Jan. 27, 1970 WASABURO MURAI ET AL 3,492,609

CIRCUIT INTERRUPTER TRIP CONTACT RESETTING MEANS

Filed Jan. 22, 1968 3 Sheets-Sheet 1

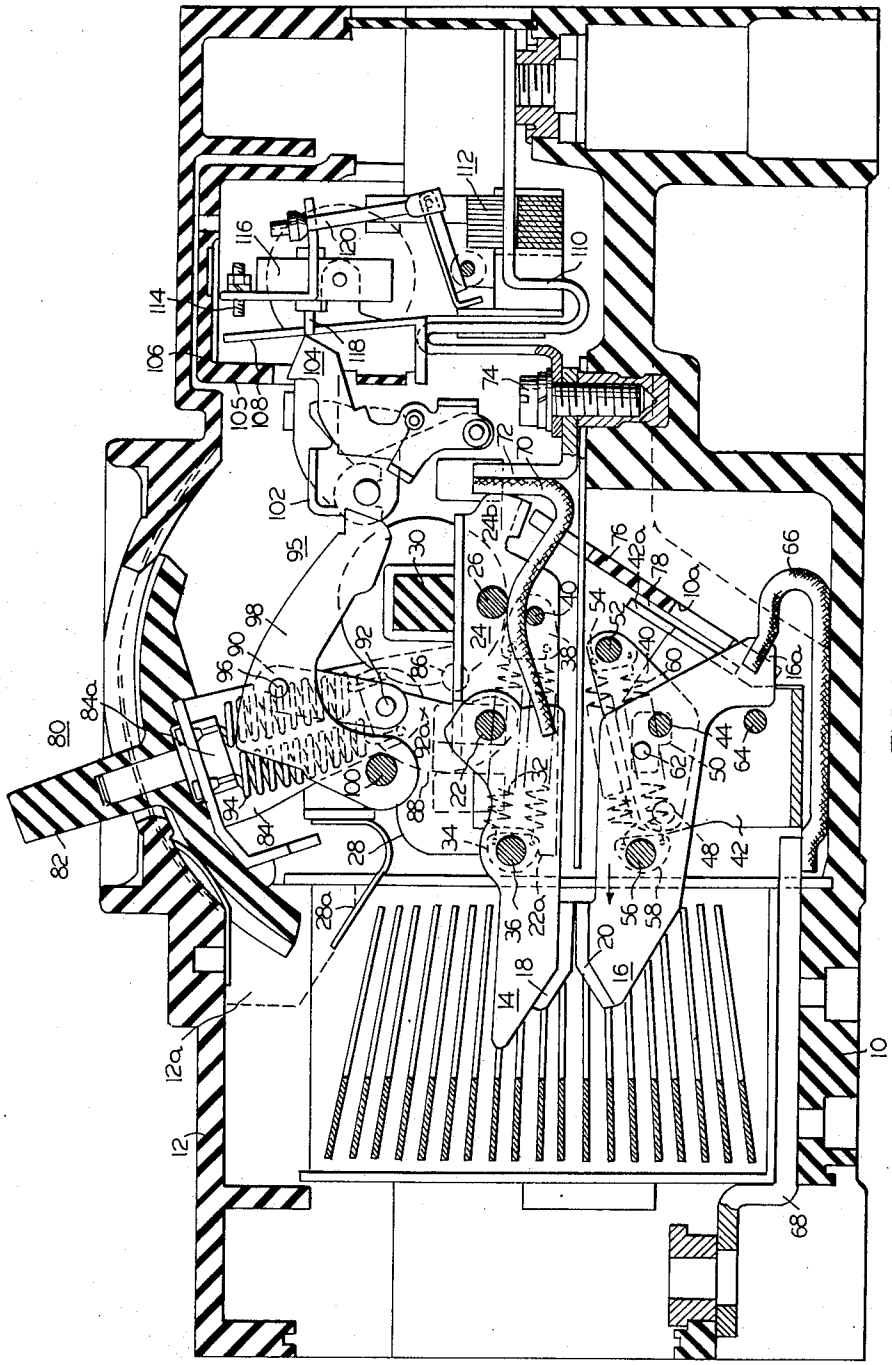

FIG. 1

INVENTORS
WASABURO MURAI
YUJIRO YASOJIMA

BY Wenderoth, Lind & Ponack
ATTORNEYS

CIRCUIT INTERRUPTER TRIP CONTACT RESETTING MEANS

Filed Jan. 22, 1968 3 Sheets-Sheet 2

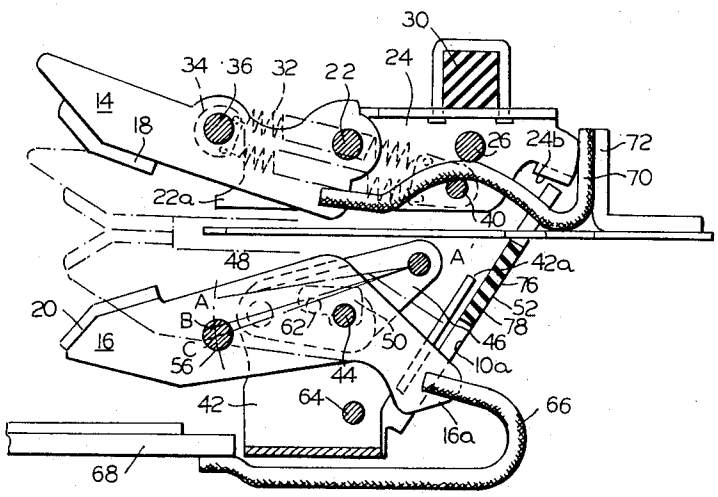


FIG.2

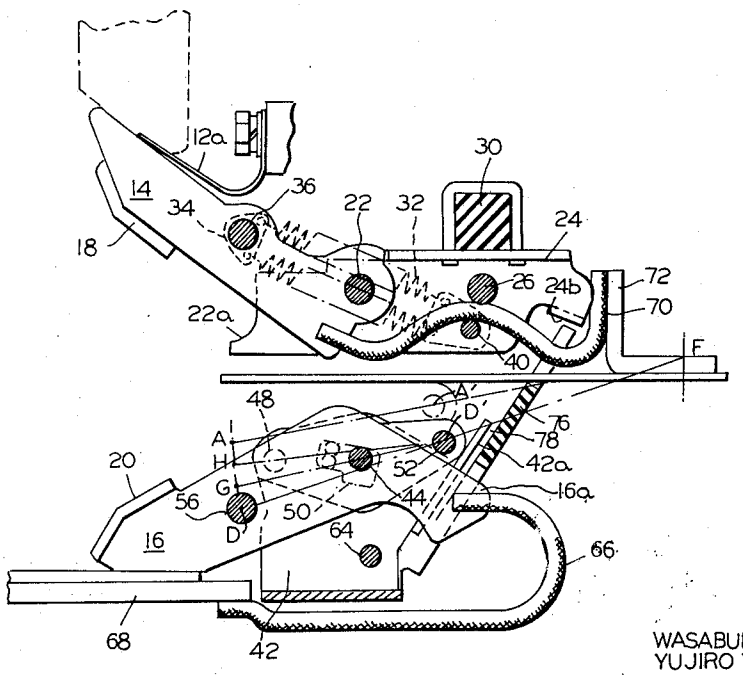


FIG.3

INVENTORS
WASABURO MURAI
YUJIRO YASOJIMA

BY Wenderoth, Lind & Ponack
ATTORNEYS

Jan. 27, 1970 WASABURO MURAI ET AL 3,492,609

CIRCUIT INTERRUPTER TRIP CONTACT RESETTING MEANS

Filed Jan. 22, 1968 3 Sheets-Sheet 3

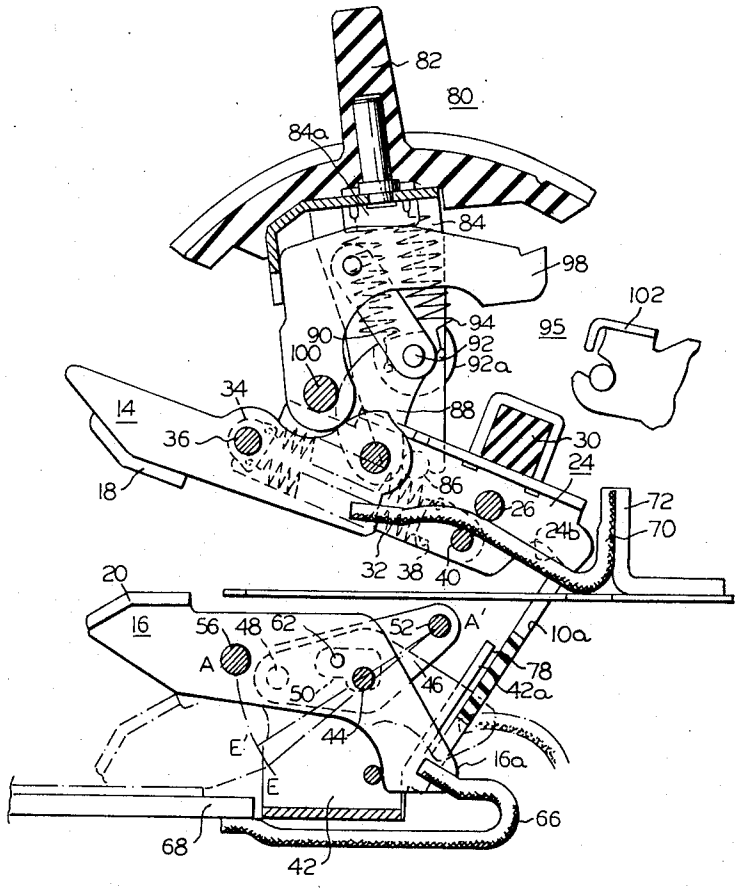


FIG.4

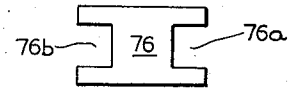


FIG.6

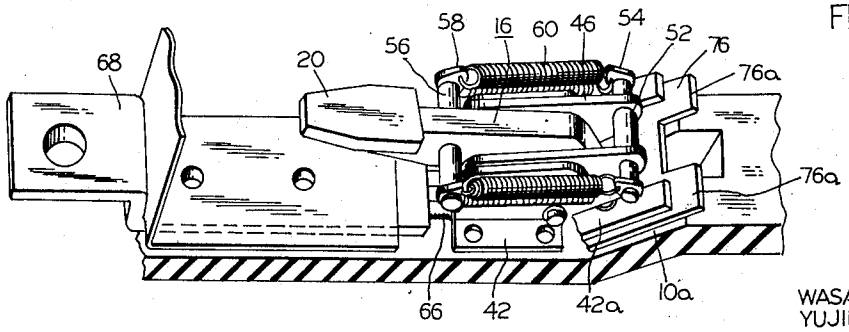


FIG.5

INVENTORS
WASABURO MURAI
YUJIRO YASOJIMA

BY Wenderoth, Lind & Ponack

ATTORNEYS

United States Patent Office

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# CIRCUIT INTERRUPTER TRIP CONTACT RESETTING MEANS

Wasaburo Murai and Yujiro Yasojima, Osaka, Japan, assignors to Terasaki Denki Sangyo Kabushiki Kaisha, Osaka, Japan

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Int. Cl. H01h 75/12

U.S. Cl. 335—16 7 Claims

## ABSTRACT OF THE DISCLOSURE

A pair of movable contact rods are disposed in parallel relationship at their closed positions and an insulating reset element is movably disposed on those sides of the contact rods remote from the respective contacts. The occurrence of a shortcircuit current generates an electromagnetic repulsion between the contact rods to rotate them in the opposite directions. Then an overcurrent responsive trip mechanism actuates an operating mechanism for switching one of the contact rods between its closed and normally open positions to put the one contact rod in its normally open position. Simultaneously a pivotable holder for holding the one contact rod strikes against the reset element to return the other contact rod to its closed position ready for the succeeding closing operation.

The invention relates to improvements in a circuit interrupter of the type wherein upon the occurrence of a shortcircuit current, an electromagnetic repulsion generated between a pair of movable contact rods is utilized to early separate them from each other thereby to decrease an interruption time as well as giving the current limiting effect.

For circuit interrupters of the type utilizing such an electromagnetic repulsion to rotate a pair of movable contact rods in the opposite directions, it is necessary to bring the contact rods thus rotated into their normally open positions to which they can be put by the operation of the associated operating or overcurrent responsive trip mechanism for the purpose of being ready for the succeeding closing operation.

Accordingly it is an object of the invention to provide a circuit interrupter of the type wherein upon the occurrence of a shortcircuit current an electromagnetic repulsion generated between a pair of movable contact rods to rotate them in the opposite directions, including improved means for effectively bringing the contact rods thus rotated into their normally open or tripped positions.

According to the invention, there is provided a circuit interrupter comprising a pair of movable contact rods disposed in substantially parallel relationship in the closed position of the interrupter, each of the contact rods being provided at one end with a contact and pivotably mounted at the other end on a pivot pin, spring means individual to each contact rod to normally apply a contact pressure to the association contact, an operating mechanism for switching one of the movable contact rods between its



closed and open positions, the other contact rod having only the contacting function, thermally and electromagnetically responsive trip means operatively coupled to the operating mechanism, and a flow of extraordinarily excessive current through the interrupter generating an electromagnetic repulsion on the pair of movable contact rods to rotate the movable contact rods in the opposite directions independently of the trip means thereby to interrupt the current, said contact rods being held in their open positions through reversal of a force of each spring means, characterized in that slightly after the contact rods have been separated from each other the trip means perform the tripping operation to cause the constrained state of the operating mechanism to collapse thereby to automatically bring the pair of contact rods into their positions identical to the normally open positions in which the rods are put through the operation of the trip means.

Preferably the one movable contact rod may be pivotably mounted to a pivotable holder and a reset element of electrically insulating material is movably disposed in slightly spaced relationship between the holder and the other contact rod on those sides thereof remote from the respective contacts. As the constrained state of the operating mechanism collapses due to the operation of the trip means the hold is rotated to push the reset element against the other contact rod to bring it in its tripped position, as well as bringing the one of the contact rods its tripped position.

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

FIGURE 1 is an elevational sectional view of a circuit interrupter in its closed position embodying the principles of the invention;

FIGURE 2 is a fragmental side elevational view illustrating the process of moving a pair of movable contact rods from their closed positions to their open positions by the action of an electromagnetic repulsion generated between the contact rods due to the occurrence of a shortcircuit current;

FIGURE 3 is a fragmental side elevational view of the movable contact rods after having been fully opened to interrupt a shortcircuit current;

FIGURE 4 is a view similar to FIGURE 3 but illustrating a pair of movable contact rods in their tripped positions;

FIGURE 5 is a fragmental perspective view of one of the movable contact rods shown in FIGURES 1 to 4 inclusive; and

FIGURE 6 is a plan view of a reset element constructed in accordance with the principles of the invention.

While the invention is applicable to current interrupters having any desired number of poles it will now be described in conjunction with a three pole circuit interrupter with a construction for the central pole thereof illustrated.

Referring now to the drawings and FIGURE 1 in particular, it is seen that an arrangement illustrated comprises a housing open at one end or the upper end as viewed in the same FIGURE 1, a cover member **12** detachably secured to the housing **10** at the open end, and a pair of movable contact rods **14** and **16** disposed in opposite relationship within the housing **10**. The housing

and cover member **10** and **12** respectively are moulding of any suitable, electrically insulating material and both the contact rods **14** and **16** are composed of any suitable, electrically conductive material. The first and second contact rods **14** and **16** respectively are provided at one end with a pair of contacts **18** and **20** respectively. When in their closed positions, as shown in FIGURE 1, the contact rods **14** and **16** are positioned in substantially parallel relationship.

The first or upper contact rod **14** is pivotably mounted by a pin **22** to a contact holder **24** which is, in turn, pivotably mounted on a pivot pin **26** supported to a fixture block generally designated by the reference numeral **28**. The contact holder **24** has fixed at its upper end a connecting rod **30** of any suitable, electrically insulating material to which the contact holders for the outer poles (not shown) are connected. The first contact rod **14** is adopted to be movable between its closed and normally open positions by an operating mechanism which will be described hereinafter.

The first contact rod **14** includes a pair of parallel contact springs **32** having one end anchored to a spring shoe **34** loosely engaging a pin **36** secured to the contact rod **14** at a position located to the left of the pin **22** as viewed in FIGURE 1 and the other ends anchored to a spring shoe **38** loosely engaging a pin **40** secured to the contact holder **24** at a position located to the right of the said pin **22** as viewed in FIGURE 1. With the interrupter put in its closed position, the contact springs **32** serve normally to exert on the first or upper contact **18** a contact pressure under which the contact **18** is maintained in contact with the mating contact **20**. However, upon the occurrence of a shortcircuit current flowing though the circuit interrupter to generate an electromagnetic repulsion between the first contact rod **14** and the second contact rod **16** substantially parallel to the upper rod, the contact springs **32** are adapted to move its line of action above the pin **22** to trigger the first contact rod **14** to its open position independently of an operating mechanism therefor and maintain it in this open position.

As shown in FIGURE 1, a stopper **28***a* is rigidly secured to a fixture block **28** to determine the open position of the first contact rod **14**. It is to be noted that the stopper **28***a* is operatively associated only with that the pole of the circuit interrupter including the fixture block, in the illustrated example, with the central pole of the three pole interrupter, while for each of the other poles a protrusion **12***a* is disposed on the internal wall surface of the cover member **12** at its position where all the first contact rods, such as **14** are substantially aligned with each other in their open positions. Further, in order to prevent an excessive rotation of the first contact rod **14** about the axis of the pin **22** in the conuterclockwise direction as viewed in FIGURE 1, by the action of the contact springs **32**, the contract holder **24** is provided at one and near to the associated contact with an abutment **22***a* opposite to the pin **36** and the contact holder **24** is also provided at the other end with an overhang **24***b* for the purpose as will be apparent hereinafter.

The second or lower contact rod **16** is pivotably mounted to a support block **42** by a pivot pin **44** and has a pair of reversing levers **46** disposed in spaced, parallel relationship on both sides thereof. The support block **42** is rigidly secured to the bottom surface of the housing **10**. The reversing levers **46** each are pivotably supported at one end near to the contact **20** on a pivot pin **48** disposed on the support block **42** and are provided on the middle portion with an L-shaped slot **50**. The other ends of the reversing levers **46** are connected together by a pin **52** and a pair of spring shoes **54** loosely engage the pin **52** at both ends (see FIGURE 5). A pin **56** extends through the middle portion of the lower contact rod **16** against movement and has secured at both ends a pair of spring shoes **58** to which a pair of contact springs **60** are anchored respectively. The contact springs **60** have the other ends anchored to the spring shoes **54**. To drive the reversing levers **46**, the second contact rod **16** further comprises a driving pin **62** movably inserted into the slots **50** on the reversing levers **46**.

Like the first contact rod **14**, the second contact rod **16** is operatively associated with a stopper **64** disposed on the support block **42** thereby to prevent an excessive rotation of the second contact rod **16** about the axis of the pin **44** in the clockwise direction as viewed in FIGURE 1.

The second contact rod **16** is electrically connected through a flexible electrically conductor **66** to an electrical conductor **68** adapted to be electrically connected to a source of electrical power (not shown). The first contact rod **14** is electrically connected through a flexible conductor **70**, and a conductor **72** to an intermediate terminal **74** screw-threaded to the housing **10**.

With the second contact rod **16** put in its closed position as shown in FIGURE 1, a straight line passing through both anchoring points where each contact spring **60** is anchored to the respective spring shoes **54** and **58** passes above the axis of the pivot pin **44** for the second contact rod **16** whereby the contact springs **60** tend to rotate the second contact rod **16** about the axis of the pivot pin **44** in the clockwise direction as viewed in FIGURE 1 thereby to maintain that rod under a predetermined pressure under which the second or lower contact **20** is in engagement with the first or upper contact **18**. The said straight line also passes above the axis of the pivot pins **48** for the reversing levers **46** the latter tend to rotate about the axis of the pin **48** in the counterclockwise direction as viewed in FIGURE 1. Thus the first and second contact rods **14** and **16** respectively are firmly maintained in their closed position when the pivot pin **44** is in engagement with the lowest portion of the L-shaped slot **50** formed on the middle portion of each reversing lever **46**.

In summary, the second contact rod **16** tends to be normally rotated about its axis of rotation to have exerted thereon a predetermined contact pressure with respect to the first contact rod **14** by the action of the contact springs **60**. However, upon the occurrence of a shortcircuit current flowing through the circuit interrupter to generate an electromagnetic repulsion between the second contact rod **16** and the first contact rod **14** disposed in substantially parallel thereto, the second contact rod is permitted to be rotated about its axis of rotation in the counterclockwise direction as viewed in FIGURE 1 by the action of the said electromagnetic repulsion until it abuts against the stopper **64**.

An H-shaped reset element **76** of any suitable electrically insulating material (see FIGURE 6) is disposed between the overhang **24***b* of the contact holder **24** and the adjacent end of the second contact rod **16** for the purpose as will be apparent hereinafter. More specifically, the support block **42** has an extension **42***a* obliquely and upwardly directed from the righthand edge (as viewed in FIGURE 1) toward the overhang **24***b* of the contact holder **24** and forming a narrow guide passageway **78** with a ramp surface **10***a* disposed in parallel to the extension **42***a* of the housing **10**. Then the reset element **76** is slidably disposed within the tilted guide passageway **78** in such a manner that a pair of leg portions on one side or the upper side (as viewed in FIGURE 1) of the H forming a recess **76***a* are disposed adjacent the overhang **24***b* on the end of the contact holder **24** while a pair of leg portions on the other side of the H forming recess **76***b* have interposed therebetween that end of the second contact rod **16**. It is noted that the reset element is not physically connected to both the contact holder and the second contact rod.

In order to move the upper contact rod **14** between its closed and normally open or tripped positions and vice versa, the circuit interrupter includes an operating

mechanism generally designated by the reference numeral **80**. The operating mechanism **80** comprises an operating handle **82** movably projecting from the cover member **12**, a switching lever **84** secured at one end to the operating handle **82** and pivotably mounted at the other end on a stationary pin **86** secured to the fixture block **28**, and a pair of toggle link members **88** and **90** articulated by a toggle pin **92**. The mechanism further comprises a pair of tension springs **94** spanned between a spring shoe **84***a* disposed at that end of the switching lever **84** integrally connected to the operating handle **82** and a spring shoe **92***a* loosely engaging the toggle pin **92**. Thus it will be appreciated that the link members **88** and **90**, the toggle pin **92** and the springs **94** from a toggle linkage of the well known construction.

The operating mechanism **80** is operatively coupled to a trip mechanism of the conventional design generally designated by the reference numeral **95**. More specifically the link member **90** engages at **96** to a trip lever **98** pivotably mounted at one end on a stationary pin **100** secured to the fixture block **28** and engaging at the other end a primary hook **102**. Then the primary hook **102** engages a secondary hook **104** extending in a casing **106** of any suitable electrically insulating material.

Disposed within the casing **106** is an overcurrent responsive trip mechanism generally designated by the reference numeral **105**. The mechanism element comprises a bimetallic element **108** adapted to be heated with an excessive current flowing through a main conductor **110** electrically connected to the intermediate terminal **74** and an instantaneously tripping electromagnet assembly **112** inductively coupled to the conductor **110**. The conductor **110** is adapted to be electrically connected to a load (not shown). The remaining components within the casing **106** will be described in conjunction with the description of the operation of the circuit interrupter.

The operation of the arrangement illustrated in FIGURE 1 will now be described.

If the circuit interrupter is desired to be manually moved from its closed position as illustrated in FIGURE 1 to its tripped or normally open position, the operating handle **82** can be thrown to the "OFF" side or in the righthand direction as viewed in FIGURE 1 to cause the constrained state of the two toggle link members **88** and **90** to collapse thereby to permit the pivot pin **22** connecting the first contact rod **14** to the holder **24** to be raised. This causes the first contact **18** to be rotated about the axis of the pin **26** in the clockwise direction as viewed in FIGURE 1 to be separated from the second contact **20** until the interrupter reaches its "OFF" position. The term "clockwise or counter clockwise direction" used hereinafter means one as viewed in the associated figure.

The circuit interrupter thus open can be again closed by throwing the operating handle **82** to the "ON" side or reversely from the turning-OFF operation.

It is now assumed that a normal overcurrent flows through the interrupter in its closed position. Under these assumed conditions, that current flows through the conductor **110** to heat it whereby the bimetallic element **108** is deflect to push against a trip adjusting screw **114** facing the same. This causes a trip shaft **116** to be rotated in the clockwise direction to disengage the catch **118** secured to the trip shaft **116** from the secondary hook **104** followed by clockwise rotational movement of the secondary and primary hooks **104** and **102**. This causes the primary hook **102** to disengage the trip lever **98**. Therefore the constrained state of the two toggle link members **88** and **90** collapses to permit the contact holder member **24** to be rotated about the axis of the pin **26** in the clockwise direction. This rotation of the holder **24** is accompanied by rotational movement of the first contact rod **14** in the same direction as the holder whereby the contact **18** is moved away from the contact **20** resulting in an interruption of the associated circuit.

If an overcurrent having a magnitude equal to 5 to 10 times the rating current for the interrupter flows through the latter, the electromagnetic assembly **112** is operated to cause the associated trip rod **120** to rotate the trip shaft **116** in the clockwise direction. Therefore the process as above described is repeated to interrupt the associated circuit.

In the operation of manually opening the interrupter or of tripping it in response to the bimetallic element or the electromagnet assembly as above described it is noted that the contact springs **60** permit the second contact rod **16** only to follow the first contact rod **14** by a very short angular distance sufficient to engage the other end of the contact rod **16** with the associated stopper **64**. Therefore the second contact rod **16** will remain in its position substantially identical to that illustrated in FIGURE 1.

It is now assumed that an extraordinarily high current such as a shortcircuit current flows the circuit interrupter. Under these assumed conditions it will be appreciated that such a current flows through the first and second contact rods **14** and **16** disposed in substantially parallel relationship, in the opposite directions as shown at the arrows in FIGURE 1 to generate a strong electromagnetic repulsion between both rods. This causes the contact rods **14** and **16** to be instantaneously and simultaneously rotated in the opposite directions resulting in an interruption of the shortcircuit current. It is to be noted that this interrupting operation is performed independently of the overcurrent responsive trip mechanism **105**. In other words, the holder **24** for holding the first contact rod **14** is maintained in its closed position by means of the operating mechanism **80** whereas the first contact rod **14** is rotated about the axis of the pin **22** in the clockwise direction by the action of the electromagnetic repulsion until the line of action of the contact springs **32** passes upwardly through the pin **22** whereupon its force is reversed in direction. This permits the first contact rod **14** to be rotated and maintained in its open position as shown in FIGURE 3 where the rod abuts at one end against the stopper **12***a*. Simultaneously with the initiation of rotation of the first contact rod **14** as above described, the second contact rod **16** also begins to be rotated about the axis of the pin **44** in the opposite or counterclockwise direction by the action of the electromagnetic repulsion as shown in FIGURE 2. During this rotational movement of the second contact rod **16**, the axis of the spring pin **56** has been moved from a position A to B as shown in FIGURE 2 whereupon the contact spring **60** has the line of action coinciding with a line passing through the position B and A′ of the axis of the spring pins **56** and **48**. At the instant that line of the action of the spring **60** has passed downwardly through the axis of the pin **48** for the reversing lever **46** the reversing levers **46** tend to begin to be rotated about the axis of the pin **48** in the clockwise direction. However, a friction around the pin **48** is effective for still holding the spring pin **52** at the position A′.

As the second contact rod **16** is further rotated, the axis of the spring pin **56** reaches a position C whereupon the driving pin **62** secured to the second contact rod **16** to drive the reversing levers **46** abuts against the lower edge of the L-shaped slots **50** on the levers to depress them in the clockwise direction. A further rotation of the second contact rod **16** causes the reversing levers **46** to begin to be abruptly rotated in the clockwise direction. As the spring pin **52** for the reversing lever **46** approaches a position D′ as shown in FIGURE 3 from the position A′ the line of action of the contact spring **60** rapidly becomes close to the pivot pin **44** for the second contact rod **16** thereby to rapidly decrease the clockwise torque on that contact rod **16** due to the springs **60**. This is very effective for decreasing a force opposing the electromagnetic repulsion exerted on the first and second contact rods.

Then the spring pin **56** for the second contact rod **16** passes through a position G (see FIGURE 3) to a posi-

tion D while the line of action of the contact spring **60** is moved below the pin **44**. Therefore the contact spring **60** exerts on the second contact rod **16** a force tending to rotate it in the counterclockwise direction which force then cooperates with the electromagnetic repulsion as previously described to rapidly move the second contact rod **16** to its position as illustrated in FIGURE 3 resulting in an interruption of the associated circuit.

On the other hand, the spring pin **56** is moved from a position H to a position G as shown in FIGURE 3 while its line of action is moved below the pin **48** whereby the reversing levers **46** are rotated in the clockwise direction about the axis of the pin **48** until it stops at its position as illustrated in the same figure at which the pin **44** engages the upper edge of the L-shaped slot **50** on each lever **46**.

After the first and second contact rods have performed an automatic interruption operation in the manner as above described, the overcurrent responsive trip mechanism **105** is adapted to be operated with a very small time delay.

As previously described, the operation of the overcurrent responsive trip mechanism **105** is accompanied by collapse of the constrained state of the operating mechanism **80** to cause the toggle link members **88** and **90** to raise the pin **22**. This permits the holder **24** to rotate about the axis of the pin **26** in the clockwise direction (FIGURE 1). At the same time the first contact rod **14** is rotated in the counterclockwise direction about that point thereon contacting with the stopper **28** or the protrusion **12***a* as the case may be. During this rotational movement, the line of action of the contact spring **32** passes downwardly through the pin **22** after which the first contact rod **14** is downwardly rotated about the axis of the pin **22** and with respect to the holder **24** until the rod returns to its normally open or tripped position as shown in FIGURE 4.

The clockwise rotational movement of the holder **24** about the axis of the pin **26** due to the operation of the toggle link members **88** and **90** is also accompanied by the overhang or striker **24***b* on the other end thereof striking against an adjacent end **16***a* of the second contact rod **16** through the reset element **76**. This causes the second contact rod **16** to be rotated about the axis of the pin **44** in the clockwise direction thereby to move the spring pin **56** for the second contact rod from the position D (see FIGURE 3) past a position H whereupon the line of action of the contact springs **60** passes through the axis of the pin **44** to cause the springs **60** to reversely exert its force on the second contact rod **16**. This permits the second contact rod **16** to return to its position as illustrated in FIGURE 4 which position coincides with its closed position.

During this returning movement of the second contact rod **16**, the spring pin **56** reaches the position H (see FIGURE 4) to pass the line of action of the springs **60** through the axis of the pin **48**. Substantially simultaneously with this passage, the driving pin **62** abuts against the upper edge of the L-shaped slots **50** to raise the reversing levers **46**. This causes the reversing levers **46** to rotate in the counterclockwise direction thereby to return the spring pin **52** to a position A′ to bring the line of action of the springs **60** on the line A–A′ until the second contact rod **116** is stopped in its tripped position as illustrated in FIGURE 4.

Therefore the succeeding closing operation can be performed in the conventional manner. Namely the operating handle **82** can be manually thrown to the "OFF" side to reset the interrupter. Then the handle **82** will be manually brought into the "ON" position to perform the closing operation.

From the foregoing it will be appreciated that while the present interrupter is of the one point interruption type the first and second contact rods can be separated from each other by a distance larger than the normal separating distance therebetween upon the occurrence of an extraordinarily excessive current such as a shortcircuit current. This establishes a sufficient interruption distance to improve the current limiting effect as in the two point interruption type of circuit interrupters. In addition, after the current limiting effect has been exhibited, the first and second contact rods are automatically and substantially simultaneously brought into their normally open or tripped positions, whereby the circuit interrupter is ready for the succeeding closing operation. This contributes to great improvements in performances of the circuit interrupters utilizing an electromagnetic repulsion.

That end **24***b* of the holder **24** remote from the contact **18** overhangs the reset element **76** to impart to the latter a stroke sufficient to return the second contact rod **16** to its closed position. Also the reset element **76** is held separated from the contact rods **14** and **16** and/or holder **24** so as to effectively utilize an impulse due to the trip operation to return the second contact rod to its closed position and still be protected from damaging due to such an impulse. On the contrary, the conventional type of circuit interrupter having a reset element physically connected between a first contact rod or its holder and a second contact rod was disadvantageous in that any impulse due to a trip operation could damage the connection of the reset element and either of the contact rod or its holder as well as complicating the assembling operation.

In order to smoothly and efficiently operate the reset element, the striker **24***b* and the struck surface of the second moved contact rod **16** are required to be disposed substantially normally to the plane of the reset element **76**. With the reset element disposed obliquely to the general bottom surface of the housing, the guide passageway for the reset element must be formed in a complicated manner because the direction of the passageway does not coincide with the standard direction in which the resulting part is removed.

According to the invention, however, the reset element **76** is slidably held within the guide passageway **78** confined by the tilted wall surface **10***a* of the housing **10** and the extension **42***a* bent from the support block **42** thereby to be separated from the contact rods and the holder. Therefore the assembling operation is easily performed and the molding process is simplified. Also one wall of the passageway is composed of the extension of the support block **42** resulting in a small sized circuit interrupter.

Further it will be understood that the second contact rod **16** is given a moment of force equal to the product of a force $f$ provided by the contact springs **60**, multiplied by a length of a perpendicular $l$ drawn from the axis of the rotation **44** to the line of action of the contact springs **60**. By properly selecting the magnitudes of both the force $f$ and the perpendicular $l$, the contact rod has applied thereto the requested contact pressure. As shown in FIGURE 2, an electromagnetic repulsion causes rotational movement of the second contact rod **16** to transfer the line of action of the springs **60** from line A–A′ to B–B′. This prevents the reversing levers **46** from being given the moment of force provided by the contact springs **60**. Under these circumstances, a force necessary to start the reversing levers **46** need only be friction around the spring pin **48**. In other words, the electromagnetic repulsion exerted on the second contact rod **16** has only a very small portion necessary to rotate the reversing levers **46**.

Upon the line of action of the contact springs **60** coinciding with line C–A′, the reversing levers **46** begin to be rotated about the axis of the pin **48** in the clockwise direction to move the spring shoes **54** toward the position D′. This causes arapid decrease in the perpendicular $l$ drawn from the axis of rotation **44** to the line of action of the springs **60**. Therefore the contact pressure on the second contact rod **16** serving as a moment of rotation in the clockwise direction also rapidly decreases with the result that the second contact rod **16** is easily moved to its open position.

Accordingly, rotational movement of the second contact rod **16** due to the corresponding electromagnetic repulsion is accompanied by the force of the spring **60** for the levers **46** being reversely directed. This causes rotational movement of the reversing levers **46** to displace the spring pin **52** from the position A' to the position D'. Therefore as the second contact rod **16** is rotated to pass the line of action of the contact springs **60** through line C–A' a force exerted in the clockwise direction on the contact rod **16** by the springs is suddenly reversed in direction with the result that the contact rod **16** is stably maintained in its open position. Thus a sufficient contact pressure is applied to the second contact rod **16** in the normal contact state and also electromagnetic repulsion exerted on the same rod can be effectively utilized to perform an opening operation.

If a position A' anchoring a contact spring is fixed as in the conventional type of circuit interrupters the force of the contact springs **60** begins to be reversed in direction when the spring pin **56** reaches a position E' as shown in FIGURE 4. Therefore, in order to ensure that such a force is reversed in direction, the second contact rod **16** should be rotated to a position E and the moment of force by the springs for the contact rod operating during the electromagnetic repulsion is difficult to attenuate. Also the angle through which the second contact rod can be rotated is required to be large. This causes an increase in depth of the housing **10** and hence in outside the dimension thereof.

Further if the contact spring **60** has one point initially fixed at the point D' shown in FIGURE 3, the same has the line of action coinciding with the line A–D', this causes a decrease in the length of the perpendicular *e* drawn from the axis of rotation **44** to the said line of action with the result that a sufficient moment of force supplying a contact pressure on the second contact rod **16** can not be produced. If the line of action of the contact spring **60** is desired to be reversed in direction at the position D' while a sufficient contact pressure is exerted on the second contact rod **16**, the anchor point where the spring **60** is anchored should extend to a position F while at the same time the spring and contact rods **60** and **16** respectively increase in length. This not only makes contact assembly large-sized but also the moment of force or the contact pressure can not rapidly decrease after the passage through the position C'.

Thus it will be appreciated that the invention also quite effective for rendering the circuit interrupter small sized.

While the invention has been illustrated and described in conjunction with a single preferred embodiment thereof it is to be understood that various changes in the details of construction and the arrangement and combination of parts may be resorted to without departing from the spirit and scope of the invention.

What we claim is:

**1.** A circuit interrupter comprising a pair of movable contact rods disposed in substantially parallel relationship in the closed position of the interrupter, each of said contact rods being provided at one end with a contact and pivotally mounted at the other end on a pivot pin, an operating mechanism for switching one of said movable contact rods between its closed and open positions, thermally and electromagnetically responsive trip means operatively coupled to said operating mechanism, and said contact rods providing a flow of extraordinary excessive current through the interrupter for generating an electromagnetic repulsion between said pairs of movable contact rods to rotate the other contact rod independently of said trip means thereby to interrupt the current, the other contact rod when rotated being held in its open position, a pivotable holder on which said one of movable contact rods is pivotably mounted, said holder being provided on that end thereof remote from the associated contact with an overhand, and a reset element of electrically insulating material being movably disposed in spaced relationship between said overhand on said holder and the adjacent end of the other movable contact rod, whereby slightly after said other contact rod has been separated from said one contact rod, said trip means perform the tripping operation to cause said operating mechanism to rotate said holder to cause said overhang to strike against the reset element which in turn strikes the end of the other contact rod thereby to return the other contact rod to its initial position.

**2.** A circuit interrupter as claimed in claim **1** in which a housing is provided for said interrupter having a tilted wall surface therein, and a support block in said housing for movably supporting the other contact rod, said support block being spaced from said tilted wall surface of the housing to define a guide passageway, and said reset element being slidably disposed in said guide passageway.

**3.** A circuit interrupter as claimed in claim **1** in which said other contact rod includes a pivotable reversing lever having a pin thereon and spring means extending from said other contact rod to said pin, the reversing lever being movably mounted on said other contact rod for being moved as said other contact rod is rotated by the electromagnetic repulsion for displacing said pin in a direction to effect early decrease in and reversal of the force applied to the rod by said spring means.

**4.** A circuit interrupter comprising a pair of movable contact rods disposed in substantially parallel relationship in the closed position of the interrupter, each of said contact rods being provided at one end with a contact and pivotably mounted at the other end on a pivot pin, an operating mechanism for switching one of said movable contact rods between its closed and open positions, thermally and electromagnetically trip means operatively coupled to said operating mechanism, and said contact rods providing a flow of extraordinarily excessive current through the interrupter for generating an electromagnetic repulsion between said pair of movable contact rods to rotate said movable contact rods in the opposite directions independently of said trip means to interrupt the current, said pair of contact rods when rotated being held in their open positions, a pivotable holder on which said one of movable contact rods is pivotably mounted, said holder being provided on that end thereof remote from the associated contact with an overhand, and a reset element of electrically insulating material being movably disposed in spaced relationship between said overhang on said holder and the adjacent end of the other movable contact rod, whereby slightly after said contact rods have been separated from each other, said trip means perform the tripping operation to cause said operating mechanism to rotate said holder to cause said overhang to strike against the reset element which in turn strikes the end of the other contact rod thereby to return the other contact rod to its initial position as well as bringing the one contact rod into its normally open position.

**5.** A circuit interrupter as claimed in claim **4**, wherein a stop is provided on said circuit interrupter for limiting rotational movement of said one contact rod due to the electromagnetic repulsion and responds to the collapse of the constrained state of said operating mechanism to push said one contact rod in a direction opposite to the direction of rotation of the rod due to the electromagnetic repulsion, and spring means associated with said one contact rod and said holder, the push by said stop causing said associated spring means to pass through its dead point to bring said one contact rod into tis tripped position.

**6.** A circuit interrupter as claimed in claim **4** in which a housing is provided for said interrupter having a tilted wall surface therein, and a support block in said housing for movably supporting the other contact rod, said support block being spaced from said tilted wall surface of

the housing to define a guide passageway, and said reset element being slidably disposed in said guide passageway.

7. A circuit interrupter as claimed in claim 4 in which said other contact rod includes a pivotable reversing lever having a pin thereon and spring means extending from said other contact rod to said pin, the reversing lever being movably mounted on said other contact rod for being moved as said other contact rod is rotated by the electromagnetic repulsion for displacing said pin in a direction to effect early decrease in and reversal of the force applied to the rod by said spring means.



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BERARD A. GILHEANY, Primary Examiner

H. BROOME, Assistant Examiner