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ELECTRIC RELAY.

APPLICATION FILED JULY 15, 1912.

1,118,173. Patented Nov. 24, 1914.

Fig. 1.

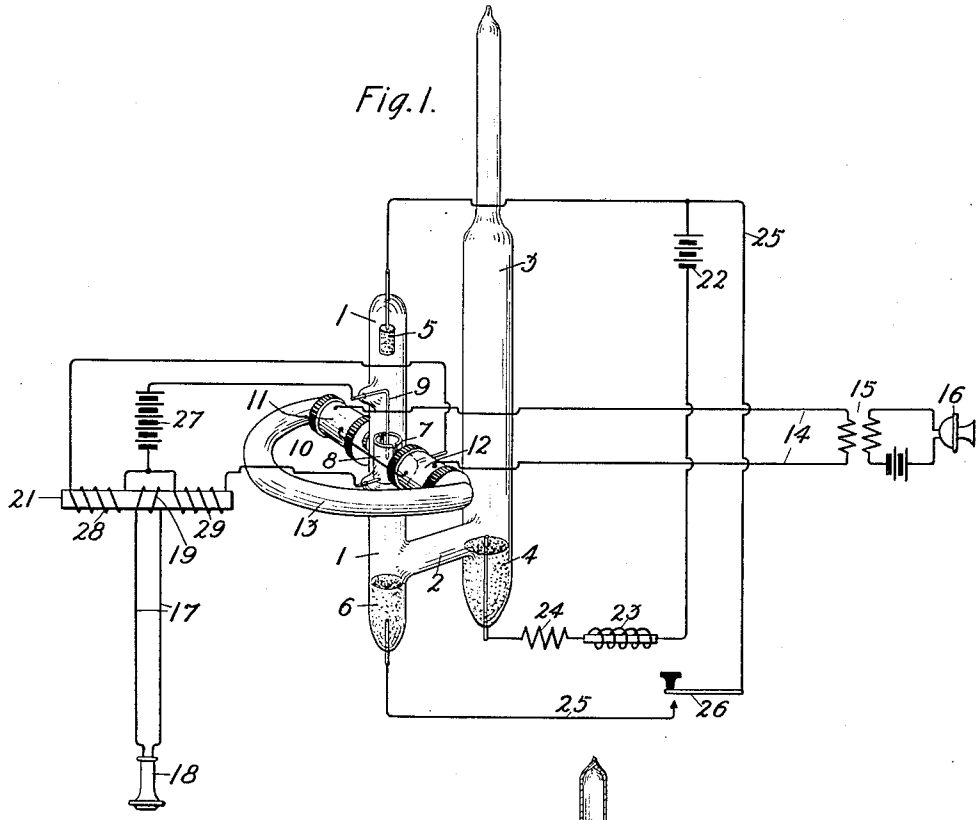
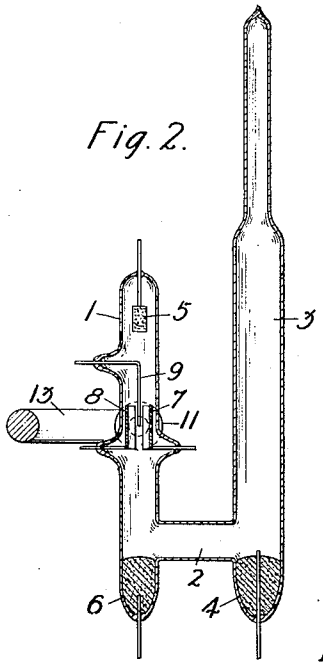


Fig. 2.



Witnesses:

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UNITED STATES PATENT OFFICE.

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ELECTRIC RELAY.

1,118,173. Specification of Letters Patent. Patented Nov. 24, 1914.

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To all whom it may concern:

Be it known that I, HAROLD DE FOREST ARNOLD, a citizen of the United States, residing at Belleville, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Electric Relays, of which the following is a full, clear, concise, and exact description.

This invention relates to relay apparatus for reproducing electric variations.

Its objects are to secure reliability, efficiency and simplicity of apparatus, uniformity of operation, sensitiveness to minute currents, amplified reproduction of variations of current energy, reproduction without distortion, and noiseless operation.

Among other uses the invention is applicable to telephony, for the purpose of obtaining in an outgoing circuit an amplification of voice currents orignating in an incoming circuit. It is also applicable to telegraphy and signaling systems generally where amplification is desirable in receiving, recording or reproducing impulses of electrical energy.

A relay embodying this invention comprises an ionized stream which may be produced in any of a number of ways, as by means of the mercury arc which has been found to be a suitable agent for the purpose, an electromagnet or other means for deflecting the stream or varying the distribution of ionization therein, and an auxiliary, detecting circuit which is independent of the circuit for establishing the ionized stream except that it traverses a portion of the vapor of the stream. This auxiliary circuit is non-arcing in character and is maintained by means of an auxiliary cathode or pair of such cathodes immersed in the stream and connected to a source of electromotive force which may be separate and distinct from the source producing the stream, the circuit being completed through an anode which may likewise be immersed in the stream. There is thus established in the vicinity of the auxiliary cathode or cathodes an electrical field, which, causes in the auxiliary circuit a flow of current the intensity of which is directly dependent upon the distribution of ionization in the auxiliary cathode field.

The invention will be more fully understood by reference to the accompanying drawing wherein—

Figure 1 shows a system of circuits and apparatus representing one embodiment of this invention, and Fig. 2 shows in elevation and cross section the apparatus of Fig. 1 separated from the circuits.

Referring to the drawings, the means for producing the ionized stream, which in this instance I have shown as a mercury arc apparatus comprises a main chamber 1 with a horizontal branch 2 and a condensing chamber 3 together with a mercury cathode 4, an anode 5 of carbon or other suitable material, and a starting mercury anode 6. Supported within the main chamber 1 are a pair of auxiliary cathodes 7, 8 which are shown semi-cylindrical in form and slightly separated from each other and from the walls of the chamber. Extending downwardly between the auxiliary cathodes is an auxiliary anode 9. The auxiliary cathodes and the auxiliary anode may be of platinum or other suitable conducting material. Leading-in conductors preferably of platinum wire are provided for the several electrodes of the device.

As the means for deflecting the ionized stream, I have shown an electromagnet 10, the means of support of which is not shown. Such magnet comprises a pair of coils 11, 12, surrounding inwardly extending pole pieces the outer ends of which are joined by a semi-circular yoke 13. The pole pieces present their faces to opposite sides of the main chamber 1 in the region of auxiliary cathodes 7, 8 so that the lines of force between the pole pieces lie in a direction transverse to the direction of flow of the ionized stream in the chamber 1 and operate to deflect the stream in the direction of one auxiliary cathode or the other, according to the direction of the current in the magnet coils.

The system shown in Fig. 1 comprises five circuits (1), an incoming circuit 14 including the coils 11, 12 of the electromagnet 10 and the secondary of an induction coil 15, the primary of which is in (2), a local circuit containing a source of current and a transmitting device such as the telephone transmitter 16; (3), an outgoing circuit 17 including a receiving device such as the telephone receiver 18 and the secondary winding 19 of a transformer 21; (4), an energizing circuit for the mercury arc comprising a battery 22, impedance coil 23 and resist-

ance coil 24, this circuit being connected, one terminal to the anode 5 and the other terminal to the cathode 4, and having a starting branch 25 connected, one terminal to the battery 22 and the other to the starting anode 6 and including a starting key 26; and finally (5), the auxiliary detecting circuit including a battery 27, one terminal of which is connected to the auxiliary anode 9 and the other branching through balanced primary windings 28 and 29 of the transformer 21 to the auxiliary cathodes 7 and 8 respectively.

The impedance coil 23 and resistance coil 24 provide a balance for the mercury arc circuit to maintain a steady flow of current therein, which when once established as by tipping the tube, closing the circuit at the starting key 26 over the path 22, 23, 24, 4, 2, 6, 25, 26, 25, 22, and then releasing the key 26, is maintained automatically over the path 22, 23, 24, 4, 2, 1, 5, 22, which includes the ionized arc stream in the main chamber 1. This stream passes by and in contact with the auxiliary cathodes 7 and 8, filling the region between them, and rendering the auxiliary circuit conductive so that current flows from the battery 27 dividing through the primary windings 28 and 29 of the transformer 21 to the auxiliary cathodes 7 and 8, to and through the ionized vapor therebetween and by way of the auxiliary anode 9 back to the battery 27. It is noteworthy of this auxiliary circuit that it is non-arcing in character and that the potential difference existing between the auxiliary electrodes is independent of, and in fact may be very much greater than, that existing between the electrodes of the arc stream. At the same time the current flow in the auxiliary circuit may be very much less than that in the arc circuit. For example, in one particular embodiment of the apparatus the potential difference existing between the auxiliary anode 9 and the auxiliary cathodes 7 and 8 was 100 volts whereas that between the anode 5 and cathode 4 of the arc was 30 volts. The current flow in this instance was .04 ampere in the auxiliary circuit and one ampere in the arc circuit. The primary coils 28, 29 of the transformer 21 are wound differentially in the auxiliary circuit, that is to say, in such a direction with respect to each other that the core thereof under normal conditions of the circuit is not magnetized. The normal current flows equally or approximately so in the two branches, this being due to the symmetrical arrangement of the auxiliary cathodes 7, 8 with respect to the ionized vapor in the space between them. When, however, the electromagnet 10 is energized by current received over the incoming circuit 14, a magnetic field is produced which deflects the stream toward one electrode or the other. The effect of this is a change in the distribution of ionization in the field or region adjacent the auxiliary cathodes and current will flow with increased strength through one primary winding of the transformer and with decreased strength through the other, thereby inducing current in the secondary winding which is transmitted over the outgoing circuit 17 and recorded or made manifest in the receiving instrument 18.

By this apparatus, minute variations of current energy such as those transmitted over great distances by a telephone or signaling device and delivered to the instrument by the incoming circuit 14 are reproduced and amplified in the outgoing circuit 17. The extremely small mass of the ionized vapor which is deflected by the electromagnet enables the reproduction of current variations to be accomplished without distortion. By reason of the non-arcing character of the detecting circuit the relaying of current variations is accomplished without disturbing or "noisy" currents in the outgoing circuit, this being of especial importance in telephone transmission systems.

I have illustrated and described two auxiliary cathodes and a branched circuit through balanced primary windings 28 and 29, for the reason that I have found that such arrangement produces the best results. My fundamental invention would, however, be embodied in an arrangement in which only one auxiliary cathode and one primary winding are employed. Also the auxiliary anode 9 may be omitted and the battery 27 may be connected with the anode 5, without departing from the spirit of my invention. Moreover, while I prefer to use two magnet coils 11 and 12, one of them may be omitted, and indeed, the arc stream may be caused to be deflected by electro-static instead of electro-magnetic means.

I claim:

1. An electric relay comprising a chamber, means including a pair of electrodes for maintaining an ionized arc stream therein, an outgoing circuit including an electrode immersed in said stream intermediate said pair of electrodes, and an incoming circuit including means for variably deflecting said stream in the region of said electrode.

2. An electric relay comprising means including an ionizing cathode for producing an ionized arc stream, means for deflecting said stream, and an auxiliary non-arcing circuit exclusive of said cathode traversing the deflected portion of the ionized vapor of the stream.

3. An electric relay comprising means for producing an ionized stream, a deflecting electromagnet, and an auxiliary cathode immersed in said stream and in the field of said magnet.

4. An electric relay comprising means for

producing an ionized stream, a primary circuit including means for producing a magnetic field transverse to said stream, and an auxiliary circuit including a cathode immersed in said stream and field.

5. An electric relay comprising a chamber, an anode and a cathode therefor and means for producing in said chamber an ionized arc stream between said anode and cathode, of an auxiliary cathode immersed in said stream, an outgoing circuit connected to said auxiliary cathode, an electromagnet in proximity to said auxiliary cathode, and an incoming circuit including said electromagnet.

6. An electric relay comprising a chamber, means for producing therein an ionized arc stream, means for deflecting said stream, a pair of electrodes in said chamber one on each side of said stream, and a transformer differentially connected to said electrodes.

7. An electric relay comprising a chamber, means for producing therein an ionized arc stream, means for deflecting said stream, a pair of electrodes in said chamber, one on each side of said stream, a third electrode immersed in said stream, and a transformer differentially connected to said electrodes.

8. An electric relay comprising a chamber, means for maintaining a state of ionization in said chamber, a pair of electrodes at opposite sides of the ionized space, means for maintaining said electrodes at a negative potential, and an output circuit oppositely connected to said electrodes.

9. An electric relay comprising means for producing an ionized stream, an auxiliary cathode immersed in said stream, and means for varying the relative positions of said ionized stream and said cathode.

10. An electric relay comprising a chamber, means for producing an ionized stream in said chamber, a plurality of electrodes immersed in said stream, a circuit including said electrodes and the ionized stream therebetween, and means for varying the relative position of said electrodes and ionized stream whereby variations are produced in the circuit of said electrodes.

In witness whereof, I hereunto subscribe my name this 13th day of July A. D., 1912.

HAROLD DE FOREST ARNOLD.

Witnesses:
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FRED DETHLOFF.