N° 18,644 A.D. 1897

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Complete Specification Left, 11th June, 1898—Accepted, 16th July, 1898

PROVISIONAL SPECIFICATION.

Improvements relating to Electric Telegraphy.

We, OLIVER JOSEPH LODGE, of 2, Grove Park, Liverpool, in the County of Lancaster, D.Sc., F.R.S., Professor of Physics in the University College, Liverpool aforesaid, and ALEXANDER MUIRHEAD, of Princes Street, in the City of Westminster, D.Sc., Electrical Engineer, do hereby declare the nature of this invention to be as follows:—

Our invention relates to systems of telegraphing by means of Hertzian waves and has for its objects to provide means whereby greater certainty of action is obtained and whereby the distance between the emitting and receiving apparatus may be materially increased; to effect, as compared with the systems of telegraphy at present in vogue, an economy in signalling between distant points, and generally to effect the improvements hereinafter indicated.

In carrying out our invention we use in the receiving circuit a recording telegraph instrument of the Kelvin siphon recorder or other suitable type connected in series with a battery and a coherer of novel construction.

The coherer may be constructed of two or more tubes containing iron or nickel filings or the like, amalgamated or not, joined up in multiple arc and in conjunction with these tubes is a vibrating hammer which is kept in constant motion, preferably by means of clockwork, and is so placed relatively to the tubes of filings that it comes into contact with each tube successively during every period of revolution.

The construction of the coherer may be such that decohesion or the restoration to sensitiveness of the mass, which forms the active part of the coherer after every passage of the Hertzian waves, takes place in the mass itself instantly after the act of cohesion, without the aid of vibrating hammers or similar devices, that is to say, in one form of coherer made according to this invention the filings form a conducting mass spread out on a strip or otherwise supported in the magnetic field between the two poles of either a permanent magnet or an electromagnet so that on the passage of Hertzian waves through the filings, when electrical cohesion or more complete contact has taken place under the electrical stimulus of such waves, a stronger current from the battery in connection with the coherer flows through the strip or mass of filings, the result being a greater deflection of the mass due to the action of the magnetic field. The bending or deflection in one direction of the strip carrying the filings or the disturbance of the mass of filings separates them and thus breaks down the cohesion between them.

For the transmitter we may employ an ordinary extra current spark such as occurs when the current of a voltaic battery is broken or when a current round a self-induction coil is varied, or started, or stopped, or when a condenser is charged or discharged, or any other means of producing an electric jerk or discontinuous or transient current such as are capable of exciting a coherer. And the effect of these electric jerks may be conveyed to the distant coherer either through space or along conductors of any kind, or along bare wires, or the outer sheathing of

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cables, or any other conductor leading from the sending station to the receiving station.

As an example of a complete telegraphic system according to this invention we may specify the following:—At each end of an uninsulated metallic wire or conductor between two stations there will be any form of coherer, such for example as those above described, in circuit with a battery and a recording instrument, one terminal of the coherer being connected to the telegraph wire, or conductor, and at the same point is connected through a self-induction coil, a Morse key and battery, one pole of the latter being to Earth. Sometimes we may connect a condenser between the earth and the terminal of the coherer opposite to that which is connected to the telegraph wire or conductor to increase the effect of the arriving electrical impulse upon the coherer.

When we employ synchronous collectors or resonators in conjunction with our system of telegraphy we in some cases connect the coherer to the extreme end of the resonator when a single resonator is used, or when a pair of equal resonators is used end to end, we place the coherer between the two inner knobs of the discharger and between the coherer and battery and receiving instrument respectively a pair of self-induction coils to isolate the coherer for oscillations.

Another arrangement is with a closed circuit similar to one of Hertz's arrangements in which little sparks occurred between the discharger knobs. At that same place we put the coherer together with its battery and receiving instrument, but to avoid the disturbance of time period caused by the arrangement, we introduce a condenser across the poles of the coherer of sufficient capacity to act as a virtual short-circuit for oscillatory currents. The addition of a condenser to any simple coherer circuit across the poles of the coherer eliminates battery and receiving instrument so far as oscillations are concerned and at the same time it gives a static charge ready to strengthen the surgings through the coherer. This use of a condenser in coherer circuits such as will enable them to have a definite time period in spite of their containing also a battery and recorder or galvanometer or other complications of coils, and the like, forms a distinct part of our invention.

A convenient arrangement of adjusting the sensibility of the coherer circuit is to place the coherer in one arm of a Wheatstone bridge arrangement so that the receiving instrument responds whenever the coherer changes in resistance. An electromagnet may be placed in another arm of the Wheatstone bridge arrangement so that whenever the coherer diminishes in resistance through the influence of electric waves the electromagnet loses much of its force and so can drop a keeper on to the coherer to tap it back. The electromagnet holds the keeper on until the change in coherer resistance drops it off without any tendency to "tremble." The electromotive force applied to the coherer can in the above arrangement be adjusted to any fraction of the battery employed.

With coherers constructed as above described we sometimes arrange the receiving circuit as follows:—In three parallel circuits we join up (1) a battery and adjustable resistance (2) a condenser and recorder and (3) the coherer of variable resistance. Or we substitute an induction coil for the condenser joining the coherer, the battery and the primary of the induction coil in series and inserting the receiving instrument in the secondary. By the above arrangements of apparatus in the receiving or coherer circuit fluctuations of current are detected in the receiving instrument rather than the current itself.

Dated this 11th day of August 1897.

A. F. SPOONER,
323, High Holborn, London,
Agent for the Applicants.

COMPLETE SPECIFICATION.

Improvements relating to Electric Telegraphy.

We, OLIVER JOSEPH LODGE, of 2, Grove Park, Liverpool, in the County of Lancaster, D.Sc., F.R.S., Professor of Physics in University College Liverpool aforesaid, and ALEXANDER MUIRHEAD, of Princes Street, in the City of Westminster, D.Sc., Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

Our invention relates to systems of telegraphing by means of Hertzian waves and has for its objects to provide means whereby greater certainty of action is obtained and whereby the distance between the emitting and receiving apparatus may be materially increased; to effect, as compared with the systems of telegraphy at present in vogue, an economy in signalling between distance points, and generally to effect the improvements hereinafter indicated.

In carrying out our invention we use in the receiving circuit a recording or receiving instrument as indicated at *a* in the accompanying drawings connected in series with a battery *b* and a coherer *c* of the construction hereinafter described or other suitable form. The receiving instrument *a* shown in the diagrams is a Kelvin siphon recorder but it may be a telephone or other instrument able to respond to slight fluctuations of current.

The coherer, which may be of any suitable construction, is indicated diagrammatically in most of the accompanying drawings as being of that form now known as a "single-point" coherer. According to our present invention, however, two or more coherers are employed (the diagram Figure 1 shows three) joined up in multiple arc and in conjunction with them is a rotating or vibrating tapper or cam *d* which is kept in constant motion, preferably by means of clockwork, and is so placed relatively to the said coherers that it comes into contact with each one successively during every period or revolution. The object of this arrangement is to ensure that at least one coherer shall be in its receptive condition.

The construction of the coherer may be such that decohesion or the restoration to sensitiveness of its active part after every passage of the Hertzian waves takes place in the sensitive part itself instantly after the act of cohesion, without the aid of vibrating hammers or similar devices. Figure 2 illustrates this form of coherer. Suitable filings *e* forming a conducting mass are spread out on a flexible light strip *f*. This strip is suitably supported in the magnetic field between the two poles N S of either a permanent magnet or an electromagnet. When the strip is made of aluminium or other suitable metal there is placed between it and the filings an insulating film f^1 of varnish or other material. It will be seen that at one end of the strip *f* the filings extend beyond the insulating film f^1 whilst at the other end the latter effectually separates the filings from such strip. A second smaller light metallic strip *g* is maintained by light springs g^1 upon the filings *e*. When, under the stimulus of Hertzian waves, electrical cohesion or more complete contact takes place, a stronger current from the battery *b* flows through the whole length of the strip *f* to the mass of filings and thence through the upper strip *g* to complete the electrical circuit; the result being a greater deflection of the strip due to the action of the magnetic field. The bending or deflection in one direction of the strip *f* disturbs the mass of filings and separates them thus breaking down the cohesion previously existing between them. The coherer may be confined within any suitable casing.

As transmitter we may employ (as shown in Figure 3) an ordinary extra current spark such as occurs when the current of a voltaic battery b^1 is broken or when a current round a self-induction coil *h* is varied, or started, or stopped, or any

other means of producing an electric jerk or discontinuous or transient current such as are capable of exciting a coherer but we prefer to use, as illustrated in Figure 4, an induction coil *i* with one or more spark gaps *j* joined up as shown. And the effect of these electric jerks may be conveyed to the distant coherer either through space or along conductors of any kind, or along bare wires such as *k* or the outer sheathing of cables, or any other good bare conductor leading from the sending station to the receiving station.

As an example of a complete telegraphic system according to this invention we may specify the following:—At each end of a bare or uninsulated metallic wire or conductor *k*, extending between any two stations, is one or more coherers *c* in circuit with a battery *b* and a receiving or recording instrument *a*, one terminal of the coherer being connected to the telegraph wire or conductor *k*, and at the same point connected through a switch *l* is a self-induction coil *h* or its equivalent, a Morse key *m* and battery b^1; one pole of which latter may go to Earth as indicated in Figure 3 or else to some lofty capacity like a lead roof.

Sometimes we may connect a condenser *n* between the earth and the terminal of the coherer opposite to that which is connected to the telegraph wire or conductor to increase the effect of the arriving electrical impulse upon the coherer also as shown in Figure 3.

When we employ synchronous collectors or resonators in conjunction with our system of telegraphy we in some cases connect the coherer to the extreme end of the resonator, when a single resonator is used, as illustrated in Figure 5; or when a pair of equal resonators is used end to end, we place the coherer between the inner ends of the resonators as shown in Figure 6. In this arrangement the battery and receiving instrument connexions if made to the resonator at all are made at the middle of the resonators otherwise they would disturb the oscillation period. The coherer being a non-conductor normally does not disturb the resonators.

Another arrangement, as shown in Figure 7, is with a large closed circuit similar to one of Hertz's arrangements in which little sparks occurred between the discharger knobs. At that same place we put the coherer *c* and in another part of the circuit we place the battery *b* and receiving instrument *a* but to avoid the disturbance of time period caused by their introduction we shunt them by means of a condenser *n* of sufficient capacity to act as a virtual short-circuit for oscillatory currents.

The addition of a condenser as a shunt to any simple coherer circuit in this manner eliminates battery and receiving instrument so far as oscillations are concerned. This use of a condenser in coherer circuits such as will enable them to have a definite time period in spite of their containing also a battery and recorder or telephone or other complications of coils and the like forms a distinct part of our invention.

A convenient arrangement of adjusting the sensibility of the coherer circuit is to place the coherer *c*, as shown in Figure 8, in one arm of a Wheatstone bridge arrangement so that the receiving instrument *a* responds whenever the coherer changes in resistance. An electromagnet *p* may be placed in another arm of the Wheatstone bridge arrangement so that whenever the coherer diminishes in resistance through the influence of electric stimulus the electromagnet loses much of its force and so can drop a keeper p^1 on to the coherer to tap it back. The electromagnet *p* holds the keeper on until the change in coherer resistance causes it to drop off without any tendency to "tremble." The electro-motive force applied to the coherer can, in the above arrangement, be adjusted to any fraction of the battery employed. The coherer shown in Figure 8 is a known kind consisting of a tube of metallic or other filings or powder but obviously any other form may be employed.

As shown in Figure 4 the receiving devices may be arranged in three parallel circuits that is to say (1) a battery *b* and adjustable resistance *q* (2) a condenser *n* and recorder or other receiving instrument *a* and (3) the coherer *c*. Or we may, as shown in Figure 9, substitute an induction coil P.S. for the condenser *n*, joining

the coherer *c*, the battery *b*, and the primary P of the induction coil in series and inserting the receiving instrument *a* in the secondary S. By the above arrangements of apparatus in the receiving or coherer circuit fluctuations of current are detected in the receiving instrument rather than the mere presence itself of a current.

Of the various alternatives hereinbefore mentioned the method we at present prefer is a spark gap at the sending end of the system excited by a Ruhmkorff coil with a bare wire or mere earth connection leading to a coherer at the receiving end, the other terminal of the spark gap and of the coherer respectively being each connected to one of a pair of elevated conductors or "sky-plates" such, for instance, as a pair of insulated roofs. The diagram Figure 10 illustrates this arrangement. *r*, r^1 depict respectively the sending and receiving sky-plates. *j* is the spark gap and *c* is the coherer. The dotted connections *s*, *s* lead to the Ruhmkorff coil, transmitting key and battery, whilst the similar connections s^1, s^1 lead to the remaining elements of the coherer circuit. *k* represents a bare wire, conducting pipes, or the like. Or instead of sky plates as shewn in Figure 10 other earth plates may be employed or there may be two bare wires instead of one between the two stations as hereinafter described. If the bare wire has to stop anywhere each end should be terminated by a large flat area.

A complete station would as before explained also contain a switch for changing it over from sending to receiving. The function of the switch in the arrangements is explained by reference to the diagram Figure 11. *r* is the sky plate and E the earth or bare wire connection. For sending, 1 and 6 and 5 and 4 are connected and 2 and 3 for safety to the coherer thereby short-circuiting it. For receiving, 1 and 2 and 3 and 4 are connected and optionally 5 and 6.

The sky-plate instead of being a mere emitter or collector may be a syntonic radiator or resonator as shown in Figure 12 everything else remaining the same as in Figure 11. In Figure 12 the oscillations sympathetically set up in the resonator overflow into the coherer as soon as they have become strong enough, by reason of sympathetic tuning or resonance.

Sometimes we employ two earthed connections or partially insulated wires and in that case, as shown in Figure 13, we connect the transmitting coil to two spark gaps *j*, *j* (either of which may be closed at pleasure) leading to the two wires, *k*, *k*, and the coherer circuit at the distant end, either in series or in shunt with its battery and detector to the other ends of the two wires. When battery and detector are joined in series with the coherer a condenser shunting them is useful as in former diagrams.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In combination, in the receiving circuit of a system of Hertzian wave telegraphy, two or more coherers joined up in multiple arc and means whereby such coherers are successively decohered substantially as set forth.

2. The coherer constructed substantially as described with reference to Figure 2 of the accompanying drawings.

3. A telegraphic system comprising one or more bare or uninsulated metallic wires or conductors between the stations, means for transmitting electric jerks or discontinuous or transient currents such as are capable of exciting a coherer into the conductor, and a coherer circuit substantially as set forth.

4. In a coherer circuit the condenser *n* or its equivalent located substantially as and for the purpose set forth.

5. Coherer circuits constructed as described with reference to Figures 5, 6 and 7 of the accompanying drawings.

6. A coherer circuit comprising a Wheatstone bridge arrangement in one arm of which is the coherer and in another arm of which is an electromagnet which latter effects the decohesion of the coherer substantially as set forth.

7. At the receiving end of a telegraphic system three parallel circuits consisting respectively of a battery and adjustable resistance, a receiving instrument and a condenser or its equivalent, and a coherer.

8. In a coherer circuit, means, substantially as set forth, whereby fluctuations of current therein are detected and recorded.

Dated this 10th day of June 1898.

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Agent for the Applicants.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1898

Fig. 1.

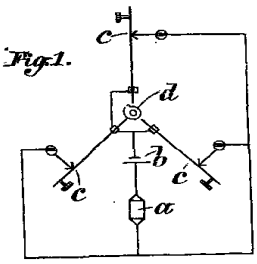


Fig. 2.

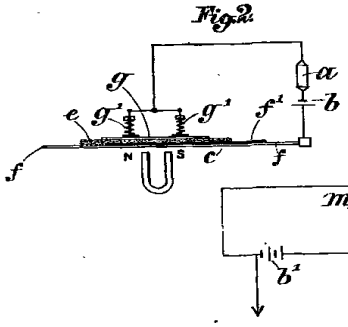


Fig. 3.

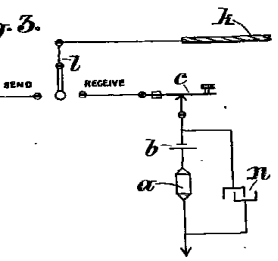


Fig. 8.

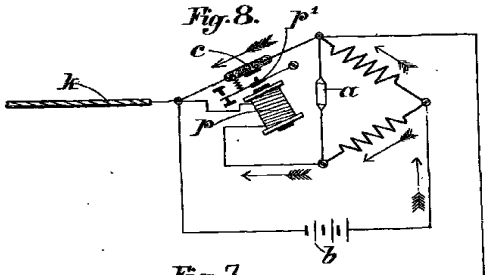


Fig. 4.

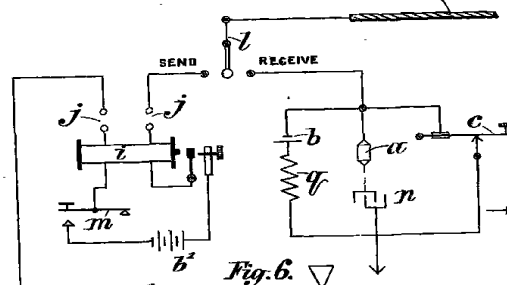


Fig. 9.

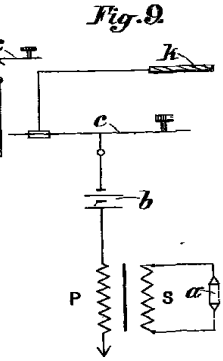
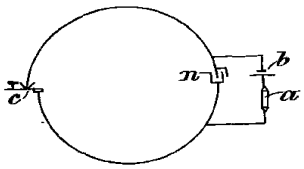


Fig. 7.



E

E

Fig. 5.

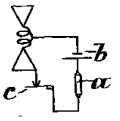


Fig. 6.

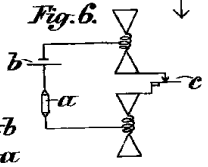


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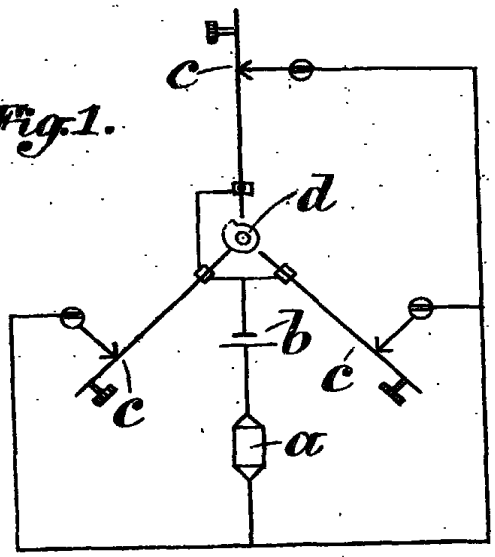
Fig. 1.



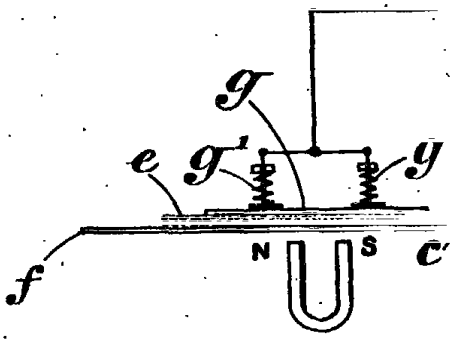


Fig. 8.

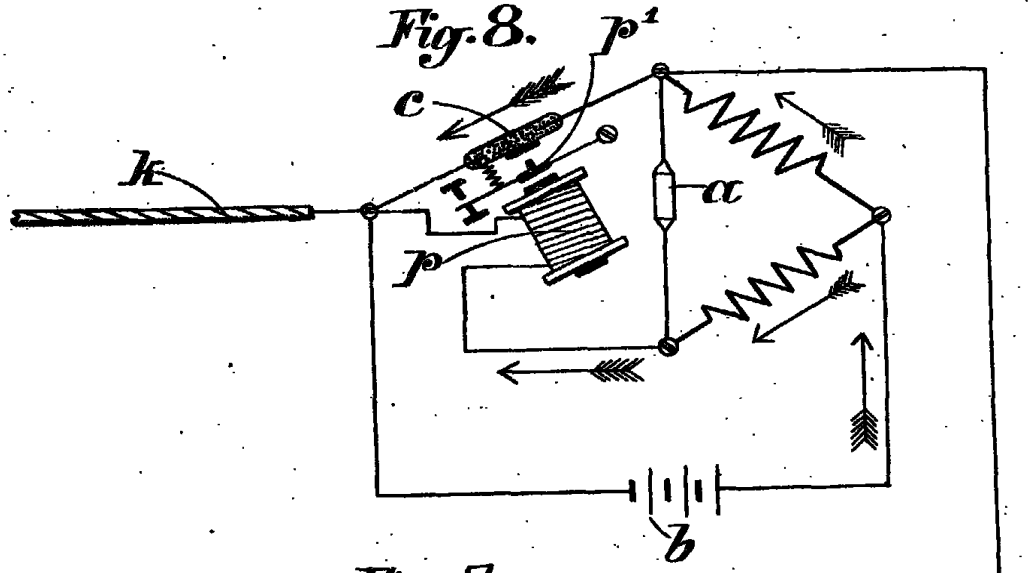
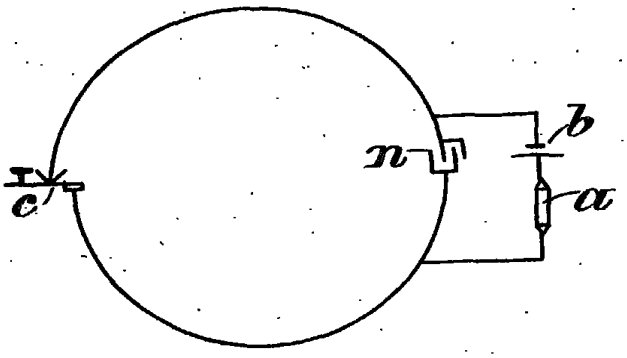
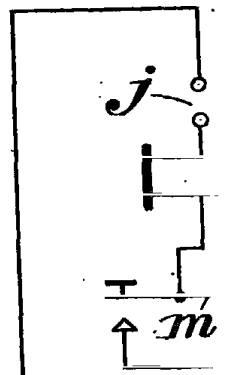


Fig. 7.





E

E

Fig. 2.

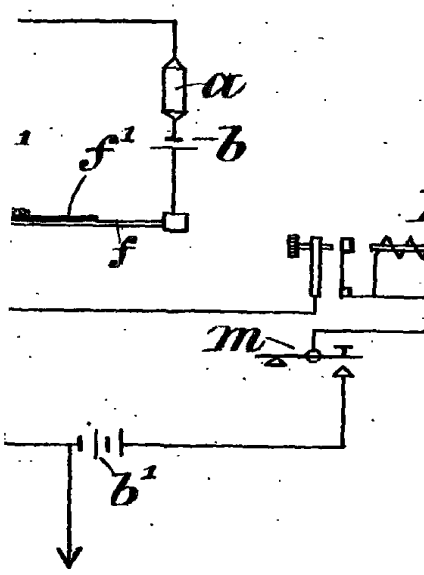


Fig. 3.

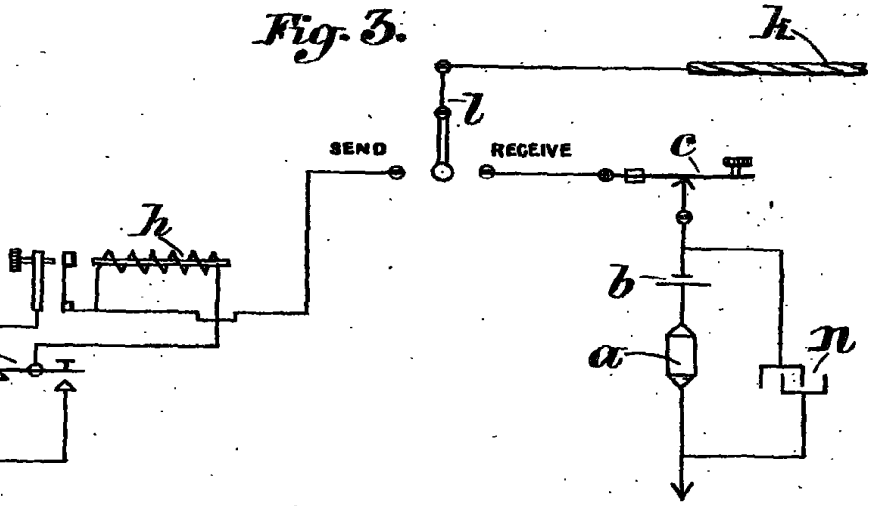


Fig. 4.

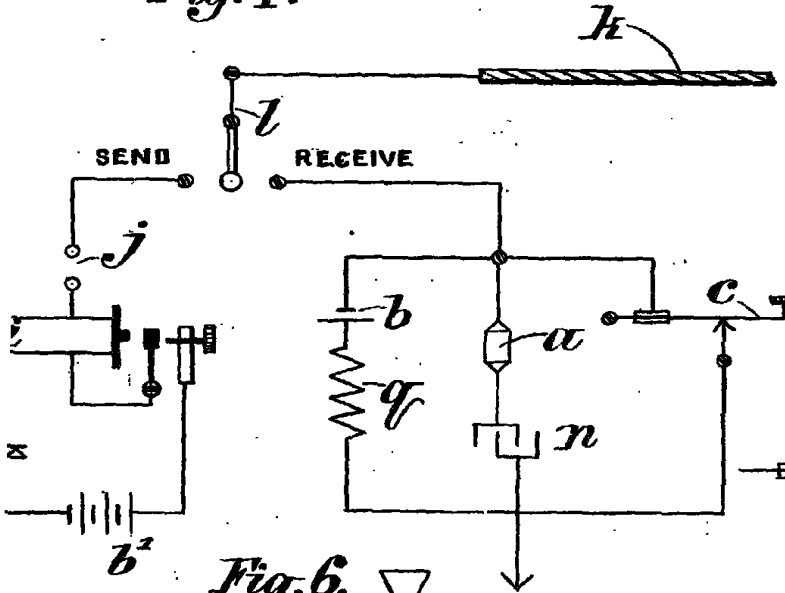


Fig. 5.

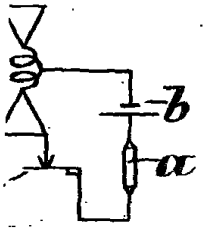


Fig. 6.

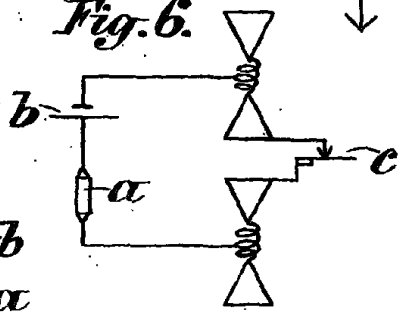


Fig. 9.

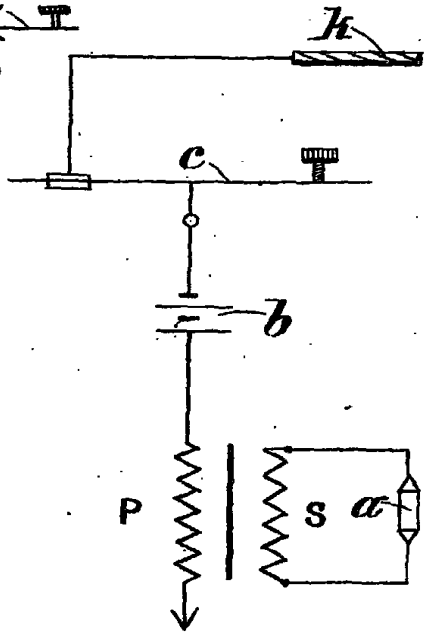


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Fig. 10.

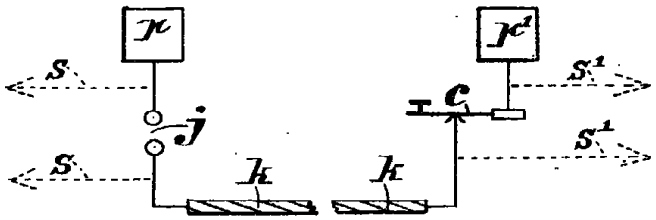


Fig. 11.

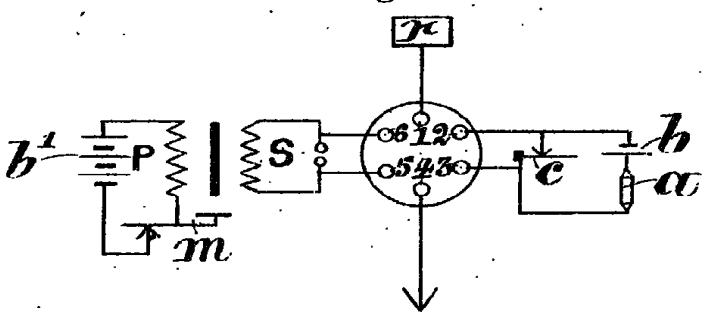


Fig. 12.

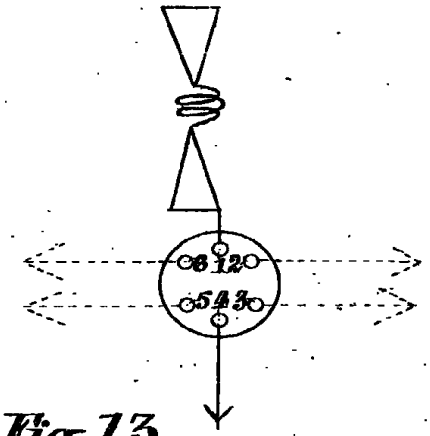
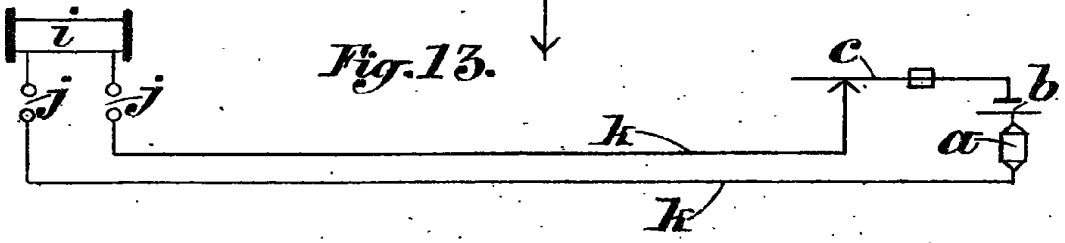


Fig. 13.



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