May 3, 1938. O. LÜHN 2,115,865

ELECTROMAGNETIC RELAY

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Fig. 1

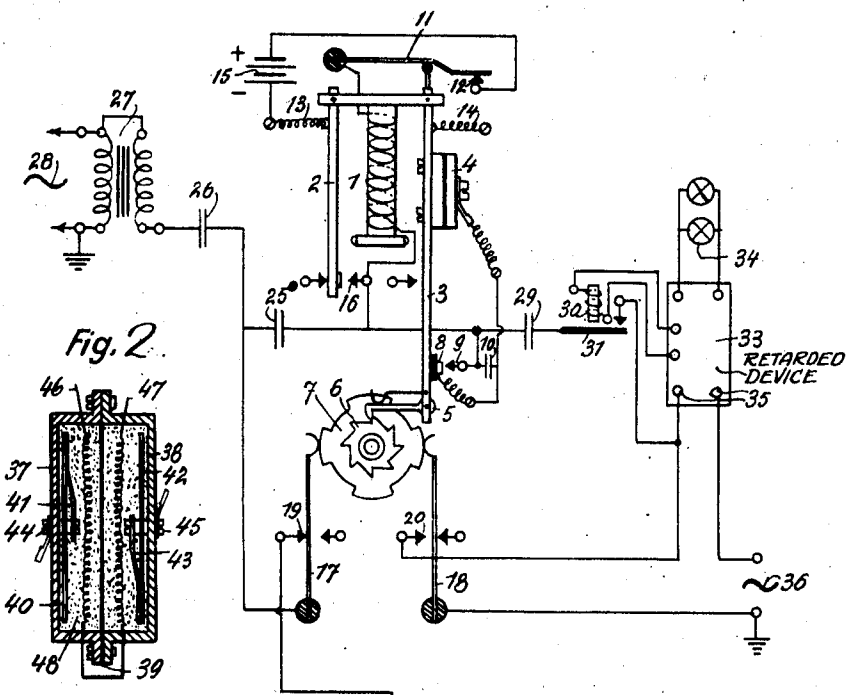

Fig. 2

Fig. 3

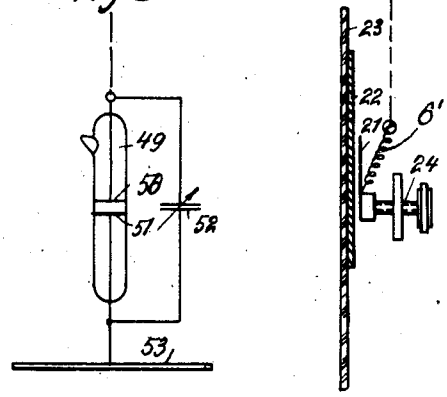

Fig. 4.

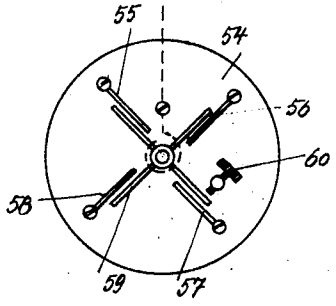

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Fig. 5.

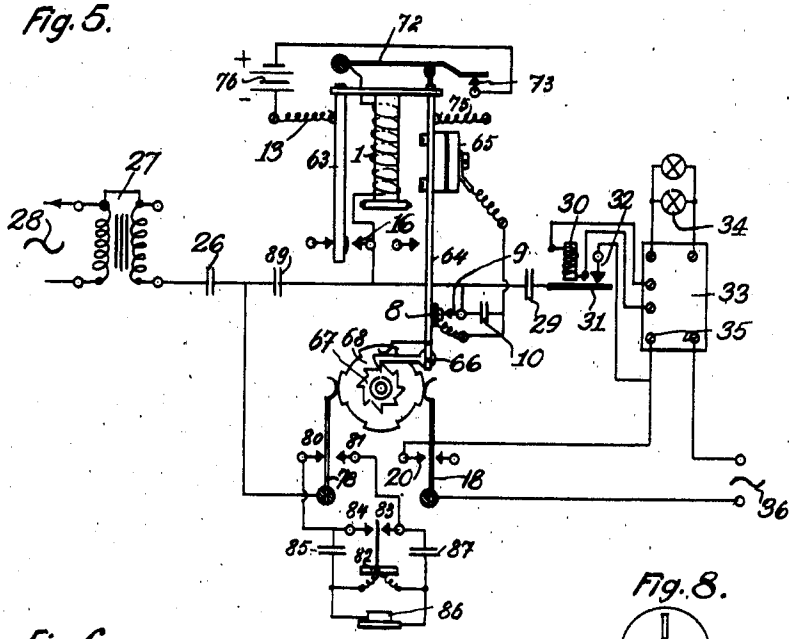


Fig. 6.

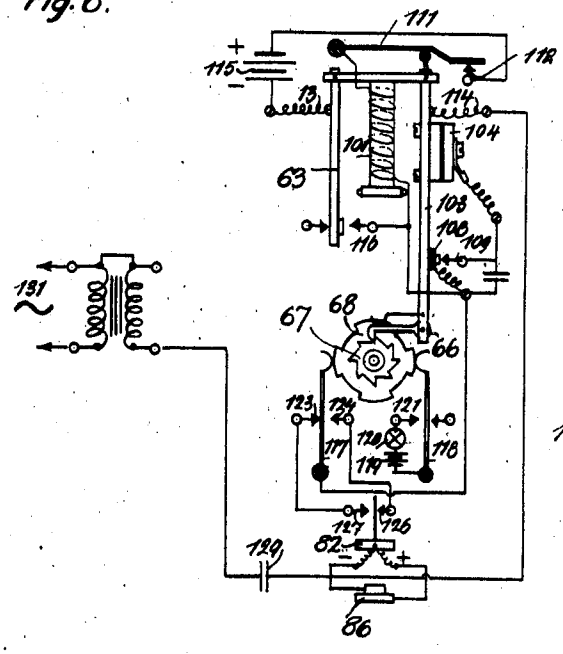


Fig. 8.

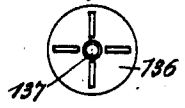


Fig. 7.

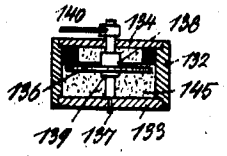
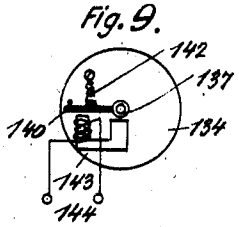


Fig. 9.



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UNITED STATES PATENT OFFICE

2,115,865

ELECTROMAGNETIC RELAY

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Application August 31, 1935, Serial No. 38,797
In Germany April 12, 1935

8 Claims. (Cl. 175—320)

It is well-known that, in the electric control of recording devices, lighting systems and the like by means of capacity variations, an amplifier must be employed if the controlling device is to operate satisfactorily. Amplification is also necessary if the controlling device operates by means of a photo-electric cell. It is also known that contacts with small directing force, such as thermal elements and moving coil contacts, produce sparkling which tends to destroy the contacts. The tendency of the contacts to stick is also a cause of failure of the controlling device, to act satisfactorily.

The usually employed amplifiers, operating with or without thermionic valves, moving coil relays, and the like, while generally too expensive, are not sufficiently reliable for ensuring a satisfactory operation of the controlling devices. The known employment of a moving coil galvanometer has proved unsuitable on account of its tendency to act under the influence of the slightest mechanical vibration.

The object of the present invention is to obtain a relay which, without being affected by mechanical vibrations, is readily responsive to capacity vibrations, and which will operate without amplifying devices and with contacts, such as thermal elements, moving coil contacts and the like having very small directing force.

With this object in view, the invention consists essentially in the combination with an electro-magnetic relay of a variable resistor of particular construction which is responsive to the smallest pulsations of current and which can be operated by means of a capacity diaphragm or other contact with very small directing force.

The variable resistor has the property of lowering its resistance under the influence of weak pulsations of current and thus allowing a local, normally inactive electric source to operate the relay.

Fig. 1 of the accompanying drawings represents a diagram of one form of the relay,

Fig. 2 is a sectional view of the variable resistor,

Figs. 3 and 4 are views showing different modifications of the operating device,

Fig. 5 is a diagram of a modified form of relay,

Fig. 6 is a diagram of a further modification,

Fig. 7 is a sectional view of a modified form of resistance,

Fig. 8 is a detail view of the resistor, and

Fig. 9 is a diagram of electric connection of the resistance.

The relay shown in Fig. 1 comprises an electro-magnet 1; a shorting armature 2; a switch-operating armature 3; a variable resistor 4 carried by the armature 3; an interrupter comprising a contact spring 11 which is operated by the armature 3 and which co-operates with a rigid contact 12; and a rotary switch comprising a cam 7 which is operated by means of a ratchet wheel 6 and a pawl 5, the latter being mounted on the armature 3. The cam 7 co-operates with two contact springs 17 and 18 which close and break circuits by co-operation with contacts 19 and 20. The circuit of the electro-magnetic relay contains the winding of the electro-magnet 1 one end of which is connected through the interrupter with the positive pole of an electric source 15, the other end of the winding being connected through contacts 16, 9 and 8, through the variable resistor 4, through the armature 3 and through the armature-controlling spring 13 with the negative pole of the source 15.

The internal resistance of the element 4 is very high so long as the element is not affected by pulsations of current, and the direct current from the source 15 will not flow through it to the extent of operating the readily responsive armature 2.

The resistor 4 comprises, as shown in Fig. 3, a pair of dished stampings 37 and 38 which are filled with tinsel 48 and connected together over an insulating frame 39 to form a casing. The latter contains a pair of oscillatory electrodes 40 and 42 which are connected by means of blade springs 41 and binding posts 44 and 45 to the two parts 37 and 38, one to each. Any weak pulsations of current to which the electrodes are exposed will, as is usual in coherers, reduce the resistance of the tinsel to the potential imposed on it by the source 15. The two masses of tinsel separated by the presence of the insulating frame 39, may be interconnected by means of a lead containing two coils 46 and 47 embedded in the tinsel. This arrangement, which somewhat reduces the resistance of the resistor 4 to the current from the source 15, will not be required except in the case of relays desired to be especially sensitive.

The relay comprises in addition a transformer 27 the primary of which is connected to the mains 28, the secondary being connected on the one hand to the mains and on the other hand, through a capacitor 26 and through the contact spring 17 and contact 19, to a vibratory tongue 21 which can be adjusted by means of a screw 24. In order to start the tongue 21 vibrating under the influence of a capacitor variation, a metal

plate 22 is provided which is slightly spaced from the tongue. The diaphragm formed by the tongue 21 and the metal plate 22, serves the purpose of setting the tongue 21 into vibrations whenever the plate 22 is influenced by hand or body capacity. The tongue, on being vibrated, makes contact with the plate 22 and thus sets up weak pulsations of current. When a metallic conductor approaches or contacts with a pole subjected to a static electric charge, sparks are produced which in their turn set up pulsations of current, and it therefore follows that such pulsations will be obtained by the contact of the tongue 21 with the plate 22. In order to enable the pulsations of current to actuate the variable resistor 4, the lead from the transformer 27 to the contact springs 17 is connected to the resistor through capacitors 25 and 10.

When, with the arrangement shown in Fig. 1, the metallic plate 22, which may be arranged behind a glass plate 23, is subjected to a capacity variation, the tongue 21 begins to vibrate, and as it touches the plate 22 impulses of current will be set up which are transmitted through the capacitor 25 to the variable resistor 4. The internal resistance of the latter then sinks and allows direct current from the source 15 to pass through the winding of the electro-magnet 1, the circuit being traced through 12—11—1—10—4—3—13—15. The shorting armature 2 will then be attracted by the magnet and placed against the contact 16, thereby cutting out the resistance from the circuit which is traced through 12,—11,—1—16—2—13—15. The magnet will then be sufficiently energized for attracting the armature 3 which lifts the spring 11 from the contact 12 and thus breaks the circuit of the relay. At the same time the armature 2 leaves the contact 16 under the influence of the spring 13, and the armature 3 is also restored by the spring 14 to its normal position. The return movement of the armature 3 brings about a rotation of the cam 7 so that the contact spring 17 will be separated from the contact 19, while the contact spring 18 will be brought into contact with the contact 20, thereby connecting a retarding device 33 to an electric source 36. Since, owing to the altered position of the cam 7, the connection of the relay with the tongue 21 is broken, further operation of the relay by capacity variations is temporarily impossible. The restoration of the device to operative position is effected after a predetermined time by means of the retarding device 33. This is effected by means of an armature 31 which, after a given lapse of time, is momentarily attracted by a magnet 30, thereby discharging through the contact 32 the tension imposed on the armature through the capacitors 26, 25, and 29 and producing sparking at the contact 32. The circuit is traced through earth, 27, 26, 25, 29, 31, 32, 20, 18 and earth. As the armature is connected through 29, 9 and 8 with the resistor 4, the latter will be affected by impulses of current due to the sparking, and the relay will once more be operated for restoring the cam and the springs 17 and 18 to their normal positions. Thereupon the relay is again ready for operation.

The operation of the relay through capacity variations can alternatively be effected by means of the tube shown in Fig. 3 which contains two electrodes 50 and 51. A capacitor formed by a plate 53 is tuned by a capacity 52 arranged across the electrodes, so that no sparking will take place between the latter except when the plate 53 is capacitively influenced.

Electric impulses by hand or body capacity can also be set up by means of the device shown in Fig. 4. This device comprises a star electrode 59 which is mounted on a supporting disc 54 so as to be easily rotatable. The four limbs of the illustrated electrode 59 co-operate with the rigid electrodes 55, 56, 57 and 58 secured to the disc 54. The distance between the cooperating electrodes is regulated by means of a screw 60. A coil 6 connects the star electrode with the contact 19. When the disc 54, which is insulated from the electrode 59, is influenced by hand or body capacity, the star electrode will be attracted by the rigid electrode, and pulsations of current will be set up by the contact between them.

The retarding device connected to the contacts 18 and 20 in Fig. 1, may be of any suitable known type. For instance it may be fitted with a clock movement which is released when the current from the source 36 passes through the terminals 35 and which, after a predetermined time, operates a switch for energizing the magnet 30. Lamps 34 or other indicating devices may be included in the circuit of the contacts 18 and 20.

The relay illustrated in Fig. 5 is similar to the one already described and is operated like the latter but by the deflection of a moving coil galvanometer 82 the needle of which makes contact with one or the other of two rigid contacts 83 and 84. The moving coil may be actuated by the illumination of a selenium cell 86 for shifting the needle from the contact 83 onto the contact 84. The slightest contact of the needle with the contact 84 will cause pulsations of current to be set up which reach the variable resistor 65 through a capacitor 89, whereupon first the armature 63 and then the armature 64 will be operated. After the armature 64 has been operated, the circuit of the source 76 is interrupted by the contact spring 72 which leaves the contact 73, thereby restoring the armatures 63 and 64 to their initial positions. The return movement of the armature 64 is brought about by a spring 75 and effects a rotation of the switch cam 68 through the medium of the pawl 66 and the ratchet wheel 67, whereupon the spring 78 leaves the contact 80 and makes contact with the contact 81. When the illumination of the selenium cell is interrupted, the needle of the coil 82 returns to the contact 83, sparks and impulses of current being then again produced for renewed operation of the relay. This causes the spring 78 to be pressed against the contact 80, thus restoring the relay to its normal condition. The retarding device in Fig. 6 is only used in some cases for retarding the restoration of the relay to its normal condition. In this case the electric connection between the contact 83 and contact 81 is interrupted, so that the restoration of the relay will be effected by means of the retarding device instead of by means of the moving coil needle. In order to nullify the suction effect on the needle due to the tension between the contacts 80 and 81, capacitors 85 and 87 are placed in parallel with the contacts 80 and 81. For instance, a suction effect would exist between the contact 84 and the needle in the absence of the capacitor 85.

The relay shown in Fig. 6 also employs a moving coil galvanometer and can be used for the same purpose as the relay shown in Fig. 5. The circuit comprises an electro-magnet 101; an interrupter comprising a contact spring 111 and

a contact 112; a source 115 of electric current; a variable resistor 104; and contacts 108 and 109. The relay differs from that of Fig. 5 principally by the feature that one pole of the source 115 is connected to the variable resistor 104 through a coil 114, the other pole being connected to the resistance through contacts 106 and 109 according to the position of the spring 117 relative to the contacts 123 and 127 or 124 and 126. The object of this arrangement is to cause the variable resistor to be short-circuited at the moment of contact between the galvanometer needle and its contacts 127 and 126. Such a contact and the resulting pulsations of current, will be sufficient to influence the variable resistor and to allow the direct current from 115 to energize the electromagnet 101. The operation is substantially the same as before. As an example, a lamp 120 or the like, fed from a source 119, can be switched on and off by means of the contacts 118 and 121. The lead containing the capacity 129 may connect the resistor 104 with a source 131 of alternating current in order to render the relay more responsive. The relay may be controlled either by direct or alternating current according to the nature of the moving coil. The spark-quenching property of the variable resistor is very large, because the internal resistance thereof sinks considerably under the influence of the electromagnetic oscillations caused by the sparking. In order to achieve this effect, the constructions shown in Figs. 2 and 7 are of importance. The resistor shown in Fig. 8 consists of a casing the body portion 132 of which is made of insulating material while the top and bottom portions 134 and 133 are adapted to serve as electrodes. The casing is filled with tinsel having the property of reducing the electric resistance under the influence of the pulsations of current. The tinsel content of the casing is divided by an insulating disc 136 into two separate portions. The shaft 137 on which the disc 136 is mounted is divided into two parts which are connected by insulating bosses 138 and 139. The disc 136 serves as a compensating means for restoring the normal positions by a rotary movement of the disc. The rotation may be effected through the medium of an arm 140 which may for this purpose cooperate either with the armature 103 or with a magnet 143 which is arranged in the relay circuit by means of leads 144.

I claim:

1. An electro-magnetic relay for operating switches and the like, comprising an electromagnet, a switch-operating armature for said magnet, a circuit for said magnet including a source of direct current, a resistor in said circuit attached to the armature and operative to prevent normally a flow of current through the magnet and to allow such flow when influenced by pulsations of current, an electric spark producer, means for maintaining said spark producer under static tension, means for actuating said spark producer, and connections between said spark producer and the resistor for transmitting to the latter impulses produced by the sparking and causing the electro-magnet to be energized.

2. The relay claimed in claim 1 in combination with an additional armature responsive to smaller currents than the switch-operating armature, and means controlled by said additional armature for cutting out the resistance from the circuit when attracted by the magnet.

3. The relay claimed in claim 1 in combination with a retarding device, and means operated by said device for restoring the relay to its initial condition.

4. A relay as claimed in claim 1 wherein the spark producer comprises a vibratory tongue connected to the source providing the static tension, and wherein the actuating means consists of a metal plate adapted to attract and make contact with said tongue under the influence of hand or body capacity.

5. A relay as claimed in claim 1 wherein the spark producer comprises an electrode tube having one electrode connected to the source providing the static tension, and wherein the actuating means consists of a plate connected to a second electrode in the tube so as to generate oscillations under the influence of hand or body capacity.

6. A relay as claimed in claim 1 wherein the spark producer comprises a spring-controlled star electrode connected to the source providing the static tension, a supporting disc whereon said electrode is rotatably mounted and from which it is insulated, and rigid electrodes mounted on said plate and operative to attract the rotary electrode on the disc being subjected to capacity variations.

7. A relay as claimed in claim 1 wherein the spark producer comprises a moving coil galvanometer.

8. The relay as claimed in claim 1 in combination with a source of alternating current, a lead connecting said source with the resistor, and a condenser arranged in said lead.

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