Dec. 2, 1941. F. D. JOHNSON 2,264,982

MOTOR CONTROL CIRCUIT FOR CIRCUIT-BREAKER CLOSING MECHANISMS

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Fig. 1.

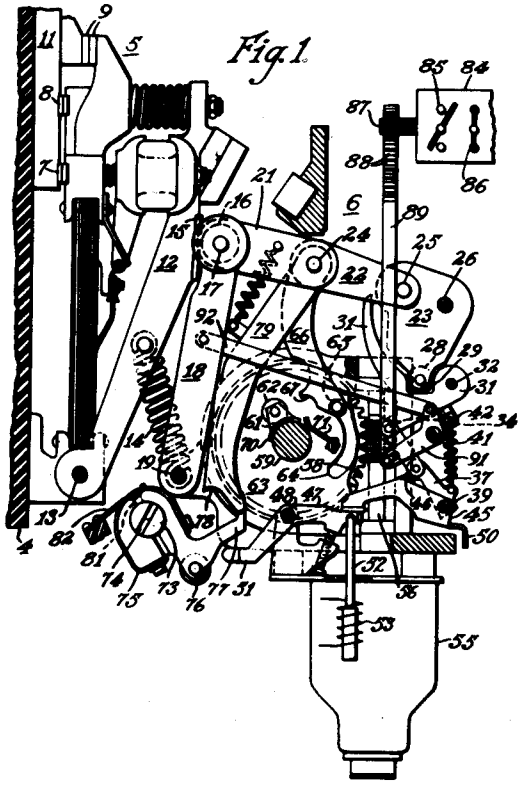


Fig. 2.

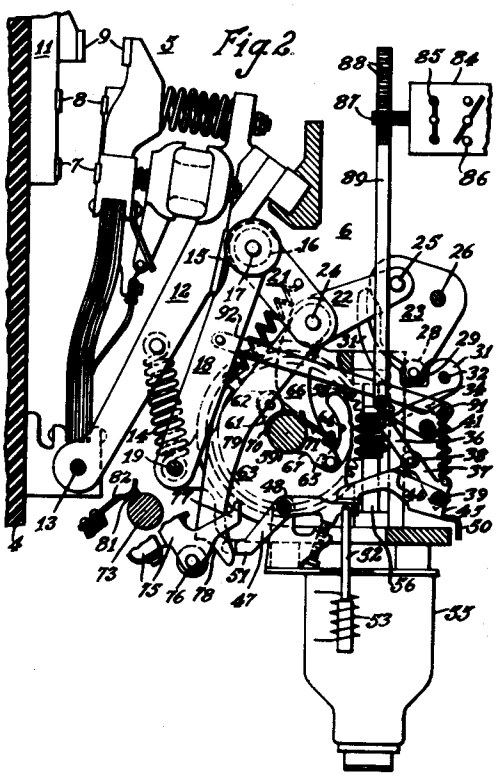
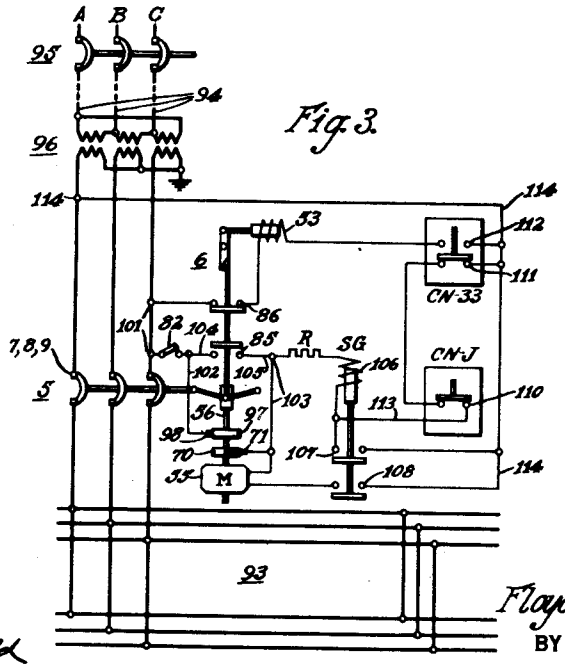


Fig. 3.



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MOTOR-CONTROL CIRCUIT FOR CIRCUIT-BREAKER CLOSING MECHANISMS

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My invention relates to motor-operated closing-mechanisms for circuit breakers, and it has particular relation to that important type of circuit breaker which has come to be known as a network protector. More specifically, my invention has particular relation to the distribution system, as distinguished from the electrical generating and transmission systems, the importance of the distribution system being indicated by the fact that it represents approximately 40% of the investment of all of the central-station operating-companies, in apparatus and plant. Still more specifically, my invention relates to the automatic, alternating-current, low-voltage network which is now recognized as the standard for serving heavily loaded areas. Such a network is served from feeders which are connected to the network, at various points, through network-transformers, the transformers and feeders being, in turn, protected by network-protectors which consist of very compactly arranged circuit breakers which are provided with special protector-relays.

Heretofore such network-protectors have given some trouble and have involved a rather exacting manufacturing procedure, in connection with the controlling means for the motor which is utilized to close the circuit-breaker mechanism, and my present invention is designed to overcome these troubles by producing a motor-control circuit which is at once simple, non-critical in its structure and adjustment, and absolutely reliable and trouble-free in service. My invention is an improvement over the network-protectors which are described and claimed in an application of Ture Lindstrom, Serial No. 156,743, filed July 31, 1937, and a patent of John B. MacNeill, No. 2,157,714, granted may May 9, 1939, both assigned to the Westinghouse Electric & Manufacturing Company.

My present invention relates to that common type of circuit breaker having a closing-mechanism which employs an electric motor with a gear reduction to drive a cam or crank shaft, or other thrust-imparting means for imparting a closing thrust to the movable contact-member of the circuit breaker during a small part of the revolution of the low-speed shaft carrying the cam or crank or equivalent thrust-imparting means. The cam or crank or other thrust-imparting means commonly actuates a toggle-linkage in order to secure a greater mechanical advantage in the last stages of the closing operation, and also in order to provide a convenient means for making the breaker trip-free by the simple expedient of displacing one end of the toggle-linkage. To deenergize the closing-motor at the completion of the closing-cycle, it has been common to provide a cutoff switch which is actuated by the toggle-linkage, and it is this cutoff switch which has been the source of cost and trouble which my present invention seeks to avoid.

In order that such a cutoff switch should operate properly, it was necessary that it should have a snap-action in both its opening and closing movements, that it should be so accurately designed, and so accurately coupled to the toggle-linkage, that it would reliably open during the very last small fraction of an inch of travel of the knee-pivot of the toggle, neither too soon nor too late, during the closing movement of the toggle; and it was further required that the closing movement of the cutoff switch should take place within the last small fraction of an inch of travel of the opening movement of the toggle toward its reset position when the circuit breaker is opening. Experience has proved that it is impractical to successfully manufacture and use such cutoff switches without providing refinements of adjustment in order to secure the necessary accuracies of operation; and the inevitable errors and changes in such adjustments have proved very troublesome in the past.

My present invention has for its object, a combination of simple switches, with appropriate circuits therefor, such that it is not necessary to utilize any cutoff switch operated from the toggle-linkage, it is not necessary to have any snap-action cutoff switch, and it is not necessary to make any adjustments. Preferably, the deenergization of my closing-motor is accomplished after the closing-mechanism is latched in its closed position, as distinguished from the previous practice of attempting to deenergize the motor just immediately before the closing-mechanism has reached its fully closed position.

A further object of my invention relates to an auxiliary switch, in the motor-control circuit, for correlating the motor-control mechanism with the position of the manual closing-means or hand-operating device which is commonly provided for manually closing the circuit breaker or network-protector.

With the foregoing and other objects in view, my invention consists in the parts, combinations, circuits, apparatus and methods hereinafter described and claimed, and illustrated in the accompanying drawing wherein:

Figure 1 is a somewhat diagrammatic partial view, in side elevation, of a network-protector

embodying my invention, showing the relative positions of the essential parts when the circuit breaker or protector is closed;

Fig. 2 is a similar view showing the position of the parts when the circuit breaker is open, with certain parts broken away to better illustrate the construction; and

Fig. 3 is a diagrammatic view of electrical circuits and apparatus embodying my invention.

As shown in Figs. 1 and 2, my invention, is illustrated as being applied to a network-protector which is mounted on an insulating panel 4, and which comprises a circuit breaker 5 and an operating mechanism 6 therefor. Each pole of the circuit breaker 5 has three main-circuit contacts 7, 8 and 9, each of which is a pair of contacts, one contact being stationary and the other contact being movable. The stationary contacts are mounted upon a stationary contact-block or bus 11, while the movable contacts are carried by a movable contact-arm 12 which is pivotally supported at 13, and which is strongly biased toward its open position by means of an accelerating spring which is diagrammatically indicated at 14. The movable contact-arm 12 is provided with an abutment-plate 15 which is adapted to be engaged by the closing-mechanism 6 in order to close the circuit breaker.

The closing-mechanism 6 comprises a closing-roller 16, and means for suitably supporting and actuating said roller so that it presses against the abutment-plate 15 of the movable contact-arm 12 during the closing movement of the mechanism. The closing roller 16 is mounted on a shaft or pivot 17 at the end of a link 18 which is pivotally supported at 19. The roller-shaft 17 is also engaged by one end of a three-part toggle-linkage which comprises two links 21 and 22 and a bell crank 23. The two links 21 and 22 are pivoted together at a knee-pivot 24 of the toggle, the other end of the first link 21 being connected to the roller-shaft or pivot 17, while the other end of the second link 22 is pivoted at 25 to the bell crank 23. The bell crank 23 is pivotally supported on a fixed pivot 26. In the closed or locked position of the linkage 21—22—23, the knee-pivot 24 is just above the line of action between the pivots 17 and 25, while the bell-crank pivot 25 is just above the line of action between the pivots 24 and 26.

The bell crank 23 is provided with a depending arm, terminating in a latch-roller 28 which is normally engaged in a notch 29 of a latch 31 which is movably mounted on a fixed pivot 32. The latch 31 has a depending arm which is pivoted at 34 (Fig. 2) to the top end of a latch-toggle comprising the links 36 and 37 which are connected by a knee-pivot 38. The top link 36 of the latch-toggle is connected to the pivot-pin 34 of the latch 31, while the bottom link 37 is pivotally mounted on a fixed pivot 39. The bottom link 37 of the latch-toggle is biased toward its latched position by means of a latch-toggle resetting spring 41, the upper end of which is connected, at 42 (Fig. 1), to the latch 31, in such position that the line of action of the latch-toggle resetting spring is practically in line with the supporting-pivot 32 of the latch when the parts are in their closed position as illustrated in Fig. 1.

The knee-pivot 38 of the latch-toggle is held in its latched position by reason of the fact that the knee-end of the lower latching link 37 abuts against an abutment 44 on the top of a main trip-lever 45. The trip-lever 45 is pivotally supported, at its front end, on a fixed pivot 39, while its rear end normally rests upon the front end of an auxiliary trip-lever 47 which is intermediately pivoted on a fixed pivot 48. The front end of the main trip-lever is provided with a manual tripping handle 50, while the rear end of the auxiliary trip-lever 47 is provided with a depending arm 51 which is adapted to be depressed by a manual operating mechanism, subsequently to be described, in order to trip the breaker.

The main tripping-means for the circuit breaker consists of a trip-rod 52 which is adapted to be raised into engagement with the rear end of the main trip-lever 45 so as to break the latch-toggle 36—37, permitting the latch 31 to swing in a counter-clockwise direction under the thrust of the latch-roller 28 of the bell crank 23, which tends to rotate in a clockwise direction as a result of the tension of the accelerating or opening spring 14 operating upon the movable contact-arm 12. When the bell crank 23 thus rotates in a clockwise direction, its linkage pivot-pin 25 is carried up, so that the line of action 17—25 is carried above the knee-pivot 24 of the main closing linkage 21—22, causing said linkage to collapse under the influence of the powerful opening or accelerating spring 14 of the movable contact-arm 12.

The trip-rod 52, which initiates the tripping-operation just described, is elevated by means of a trip-coil 53 in a manner which is well understood in the art.

The closing-mechanism of the breaker, to which my present invention particularly relates, is actuated by a vertical-shaft motor 55 having an upwardly extending worm-gear shaft 56 which is geared to a worm wheel 58. The worm wheel 58 is fixed on a slow-motion shaft 59 carrying a closing-crank 61 terminating in a closing-roller 62. The worm wheel 58 is enclosed in a gear case 63, said gear case being illustrated, for the sake of simplicity, as being provided with an arcuate slot 64 which serves as a guide for a roller 65 carried by the bottom end of a closing-link 66, the top end of which is pivoted on the knee-pivot 24 of the main closing-toggle 21—22.

When the circuit breaker is in its open position, as shown in Fig. 2, the closing-link 66 is in its lowermost position, with its roller 65 at the bottom of the guide-slot 64 which is carried by the gear case 63. The lower portion of the closing-latch 66 is provided with a depression 67 which is adapted to be engaged by the closing-roller 62 of the closing-crank 61 when the slow-motion shaft 59 is driven in a counter-clockwise direction by the closing-motor 55. When this action occurs, the closing-roller 62 engages the depression 67 in the bottom of the closing link 66 during a small part of a single counter-clockwise rotation of the slow-motion crankshaft 59, so as to elevate the closing-link 66, thereby elevating the knee-pivot 24 of the main closing-linkage 21—22 to its fully closed position just above the line of action 17—25, thrusting the closing-roller 16 backward against the abutment-plate 15 of the movable contact-arm 12, and closing the said contact-arm during this operation.

In accordance with my invention, the slow-motion crankshaft 59 is provided with an insulated electrical contact-segment 70 which is engaged, during a portion of the revolution of the crankshaft 59, by a switch-spring 71. The position of the contact-segment 70 is such that the contact between the segment 70 and the switch-spring 71 is broken soon after the closing-roller

62 quits the depression 67 in the bottom of the closing-link 66, during the counter-clockwise rotation of the crankshaft 59, so that the contact 71 is opened immediately after the closing-crank 61 ceases imparting its closing-thrust to the closing-mechanism 6 of the circuit breaker. The arcuate extent or length of the contact-segment 70 is such that it does not engage the switch-arm 71, to close the switch, during the counter-clockwise rotation of the crankshaft 59, until the closing-motor 55 has been energized by some other means (subsequently described), and preferably not until the closing-roller 62 of the closing-crank 61 is already in engagement with the depression 67 in the bottom of the closing link 66, and is in the process of elevating said link during the closing operation of the circuit breaker.

The illustrated network-protector is shown as being provided with a manual operating-shaft 73 which is disposed near the fixed pivots 13 and 19. For simplicity of illustration, the front end of the manual operating-shaft, as viewed in Fig. 1, is illustrated as being provided with a slot 74 which may be engaged by a suitable operating-handle, crank, or other tool (not shown). The manual operating-shaft 73 carries a crank-arm 75 which is provided with a closing-roller 76, and which is also provided with a tripping-extension 77. The closing-roller 76 is adapted to engage a depression 78 in the bottom end of a manually operated closing-link 79, the top end of which is in engagement with the knee-pivot 24 of the main closing-linkage 21 and 22. The tripping-projection 77 of the crank-arm 75 of the manual operating-mechanism lies over the depending rear end 51 of the auxiliary trip-lever 47.

The manual operating-shaft 73 has three operative positions, including an intermediate neutral position, as illustrated, which is commonly designated as the "automatic" position, because it is the position which the manual operating shaft 73 occupies when the automatic tripping and closing mechanism is in operation. When the manual operating-shaft 73 is rotated, in a counter-clockwise direction, from its illustrated neutral position to a closed position, its closing roller 76 elevates the manually operated closing-link 79 to close the circuit-breaker mechanism. When the manual operating-shaft 73 is rotated, in a clockwise direction, from its illustrated neutral position to its tripping position, its tripping arm 77 depresses the rear end of the auxiliary trip-lever 47, thereby causing said lever to elevate the main trip-lever 45 and trip the circuit-breaker mechanism.

In accordance with my invention, as illustrated more clearly in Fig. 2, the manual operating-shaft 73 is provided with a short insulated contact-segment 81 which is adapted to be engaged by a spring switch-arm 82 only when the manual operating-shaft 73 is in its neutral or "automatic" position, so that said switch 81—82 is closed only when the manual operating-shaft is in said position.

The illustrated network-protector is shown as being provided with an auxiliary switching-mechanism 84, which is provided with a plurality of contacts, only two contacts 85 and 86 being illustrated. This auxiliary switching-mechanism 84 is adapted to be mechanically coupled to the circuit breaker so as to be responsive to the positions or conditions of the circuit-breaker parts. For simplicity of illustration, the shaft 87 of the auxiliary switch-mechanism 84 is illustrated as being rocked by means of a rack 88, or other mechanical coupling, on a vertical rod 89, the bottom end of which is pivoted on a bell crank 91 which is rocked by means of a link 92 carried by the main operating-link 18 which supports the closing-roller 16 of the breaker-mechanism.

The electric operating-circuits of a typical apparatus embodying my invention are illustrated in Fig. 3, which shows a system in which power is supplied to a three-phase low-voltage network 93 through a three-phase high-voltage feeder 94, the distant end of which is energized through a feeder-breaker 95. The feeder 94 energizes a step-down network-transformer 96 which is connected to the network 93 through the main contacts 7, 8, 9 of a network-breaker 5. One pole of the network-breaker is illustrated in Figs. 1 and 2, it being understood that the other two poles of the breaker are mounted on the same operating-mechanism, so that all three poles are actuated simultaneously.

The breaker operating-mechanism 6 is indicated quite schematically in Fig. 3, including the previously described switches 71, 82, 85 and 86. To facilitate the schematic illustration, the switch 71 is illustrated as if it comprised two slip-rings carried by the motor-shaft 56, one slip-ring being the one carrying the previously described contact-segment 70, while the other slip-ring, indicated at 97, is a continuous slip-ring engaged by a brush 98, so that the brush 98 is constantly in electrical connection with the contact-segment 70 through the metal parts joining the second slip-ring 97 with the said contact-segment 70.

Power for operating the closing-motor 55 is derived from one of the phases of the low-voltage circuit, starting with a phase-conductor 101 and traceable through the auxiliary switch 82 which is carried by the manual operating-shaft 73 of Figs. 1 and 2, thence to two switches 71 and 85 which are in parallel circuit-relation to each other and in series circuit-relation to the auxiliary switch 82.

The switch 71 is responsive to the position of the slow-motion crankshaft 59 of Figs. 1 and 2, being mechanically coupled to said crankshaft by having its contact-segment 70 mounted on said shaft. Its circuit may be traced in Fig. 3, through a conductor 102, the brush 98, the slip-ring 97, the contact-segment 70 and the brush 71, to a conductor 103.

The switch 85 is a switch of the auxiliary switching-mechanism 84 of Figs. 1 and 2 which is responsive to the position of the circuit breaker. The switch 85 is so arranged that it is open when the circuit breaker is closed, and so that it closes at a predetermined point in the opening movement of the circuit breaker, preferably just before the circuit breaker is fully opened. In Fig. 3, the electrical connections to the auxiliary switch 85 may be traced from the conductor 102, through a conductor 104 to the switch 85, and thence through a conductor 105 to the conductor 103.

In the electrical control-circuit shown in Fig. 3, I also provide an auxiliary contactor SG having an operating coil 106 and two make-contacts 107 and 108.

I also provide an auxiliary controlling relay such as the relay marked CN—J in Fig. 3, said relay having a normally closed contact 110, which may be controlled in any manner which is customary in network-protectors, the specific details of which do not constitute a part of my

present invention, except that suitable controlling relay-mechanism is utilized. It is customary, in network-protectors, for the relay CN—J to open its back-contact 110, when the circuit breaker is open, whenever the low-voltage output of the network-transformer 96 is less than the voltage of the network 93, or is out of phase with the voltage of the network 93 by more than a predetermined amount.

The electrical control-system which is illustrated in Fig. 3 is also shown as including a normally closed back-contact 111, and a normally open front-contact 112 of a so-called "master" network-relay CN—33, the exact details of which constitute no part of my present invention, other than that suitable relaying-means are provided. It is customary to have the back-contact 111 of the master relay CN—33 open automatically, when the circuit breaker is open, whenever there is a phase-reversal of the low-voltage output of the network-transformer 96, as compared with the order of phase-sequence of the three phases of the network 93, and it is customary to have the front or "make" contact 112 of the master relay CN—33 automatically close, when the circuit breaker is closed, whenever there is a current reversal such as takes place when there is a fault on the transformer side of the breaker, so that current is being fed back from the network 93 toward the transformer 96.

Referring, again, to the electrical control-circuits which are illustrated in Fig. 3, it will be observed that the operation of the motor, M or 55, is initiated by the closure of the auxiliary switch 85 which closes whenever the circuit-breaker is opened, (or by the reclosure of the relay-contact 111 in the case where the tripping had been initiated by the contact 112 of the CN—33 relay). When this auxiliary switch 85 closes, provided that the auxiliary switch 82 of the manual operating mechanism is also closed, a circuit is energized from the low-voltage line-conductor 101 to the conductor 103, and thence, through a resistor R, to the operating coil 106 of the SG relay, after which the circuit is completed, through a conductor 113 and the serially connected back-contacts 110 and 111 of the control-relays CN—J and CN—33, to another low-voltage phase-conductor 114.

The energization of the relay SG closes its "make" contacts 107 and 108. The make-contact 107 bypasses the relay-contacts 110 and 111, so that a complete closing operation, once started, will be carried through, regardless of the subsequent operation of either one of the relays CN—J or CN—33. The make-contact 108, of the SG relay, connects one terminal of the motor 55 directly to the line 114, the other terminal of the motor being connected to the conductor 103 which is connected to the line 101 through the auxiliary switches 85 and 82.

The motor, being thus energized, begins to rotate so as to cause a counter-clockwise rotation of the crank-arm 59 in Figs. 1 and 2. After this rotation of the crank-arm 59 is well under way, and preferably after the closing-roller 62 of the closing-crank 61 has engaged the depression 67 in the bottom of the closing-link 66, and has begun to elevate said link, in the closing operation of the mechanism, the crank-arm-responsive switch 70—71 closes, thereby completing a by-pass circuit around the auxiliary switch 85, as shown in Fig. 3. As the closing motor 55 continues its rotation, the closing-mechanism of the circuit breaker reaches a predetermined point, in its closing-movement, which need not be a critically chosen point, other than that it comes at a time after the closure of the switch 70—71 and before the operating-mechanism is in its final closed position. At this predetermined point in the closing-movement of the operating-mechanism, the auxiliary switch 85 opens; but the motor 55 and the auxiliary relay SG remain energized because the bypassing contacts 70—71 are still closed.

The bypassing contacts 70—71 remain closed at least until the closing-mechanism of the circuit breaker has substantially reached its final closed position which is illustrated in Fig. 1, and thereafter the switch 70—71 opens. Preferably, the switch 70—71 opens after the closing roller 62, or other thrust-imparting means which is responsive to the rotation of the slow-speed shaft 59 in Figs. 1 and 2, has ceased giving a closing-thrust to the movable contact-arm 12, that is, in the illustrated mechanism, after the closing-roller 62 has left the depression 67 in the bottom end of the closing-link 66 (Fig. 1) during the counter-clockwise rotation of the crankshaft 59.

Since the contact-segment 70 of the switch 70—71 occupies only a small portion of the total circumference of the crankshaft 59, and since there is a relatively large angular or rotational movement of the closing-crank 61 which must take place after the closing-roller 62 has quit the depression 67 in the closing-link 66, at the end of the closing operation of the breaker, as shown in Fig. 1, (and before the closing roller 62 can reengage said depression 67 after the breaker has been tripped open, as shown in Fig. 2), there is a considerable proportion of a single counter-clockwise rotation of the crankshaft 59, in Figs. 1 and 2, in which the motor 55 may be brought to a stop, without requiring any particularly critical adjustment, the only requirement being that the motor shall stop before it drifts far enough to reclose the switch 70—71. My controlling-mechanism, therefore, is not critical, and does not require accurate adjustments of any sort.

In the control-circuits shown in Fig. 3, the automatic tripping-means of the circuit breaker is of a conventional sort, comprising a trip-circuit which may be traced from the low-voltage line-conductor 101, through the auxiliary switch 86, and thence to the trip-coil 53, after which the circuit is completed, through the make-contact 112 of the master relay CN—33, and thence to the other low-voltage line-conductor 114.

While I have illustrated my invention in a single preferred form of embodiment, referring both to the structural design and the particular illustrated electrical control-circuits, I wish it to be understood that such showing is only illustrative, and that various changes may be made, in the design, without departing from the essential spirit of my invention. I desire, therefore, that the appended claims shall be accorded the broadest construction consistent with their language.

I claim as my invention:

1. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative at times, to cause an opening movement of the movable contact-member; and closing-mechanism operative, at times, to perform an operation tending to cause a closing movement of the movable contact-member; said closing-mechanism including a rotating shaft, an electric motor for driving said

shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and energizing and controlling means for said motor; said energizing and controlling means being characterized by including a first switch-controlling means operative, when actuated, to cause the operation of said motor, means for operatively associating said first switch-controlling means with the circuit-breaker in such manner that it is moved to its actuated position at a predetermined point in an opening movement of the circuit breaker and is moved to its non-actuated position during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, and a second switch-controlling means also operative, when actuated, to cause the operation of the motor, means for operatively associating said second switch-controlling means with said shaft in such manner that it is moved to its actuated position at some time after the first switch-controlling means has moved to its actuated position and before the first switch-controlling means has returned to its non-actuated position, the operative association of said second switch-controlling means with the shaft being such that it remains in its actuated position at least until the closing-mechanism has substantially reached its final closed position, the operative association of said second switch-controlling means with the shaft being such that it thereafter returns to its non-actuated position.

2. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause an opening movement of the movable contact-member; and closing-mechanism operative, at times, to perform an operation tending to cause a closing movement of the movable contact-member; said closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and energizing and controlling means for said motor; said energizing and controlling means being characterized by including a first switch-controlling means operative, when actuated, to cause the operation of said motor, means for operatively associating said first switch-controlling means with the circuit breaker in such manner that it is moved to its actuated position at a predetermined point in an opening movement of the circuit breaker and is moved to its non-actuated position during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, and a second switch-controlling means also operative, when actuated, to cause the operation of the motor, means for operatively associating said second switch-controlling means with said shaft in such manner that it is moved to its actuated position at some time after the first switch-controlling means has moved to its actuated position and before the first switch-controlling means has returned to its non-actuated position, the operative association of said second switch-controlling means with the shaft being such that it moves to its non-actuated position after said thrust-imparting means has ceased giving a closing thrust to said movable contact-member.

3. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause an opening movement of the movable contact-member; a manually closing-means operative, when moved from a neutral position to a closed position, to perform an operation tending to cause the main contacts to be closed; and a motorized closing-mechanism operative, at times, to perform an operation tending to cause a closing movement of the movable contact-member; said motorized closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and energizing and controlling means for said motor; said energizing and controlling means being characterized by including a first switch-controlling means operative, when actuated, to cause the operation of said motor, means for operatively associating said first switch-controlling means with the circuit breaker in such manner that it is moved to its actuated position at a predetermined point in an opening movement of the circuit breaker and is moved to its non-actuated position during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, a second switch-controlling means also operative, when actuated, to cause the operation of the motor, means for operatively associating said second switch-controlling means with said shaft in such manner that it is moved to its actuated position at some time after the first switch-controlling means has moved to its actuated position and before the first switch-controlling means has returned to its non-actuated position, the operative association of said second switch-controlling means with the shaft being such that it remains in its actuated position at least until the closing-mechanism has substantially reached its final closed position, the operative association of said second switch-controlling means with the shaft being such that it thereafter returns to its non-actuated position, and a third switch-controlling means mechanically associated with said manual closing-means in such manner as to make it possible for the first switch-controlling means to initiate the operation of said motor only when said manual closing-means is in its neutral position.

4. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause an opening movement of the movable contact-member; a manual closing-means operative, when moved from a neutral position to a closed position, to perform an operation tending to cause the main contacts to be closed; and a motorized closing-mechanism operative, at times, to perform an operation tending to cause a closing movement of the movable contact-member; said closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and energizing and controlling means for said motor; said energizing and controlling means being characterized by including a first switch-controlling means operative, when actuated, to cause the operation of said motor, means for operatively associating said first switch-controlling means with the circuit breaker in such manner that it is moved to its actuated position at a predetermined point

in an opening movement of the circuit breaker and is moved to its non-actuated position during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, a second switch-controlling means also operative, when actuated, to cause the operation of the motor, means for operatively associating said second switch-controlling means with said shaft in such manner that it is moved to its actuated position at some time after the first switch-controlling means has moved to its actuated position and before the first switch-controlling means has returned to its non-actuated position, the operative association of said second switch-controlling means with the shaft being such that it moves to its non-actuated position after said thrust-imparting means has ceased giving a closing thrust to said movable contact-member, and a third switch-controlling means mechanically associated with said manual closing-means in such manner as to make it possible for the first switch-controlling means to initiate the operation of said motor only when said manual closing-means is in its neutral position.

5. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause the main contacts to open; and closing-mechanism operative, at times, to cause the main contacts to close, said closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and an electrical circuit-means operative, when energized, to cause the operation of said motor; said electrical circuit-means being characterized by including two switching-means in parallel operative relation with respect to each other and in series operative relation with respect to said circuit-means, one of said switching-means being mechanically connected to said circuit breaker in such manner that it closes at a predetermined point in an opening movement of the circuit breaker and opens during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, and the other one of said switching-means being mechanically connected to said shaft in such manner that it closes after said thrust-imparting means has begun to impart a closing thrust to the movable contact-member and remains closed substantially until the closing-mechanism is in its final closed position.

6. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause the main contacts to open; and closing-mechanism operative, at times, to cause the main contacts to close, said closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and an electrical circuit-means operative, when energized, to cause the operation of said motor; said electrical circuit-means being characterized by including two switching-means in parallel operative relation with respect to each other and in series operative relation with respect to said circuit-means, one of said switching-means being mechanically connected to said circuit breaker in such manner that it closes at a predetermined point in an opening movement of the circuit breaker and opens during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, and the other one of said switching-means being mechanically connected to said shaft in such manner that it closes after said thrust-imparting means has begun to impart a closing thrust to the movable contact-member and opens after said thrust-imparting means has ceased giving a closing thrust to the movable contact-member.

7. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause the main contacts to open; a manual closing-means operative, when moved from a neutral position to a closed position, to cause the main contacts to be closed; and a motorized closing-mechanism operative, at times, to cause the main contacts to close, said motorized closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and an electrical circuit-means operative, when energized, to cause the operation of said motor; said electrical circuit-means being characterized by including two switching-means in parallel operative relation with respect to each other and in series operative relation with respect to said circuit-means, and a third switching-means in series operative relation with respect to said circuit and said two switching-means, one of said two switching-means being mechanically connected to said circuit breaker in such manner that it closes at a predetermined point in an opening movement of the circuit breaker and opens during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, the other one of said two switching-means being mechanically connected to said shaft in such manner that it closes after said thrust-imparting means has begun to impart a closing thrust to the movable contact-member and remains closed substantially until the closing-mechanism is in its final closed position, and the third switching-means being mechanically associated with said manual closing-means in such manner that it is closed only when said manual closing-means is in its neutral position.

8. In combination; a circuit breaker having main contacts including a movable contact-member; opening-means operative, at times, to cause the main contacts to open; a manual closing-means operative, when moved from a neutral position to a closed position, to cause the main contacts to be closed; and a motorized closing-mechanism operative, at times, to cause the main contacts to close, said motorized closing-mechanism including a rotating shaft, an electric motor for driving said shaft, thrust-imparting means effective during considerably less than one complete rotation of said shaft for imparting a closing thrust to said movable contact-member, and an electrical circuit-means operative, when energized, to cause the operation of said motor; said electrical circuit-means being characterized by including two switching-means in parallel operative relation with respect to each other and in series operative relation with respect to said circuit-means, and a third switching-means in series operative relation with respect to said circuit and said two switching-means, one of said two switching-means being mechanically connected to said circuit breaker in such manner

that it closes at a predetermined point in an opening movement of the circuit breaker and opens during a closing movement of the circuit breaker before the closing-mechanism is in its final closed position, the other one of said two switching-means being mechanically connected to said shaft in such manner that it closes after said thrust-imparting means has begun to impart a closing thrust to the movable contact-member and opens after said thrust-imparting means has ceased giving a closing thrust to the movable contact-member, and the third switching-means being mechanically associated with said manual closing-means in such manner that it is closed only when said manual closing-means is in its neutral position.

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