns from the electrical battery." By the above, it is obvious that Franklin and his *confrères* were the initiators of the wireless system. But, strange to observe, forty-eight years elapsed ere the subject of wireless telegraphy was once more entertained. On this occasion, it was owing to the persistent endeavours of Bertolon, which were ably supported by Salva, the eminent Spanish physicist, who constructed an electro-chemical telegraph, and read a paper on "The Application of Electricity to Telegraphy," in which he asserted: "If earthquakes be caused by electricity going from one point charged positively to another charged negatively, as Bertolon has shown in his *Electricité des Météores* (vol. i. page 273), one does not even want a cable to send across the sea a signal arranged beforehand. One could, for example, arrange at Mallorca an area of earth charged with electricity, and at Alicante a similar space charged with the opposite electricity, connected by wire to the sea. On leading another wire from the seashore to the electrified spot at Mallorca, the communication between the two charged surfaces would be complete; for the electric fluid would traverse the sea, which is an excellent conductor, and indicate by a spark the desired signal."

Steinheil, of Munich, the man accredited by some with the introduction of the earth circuit method, asserts: "The galvanic excitation cannot be confined to the portions of the earth situated between the two ends of the wire; on the contrary, it cannot but extend itself indefinitely, and, therefore, only depends on the law that obtains in this excitation of the ground, and the distance of the exciting terminus of the wire, whether it is necessary or not to have any communication at all for carrying on telegraphic intercourse, as experiments prove that such a thing is possible, up to a distance of fifty feet."

In the *Kaleidoscope* of June 30, 1829, page 430, the following remarkable notification appeared, relative to the invention of an apparatus entitled the Anticatelephon. It ran thus: "We have received several papers descriptive of a new and curious engine, with the above name, invented by Mr. T. W. C. Edwards, Lecturer on Experimental Philosophy and Chemistry, and designed for the instantaneous conveyance of intelligence to any distance. . . . Mr. Edwards undertakes to demonstrate, clearly and briefly, in the work he has now in the press, the practicability and facility of transmitting from London, instantaneously, to an agent at Edinburgh, Dublin, Paris, Vienna, St. Petersburg, Constantinople, the Cape of Good Hope, Madras, Calcutta, etc., any question or message whatever, and receiving back again at London, within the short space of one minute, an acknowledgment of the arrival of such question or message at the place intended, and a distinct answer to it in a few minutes." This idea involved a vast amount of trouble and expense, as it necessitated the operation of sinking a series of metallic rods in the ground, or dropping them in the sea, in line with the locality desired.

On 16th December 1842 Professor Morse succeeded in telegraphing across a canal at Washington. He says: "The simple fact was then ascertained that electricity could be made to cross a river without other conductors than the water itself." Subsequently, this indefatigable experimenter successfully transmitted telegraphic messages across the Susquehanna River, in a locality where the water was nearly a mile in width. Fig. 19 demonstrates Morse's method of transmission, wherein *b* is a battery; *c* and *a* needle instruments for the trans-

f, *g*, metallic plates immersed in water, and connected, as shown in the drawing, by wires.

But this system was proved to be utterly impracticable, as the lengths of the wires *e f* and *d g* were three times the distances from *d* to *e*, and *f* to *g*.

During the month of August 1854, James Bowman Lindsay, a schoolmaster of Dundee, experimented most successfully across a mill-dam, over a distance of something like 1500 feet; and subsequently, on 10th July 1860, the *Dundee Advertiser* reported the result of his last public trial in connection with telegraphy. The article states: "The experiment was successful, and the needle was strongly moved." The latter demonstration was given across the River Tay, below the Earn,

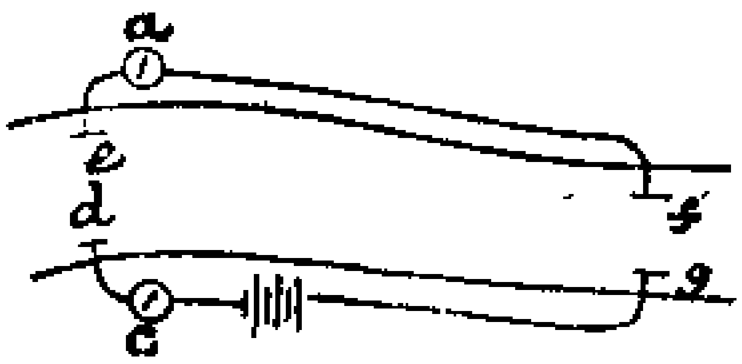


FIG. 19.—THE MORSE METHOD OF TRANSMISSION.

and at a place where the water attains a width of over one mile.

Two years prior to the date of Lindsay's last performance, two brothers, Edward and Henry Highton respectively, compiled an excellent little work on "*The Electric Telegraph, Its History and Progress*," which was published during the same year, wherein they declared: "We do not hesitate to say that it is possible, by erecting a very thick line wire from the Hebrides to Cornwall," connected to "enormous plates at each extremity, and by an enormous battery power, to transmit a current which would be sensibly perceived, in a similar line of very thick wire, with very large plates, on the other side of the Atlantic." In 1875 Professor Alexander Graham

Bell invented his telephonic device, and by the summer of 1876 had so materially improved its construction that he was able to exhibit the apparatus at the Centennial Exposition before a number of distinguished and very influential individuals, when he succeeded so far in his endeavours that he intelligibly transmitted several simple and well-known words and phrases. The reader must not imagine that Bell was the originator of the telephonic idea, as Dr. Robert Hooke, as far back as 1667, positively asserted that it was possible to hear a whisper at the distance of a furlong, as it had been accomplished.

During 1819 Sir Charles Wheatstone devised his magic lyre, which he christened "The Telephone"; accordingly he must be considered the instigator of the appellation. Forty-one years afterwards, Johann Philipp Reis, a member of the Physical Society of Frankfort, constructed an apparatus which he also designated "das Telephon," being unaware at the time that the name had been anticipated.

In A.D. 1874, Elisha Gray, who also played such an active part in experimental telegraphy, "invented an apparatus which is a complete speaking telephone; but it appears that he did not construct it, nor in any wise test it, until some years afterwards."

Four years subsequent to Bell's invention, Professor John Trowbridge accidentally discovered that the leakage from the Harvard to Boston Time signalling clock circuit affected all the neighbouring telephone instruments within a radius of four miles, and he consequently propounded a scheme to telegraph across the Atlantic by the aid of powerful currents produced by an enormous dynamo, the flow to be conveyed through an insulated cable to extend from Florida to Nova Scotia, and earthed at each end; another and similarly insulated cable to be erected along the French coast. However, in 1884, Professor Bell, then a teacher of a system of visible speech to the Deaf and Dumb Institution in Boston, read a highly interesting paper before the members of the American Association for the Advancement of Science, when Professor Bell remarked as follows :—

"Urged by Professor Trowbridge, I made some experiments. . . . The first was conducted on the Potamac River. I had two boats. In one we had a Leclanché battery of six elements, and an 'instrument' for interrupting the current very rapidly.

"Over the bow of the boat we made a water connection by a metallic plate, and behind the boat we trailed an insulated wire, with a float at the end carrying another metallic plate, so as to bring these two terminals about 100 feet apart. I then took the other boat and sailed off. In this boat we had an additional instrument, viz., 'a telephone.' In the first boat I kept a man making signals ; and, when my boat was near his, I could hear the signals very well—a musical tone—something of this kind—tum, tum, tum.

"I then rowed my boat down the river, and, at a distance of a mile and a quarter, which was the farthest distance I tried, I could still distinguish those signals."

The success achieved by Professor Bell appeared to take the wind out of Trowbridge's sails, as he did not subsequently arrive at a satisfactory conclusion with regard to his own.

In 1885 Mr. (now Sir) W. H. Preece, a gentleman well known as an assiduous investigator of the science of electricity, and also the propounder and advocate of numerous theories respecting the subject, organized a number of very interesting experiments in wireless telegraphy, in the neighbourhood of Newcastle-on-Tyne, mann, B.Sc., a member of the Institute of Electrical Engineers, etc., on page 16 of his interesting treatise on "Wireless Telegraphy," and read as follows:—

"Three years later, Mr. Preece arranged some interesting experiments on wireless telegraphy by electro-magnetic induction, in the neighbourhood of Newcastle, which were carried out by Mr. A. W. Heaviside. Two squares of wire, each side a quarter of a mile in length, were placed at distances varying from a quarter of a mile to one thousand yards apart. In the former case the signals could be easily read by a telephone in the receiving circuit, and audible sounds were produced even at the greater distance." He furthermore says: "Experiments were made with parallel telegraph lines, ten and a quarter miles apart, between Durham and Darlington, and it was found that the ordinary working currents in one line produced distinctly audible sounds in a telephone in the other." This chapter will be concluded by a short reference to the patented methods adopted by Mr. Willoughby Smith, and the latter in conjunction with Mr. W. P. Granville. The following able exemplification of the principles is also taken from page 19 of Mr. Tunzelmann's work.

"In fig. 20 a lighthouse is shown at *A*, and insulated wires lead from the terminals of a telephone in the lighthouse to metallic plates, *MN*, submerged on opposite sides of the rock. Two other plates, *P* and *Q*, submerged to a sufficient depth to be unaffected by waves, are connected by an insulated cable, having in circuit with it a battery, *B*, and an interrupter, *C*. The course of the current is shown by the arrows. The modification of Mr. Willoughby Smith's method, as introduced by Messrs. Smith and Granville, is shown in fig. 21, which illustrates its application to communication between the Fasnet Rock, off the south-west coast of Ireland, and the town

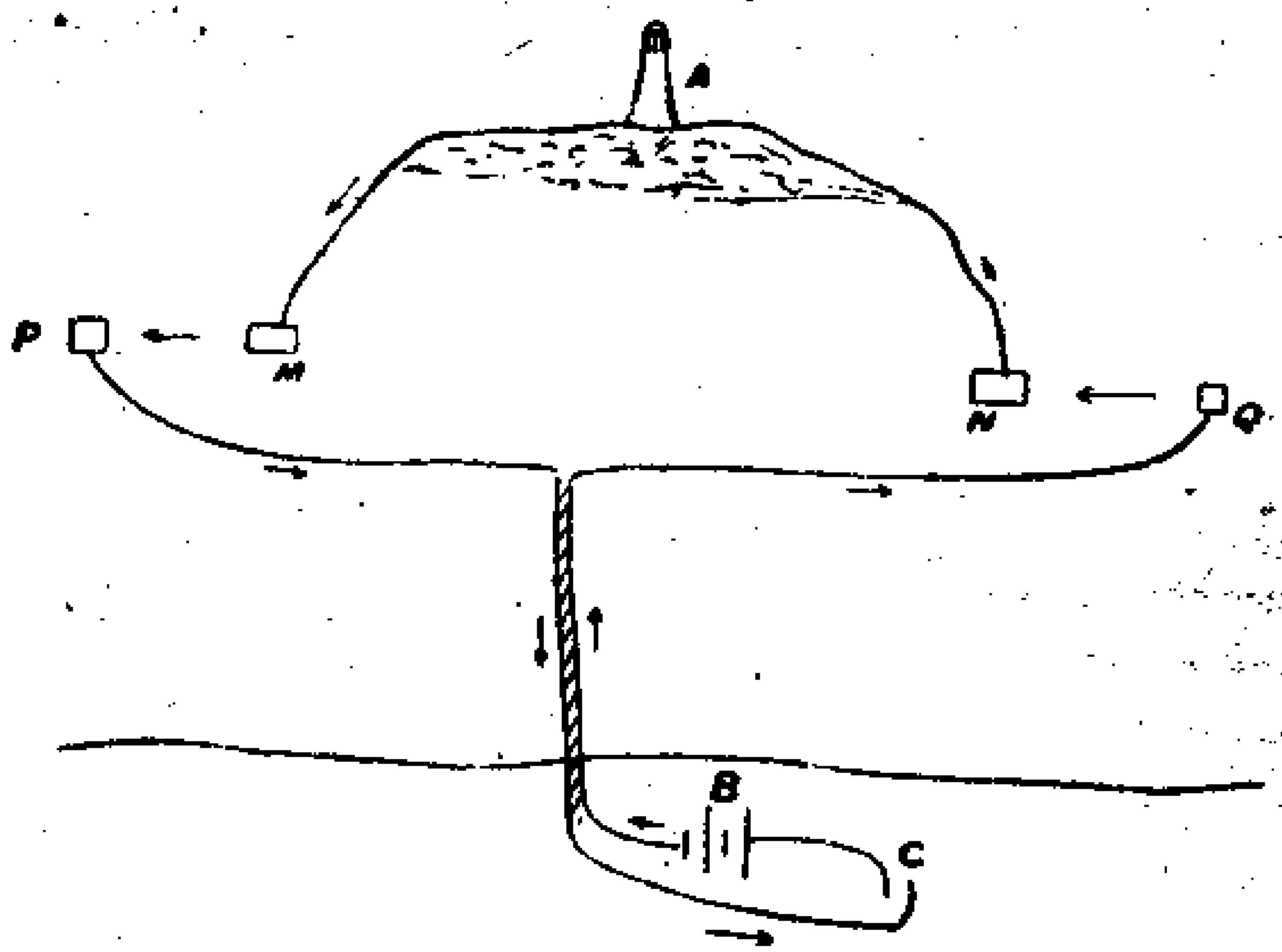


FIG. 20.—WILLOUGHBY SMITH'S METHOD OF COMMUNICATION BETWEEN A LIGHTHOUSE AND THE SHORE.

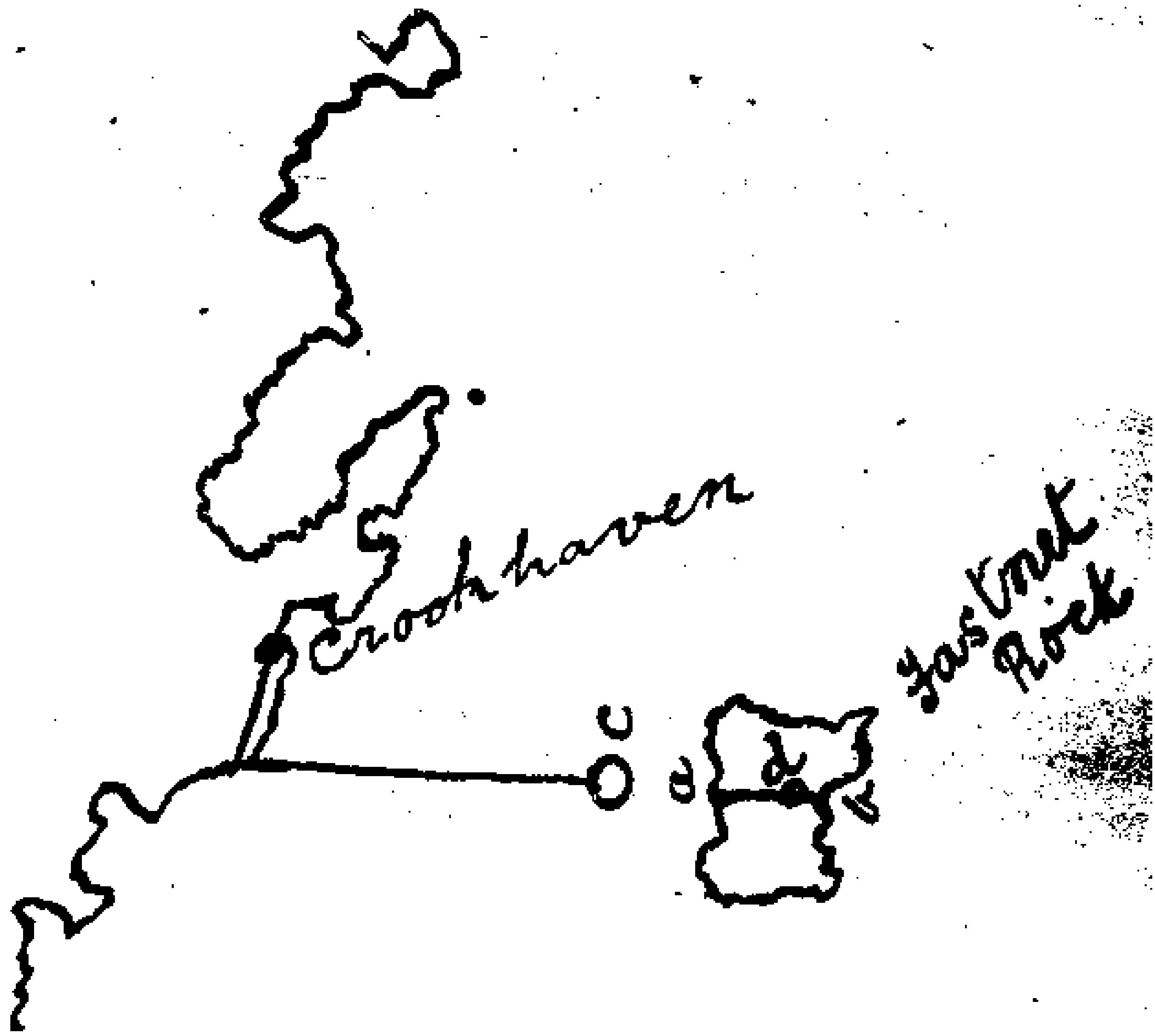


FIG. 21.—THE METHOD OF MESSRS. SMITH AND GRANVILLE EMPLOYED IN COMMUNICATING BETWEEN CROOKHAVEN AND FASNET ROCK.

of Crookhaven, eight miles away. An insulated cable from the shore is earthed at the shore end, and also by means of a heavy copper anchor, *C*, near the rock. A conductor, *ab*, containing a receiving instrument, which in this case is a D'Arsonval galvanometer, *d*, is earthed at *a* and *b*, on opposite sides of the rock, by connection with submerged masses of copper; and whenever a current flows through one circuit, there will be a difference of potential produced at the ends of the other circuit, resulting in a flow of current which is shown by the galvanometer."

CHAPTER XI

HERTZ'S DISCOVERY OF ELECTRO-MAGNETIC WAVES; BRANLY'S COHERER; THE RESEARCHES OF DR. LODGE AND LORD KELVIN; POPOFF'S INVENTION OF THE AERIAL SYSTEM OF WIRELESS TELEGRAPHY; MARCONI'S SUBSEQUENT ADAPTATION OF POPOFF'S METHODS.

IN 1888, after a series of elaborate experiments, Professor Heinrich Hertz declared that he had actually succeeded in detecting the existence of electro-magnetic waves by means of an apparatus shown in figs. 22 and 23, and which he termed an oscillator or radiator, and resonator respectively. In fig. 22, *A* represents a

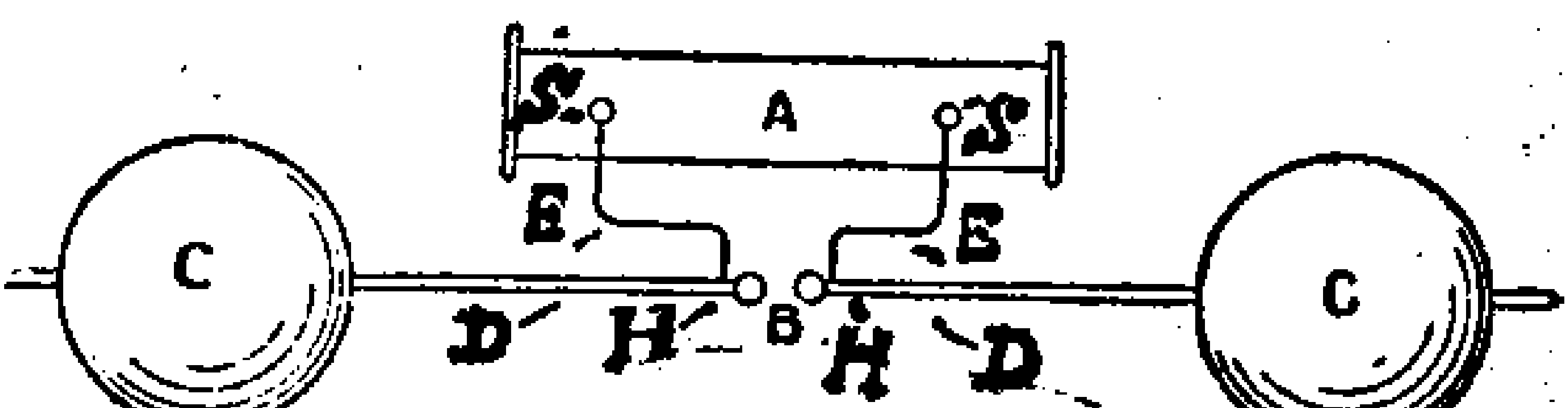


FIG. 22.—THE HERTZ OSCILLATOR OR RADIATOR.

Ruhmkorff induction coil, *SS* the secondary terminals thereof, *HH* small oscillators, between which exists the air (or spark) gap, *B*; *CC* are large oscillators, *DD* rods connecting same to small ones, *EE* wires connecting coil and small oscillators.

After the decease of this renowned scientist in 1892, Auguste Righi, a Bologna professor, vastly improved the above contrivance; and in 1893, Dr. Lodge (now Sir Oliver) made some important discoveries relative to the action of the Branly coherer, which had been invented by that praiseworthy experimenter some years before. A year later, Dr. Lodge read a highly instructive paper on "Signalling through Space without Wires," and it is owing to that circumstance that his friends regard him as the pioneer of the aerial system of wireless telegraphy. During a period of forty years prior to Dr. Lodge's investigations, Sir William Thomson (now Lord Kelvin) prosecuted a large number of most elaborate and interesting trials in order to demonstrate the existence and oscillatory character of electric waves. Nevertheless, up to the year 1895 no satisfactory method had been devised, or even suggested, for the utilization of Hertzian rays for electric telegraph purposes.

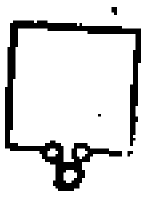


FIG. 23. — THE HERTZ RESONATOR, SHOWING SPARK GAP AT *D*.

But in April of the latter year, a young and very enterprising Russian professor, named Popoff, conducted a trial of his system of transmitting messages by the aerial or etheric principle of electric telegraphy, before a number of scientists and members of the Physical Society at Cronstadt; and demonstrated his remarks by means of a Hertz oscillator, constructed in accordance with fig. 24, which he used as a transmitter, and a device of his own, as illustrated in fig. 25, which he employed as a receiving instrument, in place of Hertz's resonator.

By comparing the drawings (figs. 22 and 24), the reader will observe that the only difference that exists between them is the addition, in fig. 24, of the battery, *K*, and Morse key, *M*, parts not shown in fig. 22, but are most essential for the purposes of transmission—the former to supply the electric current, and the latter to despatch the message. With regard to the figs. 23 and 25, however, there is no similarity between the two; and

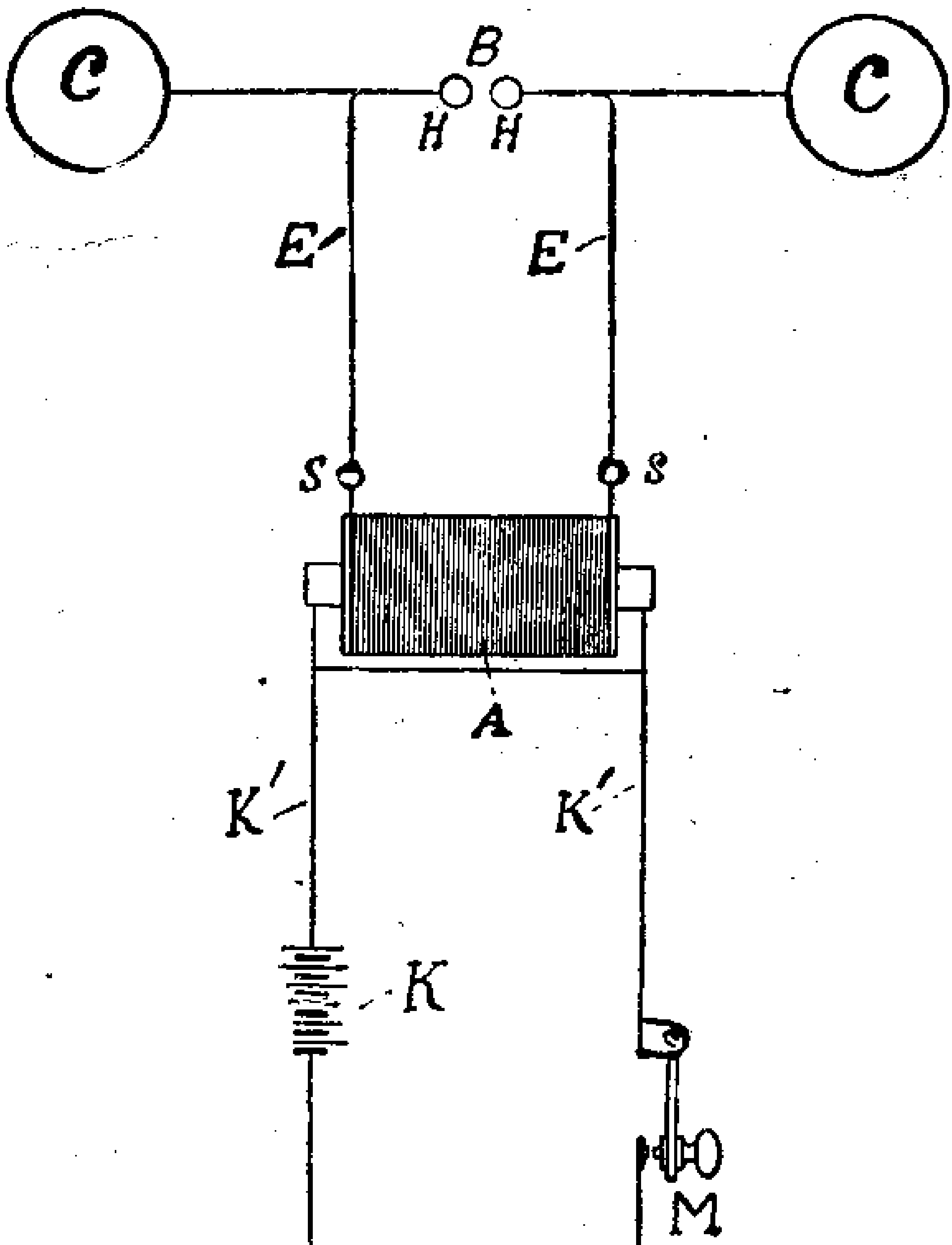


FIG. 4.—POPOFF'S HERTZIAN WAVE TRANSMITTER, DEVISED 1895.

as the illustration (fig. 25) is rather complicated, a brief description is necessary.

The apparatus may be briefly described as follows:—*K* is an ordinary battery or accumulator; J^2, a vertical wire; *T*, a coherer; J^3, an earth connection; *Z*, an electric bell contrivance operating the tapper, *D*; *E* and *F*, electro-magnets, the latter being part of the mechanism of the bell, *Z*; *N*,*N*, choking coils; *S*, a contact-screw; *H*, a relay; and *B*, B^1, B^2, B^3, B^4, B^5, circuit wires.

Although some minor alterations have been effected in the construction of Popoff's appliances by subsequent

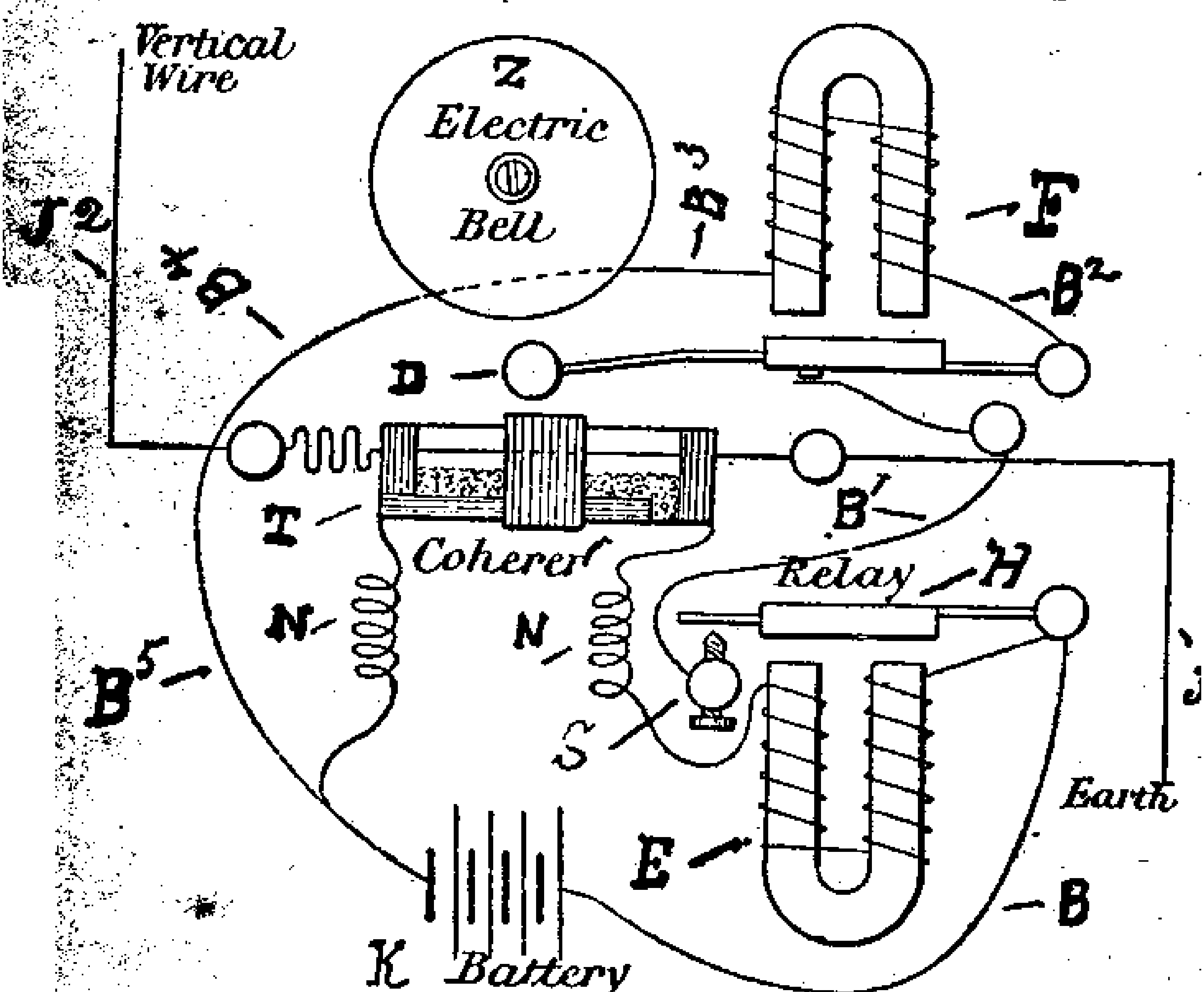


FIG. 25.—POPOFF'S HERTZIAN WAVE RECEIVER, INVENTED 1895.

experimenters and inventors, a list of whom is appended, still the action of the various systems, and the results obtained by each, are identical.

In order to prove the veracity of this statement, as well as give the reader an opportunity to use his judgment and form an opinion with reference thereto, I have selected the methods of Popoff and Marconi for comparison; but, before so doing, a short explanation regarding the instruments used in the Marconi system is requisite.

LIST ABOVE REFERRED TO.

1. Professor Popoff (Russia).
2. Signor Marconi (Italy).
3. Herr Ferdinand Braun (Germany).
4. Herr Adolf Slaby (Berlin).
5. Mons. Branly (France).
6. Mons. E. Ducretet („).
7. Signor Emile Guarini Foresio (Belgium).
8. Señor Julio Cevera Baviera (Spain).
   Herr Béla Schaeffer (Austro-Hungary).
9. Professor Reginald Fessenden (United States, America).
   Dr. Lee de Forrest („ „).
10. Sir Oliver Lodge (Great Britain).
11. Sir William Preece („).

In fig. 26 (Method No. 1), *R* is an induction coil, having its primary circuit, *C*,*C*, connected through the key, *D*, to the battery or accumulator, *E*. The terminals, *F*,*F*, of the secondary circuit are connected to the two insulated spirical conductors, *G*,*H*, by means of wires F^1,F^1; *e′* is a spark gap, and the arrangement as above shown constitutes a Hertz radiator.

Fig. 27 is a modification of method No. 1; the four spheres, *e*,*e*,*d*,*d*, being substituted for the spheres, *G*,*H*, in fig. 26. The terminals, *F*,*F*, being connected to the wires, F^1,F^1, which in turn are connected to the spheres, *d*,*d*. One of the spheres, *d*, is, by the wire, *u*, connected to the plate, *u′*, which is suspended in air by means of the cross-beam, *v′*, supported by the earthed pole, *v*. The other sphere, *d*, is, by the wire, *Z*, connected to earth, *E*.

Figs. 28 and 29 represent the receiving instruments used in the Marconi system. In fig. 28, *K* is a battery, *L*, a Morse receiving instrument; J^1,J^1, conducting wires

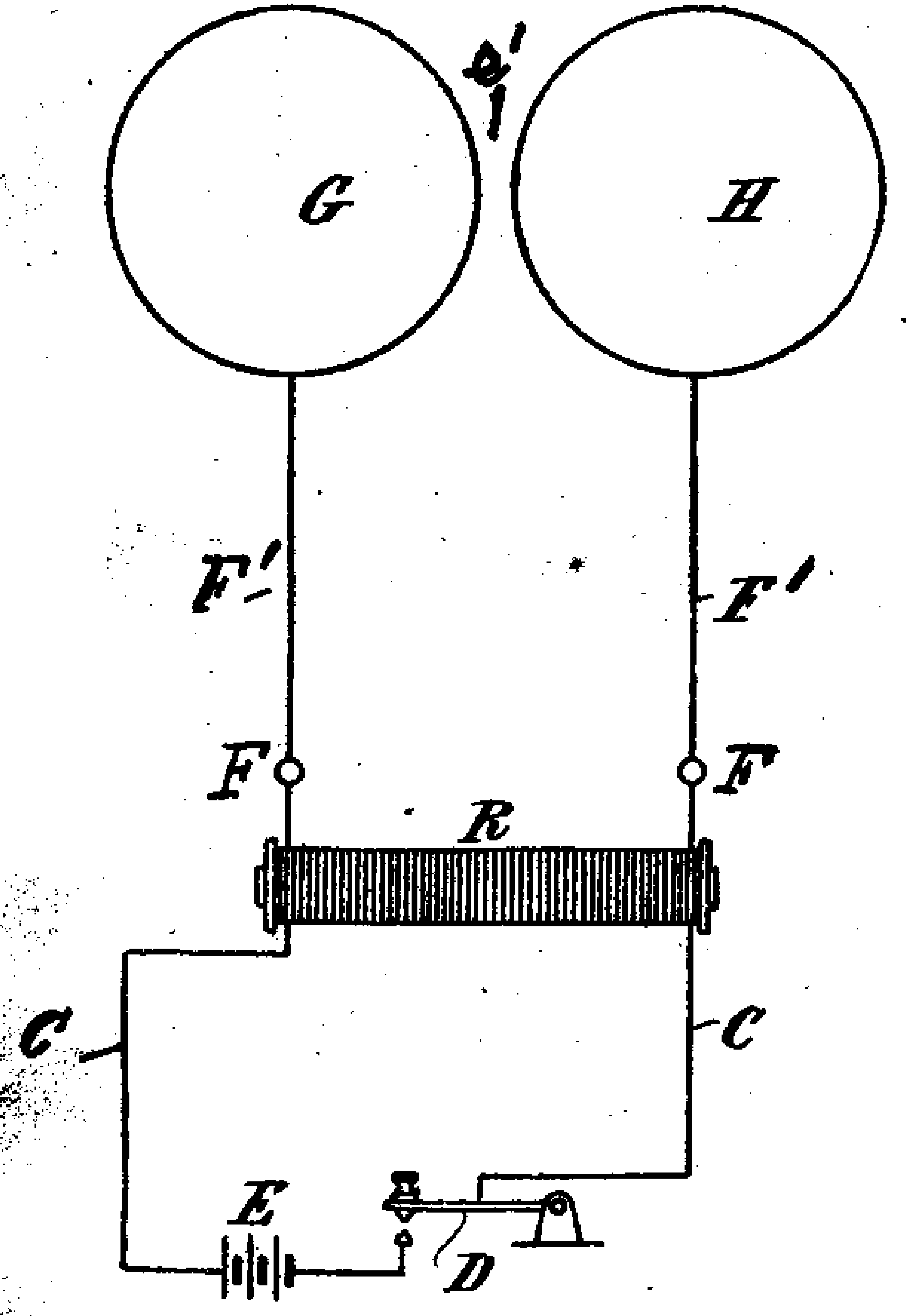


FIG. 26.—MARCONI'S HERTZIAN WAVE TRANSMITTER (No. 1), PATENTED IN 1896, AS SHOWN IN HIS ORIGINAL DRAWINGS IN SPECIFICATION (*G,B*), No. 12039.

connected to the coherer, *T*, loosely fitted with metallic filings as illustrated.

The wires, J^1,J^1, are also fastened to the plates, M,N, by the wires, J^2,J^2.

Fig. 29 is a modification of fig. 28, wherein the plate,

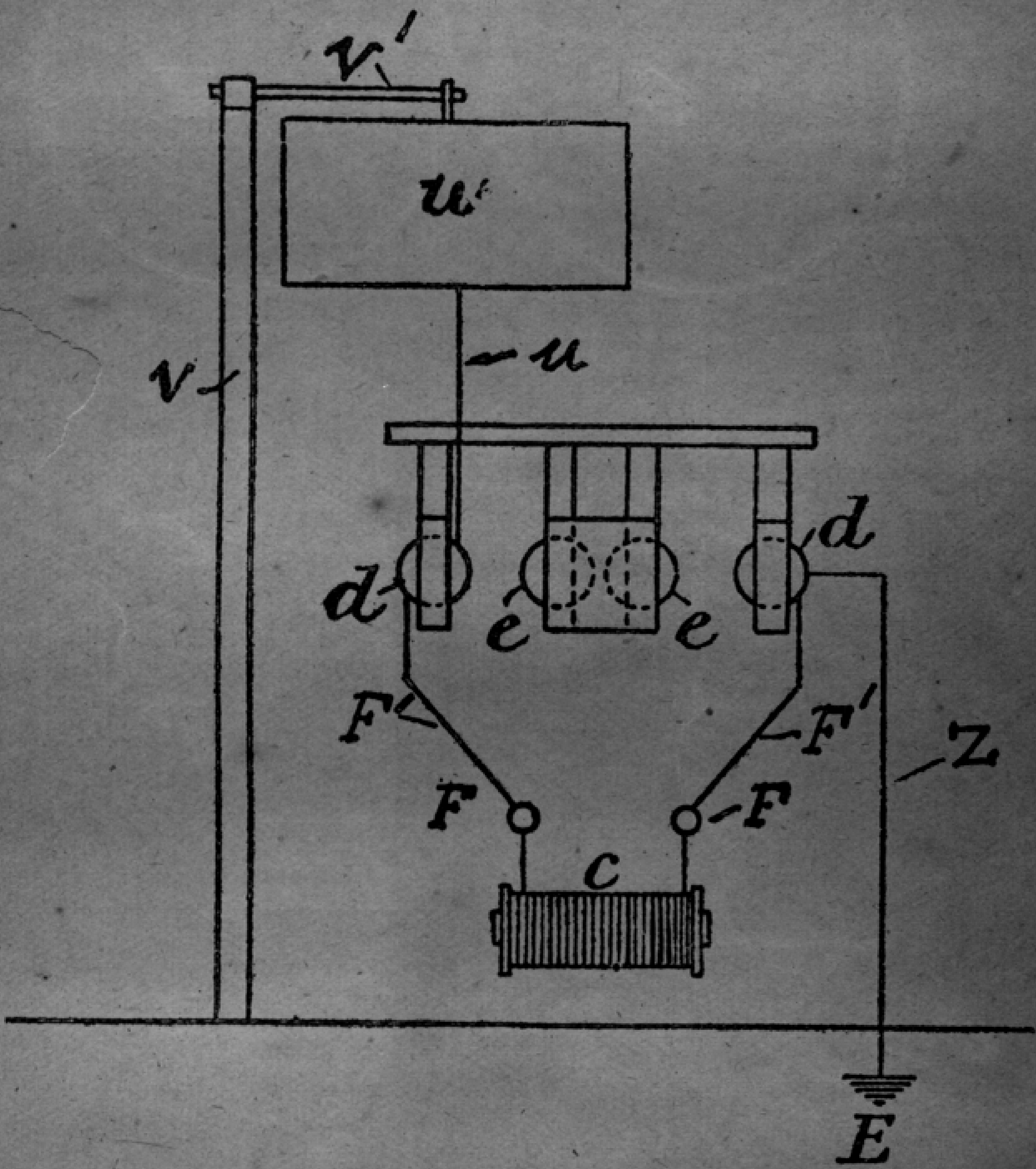


FIG. 27.—MARCONI'S HERTZIAN WAVE TRANSMITTER (No. 2), BEING A MODIFICATION OF No. 1, PATENTED IN 1896, AS SHOWN IN HIS ORIGINAL DRAWINGS IN SPECIFICATION (*G,B*), No. 12039.

W, suspended by the cross-beam, x^1, which is supported by the earthed pole, *x*, is substituted for the plates, *M,N* (fig. 28); and the imperfect contact, *j*, takes the place of the coherer, *T*. But, in this instance, the tube, *j*, is connected to earth by means of the wire, J^3, or, if pre-

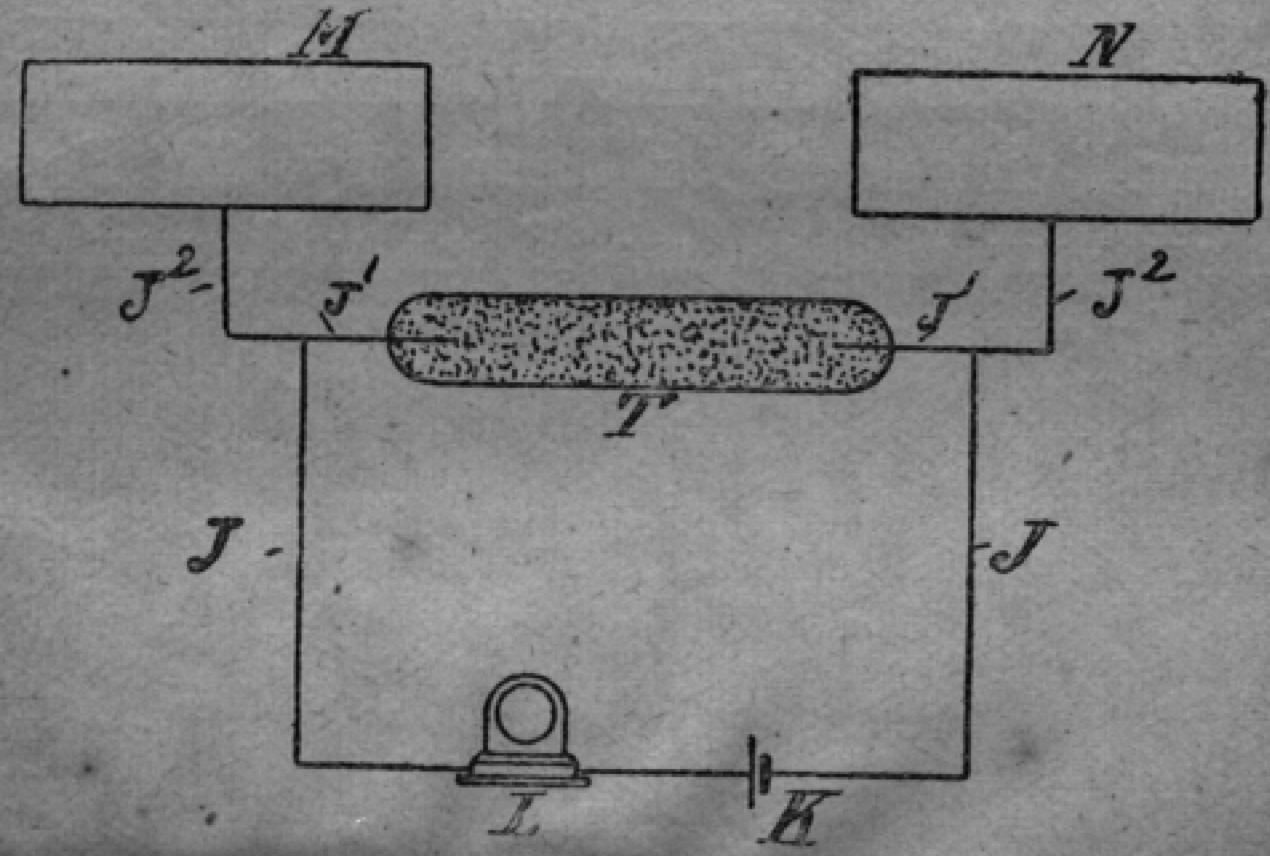


FIG. 28.—MARCONI HERTZIAN WAVE RECEIVER (METHOD NO. 1).

ferred, the terminals of the tube, *j*, may be connected to two earths by the wires, *K*,*K*, which are attached to

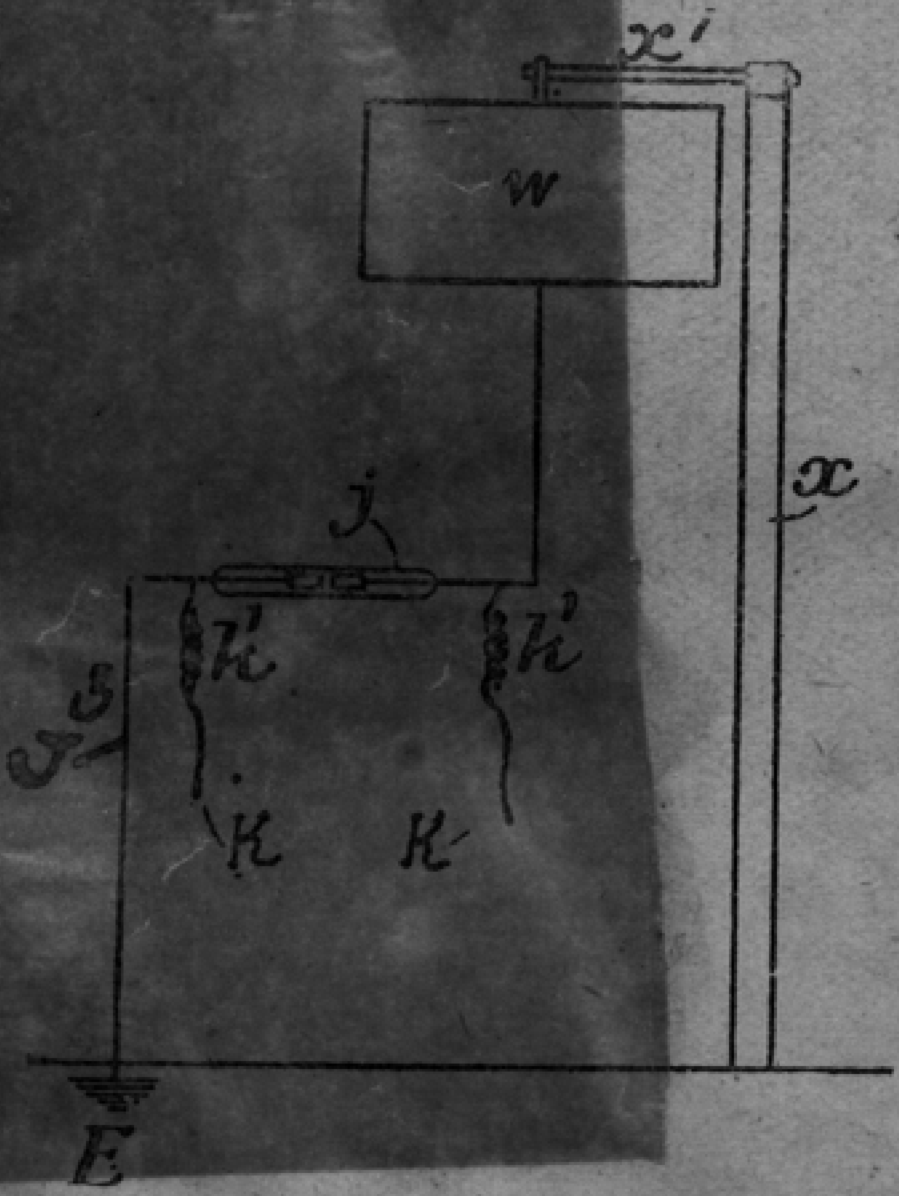


FIG. 29.—MARCONI HERTZIAN WAVE RECEIVER (METHOD NO. 2).

the choking coils, *k′*,*k′*. In the following chapter, lists of various instruments used in the Popoff and Marconi installations are given, and by carefully comparing them, and calmly perusing the descriptions of the methods of working and the results obtained by the Popoff and Marconi systems, the reader will easily observe that they are virtually the same.

CHAPTER XII

POPOFF AND MARCONI INSTALLATIONS COMPARED: METHOD OF WORKING THE AERIAL SYSTEMS: MARCONI'S ATTEMPT TO TELEGRAPH ACROSS THE ATLANTIC WITH HIS AERIAL SYSTEM: PROFESSOR FLEMMING'S OPINION: ADVERSE CRITICISMS.

TRANSMITTING APPARATUS

LIST NO. 1	LIST NO. 2
Principal parts of Popoff's Installation.	Principal parts of Marconi's Installation.
1. *A*. Ruhmkorff Coil.	*R*. Ruhmkorff Coil.
2. *S,S*. Secondary Terminals.	*F,F*. Secondary Terminals.
3. *E,E*. Conducting wires to Oscillators.	F^1,F^1. Conducting wires to Oscillators.
4. *H,H*. Small Oscillators.	*d,d*. Small Oscillators.
5. *B*. Spark Gap (air).	e^1. Spark Gap (air).
6. *C,C*. Large Oscillators.	*e,e*. Large Oscillators.
7. *M*. Morse Key.	*D*. Morse Key.
8. *K*. Battery or Accumulator.	*E*. Battery or Accumulator.
9. K^1,K^1. Primary Circuit wires.	*C,C*. Primary Circuit wires.

RECEIVING APPARATUS

10. *K*. Battery or Accumulator.	*K*. Battery or Accumulator.
11. J^2. Vertical Wire and Plate.	J^2. Vertical Wire and Plate, *W*.
12. *T*. Coherer.	*T*. Coherer.
13. J^3. Earth Connection.	*E*. Earth connecting fig. 29.
14. *Z*. Electric Bell Contrivance.	*P*. Electric Bell Contrivance. Fig. 66.
15. *D*. Tapper.	*O*. Tapper. Fig. 66.
16. *E,F*. Electro-Magnets.	*P,N*. Electro - Magnets. Fig. 66.
17. *N,N*. Choking Coils.	*k',k'*. Choking Coils.
18. *H*. Relay.	*N*. Relay. Fig. 66.
19. —Circuit wires as required.	—Circuit wires as required.

As Popoff's apparatus was devised in 1895, Marconi cannot surely be the inventor of the system in 1896.

The method of working the installations, hereinbefore referred to, and the opinions of aerial and etheric telegraphists as to how the results are obtained, may be briefly set forth as follows. In each case the letters referring to Popoff's apparatus are placed first.

It is asserted that, on closing the primary circuit at the transmitting station, by depressing the Morse key, *M* or *D*, the electric current from the battery or accumulator, *K* or *E*, passes through the primary circuit, K^1,K^1 or *C,C*, and the induction coil, *A* or *R*, thereby producing an induced current of enormous electro-motive force, *E,M,F*, which traverses the secondary winding of the coil to the terminals, *S,S* or, *F,F*, and up the conductors, *E,E* or, F^1,F^1, thereby producing electric sparks at the air (or spark) gap, *B* or e^1, between the oscillators, *H,H* (fig. 24) or, *G,H* (fig. 26), or, e^2,e^1,e^2, between the oscillators, *d,e,e,d*, (fig. 27), which are a little distance apart, thereby causing the oscillators, *C,C*, or *G,H*, or *e,e* to emit electrical waves, which are forcibly impelled through space, and impinging on the plate, *W*, of the receiver, descend the wire, J^2, pass through the coherer, *T*, to earth, J^3 or *E* (fig. 29), which magnetizes the metallic filings contained in the coherer, and closes the circuit of the local battery, *K*, containing the choking coils, *N,N* or *k′,k′*, which, acting on the relay, *H* or *N*, closes another circuit with less resistance, which, by means of an electromagnet, energizes the tapper, *D* or *O*, which, striking the coherer, *T*, disturbs the metallic filings, thereby demagnetizing it.

The coherer is thus rendered inactive until another impulse is received on the plate, *W*, when the action is repeated. Provided a transmitting apparatus such as described in fig. 27 be used, one of the oscillators, *d*, is connected to the plate, u^1, by the conducting wire, *u*, and the other oscillator, *d*, is attached to the wire, *Z*, which is connected to earth ; the sparking in this instance taking place from *d* to *e*, *e* to *e*, from the positive side: and *d* to *e*, *e* to *e*, on the negative side. In the case of using a receiver, such as fig. 28, an earth connection is not used, and the electric waves are received on the two plates, *M,N*, instead of the plate, *W*. When the coherer is connected to two earths, as may be done (see fig. 29), the receiving plate, *W*, is dispensed with, the electric surgings or impulses being conveyed through the coherer by means of the two earths.

As before observed, the theory propounded by aerial or etheric telegraphists is to the effect that all impulses or surgings emitted by the insulated spheres termed oscillators, or radiators, which are suspended on poles in mid-air at the transmitting station, are projected through space upon the aerial receiving plates, also suspended in like manner at the receiving station ; and in order to dispatch messages or signals to long distances, it is imperative for the poles, or other contrivances, upon which the aerial plates are placed, to be proportionately increased in height in accordance with the distance

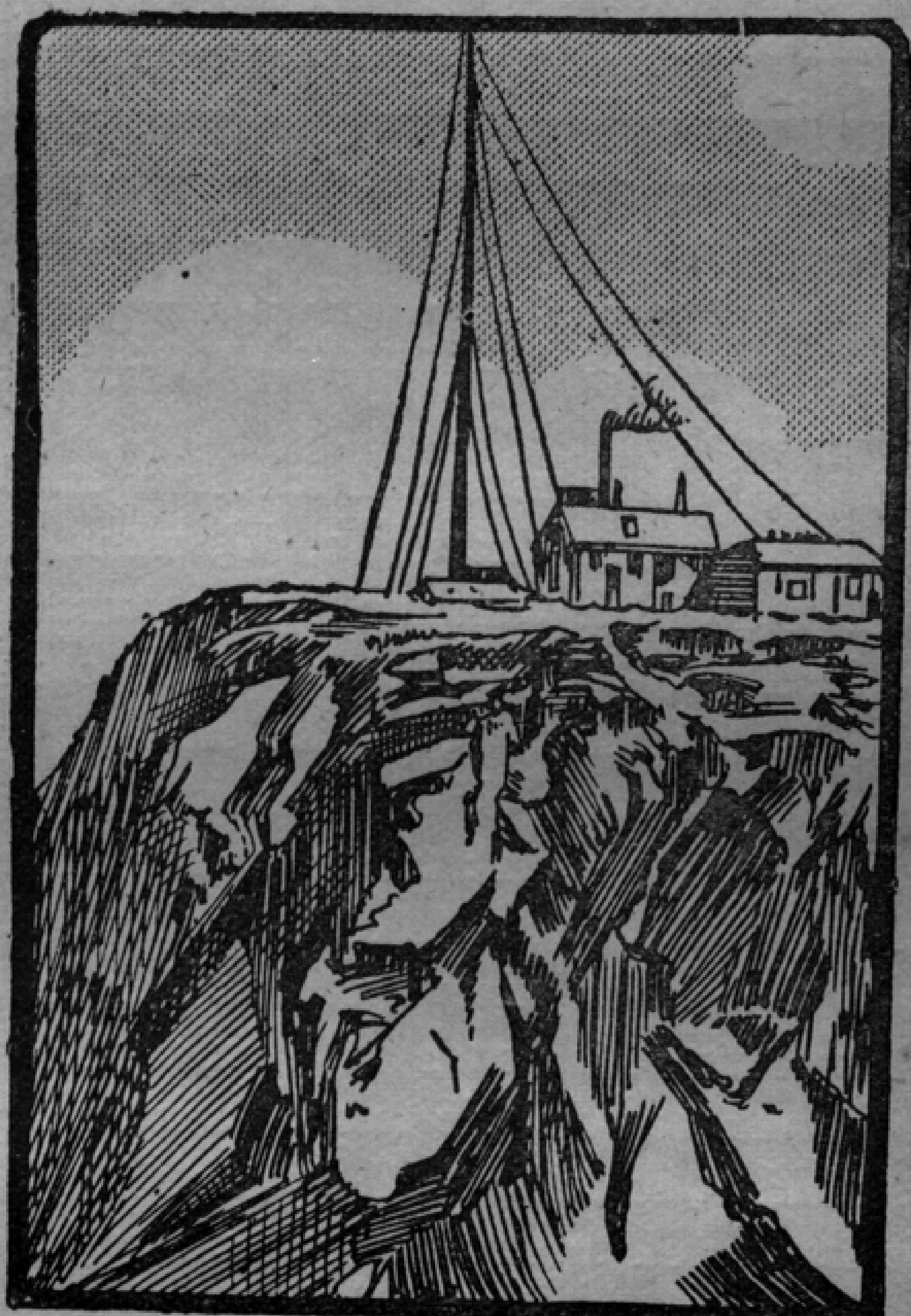


FIG. 30.—MARCONI TRANSMITTING STATION AT POLDHU, CORNWALL.

traversed. In support of this view, Mr. Richard Kerr, F.G.S., in his treatise on "Wireless Telegraphy," says : "I find Mr. Marconi succeeded in sending a message from Alum Bay to Swanage, a distance of nearly 18 miles, by using poles 150 feet high" ; and Mr. Kerr further remarks : "If increased height of wire means even approximately proportional distance, Marconi will soon manage a line 60 miles." The proportional heights between 18 miles and 60 miles would be 150 and 500 feet respectively.

Therefore, provided the above statement be correct, or even something approaching it, how is it possible that Mr. Marconi could succeed in December 1901, with a kite flying at the comparatively low altitude of 400 feet, to transmit a message over the Atlantic, a distance of about 2000 miles? whereas the proportional height of the transmitting and receiving apparatus should have been 13,333 feet, 4 inches, or, in other words, over two miles and a half high.

Fig. 32 is a diagrammatical illustration of the kite used by Mr. Marconi at the Bluff, off St. John's, Newfoundland (fig. 33), and, together with the following description, have been taken from a report in the London *Daily Express* of January 3rd, 1902, wherein it states :—

"It may be as well here to recall in a few words how the famous message was received. On the Thursday, when the kite was fixed high up above the Bluff, at St. John's, Newfoundland, Mr. Marconi and his assistant, Mr. Kemp, took up their positions within the station, and fixed the telephone receivers to their ears. According to their pre-arranged plan with the Poldhu Station in Cornwall, the operator was to begin by sending the Morse formula for 'S'—three dots—at 3 p.m., which was 11.30 a.m. in America.

"At 12.30 the first audible signals were noticed by the two watchers off St. John's. At 1.10 and 2.30 they were also distinctly heard twenty-five times in succession. The formula was repeated again and again, and they rose from their vigil quite satisfied. That is the simple story of the first wireless message (to be) received across the Atlantic.

"It is now a matter of history, and perhaps, in a matter of a few months, it may have become an ordinary thing to send a wireless message to America from over sea." In the same report Mr. Marconi is credited with

FIG. 31.—A YOUNG MAN WITH GREAT AMBITION.

saying: "There is no longer any question about my ability to transmit wireless signals across the Atlantic. All that remains to be done now is to provide adequate apparatus."

The following extract is taken from a report in the *Daily Telegraph* of January 10th, 1902, *re* Professor Flemming's co-operation with Mr. Marconi in the scientific development of ethereal telegraphy. It read as follows:—

"Mr. Marconi, by a special method of his own, threw off the ether waves that had crossed the Atlantic. The waves which Mr. Marconi employed to signal to Newfoundland were about 1000 feet long. The distance was 1800 (nautical) miles, and a simple calculation showed that a straight line from Cornwall to St. John's would go to a depth of 110 miles below the surface. A question arose, how were those waves transmitted? Did they follow the curvature of the earth, and if so, how far could they be sent? These questions must be answered by experiment. *Water is a non-conductor and reflector of the waves*, so is the rarefied air of the upper atmosphere; hence, Dr. Flemming suggested that by these *bounding* and *reflecting* surfaces, Marconi's signals were prevented being *lost in space*, and *carried successfully over the ocean*." Professor Flemming also observed "that a sound, if created loud enough, would travel to Newfoundland from Poldhu in two hours and a half, a rapid Atlantic wave in sixty hours, and Mr. Marconi's wave in the hundredth part of a second." According to this, Mr. Marconi's Trans-Atlantic transmission was either a ridiculous muddle or an utter failure; as previously observed, it took sixty minutes to send the first signal by the Morse S, forty minutes to dispatch the second, and eighty minutes to transmit the third. Two important questions arise relative to this matter: 1st, Were the signals or messages forwarded? 2nd, Were they ever received? The following quotation on the subject is from the *Daily Express*, December 27th, 1901: "High poles, situated on high points, have had to be used in order to give the waves a more or less straight course to their objective. The difficulty of getting this more or less *straight course* has always been the crux of the Marconi system. While there seems nothing insurmountable in sending messages 50, 100, or 200 miles, the problem increases in difficulty in a geometrical ratio with longer distances. Over a distance of 2000 miles—roughly

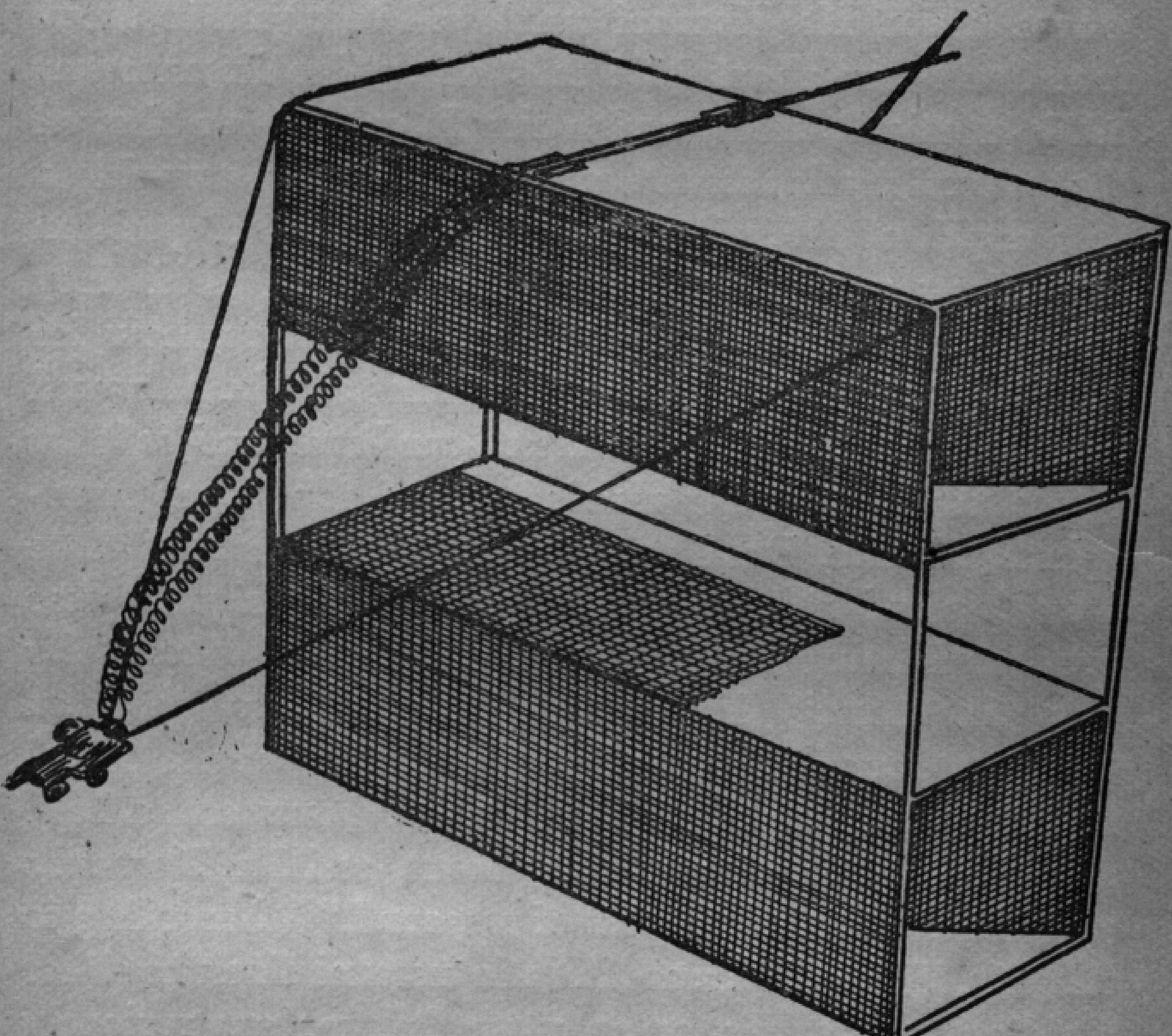


FIG. 32.—A DIAGRAM OF THE KITE USED BY MR. MARCONI IN HIS ATTEMPT TO BRIDGE THE ATLANTIC.

the distance between the Lizard and St. John's — an elevation of between 400 and 500 miles above sea level would be required to give a straight course for the 'electric waves.' It is therefore well to wait for further successes in the experiments conducted by Mr. Marconi, before accepting Trans-Atlantic wireless telegraphy as an accomplished fact."

In the *Daily Telegraph* of December 18th, 1901, the following statements appear :—

"Notwithstanding the detailed signed statement by Signor Marconi appearing in the *Daily Telegraph* yesterday, there was an indisposition . . . to accept as conclusive his evidence that the problem of wireless telegraphy across the Atlantic had been solved by the young inventor. Scepticism prevailed in the city. 'One swallow does not make a summer,' said one, 'and a series of "S"

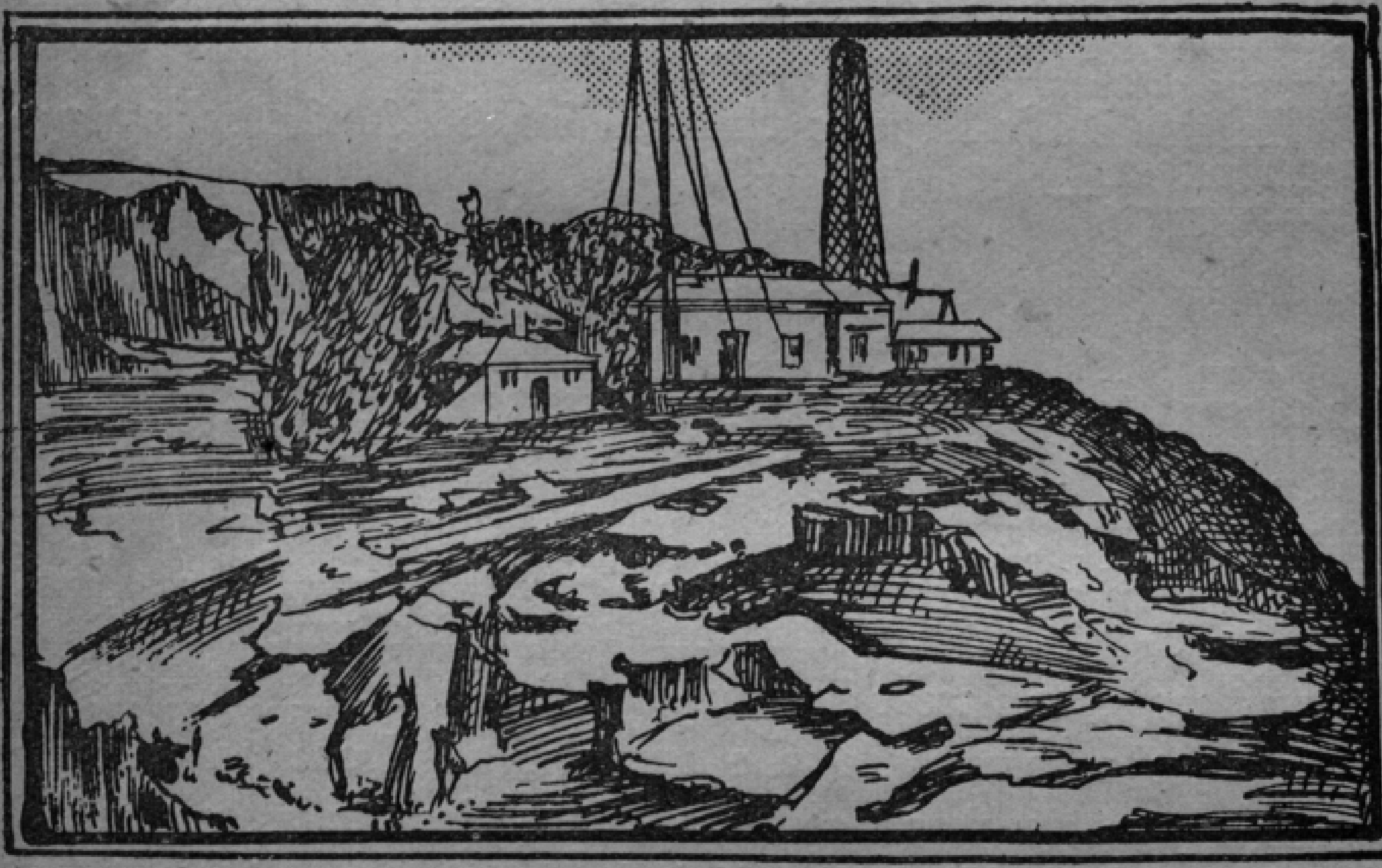


FIG. 33.—THE MARCONI RECEIVING STATION, ON THE BLUFF, OFF ST. JOHN'S, NEWFOUNDLAND.

signals do not make the Morse code.' The view generally held was that electric strays, 'not electric rays,' were responsible for actuating the delicate instrument recording the 'Ss' supposed to have been transmitted from near the Lizard to Newfoundland on Thursday and Friday. Some attributed these wandering currents to the old trouble—earth currents. Others to the presence of a Cunarder fitted with the Marconi apparatus, which was, or should have been, within 200 miles of the receiving station at St. John's on the day of the experiment." Another critic remarked, "It may be very pretty science, but it is not business." In the same article, Sir William Preece is reported as having stated that "We shall want more information than we have at present, . . . because the letters S and R are just the letters most frequently signalled as a result of disturbances in the earth or atmosphere."

The wonderful utility of the high poles and tower business in aerial telegraphy is strikingly exemplified in the appended quotations.

In the *Daily Express* of April 1st, 1902, the following appeared :—

"NEW YORK, *Monday, March* 31*st*.

"The captain of the *Umbria* has made an interesting report on the working of the Marconi wireless telegraphy during his last voyage. While messages were being transmitted between his ship and the *Campania*, the poles to which the Marconi apparatus was attached gave way, and were carried overboard, trailing for some distance astern. To the surprise of those on board, the apparatus was unaffected, receiving its messages as before the accident. This is held to demonstrate that the electrical waves will travel on the water as well as in the air." Query.—Why use the poles ?

In support of this assertion, the *Westminster Gazette* of July 18th; 1903, published the following :—

"A very considerable step will be taken towards the practical employment of wireless telegraphy, if to-day's news from New York be correct.

"This, sent by the *Daily Mail's* correspondent, is to the effect that Mr. Marconi has discovered a new principle in wireless telegraphy, and has perfected an instrument which will obviate the necessity for high towers in the transmission of messages across the ocean. 'By his new system,' says the correspondent, 'messages will be sent on the surface of the sea, and transmitted from an instrument on a table of ordinary height. As a result of the discovery, it is stated that the old apparatus and high towers will be superseded by new and simpler devices. It is on this account that the wireless stations have not yet been opened for business. The required changes are being made as rapidly as possible, and a regular service will be commenced as soon as they are completed.'" This affirmation gives rise to the question—What about the kite at St. John's, Newfoundland?

The conflicting opinions held, and the absurd statements expressed by scientists on the subject of wireless telegraphy, are most amusing; here are some of them:—

Professor Flemming, in January 1902, at the Royal Institution, declared "water, and the rarefied air of the upper atmosphere, to be non-conductors and reflectors of the waves." In 1795, Professor Salva, an eminent Spanish physicist, and inventor of the first electro-chemical telegraph, asserted that "The sea is an excellent conductor." On December 16th, 1901, the *Standard* stated that, "As Sir William Preece once said, we might indeed send by telephone to Mars, if only both planets could make the right apparatus." Sir William evidently imagines the upper atmosphere to be a good conductor. In the same article Professor Ayrton's remarks relative to wireless telegraphy are given, namely: "Professor Ayrton was not altogether rhapsodizing when, at a meeting of the Society of Arts some six months ago, he ventured to prophesy that, within a measurable distance of time, friends might communicate with friends far off in an unknown place; the one would call in a loud electro-magnetic voice, audible only to him who had the electro-magnetic ear, and a reply would come back, even from the depths of a mine, or the heights of the Andes, if only the friends are in the land of the living. Electric waves, instead of being restricted to a limited path along a wire, radiate through space, and thus may impress the instruments for which they were not intended. Electric waves, like those of light, pass unimpeded through the air." This surely disagrees with Professor Flemming's views. In the *Daily Express* of June 18th, 1903, it was stated that at a section of the Engineering Conference, held in the Guildhall, Westminster, Sir William Preece, in discussing a paper on Wireless Telegraphy, read by Mr. E. A. N. Cochin, remarked "that he had been working at the subject for fifty years. Seven years ago Mr. Marconi came to him at the post-office with his new ideas, and the government department placed everything at Mr. Marconi's disposal for working his patent and experiments. Since that period very little had been done, although they were getting to know *a little more about the theory of the thing*, about the operations of ether, about air disturbances, and the effect of the earth on conductivity. One thing they knew was that a great difference existed between the distance they could signal over sea, fresh water, and land.

"The sea was thirty times better than fresh water, and better still than land, which showed the influence of the earth."

It seems almost incredible that men holding high and responsible positions in the scientific world can propound such will-o'-the-wisp theories, and try to inculcate such astounding and erroneous ideas before they have gained sufficient knowledge of the subject to be in a position to impart to others duly authenticated and reliable information, and thereby obviate the possibility, and even probability, in after years, of their hare-brained schemes being ridiculed and treated with contempt.

CHAPTER XIII

JOURNALISTIC REPORTS *RE* THE REPEATED FAILURES BY EXPERIMENTERS IN THEIR EFFORTS TO TUNE THE ELECTRIC CURRENT: PRESS OPINIONS ON ITS ESSENTIALITY: CAUSES OF THE CONSTANT FAILURES: A RELIABLE REMEDY.

FOR years past the cry of all wireless telegraphists has been, "The electric current must be tuned, otherwise it is utterly useless for commercial purposes." Consequently it has been the constant endeavour of every experimenter and inventor, in that branch of science, to overcome the surrounding difficulties, and, if possible, attain that object. But, strange to say, up to the present they have all signally failed in the attempt, for the simple reason that, not having fully grasped the subject, they were trying to surmount what has proved to be, under the conditions proposed by themselves, an insuperable difficulty. The methods they adopted to accomplish the purpose were absurd, and embraced the use of bridged wires, helices, spirals, metallic wings, pipes, cylinders, measured rods fitted with tuning slides, relays, coherers, syphon recorders, and, in short, heaven only knows what they have not invented in their anxiety to produce something approaching satisfactory results: and day after day, week after week, month after month, and year after year, the public journals have contained articles on the subject written on the authority of various inventors, who have positively declared that at last the serious obstacle had been removed, and that a successful method of "Tuning the Electric Current" had fortunately been inaugurated. Nevertheless, the same predicament confronts them still, and the veracity of this statement is most unquestionably and conclusively proved by the following extracts from the daily papers. In the *Daily Telegraph* of July 24th, 1901, "The Naval Correspondent" remarks: "We are looking forward with much interest to the experiments of wireless telegraphy. The *Magnificent, Majestic, and Jupiter* have an installation of this method of communication, of which great things are expected, when it is possible to so *tune up our instruments* that we may be certain that our messages do not wander into the wrong hands. At present this is the weakness of the system, and, as worked in the Navy, is far from perfect." On Friday, August 16th, 1901, the *Daily Mail*, under the heading of an "Admiral's Clever Ruse," informed the London public that "it is common knowledge that if one ship is trying to communicate with another by means of wireless telegraphy, all ships or stations in the same field fitted with Marconi's instruments receive the message. The big defect of the system, in fact, is that messages cannot be *screened off*, so that they will reach only the ship for which they are intended." In Wednesday's issue of the *Daily Mail*, dated August 28th, 1901, an expert states: "In the first case, while I was communicating with my fellow-operator across the mouth of the Thames, my receiver began clicking in a manner that betokened a different hand. So I telegraphed back, 'Who are you? Don't know your sending.' The answer came immediately, 'We are H.M.S. ——, and I am Lieutenant Blank.'

"On the other occasion my receiver suddenly clicked out the words, 'I have just got back from tea. Please send me some Vs.' Now it so happens that my own correspondent never takes tea, so that I had clearly got hold of a message intended for somebody else."

The same correspondent declares: "But the greatest nuisances of all are thunderstorms. On one occasion, however, I revenged myself by harnessing the storm and making it useful. In August of last year, when ordinary telegraphic communication was entirely interrupted, I disconnected the transmitting coil from the spark gap, and found that I could still obtain a stream of sparks, three-quarters of an inch long, between a brass ball attached to the end of the vertical wire, and a similar ball connected to my earth plate. By the use of a switch key I was able so to time the sparks as to correspond with the dots and dashes of the Morse code; and with oscillations thus set up, I telegraphed to a receiving instrument placed in an outbuilding some hundred yards away. This is the first time, I think, that the electrical energy of a thundercloud has ever been utilized in telegraphy."

In the *Globe* of Tuesday, November 12th, 1901, appeared the following:—

"It is stated by the '*Army and Navy Journal*' of New York, that the American Naval authorities are dissatisfied with the existing systems of wireless telegraphy, and are continuing their search for a system which seems to adapt itself more completely to naval purposes." In December 1902 the following statement was published in the financial column of the *Daily Express*: "But the question of tuning will yet have to be solved before the system is a commercial success." The *Morning Leader* of June 12th, 1903, is responsible for the appended account of the humiliating display that took place during Professor Flemming's lecture on wireless telegraphy, at the Royal Institution, on a previous date, wherein the report says: "A rapt audience was gathered round Faraday's famous lecture-table to receive wireless messages from Mr. Marconi at far-away Poldhu, and, says the Professor, 'a deliberate attempt was made by some person outside to wreck the exhibition of this remarkable feat.' It seems that while the process of tuning one of the receivers was going on, preparatory to receiving the Poldhu messages, one of the operators suddenly discovered that another station was working—and working very near at hand, too! This was somewhat mystifying. The message from the mysterious station was taken. First of all, the receiver spelt out the fearful word 'rats.' On such a solemn occasion, with distinguished professors and earnest students gathered round the lecture-table, this kind of wireless delirium tremens would naturally come as a severe and discomposing shock. Another message followed, making allusion to a young 'Italian inventor,' which could easily be recognized as meaning Mr. Marconi himself."

To give the reader an opportunity to form an unbiassed opinion relative to the worthlessness of the present method of tuning a wireless current of electricity, the writer earnestly advises him to carefully peruse the following, and compare the statements with those that appear in the extracts that have been previously cited. In the *Daily Telegraph's* report of the Ordinary General Meeting of the Marconi Wireless Telegraph Company, Limited, which took place on February 20th, 1902, Mr. Marconi is reported as saying: "He was pleased to be able to say, that by his latest invention the problem of secrecy had been solved." And furthermore, that "a message could now be sent to Ireland without being interfered with." Nearly a year and four months after, in an article published in the *Morning Leader* on June 13th, 1903, Mr. Nevil Maskelyne, of the Egyptian Hall, London, in answer to questions put to him by a representative of that paper, "with reference to Professor Flemming's statement, that a determined attempt was made to wreck the demonstration" of Marconi's system of wireless telegraphy, he remarked: "That I absolutely and emphatically deny. Professor Flemming's practical demonstration had been carried out, and his message from Poldhu, *via* Chelmsford, had been rapturously received long before anything was done that would prevent the success of his demonstration. It was necessary to settle, once and for all, the question as to whether the Marconi messages were so protected from interference, as we had been led to believe. That, and no more, was desired. If our action has been described as 'scientific hooliganism,' by what term are we to describe the action of those who render it necessary in order to allow us to arrive at the truth? I may add that the much-talked-of message started from Poldhu at 11 a.m., at the rate of two and a half words per minute, with an expenditure of fifty or sixty horse-power, and it was repeated over and over again for five or six hours. Had the same horse-power been applied to a motor car, the message would have arrived as quickly by road. And this, this is what they call telegraphy! I don't say that the professor intentionally said anything to deceive the audience at the Royal Institution—all I say is, that it appears to me that he does not know the facts as I know them. Seeing that he is the Marconi Company's technical expert, this seems rather a pity."

At Ottawa, on Thursday, May 14th, 1903, "Mr. Zarte," says the *Daily Express* of the following day, "in asking the Government for information concerning the Canadian Marconi station, said the system seemed to work well until the stock was issued. Then it went to bed." Four days previous to the publication of the latter statement, Mr. W. S. Fielding, Minister of Finance of the Dominion of Canada, stated in the Dominion House of Commons, "that the Marconi Wireless Telegraphy system had not been the success hoped for, and the Government did not propose to make further contributions towards it." The following amusing description of Dr. Tesla's experiments on the other side of the Atlantic is worthy of notice. It appeared in the *Globe* of August 14th, 1903, and reads thus :—

"Mr. Nichola Tesla, that brilliant star of the electrical firmament, after a long occultation from the transit of Marconi, is beginning to reappear in something like his ancient splendour. Vivid flashes of light are now seen to emanate from the magical disc which, like a colossal griddle, caps his tall tower at Wardenclyffe, Long Island. It is also reported that he has succeeded in *tuning his messages* so as to prevent interference from other messages. If he succeed, he will earn enduring fame."

What an exposition of ignorance on the part of those who have for years devoted a vast amount of time to the study of the all-important branch of electrical science, viz., tuning the electrical current.

But tuning, as the term implies, in musical science is evidently beyond their comprehension. A proper definition of the term tune, in accordance with musical parlance, is correctness of pitch, and a definite arrangement by which the number and exact positions of the tones, semitones, and quartertones, of which the diatonic, chromatic, and enharmonic scales respectively are comprised, are determined, and whereby such specified sounds are maintained at definite distances from each other by a definite number of vibrations produced by a sonorous body in a definite time. It is obvious, therefore, to any person possessed of common-sense, that "tuning" must be conducted on musical principles by properly organized methods, and the operation performed by persons possessing a sound knowledge of the defined and unalterable laws of vibration, otherwise absolute failure is bound to ensue. Therefore, in order to ensure success and secure a reliable method of operation, it is imperative that the out-of-date notions and old-fangled ideas that are entertained by numbers of our leading electricians and scientists with regard to wireless telegraphy should be discarded, and the numerous fallacies which have lately been exposed in relation to this matter should be compelled to give way to truthful and more enlightened opinions; that the absurd and useless appliances that have heretofore been provided for the purpose of tuning the electric current be dispensed with, and apparatus that has already produced an abundance of ocular and tangible proof of its suitableness and reliability, and, moreover, exhibited indisputable evidence that it, and it solely, is the only method by which satisfactory results in this branch of electrical science can henceforth be obtained, utilized instead. An explicit description of the apparatus required, mode of working, and results obtained with this system, is given in Chapter XIV.

CHAPTER XIV

A DEFINITION OF THE WORD SOUND AS UNDERSTOOD IN A MUSICAL SENSE: ITS PRINCIPAL ATTRIBUTES: MATTER CAPABLE AND INCAPABLE OF PRODUCING SOUND: INDISPENSABLE ESSENTIALITIES: UNTUNABLE APPARATUS: SYNTONIZED SYNCHRONISM, OR THE JOHNSON-GUYOTT MULTITONOPHONIC SYSTEM OF ELECTRICAL TUNING.

SOUND is the natural and unavoidable result of vibration of particles of matter, and the production of a sonorous body.

Its principal attributes being: Firstly, volume or intensity—which can be augmented or diminished in proportion to the degree of sonorosity which the vibrating body possesses, and the amount of active force employed in its production.

Secondly, timbre or distinctive quality, which changes its character in accordance with the nature of the material, or constituent parts, of which the sonorous body is composed.

Sounds are divided into two classes, viz., definite and indefinite.

The former are those that are situated at a specified pitch, and produced by a definite number of vibrations having uniform periods or wave lengths, and created in a definite length of time. The latter are those wherein their positions are undefined, and created by an indefinite number of vibrations having irregular periods or wave lengths, and produced in an unspecified time.

A definite or tunable musical sound can only be produced by the action of solidified matter; consequently, common air and the various gases, although possessing resilience and compressibility, are devoid of vibratory power, and therefore incapable of producing sound; while liquids are immeasurably worse, as, in their ordinary state, they are almost incompressible, at the same time being destitute of resilient and vibratory power. Air, gases, and liquids provide facilities for the conveyance of sound, but do not in the slightest degree aid in its production; and, as this is common knowledge, it is unnecessary to trouble the reader with further explanations relative thereto.

As the despatch and receipt of messages by electrical influence can only be effected by sounds created in unison with, or octaves to, each other, it is obvious that the following are indispensable essentialities :—

The employment of specially constructed apparatus,

Effective battery power,

Facilities for the conduction of electrical energy,

The production of definite sounds,

The duplication of definite sounds, syntonously and synchronously produced,

A delicate musical ear,

A complete knowledge of the methods adopted in the transmission and reception of messages by the syntonized synchronic principle.

Each of the foregoing will be subsequently dealt with in detail.

However, before entering into a minute description of the system that I am desirous of placing before the reader, it will not be out of place to recapitulate the utilized by various experimenters in *electrical tuning*, and explain, not only the uses for which they were originally intended, but the causes assigned as the reasons of their absolute and unmistakable failures.

The following apparatus are those above referred to :—

The bridged wire, as illustrated in fig. 34, is a strained wire, *A*, supported on one or more bridges, such as *B*,*C*.

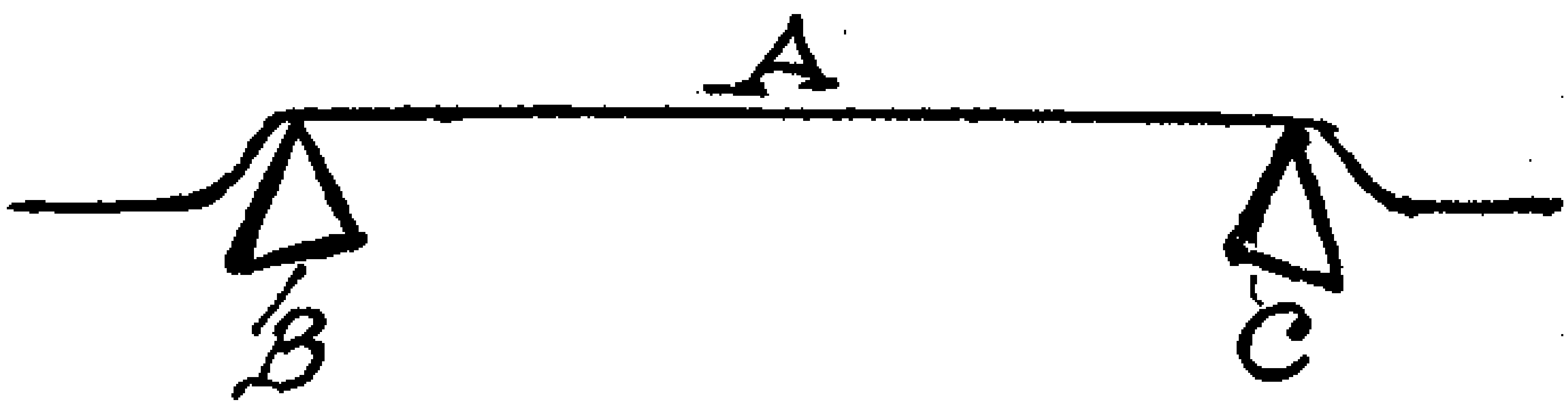


FIG. 34.—THE BRIDGED WIRE.

The spiral, as shown in fig. 35, is constructed of wire of a specified length, wound in a spiral form.

The helix (fig. 36) is also composed of wound wire, of definite dimensions. *a* is a battery; *b*, a Morse key; *c*, the secondary winding of an induction coil, the primary of which is situated immediately beneath it. *B* is a spark

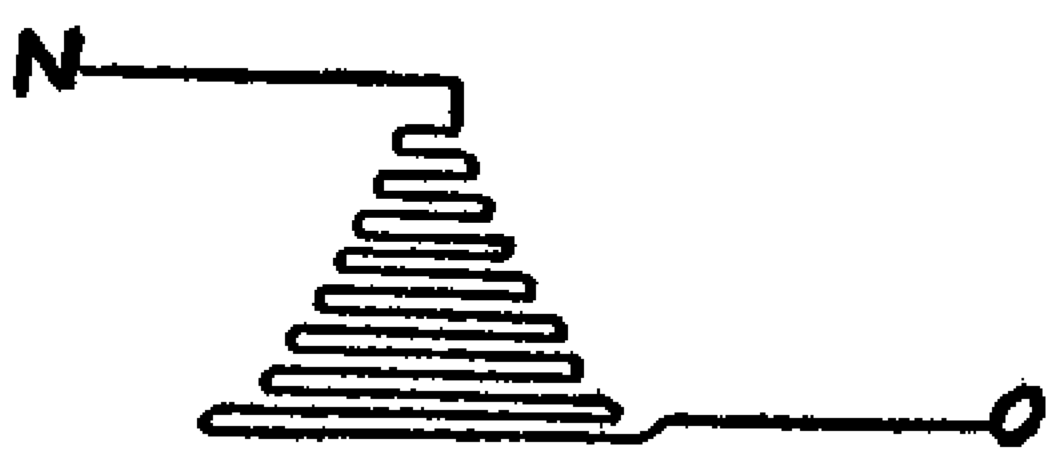


FIG. 35.—THE SPIRAL.

gap between the oscillators, as shown; *e*, a condenser in the circuit of the oscillation transformer, of which *d* is the primary, and d' the secondary, the latter being connected by a sliding contact, d^2, to the adjustable wire radiator or helix, *A*.

The metallic wings, as demonstrated in fig. 37, at *A* and *B*, are connected to the coherer, *j*, by the terminals, *c* and *d*. All the above devices have been used for the purpose of trying to reproduce the impulses, or electrical

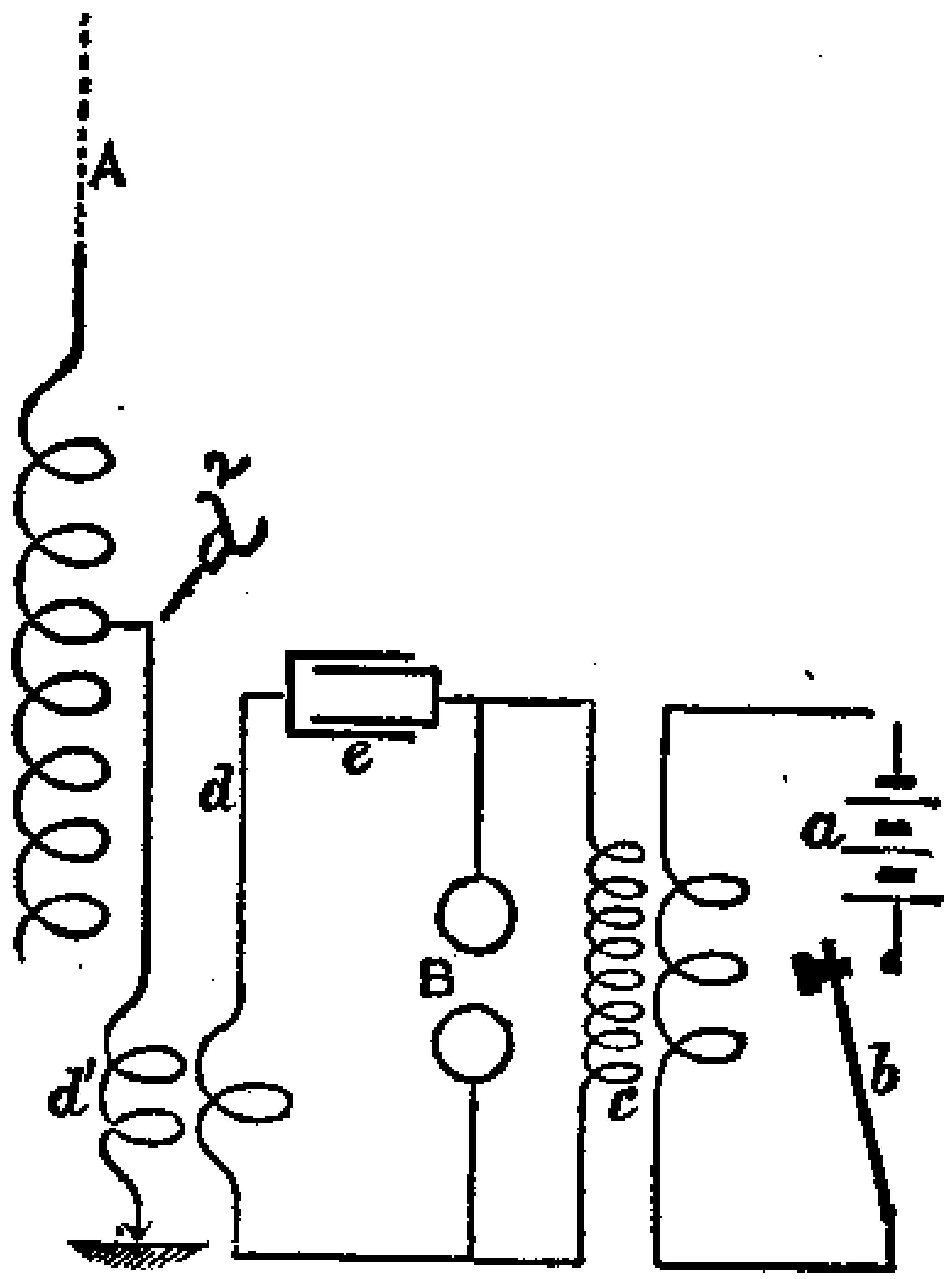


FIG. 36.—THE HELIX.

vibrations, created by the action of the transmitter at the transmitting station; but, unfortunately, have

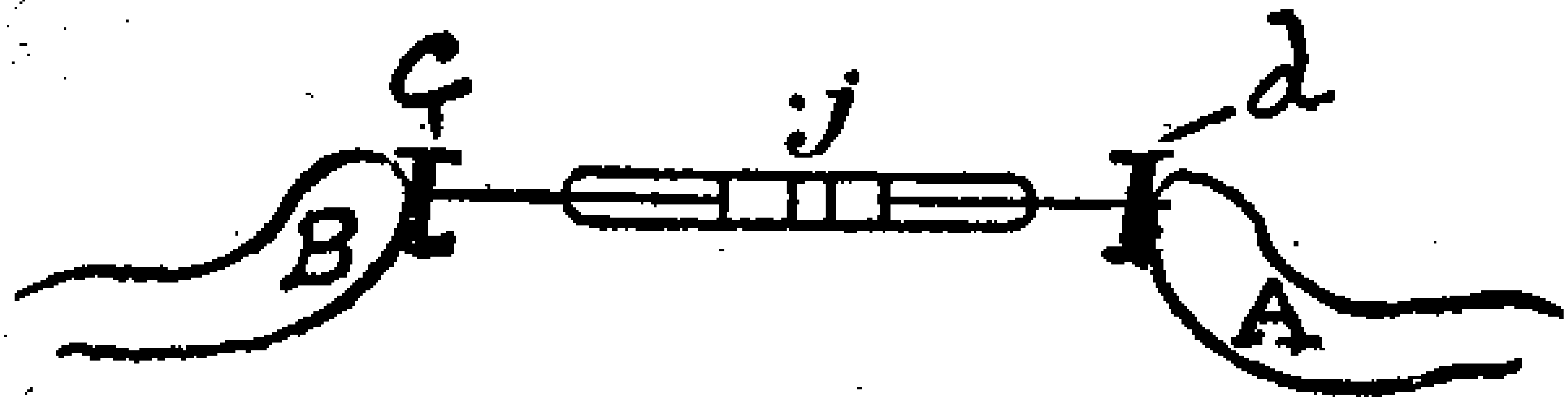


FIG. 37.—METALLIC WINGS.

proved their uselessness, as they are seriously affected by climatic changes, and therefore cannot be kept in tune.

The pipe, or tube, as exhibited in fig. 38, and the cylinder, as illustrated in fig. 39, are likewise valueless for electrical tuning, owing to their importability.

The relay (fig. 40), in which E,E are the coils of an electro-magnet; *A*, a soft iron armature attached at right

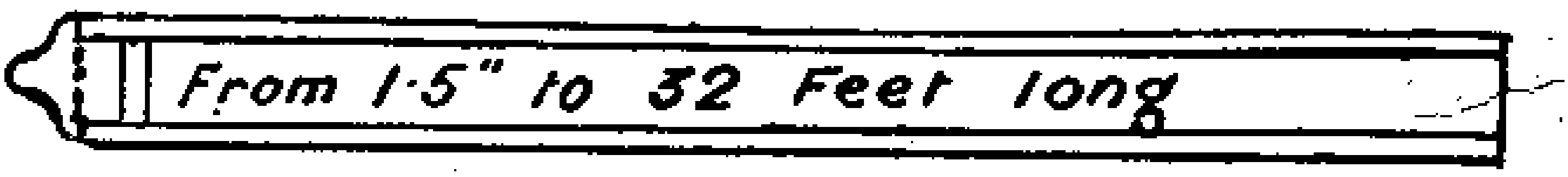


FIG. 38.—THE PIPE, OR TUBE.

angles to a vertical lever, *p*, which moves about a horizontal axis, *p′*; *m* is a vertical pillar, and C, Z, L, and T, terminals; *o*, a vertical rod. On closing the line-circuit, the current from that battery enters the coils of the electro-magnet through the terminal, L, and passes

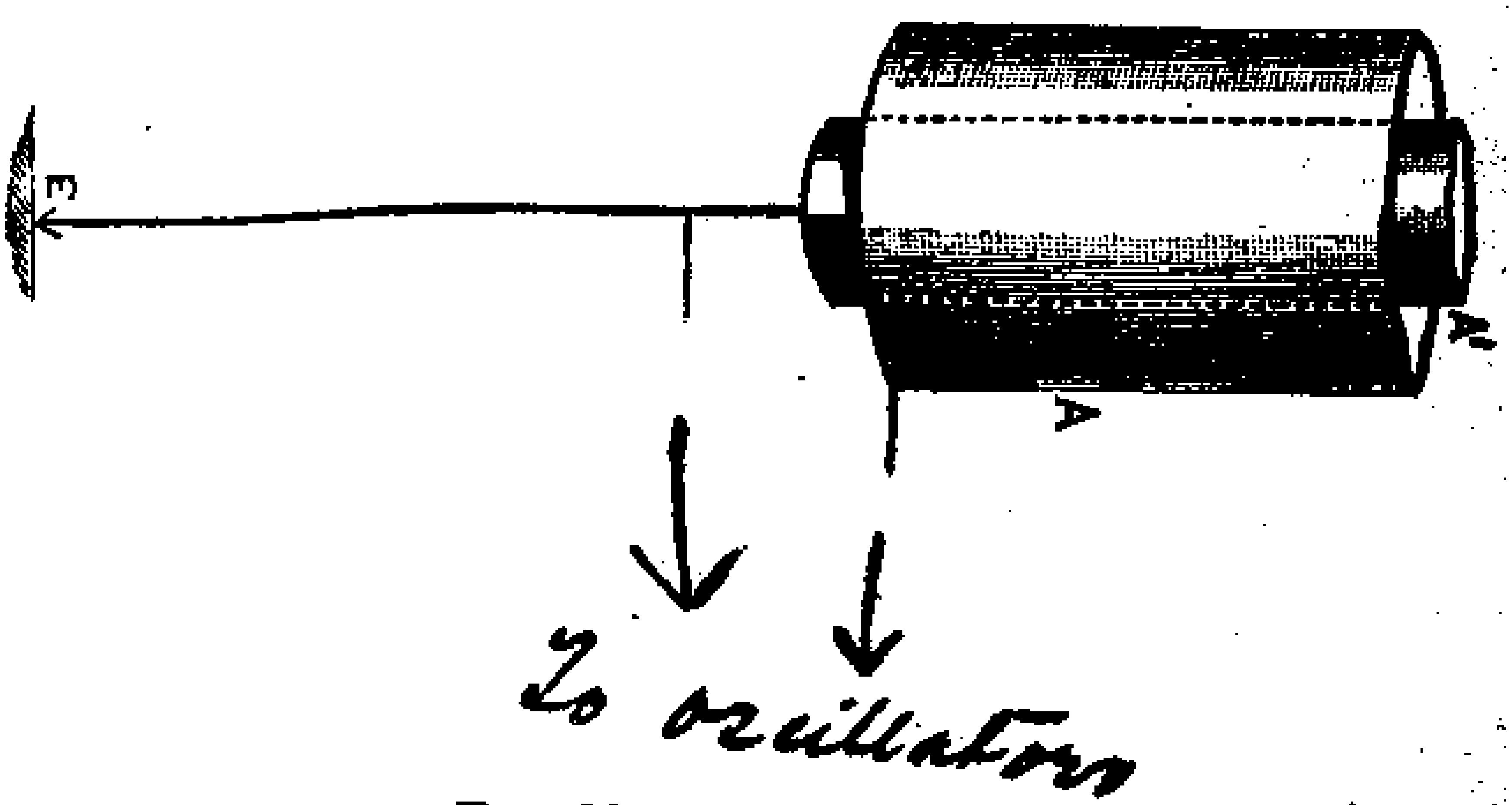


FIG. 39.—THE CYLINDER.
(From *The Electrical Review.*)

to earth at the terminal, T; causing the electro-magnet, E, to attract the armature, *A*, thereby closing the circuit of the local battery, when the current from the latter, entering at the terminal, *C*, ascends the pillar, *m*, descends the lever, *p*, and the rod, *o*, and passing through the terminal, Z, and the line wire attached thereto, enters the receiver, *r*, and returns to the local battery, *b*; the local current consequently performing the work that would have been done by the line-current, provided it had been of the necessary strength. In this case the stationary position of the armature, *A*, is the stumbling-block to

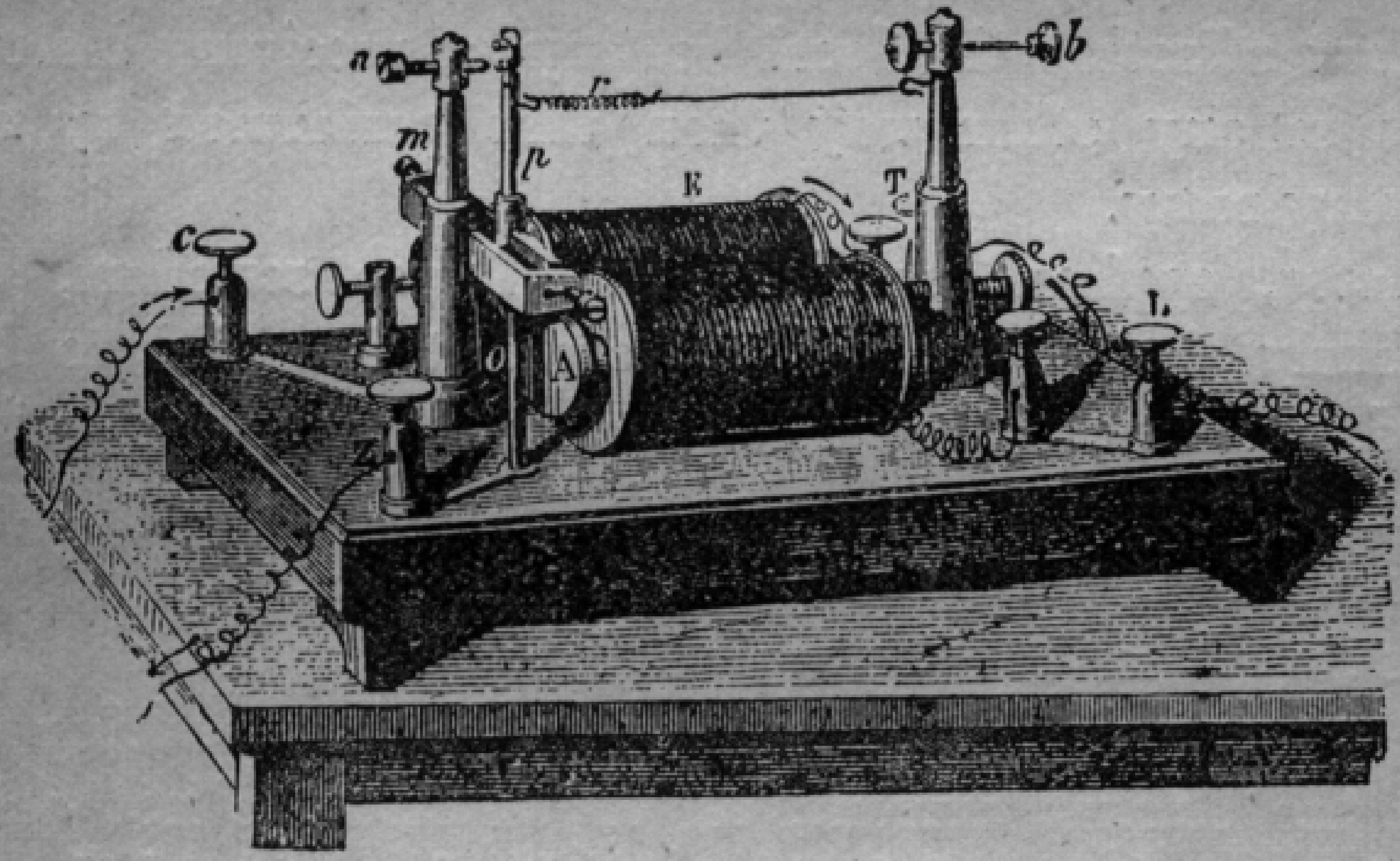


FIG. 40.—THE RELAY.

the operation of tuning, as the absence of vibration in itself precludes the passage of the impulses, created by the action of the transmitter, through the circuit of the local battery.

The coherer (fig. 41), which was introduced for the

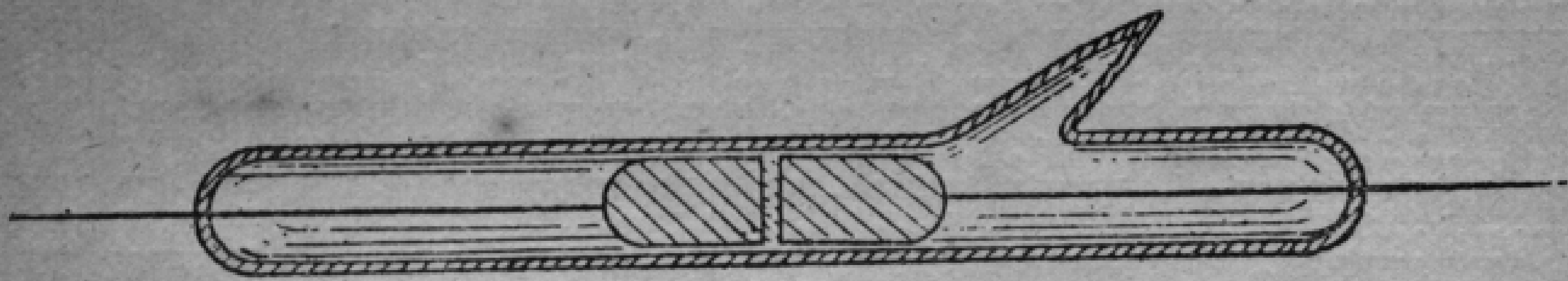


FIG. 41.—THE COHERER.

express purpose of completing the circuit, cannot, under any circumstances whatever, be tuned, as no syntonized message can ever be made to actuate a local battery that has its circuit closed by such a contrivance; and this the writer asserts positively, and defies the whole body of wireless telegraphists to prove to the contrary; as directly its magnetization is effected, the vibrations produced by the transmitting apparatus, and without the co-operation of which syntonization is impossible, pass through it directly to earth, as demonstrated in figs. 25 and 29, and fully explained in Chapter XII, without affecting the local battery or receiving instrument in any other way than that performed by an ordinary relay.

Lastly, syphon recorders and Morse sounders, as obviously their names imply, are not intended to be tuned, neither can they be so; they are used simply for recording messages, in order that operators may have ocular and tangible proofs of their existence.

Having described the various kinds of apparatus that have been devised for the purpose of endeavouring to tune the electric current, all of which have not only failed to produce satisfactory results, but proved themselves absolutely useless, I shall forthwith proceed to lay before the reader a comprehensive description of the nature, mode of working, and results obtainable, of my new method of syntonization, which is entitled "The Johnson-Guyott Multitonophonic System of Wireless Secret Telegraphy and Telephony," and is based on the unerring principle of syntonized synchronism.

For a period of over three years I have been employed in conducting public and private demonstrations of its wonderful powers, and in no instance has it failed to supply tangible evidence of its vast superiority, as an electrical tuning apparatus, to anything that up to the present time has been introduced for that purpose. It is an old saying, but one worthy of consideration, that nothing succeeds like success, and when things are proved, beyond the possibility of doubt, to be in accordance with what has been stated respecting them (see press opinions, Chapter XVII), the public have confidence, and are nearly always willing to extend a

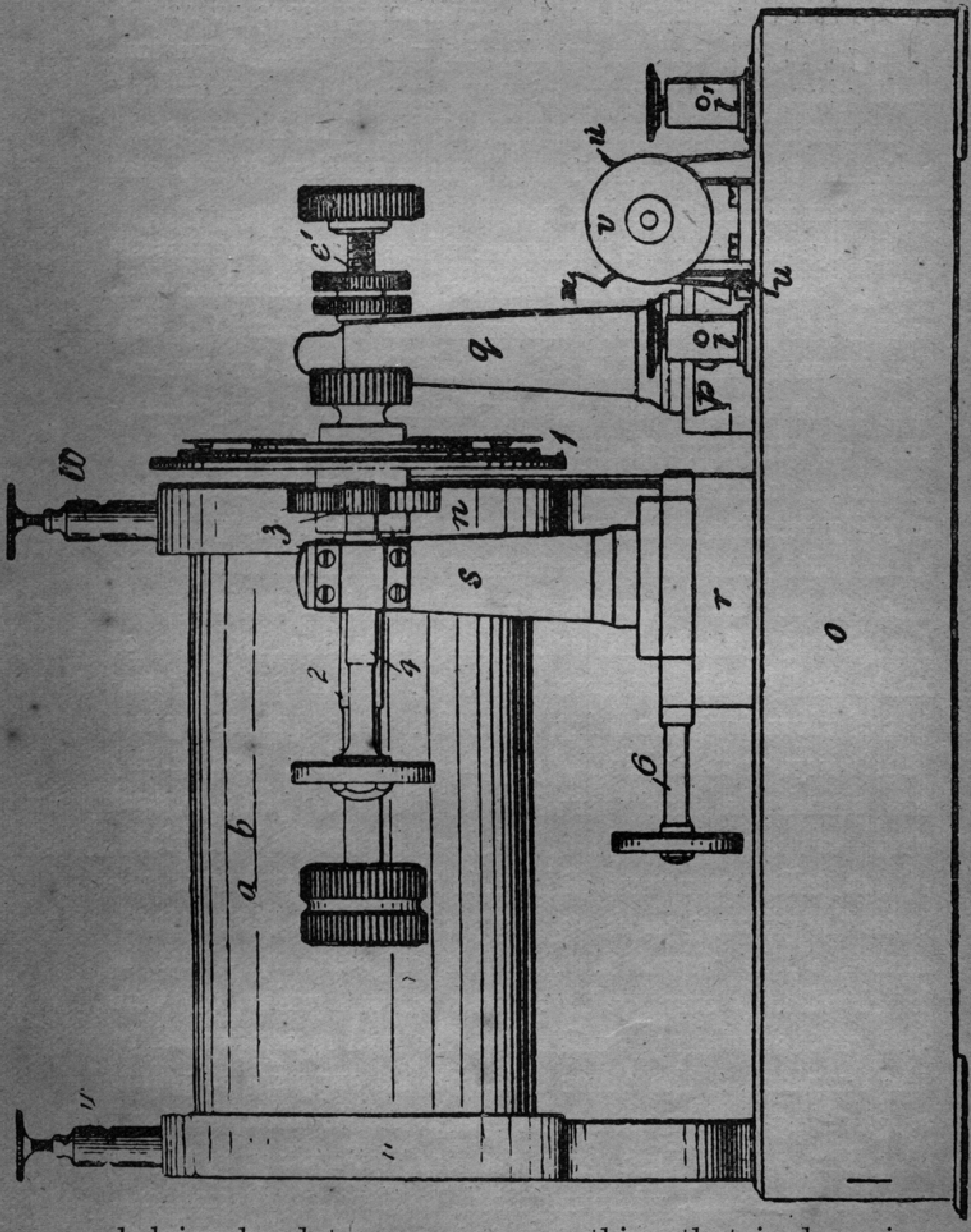


FIG. 42.—A SIDE ELEVATION OF THE JOHNSON-GUYOTT TRANSMITTER WITH TUNABLE MUSICAL TREMBLER, OR MULTITONOPHONE, ATTACHED.

helping hand to anyone or anything that is deserving of their support.

I shall now, without further introduction, describe the apparatus required for the electrical transmission and reception of messages by the multitonophonic principle.

Figs. 42, 43, and 44 are side elevation, front elevation, and plan, respectively, of a transmitting instrument, constructed in accordance with the method hereinbefore referred to. In each of the figures similar letters and numbers indicate similar parts.

In fig. 44, *c* is an iron core, while *a* and *b* represent the primary and secondary windings of an induction coil, which are more clearly shown in the skeleton (fig. 56). In the same figure, *d* is an electric battery, or generator, in circuit with the primary winding, *a* ; *e*, a speaking-reed or armature which is attached to the reed disc, and e^1, a contact-screw, which together supply means for rapidly making and breaking the circuit of the primary at definite rates of speed, as may be desired for the production of certain specified sounds ; *f* is a tuning reed, for giving audible indication that a particular rate of make and break has been attained, and a specific number of vibrations are being created in consequence ; *g* is a Morse key, or other kind of circuit controller ; *n,n* (fig. 42) are standards firmly fixed on to the base-plate, *o*, and serve as supports for the coil, *a*, *b*, *c*. Upon the base-plate, *o*, a metallic transverse slide, *p*, is securely fixed, and sustains the pillar, *q*, in the upper part of which the contact-screw, *e′*, is adjusted. Another support, *r*, which is longitudinally arranged, carries a second pillar, *s*. One end of the primary winding of the coil is connected to the terminal, *t*, the other through the support, *r*, pillar, *s*, speaking-reed or armature, *e*, adjustable contact-screw, *e′*, pillar, *g*, and slide, *q*, to the contact-spring, *u*, which can be connected, when required, to the second terminal, *t′*, by means of the rotary switch, *v*. The condenser, *o′*, which is contained in the box below the base-plate, *o*, is likewise connected to the pillar supports, *r* and *p*, in the usual manner. When using the apparatus, the ter-

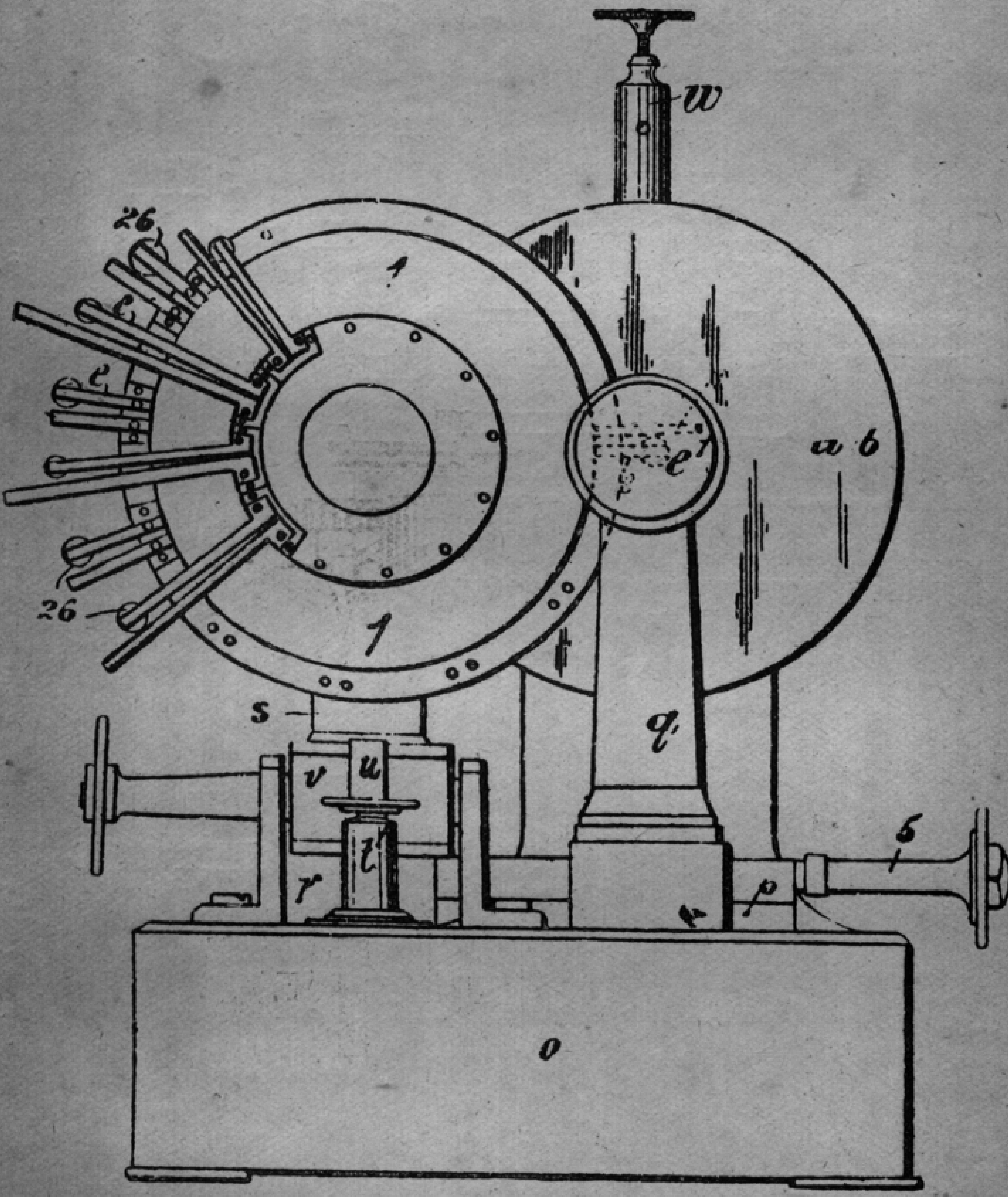


FIG. 43.—A FRONT ELEVATION OF THE "JOHNSON-GUYOTT TRANSMITTER" WITH MUSICAL TREMBLER, OR MULTITONOPHONE, ATTACHED.

minals, *t* and *t'*, are connected to the electric battery or generator, *d* (fig. 56), in the ordinary way. The second-

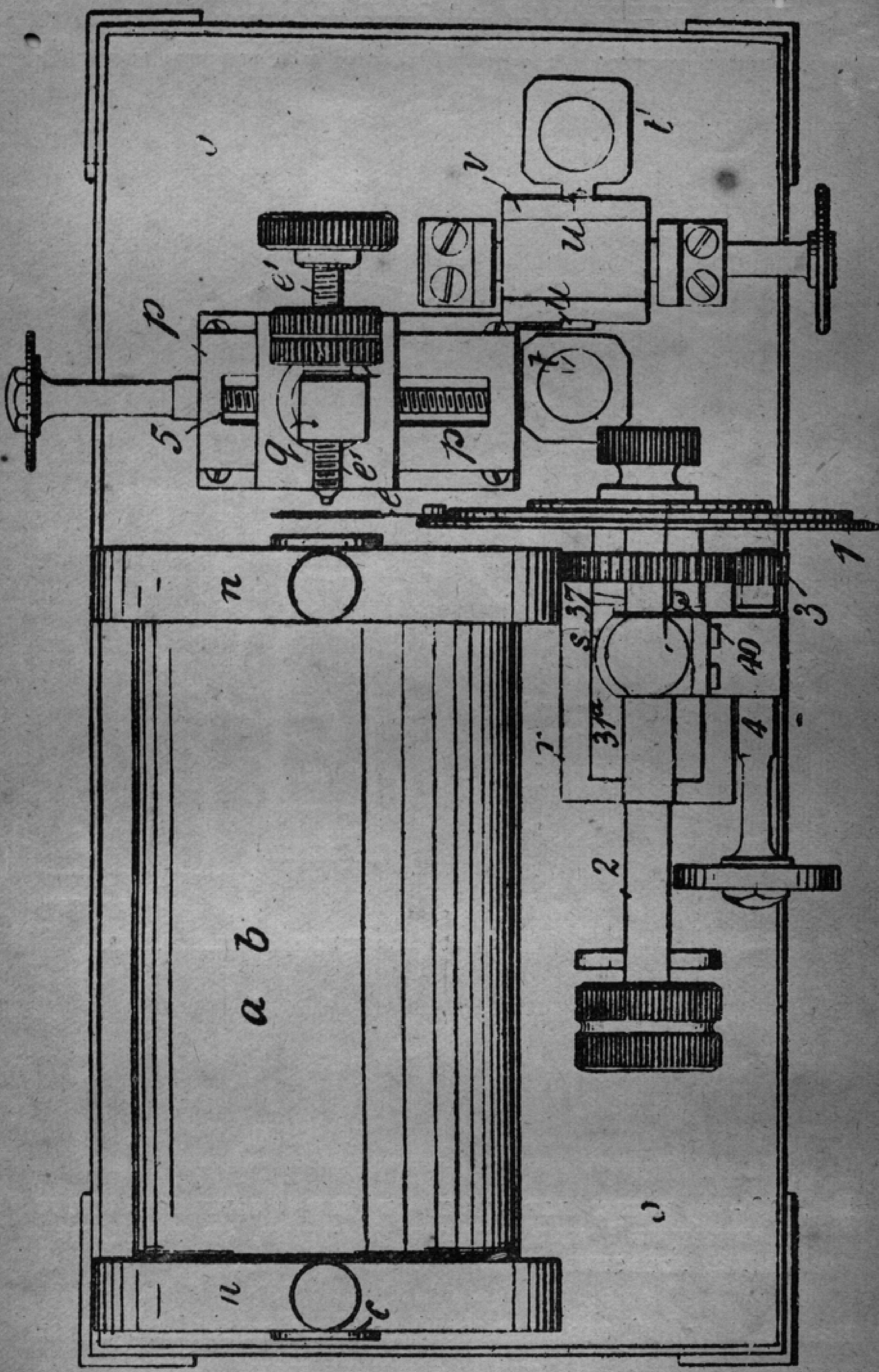
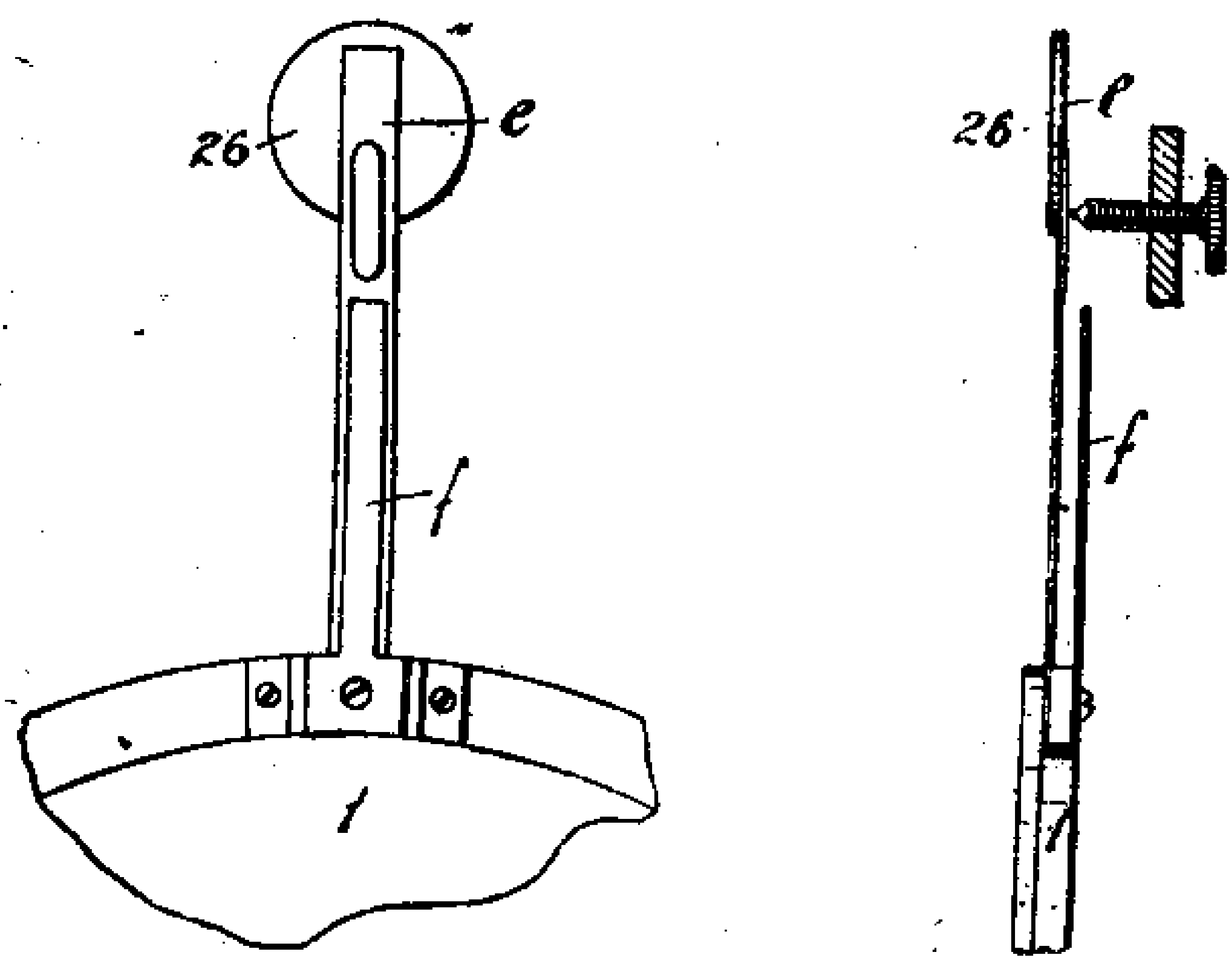


FIG 44.—PLAN OF THE "JOHNSON-GUYOTT TRANSMITTER."

ary terminals, w, w', are connected by conductors, x, x, to earth, or, as further shown in fig. 56, to earth, y, and water, y', which is in contact with earth; or both may be connected to water if so desired, provided in each and every case the connections are not less than 200 times the sparking distance of the coil apart—that is to say, supposing the induction coil be capable of producing a spark 12 inches long, then the connections should be

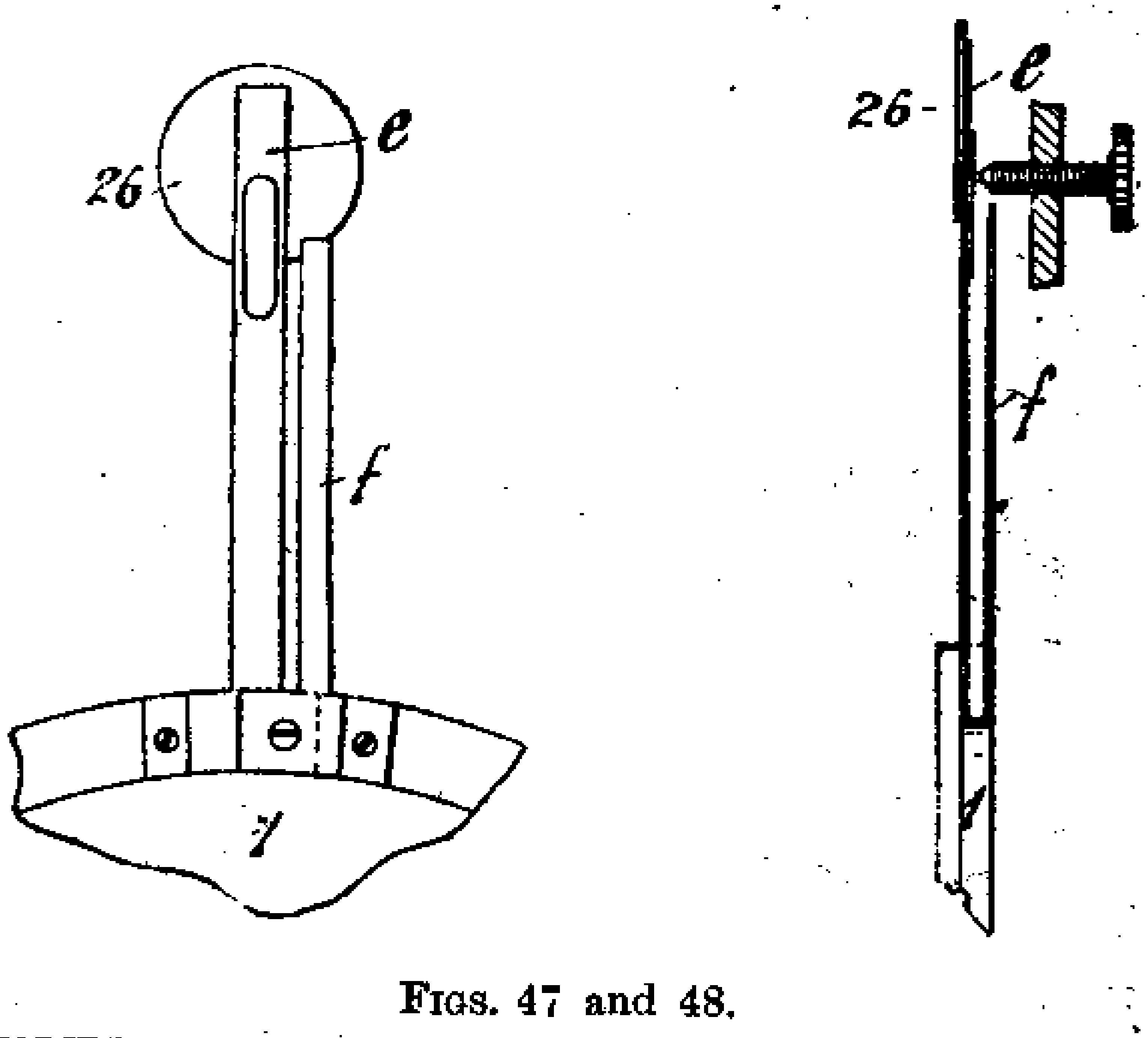


FIGS. 45 and 46.
MODIFIED CONSTRUCTION OF SPEAKING- AND TUNING-REEDS.

200 feet apart. It is preferable to connect one of the secondary terminals to earth, and the other to water in contact with earth, as the results so obtained are more satisfactory. If preferred, one of the secondary terminals may be connected to earth or water, and the other to an insulated capacity, as, for example, an insulated mass of moist earth, or metal, or a metallic plate, as shown at 27 (fig. 57).

Figs. 45 and 46 are elevations at right angles to each other, and show a modification of the multitonophone (figs. 42, 43, 44). Figs. 47, 48 are similar views to figs. 45 and 46, showing a further modification of the multitonophone. Both modifications may be advantageously employed to economize space.

Figs. 49 and 50 represent a multitonophonic receiving instrument—fig. 49 being a vertical section on the line,



FIGS. 47 and 48.
MODIFIED CONSTRUCTION OF SPEAKING- AND TUNING-REEDS.

A,A (fig. 50); fig. 50 a horizontal section on the line, *B,B* (fig. 49).

Fig. 51 is a vertical section on the line, *C,C* (fig. 52); fig. 52 is a horizontal section on the line, *D,D* (fig. 51); and fig. 53 a vertical section on the line, *E,E*, of fig. 52, and shows a modified construction of a receiving instrument, in accordance with the multitonophonic method.

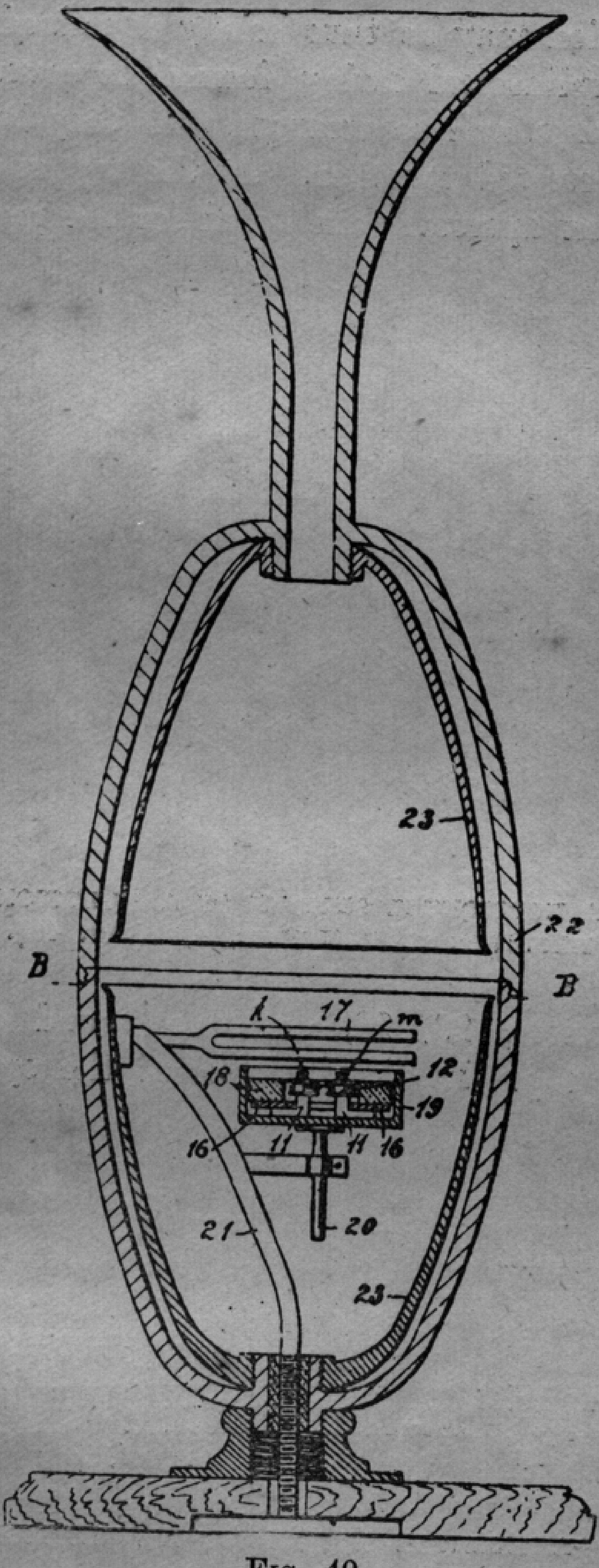


FIG. 49.

A VERTICAL SECTION OF A MULTITONOPHONIC RECEIVER ON THE LINE, A,A (FIG. 50).

Its construction may be thus briefly explained. In fig. 49, 22 is a cylindrical casing, formed in several parts, as shown at *B,B*, and so arranged that they can be unscrewed or screwed together. At the top and bottom of the cylinder apertures are bored for the reception of

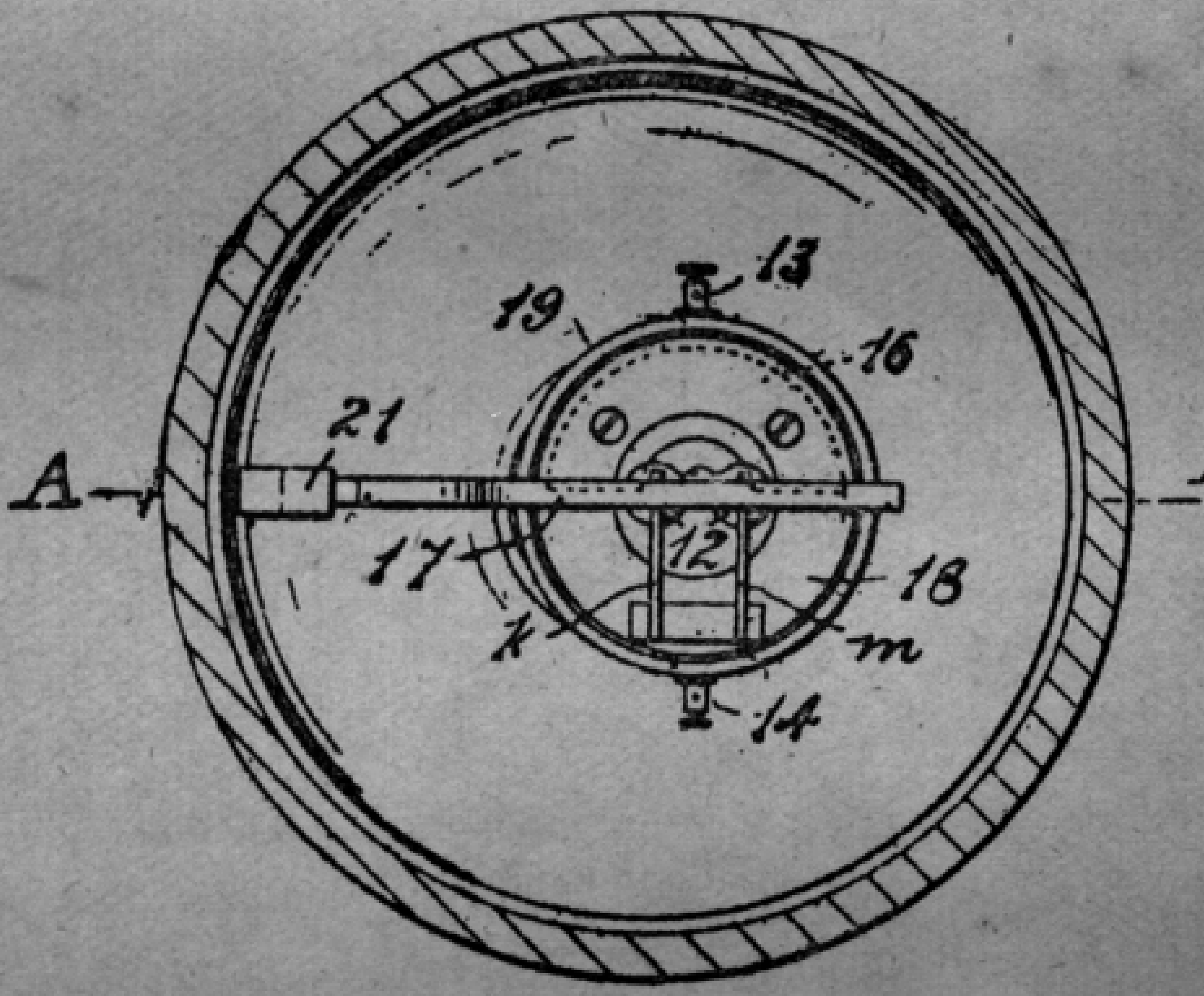


FIG. 50.—A HORIZONTAL SECTION OF A MULTITONOPHONIC RECEIVER ON THE LINE, B,B (FIG. 49).

the augmenters, 23, 23, and the sound distributor situated on top. In the interior of the cylinder the

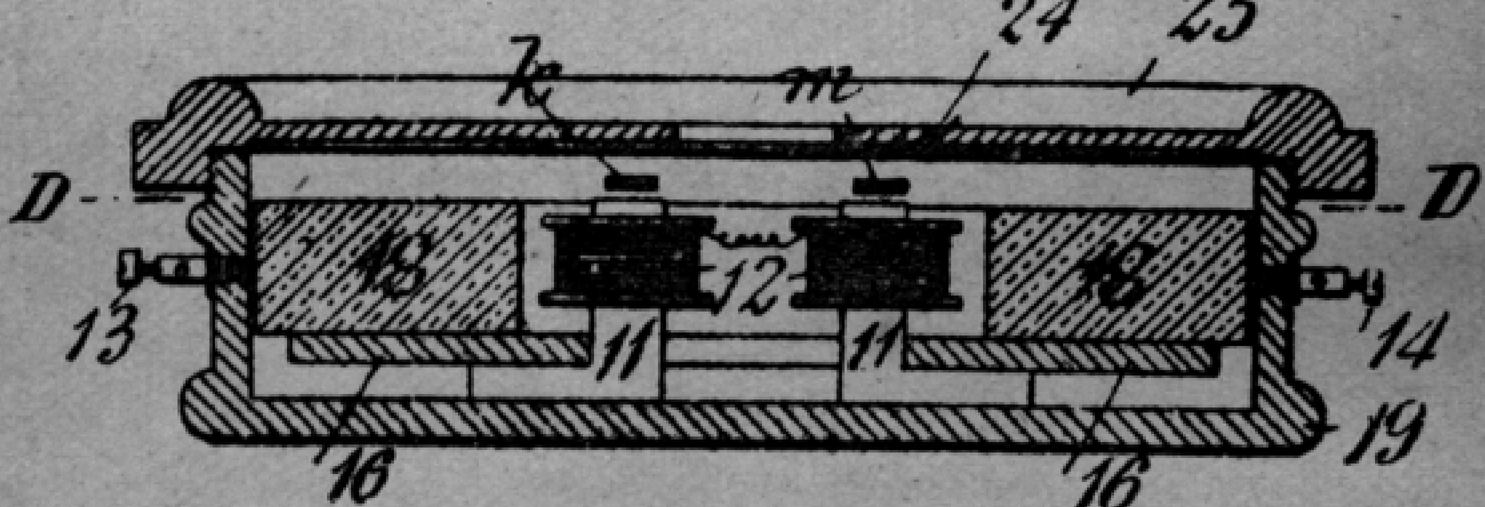


FIG. 51.—A VERTICAL SECTION OF A MULTITONOPHONIC RECEIVER ON THE LINE, C,C (FIG. 52).

electro-magnet, 11, 11, with its adjacent coils, 12, 12, are adjusted; below which is placed a permanent magnet, 16, 16 (figs. 49, 51), in order to render the receiver responsive to the weakest electrical impulses. Immediately above, and in proximity to the poles of the electro-magnet, the reeds, *k*,*m*, are fixed; the former being a common or master reed, and the latter a secret message one. For the purpose of increasing the sound produced by either, or both of them, a tuning-fork or forks, 17, may be adjusted over one or each of the reeds, care being taken that each tuning-fork corresponds exactly in the number of vibrations it produces with the

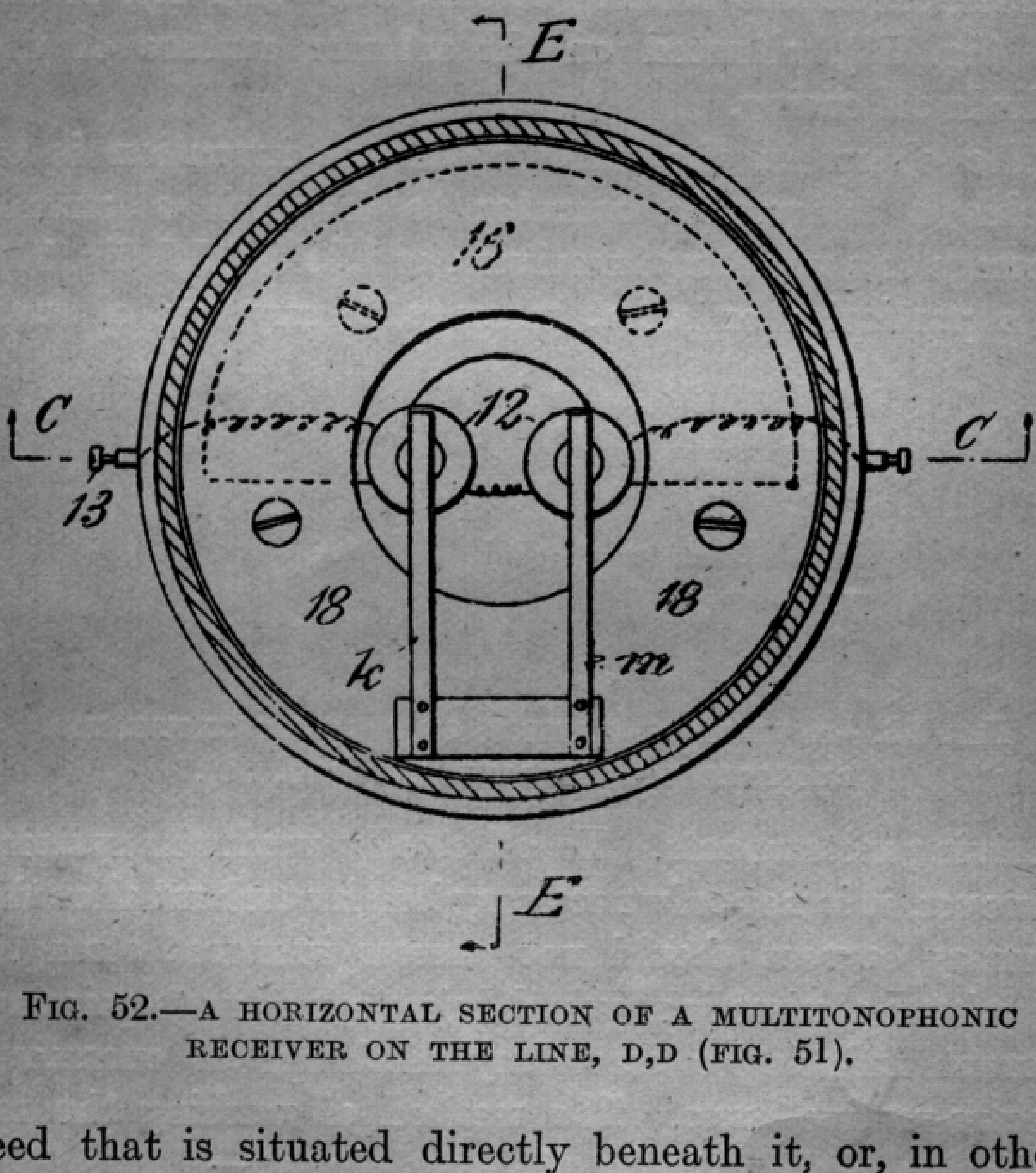


FIG. 52.—A HORIZONTAL SECTION OF A MULTITONOPHONIC RECEIVER ON THE LINE, D,D (FIG. 51).

reed that is situated directly beneath it, or, in other words, is at the same pitch. The iron cores, 11, 11, with the coils, 12, 12, of the electro-magnet, together with the permanent magnet, 16, 16, the two reeds, *k*, *m*, and the block of insulating material, 18, to which one end of each reed is firmly attached, are placed within the circular box, 19, which is adjustably supported by a stem, 20, on the bar, 21, the upper part of which carries the tuning-fork, 17. If desired, the circular box may be covered with a reticulated diaphragm, 24, held in position by the perforated cover, 25, in which case the vibrator, 17, is dispensed with. The ends of the coils of the electro-magnet are connected through insulating substances to the binding screws, d^2,d^2 (fig. I.), or 13, 14 (fig. 51), situated on the exterior surface of the cylindrical casing.

The object of the multitonophonic invention is to enable a telegraphic operator to despatch a general message to a number of receivers, as *h*,*h*,*h*,*h*,*h*,*h*,*h* (fig. 56), or a particular or secret message to any one of such

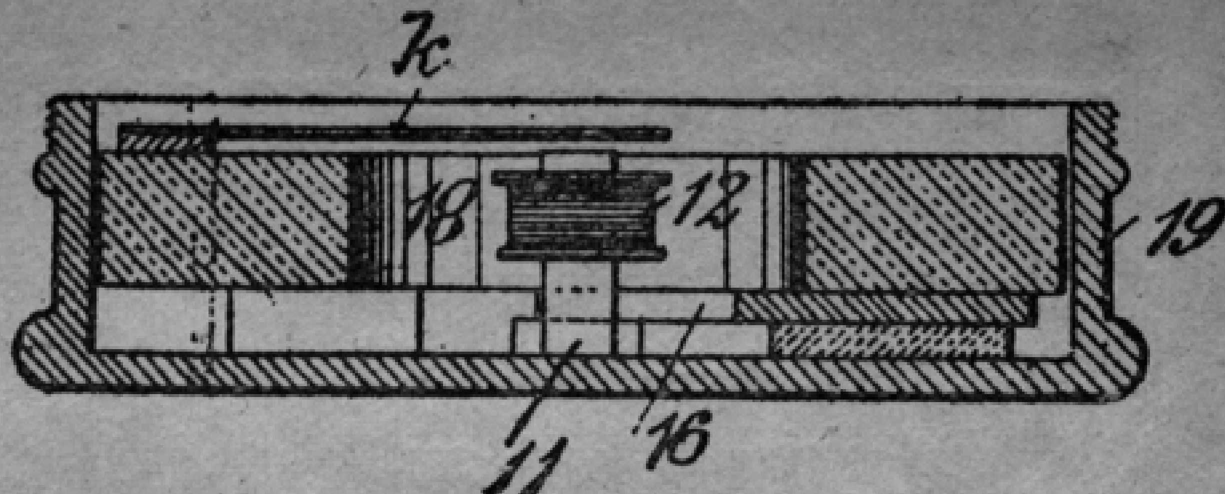


FIG. 53.—A VERTICAL SECTION OF A MULTITONOPHONIC RECEIVER ON THE LINE, E,E (FIG. 52).

receiving instruments. To effectually work the system, however, it is not only necessary but incumbent that the primary current should not possess immense strength or volume: what is required being a moderate primary current inducing a secondary discharge of enormous electro-motive force. The method of working the installation as shown in fig. 56, is as follows:—

When it is desired to send a general message to a number of receiving instruments simultaneously, as illustrated in fig. 56, the operator refers to a guide or directory which, similarly to an ordinary telephonic directory, contains the names and numbers of the subscribers, and after ascertaining the number of the common or master tuning-reed, *f*, whose rate of vibration corresponds with the common or master reeds in the various receiving instruments, places it in position for use, by rotating the multitonophone or reed disc, *I* (figs. 42, 43, 44), by means of the gearing 3 and 4, until that special reed, together with its corresponding speaking-reed, *e*, are brought between the end of the contact-screw, *e′*, and the adjacent end of the iron core, *c* (fig. 56), when the disc should be rigidly fixed by the aid of the clamping-screw, 2, the distance of the reeds from the said core being regulated, when necessary, by the adjustment of the pillar, *s*, on the sliding support, *r*. The contact-screw, *e′*, is then rotated until it bears against the speaking-reed, *e*, when the pressure of the screw, *e′*, is lessened or increased either longitudinally by its partial revolution to the right or left, or laterally, by moving the pillar, *q*, on the sliding support, *p*, until the speaking-reed, *e* (fig. 43), vibrates at such a rate as corresponds exactly with the number of vibrations requisite to set the tuning-reed, *f*, sympathetically in motion.

When this definite pitch and rate of vibration is attained by the speaking-reed, *e*, and duly indicated by the tuning-reed, *f*, then the same number, and that number only, of electrical impulses are produced in the secondary winding of the coil, *b*, by the inductive influence of the primary winding, *a*; and, by the enormous **E. M. F.** (electro-motive force) of the induced current of the secondary, transmitted to the various receiving instruments, as *h,h,h,h,h,h,h* (fig. 56), consequently causing then, by suitably operating the key, *g*, a telegraphic message can be sent by the Morse or any other code.

To send a secret telegraphic message to any one of the receiving instruments, the rotary reed-carrier, *I*, is turned round until the tuning-reed, *f*, whose pitch or rate of vibration corresponds to that of the secret message reed in the particular receiver to which it is desired to telegraph, is brought into a position in which the corre-

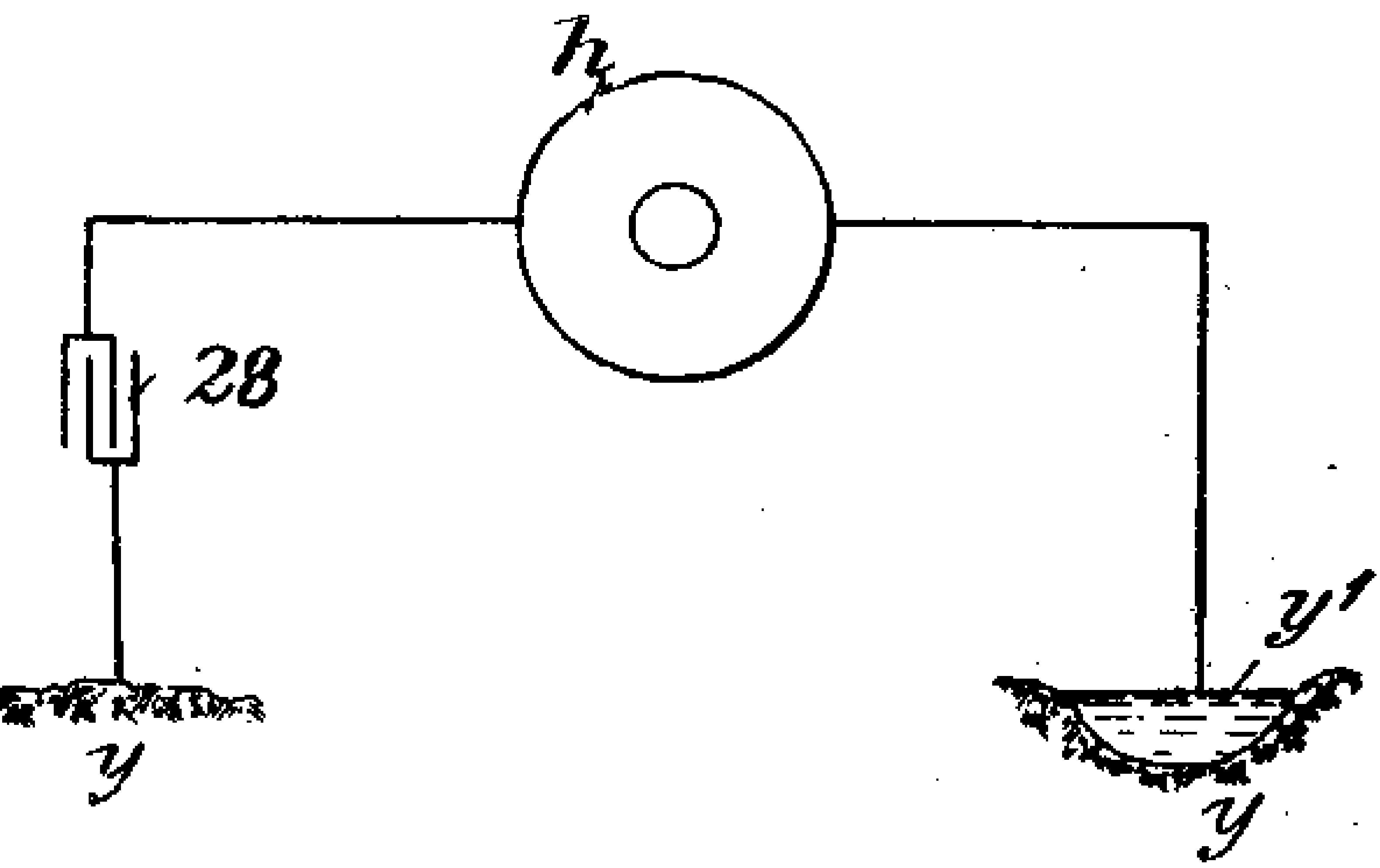


FIG. 54.

A REPRESENTATION OF A MULTITONOPHONIC RECEIVER CONNECTED TO TWO EARTHS, OR EARTH AND WATER IN CONTACT WITH EARTH, AND HAVING A CONDENSER IN CIRCUIT.

sponding speaking-reed, *e*, will be between the iron core, *c*, and the contact-screw, *e′*, when the said screw is again adjusted until the new speaking- and tuning-reeds are caused to vibrate at the required rate, when a telegraphic message can be again sent by operating the key, *g*.

With regard to the strength of battery power necessary to ensure the best results in electric tuning, a subject which has been already casually referred to in this chapter, the reader is reminded of the extreme importance of a moderate primary discharge, as electric tuning does not require, and, moreover, the operation cannot be performed with, a gigantic volume of electricity.

That any person possessed of an ordinary degree of common sense, can, for a single moment, entertain the

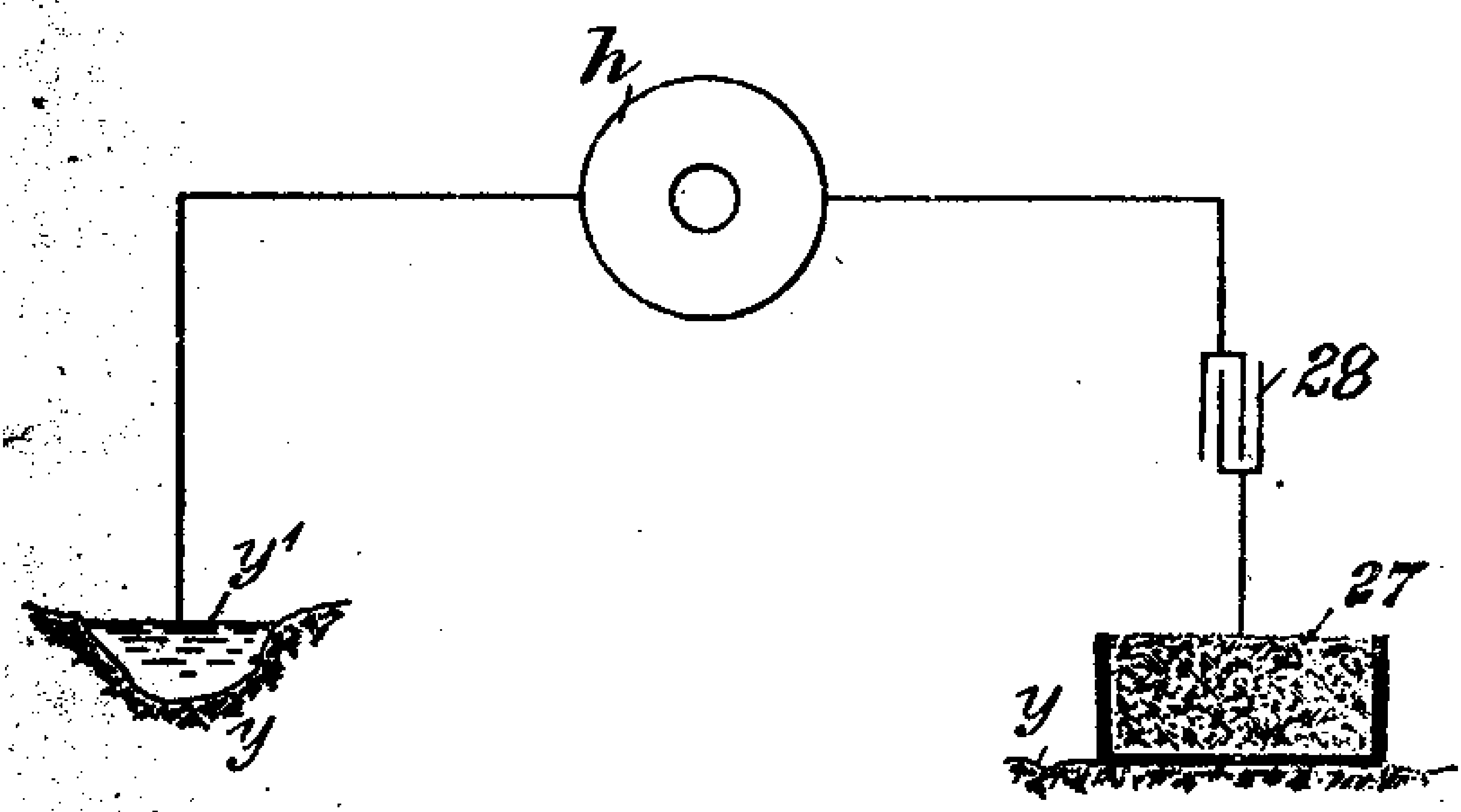


Fig. 55.

A REPRESENTATION OF A MULTITONOPHONIC RECEIVER, WITH ONE CONNECTION TO EARTH OR WATER, AND THE OTHER TO AN INSULATED CAPACITY, WITH A CONDENSER IN CIRCUIT.

preposterous idea that a dynamo-electric flow, which requires a mechanical force of from 50 to 60 horse-power to produce it, as was utilized by Mr. Marconi in his attempt to bridge the Atlantic, appears almost incredible. It is therefore not at all surprising that failure in this branch of the science has attended their every effort to try and, if possible, procure a remedy.

And now we come to the all-important and vital question of the requisite means to be employed to secure proper conduction of electrical energy.

The electric current can only be conducted in two ways—namely, by metallic substances and terrestrial matter. It can be projected aerially to the limited extent of the magnetic field, by its own spontaneity; but that is not conduction, it is simply an independent and uncontrollable action of its own. As both of the former have already been dealt with, it is only essential to take the latter into consideration.

As previously alluded to in these pages, the theory of all aerial and etheric telegraphists is to the effect that in wireless telegraphy the electric waves are projected through the air or ether upon insulated aerial plates suspended in mid-air at the receiving station, and thence conveyed by metallic conductors through the coherer to earth. But this is a fallacy, as can be proved by performing the various experiments which are hereinafter explained.

For the present, however, it will suffice to make the reader acquainted with what really does take place.

On closing the primary circuit at the transmitting station, the electric current from the secondary winding of the induction coil passes to earth by one wire, and traverses the aerial conductor to the (so-called) oscillators by means of the other; whence it is thrown off, thereby creating a magnetic field, which radiates therefrom for a distance of about one hundred times the length of the sparking distances between the secondary terminals of the coil that is being used; or, in other words, creates a magnetic field about two hundred times the sparking length of the coil in diameter, which, provided the coil were capable of producing a spark 18 inches long, would be 300 feet.

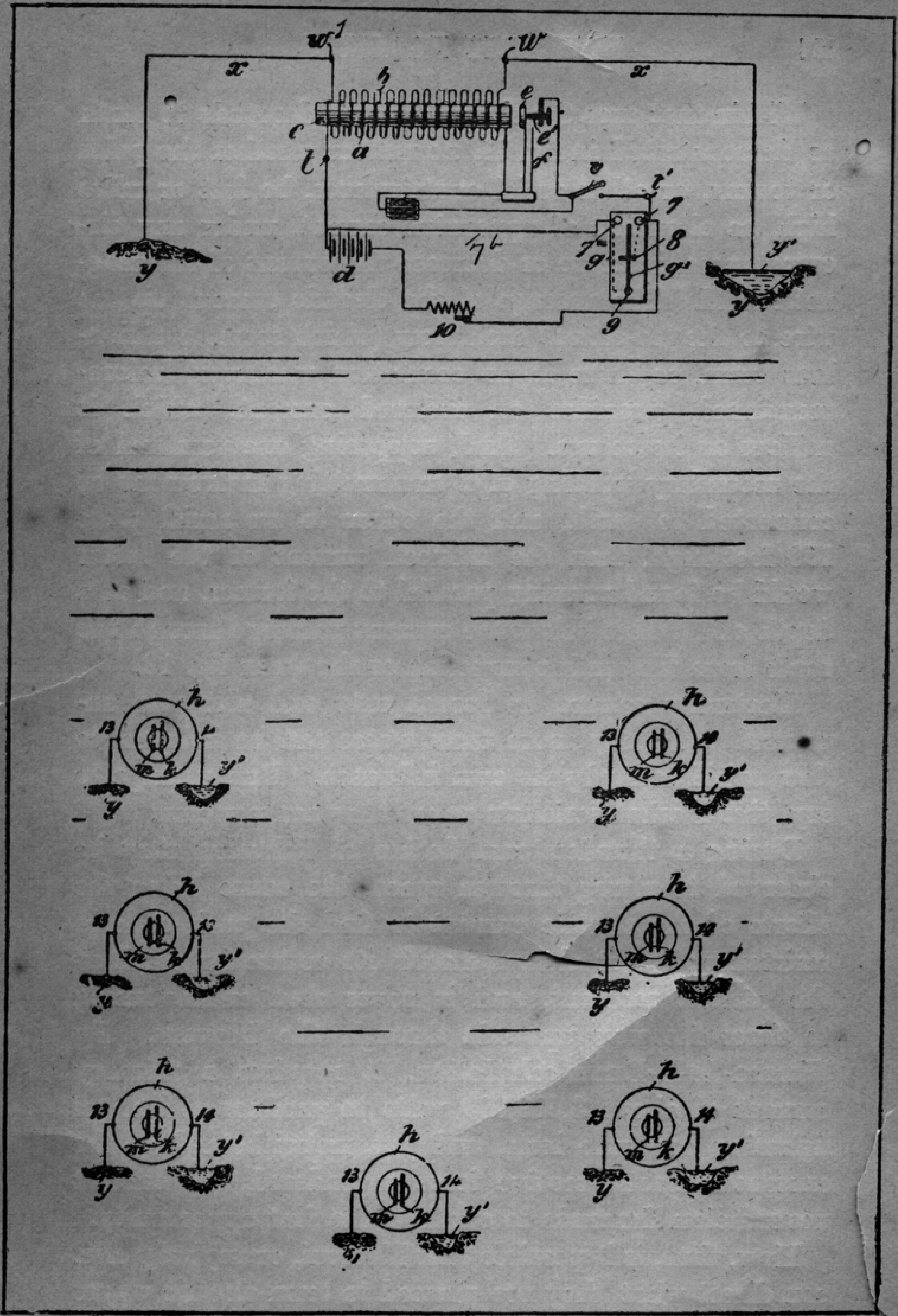


FIG. 56.—A SKELETON DIAGRAM OF A COMPLETE INSTALLATION FOR THE TRANSMISSION AND RECEPTION OF MESSAGES BY THE JOHNSON-GUYOTT MULTITONOPHONIC SYSTEM, WITH CONNECTIONS TO EARTH AND WATER ONLY, AND SHOWING A GROUP OF SEVEN RECEIVERS.

Within that area the electric current descends to earth as demonstrated in fig. 74, no matter whether the poles or towers, or other aerial contrivances, be feet or miles high, as elevation of apparatus cannot, under any circumstances, increase or decrease the extent of the magnetic field. The passage of the electric current up the wire to the (so-called) oscillators (which seems a ridiculous term, as there is no oscillation whatever) beforementioned, provides an induced current, which it utilizes as its return. And, supposing one terminal of the secondary winding of a transmitting instrument be connected to earth, and the other to an aerial plate 150 feet high, then the induced current of the latter would be found running parallel to the former, and at a depth of 150 feet below the current passing through the earth from the earth connection as shown in fig. 12.

Electricity cannot be forced into and along an unnatural path, any more than water can be induced to flow uphill solely by its own influence. But, strange to say, this is what aerialists assert they can perform.

During a thunderstorm flashes of lightning may be observed to zigzag through space, the cause being the efforts of the electric current to find the path of least resistance; but it always directs its course for earth at the earliest moment, and is never seen endeavouring to force its way upwards through the heavens. By Warren-de-la-Rue's calculation, it requires a primary current of about 3,500,000 volts to produce a flash of lightning one mile long, and yet, notwithstanding the enormous electro-motive force engendered, the current nevertheless descends to earth at the first opportunity.

How, then, is it possible that Marconi, or anybody else, can direct what they are pleased to term electric waves for hundreds and hundreds of miles over the earth and

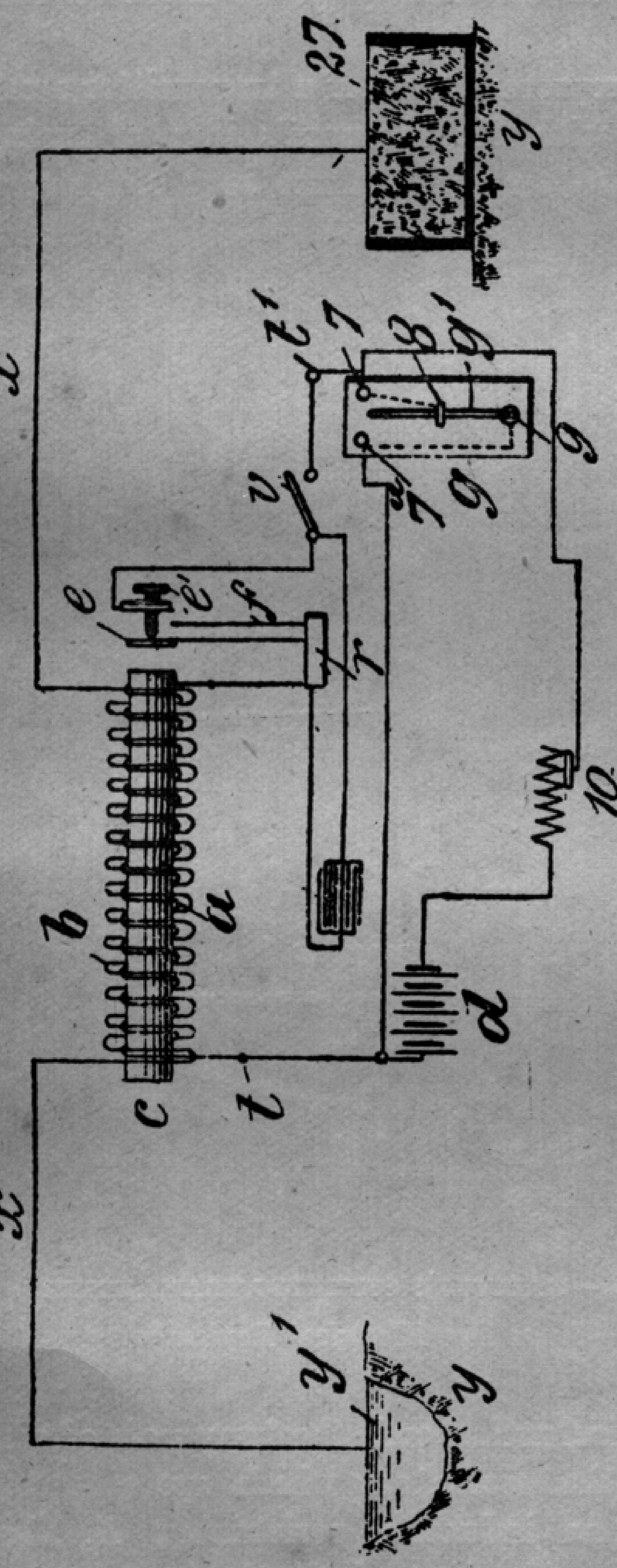


FIG. 57.—A SKELETON DIAGRAM OF A COMPLETE TRANSMITTER, AND APPENDAGES, FOR THE TRANSMISSION OF MESSAGES BY THE JOHNSON-GUYOTT MULTITONOPHONIC SYSTEM, WITH CONNECTIONS TO EARTH AND A CAPACITY, OR WATER AND A CAPACITY ONLY.

The writer leaves this knotty problem for an aerialist's solution.

Fig. 58 is a representation of a transmitter syntonized in accordance with Mr. Marconi's idea of tuning, and wherein *a* is a battery; *b*, a Morse key; *c*, the secondary

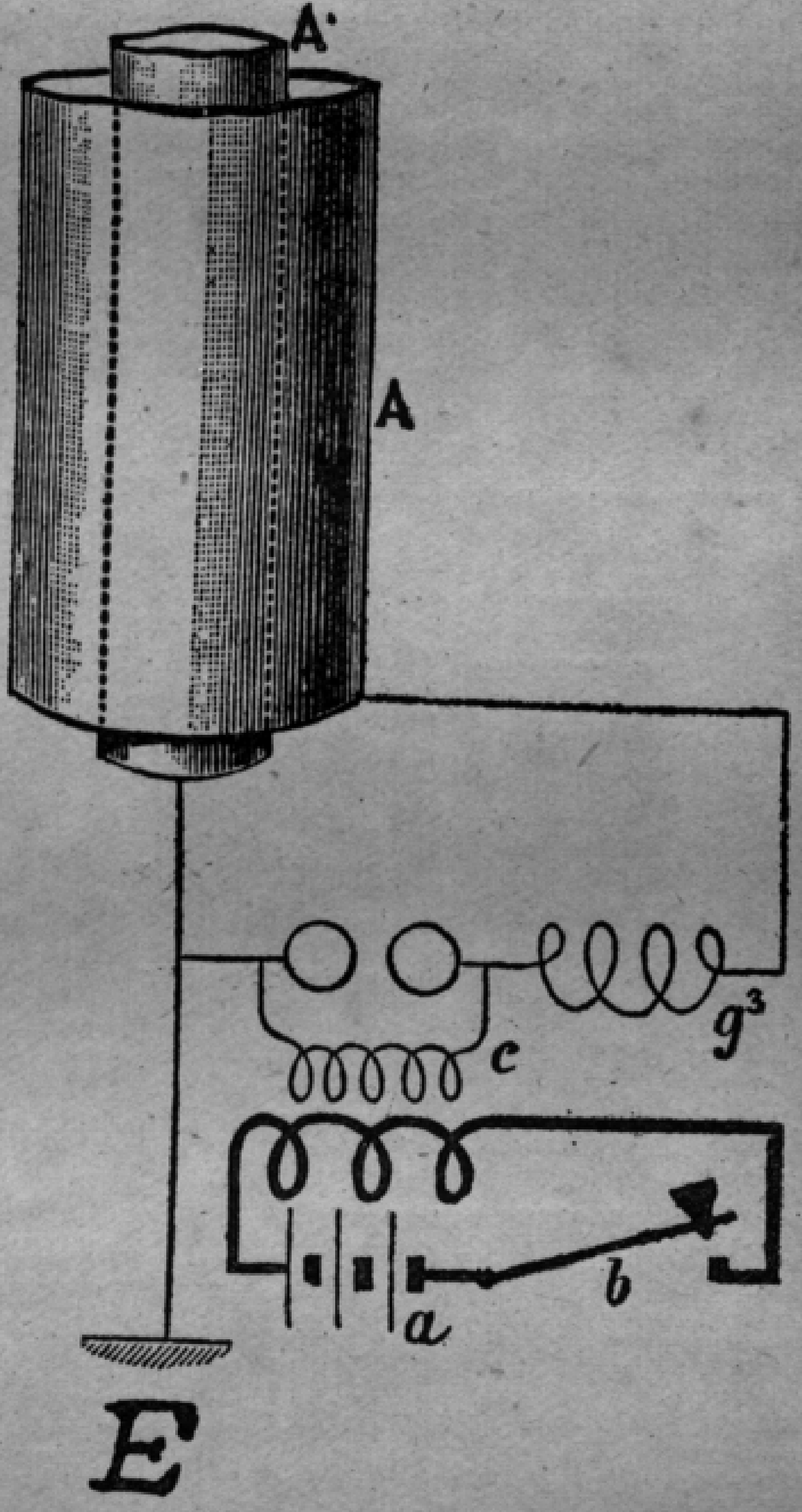


FIG. 58.—MARCONI'S SYNTONIC TRANSMITTER.
(From *The Electrical Review.*)

winding of an induction coil, the terminals of which are connected to the oscillators which are situated above them. g^3 is an inductive resistance; *A*, the outer cylinder of the radiator; and *A'*, the inner one which is earthed at *E*.

With reference to the subject of syntonization, Mr. Tunzelmann, in his work on "Wireless Telegraphy," which was published in 1901, remarks :—

"The system of wireless telegraphy described in the last chapter is subject to one very great defect, which must necessarily become increasingly serious as its employment becomes more general. This is the interference of simultaneous messages, coming from different stations, every one of which affects all receivers within range.

"This difficulty has been foreseen from the beginning, and Marconi states that it has already caused a good deal of trouble in the English Channel, where the ether is even at present very frequently in a most lively condition from wireless messages emanating from various sources.

"The only remedy for this is the employment of transmitters and receivers *tuned or syntonized*, so that any given receiver will respond only to the impulses which are intended for it, and will be unaffected by others.

"If my readers have studied the contents of Chapter IV., they will be aware that a syntonic radiator must necessarily be one which produces persistent oscillations, instead of having them damped out almost immediately, and, moreover, that the more freely a radiator gives out its energy to the ether, the more rapid must be the damping. It follows, therefore, that a radiator cannot be made syntonic without making it feebler.

"It was clear, therefore, that some form of radiator with less rapid damping must be sought for.

"Various methods of increasing the capacity of the radiator were then tried.

"The most obvious method of doing this was to increase the size of the conductor; but this, by increasing the surface in contact with the free ether, increased the radiation, and, therefore, the damping, which was not what was wanted; besides, large plates or exposed areas are altogether impracticable on board ship, and are difficult to maintain in position during wind."

Fig. 59 is a syntonic receiver, used by Mr. Marconi in conjunction with the transmitter (fig. 58). With

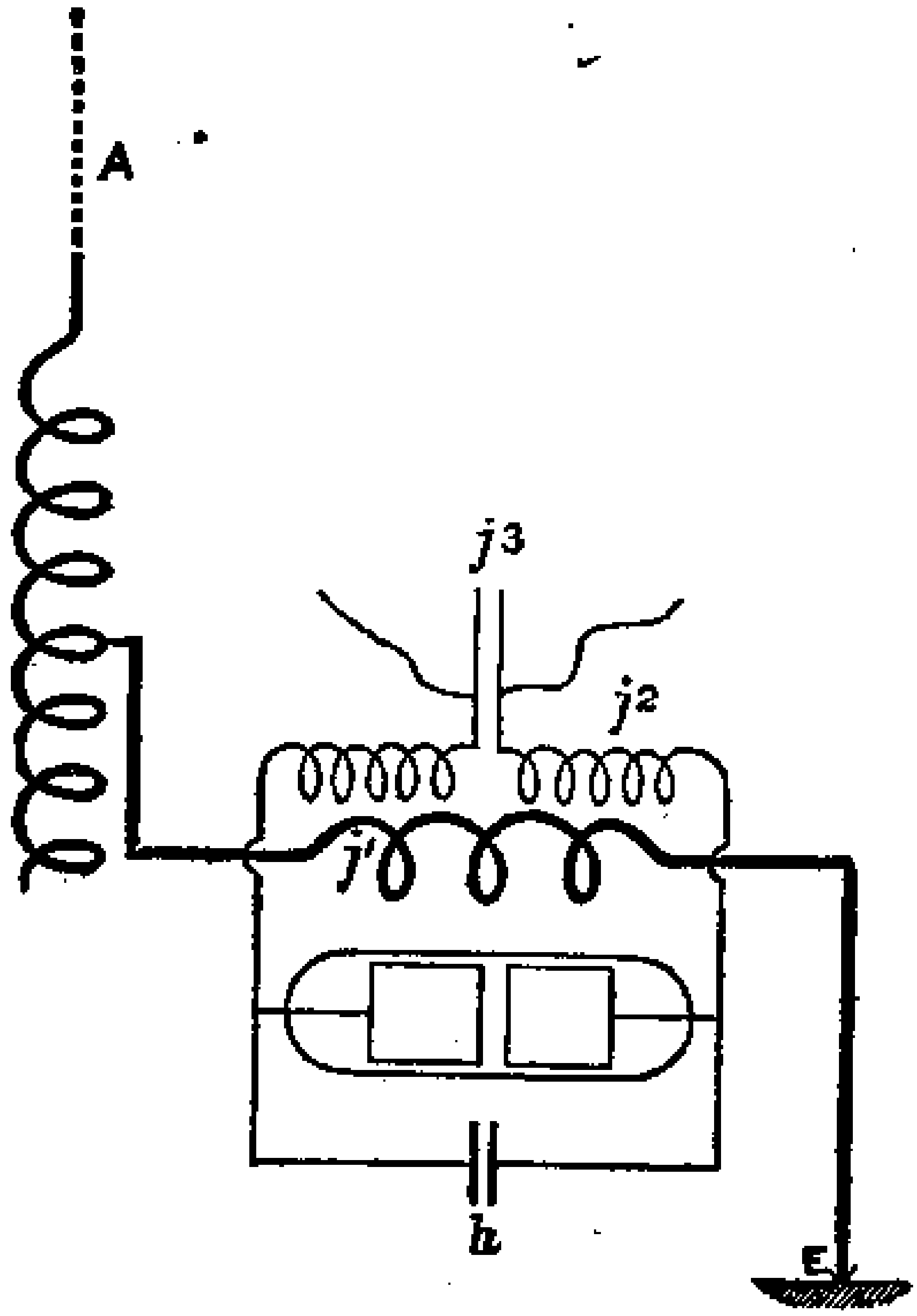


FIG. 59.—MARCONI'S SYNTONIC RECEIVER.
(From *The Electrical Review.*)

reference to its portability, it is better to give the description relative thereto in Mr. Tunzelmann's own words. He says:—

"The receiving apparatus is shown in fig. 29" (59). "A vertical conductor, *A*, of adjustable inductance, as in the case of the transmitter, is connected through the primary coil, j^1, of an oscillation transformer to the earth, *E.* The secondary, j^2, of the oscillation transformer is connected with the coherer, as in the earlier arrangement, . . . and in parallel with this is an adjustable condenser, *h*. The ends of the secondary circuit are brought to terminals, j^3, by means of which any desired inductance and capacity can be introduced."

He further observes: "This has made it possible to construct extremely portable apparatus for military purposes; a convenient method being to carry the whole arrangement on a motor car. On the roof of the car there is placed a cylinder, which can be lowered when travelling, and when in use is only between six and seven metres high."

Again, he remarks: "With zinc cylinders only seven metres high and one and a half metres in diameter, used both for transmitting and receiving, good signals were easily obtained between St. Catherine's, in the Isle of Wight, and Poole, a distance of thirty-one miles; and these signals were in no way interfered with, nor could they be read by the other wireless telegraph apparatus which was in use in the immediate vicinity. My readers will now understand that if there are receivers at different stations, tuned to different periods of electrical vibration, and if these are known at any transmitting station, the operator there will be able to send any one of the receiving stations messages which will affect its receiver only, and not those at the other stations."

Now, these statements give rise to three important questions, viz.: Is it sufficiently portable? Is it a secret system? Has the tuning problem been absolutely solved?

With reference to the first question—its portability—it is sufficient to make the calculation as to the dimensions of the cylinders in accordance with Mr. Tunzelmann's figures, and which he asserts are 7 metres high and $1\frac{1}{2}$ metres in diameter. Consequently, as a metre is 39·37 inches, which is equal to 3 feet $3\frac{37}{100}$ inches, the height of the cylinders, therefore, would be 22 feet $11\frac{50}{1200}$ inches, and the diameter 4 feet $11\frac{55}{1000}$ inches.

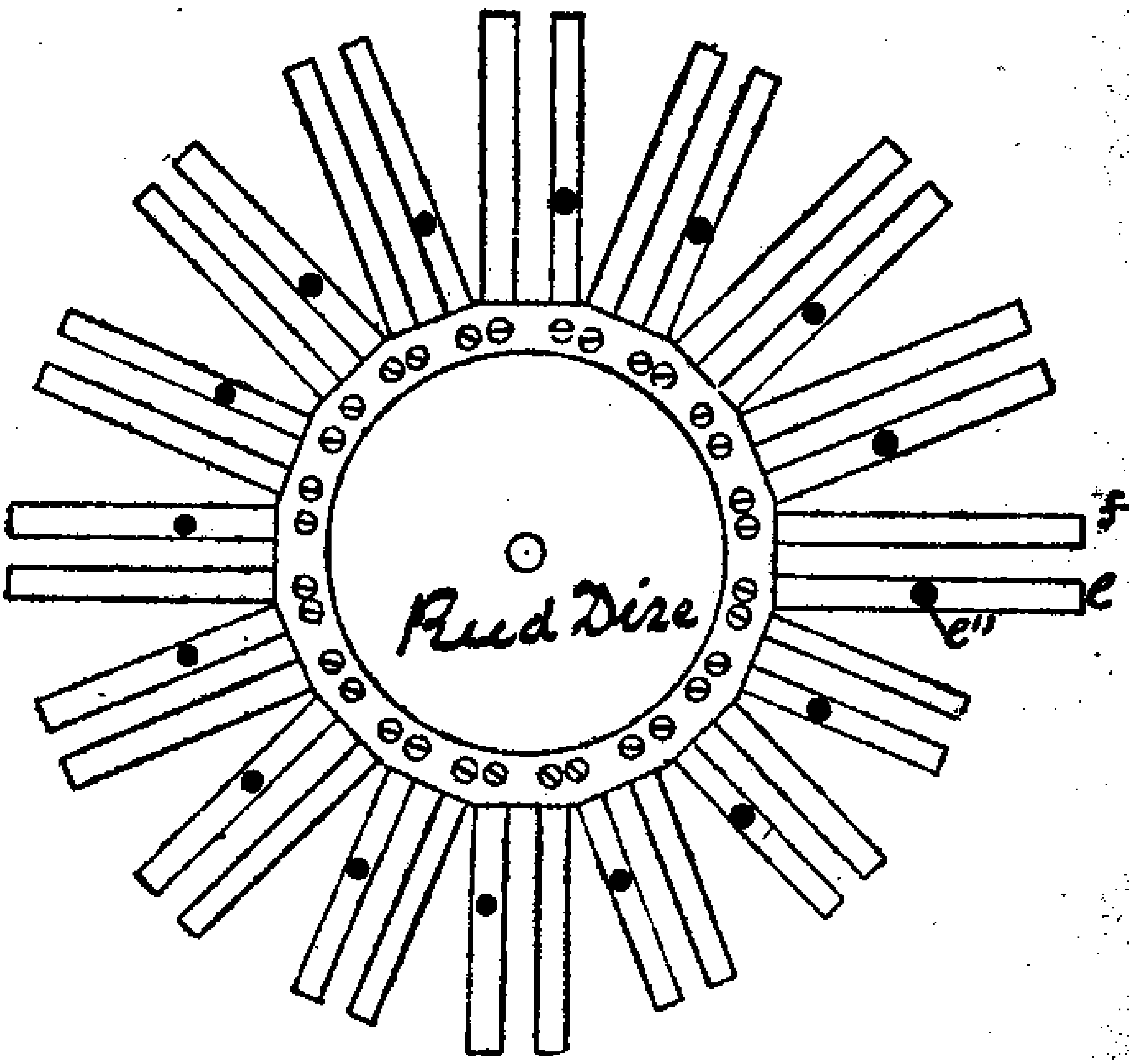


FIG. 60.—THE "JOHNSON-GUYOTT" MULTITONOPHONE OR REED DISC, SHOWING THE TUNING AND SPEAKING-REEDS IN PAIRS AT *f* AND *e* RESPECTIVELY, THE CONTACT SPOT BEING EXHIBITED AT *e''*.

Now, if the reader will just for a moment imagine a cylinder nearly 23 feet high and nearly 5 feet in diameter as the apparatus necessary to signal to one station, how is it possible for a battleship to carry the transmitters and receivers necessary to communicate with the whole of His Majesty's fleet? And, moreover, what would be the height of the cylinder requisite to transmit a message across the Atlantic? The absurdity is so apparent, that it requires no further explanation. In answer to the second, I beg to refer the reader to Professor Flemming's unfortunate experience at the Institute of the Royal Society in June 1903, and which has already, with many other similar occurrences, been alluded to. With respect

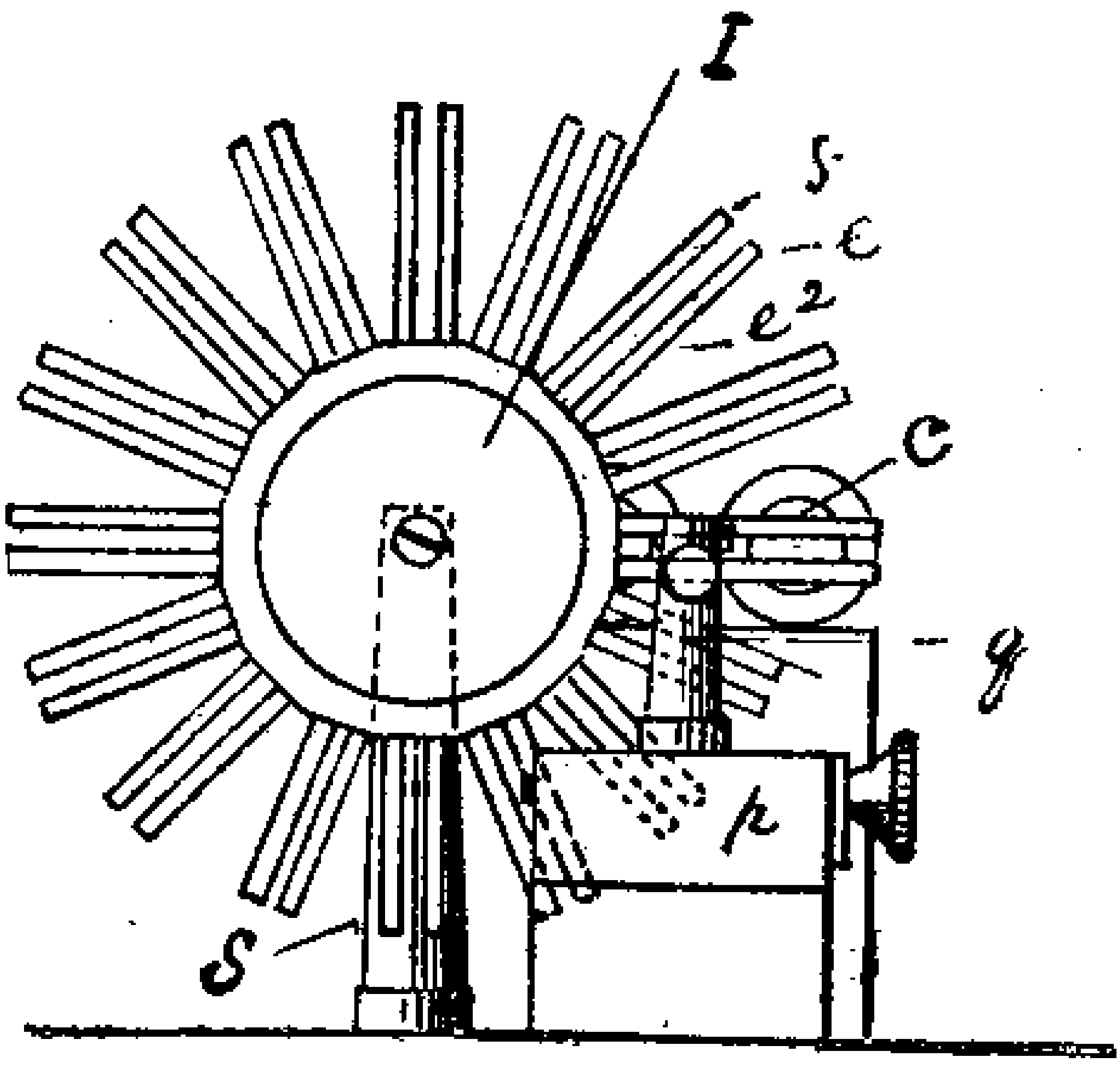


FIG. 61.—A FRONT ELEVATION OF A JOHNSON-GUYOTT MULTI-TONOPHONE, IN POSITION READY FOR IMMEDIATE USE.

to the last question, the appended quotation from the columns of the *London Echo* of Friday, February 19th, 1904, will speak for itself.

"The officer in charge of the Italian wireless telegraph station at Tientsin (China), cables that some of the messages sent by means of the Marconi apparatus from Russian stations were intercepted by Japanese battleships, owing to the want of skill on the part of the Russian operators."

In support of the above, it will be interesting to the reader to mention that, from information supplied by Mr. Cuthbert Hall, managing director of the Marconi Company, *re* the alleged attempt to wreck the demonstration of wireless telegraphy given at the Royal Society in June 1903, the representative of the *Morning*

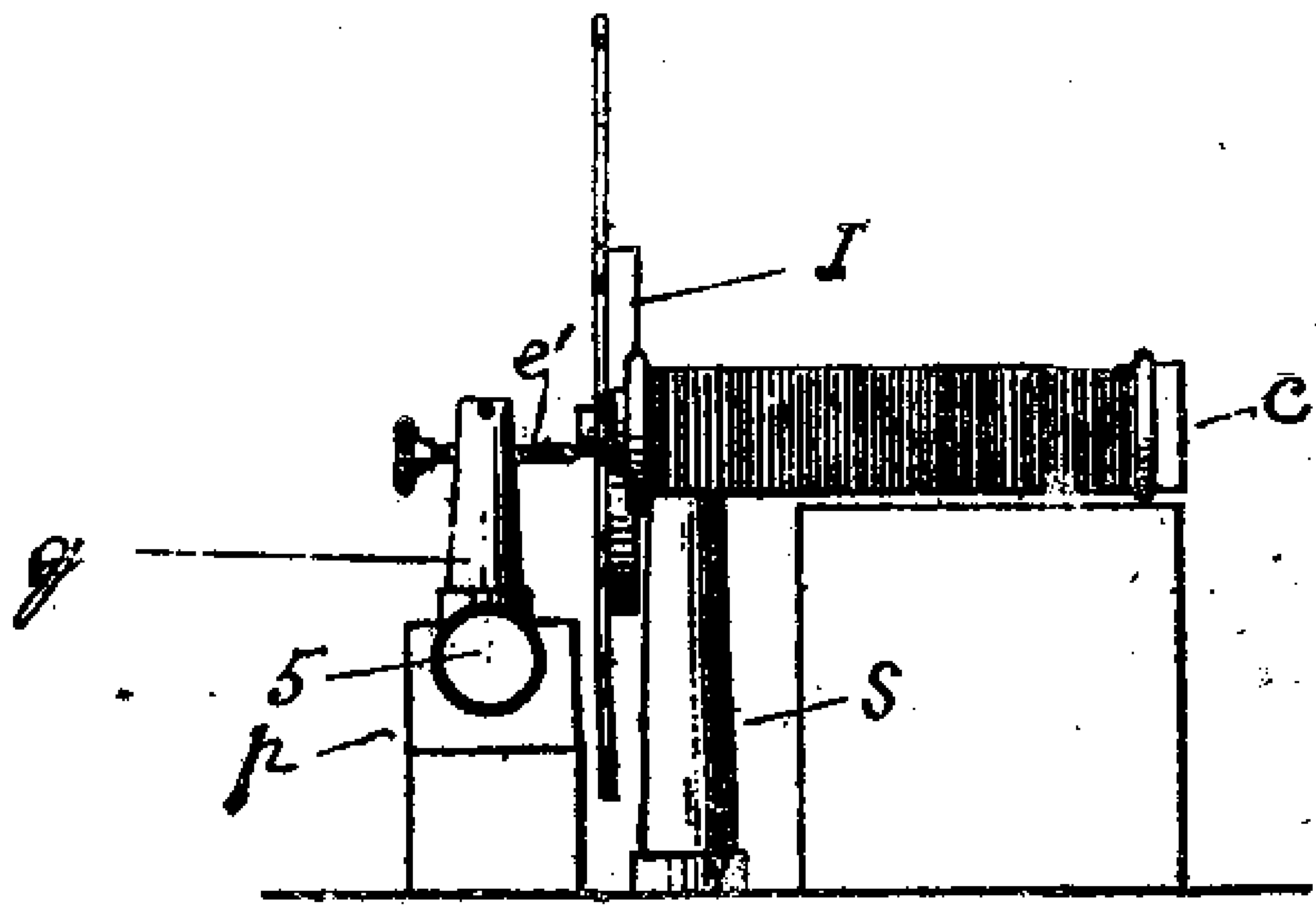


FIG. 62.—A SIDE ELEVATION OF A JOHNSON-GUYOTT MULTITONOPHONE, IN POSITION READY FOR IMMEDIATE USE.

Leader reported in the columns of the above as follows:—

"It seems that while the process of tuning one of the receivers was going on, preparatory to receiving the Poldhu messages, one of the operators suddenly discovered, as he ran through the gamut from a to z, that another station was working—and working very near at hand too." This is certainly a most ridiculous assertion to make—"As he ran through the gamut from, a to z." What Mr. Hall meant to say was, "as he ran

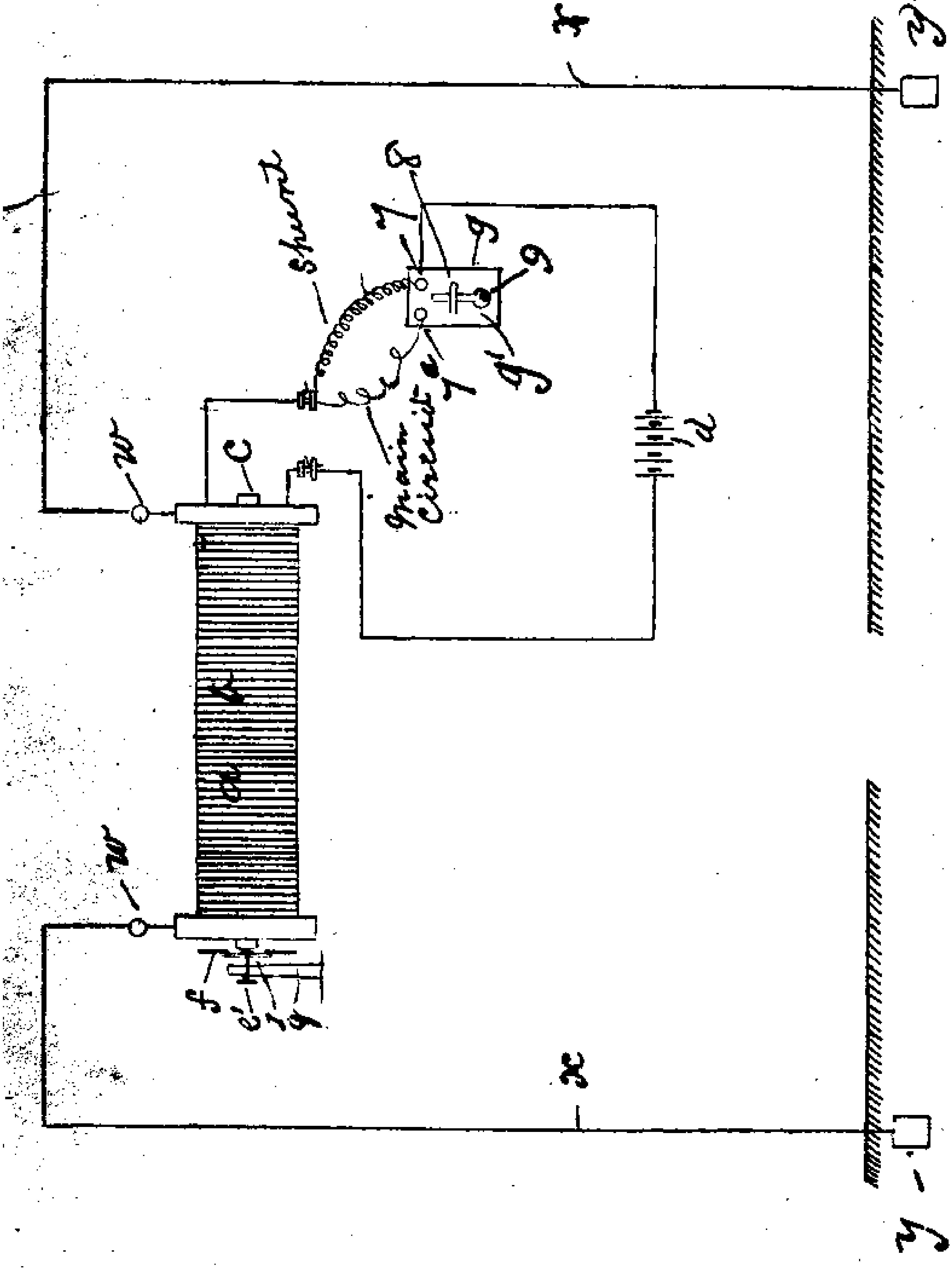


FIG. 63.—A JOHNSON-GUYOTT MULTITONOPHONIC TRANSMITTING APPARATUS, SHOWING THE MOST ESSENTIAL PARTS IN SKELETON FORM.

through the Morse alphabet from, a to z," as there is no gamut in the civilized world from, a to z, and, moreover, electric tuning cannot be performed in that slipshod manner. The transmitting and receiving instruments must be tuned in the same manufactory under an equal number of degrees of heat, and rigidly fixed in unalterable positions in readiness for immediate use. Surely such an arrangement as Mr. Hall speaks of, would not be capable of producing an average of one word per minute, let alone from thirty-five to forty as has been declared; and this perfunctory style of performing such a delicate operation as sytonizing the electric current, without the aid of a defining sound and the necessary means of duplication, with the transmitter and receiver about 150 miles apart, is what the aerialists call tuning; yea, tuning it is, with a vengeance!

But the reader may rest assured that the process of syntonization of the electric current can never be accomplished under such conditions.

Fancy a pianist tuning his instrument just before the commencement of a public performance and in the presence of the audience, or an organist attempting the same task, while the members of the congregation are quietly awaiting its completion. What an absurdity! What a waste of time to even entertain such idiotic ideas, set aside the stupidity of trying to carry them into execution! Apparatus used in the syntonization of the current must be manufactured by competent musical instrument makers, tuned by a person possessed of a delicate musical ear and a sound knowledge of accoustics, and so arranged that broken or faulty parts of the mechanism can be removed, and good ones conveniently substituted. It does not require a practical musician to adjust the appliances of a multitonophonic transmitter or receiver, or one versed in that art to despatch or receive a message by the multitonophonic system; but it is highly essential, yea, imperative, that the operator shall be thoroughly conversant with the *modus operandi* necessary for effectually manipulating the various portions of the contrivance.

CHAPTER XV

PROOF OF THE IMPOSSIBILITY TO SYNTONIZE THE ESSENTIAL PARTS OF AN AERIAL OR ETHERIC INSTALLATION

As previously observed, ever since the year 1895, when Popoff invented his supposed aerial system, experimenters in this branch of science have been constantly engaged in trying to devise some means whereby the influence of the electric current could be effectually localized, in order to secure privacy in the transmission of telegraphic messages, or, to use their own phraseology, "screened off from each other, and so confined to the stations or ships for which they were originally intended." But, up to the present time, the efforts of the wiseacres have proved abortive, and no wonder why their endeavours have lacked success, for they have tried, and are trying, their level best to perform an impossibility. Whoever heard of electricity being "screened off"? neither can it be, nor can it be obstructed in its path—and any attempt to do so would be madness in the extreme, and fraught with imminent danger to the adventurous individual who unluckily essayed the operation; and it is to be regretted that any sane persons have presumed so far on the credulity of the million, to aver that they have accomplished such an act of stupidity.

Time would fail me to give even a tithe of the number of ridiculous assertions that have recently flooded the daily press, not only of Great Britain, but the civilized world, with reference to this subject, and I have waited anxiously for an abler pen than mine to seriously take up this important topic, and in a business-like and practical manner refute the erroneous theories that exist concerning this vexed question.

As evidence of the nonsensical reasoning adduced by scientists and electrical experts *re* syntonization, I shall at once proceed to more fully explain the method that

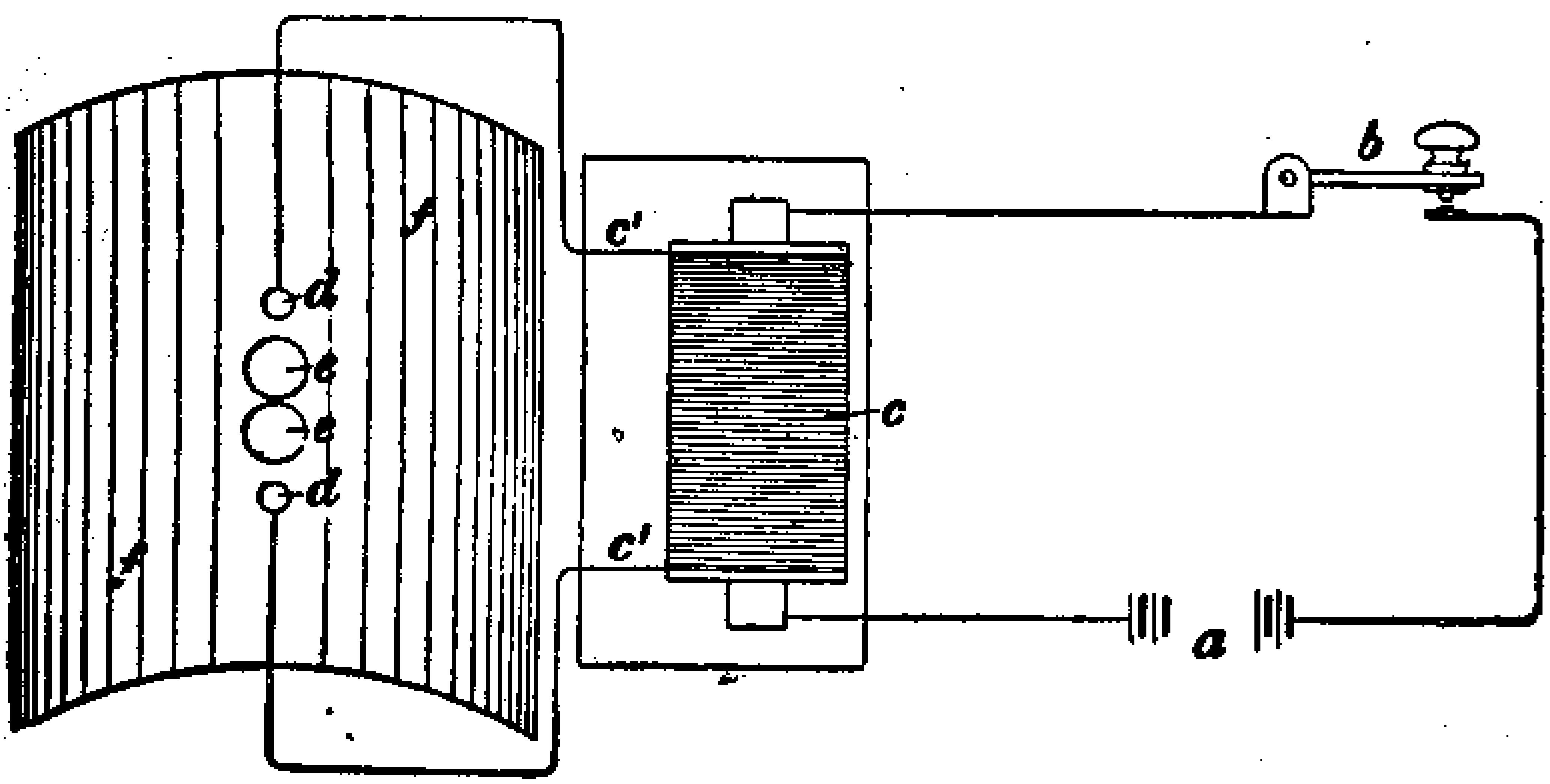


FIG. 64.—MARCONI TRANSMITTER WITH PARABOLIC REFLECTOR.

(From *The Journal of the Institution of Electrical Engineers.*)

aerialists have adopted for the purpose of tuning the electric current, and after giving, in their own verbiage, the reasons they have assigned for the failure of their scheme, thoroughly elucidate the true causes of the fiasco.

Fig. 64 is a diagrammatical sketch of a transmitting apparatus, wherein *f*,*f* is a parabolic reflector. It was designed with an idea to compel the so-called electric waves to travel in any direction that might be desired:

but which, after the exercise of a little common sense, was eventually abandoned.

Fig. 65 is an illustration of an electrical receiving instrument, with parabolic reflector, *f*,*f*, and metallic wings, *k*,*k*, attached. By a careful perusal of fig. 66, which is a diagrammatical drawing of fig. 65, with the parabolic reflector, *f*,*f*, and the metallic wings, *k*,*k*,

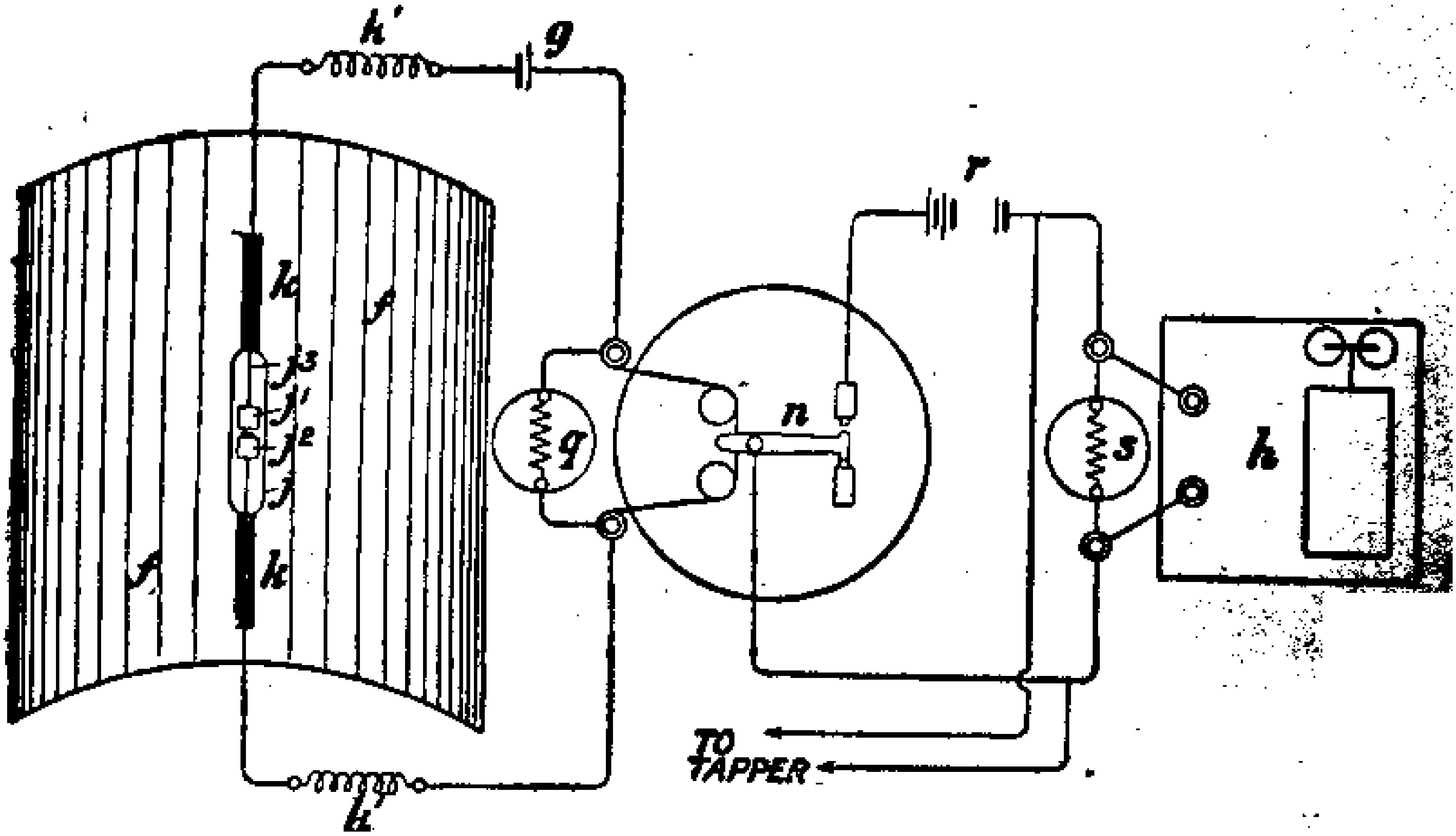


FIG. 65.—MARCONI RECEIVER, WITH PARABOLIC REFLECTOR AND METALLIC WINGS ADJUSTED.

(From *The Journal of the Institution of Electrical Engineers.*)

omitted, and by the assistance of the index letters relating thereto, the reader will easily perceive that there are three distinct circuits, through which three different currents of electricity are caused to flow. In order to produce syntonic action by electric agency, the same current must flow throughout the three circuits, and this, under the conditions I am about to explain, is an absolute impossibility; therefore, I positively assert that the individual is unborn that can syntonize or electrically tune the instruments as demonstrated in figs. 65 and 66. By referring to the latter drawing, the reader will observe that the first circuit is, according to aerialistic views, from the aerial plate upon which the electric waves impinge down the wire, *W*, to, and through, the coherer to earth at *E*. It has been before explained that the action of the current in this circuit magnetizes the metallic filings between the metal plugs, j^1, j^2, in the interior of the coherer, *j*, thereby closing the second circuit, k^1, *g*, N^1, N^2, k^1, and bringing the local battery, *g*, into action. On closing circuit No. 2, the battery, *g*, influences the relay, *n*, thereby causing its electro-magnet, E, to attract the armature, *A* (fig. 40), which closes circuit No. 3 at *r*, *h*, r^1, and *n* (fig. 66). On closing the latter circuit, the Morse recorder, *h* (fig. 66), is brought into operation; its electro-magnet, acting in a similar manner to the electro-magnet of the relay, attracts the recording armature and holds it firmly down by power of attraction till such time as the tapper, *o*, striking the coherer, *j*, demagnetizes the metallic filings of the tube, *j*, and reopens circuit No. 2, which, in turn, reopens No. 3 and releases the recording armature, when the latter regains its normal position and remains in readiness to register the next impulse.

The compound action of the three circuits consequently presents three unconquerable difficulties.

Firstly, the vibrations received from the transmitter pass through the coherer directly to earth without traversing the battery circuit No. 2, and are thereby rendered useless for syntonizing purposes.

Secondly, the vibrations which are excluded from circuit No. 2 would be of no service for tuning purposes, as the rigidity of the relay armature would debar them from influencing the current in circuit No. 3.

Thirdly, provided the previous impediments were removed, and the vibrations did manage to pass through circuit No. 3, nevertheless their efforts would be useless, as the recording armature, which is silently held down by magnetic influence, would entirely obviate the passage of all vibration during the time the current would be flowing through the electro-magnet of the recorder.

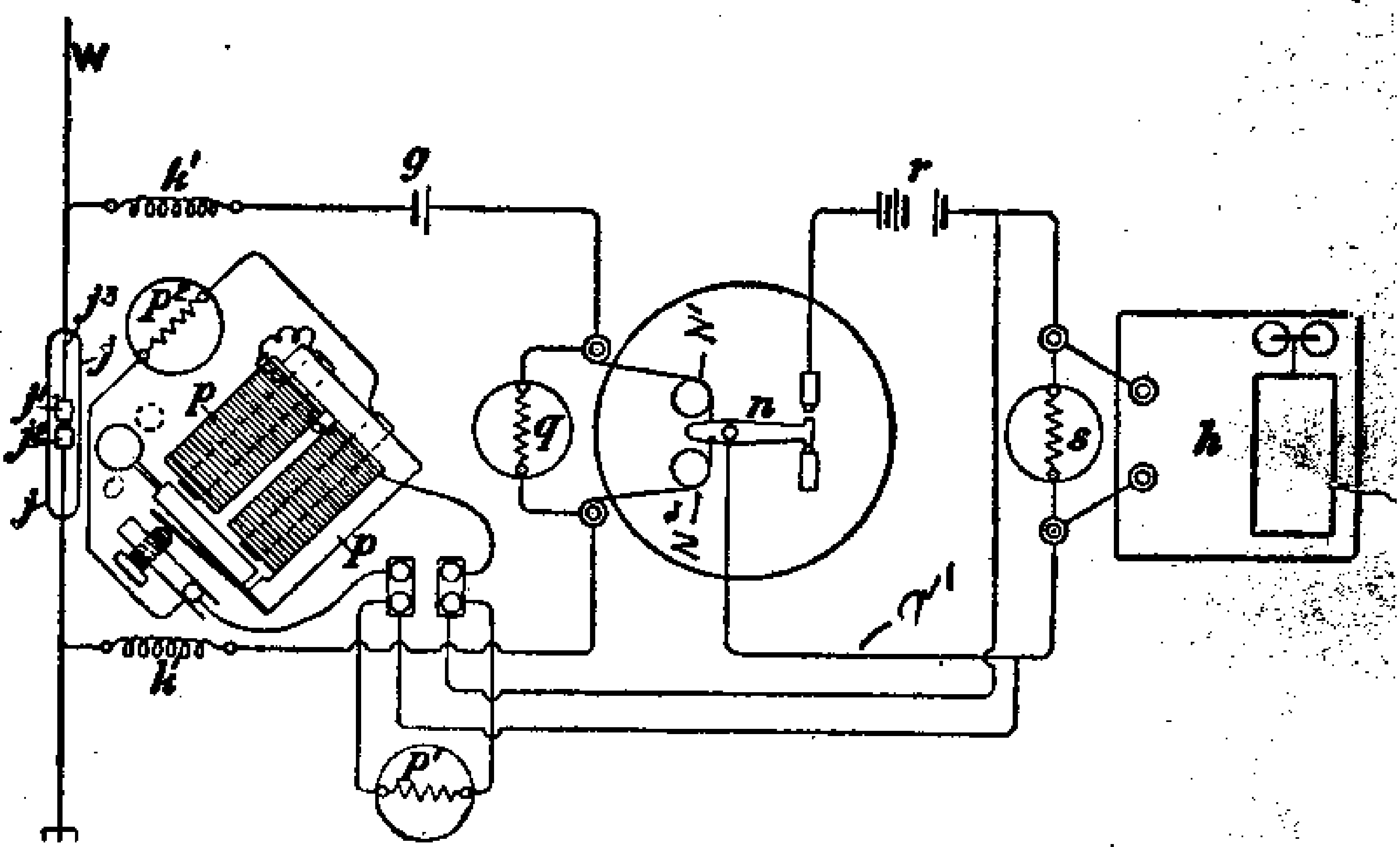


FIG. 66.—MARCONI RECEIVER WITH VERTICAL WIRE AND EARTH CONNECTION, BUT WITHOUT PARABOLIC REFLECTOR AND METALLIC WINGS.

(From *The Journal of the Institution of Electrical Engineers.*)

It is obvious, therefore, to anyone possessed of ordinary reasoning powers, that no vibrations can, under any circumstances whatsoever, travel through such a maze of difficulties as that provided by the above means. And, furthermore, I challenge any living individual using apparatus of this description, not only to tune the current successfully, but to tune it at all.

As all aerial systems are based on the coheric principle, employ transmitters incapable of syntonization, and receivers fitted with vibratory obstructors, such as previously described. It is evidently unnecessary to give further details relative to individual methods of aerial installation, as to do so would only entail a reiteration of what has already been alluded to. But before passing on to notice some of the principal reasons assigned by etheric telegraphists as the causes of their constant and conspicuous failures, it will prove interesting to the reader to give a few quotations regarding promised improvements in aerial transmission that have not been verified, and regarding which it is obvious that they, as well as the remainder of the multitude of grossly misleading statements that have been sown broadcast, were either the offsprings of scientific ignorance, or incessant claptrap.

In the *Daily Mail* of August 28th, 1901, an expert, under the title of "Invisible Hindrances," reports as follows:—

"Something is always going wrong with the apparatus, and it takes you hours and hours to find out what it is; and by the time that you have found out what has happened and put matters right, you have probably altered half a dozen other conditions without knowing it, so that you are a good deal worse off than you were before. Not very long ago I had a curious experience. A message suddenly came to hand from a mysterious source, and proceeded to imprint itself off as usual on the tape. When I tried to decipher it, however, I found it utterly unintelligible. There were dots and there were dashes, in all sorts of combinations: sometimes these resolved themselves into Morse letters, and sometimes they did not. The message—*if it were a message at all, and not the chance result of some obscure atmospheric conditions*—was simply an incoherent jumble of spasmodic gibberish.

The real cause, however, has now been discovered, and a method devised to overcome it."

From the straightforward manner in which the reporter has described his experience, no person can possibly cast a doubt upon the genuineness of his assertion that a remedy had been discovered, as of course he would rely upon the accuracy of the information which he had received.

Again, he states :—

" A greater nuisance still is the way in which one is constantly getting hold of other people's messages."

The most important part of the article is that in which he says :—

" The public have been carefully educated into believing that transmitter and receiver can be 'tuned' to one another, so that their own messages cannot be tapped." But " you cannot stop a rival operator from worrying you most fearfully by sending messages of his own; in fact, he can practically monopolize the ether for fifty or a hundred miles in every direction by simply sitting down at his transmitter and sending out dots and dashes."

Certainly a lot of "screening off" is required here.

And this state of affairs gives rise to grave doubts, and suggests the simple but important question: As these experiments were conducted in August 1901 over very short distances, and proved such failures, how was it that Signor Marconi succeeded in bridging the Atlantic in the following December ?

With respect to the latter performance, the *Standard* of December 16th, 1901, remarks :—

" The electric waves, like those of light, pass unimpeded through the air, whether it be at rest or in motion. The land have rippled in rhythm on the opposite side of the Atlantic."

What bold assertions for a man to make, more especially in the face of the previous account!

In the *Daily Mail* of January 21st, 1902, Mr. Marconi is reported as having stated that "he wanted to set at rest a doubt that had arisen, by stating that the next series of tests from Canada and the United States would include the *transmission of words and messages.*" Strange to say, that up to the present time, viz., 17th March 1904, they have failed to arrive. This is somewhat less than forty-five words per minute.

In a public announcement that appeared in the daily papers on February 2nd, it was stated: "Mr. Marconi sails from Southampton on Saturday on the *Philadelphia*, to resume his Trans-Atlantic experiments. He will try to break his previous record distance for wireless messages." Also, that he had "carefully inspected the apparatus at his Cornwall station, and arranged with his assistants the time and number of signals to be transmitted, as had been done between Poldhu and St. John's.

Rather mysterious that nothing has been heard of them, more especially as he took such a long journey for the purpose of setting the public mind at rest. However, as it might appear unseemly to dwell any longer on such an unsatisfactory matter, I shall pass on to consider the various excuses that have been devised to stave off the evil day and allay public disappointment.

On August 28th, 1901, Mr. Tunzelmann asserted that the failure "to recognize the necessity of tuning to the same oscillation period, or to octaves of the same period, the two electrical circuits, one containing the condenser and oscillators, and the primary of the oscillation transformer, and the other the secondary, *d′*, of the transof the non-successes of the earlier trials. It would be most interesting if Mr. Tunzelmann would kindly show how this alteration in any way overcame the difficulty; as, provided an instrument were so tuned, it would be incapable of transmitting in more than one key, and consequently would necessitate the employment of a separate transmitter for every private or secret message.

Later on, Mr. Tunzelmann observes: "Unless this condition" (already described) "be fulfilled, the different periods give rise to oscillations of different frequency, with a resultant effect of a feeble and unsatisfactory character. To obtain the best results, the oscillations in the two circuits should not only have the same frequency, but be in the same phase."

Here again, Mr. Tunzelmann has made two most egregious errors. For it would be impossible for the two circuits to have the same frequency if tuned in octaves, or to be in the same phase without being in unison. By the laws of vibration of sonorous matter, the term phase implies definite and relative positions of particles with reference to one another, the range of their vibrations, and constitution of their periods. Therefore, for vibratory bodies to be in the same phase, they must coincide with each other in construction, and be capable of producing a similar number of vibrations, or periods, of equal range, or amplitude, in a specified time.

But what seems more remarkable still, in face of the above opinion, is Mr. Tunzelmann's acquiescence in Mr. Marconi's belief that the opposite conditions are most essential; and on page 92 of his treatise he declares: "A necessary condition of this system is, that two conductors should be of unequal inductance, it being found preferable that the earthed conductor should have the smaller inductance." And continuing his remarks, he states: "Signor Marconi suggests what appears undoubtedly to be the true explanation of the necessity of this inequality, viz., that a difference in the phases of the oscillations in the two conductors is essential to adequate radiation, as, if they were in the same phase, their combined effort would be practically nil."

This is decidedly an opinion "made to order," and productive of the most conflicting testimony! Continuing his observations, Mr. Tunzelmann says: "In order to enable this to be done, the vertical radiator was arranged so that its inductance could be varied by means of a sliding contact as shown in fig. 36, and the condenser, *e*, was so constructed as to permit of its capacity being adjusted."

This seems to be a most astounding assertion for an electrician of the syntonic school to make, as capacity has nothing whatever to do with it.

By the term capacity is understood the quantity of electricity with which an insulated conductor "must be charged, in order to raise its potential from zero to unity."

By syntonization we understand the action necessary to duplicate a definite number of musical vibrations produced by a sonorous body at a definite rate, and in a definite period of time. As that body might weigh ten ounces or ten pounds, and yet produce a sound at the same pitch, it proves that capacity, in this instance, is at a discount, and is in no way accountable for the failure.

In February of the following year, Mr. Marconi stated positively, at the Ordinary General Meeting of the Marconi Wireless Telegraph Company Limited, that "he was pleased to say that by his latest invention the problem of secrecy had been solved." How was it, then, that Mr. Maskelyne intercepted his message to the Institute of the Royal Society in June 1903. Mr. Maskelyne, instead of being blamed for perpetrating such an act, should be applauded for it. For, when taxed by a reporter of the *Morning Leader* with committing the offence, he very correctly remarked: "I merely did what I had an absolute right to do—made an independent investigation as to the correctness of statements which I, in common with the rest of the public, was called upon to accept."

The failure of Mr. Marconi on that occasion was attributed to "Scientific Hooliganism."

The last quotation I shall give on this subject is from page 80 of Mr. Tunzelmann's work, and reads as follows:—

"By the use of reflectors it is possible to project the electric waves in an almost parallel beam, which will have no effect upon any receiver not lying in its course, *whether this receiver be syntonic with the waves or not.* This, as Signor Marconi has pointed out, would enable several forts, hilltops, or islands to communicate with each other in war time without any fear of the enemy tapping or interfering with the signals, for, if the forts were on a small height, the beams would easily be directed so as to pass over any position that might possibly be occupied by the enemy." This certainly renders confusion more confounded, and gives sensible persons an idea that electric science has drifted into a labyrinth of insurmountable difficulties with regard to electrical syntonization.

With the multitonophonic system all this scientific humbug and uncertainty is dispensed with, as the action of the most essential parts of the installation is the acme of simplicity. The portability of the instruments is perfectly surprising.

A transmitting disc, constructed in accordance with fig. 60, and having a diameter of 26 inches, which could be very conveniently carried by a child twelve years of age, would more than suffice to communicate secretly or publicly with every ship in the British Navy, as it would accommodate 700 pairs of speaking- and tuning-reeds, or vibratory armatures, capable of transmitting over sea or land 700 individual messages to a like number of persons or stations, either separately or simultaneously to every one of the group. It is not so with the aerial or etheric system: for while 700 of what they call their syntonic transmitters, as described in fig. 58,

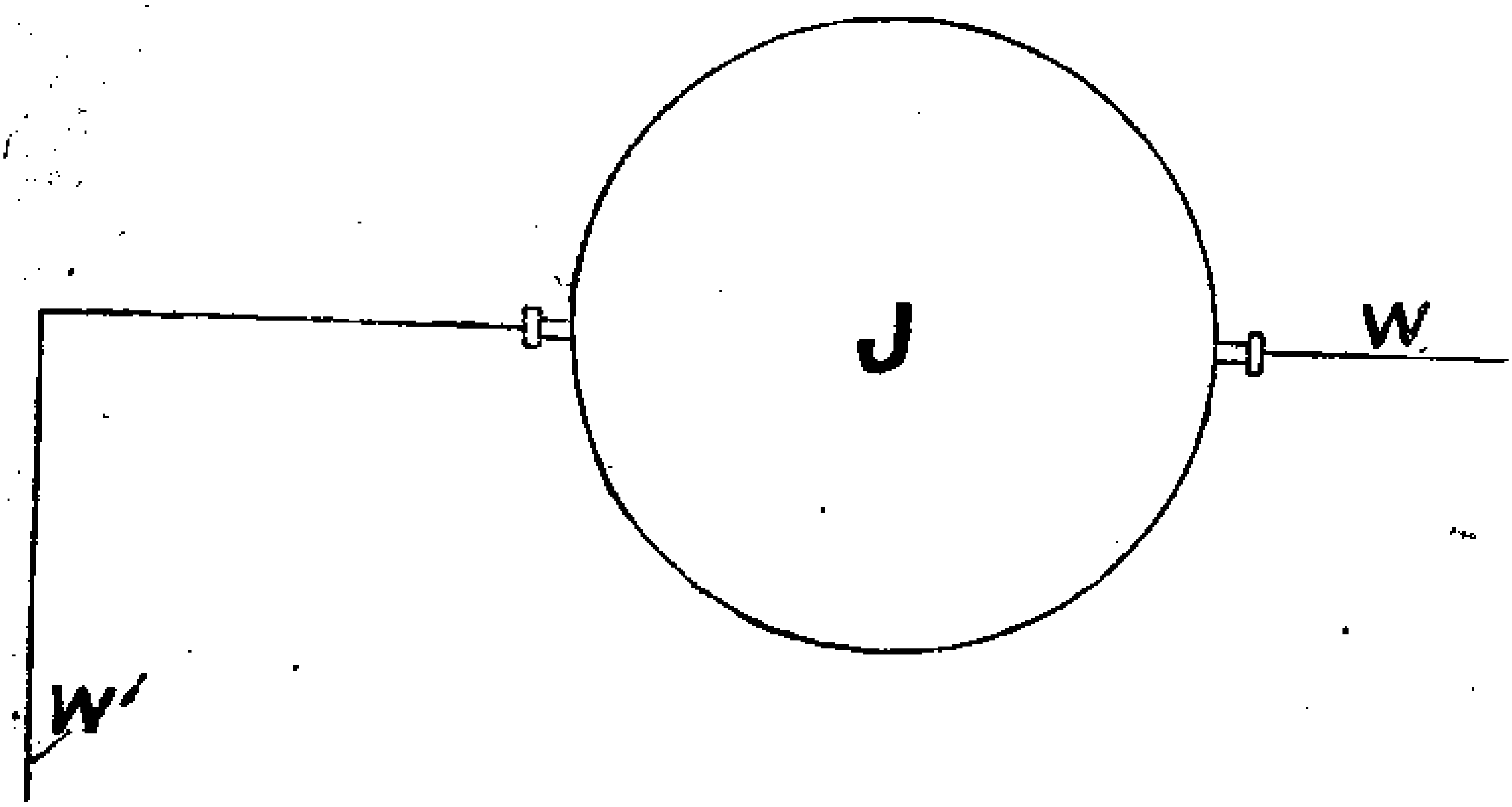


FIG. 67.—SHOWING DIRECT EARTH OR WATER CONNECTION AT W′, AND EARTH, WATER, OR CAPACITY CONNECTION AT W, OF A MULTITONOPHONIC CYLINDRICAL RECEIVER.

would weight about 35 tons, they could not despatch, secret messages, even provided the appliances were supplied.

Again, a multitonophonic receiver, as illustrated in fig. 70, weighs approximately 3 ounces, and can be stowed away in a man's waistcoat pocket, while aerial receiving apparatus would turn the scale at a considerable weight, if Mr. Tunzelmann's description be correct.

as, on page 98, he says: "This has made it possible to construct extremely portable apparatus for military purposes, a convenient method being to carry the whole arrangement on a motor car."

Moreover, a multitonophonic receiver requires no tuning up by the telegraphist—an operation which ended so disastrously at the Institution of the Royal Society on the occasion of the Marconi demonstration—as that part of the performance is undertaken by persons more skilled in the manufacture and adjustment of syntonic receivers than an ordinary operator. It would be as absurd for a telegraphist to be requested to tune his instruments, as for the manager of a firm to insist on his clerk putting his telephone in working order prior to transmitting or receiving a message. And, furthermore, with respect to this matter, a multitonophonic receiver receives the actual number of impulses direct from the transmitter (fig. 56) without being obstructed by a coherer, relay, recorder, parabolic reflector, metallic wings, or other impediments and unnecessary appliances.

Fig. 68 is a diagrammatical illustration of compound multitonophonic transmitting and receiving apparatus, wherein 41 is a microphonic transmitter, so constructed that it can, when desired, be brought into the primary circuit, *a*, of the induction coil, *a*, *b*, *c*. The following most carefully drawn and explicit description of the method of working the contrivance is by W. Lloyd Wise, Esq., of 46 Lincoln's Inn Fields, London, W.C., who drew the British and Foreign Specifications in this invention, and will give the reader an excellent idea of the general mechanism. He says:—

"The arrangement is such that when the switch lever, 41*c*, is open, and the switch, *V*, closed, the apparatus can be used as before for sending general or secret telegraphic messages to the telegraphic instruments, *h*; and

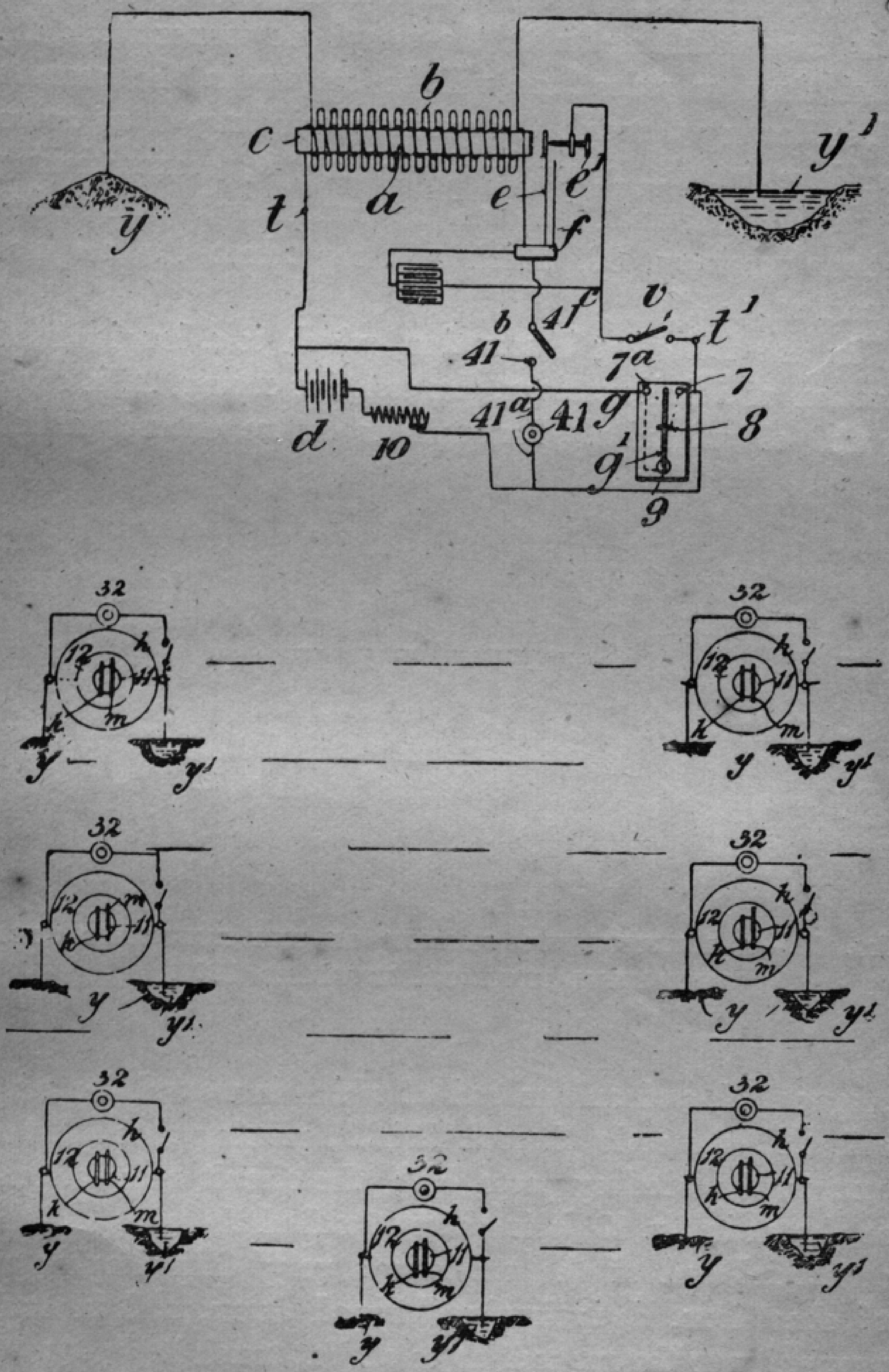


FIG. 68.—SHOWING COMPOUND TELEGRAPHIC AND TELEPHONIC TRANSMITTING AND RECEIVING APPARATUS AS USED IN THE MULTITONOPHONIC SYSTEM.

upon opening the switch, *V*, and closing the switch lever, 41*c*, and speaking on to the telephone transmitter, 41, variations or pulsations will be set up in the current then flowing through the primary winding, *a*, so as to produce in the secondary winding, *b*, corresponding secondary currents that will be transmitted to the telephone receivers, 32, which will reproduce the original vocal sounds."

In the following illustration, which is a longitudinal section of a Bell receiver, the exterior casing, *A*, is composed of vulcanite. Through its centre extends a bar

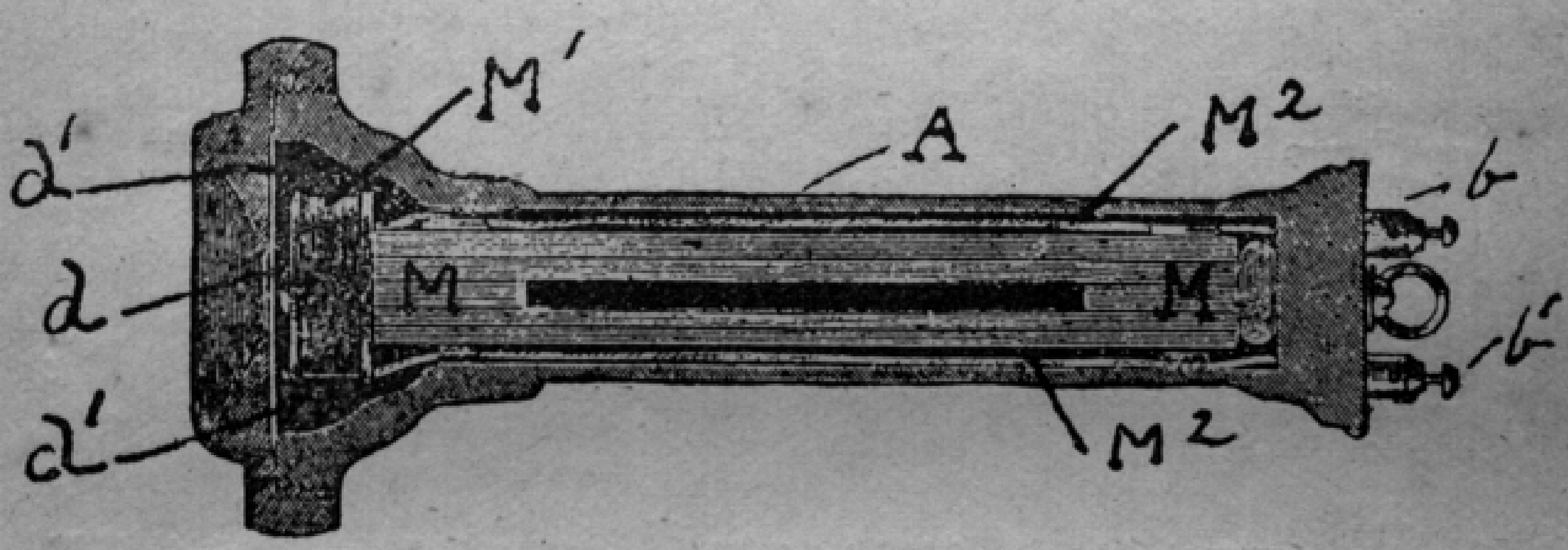


FIG. 69.—A LONGITUDINAL SECTION OF THE RENOWNED BELL TELEPHONIC RECEIVER, INVENTED 1876.

magnet, *M*, and on one end of which is wound the wire coil, M^1, the ends thereof, M^2,M^2, passing through the case to the binding posts, b,b^1; the circuit connections, as shown in fig. 18, being also attached thereto. At the auditorial end of the receiver a very thin diaphragm of sheet-iron, *d*, is firmly clamped down, and in such proximity to the magnet as to all but touch it.

Between the diaphragm and the ulterior part of the coil of wire, and round and in the immediate vicinity of the latter, is a recess, *d'*, designed for the purpose of assisting vibration, and converging the sound towards the centre of the disc, *d*.

On account of this remarkable invention, Mr. Bell has been the recipient of great and well-deserved honours, and although the receiver has been altered a vast deal in its outward appearance, as may be seen by referring to fig. 70, nevertheless the principle is virtually the same.

An instrument of this description can be used as a transmitter or receiver.

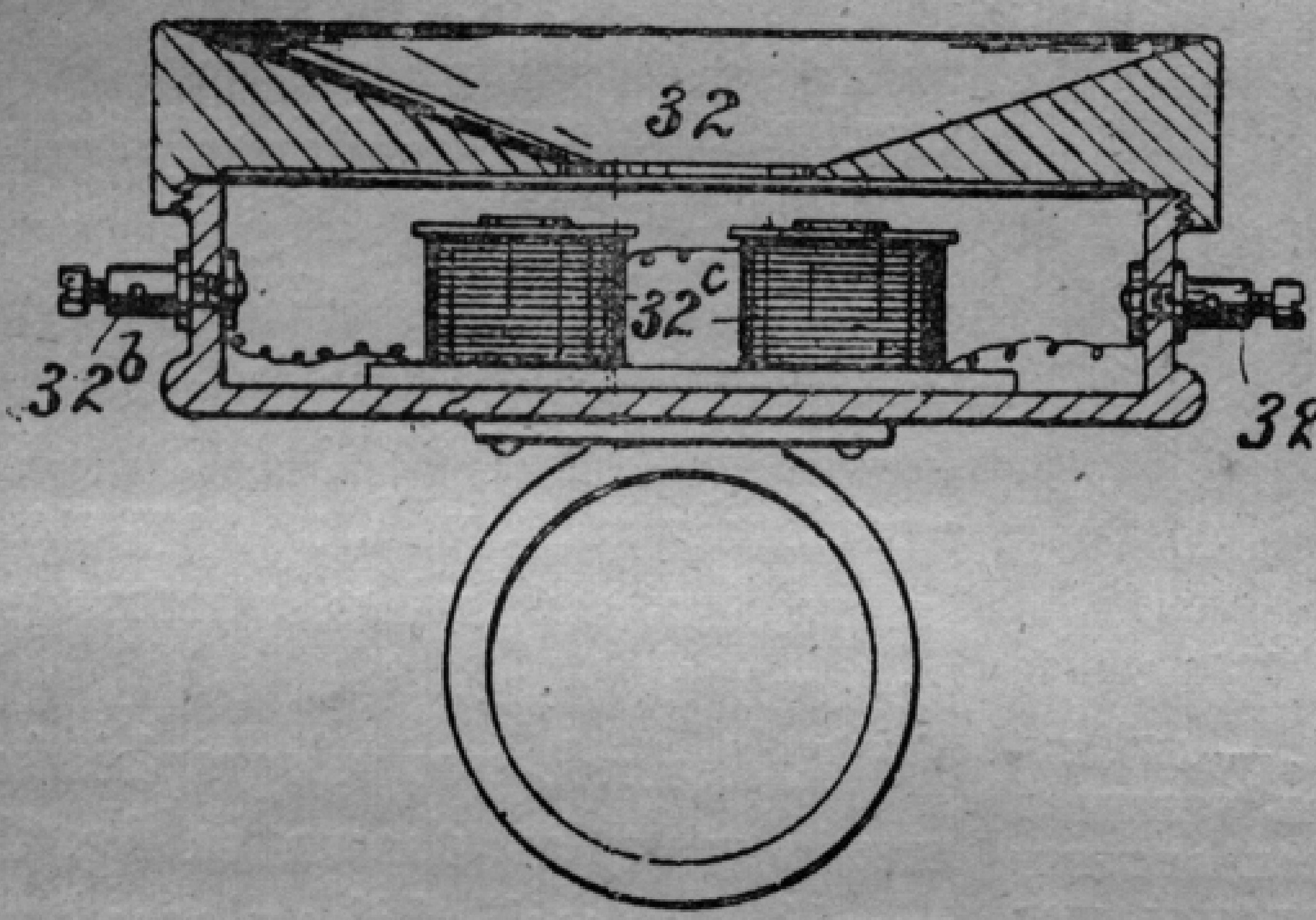


FIG. 70.

A VERTICAL SECTION OF AN ORDINARY WATCH RECEIVER.

Mr. Wise's explanation *re* transmission and reception of messages is also very clear. He states : " When it is desired to send a telephonic message, a telegraphic message is first sent to that effect, as hereinbefore described, to the telegraphic receiving instrument, *h*, or each of such instruments, which also acts as an alarm or call device, whereupon the person in charge of the telegraphic receiving instrument connects a telephonic receiver, 32 (fig. 68), in shunt to the terminal connections of the telegraphic receiving instrument, *h*. The contact-screw, *e′*, is then moved back into an inoperative position, and the circuit of the primary winding, *a*, closed through the telephonic transmitting instrument, 41, whereupon a telephonic message can be sent to the telephonic receiver or receivers by speaking on to such telephonic transmitting instrument. After receiving the telephonic message, the telephonic receiver, 32, is disconnected from the telegraphic receiving instrument, *h*, so as to leave the latter ready to again receive a telegraphic message.

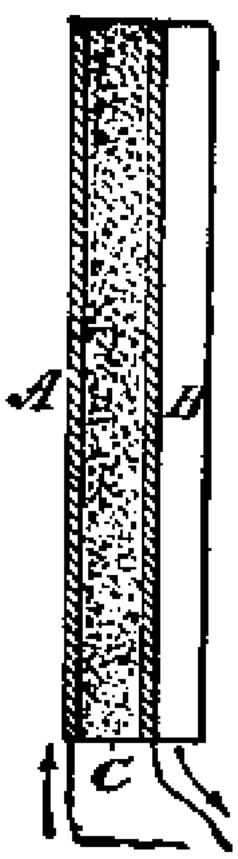


FIG. 71. — AN INTERNAL VERTICAL CENTRAL SECTION OF A GRANULATED CARBON MICROPHONE TRANSMITTER.

"By the means hereinbefore described, it will be understood that only the person or persons to whom a secret telegraphic message has been previously sent, will, at any moment, know that a telephonic message is to be sent to him.

"If desired, two telegraphic instruments may, as shown in fig. 72, be provided at each of the places between which communication is to be made—one, viz., h^2, being of the cylinder or loud sounding type (shown in fig. 49), to act more as an alarm or call device; and the other being of the watch receiver type (shown in fig. 70), by which a telegraphic message will practically only be heard by the person intended to receive the message putting the receiver to his ear or standing near to the receiver. In this case, the loud sounding receiver, h^2, may be arranged to be switched off when the other is used, so that after the attention of a person has been obtained by means of the loud speaking receiver, h^2, a secret

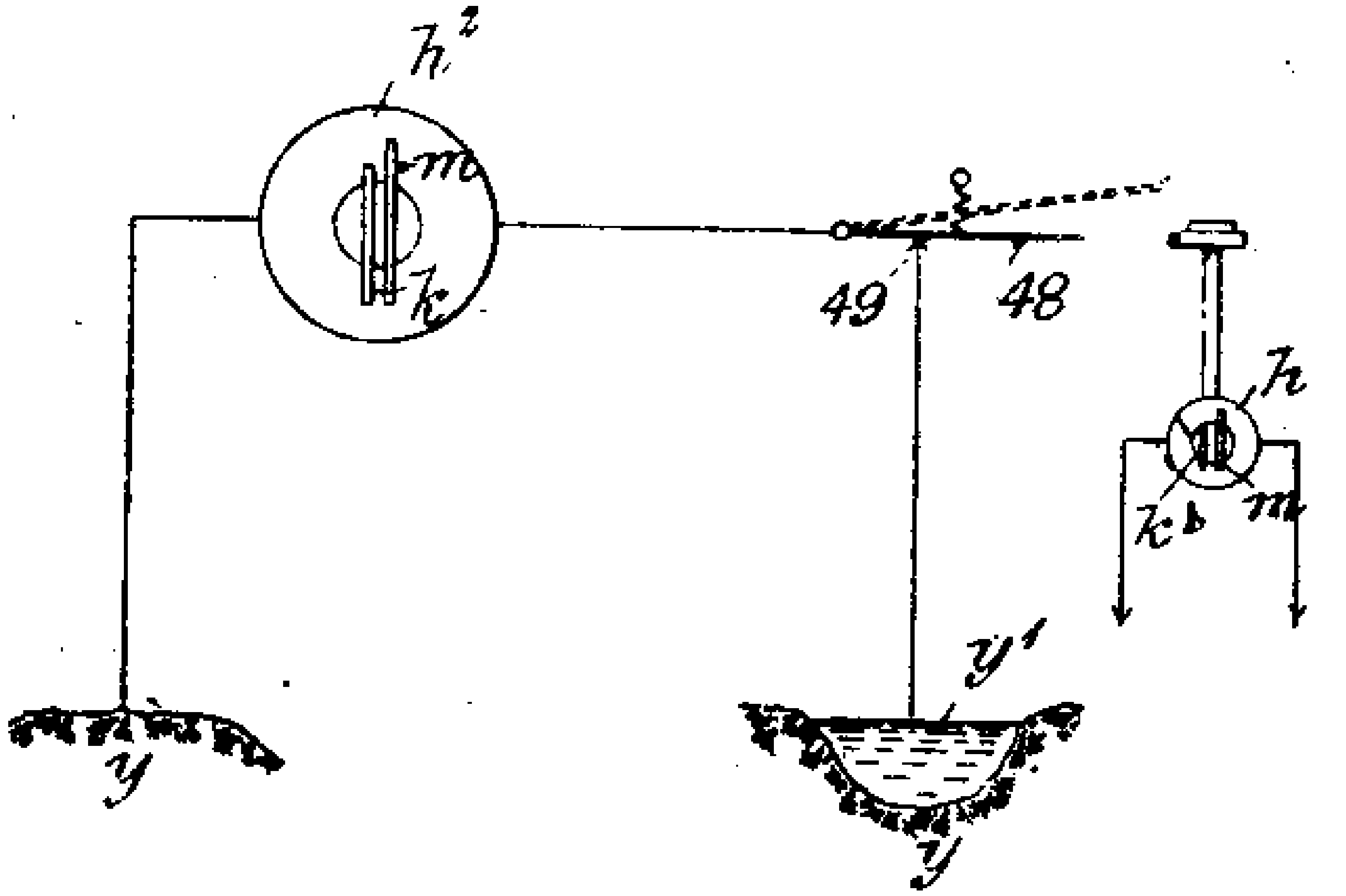


FIG. 72.—A COMPOUND MULTITONOPHONIC TELEGRAPHIC AND TELEPHONIC RECEIVER.

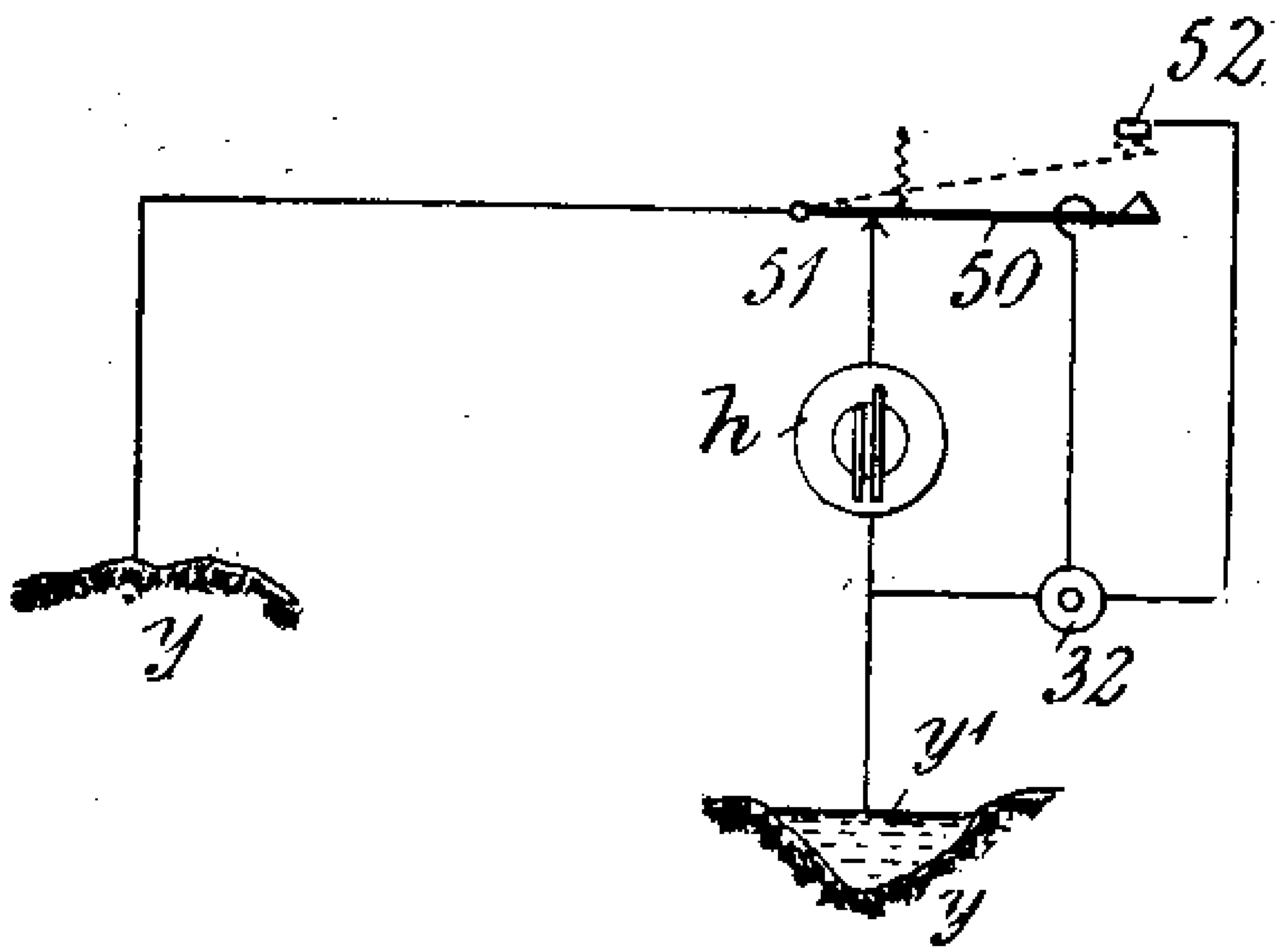


FIG. 73.—SHOWING AUTOMATIC ACTION OF A COMPOUND MULTITONOPHONIC RECEIVER.

message may be sent to, and received by, the secret reed, *m*, in the watch receiver, *h*. For this purpose, the receiver, *h*, may, be normally supported by a spring lever, 48 (fig. 72), that is held against a contact, 49, by the weight of the receiver, *h*, but will be allowed to leave the contact, 49, as shown in dotted lines, when the receiver, *h*, is removed from such lever for use.

"The terminal connections of the telegraphic and telephonic receiving instruments, *h* and 32 respectively, may also be similarly arranged, as shown in fig. 73, so that by merely moving the latter instrument from a spring lever, 50, to bring it into position for use, the said lever, 50, will automatically rise and put the former instrument, *h*, out of action by opening the circuit thereof at 51, and closing the circuit of the latter instrument, 32, at 52, the connections being reversed when the latter instrument is put back into its inoperative position."

Before closing the present chapter, it will be of interest to the reader to briefly refer to an article which appeared in the *Daily Express*, entitled "Marconi's marvels explained."

It was accompanied by an illustration (as shown in fig. 74), wherein Professor Pupin, of American celebrity, represented the etheric waves, which Marconi's supporters assert he uses in his demonstrations, as passing to and along the surface of the ocean to the deck of the ship with which he is in communication. This is a reasonable and intelligent view of what does actually take place, and one readily endorsed by persons capable of forming an unbiassed opinion on the subject. In conclusion, I advise the reader for satisfaction to make the following simple tests, when he will be amply rewarded for the time and trouble expended.

TEST No. 1.

On a dark night, place an Apps-Newton induction coil on a table in your dining-room, and connect it to an electric battery or accumulator. Adjust the points of the discharging rods in accordance with the sparking distance of the coil, say twelve inches. From each of the points, by a wire hook suspend a bunch of short copper wires, about two inches in length. Then upon a stool lay a damp cloth about seven inches below the straight line between the two points. Put out the gas in the room, and turn on the electric current, when a lovely brush discharge will be observed to emanate from the positive pole; and by rapidly reversing the commutator, the discharge will alternately appear from the points. This is quite sufficient to disprove the aerial system. For, provided a damp cloth attracts a current of electricity under such unfavourable circumstances, how is it possible for Marconi to project his electric waves for hundreds of miles over the surface of the ocean?

TEST No. 2.

Take three small induction coils, which can be purchased at about 4s. 6d. each, and by six separate wires, viz., three positive and three negative, connect them separately to the poles of the same battery or accumulator. Adjust a sparking-rod between the secondary terminals of each of the induction coils to prevent injury; tune the three contact-reeds or armatures to three different sounds, and turn on the three currents, when all the armatures will instantaneously respond and produce three sounds at different pitches, all of which will be perfectly distinct and independent of each other, although three sets of vibrations are simultaneously passing through the same generator. This test alone proves the perfection of musical syntonization.

TEST No. 3.

Connect the three positive terminals of the secondaries to one wire, and the three negatives to another; attach the loose ends of the two wires to an electromagnet, over which is adjusted a receiving reed tuned in unison or octave to one of the transmitting armatures. Turn on the three currents simultaneously, and observe that the receiving reed vibrates immediately. Turn them off one after the other, commencing with the tuned armature, when it will be seen that instantly the tuned armature is relieved of the slightest amount of mechanical resistance (which I wish to remind the reader has no connection at all with electrical resistance), the receiving reed ceases to vibrate, as the requisite number of oscillations required to cause syntonic action are not being produced; consequently, the receiver will remain stationary, notwithstanding that the other reeds, which cannot syntonize with it, are still in operation.

This proves complete secrecy, and thorough differentiation, and is accomplished without being aerially "screened off."

TEST No. 4.

Arrange three reed receivers in a semicircular manner, as *J*, *J*, *J* (fig. 75); syntonize one of them with the transmitter, *T*, and connect them up in series with *M* key, *K*, a battery with mixed and shunt circuits, as shown at *E* and *H*,*H*. Make contact in the main circuit,

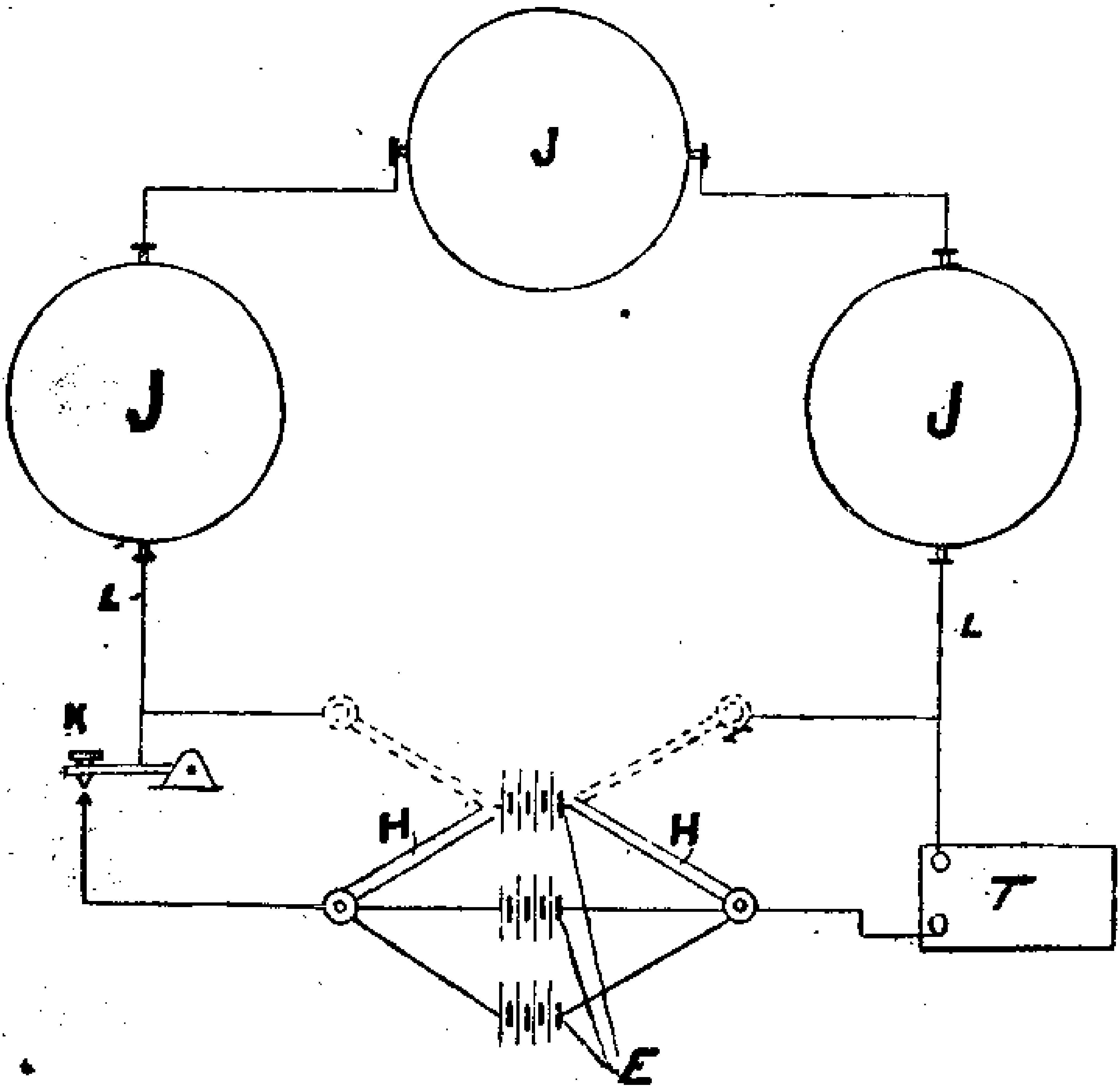


FIG. 75.—SHOWING A GROUP OF MULTITONOPHONIC RECEIVERS, HAVING THEIR MOVEMENTS ACTUATED BY MEANS OF MIXED AND SHUNT CIRCUITS.

with the tuned armature and contact-screw, in the manner previously described. Close the shunt circuit by raising the switches, as shown by the dotted lines, and manipulate the key as rapidly as possible, when the syntonised receiver only will vibrate, the others remaining perfectly quiescent, without any "screening off." These tests are highly interesting, and easily conducted, at a moderate outlay, on a table at a private residence.

CHAPTER XVI

CONCLUDING REMARKS

DURING the past nine years much has been said and written with regard to wireless telegraphy, and the hackneyed topic of electrical syntonization.

Thousands of pounds have been expended, and a vast amount of time wasted, on worthless experiments, instituted by propounders and promulgators of nonsensical theories. However, the well-known adage, that "it is a long lane that has no turn," has most assuredly been verified in this instance.

At last there is a rift in the cloud, and scientific obstinacy is being effectually dispersed by modernized and advanced views on this important subject. And although it may appear to the reader that a considerable period of time has elapsed ere light has dawned on this branch of science, yet "better late than never"; and it is highly gratifying to inform all well-wishers for the common-weal, that at last we are in a position to refute the foolish assertions, and successfully grapple with the antiquated ideas of our so-called electrical experts, and place before them, and the world in general, tangible proof of the errors of their belief, the utter absurdity of etheric telegraphy, and the impossibility to accomplish secret transmission and electrical syntonization by aerial means.

N.B.—An extensive treatise will be published shortly under the title, *A Dash for the Blue*, or *A Graphic Exposition of an Electric Muddle*, which will contain, amongst other important details, full instructions for the manufacture, adjustment, and manipulation of the essential parts of a multitonophonic installation.

CHAPTER XVII

CLIPPINGS FROM PRESS OPINIONS ON THE JOHNSON-GUYOTT MULTITONOPHONIC SYSTEM OF WIRELESS SECRET TELEGRAPHY AND TELEPHONY.

"DAILY NEWS."—*July 8th*, 1901.

"WIRELESS TELEGRAPHY AT EARL'S COURT."

"On Saturday afternoon, in the grounds of Earl's Court Exhibition, a new system of wireless telegraphy was explained to a few visitors. The system is the invention of Mr. Arthur T. M. Johnson, a member of the Amalgamated Institute of Mining Engineers, . . . a naval enemy would be foiled in the attempt to discover what was passing between a British admiral and a ship or station. . . . The invention is, we are informed, under the notice of the Admiralty."

"DAILY CHRONICLE."—*July 8th*, 1901.

"NEW SYSTEM THAT DISPENSES WITH THE MARCONI POLES."

"A wireless telegraphic station has been erected at the Earl's Court Exhibition, . . . and the installation on Saturday night was attended by the Mayor of Gravesend. The system adopted is a new one, the invention of Mr. Arthur T. M. Johnson, of the Amalgamated Institute of Mining Engineers. . . . The inventor of this system claims that it would be practically impossible for an enemy during war to tap the messages. The great novelty in the transmitter is the tuning contrivance. . . . With every change the receiver must be properly regulated so as to harmonize ; . . . messages are capable of transmission by this system through the earth . . . . and water."

"DAILY EXPRESS."—*July 12th*, 1901.

"CANNOT BE TAPPED—WIRELESS TELEGRAPHY WHICH SECURES PRIVACY."

". . . . It does not require the high poles which are the chief difficulty of the usual systems, and its messages cannot be tapped. *In spite of what is claimed for the other systems, their messages can be read, not only by those for whom they are intended, but by any other ship or station. . . . An Admiral . . . . could not signal to one of his ships . . . . without the whole of his fleet reading the message—and the enemy too, if their ships were fitted.* By this system, though there were twenty ships in his fleet, and they were twenty miles apart, the admiral could speak to one particular ship, and no other ship would receive the message."

"DAILY MAIL."—*September 26th*, 1901.

"NEW SYSTEM OF TELEGRAPHY."

"A system of wireless telegraphy has been invented, by which it is claimed a message cannot be tapped—as happened during the recent naval manœuvres—nor received at any station other than the one to which it is sent. The inventor is a Mr. Johnson, and the system is being shown at the Earl's Court Exhibition. . . . As each receiver has a different tune, it is impossible for a message to be tapped. The officials of the Admiralty have inspected the invention, and war-ships are to be fitted with the instruments for the purpose of making experiments."

"DAILY TELEGRAPH."—*August 10th*, 1901.

"CHECK ON TAPPING."

"The problem of controlling the wireless telegraph's loquacity, and confining its remarks to the persons for whom they are intended, presents many difficulties, . . . a demonstration of another system was given yesterday, which seems to possess considerable importance. It is flattering to our insular vanity that the inventor, Mr. Johnson, is an Englishman, a gentleman who was led to his ingenious discovery by combining a knowledge of electricity and music. . . . Mr. Johnson's invention does not require the lofty poles demanded by the Marconi system . . . . it is sufficiently well thought of for Captain Egerton and Lieutenant Coker to inspect it yesterday morning on behalf of the Admiralty. . . . *Mr. Johnson demonstrated beyond question* that, according to the adjustment of the vibrations, he could reproduce the note in the receiver which was attuned to it, but that at any other point the receiver was unaffected. The inventor was subjected to a searching series of questions, but he came out of them apparently with success. . . . Vibrations vary from about 8 per second for the lowest note, to 30,750 per second for the highest. Nikola Tesla only succeeded by using high electrical voltage in producing 20,000 vibrations. Mr. Johnson asserts that he can produce 30,750 vibrations with a low voltage. As the result of yesterday's demonstration, it is probable that before long a trial will be made on four war-ships."

"SUNDAY TIMES."—*August 23rd*, 1903.

"IMPROVING ON MARCONI—AN INVENTION TO SECURE SECRECY."

("*Sunday Times*" *Special*.)

"The publicity given to the experiments in wireless telegraphy have both demonstrated the utility of the invention and its present shortcomings. Not the least of the obstacles to the full development of the system has been the difficulty of securing absolute secrecy. This defect in strategical communications would, of course, be fatal, and our Continental neighbours have not been slow to expose it. Within the last week or so, several messages between our ships have been taken up with the greatest ease by foreign vessels. So far, all the conflicting systems of wireless telegraphy have failed to discover how the electric current can be tuned so that messages, instead of radiating, as they are said to do, through space in all directions, and being transmitted to all receiving stations, can be kept under control. A knowledge of the principles of music has enabled Mr. Arthur T. M. Johnson to elucidate the mystery. The inventor realized that the employment of bridged wires, spirals, helices, pipes, cylinders, relays, coherers, and syphon recorders are utterly useless in any system of electric tuning, as they are seriously affected by the various changes of the atmosphere, and therefore cannot be kept in tune. Pipes and cylinders are also rendered ineffective by reason of their bulky nature; relays obstruct the passage of all vibrations that are produced by the transmitting instruments. Coherers convey the electric vibrations directly to earth, consequently excluding the local battery circuit from the influences of all electrical impulses generated at the transmitting station, without which syntonization is impossible; and syphon recorders or Morse sounders 'cannot be attuned to receive special sounds.' It is on the principle of the tuning-fork that Mr. Johnson has based his invention. The only instrument which can be relied upon to withstand any climatic change is the reed unattached at one end. When two of these are tuned to the same pitch, they remain in harmony under all conditions. It is, indeed, the adaptation of the well-known principles of syntonized synchronism, which affirm that any sound composed of any definite number of vibrations will cause any sonorous matter capable of producing a like number of vibrations to respond instantaneously. The method is as follows: The operator at the transmitting station first ascertains the number of the reeds he is desirous of using, after which he revolves the reed disc of the tunable musical trembler, until both the tuning- and speaking-reeds respectively are situated immediately in front of the centre core, or cores, of the electro-magnet, or magnets. He then turns the screw of the contact-pillar until the end touches the platinum contact in the speaking-reed, closes the circuit, and turns the screw backwards or forwards till the speaking-reed synchronously causes the tuning-reed to vibrate also, which in turn compels the vibrator, or vibrators, at the receiving station to correspond. The tuning-reed is indispensable for the purpose of indicating to the operator whether the vibrator at the receiving station is acting or not, as instantly the tuning-reed ceases to oscillate, it shows that the speaking-reed has ceased to vibrate synchronously with it, and is also out of tune with the vibrator at the receiving station, which has stopped accordingly. It will thus be seen that the installation is founded on the multitonophonic principle, which will be familiar to all students of music. That naval experts should have been attracted by this striking improvement is not surprising. Already tests have been carried out on behalf of the Admiralty with complete satisfaction. Arrangements are now being made for long-distance experiments on board the war-ships at Portsmouth, and if the results realize expectation, an inestimable advance will have been made in the direction of perfecting wireless telegraphy. Mr. Johnson is at present giving expositions of his discovery in the garden and conservatory of a West End house with the aid of a long tank of water, and the distinctness with which the messages are delivered from a distance of some sixty feet certainly warrants the assumption that the more severe trials which the Government are about to execute will be successfully accomplished."

"DAILY EXPRESS."—*September 26th*, 1901.

"The present system . . . . requires no lofty poles, and . . . . its messages can only be read by the right ship or station. The sender will only affect a receiver in tune with it."

PRESS CRITICISMS ON THE AERIAL SYSTEM

"DAILY TELEGRAPH."—*July 24th*, 1901.

"NAVAL MANŒUVRES—'X' FLEET AT GUERNSEY."

"We are looking forward with much interest to the experiments with wireless telegraphy . . . . when it is possible to so tune up our instruments that we may be certain that our messages do not wander into the wrong hands."

"DAILY MAIL."—*August 16th*, 1901.

"ADMIRAL'S CLEVER RUSE—HOW HE READ THE ENEMY'S WIRELESS MESSAGES."

"The triumph of the invading 'X' fleet over the defending 'B' squadron has been largely attributed to the brilliant strategy of Vice-Admiral Wilson, V.C. . . . The messages cannot be screened off, so that they will reach only the ship for which they are intended. . . . In fact, Vice-Admiral Wilson had the advantage of being able to sit in his cabin and read the messages that were passing between the enemy's ships; but he took good care to issue for his own fleet a code that could not be deciphered by the foe, even if he interrupted the message."

"THE GLOBE."—*November 12th*, 1901.

"WIRELESS TELEGRAPHY."

"It is stated by the *Army and Navy Journal* of New York, that the American naval authorities are dissatisfied with the existing systems of wireless telegraphy, and are continuing their search for a system which seems to adapt itself more completely to naval purposes."

After perusing the above, it is obvious, to any intelligent mind, that the so-called aerial methods do not produce satisfactory results, and cannot under any circumstances comply with the requirements which exist; and, moreover, that the Johnson-Guyott system of syntonized synchronism, or the principle of simultaneous vibration of sympathetic and sonorous bodies, is the only effectual means whereby perfect secrecy, absolute certainty, and the possibility of communicating with a group of ships, or stations, collectively or individually, can be obtained.

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