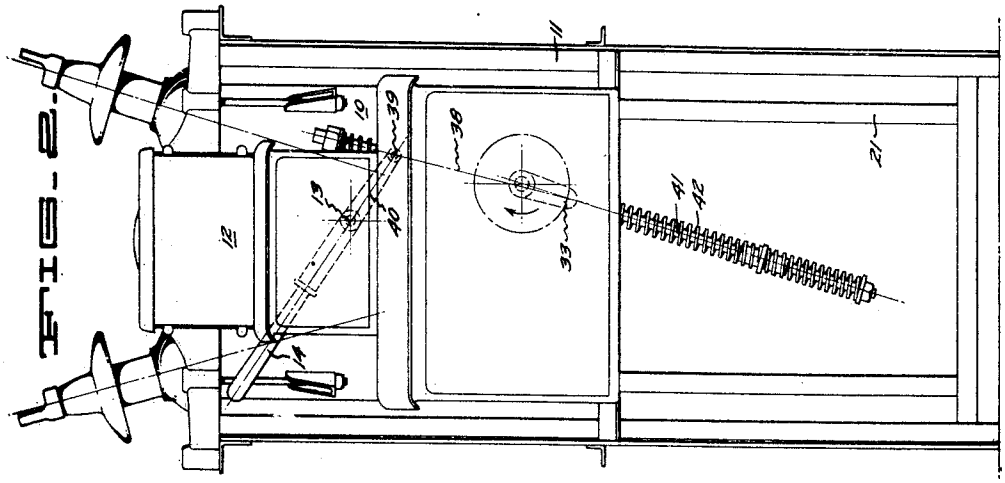
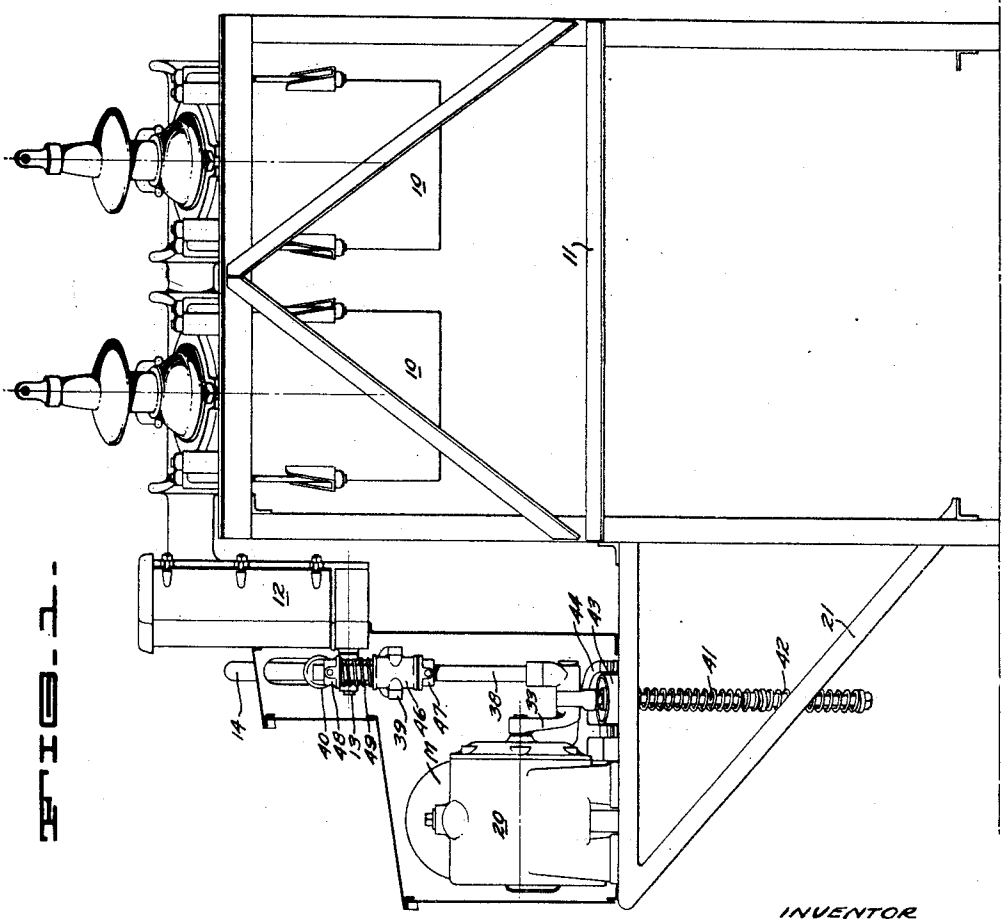
Dec. 8, 1931. J. C. REA 1,835,083

CIRCUIT BREAKER OPERATOR

Filed Aug. 2, 1926 5 Sheets-Sheet 1





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Dec. 8, 1931. J. C. REA 1,835,083

CIRCUIT BREAKER OPERATOR

Filed Aug. 2, 1926 5 Sheets-Sheet 2

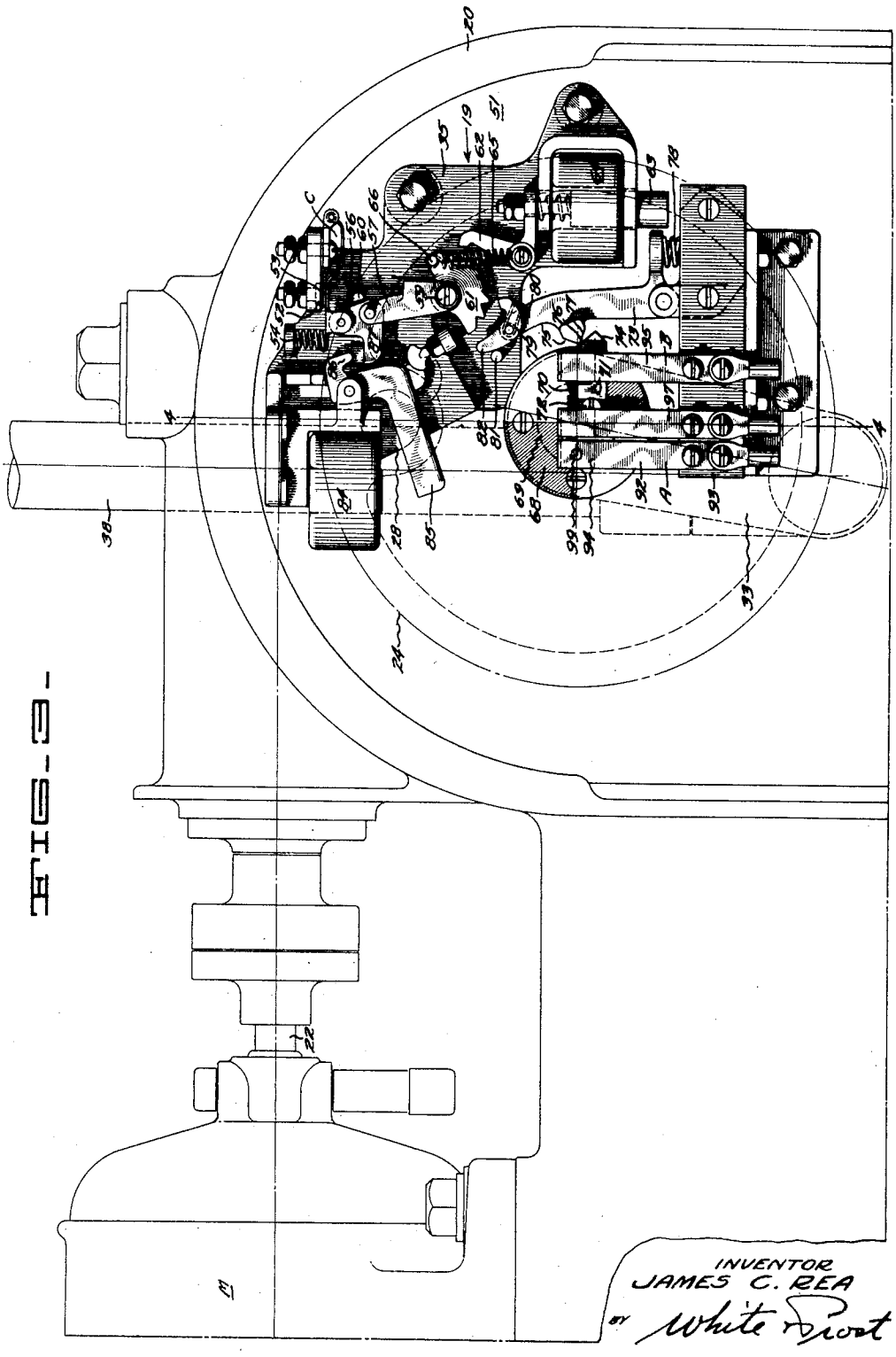


FIG. 9.

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CIRCUIT BREAKER OPERATOR

Filed Aug. 2, 1926 5 Sheets-Sheet 3

FIG. 7.

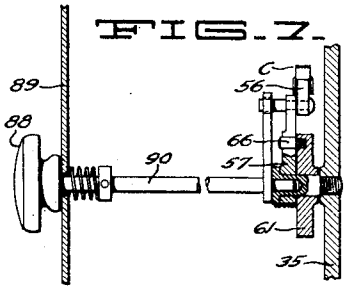


FIG. 4.

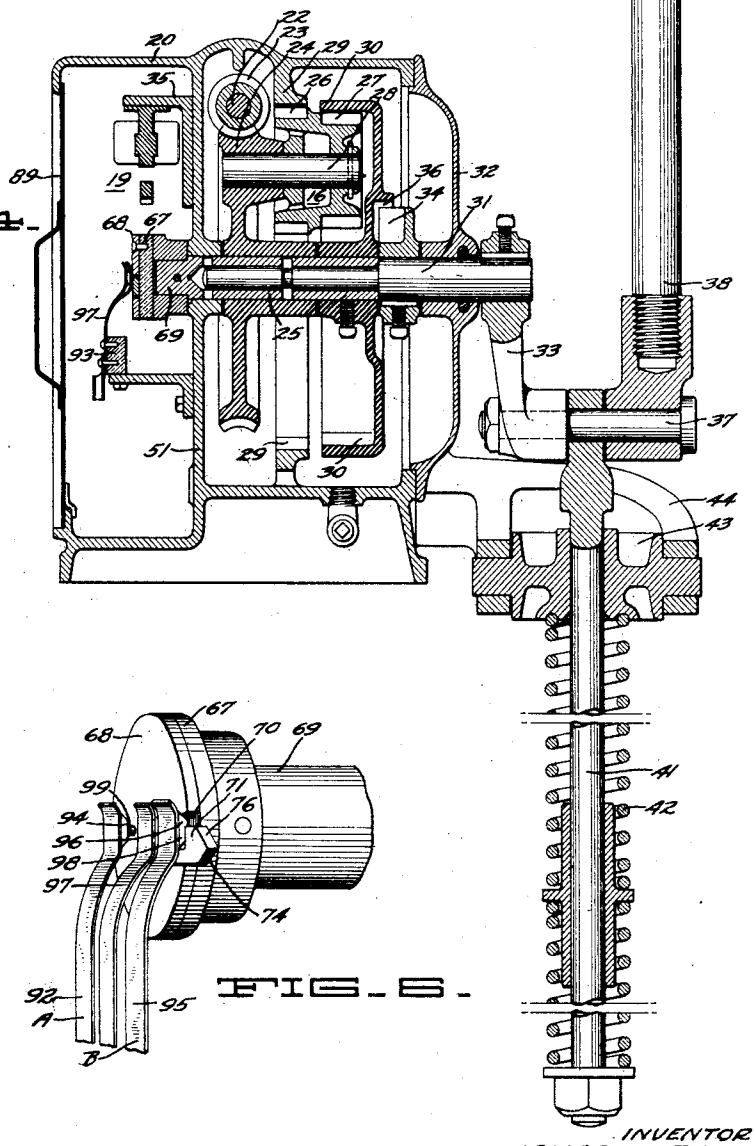


FIG. 6.

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Dec. 8, 1931. J. C. REA 1,835,083

CIRCUIT BREAKER OPERATOR

Filed Aug. 2, 1926 5 Sheets-Sheet 4

FIG. 5.

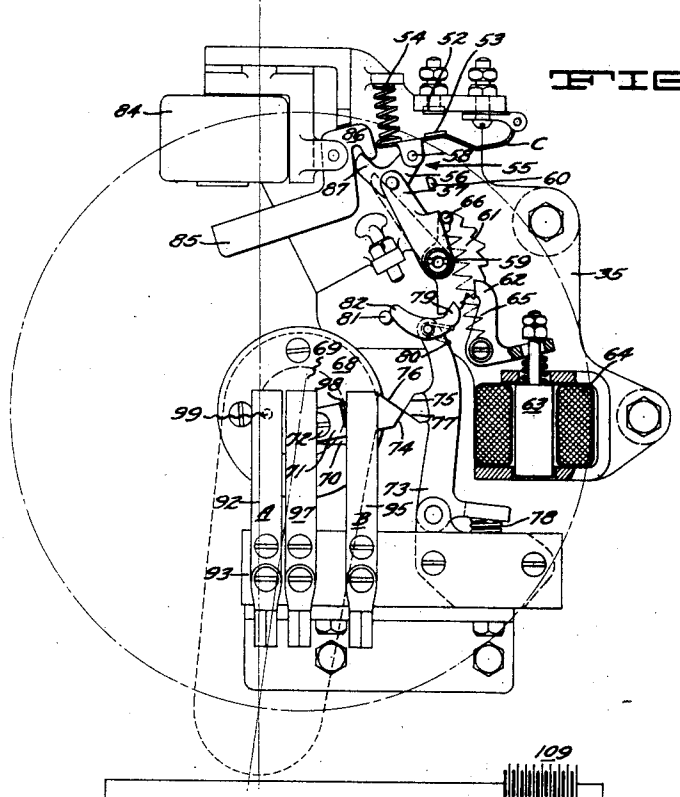
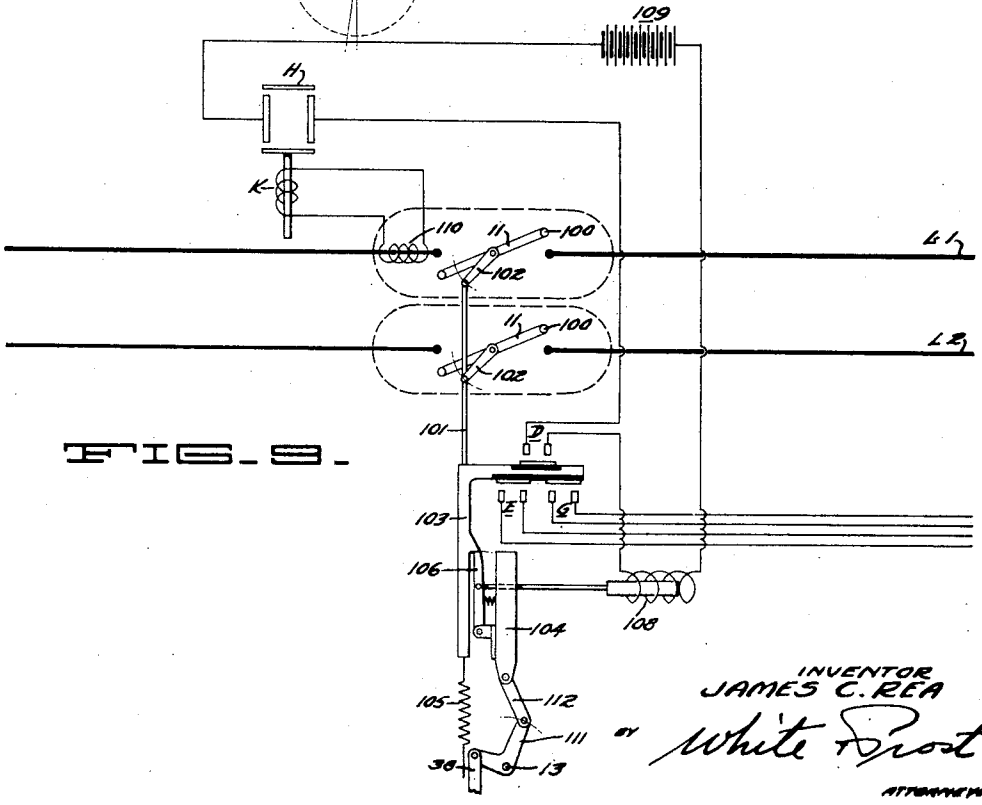


FIG. 6.

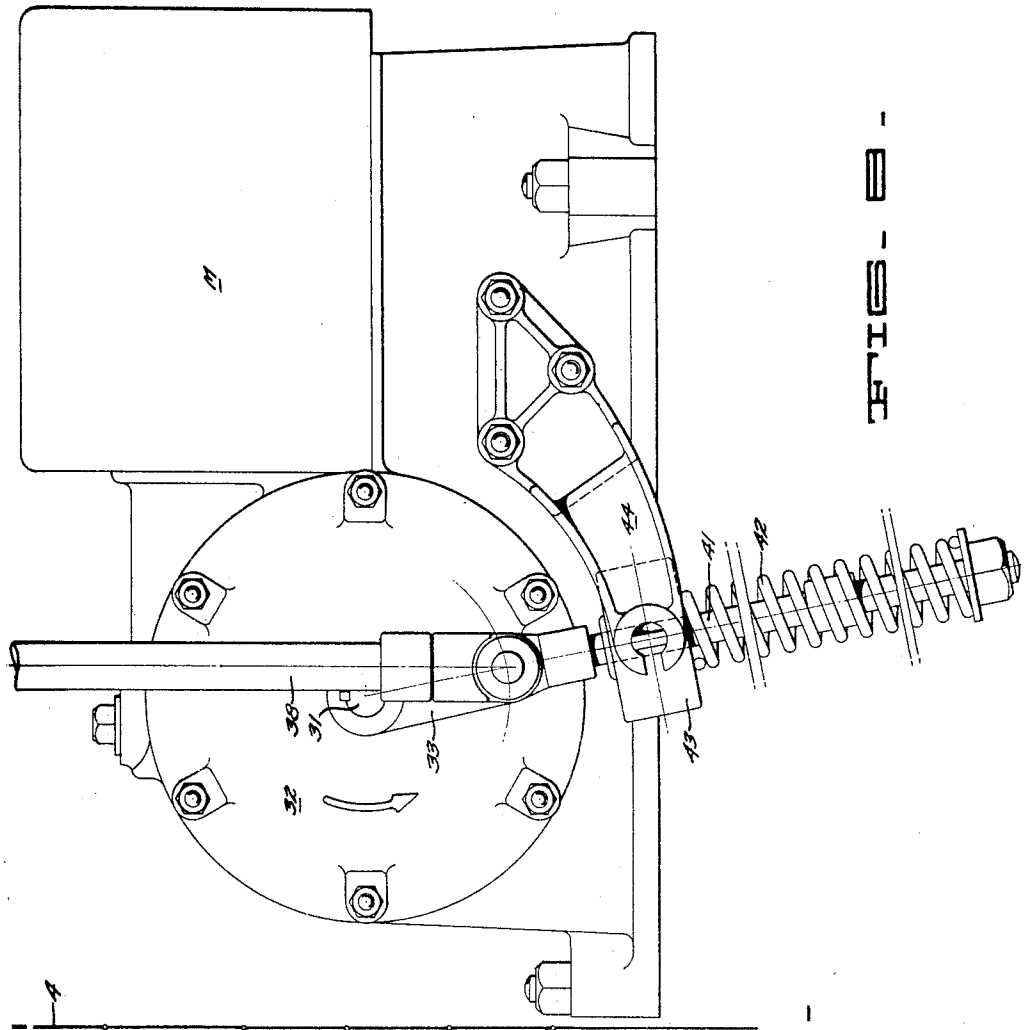


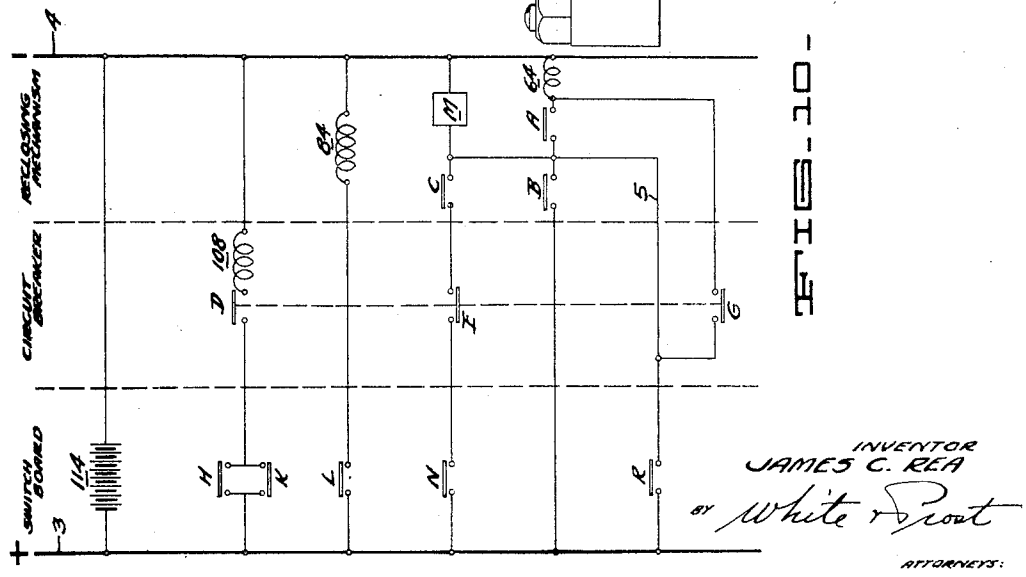
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CIRCUIT BREAKER OPERATOR

Filed Aug. 2, 1926 5 Sheets-Sheet 5





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UNITED STATES PATENT OFFICE

JAMES C. REA, OF SAN FRANCISCO, CALIFORNIA

CIRCUIT BREAKER OPERATOR

Application filed August 2, 1926. Serial No. 126,368.

This invention relates generally to systems for automatically operating an electrical circuit breaker.

In electrical power transmission systems it is customary practice to provide a circuit breaker for opening the supply lines responsive to an abnormal condition such as an excessive load. It frequently happens that this abnormal condition is temporary, as for example a flash over on a lightning arrester, so that in order to prevent discontinuance of service until the breaker can be reset by hand, it is desirable to provide automatic mechanism for effecting this operation immediately after tripping of the breaker. Thus it has been previously proposed to provide mechanism which will close the breaker a number of times after it has been tripped, the mechanism functioning in such a manner that if the breaker remains closed after any reclosing operation, thus showing that the abnormal condition has been removed, the operation of the mechanism is arrested. Prior systems of this character are complicated and unreliable in operation. They usually utilize at least two motive means, one for closing the breaker and the other for operating the timing mechanism. Being of complicated construction they have been difficult to install in connection with standard oil circuit breakers.

It is accordingly an object of this invention to devise an automatic control mechanism which may be readily incorporated with a standard type of circuit breaker.

It is a further object of this invention to devise a control mechanism in which both the timing and breaker closing operations are effected by a single motive means.

It is a further object of this invention to construct breaker control mechanism which will give proper timing of the closing operation after tripping of the breaker.

It is a further object of this invention to utilize the mechanical drive connection between the reclosing motor and the breaker as a means for timing the reclosing operations.

It is another object of this invention to generally simplify and improve mechanism for automatically closing a circuit breaker and to make its operation more reliable.

Further objects of the invention will appear from the following description in which I have set forth the preferred embodiment of the invention. It is to be understood that the scope of the invention is to be determined from the appended claims and the state of the prior art.

Referring to the drawings:

Figure 1 is a side elevational view showing the invention incorporated with a standard single phase circuit breaker.

Fig. 2 is an end view of the assembly shown in Fig. 1.

Fig. 3 is a side elevational view showing the details of the timing mechanism.

Fig. 4 is a cross sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a fragmentary view of the timing mechanism illustrating the operation of the same.

Fig. 6 is a detail view showing the construction of the timing disc.

Fig. 7 is a fragmentary cross sectional view illustrating the construction of the hand reset.

Fig. 8 is a side elevational view of the motor driven reclosing crank.

Fig. 9 is a circuit diagram of the circuit breaker and its associated switches.

Fig. 10 is a circuit diagram of the complete system.

The invention comprises generally a single motive unit such as an electric motor which is energized upon tripping of the circuit breaker. This motor actuates both the timing mechanism and furnishes the power to close the breaker. Control mechanism is provided which serves to deenergize the motor if the breaker does not trip after the lapse of a predetermined period following a closing operation, or to deenergize it after the breaker has been repeatedly closed a number of times.

Referring to the drawings, the mechanism has been shown as incorporated with a single phase circuit breaker although it is obvious that it may be employed with polyphase breakers or with breakers adapted for

direct current lines. Thus there has been provided a pair of breaker switches 10 of the oil type supported upon a suitable frame 11. These switches are mechanically connected so as to move in unison, a tripping mechanism 12 being provided to permit the switches to move to open position upon an abnormal load being placed upon the line. After being tripped the breaker may be reset by rotation of a shaft 13, a suitable hand lever 14 being usually provided for this purpose. The mechanism for automatically reclosing the switches is applied directly to this shaft 13 as a substitute or supplemental control to the hand lever 14.

The automatic reclosing mechanism includes generally an electric motor M which is mechanically connected to the shaft 13 through a drive connection including a suitable train of reducing gears 16. This drive connection is such that when the motor is energized the shaft 13 is given recurrent angular movement to reclose the breaker. In order to automatically control closing of the circuit breaker means are provided to initiate operation of the motor automatically upon tripping of the circuit breaker. After this operation has been initiated the motor will continue to reclose the breaker a predetermined number of times at regular spaced intervals. If the breaker remains closed after any one of these reclosing operations the motor is automatically deenergized to prevent further closing. The motor is also deenergized if no permanent closing occurs after a predetermined number of closing operations has occurred. The principal portion of the mechanism for effecting the above operations has been indicated generally at 19 and is mounted within a housing 20 within which the gear train 16 is also disposed. This housing also forms a suitable mounting for the motor M, the entire housing therefor forming a unit which is mounted upon a suitable bracket 21 secured to the circuit breaker frame 11.

The gear train 16 may be of any suitable construction which will properly reduce the speed of the motor shaft. Thus the motor shaft 22 has been shown as directly coupled to a suitable worm 23 meshing with a worm gear 24. Gear 24 is journaled loosely upon a sleeve 25 and carries the planetary pinions 26 and 27 upon a journal pin 28, the pinion 27 being of slightly smaller diameter and fixed with respect to the pinion 26. Pinion 26 meshes with a ring gear 29 which is fixed with respect to the housing, while pinion 27 meshes with a movable ring gear 30. Gear 30 is fixed with respect to the sleeve 25 so that upon rotation of the worm 23 the sleeve 25 will be revolved at a greatly reduced speed. Within the sleeve 25 there is journaled a shaft 31 which is extended out beyond the cover plate 32 of the housing, a crank 33 being fixedly mounted upon this extension. Between the shaft 31 and the sleeve 25 there is a lost motion connection so that the shaft 31 may be free to move through an angle of at least 180 degrees with respect to the sleeve 25. This lost motion connection for example may be in the form of a lug 34 fixed with respect to the shaft 31 and engaging a stop 36 fixed upon the side of the gear 30.

In order to mechanically connect the shafts 13 and 31 the crank 33 is pivotally connected as by means of pin 37 to a reciprocating rod 38, the upper end of this rod being provided with a pivotal connection 39 to a lever 40 which is fixed to the shaft 13. Instead of causing the motor M to supply the power directly to rotate the shaft 13 in a direction to reclose the breaker, the motor is caused to store up energy and then this stored up energy is utilized to effect the reclosing operation. Thus one end of a rod 41 is pivotally connected to a crank 33 as by means of pin 37, the other end of this rod abutting against a suitable compression spring 42. The rod 41 is slidably disposed within a suitable guide block 43, this block being pivotally mounted upon a suitable bracket 44. The upper end of the compression spring 42 is adapted to abut against the lower side of the guide block 43 so that the spring serves to tension the rod 41 to rotate the shaft 31 in a direction to pull down upon the rod 38. The pivotal mounting 39 between the rod 38 and the lever 40 preferably includes a sleeve 46 within which the rod 38 is slidably disposed and which is pivotally secured to the end of the arm 40. A collar 47 fixed to the rod 38 serves to limit the upward movement of the rod 38 with respect to the sleeve 46 while a collar 48 also fixed to the rod 38 is tensioned from the upper side of the sleeve by means of a compression spring 49.

The operation of the motor drive connection described above is as follows: When the motor is operated the sleeve 25 is caused to slowly rotate say in a clockwise direction. When the lug 34 engages stop 36 the shaft 31 moves together with the sleeve 25 to move the rod 38 upwardly. During this movement of the shaft 31 the spring 42 is being compressed to store up sufficient energy to reset the breaker. When the rod 38 has reached the limit of its upward movement the latch mechanism within the circuit breaker is engaged and the rod 41 is pulling against the dead center position of the pivot pin 37 and shaft 31. Further movement of the shaft 31 carries pivot pin 37 past dead center position and since the shaft 31 is free to move at least 180 degrees with respect to sleeve 25, the spring 42 will quickly revolve shaft 31 to complete its revolution and bring it back to its starting point. During this latter part of the revolution of shaft 31 the rod 38 is pulled

downwardly to rotate the shaft 13 and reset the breaker. The spring 49 serves to cushion this return movement and prevent breaking of the parts. As the motor M operates at a definite speed it will be obvious that these reclosing operations will occur at regular timed intervals.

The mechanism for controlling the recurrent closing operations may be mounted upon a suitable sub-base 35 secured to a partition 51 of the housing 20 and includes a switch C for opening and closing the motor circuit, this switch including a stationary contact 52 and movable contact 53 biased to open position by suitable means such as a spring 54. The switch C is normally held in closed position until a predetermined number of recurrent closing operations have occurred. Thus there is provided a toggle connection 55 comprising a pair of pivotally connected links 56 and 57, the link 56 having a suitable pivotal connection 58 with the movable contact 53, while the link 57 is provided with a pivotal connection 59 to the stationary base 35. The links 56 and 57 form a toggle which when moved to a position slightly past its dead center against the stop 60 will maintain the switch C closed, but when the toggle is broken as shown in Fig. 5 the switch is opened. The breaking of this toggle connection is controlled by means of a pivotally mounted toothed segment 61 which is normally constrained to rotate in one direction by means of a holding pawl 62 which is normally pressed against the teeth of the segment 61 by means of the armature 63 of the holding magnet 64. The segment 61 is normally biased to rotate in a clockwise direction as by means of a tension spring 65. A pin or projection 66 upon the segment 61 serves to abut the link 57 to break the toggle after the segment has been rotated a certain amount in a counter-clockwise direction.

The segment 61 is stepped up a certain amount for every successive reclosing operation. The step up mechanism includes a rotatable timing disc 68 provided with a suitable insulating mounting 67 to the extended end 69 of the sleeve 25. The disc 68 therefore rotates at the same speed as the ring gear 30. The disc 68 is recessed or cut away as at 70 to receive a finger 71 which is pivotally mounted with respect to the disc as at 72. Upon every revolution of the timing gear 68 this finger 71 is adapted to engage and actuate a step up lever 73 which engages the toothed segment 61. Thus the finger 71 is provided with a cam face 74 adapted to engage the cam face 75 provided upon the lever 73 so that upon rotation of the disc 68 in a clockwise direction the cam face 74 will engage face 75 to rotate the step up lever 73 in a clockwise direction. Oppositely inclined cam faces 76 and 77 are also provided to insure a quick return of the step up lever 73 after the lever 73 has reached the limit of its clockwise movement. These latter cam faces also cause limited rotational movement of the finger 71 with respect to the timing disc for a purpose later to be described. The step up lever 73 is preferably normally biased to move in a counter-clockwise direction as by means of a compression spring 78, and has pivotally mounted upon its free end a stepping pawl 79. A spring 80 normally biases the stepping pawl to rotate in a counter-clockwise direction with respect to the stepping lever, and a stop 81 is adapted to engage the projecting end 82 of the pawl when the stepping lever is rotated in a counter-clockwise direction. Thus when the finger 71 causes the lever 73 to rotate in a clockwise direction the pawl 79 is also permitted to rotate to bring it into engagement with the toothed segment 61.

In order to make it possible to reset the toggle connection which controls the switch C there is provided a resetting magnet 84 which is adapted to actuate an armature 85. This armature is provided with a finger 86 which is adapted to engage the member 87 extended from the link 56 so that when the armature is moved towards the magnet 84 the link 56 is rotated to again bring the toggle connection past its dead center position. As a supplement to the remote control of magnet 84 a manual reset device may be also provided. Thus there has been shown a control knob 88 extended out through the front housing cover 89, this control knob being mounted upon the end of a rotatable shaft 90 which is fixed to the pivoted end of link 57. Therefore by a manual rotation of knob 88 the toggle connection may be reset without energization of magnet 84.

Associated with the timing disc 68 are the switches A and B which perform functions to be presently described. Switch A for example may comprise merely a spring metal strip 92 suitably mounted upon an insulating block 93, and carrying a contact 94 at its free end which is adapted to make slidable electrical contact with the contacting face of the timing disc 68, this disc being made of suitable electrical conducting material. Switch B may similarly comprise a spring metal strip 95 carrying a contact 96 which engages the face or disc at a point diametrically opposite from the position of contact 94. Electrical connection is made to the disc through a suitable strip 97 also mounted upon the insulating block 93 and electrically contacting adjacent the central portion of the disc. The portion of the finger 71 which rides under the contact 96 is preferably recessed as at 98 or otherwise constructed so that the electrical connections between the contact 96 and the finger 71 will be broken for an interval following escapement of the cam face 74 past the cam face 75.

In other words when the disc 68 is rotated until cam faces 76 and 77 engage to rotate the finger 71 in a clockwise direction with respect to the timing disc, electrical connections between the spring strips 95 and 97 will be broken until the disc is rotated sufficiently to bring the face again into contact with the contact 96. If however at the instant when this electrical connection is broken, the motor circuit is also opened the disc 68 will cease to rotate before it has been carried sufficiently far by the inertia of the rotating parts to again establish connection between the contact 96 and the disc. An insulating pin 99 is also set into the disc 68 in position to engage and break the contact between contact 94 of switch A and the disc during the interval that switch B is opened by movement of finger 71.

In order to more clearly describe the operation of the device the circuit breaker and its associated tripping mechanism has been illustrated diagrammatically in Fig. 9. Thus the breaker switches 11 have been shown as inserted in the single phase power supply lines L1 and L2, these breaker switches each comprising movable contact elements 100 which are adapted to be moved in unison by suitable mechanism such as a reciprocating rod 101 connected to the cranks 102. Movement of the rod 101 has been shown as controlled by a sliding member 103 which in turn is moved by an actuator 104. The slidable member 103 is normally biased in a direction to open the movable switch elements 100 as indicated by the tension spring 105. Interengaging between the actuator 104 and the slidable member 103 there is a trigger 106 which is normally biased in engaged position and which may be released by a tripping solenoid 108. The tripping solenoid may be energized from a suitable source of current such as a battery 109 and is controlled by a solenoid switch K which is connected to a suitable current transformer 110. When an abnormal load is placed upon the line the solenoid switch K is closed to energize the tripping solenoid 108 and thus release the trigger 106 to permit the slidable member 103 to move in a direction to open the breaker switches. The resetting mechanism has been indicated comprising the rotatable shaft 13 connected to the actuator 104 by links 111 and 112. When the shaft 13 is rotated in a clockwise direction as by movement of arm 40 connected to rod 38, the trigger is moved to engaging position with the slidable member 103 and then movement of the shaft 13 in the reverse direction serves to return the slidable member 103 to its original position in which the breaker switches are closed. Manual control of the breaker may be secured by closing the switch H which is shunted across the solenoid switch K. A switch D has been illustrated diagrammatically as being incorporated with the moving parts of the circuit breaker so as to be opened upon tripping of the breaker, the switch being in series with the solenoid 108 in order to open the circuit through this solenoid after the circuit breaker has been tripped. Other switches E and G have been similarly incorporated so as to be closed upon moving of the circuit breaker to open position, these switches being incorporated with the system in the manner presently to be described.

Fig. 10 illustrates diagrammatically the entire circuit arrangement, the various switches being shown as grouped together to indicate the arrangement upon the switch board, the circuit breaker, and the reclosing mechanism. The bus conductors 3 and 4 are energized from a suitable source of current, such as a battery 114. The motor M has been shown as connected across the bus conductors in series with switch C, switch E located on the circuit breaker, and the manual control switch N which is located on the switch board. The holding magnet 64 has been shown as connected across the bus conductors in series with switches A and B. A second shunt path for current flowing through the magnet 64 is provided by switch G located on the circuit breaker and remote control switch R located on the switch board. Switch G is also placed in shunt with switch A by means of conductor 5. The resetting magnet 84 is controlled by a series switch L which is also located upon the switch board so that the mechanism after being tripped may be reset from a remote point.

In explaining the operation of the system it will be presumed that the switch N is closed, switch R is open, that the circuit breaker is initially closed, and correspondingly that switch D is closed while switches G and E are open. At this time the motor control switch C will also be closed by the toggle connection 55 but the motor will not be energized as the switches E and B are open. Now if an abnormal load occurs upon the line the switch K is closed and solenoid 108 energized to trip the breaker. As the breaker opens the switch D is opened to break the circuit through the tripping solenoid and switches E and G are closed. The motor M is then actuated to simultaneously rotate the crank 33 and the timing disc 68, rotation of the crank 33 serving to compress spring 42. As the timing disc passes the first half of its revolution the crank 33 passes its dead center position and the spring 42 then causes the crank to quickly complete its movement and pulls downward upon the rod 38 to close the breaker for the first time. The timing disc however, as it is directly connected to the ring gear 30, continues to rotate at the same speed until the finger 71 comes into contact with the stepping up lever 73. Continued moving

of the disc serves to rotate the stepping up lever 73 in a clockwise direction to move the segment 61 a sufficient distance to engage the next notch with the holding pawl 62. At this time the holding pawl 62 will be retained in engagement with the toothed segment since the holding magnet 64 will be energized. The circuit for the holding magnet 64 may be either traced through the switch A or through switch G, and thence through either switch B or switches C, E and N. When the disc 68 has rotated sufficiently far to permit return of the stepping up lever 73 and to rotate the finger 71 into a position to break the electrical connection between the disc and the switch element 95 of switch B, then the circuit through the motor may or may not be deenergized depending upon whether the circuit breaker has remained closed after the closing operation. If the circuit breaker has remained closed then switches E and G have remained open. At this instant during the rotation of the timing disc the insulating pin 99 is engaging the switch element 92 of switch A so that this switch is also open. Thus when the breaker remains closed a condition occurs in which after the first revolution of the timing disc, switches A, B, E and G are all open with the result that the circuit to the motor will be broken and the motor will arrest operation of the disc before it has moved sufficiently far to again close the switches A and B. The holding magnet 64 will also be deenergized to release the segment 61 and permit it to return to its original position.

In case however that the abnormal condition upon the line has not been removed before the first reclosing operation, then the circuit breaker will not remain closed and will immediately trip to again close switches E and G. Therefore during the interval that switches A and B are opened during rotation of the timing disc the holding magnet 64 will be energized through a circuit traced through switch G, and through switches C, E and N, while the motor will continue to be energized through a circuit traced through switches C, E and N. The timing disc will therefore start upon its second revolution and the crank 33 will again be actuated to reclose the breaker a second time. After the second reclosing the disc again completes its revolution, switches A and B are momentarily opened. As in the first reclosing operation, if the abnormal condition has been removed from the line and the breaker remains closed, then the holding magnet 64 and the motor M will be deenergized to arrest further movement and reset the toothed segment. However, if the breaker again trips immediately after the second closing then as previously the holding magnet and motor continue to be energized and the timing disc started on its third revolution. The completion of the second revolution moves the toothed segment 61 up another notch. Upon the third revolution the breaker is again reclosed for the third time and if the breaker does not remain closed the disc continues to rotate for its fourth revolution after which the toothed segment is notched sufficiently far to bring projection 66 into contact with the link 57 of the connecting toggle, thus breaking the contact and permitting opening of the switch C. Simultaneous with the completion of this fourth revolution the switches A and B are opened and thus the circuit is opened to the holding magnet 64 and motor M so that the mechanism comes to rest. The only manner in which the mechanism may then be reset is to energize the resetting magnet 84, thus moving the armature 85 to return its toggle to its dead center position, or to rotate the manual resetting knob 88. Upon returning the toggle to its dead center position the switch C will again be closed and the reclosing mechanism will again begin its cycle of movement. The resetting magnet 84 may be controlled by switch L located at a remote point as upon the switch board. Automatic control of the motor may be arrested by opening the remote switch N and direct control established by closing switch R. Manual tripping of the breaker may also be effected by closing the manual switch H which is shunted across the solenoid switch K. Manual resetting of the breaker may also be accomplished by the use of the hand lever 14, the pivot pin 39 being detachable to permit movement of the hand lever independent of the automatic reclosing mechanism.

It is obvious that by varying the number of teeth in the segment 61 any number of reclosing operations may be effected before deenergization of the motor. The single motor not only serves as the source of power for reclosing the breaker but also serves as a means for timing the reclosing operations and the operations of the various switches. Before the first closing operation the timing disc travels only one half of a revolution while between the first and second reclosing operations and between the second and third the disc must travel one complete revolution. Therefore the time interval between the initial tripping of the breaker and the first reclosing operation will be approximately one half the time interval between the first and second reclosing operations and between the second and third. This is a very desirable characteristic of my system since if the abnormal condition upon the line is only temporary it is usually removed before the first reclosing operation. By making this first interval as short as possible the service is again established almost immediately upon tripping of the breaker.

I claim:

1. Apparatus of the character described

for effecting operation of a circuit breaker, said breaker being adapted to trip open responsive to an abnormal line condition, said apparatus comprising means adapted to be operated upon opening of the circuit breaker for reclosing said breaker at recurrent intervals, a timing member moved during operation of the reclosing means, and means including a switch recurrently engaged by the timing member subsequent to each reclosing operation for arresting operation of the reclosing means if the breaker remains closed after one of the closing operations.

2. Apparatus of the character described for effecting operation of a circuit breaker, said breaker being adapted to trip open responsive to an abnormal line cindition, said apparatus comprising a motor adapted to be energized upon tripping of the breaker, drive means adapted to connect the motor and breaker to effect recurrent reclosing operations upon tripping of the breaker, a timing member actuated from said motor, switch means recurrently actuated by said member subsequent to each reclosing operation for deenergizing the motor in case the breaker remains closed after a closing operation, and switch means actuated by the timing member to deenergize the motor after the occurrence of a predetermined number of successive reclosing operations.

3. Apparatus of the character described for operating a circuit breaker, said breaker being adapted to trip open responsive to an abnormal line condition, said apparatus comprising a motor adapted to be energized upon tripping of the circuit breaker, drive means adapted to connect said motor and breaker to effect closing operation, a timing member driven from said motor, means including another member engaged and actuated by said timing member for effecting opening of the motor circuit after a predetermined number of repeated closing operations have occurred and if the abnormal condition is not removed, and means including a switch actuated by said timing member after each closing operation to effect opening of the motor circuit if the breaker remains closed.

4. Apparatus of the character described for operating a circuit breaker, said breaker being adapted to trip open responsive to an abnormal line condition, said apparatus comprising motive means adapted to be made operative upon opening of the circuit breaker for reclosing said breaker at recurrent intervals, a timing member moved thru a cycle by said motive means for each closing operation, means including a switch operated upon each cyclic movement of said timing member subsequent to each closing operation for deenergizing said motive means if the breaker remains closed after a closing operation, and means in addition to said switch for deenergizing said motive means responsive to a predetermined number of continuous cyclic movements of said timing member.

5. Apparatus of the class described for effecting reclosing operation of a circuit breaker comprising a member adapted to be actuated to close said breaker, a spring for actuating said member, a motor for storing energy in said spring adapted to be energized upon tripping of the circuit breaker, a toggle link controlling a pair of contacts in the motor circuit and means for breaking said toggle link after a predetermined number of closing operations to maintain said contacts open and said motor de-energized.

In testimony whereof, I have hereunto set my hand.

JAMES C. REA.