Dec. 22, 1942. W. L. BUTLER 2,306,244

CIRCUIT BREAKER

Filed April 28, 1941 3 Sheets-Sheet 1

Fig. 1.

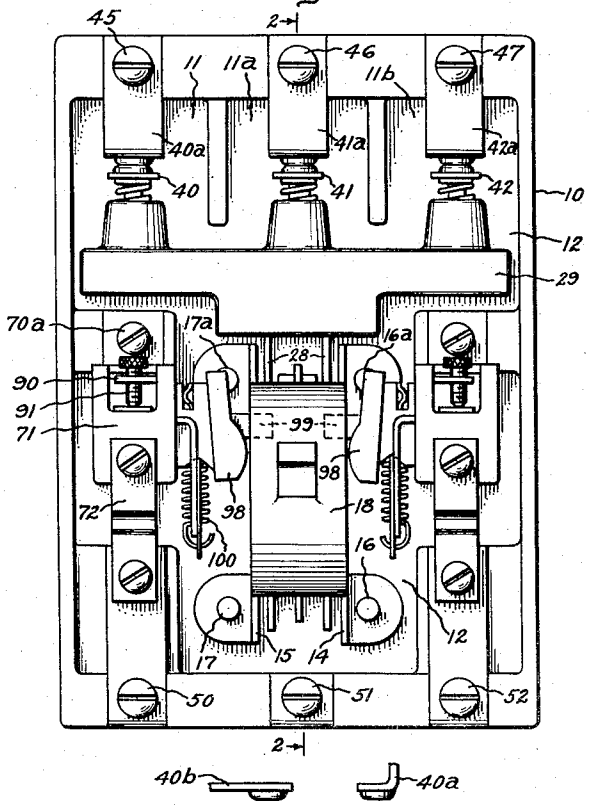
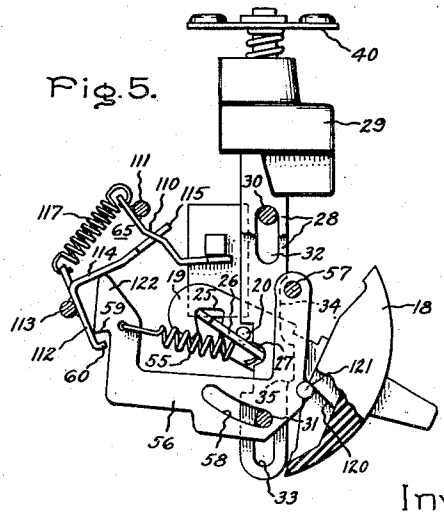


Fig. 5.



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CIRCUIT BREAKER

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Fig. 2.

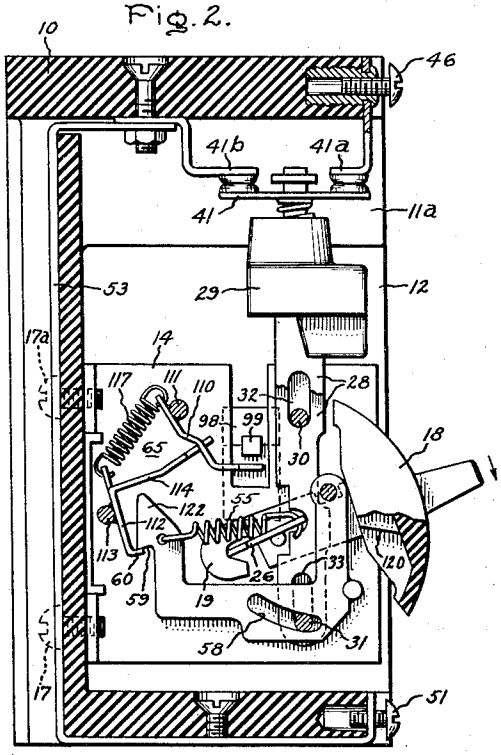


Fig. 3.

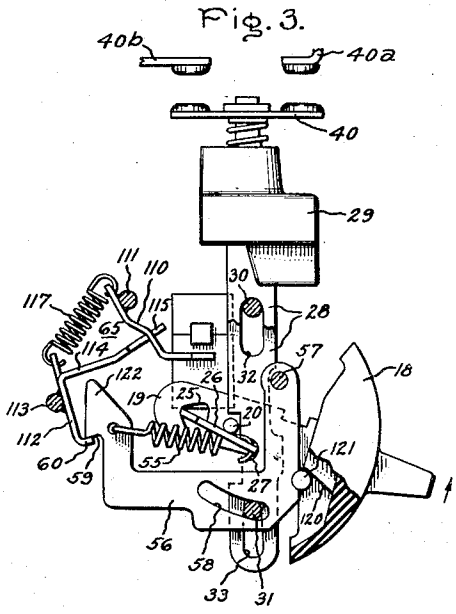
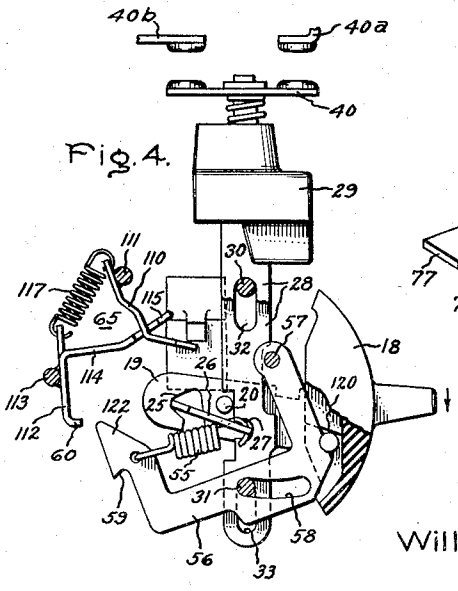


Fig. 4.



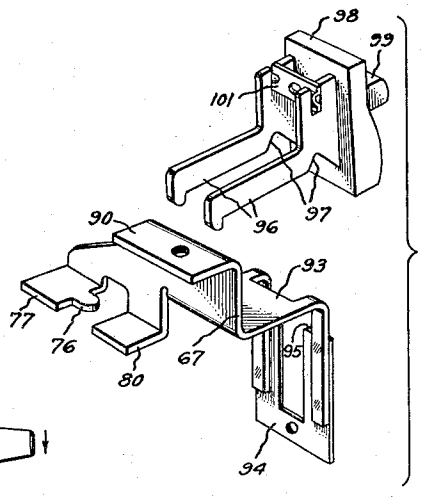


Fig. 7.

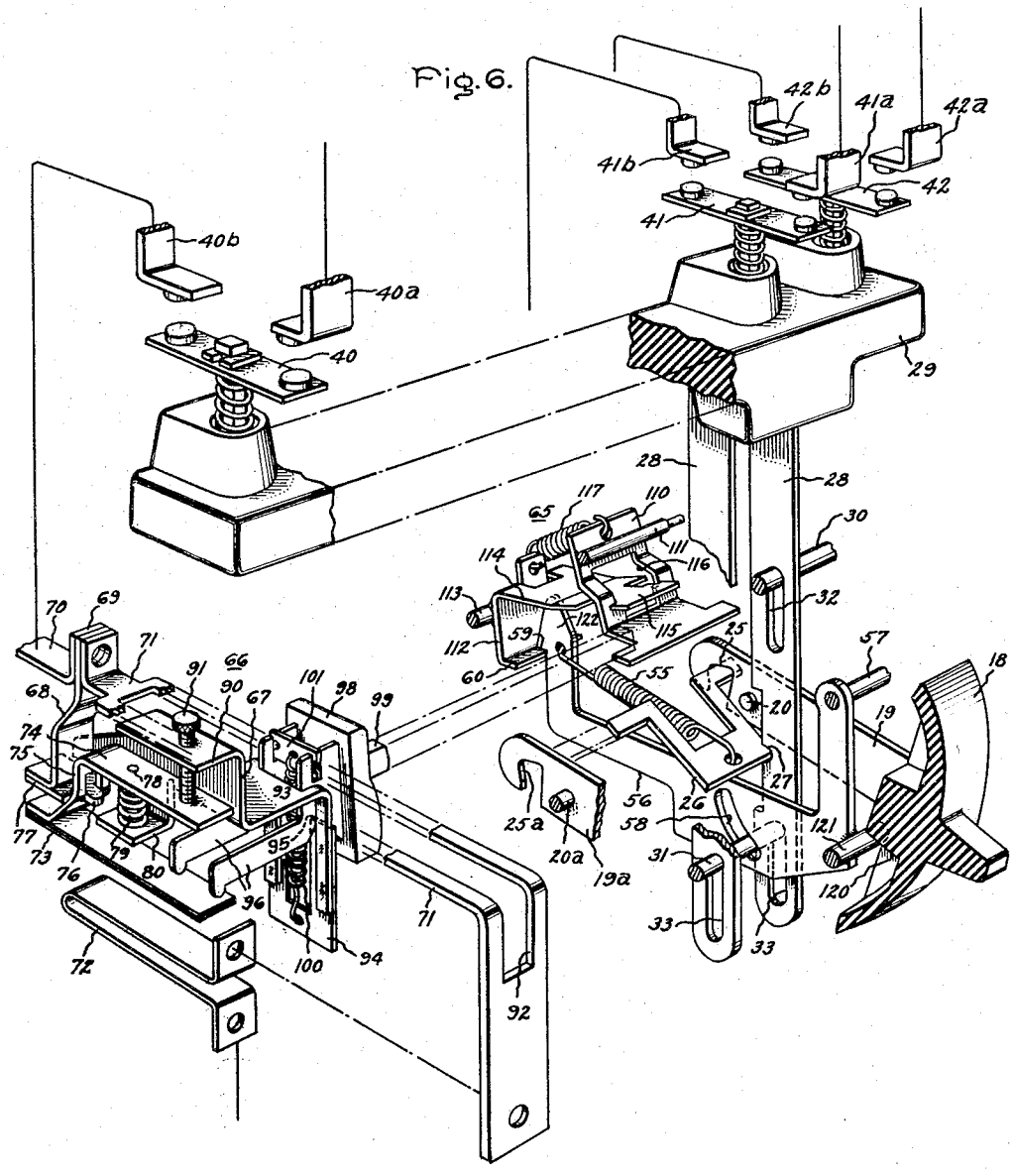
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CIRCUIT BREAKER

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Fig. 6.



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Patented Dec. 22, 1942 2,306,244

UNITED STATES PATENT OFFICE

2,306,244

CIRCUIT BREAKER

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

Application April 28, 1941, Serial No. 390,644

14 Claims. (Cl. 200—116)

My invention relates to circuit breakers and more particularly it relates to a new and improved form of manually operated overcurrent trip circuit breaker of the general class described in my Patent 2,237,713, issued February 4, 1941, upon an application filed October 25, 1939.

The principal object of my invention is to provide a simple and reliable manually operable current responsive circuit breaker which is trip free in its automatic operation and which may be easily manufactured in large quantities and at low cost.

My invention is especially useful in manually operated current responsively tripped circuit breakers used in the connection of small motors directly across a supply source without starting resistance. These devices are of small physical dimension and at the present time are used with motors up to 5 horsepower at 440 volts.

For the attainment of the foregoing and other objects and advantages my invention is preferably embodied in the detailed construction to be hereinafter more fully described and claimed, and is illustrated in the accompanying drawing in which Fig. 1 is a front view of a three-phase automatic 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 elevation of the operating mechanism only showing the mechanism in its manual "Off" position; Fig. 4 is a view similar to Fig. 3 showing the operating mechanism in its "Automatic Trip" position; Fig. 5 is a view similar to Figs. 3 and 4 showing the operating mechanism in its "Reset" position; Fig. 6 is an exploded perspective view partially diagrammatic and having various parts broken away to show the automatic overcurrent trip mechanism and the operating mechanism, the operating mechanism being shown in its "off" position; and Fig. 7 is a detailed perspective view of an over-center toggle construction forming part of the current responsive tripping mechanism.

Referring to the drawings, my invention in the form shown comprises a base 10 made of electrically insulating material such as a molded compound. The base 10 has an irregular shape for convenience in supporting various parts of the device and may suitably be divided into plurality switch compartments 11, 11a and 11b and a compartment 12 for accommodating the switch operating and tripping mechanism which will be further described hereinafter. The switch operating mechanism is carried between two supporting plates 14 and 15 which are secured rigidly to the base 10 as by bolts 16, 16a, and 17, 17a respectively, and project therefrom in parallel spaced relation. An operating handle 18 made of a suitable molded insulating material is secured to one end of a pair of metallic operating levers 19 pivotally mounted between the supporting plates 14 and 15 in parallel spaced relation. The pivot pins 20 and 20a for the operating levers 19 and 19a respectively are coaxial so that the levers 19 and 19a and the handle 18 form a single operating element.

The operating levers 19 and 19a are notched below their pivot points at 25 and 25a to receive the laterally extending ends of a U-shaped movable switch member or toggle arm 26 thereby pivotally to support the toggle arm upon the operating levers. The free end of the toggle arm 26 is fitted into a notch 27 in each of two spaced parallel slidable members or pusher rods 28. Each of the pusher rods 28 is mounted in a transverse contact carrying block 29 of electrically insulating material so that the pusher rods 28 and the block 29 act as a unitary contact carrying member. The pusher rods 28 are slidably supported upon a pair of transverse stop pins 30 and 31 fixedly mounted in the lateral supporting plates 14 and 15 and extending through slots 32 and 33 respectively in the rods 28. The ends of the slots 32 and 33, in engaging the pins 30 and 31, respectively, define the limits of the opening and closing movements of the rods 28, the contact block 29 and the toggle arm 26. As best shown at Fig. 5, the rods 28 are recessed at 34 and 35 to provide clearance for other parts of the mechanism to be described hereinafter. The irregular shape of the rods 28 has not been shown on the perspective view of Fig. 6, since in this view the parts have been so separated for purposes of clarity that no recesses for clearance are necessary.

The transverse contact carrying block 29 includes means for resiliently mounting a plurality of bridging contacts 40, 41, and 42 which cooperate respectively with a plurality of fixed contacts 40a and 40b, 41a and 41b, and 42a and 42b. The fixed contacts 40a, 41a and 42a are connected respectively to the switch terminals 45, 46 and 47 of Fig. 1 by conducting bolts such as the bolts 48 of Fig. 2. The fixed contacts 40b, 41b, and 42b are connected respectively to the switch terminals 50, 51, and 52 of Fig. 1. The fixed contact 41b is connected directly to the switch terminal 51 by an electric conductor 53 as shown at Fig. 2. As shown at Figs. 1 and 6 the connection of the

fixed contacts 40*b* and 42*b* to their respective switch terminals 50 and 52 includes current responsive tripping mechanism which is described and claimed in my copending application Ser. No. 390,643, filed April 28, 1941, and assigned to the same assignee as the instant application. This current responsive tripping mechanism will be more fully described hereinafter.

To provide a snap action for the switch member 26 an over-center spring 55 is connected between the free end of the U-shaped toggle arm and the swingable end of a pivoted U-shaped carrier 56. The carrier 56 is positioned between the pusher rods 28 and is mounted upon a pivot pin 57 supported in the lateral supporting plates 14 and 15. Limited movement in both directions is provided for the carrier 56 by a curved slot 58 in the carrier positioned to cooperate with the fixed stop pin 31. The swingable end of the carrier 56 to which the spring 55 is attached is provided with a notch 59 which engages a detent 60 for normally holding the carrier 56 in a predetermined fixed position. The detent 60 forms part of a double latch mechanism 65, similar to that described and claimed in my above mentioned copending application, and releasable by the current responsive tripping mechanism 66.

While only a single current responsive tripping mechanism 66 is illustrated at Fig. 6 and only one such mechanism will be described in detail, it will be understood that each outside phase of the switch is provided with an identical current responsive mechanism. A single latching mechanism 65 is provided in connection with the single centrally mounted movable switch member 26 and carrier 56, and is adapted to be independent by either current responsive tripping mechanism 66 as will appear hereinafter.

Referring now particularly to Figs. 6 and 7, the current responsive mechanism is supported upon a metallic base plate 67 of irregular shape. The base plate 67 is fixedly attached as by welding to a metal strip 68 which is bolted to a flange 69 on a conducting strap 70 as by a bolt 70*a* (Fig. 1). The strip 70 is fixedly mounted upon the base 10 and is connected to the fixed contact 40*b*. Also bolted to the flange 69 is a jumper 71 connected in series circuit relation with an electric heater 72, the other end of which is electrically connected to the switch terminal 50 (Fig. 1). Positioned in heat conducting relation with the electric heater 72 is a strip 73 of bimetallic thermosensitive material which is welded or otherwise rigidly attached to a mounting strip 74 of such shape as to form with the bimetallic strip 73 a U-shaped structure adapted for detachable connection to the mounting plate 67. For mounting the supporting strip 74 upon the plate 67 the strip 74 is slotted at its base 75 for cooperation with an ear 76 projecting from a ledge 77 formed upon the plate 67, and is provided with a spring seat 78 for positioning a spring 79, the other end of which is seated upon a second ledge 80 of the mounting plate 67. The mounting plate 67 is also provided with a flange 90 threaded to receive an adjusting screw 91. From Fig. 6 it may be seen that the spring 79 engages the mounting strip 74 intermediate its end and biases the base of the strip 74 into engagement with the ear 76 and the other end of the strip into engagement with the adjusting screw 91 to hold the bimetallic strip 73 in a predetermined position. The position of the bimetallic strip at any given temperature may be changed by adjusting the setting of the screw 91. From the broken line at Fig. 6 is may be observed that the jumper 71 is slotted at 92 to afford access to the knurled head of the adjusting screw 91.

The mounting plate 67 is also provided with a bifurcated flange 93 arranged to support an over-center lever, one end of which is positioned to be engaged by the bimetallic strip 73, the other end of which is arranged to engage a latch member for tripping the breaker. As best shown in Fig. 7, the depending arms of the bifurcated flange 93 are fixedly attached, as by welding, to a U-shaped plate 94, the sides of which are wider than the depending arms of the flange 93. The sides of the U-shaped plate 94 overhang the inner edges of the depending arms of the flange 93 to form adjacent each arm a knife edge 95 adapted to support a trip arm 96 by seating in a notch 97 in the arm. The two trip arms 96 are rigidly attached to a latch arm base 98 which may be of molded insulating compound so formed as to provide a latch arm 99 projecting from the other side thereof. The latch arm and trip arm assembly is given a snap action in pivoting upon the knife edges 95 by means of an over-center spring 100 fastened at one end to the base of U-shaped plate 94 and at the other end to a cross arm 101 mounted between the trip arms 96 adjacent the latch arm base 98.

Since each outside phase of the breaker is provided with a current responsive tripping mechanism of the type described above, there is a latch arm 99 projecting toward the latch mechanism 65 from each side thereof. As shown by the broken line projection in Fig. 6 the latch arms 99 are positioned to engage and independently to operate a pivoted latch member or latch lever 110. The latch lever 110 is welded to a pivot pin 111 which is received in and pivotally supported by the lateral supporting plates 14 and 15. The latch lever 110 is arranged to hold in latching position a second pivoted latch member or trip lever 112 which is likewise supported in the plates 14 and 15 upon a pivot pin 113 to which it is welded. The trip lever 112 includes the detent 60 for engagement with the notch 59 of the carrier 56. This construction is best shown at Fig. 6.

For latching the trip lever 112 in latching position, the lever 112 is provided with an arm 114 having an extending tongue 115 formed of three contiguous portions of different widths. The tongue 115 passes through and is in latching engagement with a slot 116 in the latch lever 110. The widest portion of the tongue 115 serves only as cross bar for preventing disengagement of the slot with the tongue. For cooperation of the other two contiguous portions of the tongue 115 the slot 116 has two contiguous portions of corresponding widths, the narrowest portion being adapted to receive the narrowest portion at the base of the tongue 115, and the wider portion of the slot being adapted to receive the tongue portion of intermediate width. The shoulder formed between the two contiguous portions of the slot 116 is located just beyond a slightly offset central portion of the latch member 110 for a purpose which will appear hereinafter. On the same side of each of the pivot pins 111 and 113 a latching spring 117 is connected between the latch lever 110 and the trip lever 112 to bias the lever 110 into latching engagement with the lever 112 and simultaneously to bias the lever 112 into latch releasing position with respect to the carrier 56.

Referring now particularly to Fig. 6, the opera-

tion of my new and improved circuit breaker will be clear. In Fig. 6 the mechanism is shown in its manual open position. Since for normal manual operation the carrier **56** remains stationary, that end of the over-center spring **55** which is attached to the swingable end of the carrier may be considered as fixed during such operation. Referring to Fig. 3, it will be observed that in the open position the notch **25** of the operating lever **19** is on the upper side of the over-center spring **55** so that the free end of the U-shaped toggle arm **26** is biased by the spring **55** to a retracted or switch opening position. The free end of the toggle arm **26** carries with it the pusher rods **28** and the movable bridging contacts **40**, **41** and **42**.

To move the switch member **26** from the open position of Fig. 3 to the closed position of Fig. 2 the handle **18** is moved upward about the pivot pins **20** and **20***a*, thereby to move the notches **25** and **25***a* at the other ends of the levers **19** and **19***a* to a position below the overcenter spring **55**. From Fig. 2 it will now be observed that the toggle arm **26** is now biased in the opposite direction about its pivot point in the notches **25** and **25***a*, thereby to shift the pusher rods **28** upward against the stop pins **30** and **31** to close the switch contacts.

Manual opening operation of the switch is simply the opposite of the closing operation described immediately above. In the manual opening operation the handle **18** is moved downward about its pivot points **20** and **20***a*, thereby to shift the pivot point of the toggle arm **26** above the overcenter spring **55** and bias the free end of the toggle arm downward as shown in Fig. 3.

Beginning with the mechanism in the closed position as shown in Fig. 2 a predetermined excessive current will operate the overcurrent tripping mechanism **66** and the latching mechanism **65** to place the parts in their trip positions as shown at Fig. 4. The occurrence of a predetermined excessive current first deforms the bimetallic strip **73** and causes its free end to move the trip arm **96** in a clockwise direction about the knife edges **95** as viewed in Fig. 6. As soon as the spring **100** is carried over center the trip arm and latch arm assembly **96**, **97**, **98**, **99** continues its movement with a snap action under the influence of the spring. This snapping movement of the latch arm **99** causes it to engage the free end of the latch lever **110** with a hammer blow and to move this end downwardly about its pivot point **111**. As viewed in Fig. 6 such clockwise rotation of the latch lever **110** removes the shoulder between the two contiguous portions of the slot **116** of the latch lever from engagement with the intermediate portion of the tongue **115** of the trip lever **112**. It will be noted that latch releasing movement of the member **110** has applied additional tension to the latching spring **117**. As soon as the tongue **115** is released the trip lever **112** is free to rotate about its pivot point **113** under the influence of the spring **117** and in the same direction as the movement of the latch lever **110**. Such clockwise rotation of the trip lever **112** causes the detent **60** to disengage the notch **59** of the carrier **56**. Preferably the detent **60** and the notch **59** are so related that the force of the spring **55** tending to rotate the carrier **56** will alone free the notch from the detent as soon as the latch lever **110** releases the trip lever **112**. The spring **117** then biases the trip lever **112** to released position primarily so that the abutment **122** may pass freely by the detent **60** upon resetting, as will be more fully described hereinafter.

Upon disengagement of the detent **60** from the notch **59** the carrier **56** will rotate in a counterclockwise direction, as viewed in Fig. 4, under the influence of the over-center spring **55**. Comparing now the trip position of the mechanism as shown in Fig. 4 with the closed position as shown in Fig. 2, it will be observed that counterclockwise rotation of the carrier **56** results in moving the normally fixed end of the over-center spring **55** from a point above to a point below the pivot points **25**, **25***a* of the toggle arm **26**. As shown at Fig. 4, counterclockwise rotation of the carrier **56** is limited by the stop pin **31**. In its new position the over-center spring **55** biases the free end of the toggle arm **26** downward to a switch opening position. In the trip position the over-center spring **55** is permitted to contract sufficiently so that it exerts very little tension, with the result that the operating lever **19** is substantially free to swing upon its pivot points **20** and **20***a* and oscillate the toggle arm **26** about the notch **27** in the pusher rods **28**. What little tension remains in the spring **55** will, however, tend to position the operating lever **19** and the handle **18** intermediate its open and closed positions. This may be observed by comparison of Figs. 2, 3 and 4. The handle **18**, however, is only loosely held in its "trip" position so that no harm would come to an operator in attempting to retain the handle in the manual "on" position while the overcurrent trip **66** mechanism functions.

Comparing now the "on" position of the mechanism as shown in Fig. 2 with the "off" position as shown in Fig. 3 it will be observed that the force applied to the carrier **56** by the main spring **55** is approximately the same in both positions, but that in the "on" position this force is applied through a considerably shorter lever arm than when the mechanism is in the "off" position of Fig. 3. As a result of this arrangement the latch pressure between the detent **60** and the notch **59** is considerably less in the "on" position of the mechanism than it is in the "off" position. The reduced latch pressure results in a considerable diminution of the friction at the latch surfaces and thus contributes to the ease and certainty of the tripping operation of my breaker.

To reset the breaker mechanism after the automatic tripping operation described above, the operating handle **18** must be depressed beyond its manual "open" position to engage a molded abutment **120** on the operating handle **18** with a pin **121** welded to the front leg of the U-shaped carrier **56**. As may be observed by comparing Fig. 4 with Fig. 5, continued downward pressure upon the operating handle **18** will eventually rotate the carrier **56** about its pivot pin **57** in a clockwise direction, as viewed in the drawings, until the carrier reaches the limit of its clockwise rotation by engagement of the end of the slot **58** with the stop pin **31**. During this movement an abutment **122** on the swingable end of the carrier **56** adjacent the notch **59** engages the arm **114** of the trip lever **112** and rotates the trip lever about its pivot pin **113** in a counterclockwise direction as viewed in Fig. 5. Movement of the trip lever **112** and the carrier **56** in this direction will eventually bring the detent **60** into engagement with the notch **59** of the carrier and move the tongue **115** of the trip lever **112** back in the slot **116** of the latch lever **110** until the wider portion of the tongue comes adjacent the wider portion of the

slot. As soon as the shoulder between the adjacent portions of the tongue 115 is removed from engagement with the narrow portion of the slot 116 of the member 110, the member 110 is permitted to rotate in a counterclockwise direction about its pivot pin 111 under the influence of the latch spring 117 to raise the member 110 to the position shown at Figs. 2 and 6. To fully reset, however, the handle 18 must be pressed still further back until the carrier 56 engages the stop pins 31 to cause the abutment 122 to rotate the trip lever 112 counterclockwise beyond its normal latching position, as is shown in the "reset" position of Fig. 5. In moving to the position of Fig. 5 the tongue 115 of the trip lever 112 passes the offset central section of the latch lever 110 which now acts as a cam surface to rotate the latch lever 110 counterclockwise beyond its normal latching position. As is shown in Fig. 5, this additional movement of the member 110 causes it to engage the latch arm 99 of the overcurrent mechanism to reset the over-center spring 100, the trip arm 96 and the latch arm 99 if the bimetallic strip 73 has cooled and returned to its normal position. Upon release of the handle 18 the spring 55, which at all times biases the carrier 56 for counterclockwise rotation about its pivot pin 57, will move the carrier from the position of Fig. 5 to the position of Fig. 3 where it is held by engagement of the notch 59 with the detent 60. Upon retraction of the abutment 122 from engagement with the arm 114 of the trip lever 112 the latch spring 117 will rotate both the latch members 110 and 112 clockwise through a small angle until the tongue 115 engages the shoulder between adjacent portions of the slot 116 as shown in Fig. 3. This last small movement of the carrier 56 to the position shown at Fig. 3 raises the operating handle 18 to its manual open position as shown in Fig. 3 by engagement of the pin 121 with the abutment 120 on the handle. All the parts are now fully reset and prepared for manual operation to close the breaker to the position shown in Fig. 2.

While I have described but a single preferred embodiment of my invention, many modifications will occur to those skilled in the art. For example, while I have illustrated my invention as applied to a three-phase motor starting switch provided with two overcurrent tripping mechanisms for three-phase protection, it will be understood that my operating and latching mechanism may be used to operate any desired number of switch contacts and may be combined with any desired number of independent overcurrent trip mechanisms. I, therefore, wish to have it understood that I intend in the appended claims 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:

1. An automatic circuit breaker comprising cooperating switch contacts, a support, a carrier pivotally mounted upon said support, latch means engaging a swingable end of said carrier normally to hold said carrier in a predetermined fixed position, a movable toggle arm having a free end operatively connected to one of said contacts, an over-center spring connected between the swingable end of said carrier and said free end of said toggle arm, an operating lever pivotally mounted upon said support, pivotal means for supporting said toggle arm at its other end upon one end of said operating lever for movement over center with respect to said spring thereby to bias said free end of said toggle arm selectively to switch opening or switch closing positions, stop means associated with said toggle arm to limit its movement and define said switch opening and switch closing positions, and means responsive to the current passing through said contacts for actuating said latch means to release said carrier for rotation under the influence of said over-center spring thereby to move said spring over center with respect to said pivotal means.

2. A circuit breaker comprising a support, cooperating switch contacts, a movable switch arm operatively connected to one of said contacts, an operating lever pivotally supported at a fixed point in said support and having one end pivotally connected to one end of said movable switch arm, a swingable carrier pivoted at a fixed point in said support, latch means for normally engaging the swingable end of said carrier to hold said carrier normally in a predetermined fixed position, and an over-center spring connected between the free end of said movable switch arm and the swingable end of said carrier for biasing said carrier to move said spring to a position to bias said movable switch arm to a switch opening position.

3. A circuit breaker comprising a support, cooperating switch contacts, a manually operable operating lever pivoted at a fixed point in said support, a U-shaped carrier pivoted at one end to said support and provided with stop means for limiting its movement, latch means arranged to engage the swingable end of said carrier normally to hold said carrier in a predetermined fixed position, a movable toggle arm having one end pivotally mounted upon said operating lever at a point spaced from said fixed point, means for connecting the free end of said toggle arm to one of said contacts and limiting the movement of said toggle arm, an over-center spring connected between said swingable end of said carrier and said free end of said toggle arm for biasing said carrier to move said spring to a position to bias said toggle arm to a switch opening position, and means responsive to the current passing through said contacts for actuating said latch to release said carrier.

4. A circuit breaker comprising a support, cooperating switch contacts, a manually operable operating lever pivotally mounted intermediate its ends at a fixed point in said support, a U-shaped carrier pivoted at one end to said support and slotted for cooperation with a stop pin to provide means for limiting the movement of said carrier, latch means normally engaging the swingable end of said carrier to hold said carrier normally in a predetermined fixed position, a movable toggle arm pivotally mounted at one end to one end of said operating lever and having a free end operatively connected to one of said contacts, an over-center spring connected between the free end of said toggle arm and the swingable end of said carrier, an operating handle connected to the other end of said operating lever for moving said one end of said toggle arm to opposite sides of said over-center spring thereby to bias the free end of said toggle arm selectively to switch opening and switch closing positions, and means responsive to the current passing through said contacts for actuating said latch means to release said carrier thereby to move one end of said over-center spring to a position to bias said toggle arm to a switch opening position

irrespective of the position of said operating lever.

5. A circuit breaker comprising a support, a fixed contact mounted upon said support, a manually operable operating lever having a pivot pin for pivotally mounting said lever at a fixed point in said support, a U-shaped carrier pivoted at one end in said support and provided with stop means for limiting its movement, latch means engaging the swingable end of said carrier normally to hold said carrier in a predetermined fixed position, a movable toggle arm pivotally connected to said operating lever at a point spaced from said pivot pin, a slidable rod carrying a movable contact for cooperation with said fixed contact and connected to the free end of said toggle arm for actuation thereby, pin and slot means for slidably supporting said rod and limiting its movement, an over-center spring connected between the free end of said toggle arm and the swingable end of said carrier for biasing said carrier to move said spring to a position such that said spring will bias said toggle arm to a switch opening position, and means responsive to the current passing through said contacts for actuating said latch to release said carrier.

6. A circuit breaker comprising a support, a fixed contact mounted upon said support, a manually operable operating lever having a pivot pin intermediate its ends for pivotally mounting said lever at a fixed point in said support, a U-shaped carrier pivotally mounted at one end at the second point in said support and slotted for cooperation with a stop pin to provide means for limiting the movement of said carrier, a double latch arranged normally to engage the swingable end of said carrier to hold said carrier normally in a predetermined fixed position, a movable toggle arm pivotally mounted at one end upon said operating lever at a point spaced from said pivot pin, a slotted rod carrying a movable contact for cooperation with said fixed contact, a stop pin mounted in said support and arranged to engage said slotted arm for slidably supporting said arm and limiting its movement, means for connecting said slotted rod to the free end of said toggle arm, an over-center spring connected between the free end of said toggle arm and the swingable end of said carrier, an operating handle connected to the other end of said operating lever for moving said one end of said toggle arm to opposite sides of said over-center spring thereby to bias the free end of said toggle arm selectively to switch opening and switch closing positions, and means responsive to the current passing through said contacts for actuating said latch means to release said carrier thereby to move one end of said over-center spring to a position to bias said toggle arm to a switch opening position irrespective of the position of said operating lever.

7. A circuit breaker comprising a support, cooperating switch contacts, a movable switch member operatively connected to one of said contacts, a pivoted operating lever providing means for pivotally supporting one end of said movable switch member, a swingable carrier pivotally mounted on said support, an over-center spring connected between the free end of said movable switch member and the swingable end of said carrier, a first latch member pivotally mounted upon said support and having a detent normally engaging said carrier, a tongue attached to said first latch member and formed to provide contiguous portions of different widths, a second latch member pivotally mounted upon said support and provided with a slot having contiguous portions of different widths for interlocking cooperation with said tongue, a latch spring connecting said latch members for biasing said second latch member to secure said first latch member and biasing said first latch member to release said carrier, and means responsive to the current through said switch contacts for actuating said second latch member in opposition to said latch spring thereby to release said carrier.

8. An automatic circuit breaker comprising a support, cooperating switch contacts, a manually operable operating lever pivoted at a fixed point in said support, a U-shaped carrier pivotally mounted at one end in said support and provided with stop means for limiting its movement, a movable toggle arm having one end pivotally mounted upon said operating lever at a point spaced from said fixed point, means for connecting the free end of said toggle arm to one of said contacts and limiting the movement of said toggle arm, an over-center spring connected between the swingable end of said carrier and said free end of said toggle arm for biasing said carrier to move said spring to a position to bias said toggle arm to a switch opening position, a first latch member pivotally mounted upon said support and having a detent normally engaging said swingable end of said carrier, a tongue attached to said first latch member and formed to provide contiguous portions of different widths, a second latch member pivotally mounted upon said support and provided with a slot having contiguous portions of different widths for interlocking cooperation with said tongue, one end of said second latch member being offset away from said first latch member, a spring connecting said latch members for biasing said second latch member to secure said first latch member and biasing said first latch member to release said carrier, an over-center lever for actuating said second latch member in opposition to said spring thereby to release said carrier, and means associated with said carrier for engaging said first latch member to reset said first and second latch members and said over-center lever.

9. An automatic circuit breaker comprising a pair of supporting plates mounted in parallel spaced relation, cooperating switch contacts, a manually operable operating lever pivotally mounted intermediate its ends at a fixed point on said supporting plates, a swingable U-shaped carrier pivotally mounted at one end to a second fixed point in said supporting plates and provided with stop means for limiting its movement, a movable toggle arm having one end pivotally mounted upon said operating lever at a point spaced from said first fixed point, means for connecting the free end of said toggle arm to one of said contacts and limiting the movement of said toggle arm, an over-center spring connected between said free end of said toggle arm and said swingable end of said carrier for biasing said carrier to move said spring to a position such that said spring will bias said toggle arm to a switch opening position, a trip lever pivotally mounted upon said supporting plates and having a detent arranged to engage said carrier, a projecting arm connected to said trip lever and provided with an extending tongue having contiguous portions of different widths, a latch lever pivotally mounted upon said supporting plates and having an

end portion offset away from said trip lever, said latch lever having a slot comprising two contiguous portions of different widths forming a shoulder upon said offset portion thereby interlockingly to engage corresponding portions of said tongue, a tension spring connected between said latch lever and said trip lever to bias said latch lever to secure said trip lever in latching position and to bias said trip lever to disengage said detent, an over-center lever responsive to the current passing through said switch contacts for actuating said latch lever in opposition to said tension spring thereby to disengage the wider portion of said tongue from said shoulder and permit said tension spring to actuate said trip lever to release said carrier, means associated with said operating lever to rotate said carrier in opposition to said over-center spring, and means associated with said carrier for engaging said projecting arm to actuate said trip lever against the bias of said tension spring thereby to reengage said detent and to permit said tension spring to actuate said latch lever to reengage said wider portion of said tongue with said shoulder.

10. An automatic circuit breaker comprising a support, a fixed contact mounted upon said support, a manually operable operating lever having a pivot pin for pivotally mounting said lever at a fixed point in said support, a U-shaped carrier pivoted at one end to a second point in said support and provided with stop means for limiting its movement, a movable toggle arm pivotally connected to said operating lever at a point spaced from said pivot pin, a slidable rod carrying a movable contact for cooperation with said fixed contact and connected to the free end of said toggle arm for actuation thereby, pin and slot means for slidably supporting said rod and limiting its movement, an over-center spring connected between the free end of said toggle arm and the swingable end of said carrier for biasing said carrier to move said spring to a position such that said spring will bias said toggle arm to a switch opening position, a trip lever pivotally mounted upon said support and having a detent arranged to engage said carrier, a projecting arm connected to said trip lever and provided with an extending tongue having contiguous portions of different widths, a latch lever pivotally mounted upon said support having an end portion offset away from said trip lever, said latch lever having a slot comprising two contiguous portions of different widths forming a shoulder upon said offset portion thereby interlockingly to engage corresponding portions of said tongue, a tension spring connected between said trip lever and said latch lever to bias said latch lever to secure said trip lever in latching position and to bias said trip lever to disengage said detent, an over-center lever responsive to the current passing through said switch contacts for actuating said latch lever in opposition to said tension spring thereby to disengage the wider portion of said tongue from said shoulder and permit said tension spring to actuate said trip lever to release said carrier, an abutment on said operating lever arranged to engage said carrier for moving carrier in opposition to said over-center spring, and a second abutment on the swingable end of said carrier for engaging said projecting arm to actuate said trip lever against the bias of said tension spring thereby to reengage said detent and to permit said tension spring to actuate said latch lever to reengage said wider portion of said tongue and said shoulder.

11. A circuit breaker comprising cooperating switch contacts, an operating lever mounted upon a fixed pivot, a toggle link pivotally mounted upon said operating lever at a point spaced from said fixed pivot, the other end of said toggle link being operatively connected to one of said contacts, a releasable carrier pivotally mounted upon a fixed pivot, an over-center spring connected between said carrier and said other end of said toggle link selectably to retain said toggle link in either a switch opening or a switch closing position and simultaneously to bias said carrier to a released position, latch means for engaging said carrier normally to retain said carrier in a predetermined latched position, said operating lever being manually operable when said latch is engaged to move said one end of said toggle link over center with respect to said spring, and means responsive to the current passing through said contacts when said contacts are engaged for actuating said latch to release said carrier for movement under influence of said over-center spring to move one end of said spring over center with respect to said toggle link thereby to disengage said contacts.

12. A circuit breaker comprising a support, cooperating switch contacts, a movable switch arm operatively connected to one of said contacts, an operating lever pivotally supported at a fixed point in said support and having one end pivotally connected to one end of said movable switch arm, a swingable carrier mounted upon a fixed pivot in said support, latch means for normally engaging the swingable end of said carrier to hold said carrier normally in a predetermined fixed position, and an over-center spring connected between the free end of said movable switch arm and the swingable end of said carrier for biasing said switch arm selectably to switch opening and switch closing positions, the line of action of said over-center spring being always on a predetermined side of said fixed pivot thereby to exert a torque biasing said carrier to move said spring to a position to bias said movable switch arm to said switch opening position, said switch arm in moving from said circuit opening to said circuit closing position with said carrier latched in said predetermined position being arranged to move toward said fixed pivot thereby to move the line of action of said spring toward said fixed pivot so that the biasing torque upon said carrier and the force applied by said carrier to said latch means are a minimum in said switch closing position.

13. A circuit breaker comprising a support, cooperating switch contacts, an operating lever pivotally mounted on a fixed pivot on said support, a switch arm pivotally mounted on one end of said operating lever, an operating connection between said switch arm and one of said contacts, a swingable carrier mounted on a second fixed pivot on said support, latch means for normally engaging said carrier to hold said carrier normally in a predetermined fixed angular position with respect to said second fixed pivot, an over-center spring connected between the other end of said switch arm and the swingable end of said carrier for biasing said carrier in a predetermined direction about said second pivot to a tripped position thereby to move one end of said spring to a position to bias said switch arm to a switch opening position, means responsive to the current passing through said contacts for actu-

ating said latch means to release said carrier for movement about said second fixed point to said tripped position by said over-center spring thereby to move said switch arm to said switch opening position, and means movable in conjunction with said operating lever to engage said carrier and move said carrier back to said predetermined fixed angular position to be secured by said latch means while maintaining said switch arm in said switch opening position.

14. A circuit breaker comprising a support, cooperating switch contacts, a movable switch arm operatively connected to one of said contacts, an operating lever pivotally supported at a fixed point on said support and having one end pivotally connected to one end of said movable switch arm, a swingable carrier pivoted at a fixed point on said support, latch means for normally engaging the swingable end of said carrier to hold said carrier normally in a predetermined fixed position, an over-center spring connected between the free end of said movable switch arm and the swingable end of said carrier for biasing said carrier to move said spring to a position to bias said movable switch arm to a switch opening position and said operating lever to an off position, means responsive to the current passing through said contacts for actuating said latch means to release said carrier for movement under the influence of said over-center spring to a tripped position thereby to move said switch member to said switch opening position and said operating lever to said off position, and means movable in conjunction with said operating lever to engage said carrier upon movement of said operating lever beyond said off position in a switch opening direction and to move said carrier back to said predetermined fixed position while maintaining said movable switch arm in said switch opening position.

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