

PATENT SPECIFICATION

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- (21) Application No. 22691/74 (22) Filed 21 May 1974 (19)
 (31) Convention Application No. 55593/73 (32) Filed 21 May 1973 in
 (33) Japan (JA)
 (44) Complete Specification published 17 Nov. 1976
 (51) INT. CL.² H01H 71/24
 (52) Index at acceptance

H1N 172 173 183 187 195 201 231 588 631 672 700 701 744



(54) INSTANTANEOUSLY TRIPPING DEVICE FOR CIRCUIT INTERRUPTER

(71) We, TERASAKI DENKI SANGYO KABUSHIKI KAISHA, of No. 3-3, Showa-cho 5-chome, Abeno-ku, City of Osaka, Japan, a Body Corporate, organized and existing under the laws of Japan, 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 instantaneous tripping device operative during closing of a circuit interrupter.

Recent series overcurrent tripping devices for circuit interrupters are provided with long-timing, short-timing and instantaneous trip elements. These trip elements are selectively operative in response to the magnitude of the current flowing through the circuit interrupter. In general, the higher the current the shorter the time delay with which the circuit interrupter is opened. For example, the trip element having the short timing characteristic is responsive to a flow of high current relatively approximating a short circuiting current to open the associated circuit interrupter with a time delay corresponding to from several cycles to several tens of cycles of the current. Such trip elements are used for selective interruption. Thus, where a master circuit interrupter has a load side connected to a multiplicity of branches each having connected thereto one subordinate circuit interrupter of small capacity, the occurrence of a short circuit fault at any one terminal point results in the opening of the subordinate circuit interrupter disposed at that terminal point. If the master circuit interrupter operatively associated with that subordinate one were also opened in response to the short circuit fault then a multiplicity of sound branches connected to the same would be disconnected, resulting in inconvenience. Therefore, if the master circuit interrupter can be maintained closed until the subordinate circuit interrupter has been opened, in practice for the lapse of a time interval of from several cycles to several tens of cycles of the current, then the sup-

ply of electric power to the sound branches can continue without hindrance.

Also, according to the type of circuit interrupter, the instantaneous trip element may be omitted by making the short timing region include the maximum permissible interrupting current. This results in the necessity of imparting to circuit interrupters proper electrical and mechanical strengths sufficient to permit high currents such as a short-circuiting current to flow therethrough during several tens of cycles of the current. In addition, tripping devices not including an instantaneous trip element may be required to perform the operation of completely reclosing the shortcircuited branch. Upon closing a shortcircuited branch, a very high electromagnetic repulsion is generated across the contacts involved. This leads to the necessity of increasing the electrical energy required to close the short-circuited circuit against the high repulsion, beyond that required for the normal closing operation, and also to the need of providing corresponding equipment. For example, a closing electromagnetic solenoid must be made larger. If the closing energy is insufficient then an electric arc will occur across the contacts at an inter-contact distance at which the closing force is balanced with the electromagnetic repulsion and lasts for several tens of cycles of the current, resulting in great damage to the contact units.

An object of the present invention is to provide a tripping device operative during closing of a circuit interrupter, which device is instantaneously operative only during the closing process performed by a switching mechanism involved, the tripping device being put in its locked position, where it is prevented from being operated, after the completion of the closing operation.

The present invention resides in an instantaneous trip device operative during closing of a circuit interrupter and comprising an instantaneous tripping electromagnet comprising a stationary iron core disposed to embrace a conductor and operatively associated with a movable iron armature arranged to be held or released by a

closing latch included in a switching mechanism for a circuit interrupter, through both a locking plate and a releasing plate, so that, after the completion of the closing operation performed by the switching mechanism the locking plate locks the movable iron armature in its locked position to prevent the movable iron armature from moving under the attraction of the stationary iron core, the locking plate being released only during the closing of the circuit interrupter by the switching mechanism to permit the movable iron armature to move under the attraction of the stationary iron core, whereby, upon a flow of high current through the conductor during the closure of contacts in the closing process effected by the switching mechanism, the movable iron armature is operated to actuate the tripping device to open the contacts.

The present invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a fragmental side elevational sectional view of a circuit interrupter embodying the present invention, illustrated in its closed position, with the section taken along the central axis thereof;

Figure 2 is a side elevational sectional view of one portion of the arrangement shown in Figure 1, in its tripped position;

Figure 3 is a view similar to Figure 2 but illustrating the portion of the arrangement shown in Figure 2 in its open position;

Figure 4 is a view similar to Figure 2 but illustrating the portion of the arrangement shown in Figure 2 in its intermediate position in the closing process;

Figure 5 is a fragmental front elevational view of the instantaneous tripping device shown in Figure 1, after the switching mechanism shown in Figure 1 has performed the closing operation;

Figure 6 is a view similar to Figure 5 but illustrating the instantaneous tripping device shown in Figure 5 in its operating state;

Figure 7 is a view similar to Figure 5 but illustrating the instantaneous tripping device shown in Figure 5 immediately before the switching mechanism completes the closing operation; and

Figure 8 is a side elevation view of the closing clutch and releasing plate shown in Figure 1 immediately before the completion of the closing operation.

Throughout the Figures like reference numerals designate identical components.

The circuit interrupter shown in Figure 1 comprises a contact assembly including a main stationary contact 1 and an arcing stationary contact 2 fixedly secured to a terminal 3 on the source side, a main mov-

able contact 4 and an arcing movable contact 5 fixedly secured to a movable contact holder 6 to be separably engaged by the stationary contacts 1 and 2 respectively, and a contact spring (not shown) serving to provide a contact pressure under which the movable contacts 4 and 5 are maintained engaged with the mating stationary contact 1 or 2. The movable contact holder 6 is pivotally supported on a pivot pin 7 and can be brought into its closed or open position by means of a switching mechanism as will be described hereinafter.

A terminal 8 on the load side forms a current conductor and is embraced by a stationary iron core 9 of hollow square cross section having one side open (see Figure 5). The stationary iron core 9 forms a part of an electro-magnet for an instantaneous tripping device and a movable iron armature 10 is disposed adjacent to the open side of the stationary iron core 9. The movable iron armature 10 has one end arranged to be attracted by the stationary iron core 9 against the action of a set compression spring 11 upon a flow of high current through the conductor 8. The spring biases the armature 10 away from the stationary iron core 9. A pin 12 attaches the stationary iron core 9 to a frame 13 while pivotally supporting the armature 10 to the frame 13. The movable iron armature 10 includes a portion bent in the form of a protrusion having one end 10¹ facing an instantaneous tripping lever 14.

A pin 15 is disposed on a lower protrusion (as viewed in Figure 5) from the armature 10 to be able to abut against a locking plate 16 at one end 16a (see Figure 5). The lever 14 is pivotally supported to the frame 13 at a pivot 17 and integrally connected to another instantaneous tripping lever 14¹. The lever 14 has the end capable of abutting against the end 10¹ while the lever 14¹ has one end normally touching a bolt-shaped stop 19 therefor and the other end capable of turning a trip member 20.

The locking plate 16 is of an inverted U-shape and pivotally supported on a pin 21 planted on the frame 13. The U shaped plate 16 has one lateral side divided into two legs one of which has an end 16a capable of abutting against the pin 15 as above described and the other of which has an end 16b connected to a connecting link 22 (see Figure 5). A locking spring 23 includes an intermediate portion disposed around the pin 21 on the locking plate 16 and tends to rotate the locking plate 16 in the clockwise direction as viewed in Figure 5 through 7. The connecting link 22 is similarly connected to similar locking plates (not shown) disposed for other poles.

A releasing plate 24 is pivotally sup-

ported on the frame 13 at a pivot 25 and has a lower end capable of turning the upper end of the locking plate 16. The upper end of the releasing plate 24 is connected to a releasing link 26. Bolt-shaped stop 27 limits the movement of the armature 10 and a bracket 28 serves as a support for the frame 13.

As shown in Figure 1, a switching mechanism for opening and closing the contact assembly includes an operating rod 29 of any suitable electrically insulating material having one end articulated to the contact holder 6 for each pole. As best shown in Figures 2, 3 and 4, the operating rod 29 has the other end articulated to both a connector lever 30 and an upper toggle link 31 at one end through a pin 59. The upper toggle link 31 has the other end articulated to one end of a lower toggle lever 33 through a shaft 32. The lower toggle lever 34 has the other end articulated to a guide lever 34 pivotably mounted on a pin 35. In the closed position as shown in Figure 1 an interrupting spring 36 anchored at one end to the pin 59 cooperates with a contact spring (not shown) to tend to always bias the main movable contact 4 away from the main stationary contact 1 while rotating the connector lever 30 in the clockwise direction as viewed in Figure 1. An interlocking shaft 37 fixedly extends through the central portion of the connector lever 30 as well as those provided for all the remaining poles. A rotational force provided by the connector lever 30 is exerted on a pair of upper and lower toggle levers 31 and 33 respectively to fold them into an obtuse angle. But a closing roller 38 rotatably mounted on the shaft 32 can engage a closing latch 39 pivotably secured to a pivot pin 40 to maintain both toggle links 31 and 33 in the closed position while they are extended as shown in Figure 1. The closing latch 39 tends to be rotated in the clockwise direction as viewed in Figure 1 by means of a closing spring 41 disposed around the pin 40. As best shown in Figures 2 through 4, the latch 39 has disposed on one side thereof an arm 39a provided at the extremity with an engaging surface 39b capable of engaging the roller 38. The arm 39a has a lower edge formed with a sliding surface 39c relatively slidable along the surface of the roller 38.

A rotational force in the clockwise direction as viewed in Figure 1 or Figures 2 to 4 provided by the contactor lever 30 is, for the most part, absorbed by the pin 35 for the guide lever 34 while one portion thereof remains as a force tending to rotate the lever 34 in the clockwise direction as viewed in Figure 1. When a tripping roller 42 is in abutting engagement with a trip lever 43 pivotably mounted on a pin 44 with a small

slip angle, as shown in Figure 2, that remaining force generates a clockwise torque about the axis of the pin 44. However the trip lever 43 is maintained in equilibrium by having a tripping roller 45 rotatably disposed at that end thereof remote from the roller 42 to abut against one arm of a three arm type tripping latch 46.

A trip device 47 includes, in addition to the trip member 20 and the components 43 through 46, a trip coil 48, and a movable push rod 49 projecting from the trip coil 48 toward the trip member 20 subsequently abutting against another arm of the trip latch 46.

If an overcurrent flows through a circuit operatively connected to the circuit interrupter in its closed position as shown in Figure 1 or if the trip coil 48 is energized by any means then the push rod 49 abuts against trip member 20 to rotate the latter in the counterclockwise direction as viewed in Figure 2, and also rotate the tripping latch 46 in the clockwise direction as viewed in Figure 2 with another arm of the tripping latch 46 engaged by the trip member 20. This causes the tripping latch 46 to disengage from tripping roller 45 to permit the trip lever 34 to be rotated in the clockwise direction thereby to disengage the trip lever 43 from the tripping roller 42. Therefore the guide lever 34 is rapidly rotated in the clockwise direction to rotate the connector lever 30 in the same direction as the trip lever 43 through the interconnected toggle links 31 and 33 until the contact assembly is put in its open position.

During that time, a closing coil 50 of an electromagnetic closing device is maintained energized and even if a closing lever 51 has been rotated in the clockwise direction, the closing roller 38 slides along the upper edge of the closing lever 51 forming the completely free tripping state. Thus the tripped state as shown in Figure 2 is reached.

Under these circumstances, the deenergization of the closing coil 50 permits a reset spring 53 anchored at one end to the pin 32 (see Figure 1) to further fold the pair of toggle links 31 and 33 so as to decrease the obtuse angle formed therebetween. This results in the rotation in the counterclockwise direction as viewed in Figure 3 of the closing lever 51. At the same time, a movable iron armature 52 is returned to its original or lower position by virtue of its own weight while the reset spring 53 functions to pull the toggle links 31 and 33 upwardly thereby to rotate the guide lever 34 in the counterclockwise direction as viewed in Figure 3 until the tripping roller 42 engages the trip lever 43. Then a trip spring 54 anchored to a shaft for the tripping roller 45 as shown in Figure 1 is operated to engage the tripping roller 45 with

the tripping latch 46 through the rotation of the trip lever 43 thereby to return the tripping latch 46 back to its original position by means of the action of a spring 55 anchored at the end of the one arm of the tripping latch 46 as shown in Figure 1. Thus the switching mechanism is automatically reset reaching the open state as illustrated in Figure 3.

With the closing coil 50 energized, in the open state as shown in Figure 3, the armature 52 is attracted by a stationary iron core 56 to cause the closing push rod 57 to push up a closing roller 58 attached to the closing lever 51 thereby to rotate the closing lever 51 in the clockwise direction. This permits the toggle links 31 and 33 folded to form an angle therebetween to become substantially straight to rotate the contactor lever 30 in the counterclockwise direction against the action of the interrupting spring 36 until the contact assembly is brought into its closed position.

In the closing process just described, the closing roller 38 abuts against the lower edge of the arm 39a on the closing latch 39 to slide along the closing latch 39 in the counterclockwise direction while pushing it. Eventually, the roller 38 engages the engaging face 39b at the extremity of that arm. Immediately before the completion of the closing process, the spring 41 for the closing latch 39 is operated to rapidly put the extremity of the arm of the closing latch 39 in abutting engagement with the closing roller 38 through the closing process as shown in Figure 4. This results in the closed state as shown in Figure 1.

From the foregoing it will be appreciated that the closing latch 39 is operated in response to the movement of the closing roller 38 so that the movement of the closing latch 39 becomes maximum immediately followed by the closing roller 38 losing its pushing pressure thereby to engage the engaging face 39b. Thus the closing latch 39 is returned back to its position occupied thereby before the closing operation is initiated.

This movement of the closing latch 39 is transferred to the releasing plate 24 through the releasing links 26 and 26¹. Therefore if a high current flows through the terminal 8 on the load side in the closing process effected by the switching mechanism then the stationary iron core 9 for instantaneous tripping attracts the armature 10. This permits the end 10¹ of the armature 10 to strike the tripping levers 14 and 14¹ whereupon the extremity of the trip lever 14¹ actuates the trip member 20 to trip the current interrupter into its open position.

It is to be noted, however, that, with the circuit interrupter maintained in its closed

position as shown in Figure 1, the armature 10 is prevented from responding to any flow of high current through the circuit interrupter to be attracted by the stationary iron core 9. This is because the locking plate 16 has its upper edge abutting against the lower edge of the releasing plate 24 by means of the action of the locking spring 23 while having its branched end 16a maintained in abutting engagement with the pin 15 on the movable iron core 10. Therefore the circuit interrupter cannot be opened. In other words, the armature 10 is disabled in the closed position of the circuit interrupter.

In the closing process effected by the switching mechanism, the counterclockwise movement of the closing latch 39 as shown in Figure 8 becomes maximum immediately before the completion of the closing operation. Thus the releasing plate 24 connected to the closing latch 39 through the releasing links 26 and 26¹ is rotated in the clockwise direction as viewed in Figure 8 while the locking plate 16 is rotated in the counterclockwise direction as viewed in Figures 5 through 7 about the axis of the pin 21 until the branched end 16a of the locking plate 16 does not abut against the pin 15 for the armature 10 as shown in Figure 6.

Even with the armature 10 located in its position as shown in Figure 6, it is not attracted by the stationary core 9 unless a high current such as a shortcircuiting current flows through the conductor on the engagement of the contacts. Therefore the circuit interrupter remains closed. Upon the switching mechanism having completed the closing operation, the closing latch 39 is returned to its closed position as shown in Figure 1 so that the branched end 16a of the locking plate 16 is brought into abutting engagement with the pin 15 of the armature 10. Thus the closing operation of the switching mechanism has been completed, reaching the closed position as shown in Figure 5.

Assuming that the closing operation has been performed with the associated circuit shortcircuited, the armature 10 in its position as shown in Figure 6 is attracted by the stationary iron core 9 to cause one end 10¹ thereof to strike against the trip levers 14 and 14¹. Thus the trip member 20 is upwardly pushed to trip the circuit instantaneously into its open position.

The present invention has several advantages. For example, the present invention has the short timing trip characteristic retaining the performance of selective interruption exhibited by conventional trip devices, but does not have to completely close a long-lasting shortcircuit current having a duration of several tens of cycles. Further the closing device providing the

closing energy may be relatively small-sized resulting in compact circuit interrupters.

5 WHAT WE CLAIM IS:—

1. An instantaneous trip device operative during closing of a circuit interrupter and comprising an instantaneous tripping electromagnet comprising a stationary iron
10 core disposed to embrace a conductor and operatively associated with a movable iron armature arranged to be held or released by a closing latch included in a switching mechanism for a circuit interrupter, through
15 both a locking plate and a releasing plate, so that, after the completion of the closing operation of the circuit interrupter performed by the switching mechanism the locking plate locks the movable iron armature in its locked position to prevent the
20 movable iron armature from moving under

the attraction of the stationary iron core, the locking plate being released only during the closing of the circuit interrupter effected by the switching mechanism to permit the
25 movable iron armature to move under the attraction of the stationary iron core, whereby, upon a flow of high current through the conductor during the closure of contacts by the switching mechanism, the movable iron armature is operated to actuate
30 the tripping device to open the contacts.

2. An instantaneous tripping mechanism of a circuit interrupter substantially as herein described with reference to the accompanying drawings. 35

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2. An instantaneous tripping mechanism of a circuit interrupter substantially as herein described with reference to the accom-
35 panying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

