The invention relates to circuit breakers in general and more particularly to operating mechanisms for opening and reclosing a circuit breaker.

In high voltage electrical systems or networks a very large percentage of disturbances or faults result from a short circuit or ground connection formed by an air arc. Disturbances of this type are completely cleared in most cases immediately after extinction of the arc by interruption of the circuit. In order to prevent loss of synchronism in the system in clearing such faults, it is necessary to interrupt and immediately reclose the circuit as quickly as possible. Thus, for example, in a 200 kv. line it has been found necessary to interrupt and reclose the circuit within a time interval of not more than one half a second after the manifestation of the fault. Circuit breakers of which I am aware are not capable of obtaining such high speed interruption and reclosing of the circuit because they have a characteristic time up to interruption of the circuit alone of the order of one half of a second.

Accordingly an object of the invention is the provision of an improved circuit breaker which is operable to interrupt and immediately reclose the circuit within the short time interval required to prevent loss of synchronism in the system.

Another object of the invention is the provision of a circuit breaker mechanism which is operable to effect a quick interruption and instantaneous reclosure of the circuit within a relatively short total time interval.

Another object of the invention is the provision of a circuit breaker and operating mechanism which is operable upon the occurrence of a fault condition to interrupt and instantaneously reclose the circuit within a total time interval of a half second or less measured from the manifestation of the fault.

Another object of the invention is the provision of a circuit breaker and operating mechanism therefor which is operable in response to predetermined conditions to cause the moving contact member to quickly move to full open position free of the driving mechanism, and instantaneously returned to the closed position.

Another object of the invention is the provision of a circuit breaker mechanism which is operable to cause the moving contact member to quickly move to full open position free of the driving mechanism and instantaneously return to the closed position, both of the above taking place upon opening movement and return of the driving mechanism through only a fraction of its full travel distance.

Another object of the invention is the provision of a circuit breaker mechanism which is operable to release the moving contact member from the driving mechanism to cause interruption of the circuit and to cause immediate reclosure of the contact member, and which is also operable to positively hold the moving contact member in either its open or closed position.

Another object of the invention is the provision of a circuit breaker mechanism as previously described which is simple, reliable in operation, and inexpensive to manufacture.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation together with additional objects and advantages thereof will be best understood from the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawings in which:

Figure 1 is a schematic view of a circuit breaker mechanism embodying the invention;

Fig. 2 is a schematic view of a modification of the circuit breaker mechanism;

Fig. 3 is a schematic view of a further modification of the invention;

Fig. 4 is a schematic view of the circuit breaker mechanism shown in Fig. 3 showing the moving contact member in the full open position and the driving mechanism in the partly open position where its movement is reversed to reclose the breaker, and

Fig. 5 is a schematic view showing a modified construction of the apparatus shown in Fig. 3.

Referring to Figure 1 of the drawings, the circuit breaker which is shown schematically comprises a stationary contact 1, and a co-operating movable contact member 9 in the form of a conducting bar or rod which is mounted and guided on a support 11 for vertical movement into and out of engagement with the stationary contact 1. The contact member 9 has a slotted crosshead 13 secured to its upper end which is connected to the free end of a lever 15. The lever 15 is pivoted on a fixed pivot 17 and carries a pin 19 which engages in the slot of the crosshead 13.

The movable contact member 9 is adapted to be moved to open and to closed positions for normal switching operations by a driving means.
and force transferring means comprising an operating rod 21 and an operating lever 23. The operating lever 23 is pivoted on the fixed pivot 15 by means of a latch 25 pivoted at 27 on an offset extension 29 of the lever 23. The latch 25 is provided with a rounded latch nose 31 which is used to engage a latch pin 33 carried by the switching lever 15, and is also provided with a tail portion 35 which is adapted to be engaged and moved by pivoted trip lever 37 for effecting automatic actuation of the breaker. The latch 25 is biased to latching position by a light spring 39 secured by the operating lever 23. The offset extension 29 of the operating lever 23 is also provided with a lateral projection 41 which engages the lower edge of the switching lever 15. It will thus be seen that the switching lever is held between the latch 25 and the projection 41, the latch 25 serving to hold the contact member in closed position when the operating rod 21 is in closed position, and the projection 41 serving to hold the contact member in open position when the operating rod 21 is in open position. The operating lever 23 is pivotally connected by a pin or slot connection 45 to the upper end of the operating rod 21 so as to be moved directly by the operating rod. The operating rod 21 is releasably held in the closed position shown by an electromagnetically controlled latch 45, and is adapted to be moved downwardly to open position, upon release of the latch 45, by means of a spring 47 which is disposed between a fixed support 46 and a collar 48 secured to the operating rod 21. A solenoid 49 is provided for moving the operating rod upwardly to closed position. The solenoid comprises a movable core 51 secured to the lower end of the operating rod, and an energizing winding 53 which is electrically connected to source of electrical energy represented by the supply lines 55–56. A manually controlled switch 57 is interposed in series with the winding 53. The switch 57 is adapted to be closed to effect energization of the solenoid 49 and closing of the circuit breaker contacts. An electromagnet 59 for operating the holding latch 45 is also connected to the supply lines 55–56, and energization of the electromagnet 59 is controlled by a manual switch 51 connected in series circuit with the solenoid 49. The electromagnet 59 is energized by means of a trip plunger 65 connected to the trip lever 37 and a trip coil 67 energized in response to the current in the line 53 by a suitable current transformer 69.

The movable contact member 9 is adapted to be quickly moved to open circuit position by a circuit opening or accelerating spring 71 which endorses the contact member and is disposed in compression between the support 11 and the crosshead 13. When the latch 25 is released by the trip device 67, the accelerating spring 71 quickly moves the contact member 9 upwardly to open position free of the driving and force transferring means 21–23, these parts remaining in the closed position shown. During the latter portion of the circuit opening movement the crosshead 13 on the contact member 9 engages and moves a plunger 73 upwardly compressing a circuit closing or reflecting spring 75 which is disposed about the plunger 73 between a fixed support 76 and the head of the plunger. When the movable contact member 9 reaches open position the energy stored in the reflecting spring 75 is transferred to the latch nose 31 which is reengaged under the latch lever so that the direction of movement of the contact member 9, and the spring 75 then causes the contact member back to closed position. As the contact member approaches closed position the latch pin 33 on the switching lever 15 clears the latch nose 31 and reengages under the latch lever so that the contact member is relatched in closed position. The contact member 9 and switching lever 15 are constructed to have a relatively light mass, and the strength of the springs 71 and 75 are selected so that these parts form an oscillating system. The kinetic energy given to the contact member 9 by the reflecting spring 75 aided by the force of gravity is sufficient to cause the contact member to be moved to closed position against the bias of the circuit opening spring 71 and to be relatched by the latch 25. Only a very small force is required to cause the latch pin 33 to clear the latch nose 31. If an overload or short circuit occurs on the line 53, the trip device 67 effects release of the contact member 9 from the driving and force transferring parts which have a relatively heavy mass, and the contact member is quickly moved to open position by the spring 71 and instantaneously relosed by the spring 75 so that the circuit is quickly interrupted and instantaneously reclosed. During this automatic operation the operating rod 21 and the operating lever 23 remain in closed position, held in such position by the latch 45. Since the contact member 9 and switching lever 15 have a relatively light mass and are oscillated at high speed by the actuating springs 71 and 75 completely free of the heavier driving means, the interruption and instantaneous reclosure of the circuit is accomplished in a sufficiently short time interval to prevent loss of synchronism of the apparatus in the controlled circuit or system.

To effect normal opening of the circuit breaker, the switch 51 is manually closed to cause energization of the latch controlling electromagnet 59. The latch 45 is released by the electromagnet 59, and the operating rod is moved downwardly to open position by the spring 47 causing movement of the contact member 9 and switch lever 15, which are coupled to the operating rod, to open circuit position. The projection 41 of the operating lever serves to positively hold the switch lever 15 in open position against the tension of the closing spring 75 since the combined force of the springs 71 and 47 is greater than that of the spring 75.

To effect normal closing of the circuit breaker, the switch 51 is manually closed to energize the closing solenoid 49 which moves the operating rod 21 and lever 23 upwardly to closed position. Since the contact member 9 and switch lever 15 are coupled to the operating lever by the latch 25, this movement causes the contact member to be moved downwardly to closed position. When the operating rod 21 arrives at its closed position it is restrained against movement by the latch nose 31, upwardly to closed position. Another embodiment of the invention is shown in Fig. 2. In this figure the parts which are of identical construction to those shown in Fig. 1 and described in connection therewith are identified by the same reference characters.
embodiment more positive relatching of the switching lever 15 to the operating lever 23 is effected by causing the operating rod 21 and lever 13 to be automatically moved toward open position through only a fraction of their full travel and to be immediately returned to closed position. The latch 25 is moved first in an opening direction to meet the switching lever 15 as the switching lever is being moved downwardly toward closed position by the spring 75. This insures positive relatching of the switching lever to the operating lever. The arrangement also insures positive return of the contact member to closed position by the operating rod 21 and lever 23. The required short time interval of interruption and reclosure is still obtained in this embodiment since the heavier masses of the driving parts need be returned to closed position only from a fraction of their full travel so that the total switching time required for the movement of the contact member to full open position and return thereof to closed position is substantially shortened over the time which would be required if the driving parts had to be moved to full open position. Furthermore, relatching of the operating lever is also accomplished without substantial mechanical stressing of the switching and driving parts.

Referring to Fig. 2 of the drawings the tripping lever 37 is connected to the holding latch 45 by a pin and slot connection 71 which causes the latch 45 to be released at the same time the latch 25 is released during automatic operation, and yet which permits the latch 45 to be released by its electromagnet 59 independently of the latch 25, i.e., without releasing the latch 25, for normal opening of the breaker.

The electrical control for the circuit breaker comprises the supply lines 79 and 81 which are connected to a suitable source of electrical energy (not shown). A manually operable selector switch 83 is connected to the supply line 79, and the blade of this switch is movable from a neutral position shown in dotted lines in Fig. 2 into engagement with its lower contact 85 to set the apparatus for automatic reclosing operation. The blade of the switch 83 is also movable into engagement with its upper contact 87 to effect engagement of the circuit for automatic opening of the breaker. The switch 83 is shown in Fig. 2 in full lines in the automatic reclosing position in engagement with its contact 85. The electromagnet 59 for releasing the holding latch 45 is disposed in a circuit 89 which is connected across the supply lines 79 and 81, and this branch circuit 89 has a normally open manual switch 91 in series therewith which is adapted to be closed to effect normal opening of the circuit breaker by the release of the latch 45 only. Normal opening of the breaker, however, can be effected only when the selector switch 83 is in its neutral position.

A circuit for the closing solenoid 49 extends from the lower contact 85 of the selector switch 83 through a conductor 93 through the main contact member 9 to the solenoid coil 53 and through an auxiliary switch 101, which is open only when the breaker is closed, and thence to the supply line 81. The winding 105 of the closing relay 97 is connected in a circuit 107 which is connected at one end to the conductor 93 and at the other end to the solenoid coil 53 and through an auxiliary switch 101. An auxiliary switch 109 is connected in series in the branch circuit 107, and this switch is adapted to be closed at a predetermined point in the downward or opening movement of the operating rod 21, by a projection 111 of the operating rod engaging and depressing a spring arm connected to the switch 105, when the operating rod has moved through only a fraction of its full opening throw. The closing of the auxiliary switch 105 causes the relay 97 to be energized and close its main contact 85, completing an energizing circuit for the closing solenoid 49. The auxiliary switch 101 of this energizing circuit is closed upon the initial downward movement of the operating rod 21. The closing relay 97 is provided with auxiliary contacts 113 which are closed simultaneously with the main contacts 85 to complete a locking circuit 115 for the coil of the relay 105 upon closing of the contacts 85 and 113. The locking circuit 115 maintains the relay 97 energized until the operating rod 21 has been returned to closed position and the auxiliary switch 101 has opened thereby.

The operation of the circuit breaker is briefly as follows: When the selector switch 83 is set in engagement with its contact 85, and an overload or short circuit occurs on the main line 85 controlled by the breaker, the device 67 pulls its plunger 65 downwardly to effect simultaneous release of the breaker latch 25 and the holding latch 45. The release of the latch 25 uncouples the movable contact member 9 from the driving parts and the circuit opening spring 71 quickly moves the contact member to open position to effect interruption of the circuit. As soon as the contact member 9 reaches open position, it is immediately thrown back toward closed position by the reflecting spring 75. At the same time the operating rod 21, having been released by the latch 45, is moved downwardly toward open position by the spring 47 causing clockwise movement of the operating lever 23, so that the breaker latch 25 moves upwardly to meet the switching lever 15 as the lever is being moved downwardly toward closed position. This movement causes positive relatching of the switching lever 15 with the operating lever 23. As soon as the operating rod 21 has been moved through a fraction of its full opening throw, the projection 111 thereon engages and closes the auxiliary switch 105. The closing of the switch 105 causes the closing relay 97 to close the circuit for the closing solenoid 49 and at the same time complete its locking circuit 115. This energizing circuit for the solenoid 49 extends from the supply line 79 through switch 83, conductor 93, relay contacts 95, conductor 99, energizing winding 53 of the solenoid, the auxiliary contacts 101 (which are now closed) to the opposite supply line 81. The locking circuit which is also completed at this time extends from the supply line 79 through the selector switch 83, contact 85, conductor 93 through the auxiliary contacts 113 of the relay 105, conductor 115 through the winding of the relay 97, conductor 107 and auxiliary switch 101 to the opposite supply conductor 81. The energization of the closing solenoid 49 causes the operating rod 21 to be immediately returned to closed position from its open position throw, and since the switch lever 15 has been relatched to the operating lever 23, the reclosing movement of the operating rod 21 causes positive reclosing of the contact member 9.

It will thus be seen that upon automatic operation of the breaker, the completion of its other side of the auxiliary switch 101. An auxiliary switch 109 is connected in series in the branch circuit 107, and this switch is adapted to be closed at a
upon movement and return of the operating rod 21 through only a small fraction of its full throw. A quick interruption and instantaneous closure of the circuit is obtained since the heavy driving parts comprising the operating rod 21 and lever 22 need be returned to closed position from only a portion of the total opening throw thereof, so that the total switching time is thus materially reduced over that which would be required if the driving parts had to be moved to full open position and returned to closed position.

To effect normal opening of the circuit breaker, the selector switch 83 is moved to the neutral position shown by the dotted lines in Fig. 2, and the switch 91 is closed to effect energization of the latch electromagnet 88. The energization of the latch electromagnet 88 withdraws the latch 45 from its holding engagement with the operating rod 21, and the operating rod is moved downwardly by the spring 47 this time through its full opening travel. This downward movement of the operating rod 21 causes movement of the operating lever 23 and the switch lever 15 and the movable contact lever 9 to open circuit position, the switch lever 15 remaining latched to the operating lever 23 by the latch 25 since the movement of the holding latch 45 by its operating electromagnet 88 does not effect release of the breaker latch 45.

In effecting normal closing of the circuit the selector switch 83 is moved from its neutral position into engagement with its contact 87. This completes an energizing circuit for the solenoid 49 extending from the supply conductor 19 through the switch 83, contact 87, a conductor 911, a conductor 83, winding 823 of the solenoid and through the auxiliary switch 101 to the opposite supply conductor 81. The energization of the solenoid 49 moves the operating rod 21 upwardly to closed position, effecting movement of the contact member 9 and switch lever 15 to closed position since these elements are latched to the operating lever 23 by the latch 25. As soon as the operating rod arrives at closed position, the projection 111 opens the auxiliary switch 101 to deenergize the closing solenoid.

Another embodiment of the invention is shown in Figs. 3 and 4. In this embodiment the latch levers which have a similar construction and function to those shown in Fig. 2, and described in connection therewith, are indicated by the same reference characters. In accordance with this embodiment of the invention the breaker latch 45 and the trip device 67 are eliminated and in its place the switching lever 15 and movable contact member 9 are coupled to the operating lever 21 by means of a lever system. Referring to Fig. 3 of the drawings, the upper end of the operating rod 21 is connected by a pin and slot connection 43 to one end of an operating lever 121 which is pivoted on the fixed pivot 17 of the switching lever 15. The operating lever 121 is provided with an extending arm 123 which has a recess therein for engaging the underside of a pin 33 carried by the switching lever 15. A second actuating lever 125 having the form of a bell crank lever is pivoted on the fixed pivot 17 and this lever is provided with an arm 127 which has a recess for engaging the upper side of the pin 33 of the switching lever 15. The other arm 129 of the lever 125 is connected by a link 131 to the free end of a lever 133. The lever 133 is pivoted on a fixed pivot 17 and this lever also has its free end connected by a link 137 to a pin 139 carried by the operating lever 121 intermediate the pivot 17 and the end of the lever. The link 131 is pivotally connected at one end to the free end of the arm 128 of the actuating lever 125 and is pivotally connected at its other end to the free end of the lever 133 by pivot pin 143. The pin 143 also pivotally connects the lower end of the connecting link 131 to the free end of the lever 133. The actuating lever 125 is thus positively connected to the operating lever 121 for movement thereof, and the arrangement of the lever 123 and connecting links 131 and 133 cause the actuating lever 125 to be moved at a multiplied speed upon movement of the operating lever 121 through only a fraction of its throw. In the construction shown the actuating lever 125 is moved at approximately twice the speed of the operating lever 121 and operating rod 21 during the movement of the operating rod through the fractional part of its travel throw. When the operating rod 21 is moved downwardly toward open position through a fractional part of its full throw, the actuating lever 125 is moved clockwise at approximately twice the speed of the operating lever 121 to the full open position as shown in Fig. 4, thus effecting quick release or uncoupling of the switching lever 15 and movable contact member 9 from the operating rod 21 since the movable contact member 9 is quickly moved by the spring 71 to full open position. This position of the parts is shown in Fig. 4. If the operating rod 21 is returned to closed position shown in Fig. 3 from the fractional part of its throw shown in Fig. 4, the actuating lever 125 is moved in a counterclockwise direction at approximately twice the speed of the operating lever 121, from the position shown in Fig. 4 to the closed position shown in Fig. 3. The closing spring 75 initiates closing movement of the movable contact member 9 and the actuating lever 125 insures positive closing of the movable contact member 9. The arrangement of the lever 123 and connecting links 131 and 133 are also such that when the operating rod 21 is moved downwardly to its full open position from the intermediate position shown in Fig. 4 the actuating lever 125 retrim the elements which have a similar construction and function as shown by the dotted lines in Fig. 3. During this movement, however, the extending arm 123 of the operating lever 121 moves to the full open position indicated by the dotted lines in Fig. 3, so that the movable contact member 9 is positively held in an open position against the force exerted by the closing spring 75. It will thus be seen that the switching lever 15 and movable contact member 9 are positively held in both the closed and open circuit positions thereof by the lever arms 121 and 123, respectively. In the intermediate position of the operating rod 21 and lever 121, the movable contact member 9 and switching lever 15 have a freedom of movement which is limited only by the position of the lever arm 123 and the actuating lever arm 125 since the switching lever is disposed between these two lever arms. This freedom of movement and the arrangement of the circuit opening spring 71 and reflecting spring 75 are utilized for providing a quick free movement of the movable contact member 9.

The electrical control for the circuit breaker shown in Fig. 3 is substantially similar to the electrical control shown in Fig. 2, but the trip device 67 has been omitted since there is no breaker latch to be released, and the cur-
rent transformer 88 is connected directly to the electromagnet 59 for releasing the latch 45 which restrains the operating rod in closed position. Since the elements are identical with the exceptions mentioned above, the dotted characters have been used to designate the corresponding elements.

The operation of the breaker shown in Fig. 3 is briefly as follows: When the selector switch 83 is closed upon its contact 88, and an overload or short circuit current is flowing in the coil 83, energy stored in the condenser 87 and the magnetic circuit is energized. The current in the coil energizes the electromagnet 59 which in turn is connected to the latch 45 through the normal closed contact 88 of the latch 45. When the operating rod 21 is moved downwardly, the latch 45 is released, thus allowing the operating rod 21 to move upwardly to its closed position. The operating rod 21 is then moved downwardly to its open position by the action of the coil 83, thus completing the circle of travel. During this downward movement of the operating rod 21 the actuating lever 125 is moved at approximately twice the speed of the operating lever 121 to its full open position, as shown in Fig. 3, and the movable contact member 9 and switching lever 15 is thereby released and uncoupled from driving the parts. The moving contact member 9 is moved upwardly, the energy stored in the circuit closing spring 75 is rapidly released, and the operating rod 21 moves upwardly to its closed position.

The electromagnet 59 effects release of the operating rod 21, and the operating rod 21 is moved downwardly by the spring 47 to the full open position. During the first part of the downward movement of the operating rod 21, the actuating lever 125 is moved to full open position at a multiplied speed, allowing the contact member 9 to be moved to full open position by its circuit opening spring 71. During the continued downward movement of the operating rod 21 the actuating lever 125 continues to move upwardly to engage the pin 33 on the switching lever 15 for holding the movable contact member 9 and switching lever 15 in full open position. The operating rod 21 is caused to move to full open position because of the fact that the selector switch 83 is in neutral position and thus prevents energization of the closing relay 97.

To effect normal closing of the circuit breaker the selector switch 83 is moved into engagement with its upper contact 87 completing an energizing circuit for the solenoid 49. This circuit extends from the supply conductor 79 through the selector switch 83 and its contact 87, conductor 117, coil 53 of the solenoid, and auxiliary switch 101 (which is closed) to the opposite supply conductor 81. The energization of the closing solenoid causes upward movement of the operating rod 21 from its full open position to its closed position shown in Fig. 3. During the latter portion of this closing movement the actuating lever 125 is moved at multiplied speed from its open position to its closed position shown in Fig. 3 effecting closing of the movable contact member 9.

A spring 145 may be provided which is connected at one end to the arm 123 of the operating lever 121 and at its other end to the switching lever 15. This spring 145 is stressed upon opening movement of the movable contact member 9 and serves to take up the energy of motion of the movable contact member and to reverse the direction of movement thereof at the end of the circuit opening movement so that no impacts of the heavy and quickly-moving masses arise.

A further embodiment of the invention is shown in Fig. 5. In this figure the electrical control, and the holding latch 45, electromagnet 59, and closing solenoid 49 have not been shown since they are the same as the corresponding elements shown in Fig. 3. In this embodiment of the invention a gear transfer drive is used in place of the lever transfer drive shown in Fig. 3. Referring to Fig. 5, the operating lever 121 which is pivoted on the fixed pivot 17 has a gear 147 secured thereto for movement about the fixed pivot 17. The gear 147 meshes with, and drives a controlling gear 149 which is rotatably mounted about a fixed pivot 151. A larger gear segment 153 is rigidly secured to the gear 149 for movement therewith and this gear segment is provided with gear teeth 153a for a portion of its periphery which are adapted to drive a segmental gear 157 rigidly secured to the actuating lever 127. The segmental gear 157 and actuating lever 127 are rotatably mounted on the fixed pivot 17 and are rotatable relative to the main gear 147. The ratio of the segmental gear 153 and 157 are selected to provide a multiplied speed of movement of the actuating lever arm 127 upon movement of the operating rod 21. In the embodiment shown, the ratio of the segmental gears is such as to cause the actuating lever arm 127 to be moved at approximately twice the speed of
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The operating lever 21. The gears 147 and 149 are of equal size.

The general operation of this embodiment is substantially the same as the embodiment shown in Fig. 3, and described in connection therewith. When the apparatus is set for automatic reclosing operation, and an overload or short circuit occurs, the operating rod 21 is moved downwardly by the spring 47 through only a fraction of its full travel and immediately returned to closed position. During the fractional downward movement of the operating rod 21, the operating lever 121 is moved clockwise about the pivot axis 17, causing the gear 147 to drive the gear 149 and the segmental gear 153 which is rigid with the gear 148. The segmental gear 153, in turn, drives the segmental gear 151 and actuating lever arm 127 at a multiplied speed to full open position causing the movable contact member to be moved to full open position by its spring 71 free of the driving parts. During the immediate return movement of the operating rod 21 to its closed position from the fractional part of its travel, the gears operate to cause movement of the actuating lever arm 127 from its open position to its closed position also at a multiplied speed, to effect reclosing of the movable contact member 9.

During a normal circuit opening operation the operating rod 21 is moved downwardly to the full open position to cause movement of the movable contact member to open position. During the first part of this movement the actuating lever arm 127 is moved to full open position, and during the remaining portion of the downward movement of the operating rod to its full open position the actuating lever arm 127 remains substantially in its open position, since the gear teeth 155 of the segmental gear 153 extend only over a portion of the periphery of the gear segment 153. The switching lever 15 and movable contact member 9 are positively held in both open and closed positions by the lever arms 123 and 127 the same as in the embodiment shown in Fig. 3.

All of the embodiments of the invention have been shown in the drawings somewhat schematically. It will be understood that in actual practice the contact means are preferably mounted in either a metal or plastic enclosure and immersed in a body of oil or insulating liquid therein. The operating mechanism or at least a part thereof may also be mounted within the circuit breaker enclosure, and the shape and proportions of the various parts altered in order to conform to the space requirements at hand.

While the invention has been shown in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details thereof may be made without departing from the spirit of the invention. It is desired, therefore, that the language of the appended claims be given the broadest reasonable interpretation permissible in the light of the prior art.

1. A circuit breaker, a movable contact member, operating mechanism comprising driving and force transferring means coupled to said contact member for effecting movement of said contact member to open and to closed position, means operable to cause quick movement of said contact member to open position free of said driving and force transferring means, and reflecting spring means for immediately reversing the direction of movement of said contact member to move the same toward closed position.

2. In a circuit breaker, a movable contact member of relatively light mass, operating mechanism comprising driving and force transferring parts of relatively heavy mass coupled to said contact member for effecting movement of said contact member to open and to closed position, means operable to effect release of said contact member from said driving and force transferring parts to cause quick movement of said contact member to open position, and reflecting means for immediately reversing the direction of movement of said contact member to move the same toward closed position and for causing recoupling of said contact member with said driving and force transferring parts.

3. In a circuit breaker, a movable contact member, means for biasing said contact member toward open position, operating mechanism comprising driving means coupled to said contact member and movable to open and to closed position, means operable to effect release of said contact member from said driving means to cause movement of said contact member to open position by its bias, and operable at the same time to cause opening and immediate reclosing movement of said driving means through only a fraction of its full travel distance to effect recoupling of said contact member with said driving means and positive closing of said contact member.

4. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating mechanism for effecting movement of said contact member to open and to closed position comprising driving means movable to open and closed position, and means coupling said driving means to said contact member which is operable to uncouple said contact member from said driving means upon opening movement of said driving means.

5. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating mechanism for effecting movement of said contact member to open and to closed position comprising driving means movable to open and closed position, and means coupling said driving means to said contact member which is operable to uncouple said contact member from said driving means upon initiation of opening movement of said driving means and to permit free movement of said contact member to full open position upon movement of said driving means through only a fraction of its full opening movement.

6. In a circuit breaker, a movable contact member, operating mechanism comprising an actuating element movable to open and to closed position for causing opening or closing of said contact member, driving means for moving said actuating element and means connecting said driving means to said actuating element which causes said actuating element to be moved to open position upon movement of said driving means that a fraction of its full opening throw and for causing said actuating element to remain substantially in open position during the remainder of the opening throw of said driving means.

7. In a circuit breaker, a movable contact member, operating mechanism comprising an actuating element movable to open and to closed position for causing opening or closing of said contact member, driving means for moving said actuating element and means connecting said driving means to said actuating element which causes said actuating element to be moved to open position upon movement of said driving means that a fraction of its full opening throw and for causing said actuating element to remain substantially in open position during the remainder of the opening throw of said driving means.
ing element movable to open and to closed position for causing opening or closing of said contact member, driving means for moving said actuating element, and means connecting said driving means to said actuating element which causes said actuating element to be moved to open position upon movement of said driving means through a fraction of its full opening throw and to be positively returned to closed position upon reclosing movement of said driving means through said fractional part of its throw, said actuating element remaining substantially in its open position during continued opening movement of said driving means through its full opening throw.

8. In a circuit breaker, a movable contact member biased to open position, operating mechanism comprising an actuating member movable to open and to closed position for causing movement of said contact member to open and to closed position, driving means for moving said actuating member, means positively coupling said driving means to said actuating member for causing said actuating member to be moved to full open position at a considerably greater speed than said driving means upon movement of said driving means through only a fraction of its opening throw and to be returned to closed position at said greater speed than said driving means upon reclosing of said driving means through said fraction of its throw, and for causing said actuating member to remain substantially in open position upon continued opening movement of said driving means through the remainder of its opening throw after said actuating member has been moved to open position.

9. In a circuit breaker, a contact carrying member biased to open position, operating mechanism comprising an actuating member movable to open and to closed position for causing opening and closing of said contact member, driving means for moving said actuating member, said driving means having a connection with said actuating member which causes said actuating member to be moved to open position at high speed and instantaneously returned to closed position at high speed upon opening movement and immediate return of said driving means from said fractional part of its throw, said contact carrying member being disposed between said actuating member and an element moved directly by said driving means so that said contact carrying member is positively held in either its open or its closed position.

10. In a circuit breaker, a movable contact carrying member, means biasing said contact carrying member toward open position, operating mechanism comprising an actuating member engageable with said contact carrying member and movable to open and to closed position for causing opening and closing of said contact carrying member, driving means for moving said actuating member having a connection with said actuating member which causes said actuating member to be moved at high speed to open position and to instantaneously return at high speed to closed position upon opening movement and immediate return of said driving means through only a fraction of its full throw, and which causes said actuating member to remain substantially in open position during the continued opening movement of said driving means from said fractional part of its throw on to its full open position, and spring means connecting said contact carrying member to an element moved directly by said driving means for reversing the direction of movement of said contact carrying member at the open position thereof and for giving it a circuit closing movement.

11. In a circuit breaker, a contact contact carrying member, means biasing said contact carrying member toward open position, operating mechanism comprising an actuating member engageable with said contact carrying member and movable to open and to closed position for causing opening and closing of said contact member, spring means stressed upon opening movement of said contact carrying member, driving means for moving said actuating lever having a connection with said actuating lever which causes said actuating lever to be moved at multiplied speed to open position and immediately back to closed position upon opening movement and immediate return of said driving means through only a fractional part of its full throw and which causes said actuating
lever to remain substantially in open position during the movement of said driving means from said fractional part of its throw to its full open position, a second lever pivoted about the same axis as said actuating lever and connected to be moved directly by said driving means, said second lever being engageable with said contact carrying member and movable to open and to closed position for causing opening and closing of said contact carrying member, driving means for moving said actuating lever having a connection with said actuating lever which causes said actuating lever to be moved at multiplied speed to open position and immediately back to closed position upon opening movement and immediate return of said driving means through only a fractional part of its full throw, and which causes said actuating lever to remain substantially in open position during the movement of said driving means from said fractional part of its throw to said full open position, said second lever pivoted about the same axis as said actuating lever and connected to be moved directly by said driving means, said second lever being engageable with said contact carrying member in the open and closed positions of said contact carrying member, and spring means connecting said contact carrying member and said second lever for reversing the direction of movement of said contact carrying member and giving it a circuit closing motion when said driving means has been moved in an opening direction through said fractional part of its throw.

15. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating mechanism comprising driving means coupled to said contact member and movable to open and to closed position for normally opening and closing said contact member, said operating mechanism including means for causing said driving means to automatically move toward open position through only a fraction of its full opening throw and immediately return to closed position and effect a quick movement of said contact member to its full open position and an instantaneous reclosure thereof.

16. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating mechanism comprising driving and force transferring means coupled to said contact member, means opening and closing of said contact member, means operable to cause movement of said contact member to open position by its bias uncoupled from said driving and force transferring means, and spring means stressed upon opening movement of said contact member for instantly reversing the direction of movement of said contact member to give it a circuit closing movement prior to recoupling of said contact member with said driving and force transferring means.

17. In a circuit breaker, a movable contact member, means for biasing said contact member toward open position, operating mechanism therefor comprising driving and force transferring elements coupled to said contact member for effecting opening and closing of said contact member, means operable to cause movement of said contact member to open position uncoupled from said driving and force transferring elements and means for instantaneously reversing the direction of movement of said contact member to give it a circuit closing motion prior to recoupling of said contact member with said driving and force transferring elements.

18. In a circuit breaker, a movable contact member, operating mechanism comprising driving and force transferring elements for effecting movement of said contact member to open and to closed position, means operable to cause said contact member to be moved quickly to open position free of said driving and force transferring elements and to be instantaneously returned to closed position and recoupled to said driving and force transferring elements.

19. In a circuit breaker, relatively movable contacts, operating mechanism for opening and closing said contacts, said mechanism being operable to cause full opening and instantaneous reclosing of said contacts upon opening and reclosing movement of said mechanism through only a fraction of its full normal stroke.

20. In a circuit breaker, a movable contact member, operating means movable through a full stroke to open or to closed position for normally effecting opening or closing of said contact member, said contact member being moved to full open position upon opening movement of said operating means through only a fraction of its full opening stroke, and said operating means being automatically movable toward open position through said fraction of its full opening stroke and immediately returned to closed position for effecting full opening and instantaneous reclosing of said contact member.

21. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating means movable through a full stroke to open or to closed position for normally effecting opening and closing of said contact member, means coupling said operating means to said contact member causing said contact member to move to full open position by its bias uncoupled from said operating means upon opening movement of said operating means through only a fraction of its full opening stroke and for causing positive closing of said contact member, and means connecting said driving means to said contact member which is operable upon opening movement of said driving means through only a fraction of its full opening stroke to cause movement of said contact member to full open position by its bias free of said driving means, and which is operable to positively reclose said contact member upon return of said driving means to closed position.

22. In a circuit breaker, a movable contact member, means biasing said contact member to-
ward open position, operating mechanism comprising driving means movable to open and to closed position for normally effecting opening and closing of said contact member, said driving means being coupled to said contact member through a means which causes said contact member to be quickly moved to full open position and instantaneously reclosed upon opening and reclosing movement of said driving means through only a fraction of its full throw. 24. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating mechanism comprising driving means coupled to said contact member and movable to open and to closed position for normally opening and closing said contact member, said driving means also being automatically operable to move toward open position through a fraction of its full opening movement and immediately return to closed position to cause said contact member to be moved to full open position and immediately reclosed. 25. In a circuit breaker, a movable contact member, means biasing said contact member toward open position, operating mechanism comprising driving means for effecting opening and closing of said contact member, means coupling said driving means to said contact member comprising a pair of coaxially pivoted levers engageable with said contact member and movable to open and closed position by said driving means, one of said levers connected to be directly moved by said driving means and serving to hold said contact member in open position when said driving means is in full open position, the second lever being effective to cause opening and closing of said contact member and having a connection with said driving means which causes said second lever to be moved to open position at a high speed upon opening movement of said driving means through only a fraction of its full opening throw, and which causes said second lever to remain substantially in open position during continued opening movement of said driving means through its full opening throw. 26. A circuit breaker comprising relatively fixed contact means and a cooperating movable contact member, operating means comprising spring means for biasing said movable contact member toward open position, means releasably holding said contact member in closed position, said means being releasable to cause opening movement of said contact member, and reflecting spring means which is stressed upon opening of said movable contact for at times immediately returning said contact member toward closed position.

PAUL DUFFING.