June 9, 1964 H. D. DORFMAN ETAL 3,136,921

CIRCUIT BREAKERS

Filed Dec. 10, 1957 3 Sheets-Sheet 1

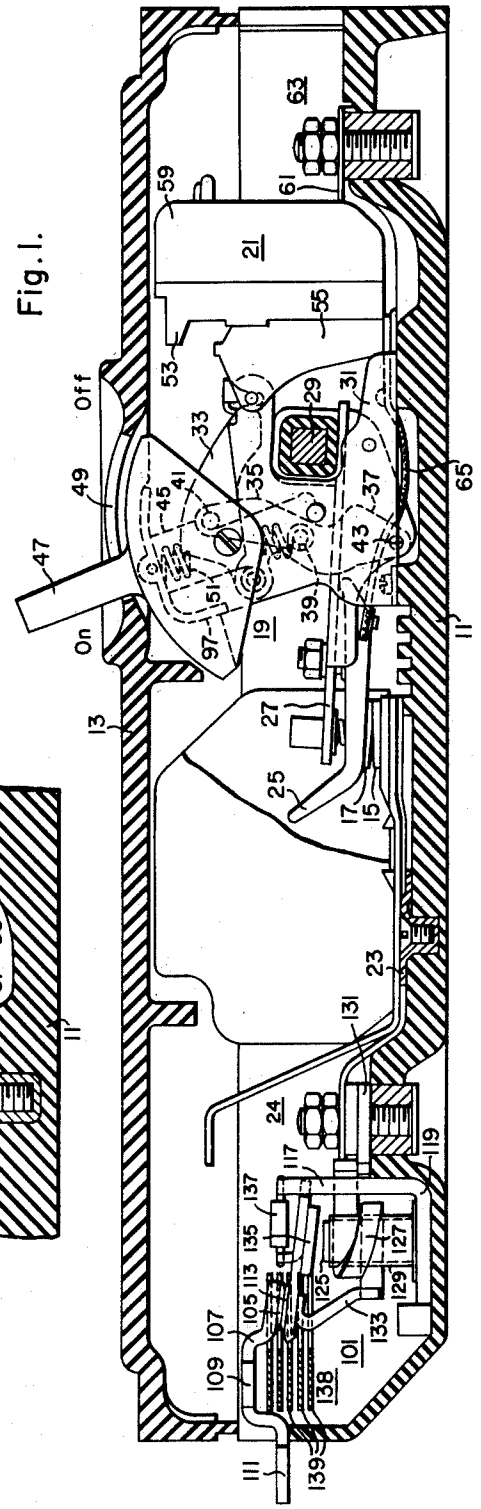


Fig. 1.

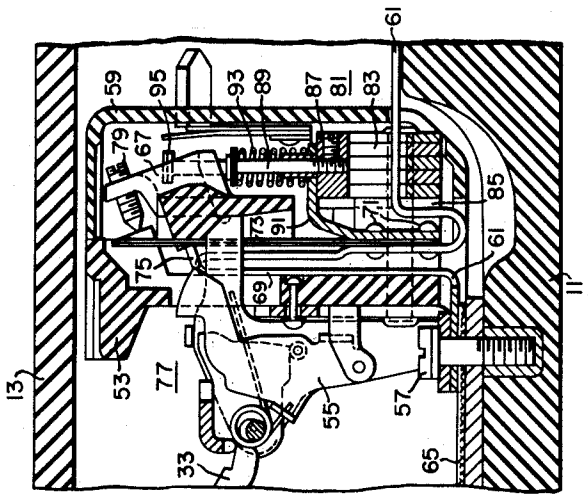


Fig. 2.

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Fig. 3.

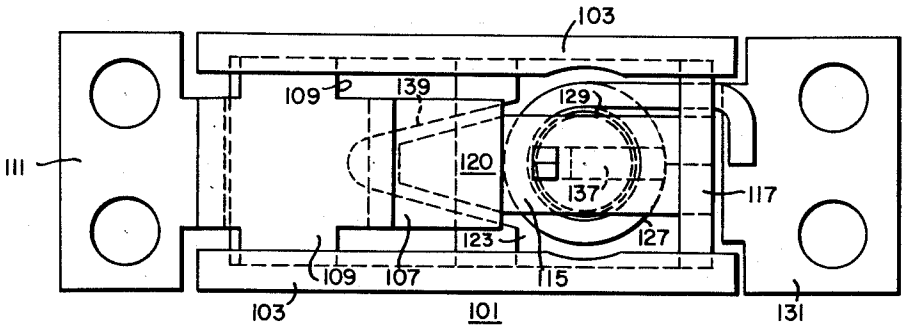
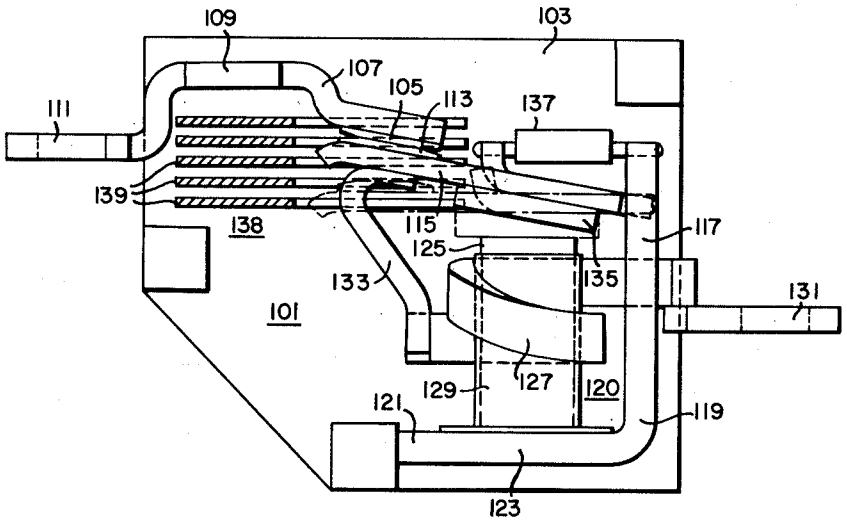


Fig. 4.



WITNESSES

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CIRCUIT BREAKERS

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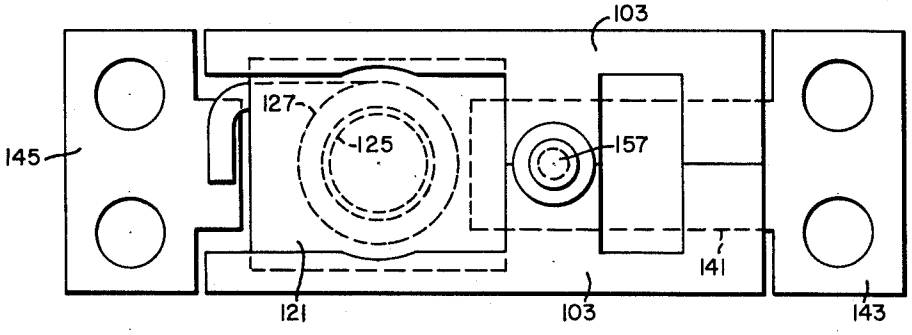


Fig. 5.

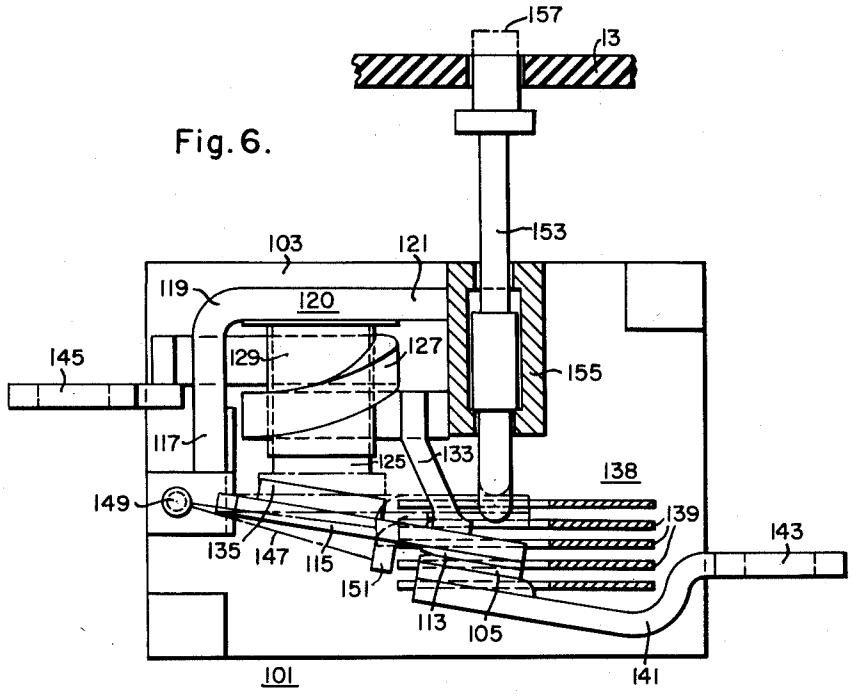


Fig. 6.

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CIRCUIT BREAKERS

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7 Claims. (Cl. 317—11)

This invention relates to circuit breakers and more particularly to circuit breakers embodying current limiting means.

An object of the invention is to provide a circuit interrupting device embodying an automatic circuit breaker and an electromagnetic current limiter which introduces a high resistance in the circuit through the breaker when the contacts open to reduce the current required to be interrupted by the breaker.

Another object of the invention is to provide a circuit interrupting device embodying a circuit breaker responsive to overload circuits to interrupt the circuit and an electromagnetic current limiter operable in response to excessive currents before said circuit breaker opens to draw an arc and thereby introduce a high resistance in the circuit and reduce the current required to be interrupted by the circuit breaker.

Another object of the invention is to provide a circuit interrupting device including a circuit breaker and a high-speed electromagnetic current limiting device having contacts connected in series with the contacts of the circuit breaker which open in advance of opening of the circuit breaker contacts to reduce the current the circuit breaker is required to open.

The invention, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description thereof when read in conjunction with the accompanying drawings.

In said drawings:

FIGURE 1 is a vertical sectional view of a circuit breaker embodying the principles of the invention;

FIG. 2 is a vertical sectional view showing the trip device for the circuit breaker;

FIG. 3 is a top plan view showing the current limiting device;

FIG. 4 is an elevational view partly in section of the current limiting device;

FIG. 5 is a top plan view of a modification of the current limiting device; and

FIG. 6 is an elevational view partly in section of the current limiter shown in FIG. 5.

Referring to FIG. 1 of the drawings, the circuit breaker comprises generally a base **11** and cover **13** both of molded insulating material, a stationary contact **15**, a movable contact **17**, an operating mechanism **19** and a trip device **21**. The circuit breaker is of the three-pole type and is provided with a set of stationary and movable contacts in each compartment of the housing comprising the base **11** and cover **13**.

Each of the stationary contacts **15** is rigidly mounted on the inner end of a conducting strip **23**, the other end of which is connected to a terminal **24** and the movable contact **17** for each pole is mounted on a contact arm **25**. Each of the contact arms **25** is supported on a movable switch arm **27**. The movable switch arms **27** are rigidly secured to a tie bar **29** which is common to all of the poles of the breaker. The operating mechanism **19**, which includes the movable switch arms **27**, is supported in a frame **31** rigidly secured to the base **11** of the housing.

The operating mechanism **19** comprises a releasable cradle **33** pivotally supported on the frame **31** and connected to the switch arm **27** for the center pole by a

toggle comprising toggle links **35** and **37**. The toggle links **35** and **37** are pivotally connected together by a knee pivot pin **39**. The toggle link **35** is pivotally connected to the releasable cradle **33** by a pivot pin **41** and the toggle link **37** is pivotally connected to the movable switch member **27** for the center pole by a pivot pin **43**.

The toggle **35—37** is manually operated to open and close the contacts by means of a generally U-shaped operating lever **45** pivoted on the frame **31** and having a handle member **47** mounted thereon and extending out through an opening **49** in the cover **13**. Two overcenter operating springs **51**, only one of which is shown, are connected under tension between the knee pin **39** of the toggle and the outer portion of the operating lever **45**.

The contacts **15—17** are opened manually in a well known manner by manipulation of the handle **47** to the "off" position which causes, through the overcenter springs **51**, collapse of the toggle **35—37** and opening movement of the switch arms **27** for all of the poles.

The contacts are closed by reversed movement of the handle **47** from the "off" to the "on" position. During this movement the overcenter springs **51** straighten the toggle **35—37** and closes the contacts with a snap action.

The circuit breaker is tripped open by operation of the trip device **21** which releases the cradle **33**. When the cradle **33** is released, the overcenter springs **51** act through the toggle **35** to rotate the cradle **33** counterclockwise to carry the pin **41** over to the left of the line of force of the overcenter springs **51**. This causes collapse of the toggle **35—37** and movement of the switch arms **27** to the open position.

The trip device **21** comprises a base **53** (FIGS. 1 and 2) mounted on a U-shaped bracket **55** rigidly mounted by means of screws **57** to the base **11** of the breaker. A sealed cover **59** is provided to enclose the trip device. The screws **57** also serve to secure to the base **11**, one end of a conductor **61** which has its other end suitably connected to a terminal **63** (FIG. 1). The inner end of the conductor **61** is connected to the movable contact arm **25** by a flexible conductor **65**. Pivotally mounted (by means not shown) on the base **53** of the trip device, is a trip bar **67** which extends across all of the poles of the breaker.

The conductor **61**, to the right of the base **53** (FIG. 2) of the trip device, forms a loop **69** to the righthand leg of which is secured by means of rivets **71** a bimetal element **73** which extends upwardly adjacent the trip bar **67**. The leg of the loop **69** to which the bimetal element **73** is secured forms a heater portion for heating the end of the bimetal element **73**, which is secured thereto, by conduction. The trip bar **67** is provided with a latch **75** which normally engages a latch mechanism shown generally at **77** and holds it in operative positions thereby releasably restraining the cradle **33**.

When the bimetal element **73** is heated a predetermined amount in response to an overload current, it deflects toward the right causing the free upper end thereof to engage an adjusting screw **79** in a projection of the trip bar **67** and rotate the trip bar clockwise. This causes the latch **75** to release the latch mechanism **77** which, in turn, releases the cradle **33** to effect automatic opening of the breaker in the previously described manner.

The circuit breaker is also tripped open instantaneously in response to fault currents or short-circuit currents by means of a tripping electromagnet **81** (FIG. 2). The tripping magnet **81** comprises a fixed magnet yoke **83** supported on a bracket **85** mounted on the rivets **71**, and a movable armature **87** secured to one end of a trip rod **89** slidably mounted in an extension **91** of the bracket **85**. The trip rod **89** together with the armature **87** is biased upwardly to unattracted positions by a compression spring

93 and at its upper end the trip rod 89 is provided with a head 95 for engaging and actuating the trip bar 67.

When an overload above a predetermined value of, for example, 1000% of normal rated current or a short circuit current occurs, the electromagnetic trip means 81 is energized and attracts the armature 87 causing the head 95 of the rod 89 to engage and rock the trip bar 67 clockwise to effect instantaneous tripping of the breaker.

Before the breaker can be closed following an automatic tripping operation, it is necessary to reset and relatch the mechanism. This is effected by movement of the handle 47 to the "off" position. During this movement a projection 97 on the operating lever 45 engages and moves the cradle 33 back to its normal latched position. Thereafter the breaker is closed in the previously described manner.

Current limiting means is provided in each pole of the breaker. The current limiting means functions in response to very high currents to limit the current the circuit breaker is required to interrupt thereby increasing the interrupting capacity for a circuit breaker of a given rating.

The current limiter, shown generally at 101 (FIGS. 1, 3 and 4), is supported between spaced plates 103 and comprises a stationary contact 105 mounted on the inner end of a conductor 107. The conductor 107 is supported between the plates 103 by lateral projections 109 extending into facing recesses in the plates. The conductor 107 extends out through the adjacent end wall of the base 11 of the interrupter and terminates in a terminal portion 111. A moving contact 113 is mounted on one end of a movable U-shaped switch arm 115 having its other end pivoted in notches formed in one leg 117 of an angular member 119 of magnetic material and forming part of an electromagnetic 120. The other leg 121 of the angular member 119 is provided with lateral extensions 123 which extend into recesses in the spaced plates 103 to support the member 119. Mounted on the leg 121 is a magnet core 125 having an energizing coil 127 wound thereon but insulated therefrom by an insulating tube 129. One end of the coil is rigidly secured to a terminal 131 secured to the terminal 24 (FIG. 1) to which the end of the conductor 23 is secured. The other end of the coil 127 is connected by means of a flexible conductor 133 to the movable switch arm 115. An armature 135 is mounted on the switch arm 115 and a spring 137 biases the switch arm to the normally closed position. An arc control device 138, comprising a plurality of slotted plates 139, is provided for controlling the arc drawn between the contacts 105—113.

The current limiter is so constructed that it does not respond to currents much below the interrupting capacity of the breaker. On the occurrence of a fault current at or near the interrupting capacity of the breaker the electromagnet 120 of the current limiter 101 operates at high-speed to open the contacts 105—113 before the circuit breaker contacts 15—17 open. When the contacts 105—113 of the current limiter 101 separate, an arc is drawn in the arc control device 138. The device 138 is so designed that the arc is not immediately extinguished, but hangs on, thus introducing a high resistance in the circuit breaker and thereby reducing the current required to be interrupted by the circuit breaker. The result is that the effective interrupting capacity of the breaker is greatly increased.

After the current is interrupted by opening of the breaker contacts deenergizing the electromagnet 120 of the current limiter, the spring 137 acts to close the contacts 105—113.

FIGS. 5 and 6 illustrate a modification of the current limiter shown in FIG. 4, the structure and operation of which is generally the same as that just described. This current limiter remains open after it functions and must be manually reset.

The stationary contact 105 of the FIG. 6 modification is mounted on a conductor 141 which has integral therewith a terminal 143 connected to the terminal 24 to which the conducting strip 23 (FIG. 1) is connected. The coil of the electromagnet 120 is connected to a terminal 145 and by the flexible conductor to the moving switch arm 115. An overcenter spring, which is not shown, but the centerline of which is indicated at 147, is connected under tension between a spring stud 149 on the leg 117 of the magnetic member 119 and a struck out portion 151 of the switch arm 115. A resetting plunger 153 is slidably mounted in a support and guide member 155 mounted between the side plates 103, and has a finger piece 157 extending out through an opening in the cover 13 of the housing to permit manual resetting of the device.

The operation of the current limiting device shown in FIG. 6 is the same as that shown in FIG. 4 except that when the switch arm 115 operates in response to excessive fault currents to the open position, the line of force of the overcenter spring 147 moves above the pivot of the switch arm and holds the switch arm in the open position after the current is interrupted by opening of the breaker contacts. The device is reset by pushing inwardly on the finger piece 157 which moves the switch arm to the closed position and in so doing moves the line of force of the overcenter spring 147 below the pivot of the switch arm 115 where it then biases the switch arm closed.

Having described the invention in accordance with the provisions of the patent statutes, it is to be understood that various changes and modifications may be made therein without departing from the spirit of the invention.

We claim as our invention:

1. A circuit-interrupting device comprising a circuit-breaker, said circuit-breaker comprising a pair of circuit-breaker contacts and means manually operable to open and close said circuit-breaker contacts, means releasable to effect opening of said circuit-breaker contacts, trip means automatically operable in response to overload currents to effect release of said releasable means, a current limiting device comprising current-limiting contacts connected in electrical series relation with said circuit-breaker contacts, said current-limiting device comprising an electro-responsive device automatically operable only in response to excessive currents to open said current-limiting contacts to thereby draw an arc between said current-limiting contacts to thereby introduce a resistance in the circuit through the circuit interrupting device, and means for maintaining said arc until said circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt.

2. A unitary circuit interrupting device comprising an insulating housing, a control mechanism supported within said housing and comprising a circuit-breaker and a current limiting device, said circuit-breaker comprising a pair of circuit-breaker contacts and manually operable means operable from outside of said housing to open and close said circuit-breaker contacts, means releasable to effect opening of said circuit-breaker contacts, trip means operable automatically in response to overload currents to effect release of said releasable means, said current limiting device comprising current-limiting contacts connected in series relation with said circuit-breaker contacts, said current limiting device comprising an electro-responsive device automatically operable only in response to excessive currents to open said current-limiting contacts to draw an arc between said current-limiting contacts to thereby introduce a resistance in the circuit interrupting device, and means for maintaining said arc until said circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt.

3. A circuit interrupting device comprising a circuit-breaker having relatively movable contacts and means releasable to effect opening of said circuit-breaker con-

tacts, trip means operable in response to overload currents to release said releasable means, current limiting means comprising a stationary contact, a movable switch arm having a movable contact thereon, said stationary and said movable current-limiting contacts being connected in electrical series with said circuit-breaker contacts, an overcenter spring normally biasing said switch arm closed, electroresponsive means operable in response to excessive currents to move said switch arm to an open position to draw an arc between said current-limiting contacts before said circuit-breaker contacts open, arc control means for maintaining said arc until said circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt, and said overcenter spring in the open position of said switch arm biasing said switch arm open.

4. A circuit interrupting device comprising a circuit breaker having relatively movable contacts and means releasable to effect opening of said circuit-breaker contacts, trip means operable in response to overload currents to release said releasable means, current limiting means comprising a stationary contact, a movable switch arm having a movable contact thereon, said stationary and said movable current-limiting contacts being connected in electrical series with said circuit-breaker contacts, an overcenter spring normally biasing said switch arm closed, electroresponsive means operable in response to excessive currents to move said switch arm to an open position before said circuit-breaker contacts open to thereby draw an arc between said current-limiting contacts before said circuit-breaker contacts open, arc control means for maintaining said arc until said circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt, said overcenter spring in the open position of said switch arm biasing said switch arm open, and manual means operable to close said switch arm.

5. A circuit interrupter comprising a circuit-breaker having relatively movable contacts and means releasable to effect opening of said circuit-breaker contacts, trip means automatically operable in response to overload currents to cause release of said releasable means, and an electroresponsive device automatically operable only in response to excessive currents to draw an arc in the circuit of the breaker before said circuit-breaker contacts open and to maintain said arc until said circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt.

6. A circuit interrupter comprising a circuit-breaker having relatively movable contacts and means releasable to effect opening of said circuit-breaker contacts, trip means automatically operable in response to overload currents to cause release of said releasable means, and an electroresponsive device having separable contacts automatically operable only in response to excessive currents to draw an arc in the circuit of the breaker before said circuit-breaker contacts open and to maintain said arc until said circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt.

7. A circuit interrupter comprising a circuit-breaker having relatively movable circuit-breaker contacts and means releasable to effect separation of said circuit-breaker contacts, trip means automatically operable in response to overload currents to cause release of said releasable means, electroresponsive current limiting means connected in series relation in the circuit through said breaker contacts, said current limiting means comprising separable contacts for drawing an arc therebetween, and electromagnetic means automatically operable only in response to excessive currents in said circuit to effect high-speed separation of said separable contacts to draw an arc between said separable contacts before said relatively movable circuit-breaker contacts open, and an arc retaining device for holding said arc until said relatively movable circuit-breaker contacts open to thereby reduce the current that said circuit-breaker contacts will interrupt.

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