

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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THE PATENT OFFICE
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 AND INVENTION

(54) CIRCUIT INTERRUPTER

(71) We, TERASAKI DENKI SANGYO
 KANUSHIKI KAISHA, of No. 27, Showa-cho-
 naka 5-chome, Abeno-ku, City of Osaka,
 Japan, a Body Corporate organized and exist-
 ing under the laws of Japan, do hereby de-
 5 clare 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 follow-
 10 ing statement:—
 THIS INVENTION relates to improve-
 ments in the circuit interrupter disclosed in
 British Patent Specification No. 1095192 in
 the name of the present applicant.
 15 Specification No. 1095192 discloses a cir-
 cuit interrupter including two movable con-
 tact arms each having at one end a respec-
 tive contact and being pivotable at its other
 end about a respective axis, the arms being
 20 substantially parallel to each other in the
 closed state wherein the said contacts engage
 each other, electrical connections to the arms
 so placed that in the closed state current flow
 in one arm will be in a direction opposite
 25 that in the other arm, means resiliently bias-
 ing a first one of the arms to its closed posi-
 tion, an operating mechanism for moving the
 second end of the arms to and from its closed
 position, and tripping mechanism responsive
 30 to flow of an overload current through the
 interrupter, the arrangement being such that,
 upon the occurrence of a very high current,
 the first one of the contact arms will interrupt
 the circuit by being immediately moved away
 35 from the second contact arm by the force
 of electrodynamic repulsion generated be-
 tween the substantially parallel contact arms
 by the flow of the very high current there-
 through, the second contact arm will initially
 40 remain stationary under the restraint of the
 operating mechanism and will then shortly
 after the first contact is put in its open posi-
 tion be released to move away from its closed
 position under the action of the tripping

mechanism, and the first contact arm will
 then as the said repulsion decreases return to
 its original position under the action of the
 resiliently biasing means.

The present invention provides a circuit
 interrupter comprising a pair of movable
 50 contact arms disposed in substantially parallel
 relationship in their closed positions, each of
 the contact arms being provided at one end
 with a contact and pivotably mounted on
 the other end portion on a pivot pin, an over-
 55 centre spring acting between the first contact
 arm and a support member therefor to exert
 on the first contact arm a force normally
 tending to maintain the arm in its closed
 position, an operating mechanism for moving
 60 the second of the movable contact arms from
 its closed position to its open position and
vice versa, and overcurrent responsive trip
 means operatively coupled to the operating
 65 mechanism, the arrangement being such that
 a flow of extraordinarily excessive current
 through the interrupter will generate an elec-
 tromagnetic repulsion between the two mov-
 able contact arms to drive the first contact
 arm to its open position independently of the
 70 trip means, the first contact arm being then
 held in its open position by the reversal of
 the force of the overcentre spring over the
 dead point thereof, and a short while after
 the first contact arm has been moved to its
 75 open position said overcurrent responsive trip
 means will perform a trip operation to cause
 the second contact arm to rotate to its open
 position, a movable coupling plate including
 80 a slot therein being disposed so that the con-
 tact bearing portions of both of the contact
 arms project through and are movable in
 said slot, and so that on opening movement
 of the second arm following the trip opera-
 85 tion the second contact arm will actuate said
 coupling plate to return the first contact arm
 to its closed position.

Preferably, the coupling plate is slidably

disposed in opposite guide slots formed on a pair of electrically insulating partitions disposed in the interrupter.

5 In order to increase the distance between a pair of separated contacts, the slot in the coupling plate is advantageously as long as possible.

10 The coupling plate may be conveniently disposed adjacent the contacts in their closed positions thereby to prevent the second contact arm from bouncing from its open position back to its closed position upon interrupting a flow of heavy current.

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

20 Figure 1 shows partly in longitudinal section and partly in elevation a circuit interrupter constructed in accordance with the invention;

25 Figure 2 is a fragmental pictorial view of a pair of movable contact arms and a coupling plate operatively connecting both arms to each other in the interrupter of claim 1, with a cover removed

Figure 3 is a plan view of the coupling plate illustrated in Figure 2;

30 Figures 4 to 7 inclusive are fragmental elevational views illustrating the positional relationship between the contact arms and the coupling plate in the various positions of the contact arms.

35 While the invention will be described in connection with a circuit interrupter of three pole type, it is to be understood that it is equally applicable to circuit interrupters of single pole type and other multiple pole types. Also it is to be understood that the components common to all the poles will be illustrated and described in terms of the central pole alone.

40 The circuit interrupter illustrated comprises a housing member 1 and a detachable cover member 2. The housing and cover members are conveniently moulded of any suitable electrically insulating plastic and constitute a closed enclosure. Within the enclosure a pair of movable contact arms 3 and 4 are disposed to as to be substantially horizontal and parallel in the closed position of the interrupter. The contact arms 3 and 4 are made of any suitable electrically conductive material and have contacts 3a and 4a attached at their respective free ends.

55 The lower or first contact arm 4 has the other end portion pivotably mounted on a rotatable shaft 7 carried by a U-shaped support member 8 for rotation about the axis of the shaft 7 and the support member 8 is rigidly secured on the bottom wall surface of the housing member 1. Disposed on either side of the lower contact arm 4 and the U-shaped support member 8 is a helical spring 9 having one end hooked to a pin

10 extending through the contact arm 4 and the other end secured to a pin 11 disposed on the U-shaped support member 8. The spring 9 serves to provide the contact pressure with which the contact 4a engages the upper contact 3a, the pressure being directed in the clockwise direction as viewed in Figure 1.

As will be apparent hereinafter, the lower contact arm 4 is arranged and adapted to respond to a flow of extraordinarily excessive current, such as a flow of shortcircuit current through the interrupter, to be rotated counterclockwise as viewed in Figure 1. In order to prevent the lower contact arm 4 from rotating clockwise from its closed position, a stop 12 is disposed on the support member 8. The lower contact arm 4 also has the said other end bent and connected by way of a flexible conductor 13 to a conductor 13a connected to a supply terminal 14.

85 The upper or second contact arm 3 is connected by way of connecting shafts 5 and 6 to a contact holder 15 having pivotably mounted thereon a holder shaft 16 of any suitable electrically insulating material. The holder shaft 16 is pivotably supported to the housing member 1 through a pair of opposite support members (not shown) disposed on the opposite wall surfaces of the housing member 1. Thus the contact arm 3 is rotatable from its closed position to its open position and *vice versa* about the axis of the holder shaft 16, along with an operating mechanism for the arm as will be subsequently described. The upper contact arm 3 is electrically connected to a connector 17 through a flexible conductor 18.

100 In order to manually move the upper movable contact arm 3 from its closed position as illustrated in Figure 1 to its open position and *vice versa*, there is provided an operating mechanism 20 which comprises an operating handle 21 movably projecting beyond the cover member 2, a switching lever 22 secured at one end to the operating handle 21 and pivotably mounted at the other end on a stationary pin 19 secured to a fixture block 23, and a pair of toggle link members 24 and 25 articulated by a toggle pin 26. The mechanism further comprises a pair of tension springs 27 spanned between a spring shoe 22a disposed at that end of the switching lever 22 integrally connected to the operating handle 21 and spring shoe 26a loosely engaging the toggle pin 26. Thus the link members 24 and 25, the toggle pin 26 and the springs 27 form a toggle linkage of well known construction.

115 The operating mechanism 20 is operatively coupled to a trip mechanism 28 of conventional design. More specifically, the link member 25 engages at 29 a trip lever 30 pivotably mounted at one end of a stationary pin 31 secured to the fixture block 23 and engaging at the other end a latch 32. The latch

32 is adapted to respond to a flow of overload current through the interrupter to be released.

The interrupter also comprises a thermally responsive device 35 for tripping the interrupter upon the occurrence of a flow of ordinary overload current. The thermally responsive device 35 includes a bimetal element 36 electrically connected to the connector 17 through a conductor 37, and a U-shaped electric resistor 38 disposed adjacent to the bimetallic element 36. The resistor 38 has one end connected to the conductor 37 and the other end connected to another conductor 39 which is, in turn, connected to a load terminal 40. As shown in Figure 1, an adjusting screw 41 is secured to the free end of the bimetallic element 36. Upon the occurrence of a flow of ordinary overload current the resistor 38 and hence the bimetallic element 36 will be heated whereby the element is bent leftwardly as viewed in Figure 1 to push against a trip piece 42 facing the same. This causes a trip shaft 43 integral with the trip piece 42 to be rotated to disengage a latch 44 secured to the trip shaft 43 from the latch 32, resulting in a tripping operation.

If an excessive current, whose magnitude may for example be of the order of 8 to 10 times the rated current, flows through the interrupter then an electromagnet device including stationary iron core 45 and armature 46 respectively is energized to perform an instantaneous tripping operation. More specifically, the stationary iron core 45 is excited by an excessive current flowing through the conductor 37 disposed adjacent to the core, so as to attract the movable iron armature 46 thereby to rotate the trip shaft 43 to disengage the catch 44 from the hook 32, resulting in an instantaneous tripping operation.

As in the conventional type of three pole circuit interrupter, the housing member 1 includes a pair of electrically insulating partition walls 1' and 1' which, with the two side walls, divide the interior into three compartments in each of which the movable contact arms 3 and 4, the overcurrent responsive trip devices 35, 45—46, 28, an arc-extinguishing chamber 47 (see Figure 1), etc. for one pole are disposed.

A slotted coupling plate 50 of any suitable electrically insulating material is provided for each pole for resetting or returning the lower contact arm 4 after movement of the latter, upon tripping or opening movement of the upper contact arm 3. The coupling plate 50 is provided with a central longitudinal slot 52 as best shown in Figure 3 and is slidably disposed in a pair of longitudinal guide grooves 54, 54' formed in opposite wall surfaces and in such positions that the contact bearing portions of the contact arms 3 and 4 project beyond the slot 52 as best shown in Figure

2. The plate 50 also serves to provide one side wall of the chamber 47.

As shown in Figure 3, the slot 52 has an enlarged portion 52a through which the free end portions of the contact arms 3 and 4 can be inserted into the slot, and a pair of transverse edges 52b and c. The slot 52 has a width sufficient to permit the contact bearing portions of the arms 3 and 4 to be freely moved therein, and serves to bring the lower contact arm 4 from its open position to its original closed position through movement of the upper contact arm 3 from its closed position to its open position as will be described hereinafter.

If an extraordinarily excessive current such as a short circuit current flows through the circuit interrupter, such a current will flow through the two parallel contacts arms in opposite directions and therefore will generate an electromagnetic repulsion between the contact arms. This electromagnetic repulsion does not affect the upper contact arm 3 because the latter is constrained by the operating mechanism 20, but it overcomes the force provided by the spring 9 so that contact arm 4 is rotated within the slot 52 in the counterclockwise direction as viewed in Figure 4 until the line of action of the spring 9, i.e. the line joining the axes of the shafts 10 and 11, moves downwardly past the shaft 7. This causes the force of the spring 9 to reverse in direction thereby to pull the contact arm 4 against the lower edge 52c of the slot 52 as viewed in Figure 3, to depress the coupling plate 50, the contact arm 4 being rapidly rotated in the counterclockwise direction as viewed in Figures 1 and 5 until it strikes against a piece 48 of sheet vulcanized fiber disposed on the bottom of the housing member 1 (see Figure 1), and is held in its open position as shown in Figure 5 even after termination of the shortcircuit current.

This separation of the lower contact arm 4 from the upper contact arm 3 is effective for limiting or interrupting the shortcircuiting current.

A short while after this interruption the overcurrent responsive trip mechanism is operated to cause the constrained state of the operating mechanism 20 to collapse to rotate the upper contact arm 3 in the clockwise direction as viewed in Figure 6 within the slot 52. When the upper contact arm 3 has been rotated through a certain angle it will strike against the edge 52b of the slot 52 (see Figure 6) thereby to raise the coupling plate 50 and the lower contact arm 4, previously engaged with the lower edge 52c of the slot 52. Upon the lower contact arm 4 reaching its position shown in solid lines in Figure 7 where the line of action of the spring 9 passes through its dead point, the arm will return to its original closed position as shown in

dotted lines in Figure 7 by its own inertia.

The stop 12 prevents the arm 4 from further rotating in the same direction. Then the interrupter can be reset in the conventional manner to be ready for the succeeding closing operation.

The interrupter described has several advantages. For example, upon interruption of a short circuit current by the electromagnetic repulsion generated between the upper and lower contact arms 3 and 4, the lower contact arm 4 is held in its open position through the reversal of the force of the associated spring 9. A little later after this interruption the overcurrent responsive trip mechanism is operated to rotate the upper contact arm toward its open position. Attendant on this rotational movement of the upper contact arm 3, the lower contact arm 4 returns to its original closed position to be ready for the the succeeding closing operation. This eliminates the necessity of locking the lower contact arm 4 in its open position by a latch or the like, with the result that the lower contact arm is smoothly driven to and held in its open position and returns to its original closed position.

It has been found to be preferable that the length of the slot 52 should be of the greatest length that will still enable the upper contact arm 3, during its opening movement, to strike against the upper edge 52b of the slot 52 and thereby raise the lower contact arm 4 from its position where it engages the lower edge 52c of the slot to its position where the force of the associated spring 9 reverses in direction. Thereafter the upper contact arm 3 continues its opening movement to raise the coupling plate 50 and the lower contact arm 4 until the lower arm is stopped by the stop 12 whereupon it reaches its closed position and simultaneously the upper arm reaches and is held in its open position.

This length of slot permits contacts 3a and 4a to be separated from each other to the maximum extent. The contact arms abut against the upper and lower edges of the slot respectively leading to a greater separation than hitherto between the contact 3a and the contact 4a.

It is well known that although the opening movement of the lower contact arm 4 is itself generally effective for completely interrupting a shortcircuit current, a shortcircuit current approximately corresponding to the upper limit of the interruption capability of the interrupter itself may not be completely interrupted through the completion of opening movement of the lower contact arm 4. Under these circumstances, the present interrupter is effective for increasing the separation between the contacts because opening movement of the upper contact arm is effected a little after the completion of opening movement of the lower contact arm as shown in

Figure 6. This ensures that any arc current is prevented from flowing between the separated contacts and the interruption time, additionally decreases resulting in increases in both the current limiting effect and the interruption capability.

Also upon interrupting a flow of heavy current in existing interrupters, one of the movable contact arms, e.g. the upper contact arm 3, is generally moved to its open position where it strikes an associated stop. This contact arm may bounce back, causing reacting or re-closing. In the present interrupter, however, the coupling plate 50 is disposed in the vicinity of the contacts 3a and 4a in their closed positions. Therefore an excessive kinetic energy of the upper contact arm 3 resulting from its opening movement is effectively spent in raising the lower contact arm 4 from its open position with the result that the upper contact arm is prevented from bouncing.

In addition the coupling plate 50 constitutes one side wall of the arc-extinguishing chamber 47. The resulting construction is simple and effectively prevents the operating mechanism and other components from thermal damage due to a flow of arc current and diffusion of arc gases occurring upon interruption of an excessive current flowing through the interrupter, and also prevents shortcircuit across the poles from occurring through the components.

WHAT WE CLAIM IS:—

1. A circuit interrupter comprising a pair of movable contact arms disposed in substantially parallel relationship in their closed positions, each of the contact arms being provided at one end with a contact and pivotally mounted on the other end portion of a pivot pin, an overcentre spring acting between the first contact arm and a support member therefor to exert on the first contact arm a force normally tending to maintain the arm in its closed position, an operating mechanism for moving the second of the movable contact arms from its closed position to its open position and *vice versa*, and overcurrent responsive trip means operatively coupled to the operating mechanism, the arrangement being such that a flow of extraordinarily excessive current through the interrupter will generate an electromagnetic repulsion between the two movable contact arms to drive the first contact arm to its open position independently of the trip means, the first contact arm being then held in its open position by the reversal of the force of the overcentre spring over the dead point thereof, and a short while after the first contact arm has been moved to its open position said overcurrent responsive trip means will perform a trip operation to cause the second contact arm to rotate to its open position, a movable coupling plate including



dotted lines in Figure 7 by its own inertia.

The stop 12 prevents the arm 4 from further rotating in the same direction. Then the interrupter can be reset in the conventional manner to be ready for the succeeding closing operation.

The interrupter described has several advantages. For example, upon interruption of a short circuit current by the electromagnetic repulsion generated between the upper and lower contact arms 3 and 4, the lower contact arm 4 is held in its open position through the reversal of the force of the associated spring 9. A little later after this interruption the overcurrent responsive trip mechanism is operated to rotate the upper contact arm toward its open position. Attendant on this rotational movement of the upper contact arm 3, the lower contact arm 4 returns to its original closed position to be ready for the succeeding closing operation. This eliminates the necessity of locking the lower contact arm 4 in its open position by a latch or the like, with the result that the lower contact arm is smoothly driven to and held in its open position and returns to its original closed position.

It has been found to be preferable that the length of the slot 52 should be of the greatest length that will still enable the upper contact arm 3, during its opening movement, to strike against the upper edge 52b of the slot 52 and thereby raise the lower contact arm 4 from its position where it engages the lower edge 52c of the slot to its position where the force of the associated spring 9 reverses in direction. Thereafter the upper contact arm 3 continues its opening movement to raise the coupling plate 50 and the lower contact arm 4 until the lower arm is stopped by the stop 12 whereupon it reaches its closed position and simultaneously the upper arm reaches and is held in its open position.

This length of slot permits contacts 3a and 4a to be separated from each other to the maximum extent. The contact arms abut against the upper and lower edges of the slot respectively leading to a greater separation than hitherto between the contact 3a and the contact 4a.

It is well known that although the opening movement of the lower contact arm 4 is itself generally effective for completely interrupting a shortcircuit current, a shortcircuit current approximately corresponding to the upper limit of the interruption capability of the interrupter itself may not be completely interrupted through the completion of opening movement of the lower contact arm 4. Under these circumstances, the present interrupter is effective for increasing the separation between the contacts because opening movement of the upper contact arm is effected a little after the completion of opening movement of the lower contact arm as shown in

Figure 6. This ensures that any arc current is prevented from flowing between the separated contacts and the interruption time, additionally decreases resulting in increases in both the current limiting effect and the interruption capability.

Also upon interrupting a flow of heavy current in existing interrupters, one of the movable contact arms, e.g. the upper contact arm 3, is generally moved to its open position where it strikes an associated stop. This contact arm may bounce back, causing re-acting or re-closing. In the present interrupter, however, the coupling plate 50 is disposed in the vicinity of the contacts 3a and 4a in their closed positions. Therefore an excessive kinetic energy of the upper contact arm 3 resulting from its opening movement is effectively spent in raising the lower contact arm 4 from its open position with the result that the upper contact arm is prevented from bouncing.

In addition the coupling plate 50 constitutes one side wall of the arc-extinguishing chamber 47. The resulting construction is simple and effectively prevents the operating mechanism and other components from thermal damage due to a flow of arc current and diffusion of arc gases occurring upon interruption of an excessive current flowing through the interrupter, and also prevents shortcircuit across the poles from occurring through the components.

WHAT WE CLAIM IS:—

1. A circuit interrupter comprising a pair of movable contact arms disposed in substantially parallel relationship in their closed positions, each of the contact arms being provided at one end with a contact and pivotally mounted on the other end portion of a pivot pin, an overcentre spring acting between the first contact arm and a support member therefor to exert on the first contact arm a force normally tending to maintain the arm in its closed position, an operating mechanism for moving the second of the movable contact arms from its closed position to its open position and *vice versa*, and overcurrent responsive trip means operatively coupled to the operating mechanism, the arrangement being such that a flow of extraordinarily excessive current through the interrupter will generate an electromagnetic repulsion between the two movable contact arms to drive the first contact arm to its open position independently of the trip means, the first contact arm being then held in its open position by the reversal of the force of the overcentre spring over the dead point thereof, and a short while after the first contact arm has been moved to its open position said overcurrent responsive trip means will perform a trip operation to cause the second contact arm to rotate to its open position, a movable coupling plate including



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5 a slot therein being disposed so that the contact bearing portions of both of the contact arms project through and are movable in said slot, and so that on opening movement of the second arm following the trip operation the second contact arm will actuate said coupling plate to return the first contact arm to its closed position.

10 2. A circuit interrupter as claimed in claim 1, wherein the interrupter is of multiple pole type and said coupling plate is slidably disposed in a pair of guide grooves formed in opposite relationship on a pair of electrically insulating walls for each pole.

15 3. A circuit interrupter as claimed in claim 1 or 2, wherein said slot in said coupling plate has a length such that the plate will raise the first contact arm from its opened position at least to its position where the force of said spring means reverses in direction on opening movement of the second contact arm, thereby to increase the distance of separation between said contacts.

20 4. A circuit interrupter as claimed in

claims 1, 2 or 3, wherein said coupling plate is disposed in the vicinity of said contacts whereby an excessive kinetic energy of the second contact arm resulting from its opening movement will be spent in raising the first contact arm from its open position thereby to prevent the second contact arm from bouncing back to its closed position.

5. A circuit interrupter as claimed in claim 1, 2, 3, or 4, wherein said coupling plate is made of electrically insulating material and forms one side wall of an arc-extinguishing chamber and said contact arms have their contact bearing portions movably projecting through said slot into said arc-extinguishing chamber.

6. A circuit interrupter substantially as herein described and illustrated in the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicant(s).

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