

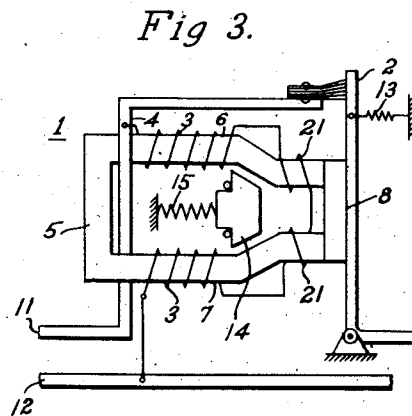
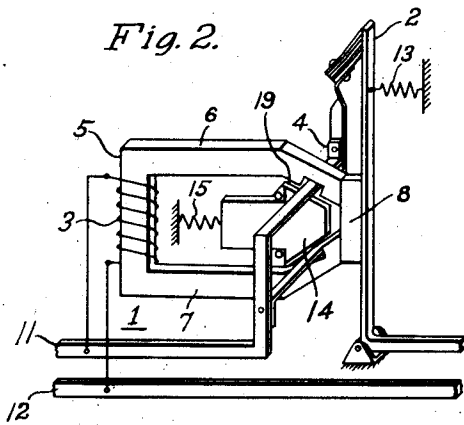
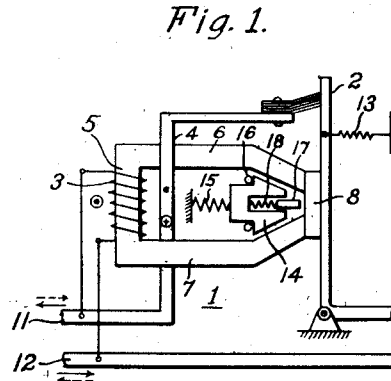
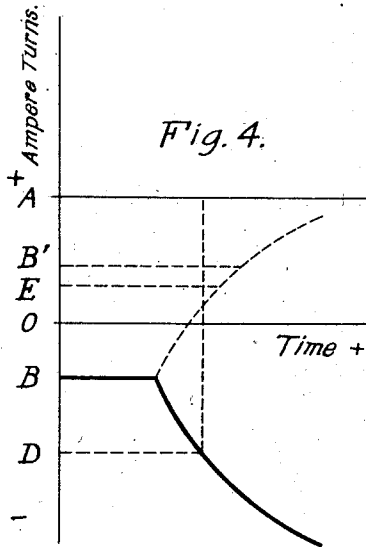
Feb. 26, 1929.

1,703,353

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CIRCUIT INTERRUPTER

Filed Jan. 24, 1928



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CIRCUIT INTERRUPTER.

Application filed January 24, 1928, Serial No. 249,143, and in Germany January 10, 1927.

My invention relates to circuit interrupters and more particularly to holding electromagnets therefor.

One object of my invention is to provide a holding electromagnet for a circuit interrupter that shall be responsive to release the circuit interrupter on either a reversal or an increase in current in one of the circuits effecting the energization of the electromagnet.

Another object of my invention is to provide an electromagnet with a plurality of armatures, one of which shall be attracted upon a predetermined change in the current energizing the electromagnet, to thereby form a short flux path to by-pass the flux from another said armature having a longer flux path.

A further object of my invention is to provide a holding magnet having a short-circuiting armature of the character just described, with a resilient bumper for the short-circuiting armature, that shall mechanically assist the said armature to release the armature it short circuits.

A still further object of my invention is to provide a circuit interrupter that shall be responsive to open upon the occurrence of an overload or a reversal in line current but which does not employ mechanical latches.

Heretofore, in constructing high-speed circuit-breakers, it has been common to employ a holding electromagnet that is directly affected by changes in the main circuit to release the movable contact. By so employing an electromagnet, the ordinary latches, tripping coils and relays, which introduce a considerable time delay between the current changes and the operation of the circuit interrupter, are eliminated. The holding electromagnets heretofore employed were responsive either to an overload current or to a reversal of current alone, but, when a protection was desired from both of these undesirable occurrences, two such holding magnets were employed and united in a manner such that the releasing of either would operate to open the circuit interrupter.

In practicing my invention, I am able to obtain protection against an overload or reversal in current by the employment of a single holding electromagnet similar to that which has heretofore been used to operate on a change in current in a single direction. This I am able to do by employing an auxiliary

armature positioned between the energizing coils and the normally operated holding armature. The auxiliary armature is attracted by an increasing flux in the electromagnet beyond a predetermined amount and this attraction closes the air-gap therebetween and forms a shorter path for the flux than that through the holding armature, the latter armature thereby becoming deenergized and opening the circuit interrupter.

Referring to the drawings:

Figs. 1, 2 and 3 are diagrammatic views of a circuit interrupter showing particular embodiments of my invention, and

Fig. 4 is a current-time diagram showing the relation between the current in the shunt and series coils.

My invention comprises, in general, a holding electromagnet 1, a circuit interrupter 2, a shunt coil 3 and a series coil 4 that operates to hold the circuit interrupter 2 in closed position when normal current is flowing in the series coil 4 but which operates to release the circuit interrupter 2 when a reversal or increase in current in the series coil 4 reaches a predetermined limit.

The holding electromagnet 1 is provided with a core 5 that has extending legs 6 and 7, the ends of which terminate in surfaces that are bridged by a holding armature 8. A voltage coil 3, that may be energized from any constant voltage source, such as the main circuit 11, 12, is mounted on the core 5. The current winding 4 comprises a straight conductor and extends between the legs 6 and 7 of the core 5. The core 5, energized by the voltage coil 3, holds the armature 8 and the circuit interrupter 2 in closed position against the tension of a spring 13. A short-circuiting armature 14 is located between the legs 6 and 7 of the core member 5 and is normally biased against stop lugs 16 by a spring 15.

The operation of the device is as follows: When the current of the circuit is reversed, that is to say, is reversed with respect to the voltage thereof, the magnetic flux of the potential coil 3 is opposed by the flux of the reversed current in the series coil 4, reducing the holding force of the armature 8 until it is less than the bias of the spring 13, at which time the circuit interrupter will be moved to open position. The connection of the potential coil 3 to the main circuit 11 and 12 is such that a magnetic flux is pro-

vided having the same polarity as the flux of the series coil 4 when current is flowing therein in normal direction, as designated by the broken arrows. The marking of the coils 3 and 4 in Fig. 1 discloses the opposite relation of this flux when the current is reversed, as designated by the full-line arrows.

When, on the other hand, an excessive current flows in the direction corresponding to a normal load, as indicated by the dotted-line arrow, the flux of the potential coil 3 and of the series coil 4, being cumulative, will operate to retain the armature 8 and, therefore, the circuit interrupter 2 in engaged position with a greater force.

When, however, the excess current has increased to a predetermined amount, the short-circuiting armature 14 is attracted, against the tension of a spring 15, until it is moved to engage the legs 6 and 7 of the core 5, whereby the flux path is short-circuited ahead of the armature 8. The flux lines now traverse the path through the core 14, and their holding action on the armature 8 ceases. The armature 8 is then moved by the tension of the spring 13, away from the core member 5, and the circuit interrupter 2 is opened.

Referring more particularly to Fig. 1, the short-circuiting armature 14 is provided with a non-magnetic extension 17 that is resiliently mounted with a spring 18 so as to strike the armature 8, the energy stored in the spring 18 during the interval of time before armature 14 has reached its final short-circuiting position serving to assist the spring 13 to release the armature 8 from the core 5.

Another method of accelerating the opening of the holding magnet I here disclose is shown in Fig. 2 in which the current winding is provided with two branches whereby a leakage path 19 is provided between the voltage coil and the current coil. In consequence of this, the armature member 14 will short circuit the leakage path 19, as well as the holding armature 8. The provision of a leakage path for the flux prevents the current winding from increasing the magnetic lines of force in the holding armature 8. The latter is thereby more quickly deenergized, when short-circuited by the armature 14.

Another method of obtaining a decrease in the time of opening of my circuit interrupter is shown in Fig. 3 in which opposing ampere turns are provided on the legs 6 and 7 of the core 5 between the two armatures 8 and 14. These opposing turns 21 operate to suppress the leakage flux occurring after the armature member 14 has been attracted, thereby more quickly deenergizing the holding armature 8 and increasing the speed of operation in the circuit interrupter 2.

The above described arrangement may be adjusted to regulate the limits of current within which the circuit interrupter remains closed. This adjustment is obtained by reg-

ulating the tension in the spring members 13 and 15 and also by varying the number of turns in the coil 3. The relation between the magnetic fluxes produced by the coil 3 and conductor 4 may readily be seen by referring to Fig. 4, in which the line A represents the ampere turns in the coil 3. This amount is proportional to the distance of A above the zero line marked O. The line marked B represents the ampere turns produced by the normal load current in the series coil 4 and here indicates a negative quantity corresponding to a small reverse current in the line. It will thus be seen that the amount of magnetizing force effective to hold the armature 8 in closed position is equal to the algebraic sum of the amounts represented by the distances OA and OB which are equal to OB'.

If the reversed current increases in value, it will do so in the manner indicated by the curve in solid line and, when it has reached an amount, indicated by the line D, such that the distance OD equals the distance OA, the resulting flux will be zero, and the circuit interrupter 2 will be opened.

If, on the other hand, the current in the coil 4 changes from reverse current to a normal-load current, it will vary as indicated by the dotted curve in Fig. 4. Accordingly, the net ampere turns magnetizing the core 5 will increase and, when they reach the amount required to actuate the short-circuiting armature 14, the circuit breaker 2 will open in the manner previously described. It will be apparent that, by changing the number of ampere turns in the coil 3 and the relative tension in the springs 13 and 15, any limits of line current may be obtained within which the circuit interrupter will remain closed.

The explanation above given for the operation of my holding electromagnet is not limited to a circuit interrupter that is released by reason of a reversal of current producing a force opposing the flux normally present in the holding armature 8. The current coil may be connected in such manner that an increase in current will oppose the ampere turns in the coil 3 and thereby cause a release of the armature 8, and that a reversal in current will produce a magnetizing force which is additive to that of the coil 3, thereby actuating the short-circuiting armature 14.

It will thus be seen that I have provided a holding electromagnet for a circuit interrupter that is simple and compact in design, requiring but a single core and one which operates on either a reversal or an increase in current. My invention is further novel in that the limits of line current between which the circuit interrupter will remain closed may be varied between any predetermined amounts to correspond to any degree of protection desired.

It is to be understood that such changes in

the form, arrangement, and connection of the component parts of my invention may be made as shall fall within the scope of the appended claims.

5 I claim as my invention:

1. In an electric circuit, an electromagnet comprising a magnetizable core having a plurality of coils associated therewith, a biased armature adapted to be held in engagement
10 with said core by the normal flux therein, and means for reducing the flux in the armature while still in engagement with said core when an increase in said flux is produced by said coils, said normal flux not being reduced.

15 2. In a circuit interrupter, the combination with a movable contact member, of an electromagnet therefor comprising a core energized by a series winding and also by a shunt winding which is connected, at all times while
20 the circuit interrupter is closed, to an exciting source, an armature for controlling the movable contact member and biased to open position, and a second armature mechanically disconnected with said first armature and actuated by an increase in current
25 in the series winding to short-circuit the flux in the first armature.

3. In a circuit interrupter, the combination with a movable contact member, of an electromagnet therefor which is connected to an exciting source at all times when the circuit interrupter is closed and comprising a core and a pair of armatures, one armature controlling the contact member and biased to the
35 open-circuit position thereof, the second armature being mechanically disconnected from said first armature and responsive to an increase in flux in the electromagnet to short circuit the flux in the first said armature.

40 4. The combination with an electromagnet comprising a core and a plurality of armatures, of means for continuously energizing the core to retain one armature in a position which closes the magnetic-circuit, and additional means for energizing the core to normally assist the first said means, but to release the armature upon a reversal of current
45 in the said additional means, and to also release it upon an increase of current in the said additional means by attracting the second said armature to short circuit the flux from the first said armature.

5. The combination with a main circuit and an interrupter therefor, of a core provided with an air gap having two armatures disposed to directly bridge each side thereof; one of said armatures maintaining the interrupter in closed position and being biased
55 to open responsively to a reversal of current in the main circuit, the other of said armatures being attracted responsively to an increase of

current in said main circuit to bridge the air gap, thereby by-passing the magnetic flux in the core from the first said armature.

6. A circuit interrupter comprising magnetic means energized by a plurality of coils one of which is connected to a source of supply at all times when the circuit interrupter is closed, the effect of said coils being cumulative in normal operation to hold the circuit
70 interrupter closed, and means whereby an increase in current reduces the effective flux that operates to hold the circuit interrupter in closed position when a predetermined amount of increase of current is present.

7. In a circuit interrupter, the combination with a movable contact member, of a holding magnet therefor comprising a core energized by a shunt and a series winding, an armature for controlling the movable contact member,
80 said armature being responsive to move said contact to open position upon a reversal in current in the series winding, a second armature actuated by an increase to a predetermined value of the current in the series winding to short circuit the flux in the first armature, and an additional winding on the holding magnet between the two armatures to hasten the opening movement of the first
85 said armature.

8. In a circuit interrupter, the combination with a movable contact member, of a holding magnet therefor comprising a core energized by a shunt and a series winding, an armature for controlling the movable contact member, said armature being responsive
95 to move said contact member to open position upon a reversal in current in the series winding, a second armature actuated by an increase to a predetermined value of the current in the series winding to short circuit the flux in the first armature, and additional means affecting the first armature to assist in its movement aforesaid.

9. In an electric circuit interrupter, an electromagnet comprising a magnetizable core, means tending to maintain a magnetic flux of predetermined value therein at all times while the circuit interrupter is closed, a biased armature adapted to be held in engagement with said core by said flux, means
105 tending to increase said flux beyond said predetermined value, and means for reducing the flux in the armature while still in engagement with said core when an increase is produced in said flux beyond said predetermined
110 value.

In testimony whereof, I have hereunto subscribed my name this 3rd day of January, 1928.

FRIEDRICH NATALIS.