June 24, 1952 J. D. WOOD 2,601,482

CIRCUIT BREAKER-BLOW OPEN, BLOW CLOSED CONTACTS

Filed March 20, 1947 3 Sheets-Sheet 1

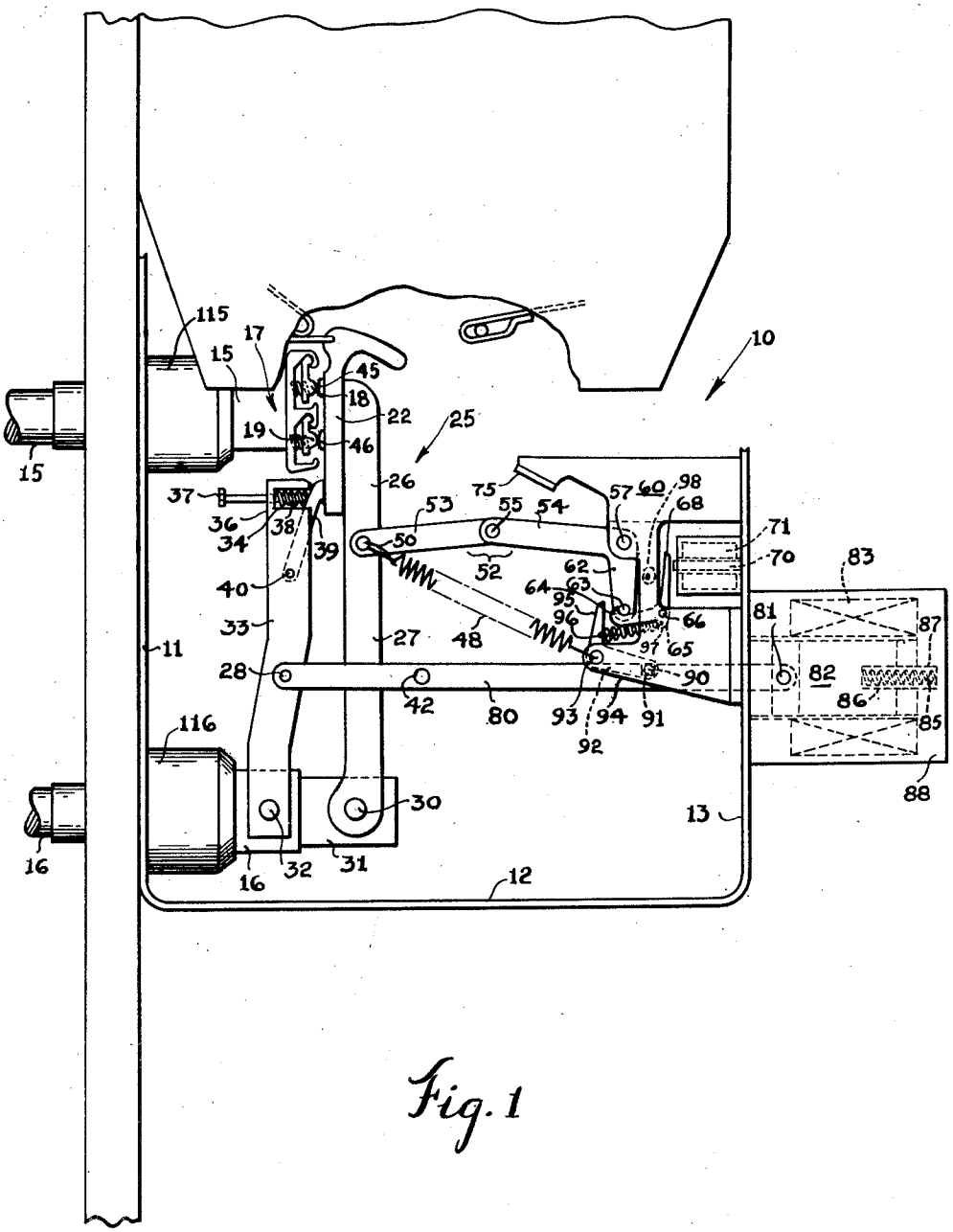


Fig. 1

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Filed March 20, 1947 3 Sheets-Sheet 2

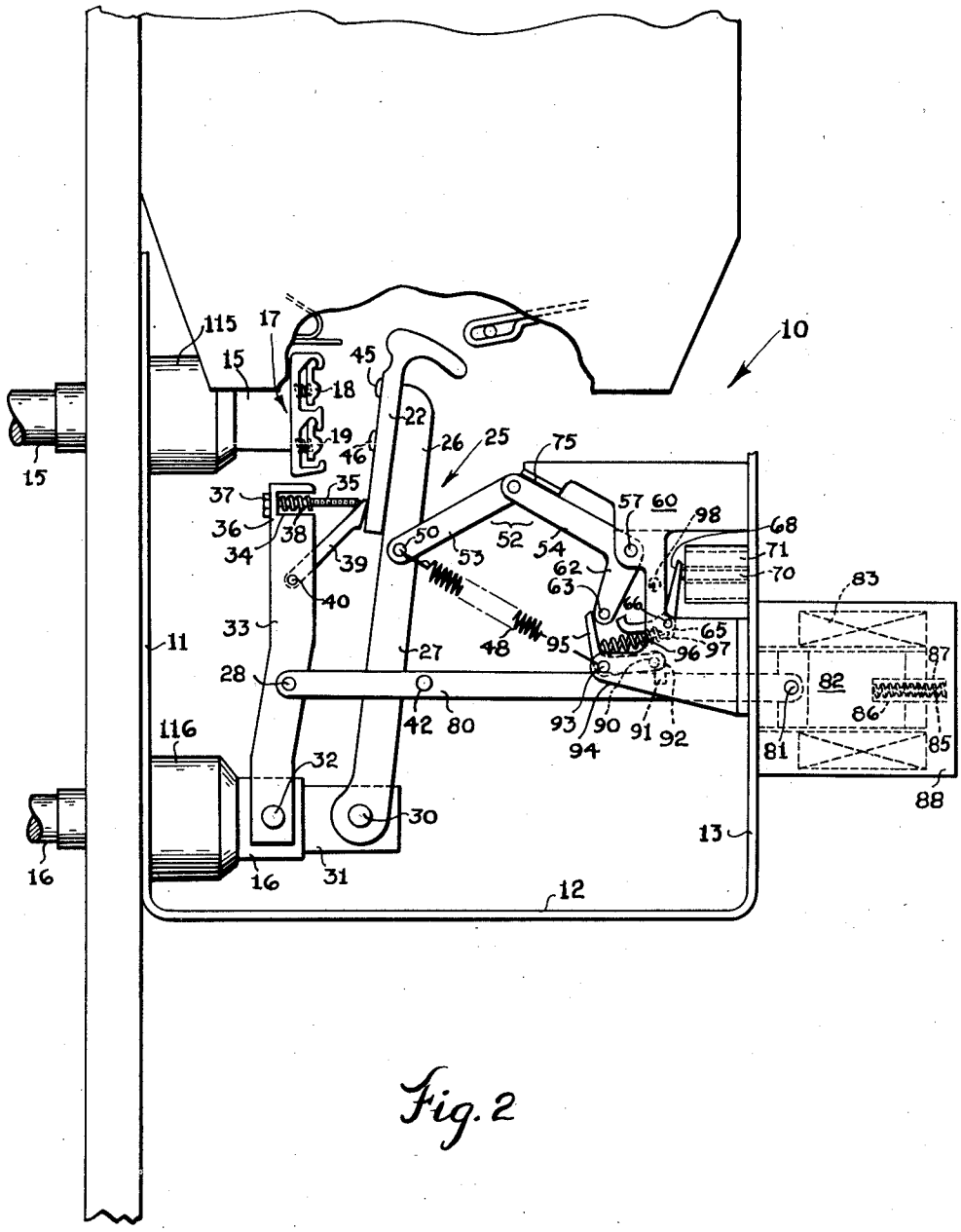


Fig. 2

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Filed March 20, 1947 3 Sheets-Sheet 3

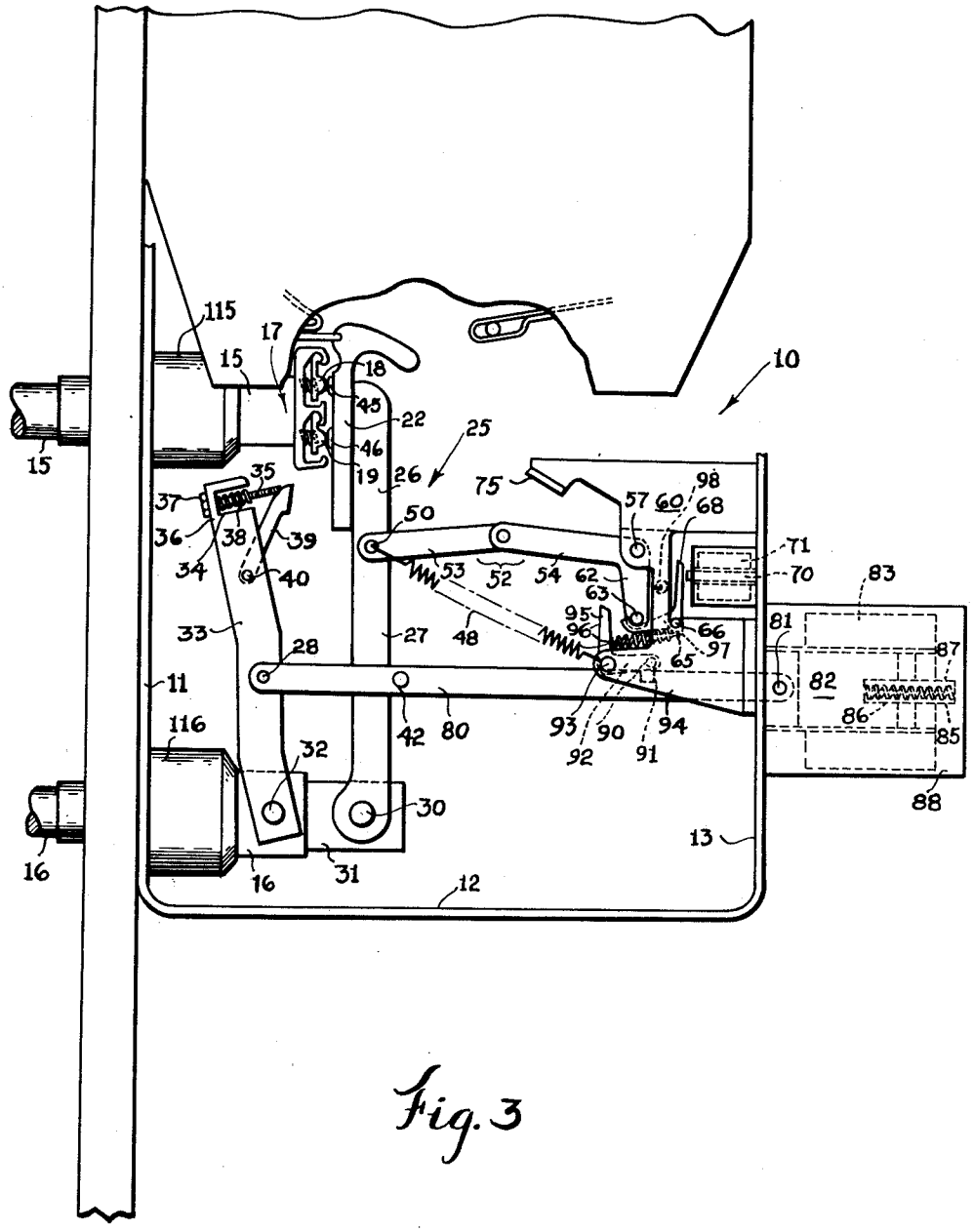


Fig. 3

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UNITED STATES PATENT OFFICE

2,601,482

CIRCUIT BREAKER-BLOW OPEN, BLOW CLOSED CONTACTS

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Application March 20, 1947, Serial No. 735,907

5 Claims. (Cl. 200—106)

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My invention relates to circuit breakers, and more particularly to circuit breakers which utilize the electromagnetic action of current in the controlled circuit for closing the breaker as well as for opening the breaker.

Heretofore, circuit breakers have been designed so that a loop is formed in the circuit path through the breaker such that short circuit current flowing sets up a magnetic field which aids the opening spring in operating the movable arm to its trip position. This is known as the "blow-open" effect.

In many instances it is also desirable during the closing operation of the circuit breaker to secure first the reverse effect, namely a "blow-closed" effect, i. e., to have the magnetic field induced by current in the controlled circuit drive the contacts closed. This insures good contact on closing in cases where the breaker may be closed against excessive current or short circuit conditions, avoids chattering and freezing at the contacts due to poor contact engagement, and permits prompt tripping in response to short circuit conditions.

One method of accomplishing this result is disclosed in my co-pending application Serial No. 4,725 filed January 28, 1948.

In accordance with my present invention, I provide one movable arm during closing and a different movable arm for opening, each of the movable arms being driven in the same direction by the magnetic forces, one of them, however, effecting a closing operation and the other a tripping operation. The closing arm during closing is such that at the instant the circuit contacts engage (but before closing movement is completed), the electromagnetic forces set up by the current in the circuit are such as to drive the movable arm through its remaining small movement to effect complete closure or contact engagement.

Thereafter during tripping in response to abnormal current conditions in the controlled circuit, the other movable arm is used so that the magnetic field induced by the current aids in driving this movable arm to its open position.

Due to the approximately U-shaped configuration of the studs and contacts of most circuit breakers, high electromagnetic forces are imposed upon the breaker parts when fault currents of approximately 20,000 amperes or more flow through the circuit. These forces become extremely high when the current value reaches 100,000 amperes. Under such conditions, the forces may reach several thousand pounds.

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To withstand these forces, the stationary parts must be made extremely strong and rigid. This can usually be done without too much difficulty. The movable parts of the breaker give the most difficulty. Many contact arrangements have been devised to construct flexible contacts so that the electromagnetic forces increase contact pressure, as for instance shown in application Patent No. 2,514,839, issued July 11, 1950. These constructions are necessary so that the breaker may remain closed and so that the contact will open in the proper sequence during the opening stroke, even in the presence of high short circuit current.

In most circuit breakers the moving contact forms substantially the bottom section of the U-shaped configuration of the circuit breaker and opens outwardly away from the two legs of the U-shape. In this arrangement, the effects of the electromagnetic forces are to force the moving contact towards the open position.

This aids high speed opening under fault conditions and aids circuit interruption, but it presents a real and difficult problem when the breaker is required to be closed against a short circuit. In fact, many of the present commercial circuit breakers admittedly will not close against a short circuit equal to their interrupting capacity much less against a current value equal to their momentary rating or the asymmetrical inrush current that occurs in the first half cycle on an alternating current short circuit.

In an electrically operated circuit breaker, the electrical operating mechanism is required to function properly over a specified range of control voltage. For instance, a 125 direct current closing mechanism is required to close the breaker from 90 volts to 140 volts, at the closing mechanism. This represents a wide range and is about as much as can be expected. Breakers that just close on the low voltage will slam closed on the high voltage with so much energy that there is danger of breaking parts even at no load and without consideration of the forces imposed by short circuit current. The solution to the problem does not lie in making bigger and stronger closing mechanism which will have power enough to force the breaker to the closed position in the presence of a short circuit. Such a strong mechanism would surely damage the breaker when closing at no load over this wide range of control voltages.

I have solved the problem by providing a novel circuit breaker in which the electromagnetic forces assist in closing the breaker and give

faster and more positive closing in the presence of a high short circuit current.

The operation of my novel circuit breaker when closing, over the control voltage range, is practically the same whether it carries large or small amounts of current. That is to say, the breaker operates effectively for all values of current over the entire range up to its momentary rating, because my novel invention employs the natural electromagnetic forces to assist in the operation of closing.

However, when the breaker is opening, my invention contemplates using the electromagnetic forces in such a way as to assist this opening operation and cause the breaker to open faster in direct proportion to the magnitude of the current in the system. It should also be noted that when closing against a short circuit, no electromagnetic blow-open force is imposed on the moving arm since no current is flowing until the contacts touch; the full electromagnetic blow-open force is then instantly present.

Another way to express the characteristics of my novel breaker is to say that the electromagnetic forces due to short circuit currents cause the breaker to "blow-closed" when closing, "blow-open" when opening; and the contacts of the circuit breaker to "blow-closed" if held in the closed position.

It is thus an object of my invention to utilize the short circuit or fault current itself to aid in the closing of the contacts of the circuit breaker.

It is another object of my invention to so arrange the contacts of a circuit breaker that the blow-closed effect of the electrical and magnetic forces around the contacts will be such as to drive the contacts together when the circuit breaker is closed.

It is another object of my invention to so arrange the contacts that even through a blow-closed effect is achieved when the circuit breaker is closed, a blow-open effect is nevertheless achieved during the opening operation of the circuit breaker.

Specifically a further object of my invention is the provision of a blow-closed, blow-open circuit breaker so arranged that the resetting of the elements after the occurrence of a tripping operation will result sequentially and without further operations in the closing of the circuit breaker.

The foregoing and many other objects of my invention will become apparent in the following description and drawings in which:

Figure 1 is a schematic side view of my novel circuit breaker contact arrangement showing the circuit breaker contacts closed.

Figure 2 is a view corresponding to that of Figure 1 showing the contacts tripped open, but before the latches are reset.

Figure 3 is a view corresponding to those of Figures 1 and 2, showing the circuit breaker fully open, with the latches reset and prepared to close.

Referring now to the figures, I have here shown my novel circuit breaker **10** which is so arranged that during the closing movement and just as the contacts engage, but before they have fully engaged, the current loop through the elements provides a blow-closed effect. When the circuit breaker is tripped, the elements are so arranged that the current loop provides a blow-open effect and the contacts are of the blow-closed construction.

The circuit breaker **10** is supported in any suitable manner on a panel **11**, carrying the additional supporting bracket **12**, and front panel **13**.

The back panel **11** carries an upper back connection stud **15** and a lower back connection stud **16**, mounted in any suitable insulator **115** and **116**. The upper back connection stud **15** carries at the end thereof a stationary contact structure **17** comprising an arcing contact **18** and a main stationary contact **19**. The arcing and main contacts **18** and **19** are supported in any suitable manner in the contact structure **17** and are biased toward current carrying relation with the movable contact elements by any suitable means such as compression springs or the like. They are so arranged in any of the well known methods so that the electromagnetic force due to high short circuit current will tend to force them into better contact engagement with the moving contact.

The insulated movable contact arm **25** is of insulating material and is provided with an upper section **26** and a lower section **27** which are continuous with each other. The lower end of the arm **25** is rotatably mounted on the pivot **30** connected to the extension **31** of the lower back connection stud **16**. The lower back connection stud **16** also carries pivotally secured thereto at the pivot **32** the current carrying closing arm **33**. Insulated movable contact arm **25** includes a movable contact element **22** carried at the upper end of movable contact arm **25**, which movable contact element carries the main movable contact **46** and the movable arcing contact **45**.

The upper end of arm **33** is provided with a recess **34** having an opening **35** at the front and communicating with a hole **36** at the back in which is carried the plunger **37**. Compression spring **38** in the recess biases the plunger **37** to the right pushing the front end of plunger **37** against the pivoted contact link **39**, the said pivoted contact link **39** bearing against the upper portion of arm **25** and actually being in engagement with the lower extension of the contact structure **22**.

The spring **38** is sufficiently powerful to push the contact link **39** to the right, causing it to rotate clockwise about its pivot **40**, and keep it in engagement with contact element **22** during the opening stroke of insulated movable contact arm **25**.

The current path established when the contacts are closed is thus from the upper back connection stud **15** to the stationary contact structure **17**, including the arcing contact **18** and the main contact **19**, then through the movable arcing contact **45** and the movable main contact **46** to the movable contact carrying element **22**, to the contact link **39**, the pin **40**, the arm **33**, the pivot **32** and the lower stud **16**.

It will thus be seen that when the contacts are closed, a U-shaped current loop is established with the contact elements **18**—**45** and **19**—**46** at one of the bends or corners of the loop.

Accordingly, a force tending to blow open is set up on the contacts when the breaker is in the closed position.

As above pointed out, contact arm **25** is biased in a clockwise direction toward opening position by the spring **48** acting on arm **25**. This spring becomes effective when the latch which holds the contact arm **25** closed is removed. Contact arm **25** is held in the closed position by the toggle **52** comprising links **53** and **54** and the knee pin **55**. Link **53** may be of insulating material and is connected by pin **50** to the contact arm **25** and at its opposite end is connected to knee pin **55**.

Link 54 is connected at one end to pin 55 and at its opposite end is pivoted on the pin 57 mounted between the sides of bracket 60 which in turn is supported on the front panel 13.

Link 54 has an angular extension 62 so that members 54—62 form a bell crank lever revolvable around the pin 57. The outer or lower end of extension 62 carries a latch roller 63 which is engaged by the latching notch 64 of the pivoted latch member 65. Latch member 65 is in the form of a bell crank lever rotatably mounted on the pin 66 carried between the sides of bracket 60.

The eccentric stop 98 cooperates with the extension 62 of the link 54 in order to keep the latch roller 63 close to the latching notch 64 and prevent the linkage 52 from riding under center.

The upper arm 68 of the latch lever 65 is in the path of movement of the armature 70 of trip coil 71. When the trip coil 71 is energized in response to predetermined circuit conditions, the armature 70 is driven to the left to rotate the arm 68 and hence the latch member 65 in counterclockwise direction to release the latch notch 64 of the latch 65 from the latch roller 63 of the bell crank lever 54—62.

Since the toggle 53—55—54 is broken slightly upwardly in the closed position of the circuit breaker, the arm 25 may now on release of the latch roller 63 rotate clockwise around the pin 30, breaking the toggle 52 up to the position shown in Figure 2. This movement of the arm 25 in a clockwise direction is in response to the force of the compression spring 38 and tension spring 48 which, therefore, act as the opening springs of the circuit breaker. Compression spring 38 pushing on link 39 which rotates on pivot 40 pushes the contact arm clockwise.

During this opening stroke of the breaker, it will be noted that the effect of the electromagnetic forces due to current flowing in the circuit, is to hasten the contact opening thus aiding high speed circuit interruption. This I have called the "blow-open" effect.

When the breaker 10 opens, as shown in Figure 2, the pivoted contact link 39 and the current carrying contact closing arm 33 will follow the insulated contact carrying arm 25 maintaining contact with the contact element 22 in order to insure that rupturing takes place at the contacts 18—45, 19—46.

A portion of the link 54 strikes the buffer 75 carried by the bracket 60 and the upward breaking of the toggle 52 and hence the opening movement of contact arm 25 is thereby limited.

As the lever 62 is rocked counterclockwise about pin 57 it strikes lever 95 rocking this lever counterclockwise about pin 93 and removing pin 90 from slot 91 thus removing the latch from the arm 80.

The closing arm 80 which may be of insulating material is connected at one end to the pin 28 on arm 33 and at the opposite end to a pin 81 on armature 82 of the closing solenoid 83. The armature 82 is normally biased toward the left by the compression spring 85 which is seated at one end in the recess 86 of armature 82 and at the opposite end in the recess 87 of the housing 88 for the coil 83. Housing 88 is supported from the front panel 13.

When the latch is removed from arm 80 as described above, arm 80 is moved to the left under the action of spring 85 to operate arm 33 counterclockwise about its pivot 32 as shown in Figure 3.

Simultaneously pin 42 has engaged arm 27 and rocked it counterclockwise about pin 30 until contact 45—18 and 49—16 are engaged. At this time, however, the circuit is open at 39—22.

Thus with the circuit breaker in the open position, the compression spring 85 as seen in Figure 3 has moved the armature 82 fully to the left, thus moving the closing arm 80, and the pin 28 to the left and rotating the closing arm 33 to the left.

With the circuit breaker 10 in the position of Figure 3, it is reset and in condition for closing which is accomplished by energizing the closing solenoid 83. This draws the closing arm 80 to the right and rotates the current carrying closing arm 33 clockwise to bring the pivoted contact link 39 into engagement with the movable contact element 22.

In the fully closed position of the circuit breaker (Figure 1) the energization of the closing coil 83 has attracted the armature 82 to the right compressing the spring 85 and pulling the arm 80 and pin 28 to the right and rotating the lower arm 33 to the right around pin 32. When the closing movement is completed, the arm 80 is latched in closed position as shown in Figure 1 by the latch roller 90 in the latch detent 91 of the arm 80.

Latch roller 90 is supported at the end of the bell crank latching lever 92, which latching lever is rotatably supported on the pin 93 carried by an extension 94 of bracket 60. As described the upper arm 95 of latching lever 92 is so arranged that during the opening movement of the circuit breaker, that is, when the circuit breaker moves from the position of Figure 1 to the position of Figure 2, the latch roller 63 at the end of arm 54—62 will strike the upper end of arm 95 of the latch lever 92, as seen in Figure 2, to rotate the latching lever 92 counterclockwise and to move the latch roller 90 out of the latching detent 91 of closing arm 80 so that the closing arm 80 may move to the left in response to the bias of compression spring 85.

Tension spring 96 connected between the arm 95 of the latching lever 92 and extension 97 of the latching lever 65 biases the latching lever 92 toward clockwise rotation and hence toward latching position with respect to arm 80, and at the same time biases the latching lever 65 toward clockwise rotation and interengagement with the latch roller 63. The single spring 96 is thus used to reset both of the latching levers 65 and 92.

It will be seen that when the position of Figure 2 is reached, the opening spring 48 has biased the contact arm 25 clockwise to its fullest extent. During the reset for the closing movement, the first operation as shown in Figure 3 is to move the arms 33 and 27 fully to the left. Movement of arm 27 not only recloses contacts 45—18, 46—19, but also straightens toggle 52 until pin 63 is reengaged by its latch.

In preparation for the closing movement, detent 91 of arm 80 moves opposite roller 90 and the spring 96 rotates the bell crank lever 92—95 clockwise to cause the roller 90 to enter the detent 91 and hold the arm 80 in extended position.

In reclosing, the magnet 83 is engaged operating its armature to the right against the action of spring 86. Arm 33 is moved to the right until contact 39 engages contact 22 reclosing the circuit.

During the closing movement, the blow-closed effect drives the moving contact closed to the final position and at the same time further com-

presses spring 38 back to the position of Figure 1 to reach the fully closed position of Figure 1.

Summarizing the above, on a tripping of the circuit breaker, the armature 70 rotates latch lever 65 counterclockwise to release the latch roller 63 and to permit the toggle 52 to break upwardly so that the arm 25 may rotate clockwise toward opening position in response to the bias of spring 46. This is the initial step which occurs during tripping and is shown in Figure 2.

As the toggle 52 breaks upwardly, roller 63 strikes the upper arm 95 of the latching lever 92, rotating the latching lever 92 counterclockwise and lifting the latch roller 90 out of the latching detent 91. The arm 60 is now free to move in response to the bias of the compression spring 85 and moves to the left carrying the pin 28 with it and rotating arm 33 carrying the spring 38 and link 39 counterclockwise. This removes arm 33, spring 38 and link 39 from a position where they would otherwise interfere with the closing movement of the circuit breaker.

The magnetic forces induced by the current loop during closing are such as to result in a blow-closed effect. This is so because effective pivoting of the arm 33 during the final closing operation is around the pin 32. Thus it will be seen that with the contact element 22 held rigidly in the closed position the movable current carrying closing arm 33 is free to be moved about its pivot 32 and be forced into strong contact engagement with the contact element 22.

During the tripping of the circuit breaker, the entire tripping operation takes place around the pin 30 when the toggle 52 breaks on energization of the trip magnet 71. The entire opening operation is thus a blow-open operation.

In this way, therefore, the effective centers of rotation of the elements are shifted to produce a blow-closed effect during closing and a blow-open effect during opening.

Summarizing the above operations, it will now be clear that when the circuit breaker is closed, an electric circuit protected by the circuit breaker extends from the stud 15 through contact 19, contact 46 on the movable arm 26, through the conducting unit 22, through the contact 39, over arm 33 to the stud 16. This forms a loop circuit and the magnetic forces set up are such as to tend to rotate the arm 33 about its pivot 32 in a clockwise direction. This in turn, of course, effects a corresponding tendency of rotation of arm 27 about its pivot 30. However, the circuit breaker is latched against such movement at this time.

If now in response to a fault current the tripping mechanism is open in the well known manner, the magnetic forces set up will effect rotation of the arms 33 and 27 in a clockwise direction and the circuit breaker will open contacts 19 and 46.

I define this action as a "blow open" action.

When the circuit breaker is to be reclosed, the operations such as described in connection with Figure 3 occur; the arm 27 is moved counterclockwise about its pivot 30 to effect re-engagement of the contacts 19 and 46. At this time arm 33 is held in a position so that contact 39 is held out of engagement with the conducting member 22 as shown in Figure 3.

Upon complete engagement of contacts 19 and 46, an operation of the operating coil 82 moves the arm 33 in a clockwise direction to move the contact member 39 into engagement with the conducting member 22. At the instant of engagement between the contact 39 and conducting member 22, which completes the circuit of the main power line, the magnetic forces set up tend to rotate the member 33 in a clockwise direction as described above, therefore driving the contacts 39 into closer engagement with contact 22.

This latter action, namely the operation of driving the movable contact carrying arm 33 with its contact 39 into engagement with the conducting member 22 during the closing operation, I define as "blow closed" action.

Thus by my novel circuit breaker construction I have provided in the same circuit breaker a "blow open" and a "blow closed" action.

The various benefits and advantages and arrangement of the forces to produce both blow-closed and -open effect have already been described in my application Serial No. 4,725 referred to above. My present device provides a novel means for producing this effect.

In the foregoing I have described my invention in connection only with a specific illustrative embodiment thereof. Since many variations and modifications of my invention should now be obvious to those skilled in the art, I prefer to be bound not by the specific disclosures herein contained, but only by the appended claims.

I claim:

1. In a circuit breaker for protecting an electrical circuit, said circuit breaker having a first pair of cooperable contacts, one of said contacts being movable into and out of contact engagement with the other of said contacts, a first pivoted arm for carrying said movable contact in a predetermined direction for effecting disengagement of said contacts, a latch connected to said first arm for holding said contacts in engagement, a trip mechanism constructed to be responsive to fault currents in the circuit to be protected by said circuit breaker for tripping said latch, biasing means for operating said arm to move said contacts to disengaged position in response to the tripping of said latch, a second pair of cooperable contacts, a second pivoted conducting arm carrying one of said second pairs of contacts for effecting engagement of said second pair of cooperable contacts, said second pair of cooperable contacts and said second arm with said first mentioned pair of cooperable contacts being connectible to said circuit to form a loop conducting circuit said second arm being movable within said loop, a contact closing mechanism connected to said second arm for operating said arm within said loop in the same direction as said predetermined direction of movement of said first arm to effect contact engagement of said second pair of cooperable contacts, a latch for said contact closing mechanism and operable after engagement of said second pair of cooperable contacts for latching said contact closing mechanism in position, the electro-magnetic forces in said loop circuit in response to a fault current being in a direction to drive said first arm in said predetermined direction to effect disengagement of said first cooperable contacts and the electro-magnetic forces in said loop circuit due to fault current operating said second arm in said same predetermined direction for effecting tight contact engagement between said second pair of cooperable contacts during circuit closing operation.

2. In a circuit breaker for protecting an electrical circuit, said circuit breaker having a pair of cooperable contacts, one of said contacts being movable into and out of contact engagement with the other of said contacts, a contact carry-

ing arm mechanism for carrying said movable contact in a predetermined direction for effecting disengagement of said contacts, a latch connected to said contact carrying arm mechanism for holding said contacts in engagement, a trip mechanism constructed to be responsive to fault currents in the circuit to be protected by said circuit breaker for tripping said latch, biasing means for operating said arm mechanism to move said contacts to disengaged position in response to the tripping of said latch, means including said contact carrying arm mechanism when said contacts are in latched engagement for applying the electro-magnetic forces due to a fault current in the circuit protected by said circuit breaker to said contact carrying arm mechanism for driving said contact carrying arm mechanism in a direction to effect disengagement of said contacts and an arm carrying a second movable contact into engagement with said first mentioned movable contact, a contact closing mechanism connected to said arm for operating said arm in the same direction as said predetermined direction of movement of said arm mechanism to effect contact engagement of the second movable contact on said arm with said first mentioned movable contact.

3. In a circuit breaker for protecting an electrical circuit, said circuit breaker having a pair of cooperable contacts, one of said contacts being movable into and out of contact engagement with the other of said contacts, a contact carrying arm mechanism for carrying said movable contact in a predetermined direction for effecting disengagement of said contacts, a latch connected to said contact carrying arm mechanism for holding said contacts in engagement, a trip mechanism constructed to be responsive to fault currents in the circuit to be protected by said circuit breaker for tripping said latch, biasing means for operating said arm mechanism to move said contacts to disengaged position in response to the tripping of said latch, said contact carrying arm mechanism and said contacts forming when said contacts are in latched engagement, a loop circuit for applying the electro-magnetic forces, due to a fault current in the circuit protected by said circuit breaker to said contact carrying arm mechanism for driving said contact carrying arm mechanism in a direction to effect disengagement of said contacts and an arm mounted within said loop circuit and carrying a second movable contact into engagement with said first mentioned movable contact, a contact closing mechanism connected to said arm for operating said arm to effect contact engagement of the second movable contact on said arm with said first mentioned movable contact.

4. In a circuit breaker for protecting an electrical circuit, said circuit breaker having a pair of cooperable contacts, one of said contacts being movable into and out of contact engagement with the other of said contacts, a contact carrying arm mechanism for carrying said movable contact in a predetermined direction for effecting disengagement of said contacts, a latch connected to said contact carrying arm mechanism for holding said contacts in engagement, a trip mechanism constructed to be responsive to fault currents in the circuit to be protected by said circuit breaker for tripping said latch, biasing means for operating said arm mechanism to move said contacts to disengaged position in response to the tripping of said latch, said contact carrying arm mechanism and said contacts forming

when said contacts are in latched engagement, a loop circuit, for applying the electro-magnetic forces due to a fault current in the circuit protected by said circuit breaker, to said contact carrying arm mechanism for driving said contact carrying arm mechanism in a direction to effect disengagement of said contacts and an arm mounted within said loop circuit and carrying a second movable contact into engagement with said first mentioned movable contact, a contact closing mechanism connected to said arm for operating said arm to effect contact engagement of the second movable contact on said arm with said first mentioned movable contact, said arm and second movable contact being in said loop circuit and being operated by the electro-magnetic forces due to a fault current in the circuit protected by said circuit breaker to drive said arm with said second movable contact into contact engagement with said first mentioned contact on said contact carrying arm mechanism.

5. In a circuit breaker for protecting an electrical circuit, said circuit breaker having a first pair of cooperable contacts, one of said contacts being movable into and out of contact engagement with the other of said contacts, a contact carrying arm mechanism for carrying said movable contact in a predetermined direction for effecting disengagement of said contacts, a latch connected to said contact carrying arm mechanism for holding said contacts in engagement, a trip mechanism constructed to be responsive to fault currents in the circuit to be protected by said circuit breaker for tripping said latch, biasing means for operating said arm mechanism to move said contacts to disengaged position in response to the tripping of said latch, a second pair of cooperable contacts, one of said second pair of contacts being mounted on said contact carrying mechanism, an arm carrying the other of said second pair of contacts into contact engagement with its associated contact, a contact closing mechanism connected to said arm for operating said second pair of contacts into contact engagement, said first and second pair of contacts being arranged to form a loop circuit with the circuit to be protected for applying the electro-magnetic forces, due to a fault current in the circuit protected by said circuit, to said contact carrying arm mechanism for driving said contact carrying arm mechanism in a direction to effect disengagement of said first cooperable contacts and for applying the said electro-magnetic forces to said arm in a direction to effect engagement of said second pair of cooperable contacts.

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