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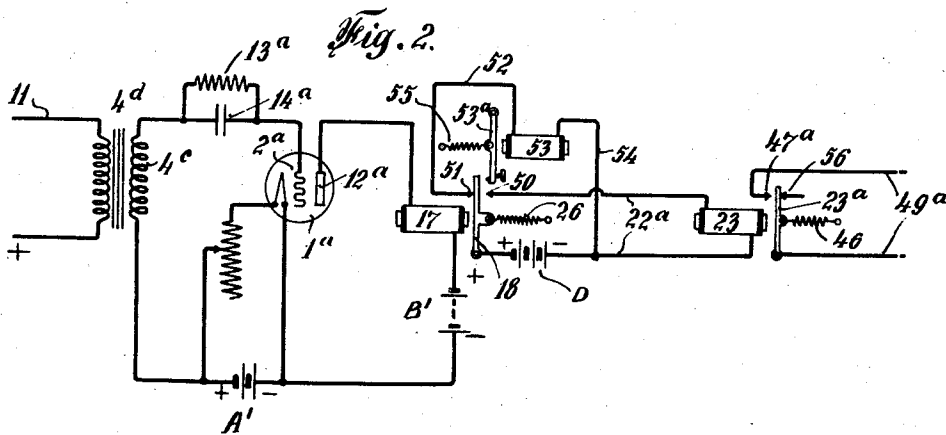
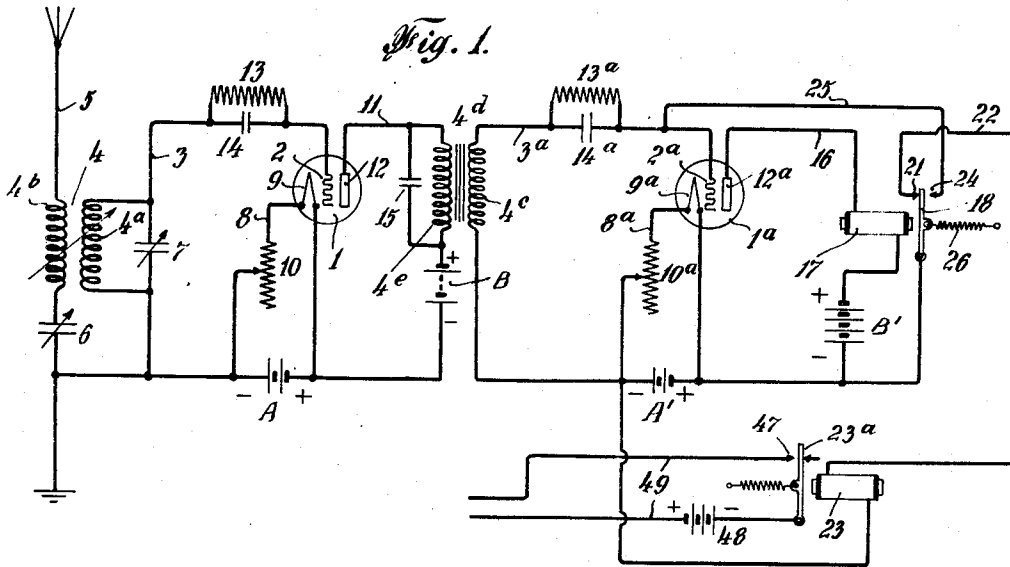
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ELECTRICALLY OPERATED RELAY

Filed Aug. 15, 1924

3 Sheets-Sheet 1



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Fig. 3.

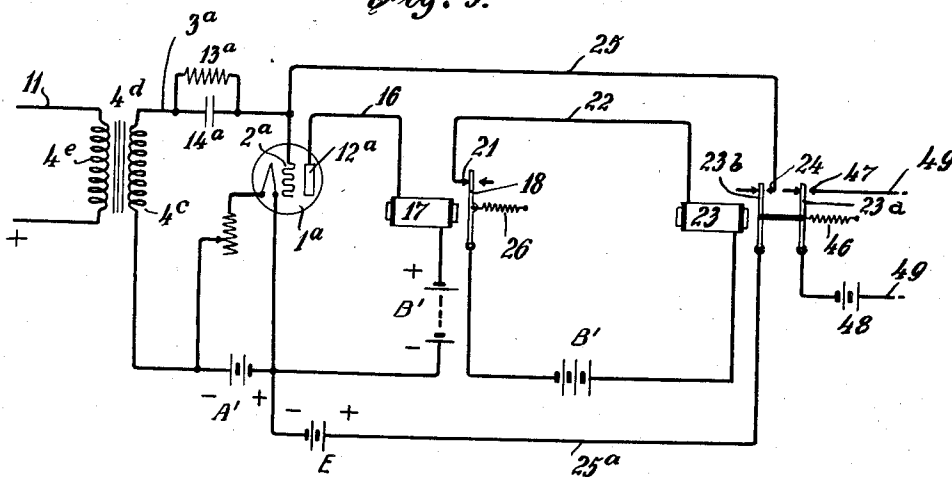
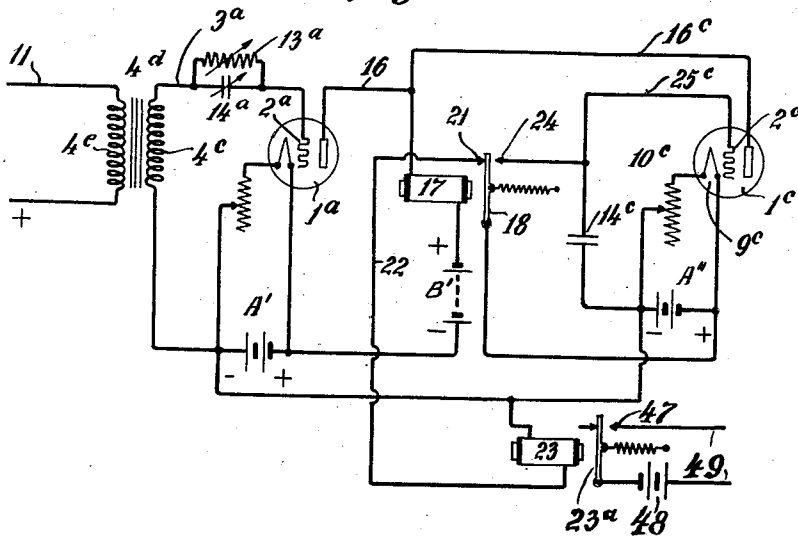


Fig. 4.



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ELECTRICALLY-OPERATED RELAY

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The object of my invention is to control the operation of a device or mechanism by means of electrical signals which in and of themselves do not possess sufficient electrical energy to operate said device or mechanism, whereby I am enabled to produce desired mechanical or electrical operations from a source of electrical energy too weak or lacking sufficient power to itself produce the final results desired.

My invention also comprises novel details of improvement that will be more fully hereinafter set forth and then pointed out in the claims.

Reference is to be had to the accompanying drawings forming a part hereof, wherein

Fig. 1 is a diagrammatic view illustrating a preferred form of my invention;

Figs. 2, 3 and 4 are diagrammatic views illustrating modifications;

Fig. 5 is a side elevation of a relay adapted for use in connection with my improvements;

Fig. 6 is a plan view, partly in section on line 6, 6, in Fig. 5;

Fig. 7 is a cross section on line 7, 7, in Fig. 5; and

Fig. 8 is a perspective detail of the armature and movable contacts of Fig. 5.

Similar numerals of reference indicate corresponding parts in the several views.

In accordance with my invention illustrated in the accompanying drawings I have shown means for utilizing an audio frequency signal of small intensity, such as produced in an ordinary radio receiver from a spark transmitting station, to operate a relay for the purpose of actuating another device or mechanism to produce desired results, such as for operating a recording device so as to make a permanent record of the transmitted signals, or produce audible signals, or produce other desired result.

At 1 is indicated a well known audion or thermionic relay adapted to receive signals

from a suitable input circuit from a transmitting station. The element 1 may be a crystal detector with appropriate circuits if preferred. In the example illustrated the grid 2 of the audion or detector 1 is connected with a circuit at 3 which includes the secondary winding 4^a of a transformer 4. The primary 4^b of said transformer is adapted to receive signals from an aerial 5, and a variable condenser 6 may be included in such circuit, (Fig. 1). A variable condenser 7 may be bridged across the terminals of secondary 4^a. The circuit 8 of the audion filament 9 includes the battery A, and a variable resistance 10 if desired. The circuit 11 of the plate 12 of the audion 1 includes the battery B. There may be used in my improved system one or more audions or amplifying means. In Fig. 1 an audion or thermionic relay 1^a is provided with grid 2^a connected to circuit 3^a including secondary 4^c of the transformer 4^a, the primary 4^e of which transformer is included in the circuit of plate 12 of audion or detector 1. Grid leaks 13, 13^a and condensers 14, 14^a are shown associated with the grid circuits 3, 3^a. A fixed condenser 15 is shown bridged across the primary coil 4^e. The circuit 8^a of filament 9^a of audion or detector 1^a may include a rheostat 10^a, and said circuit connects with battery A' which is also connected with the grid circuit 3^a. The parts described are well known in the radio art, and are illustrated as a means or input circuit for producing signals for operation of my improvements.

The circuit 16 of the plate 12^a of the audion or detector 1^a includes the winding of a relay 17 and a battery B', so that when a reduction of the current of said plate circuit is effected the relay will be deenergized to produce desired results and operate another device or mechanism. The relay is adapted to cause its armature 18 to make and break one or more circuits to control the device or mechanism to be operated. In the example

illustrated the armature 18 has contacts 19 and 20, the contact 19 being adapted to engage a contact 21 in a circuit 22 which includes a relay 23, said circuit being connected to one side of battery A', and the contact 20 is adapted to engage a contact 24 connected by conductor 25 to grid 2^a of audion 1^a. The spring 26 of relay armature 18 is adapted to cause the contact 20 to engage contact 24 when relay 17 is deenergized or when the normal operating current from plate 12^a of audion or detector 1^a is reduced. The spring 26 is shown connected at one end with armature 18 and at the other end is shown provided with a cord or flexible connection 27 wound around a shaft 28 supported in a bearing 29, the shaft being frictionally retained, as by means of clamp 30, whereby when knob or handle 31 is rotated the tension of the spring may be regulated. (Figs. 5 and 6). The core 17^a of relay 17 is shown in horseshoe-like form having a winding on each member, the poles of said core being located adjacent to armature 18 and the closed end 17^b of said core being shown provided with a yoke 32 attached by means of screw or bolt 33 and provided with a threaded extension 34 slidable in an opening in a post 35, nuts 36, 37 serving to adjust and retain in set position the core 17^a. The contact 21 is shown carried by a post 38, and the contact 24 is shown carried by a post 39 supported upon base 40. (Fig. 5). The post 38 is shown made in two parts connected by screw 41, (Fig. 7), whereby the arms of core 17^a may be attached to the post and said arms may rest upon the lower portion 38^a of the post. A spring 42 is provided with an aperture 42^a to receive post 38, and said post has projections 43 bearing upon the spring, the latter having stops 44 to engage the projections 43, (Fig. 5). The construction is such that the relay core 17^a will be securely and yet slidably carried by post 38 for the purpose of adjustment of the relay core relatively to the armature 18. The lower end of said armature is shown secured to base 40 by means of screws 45, and said armature may be of resilient material so as to move between the contacts 21 and 24. The construction of the relay described is such as to enable very fine adjustments to be made between the relay core and its armature as well as delicate adjustment of the spring 26, since the relay is intended to operate with relatively small changes of electrical energy.

The relay 23 is illustrative of a device or mechanism to be controlled or actuated by means of relay 17.

In accordance with the illustration in Fig. 1 when relay 17, by reason of the normal current through the circuit of plate 12^a of audion or detector 1^a, is energized and attracts armature 18, the latter will close the circuit of relay 23, at contact 21, and break the circuit through 25 and the grid 2^a at contact 24. The armature 23^a of relay 23 is normally drawn by spring 46 against contact 47, when relay 23 is deenergized. The contact 47 and battery 48 are included in the working circuit 49 that is adapted for use to control any desired instrument. When armature 18 is attracted by relay 17 the circuit of relay 23 will be completed and said relay 23 will attract its armature 23^a and break the working circuit at contact 47. When relay 17 is deenergized or its working current is sufficiently reduced its armature 18 will be released, and the spring 26 will draw the armature to close circuit at contacts 20 and 24 through the grid circuit of audion 1^a, and the circuit of magnet 23, at 21, will be opened and spring 46 will operate armature 23^a to close the working circuit 49 at contact 47. It will thus be noted that in Fig. 1 relay 17 must be energized through the plate circuit of audion or detector 1^a in order to restore armature 18 to make contact at 21. The current flowing through relay 17, when no signal is being received through the input circuit, may not be sufficient to restore armature 18 to its operated position so that circuit 25, (Figs. 1 and 3), is provided, whereby when armature 18 engages contact 24 a positive potential from battery A' is applied to grid 2^a, thereby increasing the plate current abnormally and thus energizing relay 17 with sufficient current to operate said relay and attract armature 18. When armature 18 is thus attracted the circuit of grid 2^a through contact 24 will be broken and positive potential removed from grid 2^a, restoring said grid to normal, under the control of the input circuit and leaving armature 18 resting against contact 21. If the incoming signal is prolonged and of sufficient magnitude to maintain grid 2^a at a sufficiently negative potential to reduce the plate current through relay 17 to subnormal, relay 17 will be immediately deenergized and will release armature 18 which will contact with 24 which will again place a positive charge on the grid. This cycle will be repeated as long as such signal continues. The relay 23 under such conditions may be adjusted so as not to follow the rapid oscillations of armature 18 but armature 23^a will remain on its back contact 47 during the period of such prolonged signal.

In accordance with the illustration in Fig. 2 the armature 18 is operated by spring 26 to close circuit 22^a of relay 23 at contact 50, when the armature is released by relay 17. A local battery D is included in circuit 22^a to operate relay 23. Armature 18 of relay 17 is restored by mechanical operation independent of the energization of said relay, the armature 53^a of magnet 53 in this instance being utilized to restore the armature 18 to contact 51. Said contact is connected by conductor 52 with magnet 53, conductor 54

connecting said magnet with battery D. The armature 53^a of magnet 53 is operated by spring 55 to cause armature 18 to break circuit at contact 50 and close circuit at contact 51, and when the last named contact is made the magnet 53 will be energized to attract armature 53^a to permit armature 18 to be subsequently released when relay 17 is deenergized. In this instance the armature 23^a of relay 23 is normally held against back stop 56 by spring 46, and said armature is adapted to close normal open working circuit 49^a, at 47^a, each time that relay 17 releases armature 18 to permit circuit of relay 23 to be closed at 50. If the incoming signal is prolonged and of sufficient magnitude to maintain grid 2^a at a sufficiently negative potential to reduce the plate current through relay 17 to subnormal, relay 17 will be immediately deenergized and will release armature 18 which will engage contact 50 and open circuit of magnet 53, at contact 51, permitting retractile spring 55 of armature 53^a to move said armature against armature 18 restoring said armature 18 to normal operated position. This cycle will be repeated as long as such signal continues. The relay 23 under such conditions may be adjusted so as not to follow these rapid oscillations of armature 18 but armature 23^a will remain on its front contact 47^a during the period of such prolonged signal. In Fig. 1 it will be noted that when armature 18 is in transit between contacts 21 and 24 there is a short interval of time when the positive potential is not connected to grid 2^a and the operation of relay 17 is somewhat dependent upon the mechanical inertia of armature 18. In order to obviate such possibility of erratic action in case relay 17 is not correctly adjusted a construction is illustrated in Fig. 3, whereby positive potential is supplied through the medium of a contact arm 23^b of relay 23, shown connected to armature 23^a, so that such positive potential is maintained on grid 2^a until relay 17 has completed its full cycle of operations, and has energized relay 23 to remove such positive potential. In Fig. 3 I have also shown the use of an additional battery E in case the characteristic of electron or thermionic relay 1^a is such that an additional positive potential other than that obtainable from battery A is required to increase the plate current sufficiently to insure satisfactory operation of relay 17.

In Fig. 4 I have illustrated another means for restoring the armature of relay 17 to normal attracted position by means of utilizing the plate circuit 16^c of a second thermionic relay or audion 1^c, the action of which is as follows: when a signal is received from the input circuit of audion 1^a, (Fig. 4), the grid of such audion will be made more negative in respect to filament, plate current through relay 17 will be reduced in accordance with the pre-

vious description, and armature 18 will be released at a predetermined value which will cause a positive potential to be applied to the grid of audion 1^c through circuit 25^c, which will increase the current flowing through plate circuit 16^c, thereby increasing current through relay 17 abnormally and causing its armature 18 to be attracted, opening contact at 24 and closing contact at 21 which will cause operation of relay 23 for functioning in accordance with the description of relays 23 in Figs. 1 and 3. As soon as contact at 24 has been broken grid 2^c will become negative because of condenser 14^c which will permit the accumulation of negative electrons on such grid, thus reducing plate current through circuit 16^c to such a value as to restore relay 17 to the control of plate circuit 16 of audion 1^a, (Fig. 4).

From the foregoing it will be seen that it is possible to operate a relay by means of a variation in strength of current which in itself would not be sufficient to restore the relay to normal, but is strong enough to hold its armature in operated position after it has been restored to this position but independent of the strength of the controlling signal that is utilized to operate the relay. This permits utilization of much weaker signals than would be possible if the deenergization and energization of the relay 17 was dependent upon the amount of energy received from the input circuit. It will be thus apparent that the system described is desirable where very minute signals are to be utilized. For example, the constants of grid resistance 13^a and grid condenser 14^a may be such that after a long interval of time a minute signal would build up a sufficient negative potential of grid 2^a to reduce the plate current to a releasing value for relay 17. Upon release of relay 17 it would be immediately restored to normal operated position and a single signal impulse would be transmitted to relay 23, and after another comparatively long interval of time the signal would build up another charge sufficient to repeat the above cycle. It thus will be seen that the time interval between signal pulses of relay 23 may be utilized to determine the strength of the incoming signal, such as for the purpose of determining the minimum signal point on directional apparatus or other devices which depend upon the determination of a minimum signal for their correct functioning.

In the illustrations I have shown the thermionic relay 1^a adapted to be operated by audio frequency current, but it will be understood that the frequency of the incoming signal is not material inasmuch as resistance 13^a and condenser 14^a may be so proportioned and/or normal potential of grid 2^a may be such as to receive signals of any frequency or frequencies. The grid resistance 13^a may be utilized to prevent the accumulation of

sufficient negative charge of grid 2^a to cause operation of relay 17 caused by extraneous signals or "strays". If such resistance is reduced the individual static strays or pulses will not be sufficient to maintain grid 2^a charged to a sufficient negative potential to cause operation of relay 17. However, as resistance 13^a is increased the tendency to collect negative potential on grid 2^a is increased and the sensitivity of the device thereby enhanced. This resistance and capacity should be of sufficient value to cause the normal noise or static level to just maintain the grid above its relay operating negative potential. In accordance with Fig. 4 either grid resistance 13^a or condenser 14^a, or both, may be variable for the purpose of regulating the sensitivity of the system. Such variability of the condenser, grid leak and grid condenser is applicable to all the forms of the invention illustrated.

While I have illustrated and described my invention as embodying means for causing the relay 17 to retain its armature in operated position by reason of the normal plate current flowing through the relay, it will be understood that the circuits may be so organized that a signal will increase the normal plate current so as to attract the armature of the relay and the restoring means may be so arranged as to greatly reduce the current through such relay, instead of increasing it as shown, to restore the relay armature 18 to a normal unoperated position. Also, a circuit for relay 17 may be so organized as to use the received energy of an input circuit to cause the operation of the relay armature in either direction, and the local means so organized and controlled by the operation of the relay as to cause operation of said armature in a direction opposite to its operation by the signal.

Having now described my invention what I claim is:

1. The method of operating a relay consisting in supplying it with current from the plate circuit of a thermionic relay to cause the first named relay to place its armature in operated position, causing variation of the strength of the plate circuit by impressing a potential on the grid circuit of said thermionic relay to change the strength of the current in the first named circuit, and causing release of said armature to impress potential upon the grid circuit so as to increase the plate current and then cause the relay to restore its armature to the initial position and remove said potential from the grid circuit.

2. The combination of a relay having an armature, a thermionic relay having a plate circuit including a winding of the relay, signal means, means to vary the normal current through such first named relay, and normally inactive means to supply said thermionic relay with current of opposite value

from the signal means to cause restoration of said first named relay at the cessation of a signal.

3. The combination of a relay having an armature, a thermionic relay having a plate circuit including the winding of the relay, an input circuit for the grid of the thermionic relay for varying the strength of the current in the plate circuit to cause an operation of said armature, and normally inactive means different from such signal means to cause another operation of the armature.

4. The combination of a relay having an armature, a thermionic relay having a plate circuit including the winding of the relay, an input circuit for the grid of the thermionic relay for varying the strength of the current in the plate circuit to cause an operation of said armature, and normally inactive means different from such signal means to cause an operation different from the first named operation of the relay.

5. A relay apparatus comprising in combination an electromagnetic coil included in a circuit associated with a signal receiving circuit, an armature therefor, means to energize the coil with a potential that is normally sufficient to cause the retention of the armature and insufficient to restore it when released, and a normally inactive local circuit associated with a local battery and including the said relay armature which circuit is adapted to be closed by the release movement of the said armature due to a drop in current through the coil owing to the receipt of a signal, for causing additional current to be supplied to the relay coil sufficient to restore the armature to its normal position.

6. A relay apparatus according to claim 5, wherein the signal receiving circuit and the local circuit are associated with an audion or detector, and the coil is included in the plate circuit thereof, and in which the local circuit associated with the local battery includes a connection with the grid circuit of the audion or detector for supplying additional current to the grid upon the release of the armature, for restoring the said armature to normal position.

7. A relay apparatus comprising in combination an electromagnetic coil associated with a signal receiving circuit, an armature herefor, means to energize the coil with a potential that is sufficient to cause the retention of the armature and insufficient to restore it when released, normally inactive audion or detector circuit associated with a local battery and including the said armature, and comprising a connection between the coil and the plate of the audion, and means responsive to the release movement of the said armature due to the receipt of a signal to increase the current supply from the local battery through the plate connection to the coil to restore the armature to

normal position.

8. The combination of a relay, a winding of which is included in the plate circuit of a thermionic relay, means to cause retention of an armature of the first named relay in a signal circuit in a given position, means to cause movement of said armature by a signal, and normally inactive means to cause restoration of said armature to its initial position after its movement by a signal but without regard thereto.

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