PATENT SPECIFICATION (11) 1 576 877

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(21) Application No. 37990/77 (22) Filed 12 Sept. 1977 (19)
(31) Convention Application No. 7 628 412
(32) Filed 21 Sept. 1976 in
(33) France (FR)
(44) Complete Specification published 15 Oct. 1980
(51) INT. CL.³ H01H 51/10
(52) Index at acceptance
H1N 188 195 204 205 320 336 393 565 637 664 671 672 681 693 700 701 72X 744

(54) APPARATUS FOR THE RAPID INTERRUPTION OF CURRENTS

(71) We, MERLIN GERIN, a French Body Corporate, of Rue Henri Tarze, 38 Grenoble, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus for the rapid interruption of currents and more particularly to a high speed apparatus, comprising a movable contact assembly normally biased to close a circuit and an electrodynamic operating mechanism responsive to a logic trip control device to move the movable contact assembly to open said circuit when the current flowing through the apparatus exceeds a predetermined value, retaining means being provided for retaining the movable contact assembly in the position opening the circuit.

On the occurrence of overload or short circuit fault conditions an apparatus or circuit breaker of this kind achieves contact separation so rapidly that the maximum short circuit current is limited. In a power distribution system the current to be interrupted during circuit breaker operation is thus reduced, but it is not possible to achieve selective tripping of circuit breakers in series. It has been proposed to achieve selectivity by simultaneously tripping all the series connected circuit through which the short circuit current flows, and to reclose the circuit breakers selectively by a logic control circuit with pilot wires or by successively reclosing all the circuit breakers except the circuit breaker clearing the fault. These solutions are not satisfactory because the brief absence of voltage in the parts of the system which are not affected by the short-circuit has the effect of releasing protective relays in the system. The same drawback occurs when the apparatus must, after opening of a first circuit, close another circuit for instance of another power source.

In accordance with the present invention there is provided apparatus for the rapid interruption of currents comprising: a movable contact assembly normally biased to close a first circuit; an electrodynamic operating mechanism responsive to a logic trip control device to move said movable contact assembly to open said first circuit and close a second circuit when the current flowing through said apparatus exceeds a predetermined value; latch means for temporarily maintaining said movably contact assembly in the position closing the second circuit; and retaining means for retaining the movable contact assembly, after release of the latch means and for as long as the current flowing through said apparatus exceeds a predetermined value, in an intermediary position wherein said first and second circuits are both open.

In a selective power distribution system the electrodynamic operating mechanism rapidly moves the movable contact assembly to open the first circuit and draw an arc between the separated contacts and to close the second circuit to rapidly insert a current limiting resistance into the electric load circuit for a period affording the other circuit breakers of the distribution system time to clear the short circuit. The limited current flows in the system during the period the resistance is inserted to permit the logic trip control device to detect the clearing of the fault conditions and provoke the reclosing of the first circuit or detect the persistence of the fault conditions and open the first and second circuits. A time delay of the latch means may be a fixed one or a variable one, for instance in accordance with the fault current.

A current limiting apparatus according to the invention safeguards against the possibility of currents above a predetermined value in the whole system and the other circuit breakers, of course, may be rated in view of this limited current imposed on them. The electrodynamic operating mechanism makes use of the well-known Thomson effect that a repulsive force is exerted

between a conductive disc and a coil when a current suddenly flows in the coil. A logic control device has a current transformer which measures the current and delivers a tripping signal when the current increases above a given threshold.

According to an embodiment of the invention, the current limiting apparatus has main contacts connected in parallel with the contacts of the first circuit, the latter being arcing contacts which open after the main contacts and on which the arc is drawn.

When the apparatus according to the invention is used for connection of a load to another power source, the second circuit does not have a current limiting resistance and is directly connected to the other power source.

In order that the invention may be more fully understood, an embodiment thereof will now be described by way of example with reference to the accompanying drawing the single Figure of which is a diagrammatic representation of a power distribution system including an apparatus for the current limiting interruption in accordance with the invention.

The power distribution system represented by the drawing is of the kind having two levels or sections A and B connected by a busbar 12. A power supply circuit 14 of section A connects busbar 12 to a power transformer 16 and several feeder circuits 18, 20, 22 . . . of section B are connected in parallel to busbar 12, each feeder circuit 18, 20, 22 . . . being protected by a circuit breaker 24, 26, 28 . . . with instantaneously operating release. A current limiting circuit breaker D in power supply circuit 14 comprises a main circuit 30 having stationary 50, 52 and movable 32 main contacts and an operating mechanism 34 responsive to a logic control device 36 having a current transformer 38 inserted in circuit 14. The operating mechanism 34 is of the kind using the electrodynamic or Thomson effect and comprises a conductive disc 54 adjacent to and substantially coaxial with a coil 56 supplied by a previously charged capacitor (not shown). The movable main contact 32 or main bridge contact is mechanically connected to the disc 54 through the intermediary of a rod 58 cooperating with retaining means 60 which may be of the kind described in our French Patent Specification No. 2.247.118. Retaining means 60 retains the movable main contact 32 and the rod 58 in the open position of main circuit 30 and release of said retaining means 60 enable reclosing of the main contacts 50, 52, 32 by a spring 62.

Responsive to the value of current flowing in the supply circuit 14 measured by the current transformer 38 the logic control device 36 causes energization of coil 56 to move the main contact 32 rapidly to the open position when the current increases above a given threshold or causes release of retaining means 60 and closing of the main circuit 30 for a current lower than said given threshold.

Stationary arcing contacts 66, 68 cooperating with a movable bridge contact 70 are connected in parallel with the main contacts 50, 52, 32 in an arcing circuit 64 of the kind described in our French Patent Specification No. 2.333.337. An operating rod 72 is fixedly secured to the bridge contact 70 and its end is positioned adjacent the movable main contact 32, in contact-closed position so that the main contact 32 moves towards the open position, it engages the rod 72 after a lost motion d to move the bridge contact 70 towards the open position, the arcing contacts 66, 68, 70 separating in well known manner after the main contacts 50, 52, 32.

Arc-extinguishing units 74, 76 are provided to extinguish the arcs drawn between the arcing contacts 66, 68, 70. A shunt circuit 40 is electrically connected in parallel with the arcing circuit 64 and the main circuit 30 and comprises two fixed resistors 42, 44 connected in series with auxiliary stationary contacts 78, 80 cooperating with the bridge contact 70.

The bridge contact 70 may adopt three different positions:

a: closed position of the arcing contacts 66, 68, 70 (shown in heavy line);

b: open position (shown in dotted line) wherein rod 72 rests on the open movable main contact 32;

c: closed position of the auxiliary contacts 78, 80, 70 wherein rod 72 is latched by time delayed latch means 82 (shown in fine line).

The movable bridge contact 70 acts in the positions a and b as an arcing contact and in position c as a resistance inserting switch in the power supply circuit 14.

The apparatus operates as follows:

In its closed position, as shown in heavy lines, the current flows essentially in the main circuit 30 to the feeders 18, 20, 22.

If a short circuit occurs, for instance on feeder 18, logic control device 36 provides excitation of coil 56 rapidly to move the main contact 32 away from its closed position towards its open position. During this movement and after the lost motion d the main contact 32 engages the end of the rod 72 to push the bridge contact 70 towards open position b and two series connected arcs are drawn between the arcing contacts 66, 68, 70. The main contact 32 is locked in the open position by retaining means 60 while bridge contact 70 continues its move-

ment towards position c to close the auxiliary contacts 78, 80, 70. Latch means 82 temporarily retains the rod 72 and the bridge contact 70 in this position. After commutation of the current into the shunt circuit 40 the two arcs rapidly extinguish and at time t_2 the latch means 82 releases the rod 72 and the bridge contact 70 moves towards position b if the main contact 32 is still open or in position a if the main contact 32 is reclosed in dependence on whether or not the fault is cleared.

In the application shown in the drawing of selective protection of a power distribution system, time t_2 is longer than the tripping time t_1 of circuit breakers 24, 26, 28 and the resistance value of resistors 42, 44 provides a short circuit current limitation, e.g. to about 5 I_n, I_n being the normal current rating and a voltage drop smaller than 20% of the rated voltage when a rated current I_n flows through resistors 42, 44.

When a short circuit occurs, for instance on feeder 18, and the circuit breaker D opens, the current is for a few milliseconds limited by arcs drawn between arcing contacts 66, 68, 70 and thereafter by resistors 42, 44 inserted by the closed auxiliary contacts 78, 80, 70. At the same time circuit breaker 24 responsive to the current increase clears the fault at the time t_1. Current transformer 38 detects the end of the overcurrent and the logic control device 36 causes release of retaining means 60. Main contacts 50, 52, 32 reclose and the healthy sections of the distribution system are supplied at the rated voltage. At time t_2 latch means 82 releases the rod 72 and bridge contact 70 moves to the initial position a.

It is noted that insertion of resistors 42, 44 into the circuit assumes three functions:

— short circuit current limitation,

— current supply to the healthy sections with a voltage drop less than 20% and with very brief absences of voltage of about some milliseconds corresponding to the current commutation in shunt circuit 40,

— a limited current is maintained to permit the current transformer 38 to detect the clearance of the fault.

As a matter of fact the circuit-breakers 24, 26, 28 of section B need to be rated only for the reduced maximum current limited at first by the arcs and then by resistors 42, 44. Further main contacts 50, 52, 32 reclose after the fault is cleared when the current is less than the rated value.

If the fault is not removed by a circuit breaker 24, 26, 28 of section B, for instance if the fault occurs on bus bar 12, the current transformer 38 will detect the continuing existence of the fault and the main contacts 50, 52, 32 remain open. At time t_2 the released rod 72 abuts and rests on open movable main contact 32 in open position b, to interrupt the residual limited current. Time delay t_2 may be variable in accordance with the limited current value so as to reduce time t_2 for large short circuits. Of course, the main contacts 50, 52, 32 of circuit breaker D may be omitted.

The applications of the apparatus according to the present invention are not limited to the above described selective current limiting protection of a power distribution system. This apparatus may for instance be used for rapidly switching over to a reserve power supply in the event of trouble with the main power supply. In this application contacts 66, 68, 70 connect the load to the main supply and contacts 78, 80, 70 to the reserve supply while contacts 50, 52, 32 and resistors 42, 44 may be omitted. In the event of trouble operating means 34 opens contacts 66, 68, 70 to isolate the load from the main supply and closes auxiliary contacts 78, 80, 70 to connect the load to the reserve supply, latch means 82 locking the contact assembly in that position temporarily, for instance as long as the trouble persists. The switching over occurs in a few milliseconds without notable interruption of the current supply.

WHAT WE CLAIM IS:—

1. Apparatus for the rapid interruption of currents comprising: a movable contact assembly normally biased to close a first circuit; an electrodynamic operating mechanism responsive to a logic trip control device to move said movable contact assembly to open said first circuit and close a second circuit when the current flowing through said apparatus exceeds a predetermined value; latch means for temporarily maintaining said movable contact assembly in the position closing the second circuit; and retaining means for retaining the movable contact assembly, after release of the latch means and for as long as the current flowing through said apparatus exceeds a predetermined value, in an intermediary position wherein said first and second circuits are both open.

2. Apparatus as claimed in claim 1, wherein the same movable contact cooperates selectively with two sets of fixed contacts to close said first and said second circuits in respective end positions of the movable contact and to open said first and second circuits in an intermediary position of the movable contact.

3. Apparatus as claimed in claim 1 or 2, wherein said first circuit is an arcing circuit electrically connected in parallel with a main circuit having a movable main contact forming a part of said movable contact assembly.

4. Apparatus as claimed in claim 1, 2

or 3, wherein said second circuit is electrically connected in parallel with said first circuit and comprises a resistor having a resistance value selected so that it provides a voltage drop less than 20% for the rated current of the apparatus.

5. Apparatus as claimed in claim 4, wherein a current detector controls said electrodynamic operating mechanism and said retaining means so that said operating mechanism moves said movable contact assembly to open said first circuit when said current exceeds a given threshold and so that said retaining means releases said movable contact assembly to afford reclosing of said first circuit when said current is smaller than said given threshold.

6. Apparatus as claimed in any preceding claim, electrically connected in series with a circuit breaker in a distribution system wherein a time delay of said latch means is longer than the tripping time of said circuit breaker in response to a fault.

7. Apparatus as claimed in any preceding claim, wherein said first circuit connects a load to a main power supply and said second circuit connects the load to a reserve power supply.

8. Apparatus substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1576877 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*