Feb. 13, 1934. L. S. WALLE 1,947,236

ELECTRORESPONSIVE DEVICE

Filed April 12, 1933

Fig. 1.

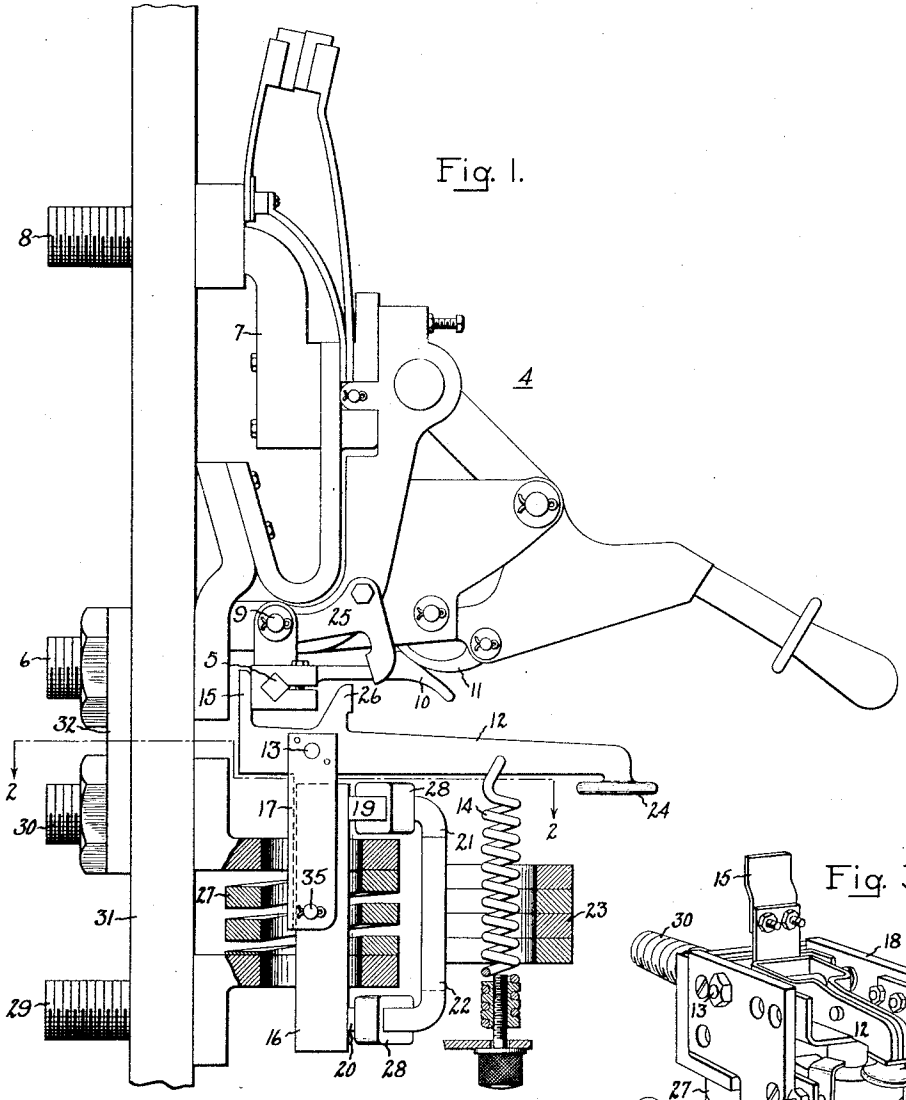


Fig. 2.

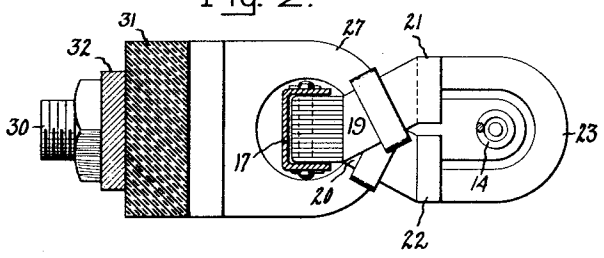
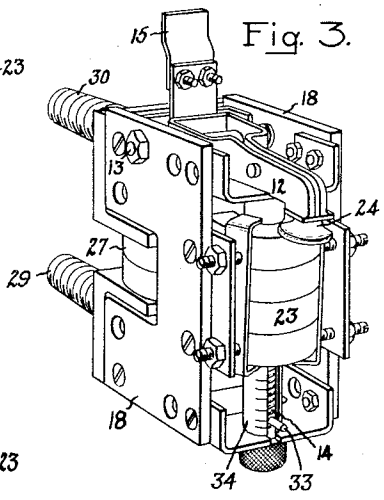


Fig. 3.



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ELECTRORESPONSIVE DEVICE

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6 Claims. (Cl. 200—109)

My invention relates to improvements in electroresponsive devices whose operation is dependent on a reversal of the direction of an electric quantity and more particularly to improvements in electroresponsive devices which operate on the occurrence of a reversal of the current or of the voltage of a direct current circuit. One object of my invention is to provide an improved directional responsive device whose operation is dependent only on the direction of the electric quantity in question and is reliable regardless of the magnitude of the quantity and how quickly reversal occurs. Another object of my invention is to provide an improved directionally responsive device which is comparatively simple in construction and readily applicable to circuit breakers as a direct tripping device. Further objects of my invention will hereinafter appear.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a side elevation of a current directional device embodying my invention and illustrated as being applied to a circuit breaker, certain parts being shown in section and the frame supporting structure omitted for clearness; Fig. 2 is a horizontal sectional view on the line 2—2 of Fig.1; and Fig. 3 is a perspective view of the directional current device illustrated in Fig. 1 showing the frame supporting structure.

In Fig. 1 I have shown an embodiment of my invention in the form of a direct tripping device applied to an automatic air break circuit breaker 4. The particular arrangement I have chosen for illustration in connection with the circuit breaker 4 is operative to effect the opening of the circuit breaker through the actuation of the tripping bar or lever 5 whenever the direction of the current flowing from one stud 6 of the circuit breaker through the contact 7 to the other stud 8 is reversed from its normal direction. The tripping bar 5 is pivoted at 9 and upon counter-clockwise rotation moves an associated tripping lever 10, of which there may be one for each pole of the circuit breaker, to trip the latch 11 of the respective pole.

For actuating the tripping bar 5 directionally responsive devices embodying my invention may be provided with an operating member 12 which is mounted on a fixed pivot 13 and biased for clockwise movement by suitable means, such as a spring 14 so that a projection 15 on one end of the operating member 12 engages the tripping bar 5. The spring 14 may be made adjustable, as shown, in order to regulate the tripping force to correspond to that necessary for moving the tripping bar 5 and also to calibrate the device for tripping at a predetermined value of reverse current. The calibration may be facilitated by the position of the pin 33 with respect to graduations on the spring tube 34.

For controlling the movement of the operating member 12, I provide a movable armature 16 which is loosely suspended from the fixed pivot 13 through suitable means such as a clevis 17, which is rigidly secured to the operating member 12. In Fig. 1 the frame, which supports the fixed pivot 13 and certain other parts of the directionally responsive device, is not shown for clearness. The frame structure will, however, be clear from Fig. 3 which shows the frame side plates 18 and the supporting members for the various parts.

For controlling the movement of the armature 16 and thereby the movement of the operating member 12, I provide a cooperating magnetic structure which includes two polar projections 19 and 20 for engaging and holding the armature. In order to have correct alignment of the armature 16 with the polar projections, the armature may be mounted on a pin 35 carried by the clevis 17. The polar projections are provided with legs 21, 22 respectively. As shown, these legs are substantially parallel and separated by a comparatively narrow air gap so that the magnetic circuit, including the armature and the polar projections with their respective legs, is of comparatively low reluctance.

For polarizing the projections 19 and 20, I provide a permanent magnet 23 which cooperates with the magnetic structure comprising the polar projections and their respective legs. As shown, the permanent magnet 23 is so mounted as to have its poles respectively engage the legs 21 and 22. The magnetic strength of the permanent magnet 23 may be such that when the operating member 12 is moved counter-clockwise against the biasing spring 14 to bring the armature 16 against the polar projections 19 and 20, the armature will remain there and thus keep the device in the ready to trip position. The counter-clockwise movement of the operating member 12 may be effected by pushing up on the hand button 24 or the circuit breaker mechanism may be provided wtih a lever 25 so arranged that upon the opening of the circuit breaker the lever 25

engages a projection 26 on the operating member 12 whereby to turn this member counterclockwise into the position shown in Fig. 1.

For energizing the magnetic structure including the armature 16 and the polar projections 19 and 20, I provide an energizing winding 27 which is operative when energized by current in one direction to produce a flux in a direction to assist the permanent magnet 23 in polarizing the projections 19 and 20, whereby to maintain the armature 16 in the attracted position to hold the operating member 12 against movement, as shown in Fig. 1. However, upon a reversal of current in the winding 27, the flux generated by this winding opposes the polarizing action of the permanent magnet 23 whereby to effect the release of the armature 16 and the movement of the operating member 12 under the bias of its spring 14. In this way the tripping action is effected. It will be observed that if the air gap between the legs 21 and 22 of the magnetic structure is made comparatively small so that the reluctance of the magnetic circuit including the armature and the polar projections with their respective legs is low, there is provided a leakage path for the magnetic flux of the winding 27. This prevents a strong magnetic flux from demagnetizing the permanent magnet 23 upon a reversal of current in the winding 27.

In order always to insure positive tripping regardless of the magnitude and suddenness of the change in the direction of the current in the winding 27, I provide means for preventing a quick increase of flux in the magnetic structure including the armature 16, the polar projections 19 and 20 and their respective legs. The particular means shown is a closed circuit winding 28, one of which may be placed around each of the polar projections 19 and 20.

While the arrangement of the parts may be such that my directional responsive device is an integral part of the circuit breaker, its application may be more flexible if the device is provided with its own connecting studs 29 and 30 between which the current winding 27 is suitably mounted. In this case the circuit breaker and the tripping device can be mounted on any suitable supporting structure such as the switchboard 31 and a conducting strap 32 applied between one stud, for example, 30 of the directional responsive device, and a stud 6 of the circuit breaker. Depending upon the normal direction of current flow through the circuit breaker 4, this strap connection may be run from the circuit breaker stud 6 to the device stud 29.

With the arrangement shown, it will be obvious that when the operating member 12 is raised to the position shown in Fig. 1, the armature 16 will engage the polar projections 19 and 20 and be retained by the flux due to the permanent magnet 23. When the circuit breaker is closed, if the direction of the flow of current through the winding 27 is such as to polarize the projections 19, 20 in the same way as they are polarized by the permanent magnet 23, the armature 16 will be more forcibly held. If the direction of current is in a different way or if the current is reversed at any time, then the polarity of the projections 19 and 20 is changed by the predominance of the flux due to the winding 27 over the flux due to the permanent magnet 23. As the flux in the polar projections 19 and 20 reverses or goes through the zero position, the armature 16 will be released so that under the action of the biasing spring 14 the operating member 12 is moved in a direction to cause tripping of the circuit breaker. If the reversal of current is extremely fast and the magnitude of the current is high, the passing of the flux at the polar projections through the zero value will not be fast enough for the inertia of the parts to delay movement until the flux becomes strong enough in the opposite direction to hold the armature in the attracted position because of the choking action of the short-circuited windings 28.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A directionally responsive electromagnetic device comprising an armature biased for movement in one direction, a cooperating magnetic structure including two polar projections for engaging and holding said armature, a permanent magnet cooperating with said magnetic structure to polarize said projections, a winding for energizing said magnetic structure and armature operative when energized by current in one direction to produce a flux in a direction to assist said permanent magnet in polarizing said projections whereby to maintain said armature in the attracted position and upon a reversal of current to oppose the polarizing action of said permanent magnet whereby to effect the release of said armature and a closed circuit winding on one of said polar projections.

2. A directionally responsive electromagnetic device comprising an armature biased for movement in one direction, a cooperating magnetic structure including two polar projections for engaging and holding said armature, a permanent magnet cooperating with said magnetic structure to polarize said projections, a winding for energizing said magnetic structure and armature operative when energized by current in one direction to produce a flux in a direction to assist said permanent magnet in polarizing said projections whereby to maintain said armature in the attracted position and upon a reversal of current to oppose the polarizing action of said permanent magnet whereby to effect the release of said armature and means for preventing a quick increase of flux in the magnetic circuit of said armature and magnetic structure on the occurrence of a sudden reversal of current substantially independently of the magnitude of the current.

3. A directionally responsive electromagnetic device comprising an armature biased for movement in one direction, a cooperating magnetic structure including two polar projections for engaging and holding said armature, each of said projections having a leg of magnetic material and said legs being separated by a narrow air gap, a permanent magnet having its poles respectively engaging said polar projection legs to polarize said projections, a winding for energizing said magnetic structure and armature operative when energized by current in one direction to produce a flux in a direction to assist said permanent magnet in polarizing said projections whereby to maintain said armature in the attracted position and upon a reversal of current to oppose the polarizing action of said permanent magnet whereby to effect the release of said armature and a closed circuit winding on each of said polar projections intermediate the armature and said permanent magnet.

4. In a directionally responsive tripping device for circuit breakers, a tripping member biased for movement in one direction and magnetic

means for controlling said movement including a movable armature, a cooperating magnetic structure including two polar projections for engaging and holding said armature, said projections having substantially parallel legs separated by a narrow air gap, a permanent magnet cooperating with said magnetic structure to polarize said projections, a winding for energizing said magnetic structure and armature operative when energized by current in one direction to produce a flux in a direction to assist said permanent magnet in polarizing said projections whereby to maintain said armature in the attracted position to hold said member against movement and upon a reversal of current to oppose the polarizing action of said permanent magnet whereby to effect the release of said armature and the movement of said member and a closed circuit winding around one of said projections.

5. In a directionally responsive tripping device for circuit breakers, a tripping member biased for movement in one direction, and magnetic means for controlling said movement including a movable armature, a cooperating magnetic structure including two polar projections for engaging and holding said armature, said projections having substantially parallel legs separated by a narrow air gap, a permanent magnet cooperating with said magnetic structure to polarize said projections, a winding for energizing said magnetic structure and armature operative when energized by current in one direction to produce a flux in a direction to assist said permanent magnet in polarizing said projections whereby to maintain said armature in the attracted position to hold said member against movement and upon a reversal of current to oppose the polarizing action of said permanent magnet whereby to effect the release of said armature and the movement of said member and means operative on the occurrence of a sudden reversal of current in said winding for preventing a quick increase of flux in said magnetic means substantially independently of the magnitude of the reverse current.

6. A circuit breaker, a directionally responsive tripping device therefor including a tripping member biased for movement in one direction and magnetic means for controlling the movement of said member including a movable armature, a cooperating magnetic structure including two polar projections for engaging and holding said armature, a permanent magnet cooperating with said magnetic structure to polarize said projections, a winding for energizing said magnetic structure and armature operative when energized by current in one direction to produce a flux in a direction to assist said permanent magnet in polarizing said projections whereby to maintain said armature in the attracted position to hold said member against movement and upon a reversal of current to oppose the polarizing action of said permanent magnet whereby to effect the release of said armature and the movement of said member and means associated with said circuit breaker for resetting said armature upon the opening movement of the circuit breaker.

LUDWIG S. WALLE.