

N^o 7777



A. D. 1900

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PROVISIONAL SPECIFICATION.

“Improvements in Apparatus for Wireless Telegraphy.”

We, GUGLIELMO MARCONI, Electrician, and MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED, both of 28 Mark Lane, in the City of London, do hereby declare the nature of this invention to be as follows:—

5 The object of this invention is not only to increase the efficiency of the apparatus hitherto employed, but also to so control the action as to cause intelligible communications to be established with one or more stations only out of a group of several receiving stations.

10 In the Specification of a former Patent, No. 12039 of 1896, a transmitter is described which consists of an induction coil, one terminal of the secondary circuit being connected to a metal sphere connected to earth and the other to a similar sphere connected to an insulated conductor which generally takes the form of a more or less vertical wire which may or may not terminate or have attached to it a metal body of extended surface, giving it increased electrical capacity.

15 According to the present invention, the vertical wire is connected to earth through the secondary winding of a transformer of a kind suitable for the transformation of very rapidly alternating electric currents and the primary of this transformer is connected to the spheres or terminals of the sparking appliance.

20 A condenser of suitable capacity is introduced in series with the primary or each end of the primary may be connected to one of the plates of two condensers of suitable capacity, the other plates of which are connected to the sparking appliance.

25 This device enables much more energy to be imparted to the radiator than heretofore, the approximately closed circuit of the primary being a good conserver and the open circuit of the secondary a good radiator of wave energy.

The arrangement works as follows:—

30 On pressing the key and actuating the induction coil (in order to produce a signal) the condenser in circuit with the transformer is charged and subsequently discharges through the spark gap. If the capacity, the inductance, and the resistance of the circuit are of suitable values, this discharge is oscillatory, with the result that alternating currents of high frequency pass through the primary of the transformer, and induce similar oscillations in its secondary these oscillations being communicated to the elevated conductor.

35 The circuit of the elevated conductor should preferably be suitably attuned for this purpose.

The effect of these oscillations in the elevated conductor is to inductively affect similar distant conductors if the self-induction and capacity of the said conductors is of a suitable value or values.

40 At the receiving end a receiver is employed capable of being actuated by electrical oscillations of high frequency such as those described in the Specifications Nos. 12326 of 1898, and 6982 of 1899.

45 The transformer which has been used at the transmitting station preferably consists of two windings of a few turns of insulated wire. The length of the wire and dimensions of the transformers may vary between wide limits, but satisfactory results have been obtained when working with vertical wires 100 feet long, with coils constituted of 10, 20, 30, and 40 turns of copper wire two millimetres in diameter, insulated with gutta percha or other suitable insulating material, each turn being about 4 inches in diameter, the primary and secondary being of the same thickness of wire and approximately of same length.

[Price 8d.]

Improvements in Apparatus for Wireless Telegraphy.

The condensers used in connection with these transformers were usually three or four pint Leyden jars. If the inductance of the induction coil used at the receiving station is varied, the inductance of the condenser circuit, or the capacity of the condenser, or both, should also be varied at the transmitting station.

In employing this invention to localise the transmission of intelligence to one out of several receiving stations one of the following methods is adopted. 5

The inductance coils at the receiving stations are wound with different lengths of wire and the self induction and capacity of the transformer, condenser, and elevated wire is accordingly varied over wide limits. It is found that if these factors are varied at the transmitting station until the electrical system composed of the elevated wire and its associated transformer circuit are in resonance with the receiving elevated wire and its induction coil and coherer connections of one of the receiving systems, that one alone, out of all the number of receiving stations responds, provided that the distance between the transmitter and receiver is not too small. In this manner each receiving instrument can be adjusted to respond only to the transmitter when the inductance of that transmitter has a certain value or values. 10 15

At the receiving station the period of oscillation of the system can be altered by altering the capacity and self-induction of the elevated conductor by varying its section or by connecting it to conducting bodies of large surface, or by introducing inductance coils in series with it, preferably at its highest extremity, or by varying the dimensions of the wire and the size of the induction coils used. 20

The period of the receiving system may also be altered by associating with the circuit of the induction coils condensers of suitable capacity, placed some in parallel and some in series with the primary and secondary. 25

At the transmitter the frequency may be varied in the same way as has been described for the receiver.

Dated this 26th day of April 1900.

G. MARCONI
MARCONI'S WIRELESS TELEGRAPH CO LTD 30

By G. MARCONI,
Director.
S. FLOOD PAGE,
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HENRY W. ALLEN 35
Secretary.

COMPLETE SPECIFICATION.

"Improvements in Apparatus for Wireless Telegraphy."

We, GUGLIELMO MARCONI, Electrician, and MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED, late of 28 Mark Lane, and now both of 18 Finch Lane, in the City of London, 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:— 40

The object of this invention is not only to increase the efficiency of the apparatus hitherto employed, but also to so control the action as to cause intelligible communications to be established with one or more stations only out of a group of several receiving stations. 45

In the Specification of a former Patent No. 12039 of 1896 a transmitter is described which consists of an induction coil, one terminal of the secondary circuit being connected to a metal sphere connected to earth and the other to a similar sphere connected to an insulated conductor which generally takes the form of a more or less vertical wire which may or may not terminate in or have 50

Improvements in Apparatus for Wireless Telegraphy.

attached to it a metal body of extended surface, giving it increased electrical capacity.

According to the present invention the vertical wire is connected to earth through the secondary winding of a transformer of a kind suitable for the trans-
5 formation of very rapidly alternating electric currents and the primary of this transformer is connected to the spheres or terminals of the sparking appliance.

A condenser of suitable capacity is introduced in series with the primary or each end of the primary may be connected to one of the plates of two con-
10 densers of suitable capacity, the other plates of which are connected to the sparking appliance.

This device enables much more energy to be imparted to the radiator than heretofore the approximately closed circuit of the primary being a good con-
server and the open circuit of the secondary a good radiator of wave energy.

The arrangement works as follows:—

15 On pressing the key and actuating the induction coil (in order to produce a signal) the condenser in circuit with the transformer is charged and subsequently discharges through the spark gap. If the capacity, the inductance, and the resistance of the circuit are of suitable values, the discharge is oscillatory,
20 with the result that alternating currents of high frequency pass through the primary of the transformer, and induce similar oscillations in its secondary these oscillations being communicated to the elevated conductor.

The circuit of the elevated conductor should be suitably attuned for this purpose.

The effect of these oscillations in the elevated conductor is to inductively affect similar distant conductors if the self induction and capacity of the said
25 conductors is of a suitable value or values.

At the receiving end a receiver is employed capable of being actuated by electrical oscillations of high frequency such as are described in the Specifications Nos. 12326 of 1898, 6982 of 1899, and 25186 of 1899.

The four circuits namely those including the primary and the secondary of the
30 transformer in the transmitter and the primary and secondary of the transformer in the receiver should be so adjusted as to make the electric time period the same in each *i.e.* the product of the self induction multiplied by the capacity is the same in each case. But in lieu of the time periods being the same in each they may be harmonics of each other.

35 In employing this invention to localise the transmission of intelligence from a station to one only out of several receiving stations the time period of the circuits at each of these stations is so arranged as to be the same but different from those of the other receiving stations. If the time period of the circuits of the transmitting station are varied until they are in resonance with those of one of
40 the receiving stations that one alone out of all the number of receiving stations will respond, provided that the distance between the transmitter and receiver is not too small.

The adjustment of the self induction and capacity of the circuits can be made in any convenient manner. As a practical guide to putting the invention in
45 practice we subjoin the arrangements which we find work best.

Figures 1 and 2 are diagrams of the transmitter and of the receiver respectively, whilst Figure 3 shows a side view and Figure 4 an edge view of a transformer used at the transmitting station, and Figures 5 to 11 show various induction coils used at the receiving station.

50 *a* is a battery, *b* a Morse key, *c* a Ruhmkorff coil the primary of which is in circuit with the battery whilst the terminals of the secondary are connected to the primary *d* of a transformer one of the connections being through a condenser *e*, or there may be a condenser in both of the connections. The secondary *d'* of the transformer is connected to an aerial conductor *A* which may have at its top a
55 metallic cylinder *f* and to earth or a capacity *E*. Between the secondary and the aerial conductor or it might be between the secondary and earth is sometimes inserted an inductance coil *g* having numerous coils and the connection is such

Improvements in Apparatus for Wireless Telegraphy.

that a greater or less number of turns of the coil can be put in circuit, the proper number to use being ascertained by experiment.

The receiver (Figure 2) consists of an aerial conductor A which may have a cylinder f^1 at its top connected through an inductance coil g^1 similar to g and through the primary j^1 of an induction coil to earth or a capacity E; a small 5 condenser h may be inserted in parallel with the primary j^1 .

The secondary j^2 of the induction coil is divided in the middle and has its inner ends connected to the plates of a condenser j^3 while its outer ends are connected it may be through inductance coils g^2 similar to g to a detector or coherer T; a condenser h^1 may be inserted in parallel with the detector. The local circuit 10 containing a battery cell B and relay or telegraph instrument R is connected through choking coils $c^1 c^2$ to the plates j^3 of the condenser.

The condensers $h h^1$ are preferably in the form of two metallic tubes separated by a dielectric and sliding telescopically on each other as in this way their capacity can readily be varied with accuracy to tune the circuits. 15

The following are details of arrangements which have been found to work best.

The cable used for the aerial conductor at either station and for the transformer $d d^1$ at the transmitting station is in all the examples given composed of seven strands of copper wire .889 m.m. in diameter. The aerial conductor at the receiving station is in each instance exactly similar to that at the transmitting 20 station for the corresponding time.

The details of the transformers $d d^1$ are as follows:—

Transformer No. 1. The total length of the primary d including connections to spark gap and condenser is .946 metres and it is bent round a square d^2 of insulating material of which the side is .17 metres long while the secondary d^1 consists of 25 two turns or squares one lying on each side of the primary (see Figures 3 and 4). The insulation of both primary and secondary consists of 1.25 m.m. of rubber and 1 m.m. of jute making a total thickness of 2.25 m.m.

Transformer No. 2 is exactly similar to No. 1 except that the total length of the primary d is 1.93 metres. 30

Transformer No. 3. The primary consists of ten turns of cable wound on a cylindrical core 10.16 c.m. in diameter; over this but separated from it by 2 m.m. of paper or other insulating material is wound the secondary also of ten turns.

Transformer No. 4. The total length of the primary d is 1.50 metres and it is bent round a square of insulating material d^2 of which the side is .3048 metres 35 long while the secondary d^1 consists of 6 turns or squares three lying on each side of the primary in one layer. The insulation of both primary and secondary is the same as in No. 1.

Transformer No. 5. The primary consists of ten insulated wires each 1.5 metres long wound side by side in one layer and connected in parallel each wire making 40 one turn on a square frame similar to that described for transformer No. 4.

Over this primary layer is put a covering of paper 1 m.m. thick, upon this is wound 48.64 metres of wire. The winding is arranged in layers, the number of turns in each successive layer being in the first layer that is in that nearest the primary 9, in the second 8, in the third 7, in the fourth 6, in the fifth 5, in the 45 sixth 2.

The insulation is the same as in No. 1.

Transformer No. 6. The primary consists of seven wires wound side by side each wire making one turn on a square frame as used for transformer No. 4. The seven wires are joined in parallel and the length of each is 1.50 metres. 50 Over this primary layer is wound a secondary 30.4 metres long, the winding being arranged in layers the number of turns in the successive layers being in the first layer 7 turns, in the second 6, in the third 5, in the fourth 4.

The transformers should be placed in an oil bath, especially if the turns are at all numerous. 55

The inductance coils $g g^1$ are of copper wire 6.25 m.m. in diameter wound on a cylinder 10.64 c.m. in diameter an interval of 2.28 m.m. being left between

Improvements in Apparatus for Wireless Telegraphy.

adjacent turns while the inductance coils j^2 inserted in series with the secondary j^3 of the induction coil at the receiving station are of copper wire, silk covered, of .19 m.m. diameter wound on cylinders 3.7 c.m. in diameter.

Figures 5 to 11 show details of the induction coils j^1 j^2 .

5 These diagrams are greatly enlarged half longitudinal sections, but are not strictly to scale. In place also of showing the section of each coil or layer of wire as a longitudinal row of dots or small circles as it would actually appear, it is for simplicity shown as a continuous longitudinal straight line.

10 Induction coil No. 1—see Figure 5. The primary consists of 3.048 metres of silk covered copper wire .71 m.m. in diameter wound in one layer on a core 2.9 c.m. in diameter. Insulating material is wound over and on each side of this so as to make a cylindrical core 3.13 c.m. in diameter on which is wound the secondary each half consisting of 6.4 metres of silk covered copper wire .19 m.m. in diameter joined to 13.41 metres of silk covered copper wire .37 m.m. in diameter
15 wound in the same sense as the primary, the thinner wire being over the primary and the thicker being beyond the ends of the primary.

Induction coil No. 2—see Figure 6. The primary j^1 wound on a core j .6 c.m. in diameter consists of 100 turns of copper wire .037 c.m. in diameter insulated with single silk and coated with paraffin wax, the secondary j^2 is of copper
20 wire .019 c.m. in diameter insulated with single silk covering and is wound over the primary commencing in the middle and in the same sense as the primary. Each half of the secondary is in layers of the following number of turns: first layer 77, second 49, third 46, fourth 43, fifth 40, sixth 37, seventh 34, eighth 31, ninth 28, tenth 25, eleventh 22, twelfth 19, thirteenth 16, fourteenth 13,
25 fifteenth 10, sixteenth 7, seventeenth 3, making 500 in all.

Induction coil No. 3—see Figure 7. The primary consists of 3.048 metres silk covered copper wire .19 m.m. in diameter and the secondary 30.48 metres long of silk covered copper wire .1 m.m. in diameter wound in one layer on a core 4 c.m. in diameter, the primary being in one layer outside the secondary.

30 Induction coil No. 4—see Figure 8. The primary consists of 3.048 metres silk covered copper wire .37 m.m. in diameter wound on a core 2.9 c.m. in diameter and inserted in a tube j^x of 4 c.m. external diameter on which is wound the secondary of 27.432 metres silk covered copper wire .12 m.m. in diameter, the break at the middle of the secondary being over the middle of the primary.

35 Induction coil No. 5—see Figure 9. The secondary consists of 73.15 metres of wire wound in one layer on a tube 5 cms. in diameter and is divided at its middle point, the wire being .12 m.m. in diameter single silk covered.

There are two primaries each consisting of 2.75 metres of wire .7 m.m. in diameter wound on tubes 6.5 cms. external diameter. The two primaries are
40 placed symmetrically side by side one over each half of secondary and are joined in parallel.

Induction coil No. 6—see Figure 10. The secondary consists of 48.64 metres of single silk covered copper wire .37 m.m. in diameter wound on a tube of 9.6 cms. diameter in one layer and is cut at its middle point. Symmetrically over the
45 middle portion of the secondary is wound the primary 3.64 metres long of wire .7 m.m. diameter, single silk covered.

Induction coil No. 7—see Figure 11. The primary consists of four wires each 3.04 metres long wound in four layers and joined in parallel, the layers being one under the other, the wire is .71 m.m. in diameter insulated with a single covering
50 of silk.

The secondary which is wound on a tube of 3.3 cms. external diameter consists of 21.24 metres of wire .12 m.m. diameter insulated with a single covering of silk. The secondary is divided at its middle point and the primary is placed symmetrically inside the secondary.

55 The following table give the adjustments, those details opposite any tune in the transmitting station table being of course used in connection with those opposite the same tune in the receiving station table.

Improvements in Apparatus for Wireless Telegraphy.

TRANSMITTING STATION.

| Tune | Aerial conductor | Transformer <i>d d</i> ² | Inductance. Number of turns of <i>g</i> included | Capacity in microfarads <i>e</i> | Length of spark in millimetres |
|------------------|--|--|---|-------------------------------------|--------------------------------------|
| N ^o 1 | 36.576 metres of cable | N ^o 1 | None | .006934 | 3 |
| N ^o 2 | ditto | N ^o 1 | 45 | .016395 | 4 |
| N ^o 3 | ditto | N ^o 2 | None | .004112 | 3 |
| N ^o 4 | ditto | N ^o 2 | 100 | .016849 | 4 |
| N ^o 5 | Zinc cylinder 9.144 metres long, 1.524 metres in diameter hoisted 3.048 metres above ground | N ^o 2 | None | .001600 | 12.5 |
| N ^o 6 | 30.48 metres of cable | N ^o 3 | None | .000573 | 4 |
| N ^o 7 | Four vertical wires each 48.6 metres long connected together at top and bottom but kept apart throughout their length by being suspended from the arms of a wooden cross each arm of which is 4 metres long. | N ^o 4 | None | .016 | 6 |
| N ^o 8 | One vertical wire 48 metres long | N ^o 5 | None | .007 | 6 |
| N ^o 9 | One vertical wire 30.4 metres long | N ^o 6 | None | .0026 | 5 |

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Improvements in Apparatus for Wireless Telegraphy.

RECEIVING STATION.

| Tune | Induction coil | Capacity in microfarads of | | Inductance introduced in | |
|---------------------|------------------|----------------------------|---------|---------------------------|---|
| | | h | h^1 | g^1 Number of turns. | g^2 |
| N ^o 1 | N ^o 1 | Omitted | Omitted | None | None |
| N ^o 2 | N ^o 1 | Omitted | ·00004 | 45 | None |
| 5 N ^o 3 | N ^o 2 | ·0046 | Omitted | Up to 21 may be inserted | None |
| N ^o 4 | N ^o 2 | ·0046 | Omitted | 100 | 2 coils of 15·24 metres at each end of secondary. |
| N ^o 5 | N ^o 3 | Omitted | Omitted | None | None |
| N ^o 6 | N ^o 4 | Omitted | Omitted | None | None |
| N ^o 7 | N ^o 5 | Omitted | Omitted | None | None |
| 10 N ^o 8 | N ^o 6 | Omitted | Omitted | None | None |
| N ^o 9 | N ^o 7 | Omitted | Omitted | None | None |

NOTE. In tune No. 9 a small condenser having an approximate capacity of ·00008 microfarad is inserted between the lower end of the receiving aerial conductor and the induction coil.

15 It will be observed that both the transmitter and the receiver are the same for tunes 1 and 2 and that when the capacity of the condenser e is varied, the two stations can be brought into tune by including 45 turns of each of the coils g g^1 and by introducing a condenser h^1 of small capacity in parallel with the coherer T. Similarly the transformer and receiver are the same for tunes 3
20 and 4 and when the capacity of e is varied, the stations are tuned by including 100 turns of each of the coils g g^1 and also by including the two coils g^2 .

Tunes Nos. 7 and 8 give very good signals over a distance of 190 miles.

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
25 we claim is:—

1. A transmitter for electric wave telegraphy consisting of a spark producer

Improvements in Apparatus for Wireless Telegraphy.

having its terminals connected through a condenser with one circuit of a transformer the other circuit being connected to a conductor and to earth or a capacity the time period of electrical oscillations in the two circuits being the same or harmonics of each other.

2. A system of electric wave telegraphy in which both the transmitter and the receiver contain a transformer the time period of electrical oscillations in the four circuits of the two transformers being the same or harmonics of each other.

3. A system of electrical wave telegraphy in which both the transmitter and the receiver contain a transformer one circuit of which is a persistent oscillator and the other a good radiator or absorber of electrical oscillations all four circuits having the same time period or being harmonics of each other substantially as described.

4. Apparatus for wireless telegraphy substantially as described and illustrated in the drawings.

Dated this 25th day of February 1901.

15

G. MARCONI

MARCONI'S WIRELESS TELEGRAPH CO. LD.

By Carpmael & Co
Agents

ERRATA.

SPECIFICATION No. 7777. (3rd Edition.) A.D. 1900.

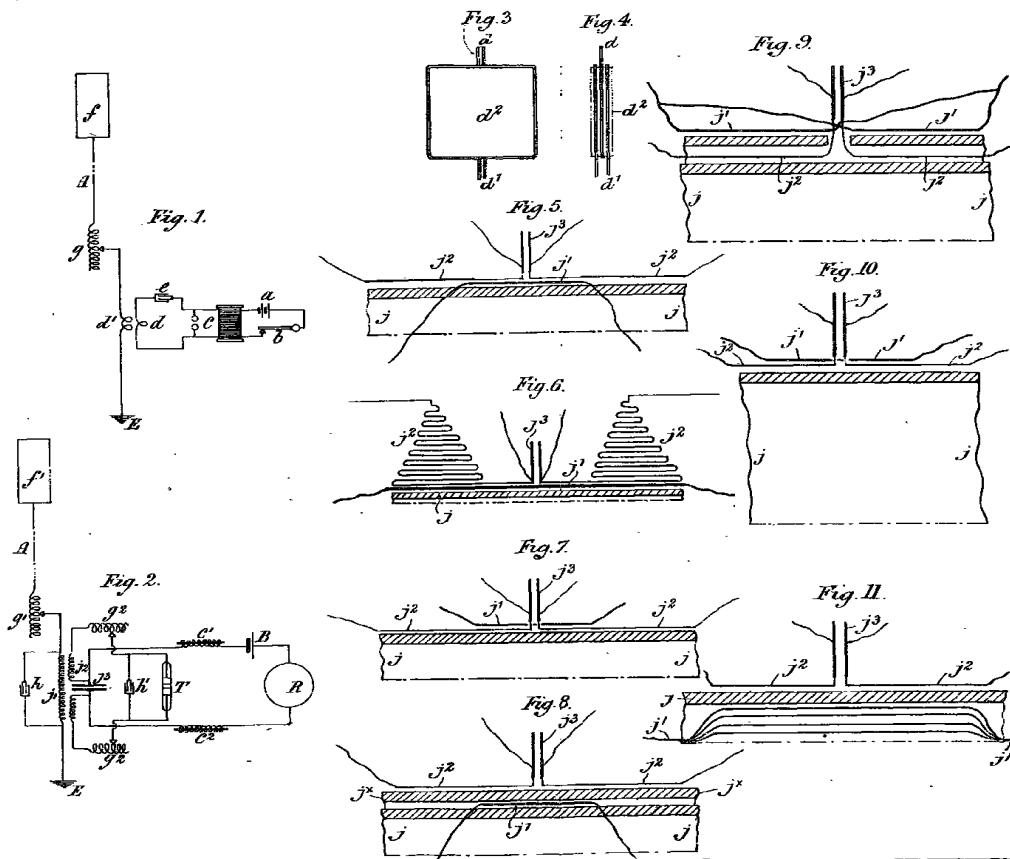
Page 3, line 52, *delete* " of " *after* " transformer."

„ 7, last line, *for* " telgraphy " *read* " telegraphy."

„ 8, line 13, *for* " substantially " *read* " substantially."

PATENT OFFICE,

9th Nov., 1910



[This Drawing is a reproduction of the Original on a reduced scale.]

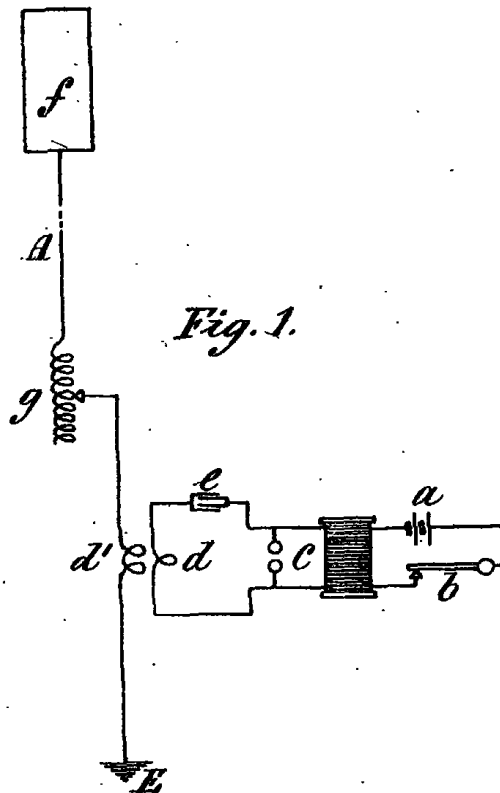


Fig. 1.

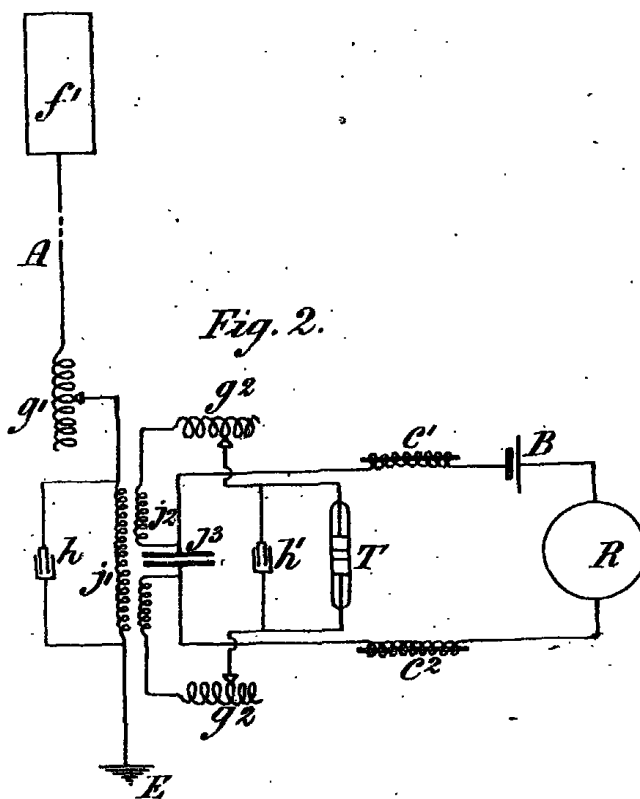
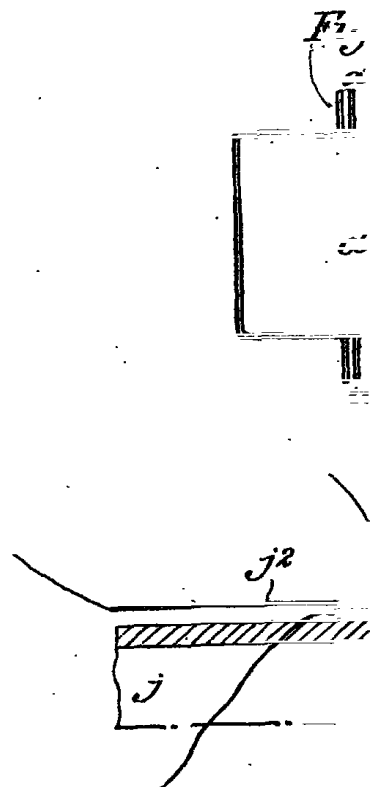
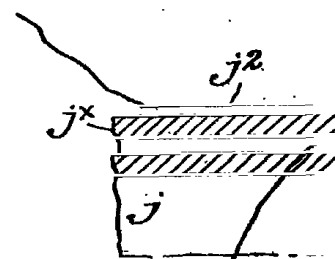
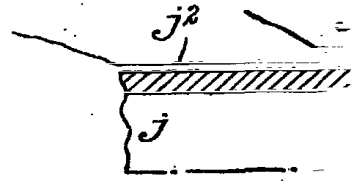
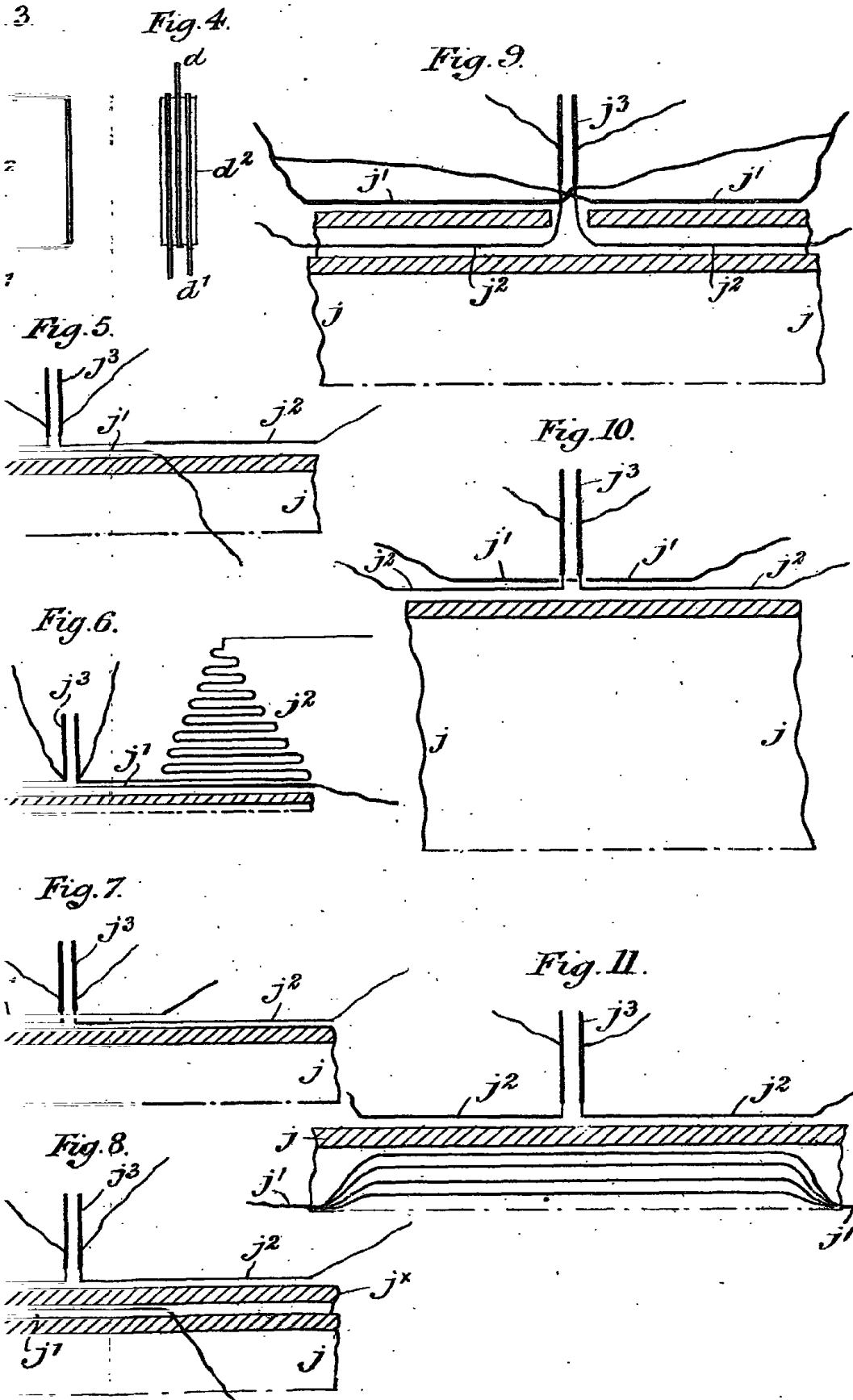


Fig. 2.





[This Drawing is a reproduction of the Original on a reduced scale.]