Jan. 23, 1968 TEIZO FUJITA 3,365,682

HAND RESETTABLE TRIP-FREE ELECTRIC CIRCUIT BREAKER

Filed Aug. 31, 1965

FIG. 1

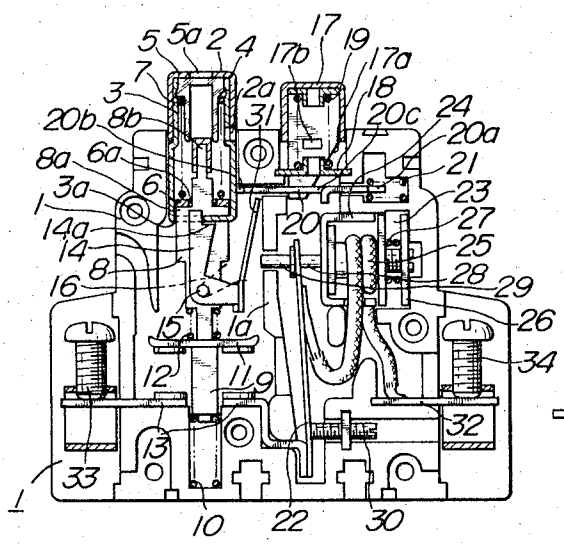


FIG. 2

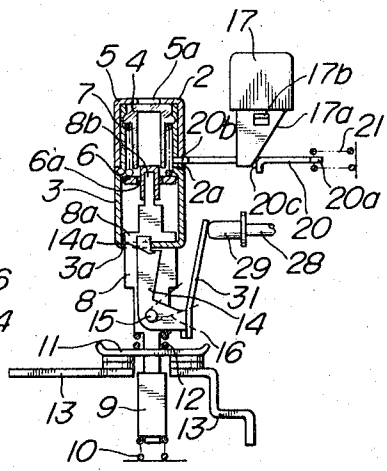
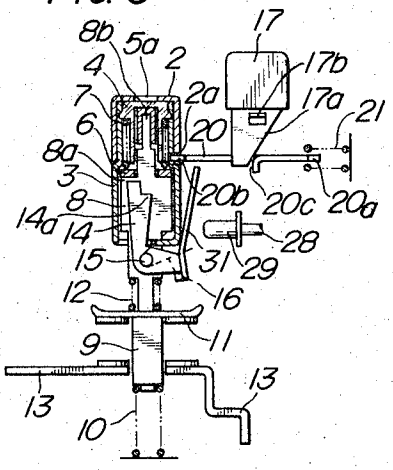


FIG. 3



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HAND RESETTABLE TRIP-FREE ELECTRIC CIRCUIT BREAKER

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ABSTRACT OF THE DISCLOSURE

A hand resettable miniature sized electric circuit breaker which is constructed to provide a trip-free mechanism compatible with an included indicating mechanism for visually signalling tripping. The tripping apparatus is designed to be operated when overcurrents of several times rated current are encountered by a bimetallic strip and to be operated by an electromagnetic coil when excessive currents, for example over ten times rated current flows through the coil. A push-button receives an operating plate which is adapted to be collapsed therein by tripping operation, which disengages the operating plate from the push button. A second push-button is provided with a slide to lock the first push-button and to release same for resetting.

This invention relates to circuit breakers and more particularly to those which are compact and extremely limited in size.

In general, circuit breakers are required to operate to open the circuit with a more or less time delay under overcurrents of up to several times the magnitude of the rated current of the breaker and instantaneously under excessive currents of more than ten times the magnitude. Also, it is desirable for circuit breakers to function with time delay characteristics corresponding to the higher circuit requirements or under a predetermined voltage, frequency or other circuit condition, and further to function under a predetermined current magnitude instantaneously to interrupt the circuit with no time-delay characteristics.

Ordinarily, these interrupting functions have been accomplished by use of a heat-responsive or electromagnetic tripping mechanism. With such circuit breakers, however, attention must be paid to the fact that circuit troubles do not always take place when the circuit is in closed state and that unusual currents are rather caused at the time when the breaker is initially closed. In view of this, circuit breakers should be constructed "trip-free," as commonly called, or they should be able to interrupt the circuit even at the instant when they are closed, that is, when the operator's hand is still in position closing the breaker.

Also, it is desirable that after the tripping mechanism has operated the tripped state of the circuit breaker can be confirmed exteriorly and that the breaker cannot be reclosed before the entire breaker assembly is reset.

The present invention has for its object to provide a novel circuit breaker which is structurally very compact, and trip-free including a tripping mechanism capable of both instantaneous and time delayed tripping operations and which can be reclosed only after the entire breaker assembly has been reset.

Another object of the present invention is to provide a circuit breaker including a novel trip-free mechanism which allows tripping operation even when the closing pusher member is held in closing position.

A further object of the present invention is to provide a circuit breaker including an operation-indicating device which can indicate the tripped state of the breaker clearly and without fail.

With conventional circuit breakers, operation of the tripping element responding to an overcurrent is transmitted to the movable contacting member only through a holding mechanism including a dead-center link and other interengaging members to open the breaker contacts. This means that there has been a considerable time lapse between the operation of the tripping element and the contact-opening motion of the movable contacting member because of the manufacturing allowances and errors of the associated parts. In contrast, the tripping mechanism of the present invention is instantaneously operable or has a very limited responding time for tripping operation since the tripping motion of the tripping element in the present mechanism is directly associated with the contact-opening movement of the movable contacting member.

Also, according to the present invention, the tripping element of the tripping mechanism is arranged so as to make displacement conforming to the vertical movement of the pusher member and, unlike conventional mechanisms, no inclination or tilt is required of the tripping element for holding engagement. This apparently eliminates any unpredictable mechanical strain otherwise occurring in the mechanism during its engaging or disengaging operation.

With conventional circuit breakers, indication of the tripping operation has been made, for example, by displacement of the operating lever or its assuming a position slightly displaced from its positions assumed before and after its closing operation. With such an indicating device, however, it is rather difficult to confirm the tripping operation and no indication can be given as long as the operating lever is held in closing position. Another example of indicating devices, previously used are those operatively associated with the tripping mechanism so as to make the indication sidewise of the breaker casing. This recent form of indicating device, however, involves the danger that it may lack reliability due to any trouble possibly occurring in the operative connections between the tripping mechanism and the movable contacting member.

According to the present invention, an indicating rod is provided which is movable within the closing push member to approach its top surface so that the tripping operation may be confirmed exteriorly with ease and such indicating rod is directly associated with the movable contacting member to make the indication clear and positive.

The circuit breaker according to the present invention is also advantageous in that it can be made compact in size with a minimized number of component members required, employing a simplified tripping mechanism and an effective operation indicating device.

The above and other objects, features and advantages of the present invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, which illustrate a preferred embodiment of the invention by way of example only and not of limitation and in which like reference numerals indicate like parts having the same functions throughout the several figures. In the drawings:

FIGS. 1 to 3 illustrate a preferred embodiment of the invention, representing a front view, partly in section, of the embodiment in its open, closed and tripped conditions, respectively.

Referring to FIGS. 1 to 3, the embodiment shown includes a casing 1 carrying a closing push-button 2, which takes the form of a frame structure including a U-shaped engaging section 3, a transparent section 4 carried in the reduced top portion thereof and a covering cap 5 fitted over the latter to enclose the transparent section 4. An abutment plate 6, fixed to the casing 1,

is arranged in the push-button structure with compression spring 7 interposed between the plate and the push-button 2 to bias the latter upwardly. An operating plate 8 is connected with a movable-contact support member 9, which rests on a spring 10 anchored at the bottom to the casing 1. Thus, the operating plate 8, having its top shouldered as at 8*a*, is normally biased upwardly into pressure engagement with the abutment plate 6.

The operating plate 8 has an upward extension forming an indicating rod 8*b*, which extends loosely through an aperture 6*a* formed in the abutment plate 6 centrally thereof and is extensible into the transparent section 4 of the push-button 2 so as to be observable through a viewing aperture or window 5*a*, formed in the top center of the cap 5.

A movable contacting member 11 is supported on the support member 9 by way of a compression spring 12 arranged thereon and is positioned opposite to a fixed contacting member 13, which is, in fact, comprised of two spaced contact elements arranged so as to be bridged by the movable contacting member 11 when the latter is lowered by the closing operation of the push-button 2.

A tripping element 14 is pivoted at the bottom on a pivot stud 15, fixed to the bottom portion of the operating plate 8, and is normally biased clockwise by spring means 16. The engaging section 3 of the closing push-button 2 is formed in its bottom wall with a through aperture 3*a* which is so defined as to allow the upwardly extending main portion of the tripping element 14 and the operating plate 8 to pass loosely therethrough. The tripping element 14 is shouldered at its top on the right-hand side thereof, as indicated at 14*a*, to normally engage the adjacent edge of the through aperture 3*a* in the bottom of the engaging section 3 under the bias of the spring 16.

An opening push-button 17 is supported resiliently by a compression spring 19, which is arranged on another abutment plate 18 fixed to the casing 1, and is, bevelled at the bottom as indicated at 17*a*.

A movable plate 20 is mounted horizontally in the casing 1 for free horizontal sliding movement with a compression spring 21 arranged to bias the movable plate to the left, as viewed in FIG. 2 of the drawing so that the left-hand end of the plate is normally held in pressure contact with the lower portion of the closing push-button 2. The side wall of the push-button 2 adjacent to the movable plate 20 is formed in its upper portion with a transverse aperture 2*a* and when the push-button 2 is depressed the left-hand end 20*b* of the movable plate 20 is allowed to fit in the transverse aperture 2*a* to hold the push-button 2 in its lower position. The movable plate 20 has a slot 20*c* formed intermediate its ends to allow the opening push-button 17 to descend with its bevelled bottom 17*a* acting to move the movable plate to the right as viewed in the drawing.

Reference numeral 22 (FIG. 1) indicates a bimetal strip for overcurrent protection; and 23 an electromagnet for protection against excessive current magnitudes, which includes a fixed iron core 24, an exciting coil 25 and a movable iron core 25 supported by a coiled spring 27. Threadably secured to the movable iron core 26 is a horizontal plunger or actuator rod 28 which is axially movable and, having a threaded right-hand end portion formed with a slit to receive an appropriate screw driver, is adjustable in axial position. The left-hand end portion of the actuator rod 28 extends freely through the free top end of the bimetal strip 22 and is loosely fitted with a cap 29, which extends loosely through a partition wall 1*a*, fixed to the casing 1, toward a temperature compensating bimetal strip 31 secured to the end of a laterally extending arm of the tripping element 14. The temperature correction bimetal strip 31 is arranged so that its top free end approaches the cap 29 on the actuator rod 28 when the closing push-button 2 is depressed.

Reference numeral 32 indicates a terminal plate; 33 and 34 terminal screws; and 30 a screw for adjusting the bimetal strip 22. The opening push-button 17 has cutout lugs 17*b* on its opposite side walls, which lugs are in sliding engagement with elongated slots formed vertically in respective portions of the casing 1. It is to be understood that the closing push-button 2 is also provided with a similar guiding structure, though not shown in the drawing.

In operation of the circuit breaker, when the closing push-button 2 in its normal position shown in FIG. 1 is depressed against the bias of spring 7, the engaging section 3 of the push-button 2 descends while maintaining engagement with the tripping element 14 and thus the operating plate 8 to which the tripping element is pivoted is lowered together with the support member 9 against the bias of the spring 10 until the movable contacting member 11 is brought into bridging engagement with the fixed contacting member 13. At the same time, the transverse aperture 2*a* formed in the right-hand side wall of the closing push-button 2 comes into alignment with the left-hand end 20*b* of the movable plate 20 to receive the latter. In this manner, the push-button 2 is held in its depressed position, as shown in FIG. 2, forming a closed circuit including terminal 33, fixed and movable contacting members 13 and 11, bimetal strip 22, exciting coil 25 and terminal 34. As seen in FIG. 2, the indicating rod 8*b* is lowered together with the push-button 2 and the top free end of the bimetal strip 31 is positioned opposite to the left-hand end of the cap 29, projecting through the partition wall 1*a*.

Let it be assumed that an overcurrent of up to several times the magnitude of the rated current flow through the circuit is encountered. Then the bimetal strip 22 bends to the left as viewed in the drawing so that its top end acts to press the cap 29 against the top free end of the bimetal strip 31. The tripping element 14 carrying the bimetal strip 31 is thus turned counterclockwise about the pivot 15 against the bias of spring 16 so that the shoulder 14*a* formed at the top end of the element 14 is disengaged from the adjacent edge of the bottom aperture 3*a* formed in the engaging section 3 of the closing push-button 2.

Consequently, the tripping element 14 is allowed to rise together with the operating plate 8 into the push-button 2 through the bottom aperture 3*a* under the bias of spring 10, which urges the operating plate 8 upwardly by way of the support member 9, until the shouldered top portion 8*a* of the operating plate 8 comes into engagement with the abutment plate 6, as shown in FIG. 3. In this manner, the movable contacting member 11, supported on the support member 9 is disengaged from the fixed contacting member 13 to open the circuit and the indicating rod 8*b*, rising through the abutment plate 6 into the transparent section 4 of the closing push-button, now held in its depressed position, is brought close to the top surface of the push-button 2, enabling the attendant to visually confirm the completion of the tripping operation through the central aperture or window 5*a* formed in the button cap 5.

Assume next that under the closed condition shown in FIG. 2 an excessive current of more than ten times the magnitude of the rated current takes place. Then the electromagnet 23 for protection against excessive current magnitudes is operated. Namely, the exciting coil 25 is energized to draw the movable iron core 26 to the left (FIG. 1) against the bias of spring 27 so that the actuator rod 28 acts through the cap 29 thereon to turn the bimetal strip 31 counterclockwise against the bias of spring 16. The operation of the tripping mechanism caused by the leftward movement of the actuator rod 28 is similar to that initiated by the bimetal strip 22. That is, the circuit is opened while maintaining the closing push-button 2 in its depressed or closed position and the completion of the tripping operation is indicated through the top aper-

ture 5*a* in the push-button. Under this tripped condition, it is to be noted that the circuit cannot be reclosed by depression of the closing push-button, which is now held in its closing position.

For reclosing the circuit, the opening push-button 17 is depressed so that the movable plate 20 is moved to the right as viewed in the drawing by the bevelled bottom 17*a* of the push-button against the bias of spring 21. The left-hand end 20*b* of the movable plate 20 is thus disengaged from the transverse aperture 2*a* formed in the closing push-button 2 to allow the latter to be restored to its upper or normal position under the bias of spring 7. On this occasion, when the bottom aperture 3*a* in the engaging section 3 of the closing push-button 2 is brought into alignment with the top shoulder 14*a* of the tripping element 14, the engaging section 3 of the push-button 2 is engaged by the shoulder 14*a* of the tripping element 14, which is biased clockwise by the spring 16. Thus, the entire assembly is reset to the normal position shown in FIG. 1, allowing the closing push-button 2 to be depressed to reclose the circuit.

While the invention has been shown in several forms, it is obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit and scope of the claimed invention.

What is claimed is:

1. An electric circuit breaker comprising a push member, an engaging frame member provided on said push member, an operating plate having an indicating member and adapted to be collapsed into said engaging frame member, a support member for the indicating member, a movable contact member and an opposed fixed contact member with the movable contact member being adapted

to be urged into contact with the fixed contact member, a tripping element adapted to engage and disengage said operating plate with and from said engaging frame member, overcurrent detecting means for operating the tripping element whereby the circuit breaker performs switching operation, under normal condition, with said push member coupled in abutment with said support member by means of said tripping element, and performs circuit-breaking operation, upon detection of an overcurrent, with said operating plate collaped into said engaging frame member by means of tripping operation of said tripping element, thereby causing said indicating member to approach the surface of said push member to indicate the tripping operation; a further push member, a movable slide plate for movement by said further push member, said slide plate having a transverse opening and said further push member having a camming surface to move the slide member via the transverse opening, said first mentioned push member having an opening adapted to receive an end of the slide plate in one position and biasing means maintaining the engagement of the slide and first mentioned push member until reset by movement of the second push member.

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