Feb. 4, 1941. J. W. OWENS 2,230,726

CIRCUIT BREAKER

Filed Oct. 27, 1939

Fig. 1.

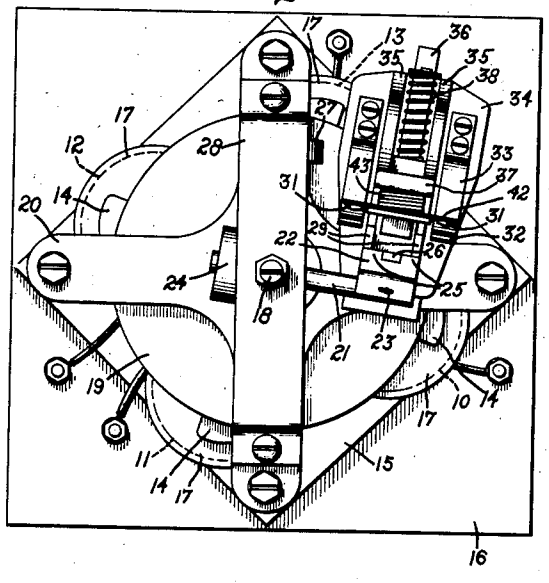
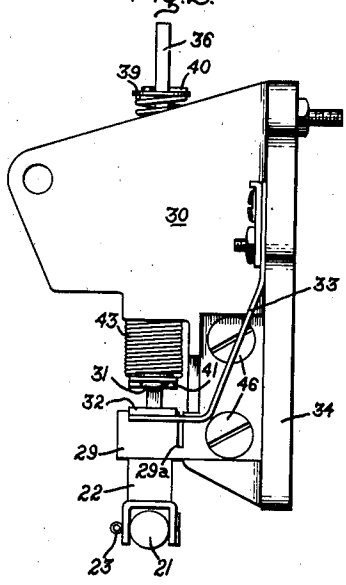



Fig. 2.



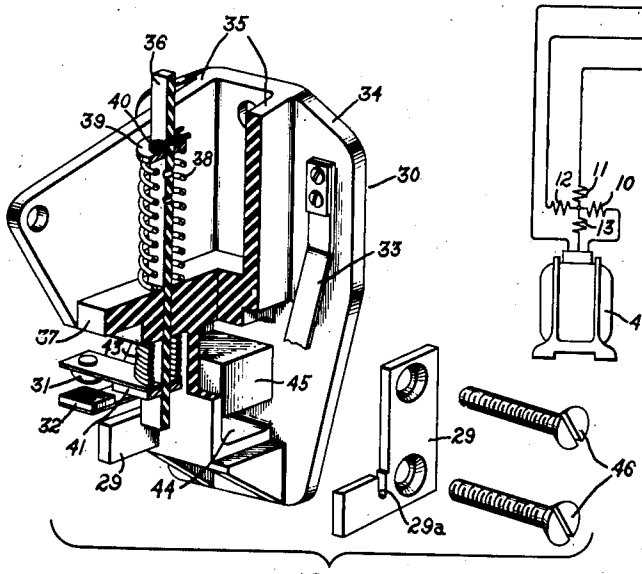
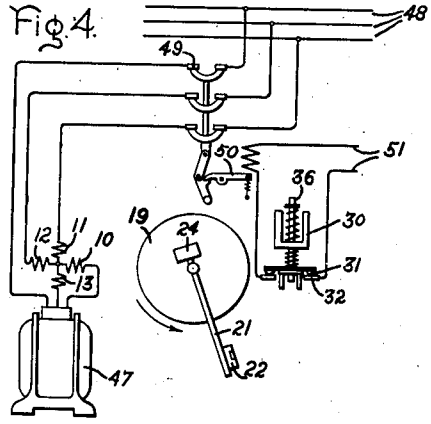




Fig. 3.

Fig. 4.




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# UNITED STATES PATENT OFFICE

2,230,726

## CIRCUIT BREAKER

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Application October 27, 1939, Serial No. 301,640

4 Claims. (Cl. 200—87)

My invention relates to circuit breakers, more particularly to magnetic holding and releasing devices for electrical switches or relays, and has for an object the provision of a device of this character which is releasable with a minimum of actuating force, and which is reliable and inexpensive to manufacture.

While my invention is capable of general use for circuit breakers, it is particularly useful in connection with certain relays, such as phase failure relays, inherently capable of furnishing but a small actuating force in operating its contacts. Relays of this character preferably have a switching means which is latched in an initial position and then is tripped for movement to an operated position by action of the relay when it operates. If the power required to trip the latch is either large or variable, the accuracy of the relay is impaired. This is especially noticeable on relays which have a close range of adjustment, or which have only a small amount of torque available at the tripping point.

Accordingly, I have provided a magnetic latching mechanism which requires no force or torque in the actual tripping operation, but rather, it furnishes force or torque to the operating member of the relay during tripping. This is accomplished by using a magnetic means including an armature secured to the switching means to hold the switching means in an initial position against the bias of an operating spring. In addition, an element of suitable magnetizable material, preferably a permanent magnet, is mounted on the moving member of the relay and at the tripping or operating value of relay current is moved toward the magnetic means holding the switching means in the initial position. When the magnetic element and magnetic means are almost touching, the magnetic element is pulled into contact with the magnetic means, thereby furnishing force or torque to assist the moving member of the relay. The magnetic element itself, when brought into proximity to the magnetic means, changes the distribution of magnetic flux in the magnetic means so that the holding force on the armature and switching means is weakened for release and operation by the biasing spring. In resetting or relatching the device, a movable pushrod returns the switching means and armature attached thereto back to the initial position. In this position the armature and the switching means are restrained by the magnetic means. A small amount of overtravel of the pushrod during resetting forces the magnetic releasing element out of engagement with the magnetic means, and the device is ready for operation.

Further objects and advantages of my invention will become apparent from the following specification, and for a more complete understanding of my invention, reference should be had to the accompanying drawing in which Fig. 1 is a plan view of a phase failure relay provided with a magnetic latching and switching device embodying my invention; Fig. 2 is an enlarged side elevational view of the latching device shown in Fig. 1; Fig. 3 is an enlarged perspective view partly in section and partly disassembled of the latching and switching device embodying my invention; and Fig. 4 is a schematic diagram of the circuit connections for a relay embodying my invention.

I have shown my invention in one form adapted for use with a phase failure relay, such as described and claimed in United States Patent No. 1,620,555 to B. W. Jones et al., patented March 8, 1927. Briefly, this relay is for the purpose of causing the interruption of a multiphase circuit upon failure of one of its phases or upon a phase reversal. It comprises four windings, 10, 11, 12 and 13, which, as shown in Fig. 4, are connected in pairs in two phases of a 3-phase circuit. These windings are wound on the usual magnetic cores 14, mounted on a magnetic base 15, which is suitably secured to an insulating base 16. Shading rings 17 are provided on the magnetic cores 14 to improve operation. The four windings and their cores are arranged symmetrically around a central axis 18 and a suitable rotatable disc 19, such as a copper disc, is centrally mounted on a rotatable shaft so as to be rotated by the rotating field set up by the four windings. In addition, a cross-shaped magnetic member 20 is mounted above the disc 19 to vary the effect of the flux from the magnets 14 on the rotatable disc 19. The four arms of the magnetic member 20 are displaced slightly to one side of the respective axes of the magnets 14. In this manner, a torque independent of the rotating field due to the polyphase circuit is set up and gives a torque resulting from the single-phase flux of the individual magnets.

With the magnetic member 20 displaced as shown, this single-phase torque tends to rotate the disc 19 in a counter-clockwise direction. The torque due to the rotating field normally predominates over the independent opposing torque just mentioned, so that the disc will normally rotate in a clockwise direction. If, however, one phase of the polyphase circuit is open, there will no

longer be a rotating field and the single-phase torque then causes rotation of the disc 19 in a counter-clockwise direction. Counter-clockwise rotation of the disc 19 is utilized to carry a latch releasing means adjacent a switching means held in the latched position to bring about a release of the switching means in a manner to be more fully described hereinafter.

A movable operating arm 21 is suitably secured to the rotatable shaft at the axis 18 for rotation with the disc 19. As seen in Fig. 4, the long end of the movable arm carries a magnetic member 22 which is fastened at the end of the arm by a fork and cotter pin 23. The movable arm 21 is provided at its opposite end extending at the other side of the axis shaft with a suitable balance weight 24 to counter balance the weight of magnet 22 and arm 21. For reasons that will become more fully apparent from the description hereinafter, the magnetic element 22 preferably is in the form of a permanent magnet having a pair of pole faces 25 at one side thereof separated by a central slot 26. Under normal operating conditions of the relay, the torque due to the rotating field rotates the disc 19 and with it the operating arm 21 to an extreme clockwise position (not shown) into engagement with a suitable stop, such as a leaf spring 27, supported by a bracket 28 which also assists in mounting the axis shaft. The operating arm 21 normally remains in the clockwise position just described until phase failure or phase reversal occurs. As shown, the operating arm 21 and the magnetizable member 22 are in the operated or latch-releasing position after counter-clockwise rotation due to the single-phase torque, the pole faces 25 being respectively in engagement with a pair of pole pieces 29 made of magnetic material for releasing a magnetically latched circuit breaker 30 as explained herebelow.

The breaker 30 comprises a pair of bridging contacts 31 movable into engagement with a pair of resiliently supported fixed contacts 32, the fixed contacts 32 each being mounted on a resilient strip 33 secured to a base 34 of suitable insulating material. As seen in Fig. 3, the base 34 is provided with a pair of spaced-apart walls 35 to separate and insulate the resilient conducting strips 33 and their respective terminals from each other, the walls 35 also forming a partial enclosure for a reset pushrod 36 extending between these walls and carrying the movable contacts 31. The reset pushrod 36 is slidable in an aperture provided in a transverse wall 37 interposed between the walls 35, the upper end of the pushrod 36, as viewed in Fig. 3, being encircled by a main biasing spring 38 which is seated between the wall 37 and an axially adjustable washer 39 held in place on the pushrod 36 by a cotter pin 40. The spring 38 biases the pushrod 36 in a direction to disengage the movable contacts 31 from the fixed contacts 32. At the other side of the wall 37 the lower extending end of the pushrod 36 serves to slidably mount a magnetic armature 41 for movement into bridging engagement with the pole pieces 29 when the pushrod is moved downwardly, the magnetic attraction between the armature 41 and the pole pieces 29 being sufficient to retain or latch the pushrod 36 in the down position against the force of the spring 38, and also hold the contacts 31 and 32 in engagement. The armature 41 is prevented from slipping off the lower end of the pushrod 36 by an enlarged end on the pushrod forming a pair of transverse shoulders.

Also slidable on the pushrod 36 and mounted just above the armature 41, but separate or loose therefrom, is a bridging contact strip 42 which supports the movable contacts 31. The bridging contact strip 42 is biased against the armature 41 and the armature against the transverse shoulders of the pushrod 36 by a helical spring 43 encircling the lower end of the pushrod 36 and interposed between the wall 37 and the strip 42. The spring 43 is weaker than the spring 38 so that the resultant biasing force of these springs is always in a direction to move the movable contacts 31 out of engagement with the fixed contacts 32.

In order to assemble the pushrod 36 and its biasing springs 38 and 43 in position on the base 34, the armature 41, the contact strip 42, and the spring 43 are first slipped onto the upper end of the rod and slid down along the rod until the armature 41 is against the transverse shoulders on the lower end of the rod. The upper end of the rod is then inserted through the aperture in the wall 37. The upwardly extending portion of the rod 36 is then ready to receive the spring 38, the washer 39, and finally the retaining cotter pin 40.

The base 34 is provided with a recess 44 for receiving and retaining the magnetic means which maintains the pole pieces 29 in a magnetically energized condition. This magnetic means preferably comprises a block-shaped permanent magnet 45 of relatively high coercive force. As shown in Fig. 3, the pole pieces 29 are substantially L-shaped, having the outwardly extending legs forming the attracting pole faces for the armature 41. The other legs of the L are arranged to fit in recessed portions of the base 34 adjacent the recess 44 for closing off the sides of the recess after the permanent magnet 45 has been inserted between the pole pieces 29. The magnet 45 is secured between the pole pieces with the aid of the fastening bolts 46 passing through the recess 44 at either side of the magnet 45. Each of the pole pieces 29 is preferably provided with a notch 29a for increasing the reluctance of the magnetic circuit including the latched armature 41.

In operation, as explained hereinbefore, the magnetic releasing magnet 22 is rotated in the extreme clockwise position against the stop spring 27 by the torque from the polyphase flux applied to the disc 19. At this time the pushrod 36 may be moved downwardly, as viewed in the drawing, to place the armature 41 which bridges the pole pieces 29 in its magnetically restrained or latched position, wherein the fixed contacts 32 are bridged by the movable contacts 31 which are also carried downwardly, as the rod is moved, by the biasing force of the spring 43. The fixed contacts 32 are so positioned that the movable contacts 31 come into engagement therewith and are prevented from further movement before the armature 41 actually engages the pole pieces 29. In this manner as the rod 36 proceeds in its downward resetting movement, the contacts 31 and 32 are held into engagement solely by the force of the spring 43, and the contact pressure between these contacts in turn is determined solely by the force of the spring 43. Once the contacts 31 assume a fixed position in engagement with the contacts 32, there is no further force from the spring 43 which tends to make the armature 41 follow the downward

movement of the pushrod 36. Such a force on the armature 41 is unnecessary, however, since the armature has been moved into the field of attraction of the pole pieces 29 and is pulled into engagement with the pole pieces by the magnetic forces. Since the magnetic forces on the armature 41 when it is in its attracted position are greater than the opposing forces of the spring 38, the armature thereafter retains the pushrod 36 in its down or reset position while the contacts 31 and 32 are held in engagement by the force of the spring 43.

Referring now to the circuit diagram shown in Fig. 4, a polyphase dynamo-electric machine to be protected against phase failure or phase reversal, such as, a polyphase induction motor 47, is supplied with polyphase power from a suitable source 48 through a circuit breaker 49. As previously explained, the rotating field windings 10, 11, 12 and 13 of the phase failure relay are connected in pairs in two phases of the supply as shown. The contacts 31 and 32 of the circuit breaker 30 are connected in a separate energizing circuit for the energizing winding of a normally energized tripping mechanism 50 for holding the circuit breaker 49 closed, this circuit being supplied from a suitable electric source 51. When the circuit breaker 49 is in the closed position shown, the tripping mechanism 50 serves to latch the circuit breaker in the closed position upon closure of the contacts 31 and 32. It is apparent, of course, that these contacts are themselves held in engagement by the magnetic forces from the magnet 45 on the armature 41. Simultaneously, under normal operating conditions the rotating field set up by the relay windings 10, 11, 12 and 13 causes the disc 19 and the arm 21 to be rotated and maintained in the clockwise position against the stop 27.

Upon phase failure or phase reversal, the disc 19 and operating arm 21 are rotated counter-clockwise in the direction of the arrow in Fig. 4. As the magnetizable element 22 comes within the magnetic field at the pole pieces 29, the attraction between these elements increases the torque already applied to the arm 21 and further movement of the arm in the counter-clockwise direction to release the latching device 30 occurs with an increasing force applied. Thus the relay is not called upon to furnish additional operating torque at the point of latch release.

When the magnetizable element 22 engages and bridges the pole pieces 29, the magnetic flux previously having only one low reluctance path through the armature 41 now has another low reluctance shunt or parallel path through the magnetizable element 22. Thereby, the attracting flux passing through the armature 41 is divided and weakened so that the force of the spring 38 overcomes the force on the armature 41 to release the pushrod 36 and disengage the contacts 31 and 32. Deenergization of the winding of the tripping mechanism 50, then causes the circuit breaker 49 to open and disconnect the motor 47.

As pointed out above, for the most effective operation, the magnetizable element 22 is preferably a permanent magnet, although by properly choosing the reluctances of the main and shunt magnetic paths with the aid of the notch 29a in the pole pieces or by similar means, a piece of unmagnetized soft iron or the like may be used. If a permanent magnet is used as the element 22, its poles are arranged opposite in polarity to the polarity of the respective pole pieces 29. In this manner, the flux distribution in the pole pieces and armature 41 is best affected for releasing the armature 41.

To reset the circuit breaker 30, the pushrod 36 is moved downwardly. The spring 43 moves the contacts into engagement. The armature 41 is attracted and restrained by the pole pieces. At the same time the pushrod 36 is moved slightly beyond the point necessary to position the armature 41 to enable the projecting lower end of the pushrod to force the magnetizable element 22 and the arm 21 away from the pole pieces 29 and rotate them toward the clockwise position.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In an electromagnetic device having a member rotatable in response to predetermined current conditions in said device, switching means including fixed and movable contacts arranged to be operated by a predetermined movement of said rotatable member, magnetic means including spaced apart pole pieces, an armature movable into bridging relation with said pole pieces for magnetically retaining said switching means in a predetermined position, supporting means for said armature and said movable contact including a slidable pushrod, means biasing said rod for movement away from said pole pieces, means biasing said movable contact in a direction to engage said fixed contact when said armature is held by said pole pieces in bridging relation therewith, and means including a permanent magnet having pole faces arranged for movement by said rotatable member adjacent said pole pieces, each of said pole faces being of a polarity opposite to the polarity of the respective pole piece toward which it is moved for causing a strong magnetic attraction between said permanent magnet and said pole pieces to assist in rotating said rotatable member, said permanent magnet when in proximity to said pole pieces causing a change in the flux distribution therein for enabling release of said armature and said pushrod from said magnetically restrained position.

2. A circuit breaker comprising a base, a pushrod slidably mounted on said base, switching means including a movable contact and a relatively fixed contact, means mounting said movable contact on said pushrod and for limited movement independently thereof, a first spring biasing said pushrod in a predetermined direction, another spring biasing said movable contact in the other direction, an armature slidable on said pushrod and subject to the force of said other spring until engagement of said contacts, magnetic means for restraining said armature in a predetermined position for holding said pushrod against the bias of said first spring, said other spring serving to retain said contacts in engagement independently of said pushrod when said armature is in said predetermined position, and means including a permanent magnet movable adjacent said magnetic means for changing the distribution of flux therein, thereby to release said armature and said pushrod for movement under the force of said first spring to disengage said contacts.

3. A circuit breaker comprising a base, a push rod slidably mounted on said base, a pair of stationary contacts on said base on opposite sides of said push rod, a movable bridging contact slidably mounted on said push rod, a helical spring surrounding said push rod having one end engaging said base and its other end engaging said movable bridging contact to hold said contact against said stationary contacts, a permanent magnet on said base having pole pieces on opposite sides of said push rod, an armature of magnetic material mounted on said push rod on the side of said bridging contact opposite said spring so as to hold said bridging contact on said push rod against the force of said spring, a second helical spring surrounding said push rod for biasing said push rod in a direction opposite to said first spring, said second spring being stronger than said first spring and thereby normally moving said bridging contact out of engagement with said stationary contacts, said push rod being arranged when depressed to bring said bridging contact into engagement with said stationary contacts and upon further movement of said push rod to bring said armature into engagement with said pole pieces whereby said armature is held by said pole pieces and said bridging contact is held in engagement with said stationary contacts by said first spring, a permanent magnet movably mounted for engagement with said pole pieces with pole faces of opposite polarity in engagement with each other whereby said first permanent magnet is caused to release said armature and said push rod is moved by said second spring to move said bridging contact to an open circuit position.

4. A switching device comprising in combination with a member rotatable in response to a predetermined condition, a support made of electrically insulating material provided with an aperture, a rectangular block-shaped permanent magnet fitting in said aperture with pole faces on its ends projecting from opposite ends of said aperture, a member of magnetic material engaging each of said pole faces, a pair of bolts embracing said magnet and clamping said magnetic members on said magnet, an arm carried by said rotatably mounted member, a permanent magnet secured to said arm arranged upon rotation of said member in one direction to move into engagement with said magnetic members, switching means, and an armature of magnetic material carried by said switching means arranged to be moved into engagement with said magnetic members so as to be held thereby whereby said switching means is held in one position, said armature being released for operation of said switching means to another position when said movable magnet is moved into engagement with said magnetic members.

JOSEPH W. OWENS.