July 5, 1949. W. L. BUTLER 2,475,308

CIRCUIT BREAKER

Filed Nov. 15, 1946 2 Sheets-Sheet 1

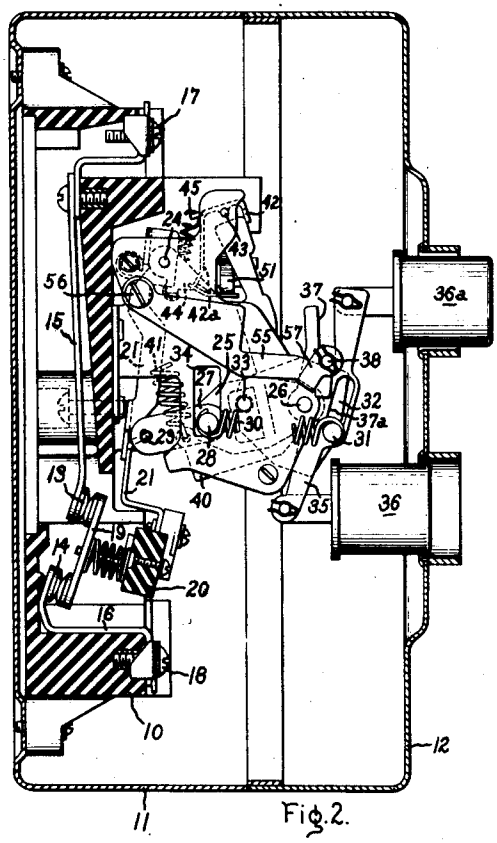


Fig. 2.

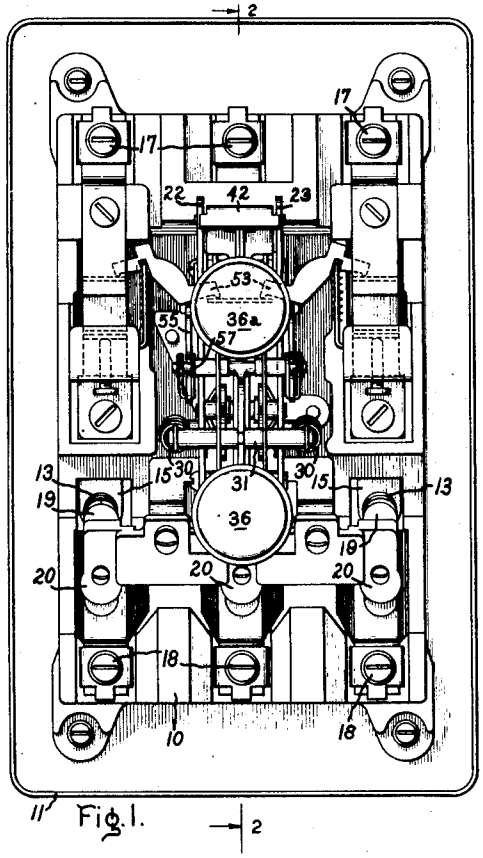


Fig. 1.

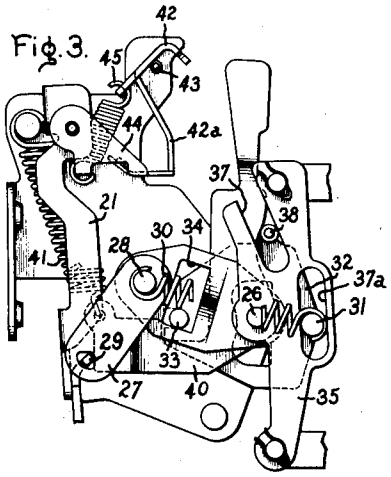


Fig. 3.

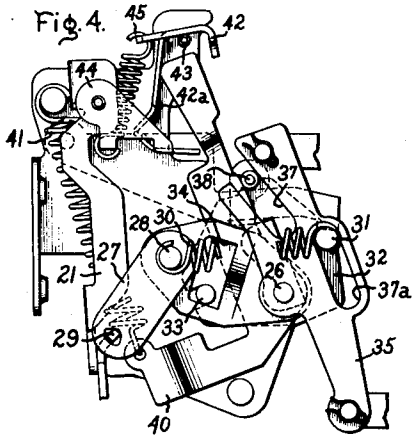


Fig. 4.

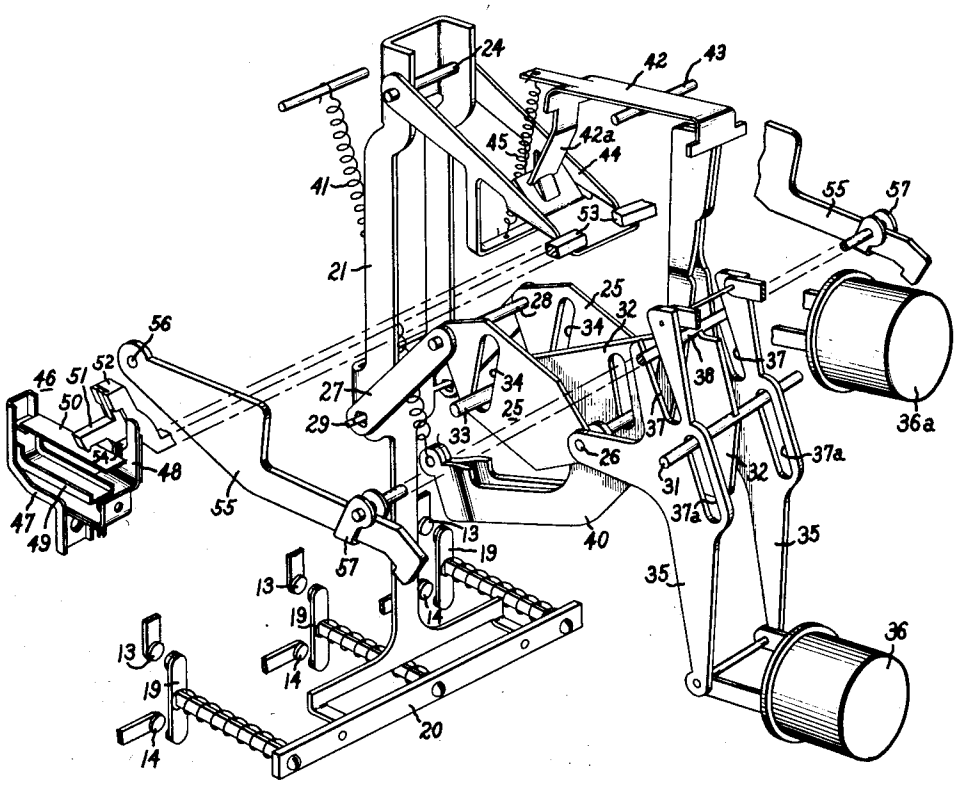
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Fig. 5.



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2,475,308

CIRCUIT BREAKER

William Lawrence Butler, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application November 15, 1946, Serial No. 710,138

1 Claim. (Cl. 74—100)

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My invention relates to circuit breakers, and more particularly to new and improved manually operable current responsively tripped circuit breakers of the type described in my Patent 2,230,713, issued February 4, 1941.

It is a general object of my invention to provide a new and improved circuit breaker of the above type which is trip-free in its automatic operation and which is durable, dependable and inexpensive to manufacture.

It is a further object of my invention to provide a new and improved push button operating mechanism for a circuit breaker actuating linkage.

It is still another object of my invention to provide a new and improved reset means for an over-center current responsive tripping mechanism when used in conjunction with the circuit breaker of the foregoing description.

My invention is especially useful in manually operable current responsively tripped circuit breakers used for the connection of the small motors directly across a supply source without a starting resistor. These devices are of small physical dimensions and at the present time are used with motors up to 7½ horsepower.

For a more complete understanding of my invention and a further appreciation of its various objects and advantages reference should now be had to the following detailed specification taken in conjunction with the accompanying drawings, in which Fig. 1 is a front view of a three-phase motor starting switch embodying my invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows and showing the operating mechanism in its "on" position; Fig. 3 is a side elevational view of the operating mechanism with one of the lateral supporting plates removed to show the mechanism in its automatic "trip" position; Fig. 4 is a view similar to Fig. 3 showing the operating mechanism in its "reset" position; and Fig. 5 is an exploded perspective view of the switch mechanism with various parts broken away and showing the mechanism in its manual "off" position.

Referring now to the drawings, my invention in the form shown comprises a circuit breaker mechanism mounted upon a base 10 made of any suitable electric insulating material, such as a suitable molded insulating compound, the base 10 serving as a support both for the switch contacts and for a switch actuating and releasing mechanism. The base 10 along with the mechanism mounted thereon is mounted in an enclosing casing 11 having a cover 12. The base 10

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has an irregular shape determined by convenience in supporting the various parts of the device.

By way of illustration I have shown my invention as applied to a three pole or three circuit motor starter, such as might be used with a three-phase motor. As best illustrated in Figs. 1, 2 and 5, each of the three circuits comprises a pair of fixed contacts 13 and 14 connected by suitable conductors to terminals 17 and 18, respectively, at opposite ends of the base 10. In the center circuit (Fig. 2) the contact 13 and terminal 17 are directly connected by a conductor 15. In each outside circuit there is included a series heater for the current responsive tripping mechanism, as in my prior Patent 2,230,713. Each contact 14 is connected to the associated terminal 18 by a conductor 16.

Each pair of fixed contacts 13 and 14 is arranged to be connected together by a movable bridging contact 19. The three bridging contacts 19 are mounted upon a common insulating cross arm 20 which is carried at the end of a pivoted lever 21. The pivoted lever, or switch member, 21 is part of a switch actuating mechanism which is mounted between two metallic supporting plates 22 and 23 which extend upwardly in parallel spaced relation from the base 10 substantially in alignment with the center phase of the breaker. The switch member 21 is mounted at one end on a fixed pivot 24 carried by the supporting plates 22 and 23. The pivoted lever 21 is formed of two parallel side rails spaced apart and connected together for rigidity by channel-shaped sections, the unsupported end of the lever being provided with an extension carrying the movable cross arm 20.

The switch member or lever 21 is arranged to be moved between circuit opening and circuit closing positions by a toggle mechanism which comprises a pair of links 25 pivotally mounted at one end upon a fixed pivot 26 carried by the supporting plates 22 and 23, and a pair of links 27 pivotally connected in parallel spaced relation to the ends of the links 25, as by a pin 28. The links 27 are pivotally connected at their opposite ends to an intermediate point of the switch lever 21, as by projections 29 on the lever 21. As best shown at Figs. 2, 3 and 4, a pair of over-center toggle springs 30 is connected between the outer ends of the pin 28 and a pin 31 which is movable manually over-center with respect to the fixed pivot pin 26.

The manually movable pin 31 to which one end of each over-center spring 30 is connected is carried upon a pivoted actuating plate or lever 32.

The lever 32 is centrally positioned between the pivoted links 25 and is pivotally mounted upon a fixed pivot 33 carried by the supporting plates 22 and 23. To permit movement of the pivoted links 25 without interference by the fixed pivot pin 33, the links 25 are slotted, as at 34, and the pin 33 passes through the slots.

In order to move the actuating plate 32 upon its pivot 33 and thus to move the line of action of the toggle springs 30 over-center with respect to the fixed pivot 26 for manual opening and closing operation of the breaker contacts, I provide a push button linkage comprising a pair of rocker arms 35 pivotally mounted in parallel spaced relation upon the fixed pivot pin 26 and connected at opposite ends to a pair of reciprocable push buttons 36 and 36a. The push buttons 36 and 36a extend through suitable apertures in the cover 12 of the metal enclosure 11. The movable end of the actuating plate 32 is coupled to the rocker arms 35 for movement by camming action as the rocker arms are oscillated by the push buttons. For this purpose the rocker arms 35 are provided at one end with open ended slots 37 into which extends a transverse pin 38 fixed upon one side of the actuating plate 32. The slots 37 are generally tangent to a circle having its center at the fixed pivot 33, and camming action between the slots 37 and the pin 38 amplifies the angular movement of the actuating lever 32 with respect to angular movement of the rocker arms 35. The rocker arms 35 are also slotted centrally in the direction of their length at 37a in order to accommodate arcuate movement of the spring pin 31 on the plate 32.

For automatic tripping operation in response to excessive current through the contacts, I provide a spring biased tripping arm and latching mechanism substantially the same as shown and described in my Patent 2,337,713, issued February 4, 1941, upon an application filed October 5, 1939. This mechanism comprises a substantially L-shaped trip member 40 pivotally mounted as a bell crank upon the fixed pivot 26 and having one end connected to a tension spring 41. The spring 41 is arranged to pull the trip member 40 forcibly against the toggle pin 28, thereby to break the toggle and to move the line of action of the toggle springs 30 over-center with respect to the fixed pivot 26. Normally, however, the pivoted trip member 40 is held in retracted position against the force of the spring 41 by a latch lever 42 forming part of a double latch lever mechanism such as that described in my foregoing Patent 2,230,713. As described in that patent, the latch lever 42 is mounted intermediate its ends upon a fixed pivot 43 so that one end is in latching relation to one end of the trip member 40. The opposite end of the latch lever 42 comprises a portion 42a which extends laterally to a position near the trip member 40 and engages a second latch lever 44. The latch lever 42 is prevented by the latch lever 44 from moving to a position to release the trip member 40. The lever 42 is biased to latch releasing position by a tension spring 45 connected between the lever 44 and one end of the lever 42. The latch lever 44 is pivotally mounted upon the fixed pivot 24 and is movable against the force of the spring 45 to release the latch lever 42.

For the purpose of moving the lever 44 to release the latching mechanism upon excessive current, each outside circuit of the circuit breaker is provided with a thermal responsive tripping

mechanism 46 heated by a current carrying heater (not shown), the heaters being connected in series circuit relation in the outside circuits as in my foregoing patents. Each tripping mechanism 46 comprises a generally L-shaped mounting bracket 47 of channel-shaped cross section having extending therefrom an angle bracket 48. Adjustably mounted upon the bracket 47 there is provided a U-shaped thermal unit comprising a rigid L-shaped mounting strip 49 connected to a flat bimetallic bar 50. The bimetallic member 50 is movable into and out of engagement with an arm 51 extending from the side of an over-center trip lever 52. The trip lever 52 is endowed with a snap action by means of an over-center spring 53 connected between the bracket 48 and the trip lever 52. Each over-center trip lever 52 is provided with an inwardly projecting arm 53 extending toward the center of the circuit breaker and into position to engage the latch lever 44. This construction of the thermal responsive tripping mechanism is described in greater detail and claimed in my Patent 2,318,987, issued May 11, 1943, upon an application filed June 19, 1942.

The pin 38 carried by the actuating plate 32 is so positioned that, when the actuating plate is manually moved toward the switch opening position to reset the breaker after an automatic tripping operation, the pin 38 engages the trip lever 40 and forces it back into latching engagement with the latch lever 42. In this resetting movement the trip member 40 first engages the portion 42a of the latch lever 42 and rotates the latch lever 42 to its latching position, as described in my foregoing Patent 2,230,713. When the latch lever 42 is so returned to the latching position the latch spring 45 is stressed and tends to return the second latch lever 44 to its latching position. However, the spring 45 is unable, without further aid, to so return the second latch lever 44 when over-center trip levers 52 of the type herein described are used, because the over-center springs 54 of the trip levers 52 are necessarily stronger than the latching spring 45. It is therefore necessary to provide separate means operable upon resetting movement for returning the over-center trip levers 52 to their initial position so that the latching spring 45 can return the second latch 44 to its latching position.

For the purpose of restoring the over-center trip levers 52 to their normal positions by resetting movement after an automatic tripping operation has occurred, I provide a pair of reset levers 55 mounted externally of the supporting plates 22 and 23 upon fixed pivots 56. These levers are in position to engage the inwardly extending arms 53 of the over-center tripping levers 52, and the movable upper ends of the reset levers 55 are coupled by slidable links 57 to opposite ends of the pin 38 which is carried by the actuating plate 32.

Referring now particularly to Figs. 2, 3, 4 and 5, the manual and automatic operation of my new and improved circuit breaker will be clear from the following brief description.

At Fig. 5 the mechanism is shown in the manual "open" position. The contacts may be closed manually by depressing the push button 36, thereby to rotate the rocker arms 35 in a clockwise direction, as viewed in the drawings, about the pivot pin 26.

When the rocker arms are thus rotated the lower edges of the open-ended slots 37 in the rocker arms engage the transverse pin 38 on the

plate 32 in such a position that the pin is forced to slide inwardly in the slots 37 thereby to move the actuating plate 32 by camming action about its fixed pivot 33 in a clockwise direction, as viewed in the drawings. The apertures 37a in the rocker arms 35 simply accommodate the transverse pin 31 and allow freedom of movement of the actuating plate 32. The camming action between the pin 38 and the slots 37 produces a relatively large angular movement of the actuating lever 32 as a result of small angular movement of the rocker levers 35.

When the plate 32 moves in a clockwise direction it carries with it the attached pin 31, to the ends of which are attached the toggle springs 30. In this manner the line of action of the toggle springs is moved over center with respect to the fixed pivot 26, so that the toggle links 25 are biased to the opposite side of the pivot 26. The toggle links 25 therefore move in a counterclockwise direction about the fixed pivot 26 and straighten the toggle links 27, thereby to force the pivoted switch member 21 downwardly and close the contacts. After this operation is completed the breaker mechanism is in the position shown at Fig. 2 of the drawing.

It will, of course, be understood that manual opening operation is simply the reverse of the closing operation described above. Referring to Fig. 2 the breaker contacts are opened by depressing the push button 36a and thus rotating the rocker arms 35 about the fixed pivot 26 in a counter-clockwise direction. In so moving the upper edges of the open-ended slots 37 in the rocker arms 35 engage the transverse pin 38 in such a position that the pin 38 is forced to slide outwardly along the slots 37, thereby to rotate the actuating plate 32 in a counterclockwise direction about its fixed pivot 33. Such counterclockwise movement of the actuating plate 32 carries the pin 31 and the toggle springs 30 over center with respect to the fixed pivot 26, and thus breaks the toggle to the position shown at Fig. 5.

Assuming now that the mechanism is in the manual closed position shown at Fig. 2, an automatic tripping operation upon the occurrence of an excessive current takes place as follows: Upon the occurrence of a predetermined excessive current the thermal strip 50 is heated and deformed in such a direction that the trip lever 52 is moved slowly in a clockwise direction, as viewed at Fig. 5. As soon as the trip lever 52 is carried over center the trip lever continues in movement with a snap action under the influence of its over-center spring 54, thereby to bring the inwardly extending arm 53 of the trip lever into striking engagement with the second latch lever 44. The latch lever 44 is thus moved in a clockwise direction, as viewed in the drawings, against the bias of the latch spring 45 and to a position to release the latch lever 42. When the latch lever 42 is released by the latch lever 44 the latch spring 45 rotates the lever 42 in a counterclockwise direction, as viewed in the drawings, thereby to release the latched end of the trip lever 40.

Upon release of the trip lever 40 the spring 41 forcibly rotates the member 40 in a clockwise direction and brings it into striking engagement with the toggle pin 28. The toggle pin 28 is thus forced to move to the left, as viewed at Fig. 3, thus breaking the toggle and moving the toggle springs 30 over-center with respect to the fixed pivot 26. This movement of the toggle springs 30 carries the actuating

plate 32 to a mid-position, as illustrated at Fig. 3. In moving to such mid-position the plate 32 by camming action moves the rocker levers 35 to a mid-position, so that in the trip position of the breaker mechanism the push buttons 36 and 36a are also in a mid-position. This positioning of the push buttons serves as an indication of the tripped condition of the mechanism.

In order to reset the breaker mechanism after an automatic tripping operation such as that described above, the rocker arms 35 must be moved in a counterclockwise direction beyond their manual "open" position by depression of the push button 36a. The "reset" position of the mechanism is shown at Fig. 4; and by comparison with Fig. 5 it may be seen that in resetting operation the camming pin 38 on the actuating plate 32 is moved by the rocker arms 35 to an extreme outward position in the slots 37; that is, the actuating plate 32 is rotated to an extreme counterclockwise position. In moving to this position the pin 38 on the plate 32 presses against the upper arm of the pivoted trip member 40 and rotates the trip member in a counterclockwise direction against the bias of the spring 41 and beyond its normal latched position. As clearly shown at Fig. 4 extreme counterclockwise or resetting movement of the trip member 40 causes the normally latched end of the trip member to engage the lower arm 42a of the latch lever 42, thereby to rotate the latch lever 42 in a clockwise direction to its latching position. In moving to this position the latch lever 42 stresses the latch spring 45 and thus biases the second latch lever 44 to its latched position shown at Fig. 5. As pointed out previously, however, the second latch lever 44 cannot move to this position until the trip levers 52 on the overcurrent tripping mechanisms 46 are first reset by operation of the reset levers 55.

During the resetting movement of the breaker mechanism the reset levers 55 are rotated in a counterclockwise direction by the pin 38 on the plate 32. As the pin 38 is moved to its extreme counterclockwise or "reset" position it carries with it the reset levers 55, slight sliding movement of the pin 38 with respect to the levers 55 being allowed by the slidable links 57. Thus during the resetting movement the reset levers 55 rotate counterclockwise and engage the tripping arms 53, thereby to force the tripping levers 52 over center to their normal positions as shown at Figs. 1, 2 and 5. With the tripping levers 52 thus removed from the path of the latch lever 44 by operation of the reset levers 55, the latch lever 44 resets itself under the influence of the latching spring 45 so that the mechanism assumes the position shown at Fig. 4. When the push button 36a is released, the tension spring 41 returns the trip member 40 to its normal latched position shown at Fig. 2 by a slight clockwise movement. Such clockwise return movement of the trip lever 40 causes a slight clockwise return movement of the actuating plate 32 to the manual "open" position shown in Fig. 5, and by camming movement of the pin 38 against the slots 37 the rocker arms 35 are moved slightly clockwise to the manual "open" position. All parts are now fully reset to the "open" position shown at Fig. 5 and prepared for manual operation to close the breaker.

While I have described but a single preferred embodiment of my invention by way of illustration, many modifications will occur to those skilled in the art. For example, while I have illustrated

my invention as applied to the three circuit motor starting switch provided with two over-current tripping mechanisms for three phase protection, it will be understood that my actuating and latching mechanism may be used to operate any desired number of switch contacts and may be combined with any desired number of independent over-current tripping mechanisms. I therefore wish to have it understood that I intend in the appended claim to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

A circuit breaker comprising a switch member movable between open and closed circuit positions, an over-center toggle mechanism connected to move said switch member and including a toggle spring having one end connected to the knee of said toggle, an actuating plate pivotally mounted at a first fixed point and having a movable point thereof connected to the other end of said spring thereby to control said toggle mechanism, a rocker arm pivotally mounted intermediate its ends at a second fixed point disposed between the pivoted and movable points of said

actuating plate, said rocker arm being disposed transversely of a line between said pivoted and movable points, and a camming pin fixedly mounted on said actuating plate and laterally displaced from said line, said rocker arm being slotted at one side of its pivot point along a line generally tangential to a circle through said first fixed point and said camming pin being slidably disposed in said slot, whereby oscillation of said rocker arm about said second fixed point effects amplified angular movement of said actuating plate about said first fixed point.

WILLIAM LAWRENCE BUTLER.

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