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Kussy et al.

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[54] **CURRENT LIMITING CIRCUIT BREAKER WITH MAGNETIC LATCH**

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[52] **U.S. Cl.**.....**335/18**, 335/174

[51] **Int. Cl.**.....**H01h 73/00**

[58] **Field of Search**.....335/18, 41, 174, 16

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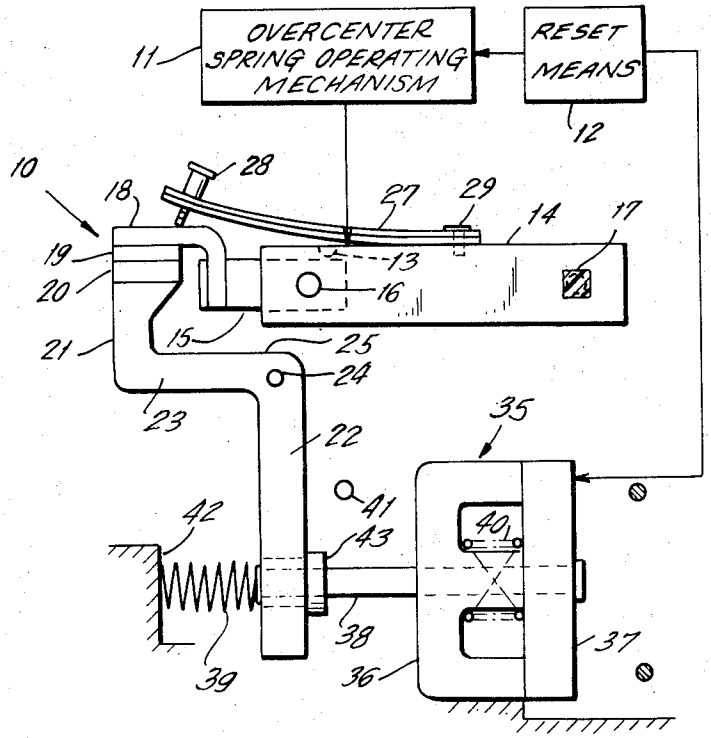
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[57] **ABSTRACT**

A very fast opening current limiting circuit breaker is provided by utilizing a permanent magnet latch to maintain a semi-stationary contact in its operative position against the force of a biasing spring tending to move this contact to an inoperative position in which it is disengaged from the movable contact and is not engageable by the latter. The permanent magnet latch is released by a bucking flux generated in response to detection, by a monitoring means, of a current rate of rise in the circuit breaker which exceeds a predeterminded value.

9 Claims, 4 Drawing Figures



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SHEET 1 OF 2

FIG. 1.

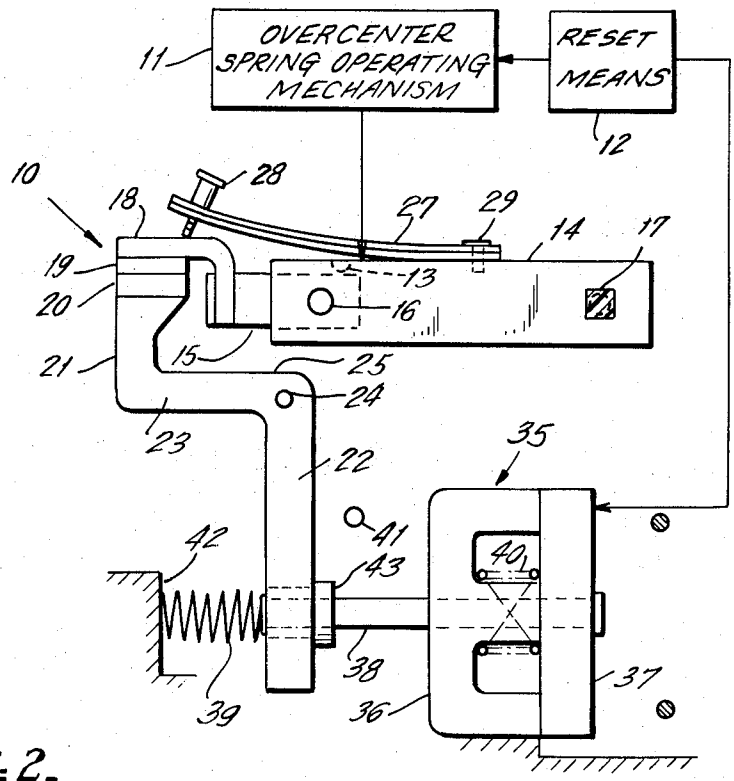
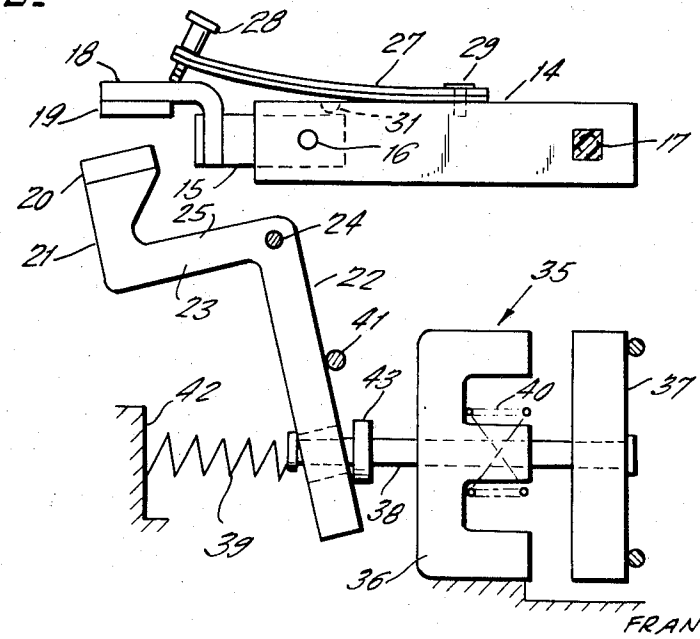


FIG. 2.



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FIG. 3

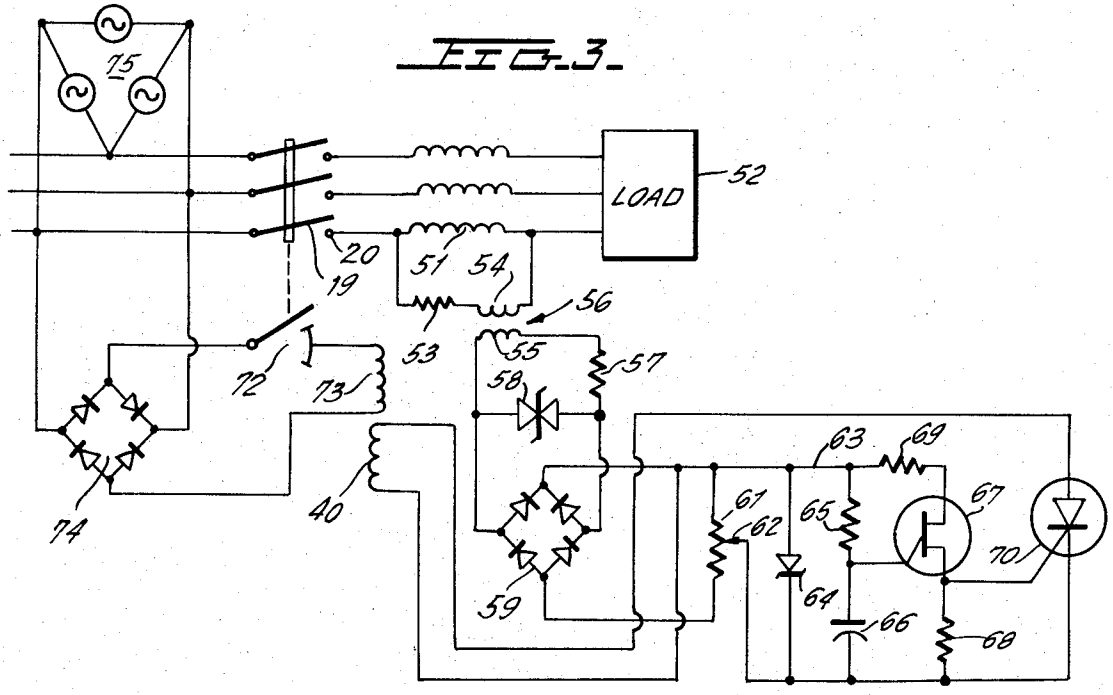
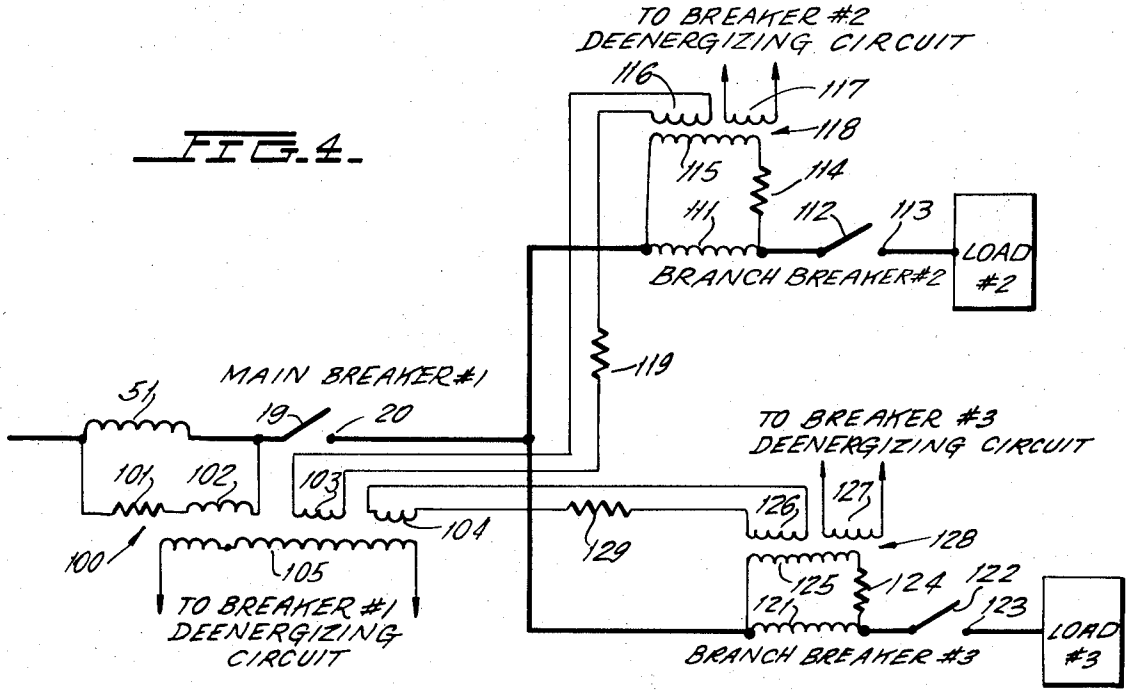


FIG. 4



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CURRENT LIMITING CIRCUIT BREAKER WITH MAGNETIC LATCH

This invention relates to circuit breakers in general, and more particularly to a circuit breaker having current limiting action.

In the prior art, current limiting action of a circuit breaker was obtained by opening the contacts in the case of a fault current before this current reached values which could damage the load equipment or the circuit breaker. Usually such circuit breakers provide means for tripping as soon as possible after the fault current had reached a predetermined value. However, since there is a minimum contact force which must be maintained under overload conditions, the contacts must remain closed for an excessive period of time under extreme short-circuit conditions.

In accordance with the instant invention, extremely fast tripping is obtained by opening the circuit breaker independently of the magnitude of current flowing through the circuit breaker, but depending upon the rate of rise of current. In predominantly resistive circuits, peak current is reached in approximately ¼ cycle, and in predominantly reactive circuits this peak is reached after approximately ½ cycle. The rate of rise is always dependent upon the peak value and is usually greatest as current starts to rise after a current zero point. By monitoring the load current with a sensor that detects current rate of rise, extremely high current short circuits are detected very shortly after they occur and action is taken to separate the circuit breaker contacts before the short circuit current becomes excessive.

Accordingly, a primary object of the instant invention is to provide a current limiting circuit breaker in which opening under short circuit conditions is controlled by current rate of rise.

Another object is to provide a circuit breaker of this type in which a semi-stationary contact is normally held in operative position by a permanent magnet latch.

A further object is to provide a current limiting circuit breaker in a novel selective trip arrangement.

These objects as well as other objects of this invention will become readily apparent after reading the following description of the accompanying drawings in which:

FIG. 1 is a schematic representation of a circuit breaker constructed in accordance with teachings of the instant invention with the circuit breaker contacts closed.

FIG. 2 illustrates the circuit breaker contacts of FIG. 1 opened as a result of tripping under high short circuit conditions.

FIG. 3 is an electrical schematic of the current rate-of-rise detector and deenergizing circuit for automatically opening the circuit breaker of FIG. 1.

FIG. 4 is an electrical schematic illustrating the utilization of the elements of FIGS. 1-3 in a selective trip arrangement.

Now referring to the Figures and more particularly to FIGS. 1 and 2. Current limiting circuit breaker 10 comprises a conventional manually or power operated trip free overcenter spring operating mechanism 11 having reset means 12 for returning mechanism 11 to a contact closing condition after automatic tripping due to overload and short circuit currents.

Mechanism 11 is connected to a movable contact arm means comprising main arm 14 and auxiliary arm 15 pivotally connected by pin 16 near the left end of arm 14. Arm means 14, 15 is pivotally mounted at the right end of main arm 14 to a pivot coaxial with insulating tie bar 17. L-shaped movable contact member 18 is secured to auxiliary arm 15 at the left end thereof which extends to the left of main arm 14. Movable contact 19, on the horizontal leg of member 18, is engageable with semi-stationary contact 20 on the upper end of left vertical offset 21 of member 25. Right vertical offset 22 of member 25 is connected to left offset 21 by horizontal connecting section 23. Member 25 is mounted to stationary pivot 24 located at the junction between offset 22 and section 23.

Screw 29 fixedly secures one end of leaf spring 27 to main arm 14 and the other end of spring 27 mounts pressure adjustment screw 28 which is in engagement with member 18. As will hereinafter be seen, spring 27 provides contact pressure by biasing auxiliary arm 15 in a counterclockwise direction about pin 16. Stop 31 on main arm 14, positioned to the right of and above pin 16, is in position to block and thereby limits counterclockwise movement of auxiliary arm 15.

Magnetic latching device 35 maintains member 25 in its normal position of FIG. 1 wherein contact 20 is engageable by moveable contact 19. More particularly, device 35 includes a magnetic frame comprised of stationary E-shaped yoke 36 and I-shaped movable armature 37. Rod 38 secured to armature 37 extends to the left thereof through a passage in the center leg of yoke 36 and through an opening in offset 22. Coiled compression spring 39, bearing against stationary abutment 42 and offset 22, biases member 25 in a counterclockwise direction limited by stop 41. The latter establishes the tripped position (FIG. 2) for semi-stationary contact 20 wherein it is not engageable by movable contact 19.

Armature 37 contains a permanent magnet (not shown) which normally latches armature 37 in the pulled-in position of FIG. 1. As armature 37, under the action of reset means 12, moves from its released position of FIG. 2 to its latched position of FIG. 1, rod 39 moves to the left with collar 43 on rod 39 engaging offset 22 and pivoting member 25 clockwise to its normal position of FIG. 1. Armature 37 is released when the flux of the permanent magnet latch is neutralized sufficiently that the armature holding power is overcome by the force stored in spring 39. The magnitude of current flowing in coil 40 determines whether armature 37 is released from yoke 36.

As seen in FIG. 3, current rate of rise detector coil 51 is in series between circuit breaker contacts 19, 20 and load 52. The voltage induced in coil 51 is applied to the series combination of resistor 53 and primary winding 54 of transformer 56. Voltage induced in primary 54 is transformed and appears across transformer secondary 55. The latter forms a series combination with resistor 57, such series combination being connected in parallel with surge protecting thyristor 58 whose terminals are connected to the input of bridge rectifier 59. Potentiometer 61 is connected across the output of rectifier 59, and the output of potentiometer 61 is taken between its movable potentiometer arm 62 and conductor 63.

Circuit protecting Zener diode 64 is connected between arm 62 and conductor 63. One end of resistor 65 is connected directly to conductor 63, and the other end is connected through capacitor 66 to arm 62. The main current circuit of uni-junction transistor 67 extends from arm 62 through resistor 68, unijunction transistor 67 and resistor 69 to conductor 63. The junction between resistor 65 and capacitor 66 is connected to the base electrode of transistor 67. One end of flux bucking coil 40 is connected to conductor 63 and the other end of coil 40 is connected through the main current circuit of silicon controlled rectifier 70 to potentiometer arm 62. The control electrode of SCR 70 is connected to the junction between resistor 68 and transistor 67.

In operation, under overloads and low faults, mechanism 11 automatically operates movable contact 19 as in conventional circuit breakers. However, on very large faults the rate of rise of current will be very steep, thereby inducing a very high voltage in coil 51. This induced voltage is rectified by bridge circuit 59 and when the output of rectifier 59 is high enough, transistor 67 will be triggered, thereby turning on SCR 70 and causing current flow in coil 40 which generates a flux to buck the permanent magnet holding flux operating to hold armature 37 in its pulled-in position of FIG. 1 with contact 20 in its operative position. When armature 37 is released, spring 39 acts to pivot member 25 in a counterclockwise direction, thereby moving semi-stationary contact 20 to its inoperative position of FIG. 2 wherein contact 20 is not engageable by movable contact 19.

When mechanism 11 is operated to close contacts 19, 20, switch 72 is closed for a short time. The latter is in a series circuit with coil 73, with this series circuit being connected to the output of bridge rectifier 74 having its input connected across one phase of energizing source 75. Current flowing through coil 73 is effective to generate a flux in yoke 36 to aid the flux of the permanent magnet in armature 37 and provide an additional force for holding semi-stationary contact 20 in its operative position of FIG. 1 against the dynamic forces of the operating spring in mechanism 11 as such spring drives contact 19 into engagement with contact 20.

The circuit arrangement of FIG. 4 illustrates the instant invention adapted for selective tripping. In particular, current rate of rise detector winding 51, in series with contacts 19, 20 of main breaker No. 1, is connected in parallel with the series combination of resistor 101 and primary 102 of transformer 100. The latter also includes two additional primary windings 103, 104 and a single secondary winding 105 which is connected to the current rate of rise deenergizing circuit for main breaker No. 1, by being connected thereto in place of secondary winding 55 of FIG. 3.

Current rate of rise detector winding 111 is connected in series between contacts 19, 20 of main breaker No. 1 and contacts 112, 113 of branch breaker No. 2 which is connected directly to load No. 2. Detector winding 111 energizes the series combination of resistor 114 and primary winding 115 of transformer 118. Winding 103 is connected through resistor 119 to winding 116 of transformer 118 and secondary winding 117 of transformer 118 is connected to the deenergizing circuit for branch breaker No. 2.

Similarly, current rate of rise detecting coil 121 is connected between main contacts 19, 20 of main breaker No. 1 and main contacts 122, 123 of branch breaker No. 3. The series combination of resistor 124 and primary winding 125 of transformer 128 is connected across winding 121. Winding 104 is connected through resistor 129 to winding 126 of transformer 128 whose secondary winding 127 is connected to the deenergizing circuit for breaker No. 3. The polarity of winding 102 is opposite to the polarities of windings 103 and 104.

If a fault occurs at load No. 2 or between breaker No. 2 and load No. 2, it will be advantageous to have only breaker No. 2 trip. Tripping of breaker No. 1 causes power to the other load (in this case load No. 3) to be turned off. Since branch breakers No. 2 and No. 3 and main breaker No. 1 are connected by windings 102, 103, 104, selective tripping may be obtained. Both windings 51 and 111 monitor the same fault current. However, the monitored current from transformer 118 is conducted back to winding 103 of transformer 100. The polarities of windings 103, 104 being opposite to the polarity of winding 101, the field created by current flowing in winding 103 bucks the field from winding 101 so that the current in winding 101 which would normally cause tripping of main breaker No. 1 is neutralized. Thus, branch breaker No. 2 clears the fault, but main breaker No. 1 does not trip, and the power to load No. 3 is not interrupted. Similarly, if the fault occurred on the load connected to branch breaker No. 3, selective tripping occurs and the power to load No. 2 is not interrupted.

Thus, it is seen that the instant invention provides a current limiting circuit breaker that acts extremely fast but still maintains contact pressure if the rate of current rise under fault condition is below a predetermined magnitude at which the circuit breaker becomes current limiting.

Although there have been described preferred embodiments of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited not by the specific disclosure herein but only by the appending claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows.

1. A circuit breaker including first and second contact means operable into and out of engagement; first means urging said first contact away from a closed position wherein the latter is engageable by said second contact toward an inoperative position wherein said first contact is not engageable by said second contact; second means for maintaining said first contact in said closed position; third means for detecting current rate of rise in said circuit breaker and automatically releasing said second means to permit said first means to move said first contact to said inoperative position when said current rate of rise exceeds a predetermined magnitude; an operating mechanism for automatically disengaging said contacts by moving said second contact, as said first contact remains in its said closed position, in response to overload currents in said circuit breaker of a nature that will not cause said third means to automatically release said second means.

2. A circuit breaker as set forth in claim 1 in which said second means includes magnet means having a movable armature connected to said second contact means for movement in unison therewith; said first means biasing said armature to an open position wherein said second contact means is in its said inoperative position; said magnet means having a section generating a holding flux for maintaining said armature in a closed position wherein said second contact means is held in its said operative position; said third means including generating means operative, when said current rate of rise exceeds said predetermined magnitude, to generate a bucking flux which counteracts said holding flux thereby permitting said first means to move said second contact means to its said inoperative position.

3. A circuit breaker as set forth in claim 2 in which the section generating said holding flux includes a permanent magnet.

4. A circuit breaker as set forth in claim 3 in which the bucking flux is generated by current flowing through a coil means coupled to said magnet means.

5. A circuit breaker as set forth in claim 2 in which said generating means is also connected in series circuit to at least one additional circuit breaker having means for generating a bucking flux to counteract a contact holding flux.

6. A circuit breaker as set forth in claim 2 in which there is a further means active for a limited period of time after closing said circuit breaker to generate a flux aiding said holding flux.

7. A circuit breaker as set forth in claim 6 in which said generating means is also connected in series circuit to at least one additional circuit breaker having means for generating a bucking flux to counteract a contact holding flux.

8. A circuit breaker including first and second contact means operable into and out of engagement; first means urging said contacts out of engagement; second means for maintaining said contacts in engagement; third means for detecting current rate of rise in said circuit breaker and automatically releasing said second means to permit said first means to open said contacts when said current rate of rise exceeds a predetermined magnitude; an operating mechanism for moving said first contact means into and out of engagement with said second contact means when the latter is maintained in an operative position by said second means; said second means including magnet means having a movable armature connected to said second contact means for movement in unison therewith; said first means biasing said armature to an open position wherein said second contact means is in an inoperative position in which said first and second contact means are not engageable with each other; said magnet means having a section generating a holding flux for maintaining said armature in a closed position wherein said second contact means is held in its said operative position; said third means including generating means operative, when said current rate of rise exceeds said predetermined magnitude, to generate a bucking flux which counteracts said holding flux thereby permitting said first means to move said second contact means to its said inoperative position; a main arm and an auxiliary arm pivotally connected to said main arm near one end thereof for limited pivotal movement with respect thereto; said first contact means mounted to said auxiliary arm and extending beyond said one end of said main arm; means pivotally mounting said main arm near the other end thereof; said mechanism connected to said main arm for imparting pivoting movement thereto; and means for directing an electrodynamic force against said first contact means to pivot the latter and separate it from said second contact means.

9. A circuit breaker including first and second contact means operable into and out of engagement; first means urging said contacts out of engagement; second means for maintaining said contacts in engagement; third means for detecting current rate of rise in said circuit breaker and automatically releasing said second means to permit said first means to open said contacts when said current rate of rise exceeds a predetermined magnitude; an operating mechanism for moving said first contact means into and out of engagement with said second contact means when the latter is maintained in an operative position by said second means; said second means including magnet means having a movable armature connected to said second contact means for movement in unison therewith; said first means biasing said armature to an open position wherein said second contact means is in an inoperative position in which said first and second contact means are not engageable with each other; said magnet means having a section generating a holding flux for maintaining said armature in a closed position wherein said second contact means is held in its said operative position; said third means including generating means operative, when said current rate of rise exceeds said predetermined magnitude, to generate a bucking flux which counteracts said holding flux thereby permitting said first means to move said second contact means to its said inoperative position; said circuit breaker being connected in series circuit to a first load by a first branch circuit breaker having a fourth means for generating a bucking flux to counteract a contact holding flux, said circuit breaker also connected in series circuit with a second branch circuit breaker having a fifth means for generating a bucking flux to counteract a contact holding flux; said fourth and fifth means having means for detecting current rate of rise in the respective first and second loads; rate of rise detecting portions of said third, fourth and fifth means connected in a circuit arrangement fed by third, fourth and fifth outputs derived from the current rate of rise detecting portions in the respective third, fourth and fifth means; said fourth and fifth outputs arranged in opposition to said third output whereby either one of said branch circuit breakers may trip open without deenergizing the load connected to the other one of said branch circuit breakers.

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