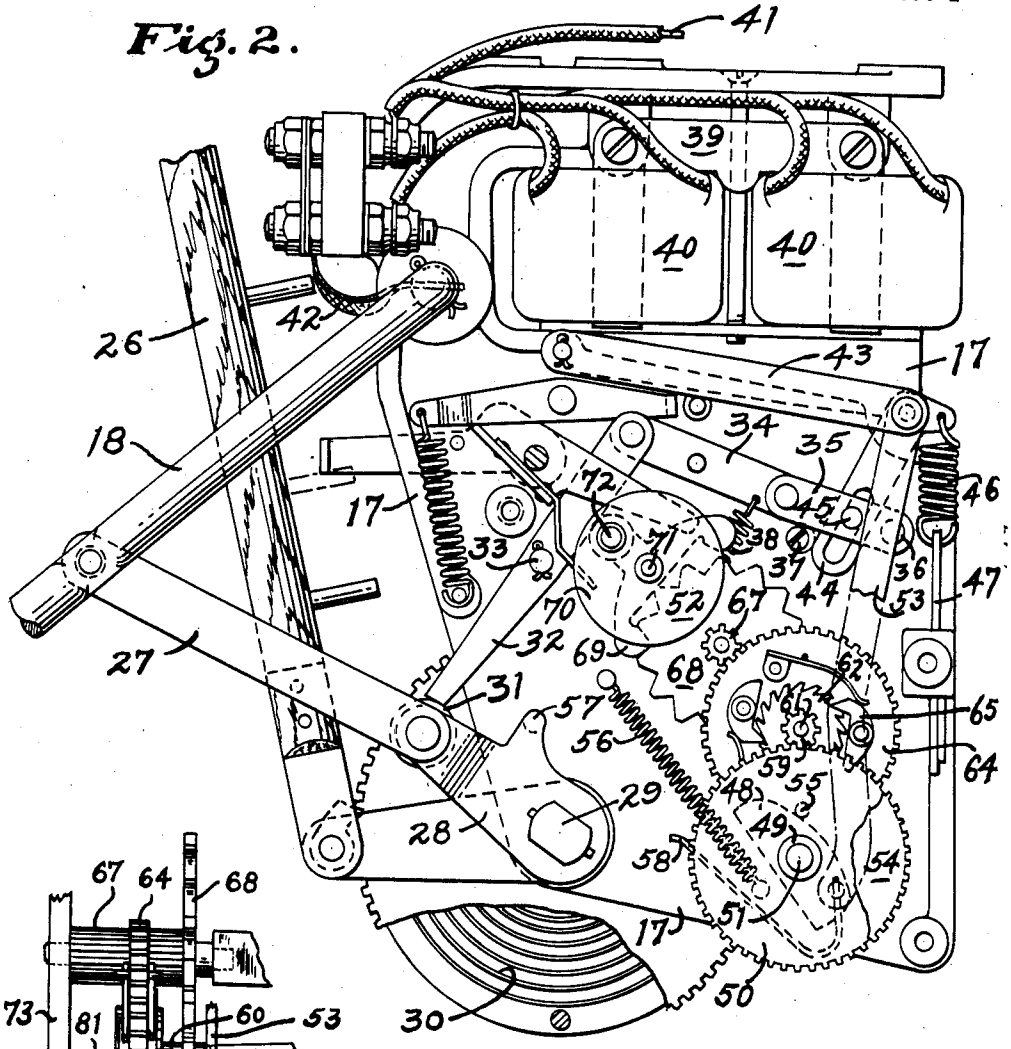
May 4, 1943. J. S. THOMPSON 2,318,343

SERVICE RESTORING CIRCUIT BREAKER

Original Filed Oct. 1, 1941 3 Sheets-Sheet 1

Fig. 2.



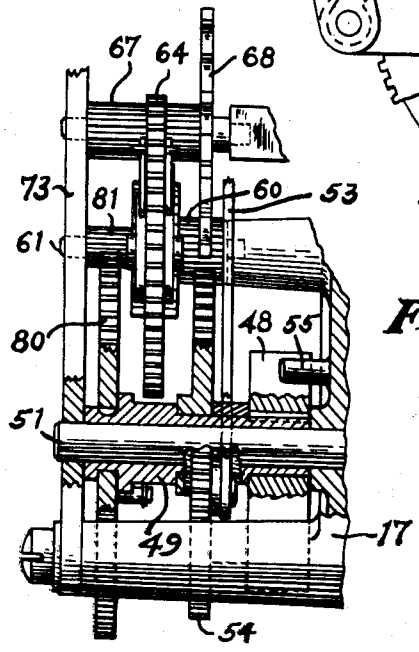


Fig. 7.

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SERVICE RESTORING CIRCUIT BREAKER

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Fig. 3.

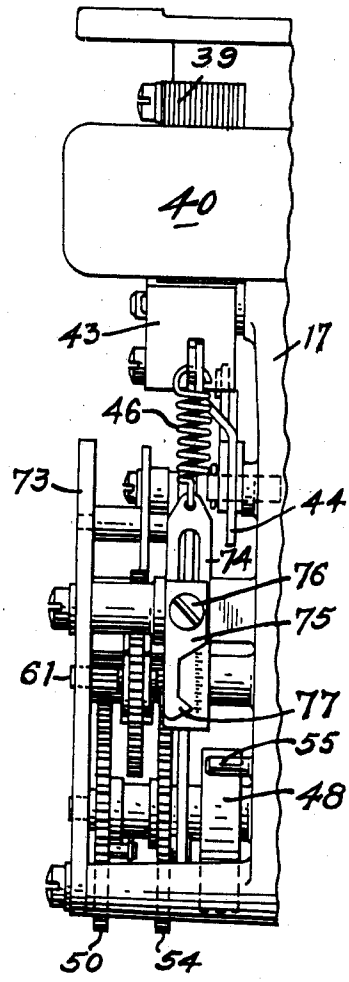
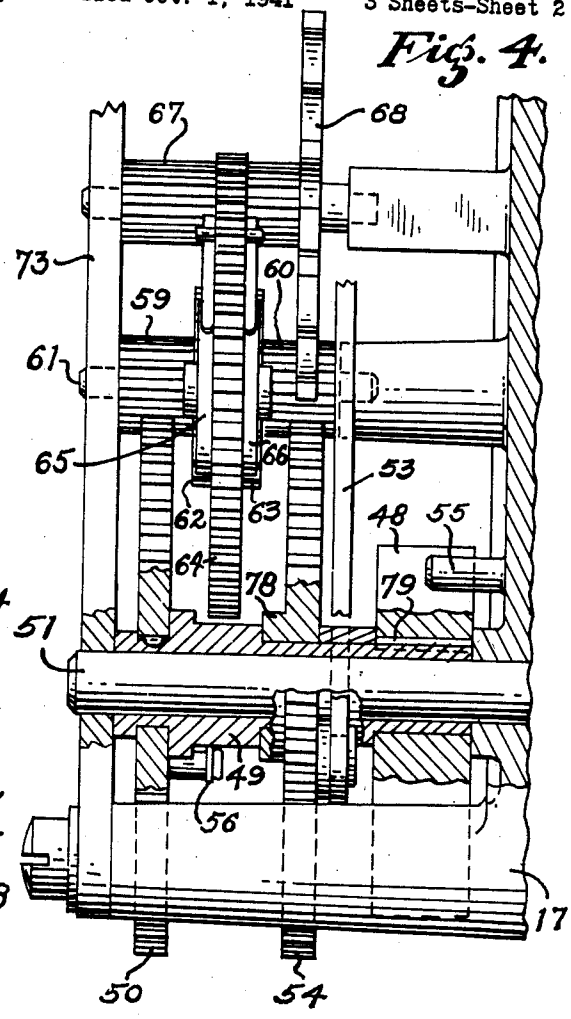


Fig. 4.



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SERVICE RESTORING CIRCUIT BREAKER

Original Filed Oct. 1, 1941 3 Sheets-Sheet 3

Fig. 1.

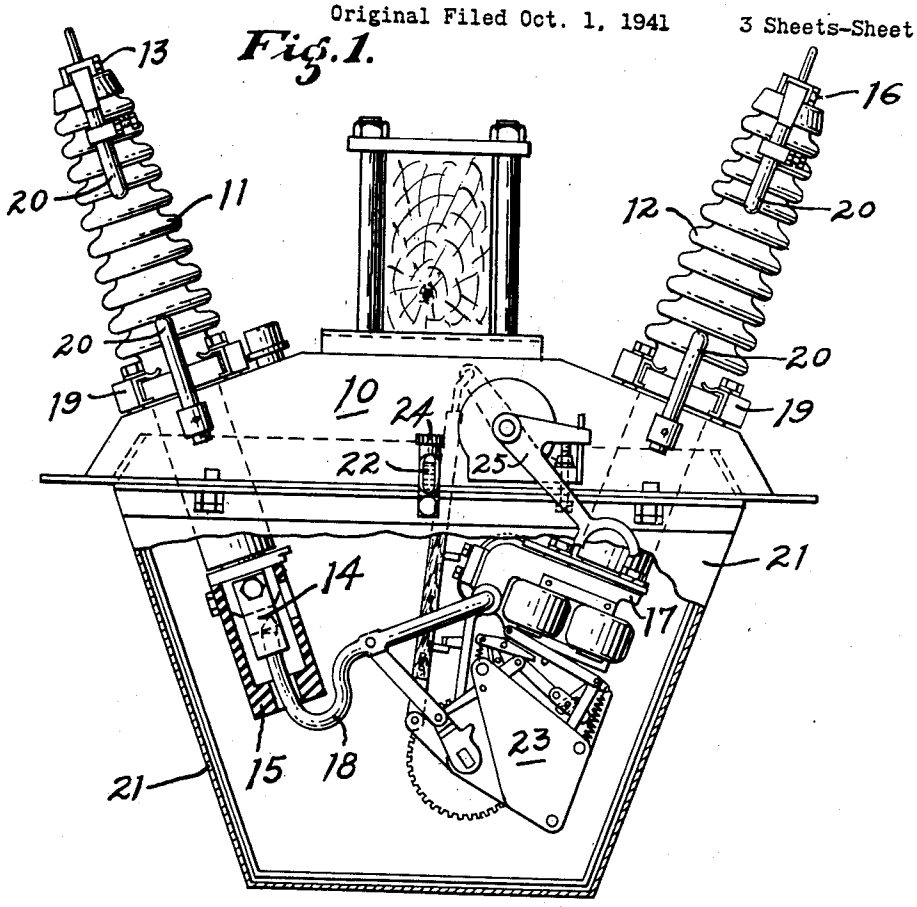


Fig. 5.

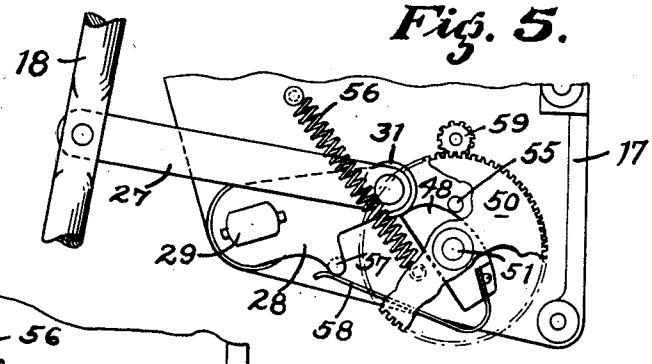
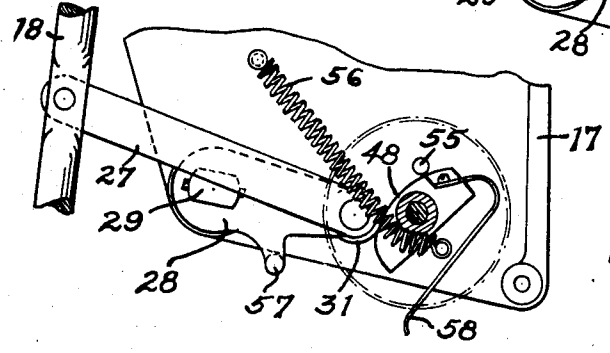


Fig. 6.



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Patented May 4, 1943

2,318,343

UNITED STATES PATENT OFFICE

2,318,343

SERVICE RESTORING CIRCUIT BREAKER

Joseph S. Thompson, Los Altos, Calif., assignor to Pacific Electric Manufacturing Corporation, San Francisco, Calif., a corporation of California

Original application October 1, 1941, Serial No. 413,175. Divided and this application August 18, 1942, Serial No. 455,177

10 Claims. (Cl. 200—89)

The present invention relates to reclosing circuit breakers of the high potential type, such as are customarily used on rural power transmission lines, and more particularly it relates to a timing mechanism for circuit restorers of the type illustrated and described in my copending application for patent, Serial No. 413,175, filed October 1, 1941, and of which this application is a division.

An object of the invention is to provide a timing mechanism for a reclosing circuit breaker of the character designated that is simple in construction, reliable in its action and fully automatic in its operation.

Another object of the invention is to provide a new and novel operating and time controlling mechanism for a reclosing circuit breaker of the type designated in which the operation of the circuit breaker is produced by an energy storing spring.

Another object of the invention is to provide a timing mechanism for an automatically operating reclosing circuit breaker in which a single timing means is adapted to introduce a controllable time delay in the tripping of the circuit breaker after overload and in a subsequent reclosing thereof after opening.

A further object of the invention is to provide a timing mechanism for a circuit breaker of the character described in which a single timing means is adapted to time both the opening of the circuit breaker under overload conditions and also the period which will elapse before a subsequent reclosing thereof.

With the increasing use of electrical energy for domestic and industrial purposes in rural districts, it has become more and more important that protective means be provided for these transmission lines that will protect the power circuit against overloads and other abnormal conditions, and at the same time provide, as nearly as possible, an uninterrupted service for these customers. Line troubles in the circuits supplying such users, due to transmission difficulties, are generally more frequent than on the main transmission lines, but in the majority of cases the fault is of short duration. It is, therefore, a further object of the invention to provide a circuit breaker which will open after a predetermined time interval when a fault occurs, and automatically reclose after a further predetermined time interval on the assumption that the trouble has disappeared and which, in the event of a sustained fault or overload, will provide a series of suitably timed circuit opening and circuit reclosing operations and finally lock out in the event that the fault or overload has not been cleared from the line during any of these successive circuit opening and reclosing operations.

Other objects and advantages of the invention will be in part evident to those skilled in the art to which this invention appertains as the description thereof proceeds, and in part pointed out hereinafter in connection with the description of the accompanying drawings, wherein there is shown by way of illustration and not of limitation, a preferred embodiment of the invention.

In the drawings, wherein like numerals refer to like parts throughout the several views;

Figure 1 is a front elevation of a single pole circuit breaker having a timing mechanism constructed and arranged to operate in accordance with the present invention and with a portion of the tank broken away to expose the operating mechanism,

Figure 2 is a front view of the operating and timing mechanism which controls the opening and reclosing operations of the circuit breaker contacts,

Figure 3 is a side view of the apparatus as illustrated in Figure 2 looking from the right of Figure 2.

Figure 4 is an enlarged detailed view with parts broken away to more clearly illustrate the operating parts of the timing mechanism of the circuit breaker,

Figures 5 and 6 are fragmentary detailed views showing the positions of the parts during the timing of a reclosing operation of the circuit breaker, and

Figure 7 is a view similar to Figure 4 showing a modified form of the timer mechanism.

Reference is now made to the drawings for a description of the invention. For the purpose of this description the invention is shown as embodied in a circuit breaker of the single pole type, but it is to be understood that the invention may be embodied in a circuit breaker of the multiple pole type, as will be readily apparent to those skilled in the art.

As illustrated in Figure 1 of the drawings, the entire circuit breaker mechanism is adapted to be mounted as a unit upon an elevated support, such as the crossarm of a pole, but it may be mounted upon a bracket carried by any suitable supporting structure. As shown, the entire circuit breaker is carried by a cover-like supporting member 10 which also supports two insulators 11 and 12 that are preferably of the bushing type. The insulator 11 has a line terminal 13 at its outer end and at its lower end it projects downwardly

through the cover-like supporting member 10 and supports a suitable stationary contact 14 that is enclosed in an arc extinguishing chamber 15. Likewise, the insulator 12 carries a line terminal 16 at its upper end and projects downwardly through the cover-like supporting member 10 where it carries a suitable supporting frame 17 upon which a contact 18 is movably mounted so as to cooperate with the stationary contact carried by the insulator 11. In addition to the movable contact 18, the supporting frame 17 also serves as a support for a complete operating and timing mechanism for controlling the movements of the contact member 18 into and out of engagement with the cooperating stationary contact 14 at the lower end of the bushing 11. The insulators 11 and 12 are preferably secured intermediate their ends to the cover-like supporting member 10 by means of suitable clamps 19 and they each include centrally disposed conductors (not shown) that provide for connections respectively between the line terminals 13 and 16 and the contacts 14 and 18 at the lower ends thereof. In this figure of the drawings the insulators 11 and 12 have arcing horns 20 disposed adjacent their exposed exterior portions. The cover-like supporting member 10 also carries an enclosure forming tank 21 that is adapted to carry an insulating oil or other arc extinguishing fluid 22 into which the stationary contact 14 with its arc extinguishing chamber 15 and the supporting frame with the movable contact 18 and its operating and timing mechanism, here designated by the numeral 23, are adapted to be completely submerged. The tank 21 projects upwardly under the cover-like supporting member 10 and is provided with a gauge 24 through which the oil therein may be observed. At this point it will be noted that the cover-like supporting member 10 also carries a manually operable lever means 25 by means of which the operating mechanism 23 may be manually controlled. This manually operable lever means 25 is connected to the operating mechanism 23 through an insulating rod 26 which, when reciprocated by an oscillation of the lever means 25, operates to effect a winding of an energy storing spring, and at the limits of its reciprocating movement, the insulating rod 26 is also adapted to cooperate with the operating mechanism 23 to accomplish other functions which are fully set forth in my above identified copending application.

Upon referring to Figure 2 of the drawings, it will be seen that the movable contact member 18 is pivotally mounted at its upper end to the supporting frame 17 and, intermediate its ends, this contact member 18 carries a link 27 that connects with a crank arm 28 which is mounted upon a shaft 29 that is adapted to be rotated through a series of complete revolutions by an energy storing clock spring 30, as will hereinafter appear. At the end of the crank arm 28 there is an abutment engaging roller 31 which engages a movable abutment 32 when the movable contact 18 is in its circuit closed position, as here illustrated. This movable abutment 32 is shown as pivoted upon a stud 33 intermediate its ends, and at its upper end it connects with a toggle mechanism that is formed by two connected links 34 and 35, the latter of which is secured to the supporting frame 17 upon a stud 36. Associated with the link 35 there is also an eccentrically mounted stop pin 37 that is adjustable to hold the toggle links 34 and 35 in a slightly overcenter position when the toggle mechanism is extended. A spring 38 connected to the link 34 operates to extend this toggle mechanism and thus return the movable abutment 32 into an operative position to engage the roller 31 upon the crank arm 28 after each operation thereof. At the upper part of the supporting frame 17 there is a magnetic field structure 39 which is excited by a winding that is shown as composed of two coils 40 which may be connected either in series or in parallel with each other. One end of this winding, designated by the numeral 41, is adapted to be connected to the terminal 16 at the outer end of the bushing 12, and the other end of this winding is arranged to be connected to the upper end of the movable contact member 18 by means of a flexible current conducting jumper 42. Associated with the field structure 39 there is a pivotally mounted armature 43 that is adapted to be attracted and moved upwardly when the current flowing through the coils 40 reaches a predetermined value; as for example, an overload current condition. Attached to the pivotally mounted armature 43 there is a slotted link 44 which engages a pin 45 intermediate the ends of the link 35 of the toggle mechanism, and at its outer end the pivotally mounted armature 43 is connected through a tension spring 46 to an adjustable securing means 47 by which the tension upon the spring 46 may be varied to determine the value of current at which the pivotally mounted armature 43 will be attracted upwardly. When this pivotally mounted armature 43 is attracted by the magnetic field structure 39, as is understood in the art, the slotted link 44 will be carried upwardly a distance sufficient to trip or collapse the toggle mechanism formed by the links 34 and 35. This collapse of the toggle mechanism will move the pivotally mounted abutment 32 in a clockwise direction about the stud 33 and, as a result, the abutment engaging roller 31 at the outer end of the crank arm 28 will become disengaged and thus permit the energy storing clock spring 30 to rotate the crank arm 28 through an arc of its path of movement sufficient to effect a disengagement of the movable contact member 18 from its cooperating stationary contact 14 and thus open the circuit. In this circuit opening operation of the movable contact 18 the abutment engaging roller 31 at the end of the crank arm 28 will be brought into engagement with a second movable abutment 48 that is carried by a sleeve 49 which also carries a gear 50 and is rotatably mounted upon a shaft 51. As will presently appear, the gear 50 is associated with an escapement type of timing mechanism, designated generally by the numeral 52, which will operate to time the movements of the second movable abutment 48 as it moves to release the abutment engaging roller 31 and permit a circuit reclosing operation of the movable contact 18 under the influence of the energy storing spring 30.

In order to also provide for a time interval of delay in the circuit opening operation of the movable contact member 18, the pivotally mounted armature 43 carries a second link 53 which extends downwardly and is connected to a second gear 54 that is freely rotatable about the sleeve 49 and is associated with the timing mechanism 52 above referred to as associated with the gear 50. With this latter arrangement when the movable armature 43 is attracted, due to an overload current condition, with sufficient force to overcome its calibrating spring 46, the armature 43 will move upwardly at a rate of move-

ment which will be determined by the adjustment of the timing mechanism 52. In this manner the circuit opening operation of the movable contact 18 can be delayed or timed to occur after any desired lapse of time in the event of a sustained overload condition upon the circuit. When the movable contact member 18 has been moved into its open circuit position, as above indicated, the abutment engaging roller 31 at the end of the crank arm 28 will be brought into restrained engagement with the second abutment 48 where its further movement will be controlled by the timing mechanism 52. This second movable abutment 48 is normally biased in a clockwise direction against a stop 55 by a spring 56. As shown, the abutment 48 has a substantially flat roller engaging portion that is adapted to provide an impact surface for the abutment engaging roller 31, and leading from this impact surface it has a receding cam-like surface that will permit a passing of the abutment engaging roller 31 thereover when the abutment 48 is rotated counter-clockwise from the position illustrated in Figures 2 and 5 of the drawings. In order to provide for this counter-clockwise movement of the second abutment 48, the crank arm 28 is provided with a spring engaging projection 57 that is adapted to engage the outer end of a leaf spring 58 which is carried by the second abutment 48 in such a manner that it will be placed under stress when the abutment engaging roller 31 is brought into contact with the second abutment 48. Because of the stress thus placed upon the leaf spring 58, the second abutment 48 and its attached gear 50 will tend to rotate in a counter-clockwise direction and as this rotation continues, the abutment engaging roller 31 upon the crank arm 28 will, because of the cam-like surface of the second abutment 48, cause this latter abutment to rotate more positively under the action of the energy storing spring 30. But, due to the timing mechanism 52 with which the gear 50 connects, the release of the crank arm 28 will be delayed for a period which will be determined by the adjustment of the timing mechanism. As soon as the second abutment 48 has rotated counter-clockwise a sufficient distance to release the crank arm 28, the clock spring 30 will again operate through the link 27 and cause the crank arm 28 to swing the movable contact member 18 into circuit making engagement with the stationary contact 14 and thus reclose the circuit through the circuit breaker.

It will be understood that the gears 50 and 54, which respectively control the rotation of the second abutment 48 and the upward movement of the pivotally mounted armature 43, are each of the same diameter and rotate independently about the axis of the shaft 51. These gears 50 and 54 are so spaced axially with respect to each other that at their peripheries they will engage corresponding pinions 59 and 60. Each of the pinions 59 and 60 are mounted upon and rotate freely about a shaft 61 and formed upon their adjacent ends they respectively carry ratchet wheels 62 and 63, one of which is disposed on each side of a central gear 64. This central gear 64 carries ratchet wheel engaging pawls 65 and 66 that cooperate with the ratchet wheels 62 and 63 and thus provide a driving connection between the central gear 64 and the gears 59 and 60 when they are rotated in a counter-clockwise direction. When the central gear 64 is thus driven, it will move in a clockwise direction and operate through a pinion 67 to rotate a notched escapement wheel 68 with which a controlling archor 69 cooperates. To control the oscillations of the anchor 69 there is an inertia weight 70 which rotates about a shaft 71 and is attached eccentrically to the controlling anchor 69 at a point 72. With the above described arrangement it will be seen that, because of the ratchet and pawl connection between the central gear 64 and the two outer gears 50 and 54, the gear 50 will be free to return to its initial position under the influence of the spring 56, and the gear 54 will be free to return under the influence of the armature calibrating spring 46. As a result, the timer engaging gears 50 and 54 will always be in a position to operate in conjunction with the timing mechanism 52 at the instant their particular operation is required.

Upon referring to Figures 2 and 3 of the drawings, it will be seen that the supporting frame 17, upon which the circuit breaker operating mechanism 23 and the energy storing spring 30 are mounted, is provided with a depending plate-like portion from which there extends a plurality of integral bosses to which there is secured an outer plate 73. This outer plate 73, in addition to protecting the circuit breaker operating mechanism 23, also serves as a support for the ends of the several shafts upon which the various rotary elements are mounted. As is more clearly shown in Figure 3 of the drawings, the adjustable securing means 47 to which the spring 46 is connected at its lower end comprises a slotted plate 74 that is adapted to slide below a clamping member 75 which is secured upon the supporting frame 17 by means of a screw 76. The clamping member 75 has a pointer 77 which, as here illustrated, cooperates with certain graduations upon the member 74 to indicate the tension exerted upon the armature 43 by the spring 46. To further illustrate the manner in which the timer engaging gears 50 and 54 are mounted to rotate about the axis of the shaft 51, Figure 4 shows these gears with portions broken away and in section. It will be noted that the inner gear 54 is provided with a hub 78 which is freely journaled upon the relatively long sleeve or extending hub 49 which carries and connects the outer timer engaging gear 50 with the second abutment 48, the abutment 48 being splined upon the inner end of this sleeve or hub 49 by a key 79.

Reference is now again made to Figure 2 and to Figures 5 and 6 of the drawings for a more detailed description of the operation of a circuit breaker timing mechanism as constructed in accordance with the present embodiment of my invention. In the latter figures of the drawings, the timer mechanism and other elements have been omitted to more clearly show the means which serves to limit and control the operative movements of the movable contact member 18 during a series of circuit opening and reclosing operations. It will first be assumed that the movable contact member 18 of the circuit breaker is in its circuit closed position, as shown in Figure 2, and that the pivotally mounted armature 43 is in the position shown with the movable abutment 32 operating to retain the crank arm 28 and the movable contact member 18 in their closed circuit position against the action of the energy storing spring 30 which, it will also be assumed, is in a fully wound condition. Now, should an overload condition occur, the excessive current passing through the coils 40 will further energize the magnetic field structure 39 and thus attract the pivotally mounted armature 43. The

armature 43 will then be moved upwardly against the action of the calibrating spring 46 until the slotted link 44 carried thereby has tripped the toggle mechanism formed by the links 34 and 35. However, during its upward movement, the pivotally mounted armature 43 will be delayed by the timing mechanism 52 acting through the connecting link 53 which is secured to the timer engaging gear 54. Under these conditions, the timer engaging gear 54 will be turned freely in a counter-clockwise direction about the sleeve 49 upon the shaft 51 and the associated pinion 60 with its ratchet wheel 63 will operate through the ratchet engaging pawls 66 to drive the larger central gear 64 in a clockwise direction and thus rotate the pinion 67 which carries the notched escapement wheel 68. Then, as the notched escapement wheel 68 is thus caused to turn, its controlling anchor 69 will oscillate in the well understood manner to retard and permit a step-by-step turning of the notched escapement wheel 68. In this manner the upward movement of the pivotally mounted armature 43 may be delayed for any desired period of time, as will be determined by the nature and adjustment of the inertia weight 70 which controls the oscillating periods of the anchor 69. As soon as the armature 43 has moved upwardly a distance sufficient to trip the toggle mechanism formed by the links 34 and 35 and releases the crank arm 38, as above described, the circuit will be opened. Then, as soon as the circuit is opened, the coils 40 will be deenergized and the armature 43 will be free to return to its initial position under the influence of the spring 46. This will carry the gear 54 back to its original position free of the timing mechanism 52 and again reset the ratchet connection between the pinion 59 and the larger central gear 64 for a subsequent delayed or timed opening of the circuit breaker should the fault or overload condition still exist at the time of the next circuit reclosing operation of the circuit breaker.

As soon as the pivotally mounted armature 43 has moved in the above manner sufficiently to trip the toggle mechanism formed by the links 34 and 35, the movable abutment 32 will be carried out of interfering relation with the roller 31 at the end of the crank arm 28 and, as a result, the energy storing spring 30, will be free to operate through the shaft 29 and move the roller 31 into abutting engagement with the second abutment 48, as shown in Figure 5 of the drawings. During this movement of the crank arm 28, it will be seen that the spring engaging projection 57 upon the crank arm 28 will engage the leaf spring 58 and thus produce a preliminary rotating bias upon the second abutment 48 which will tend to turn this abutment in a counter-clockwise direction. At this point, however, the counter-clockwise rotation of the second abutment 48 will be controlled by the timer mechanism 52 and, as a result, the circuit breaker reclosing movement of the crank arm 28 under the influence of the energy storing spring 30 will be delayed until the second abutment 48 has rotated around and into the position where it is illustrated in Figure 6 of the drawings. During this rotation of the movable abutment 48, the gear 50 will be caused to turn with the sleeve 49, upon which the movable abutment 48 is mounted, and drive its associated pinion 59 in such a direction that the ratchet wheel 62 and the engaging pawls 65 will drive the larger central gear 64 in a clockwise direction or in a manner similar to that in which this central gear 64 was previously rotated in controlling the upward movement of the armature 43. This will cause its associated pinion 67 to turn the notched escapement wheel 68 with a step-by-step movement, as will be determined by the position and adjustment of the inertia weight 70 that controls the escapement anchor 69. During this rotation of the gear 54, its biasing spring 56 will be stretched out, as is more clearly illustrated in this latter figure of the drawings, until the crank arm 28 is released. Then, when this occurs, the spring 56 will return the gear 50 and the second movable abutment 48 to their initial positions with the abutment 48 held against the stop 55 where it will be in a position to engage the roller 31 upon the end of the crank arm 28 should the armature 43 be again attracted to collapse the toggle mechanism and thus cause another opening operation of the circuit breaker, as would be the case in the event that the circuit breaker is closed at the time of an existing fault or overload condition upon the circuit controlled thereby. It will now be seen that when the abutment engaging roller 31 at the end of the crank arm 28 is free to pass by the abutment 48, it will continue around until the movable contact member 18 has been again brought into full engagement with its cooperating stationary contact 14. At the same time, the roller 31 upon the crank arm 28 will come to rest against the movable abutment 32. Should it happen that the overload or fault is cleared from the circuit during this initial opening and reclosing operation of the circuit breaker, the parts will remain in the positions illustrated in Figure 2 of the drawings. However, if the fault continues through this initial opening and reclosing operation, the pivotally mounted armature 43 will be again attracted by the magnetic field structure 39 and the above operations will be repeated through a predetermined cycle or until the energy storing spring 30 has become nearly exhausted of its stored energy, as described in my aforesaid copending application for patent. This will leave the apparatus in a position where it will no longer operate automatically and, as a result, it will then be necessary for a lineman to manually rewind the energy storing spring 30. This can be done by means of an operating pole and the external lever means 25 previously described in connection with Figure 1 of the drawings. Should it happen that the overload or fault is removed from the circuit breaker prior to any one of the above described reclosing operations, the circuit breaker will remain in its circuit closed condition.

With a timing means as above described, it will be seen that, because of the control exerted by the inertia weight 70 upon the timing mechanism 52, the lapsed time interval in the operation of the electromagnetic armature 43 to trip the toggle mechanism and the movement of the movable abutment 48 to release the crank arm 28 will be determined by the amount of torque exerted by the magnetic armature 43 and the crank arm 28 respectively upon the gears 54 and 50. Therefore, it these torques are of different magnitude, the timing provided for by the timing mechanism 52, as shown, will be different for each of these operations. To overcome this limitation and make possible, if desired, a uniform time interval for each of these operations and/or a time interval which may not be respectively proportional to the torque or movement available to turn the gears 50 and 54, it is contemplated,

as illustrated in Figure 7 of the drawings, that the gears 50 and 54 and their cooperating pinions 59 and 60 may be of different diameters so as to provide different ratios of transmission which will compensate for any difference in the available operating torque or movement, or provide within limits for any desired timing interval for the respectively controlled operations of the circuit breaker. In this latter figure of the drawings, the electromagnetic armature 43 is shown as connected to the timing mechanism through the gear 54 and the pinion 60 in the manner above described. But, the movable abutment 48 is, in this instance, connected to the timing mechanism 52 through the medium of a larger gear 80 that cooperates with a smaller pinion 81 which operates through the ratchet wheel 62 to drive the gear 64 of the timing mechanism 52. With this modification it will be seen that with the timer mechanism 52 adjusted to a predetermined period, the rotation of the gear 80, and consequently the movement of the movable abutment 48, will be retarded to a greater extent than was the case with the smaller gear 50 in the earlier described arrangement, and in this manner the greater amount of torque available to operate the movable abutment 48 may be compensated for in such a manner that a substantially equal time interval of delay will be introduced in the operation of both the circuit opening and circuit reclosing operations of the circuit breaker. It will also be understood that the gear 80 may be made larger than the gear 54 if the operating conditions dictate such a change. From this it will be apparent that by suitably proportioning the gears 50, 54 and the pinions 59 and 60, any desired timing period may be produced in circuit opening and reclosing operations of the circuit breaker.

While I have, for the sake of clearness and in order to disclose the invention so that the same can be readily understood, described and illustrated specific devices and arrangements, I desire to have it understood that this invention is not limited to the specific means disclosed, but may be embodied in other ways that will suggest themselves to persons skilled in the art. It is believed that this invention is new and all such changes as come within the scope of the appended claims are to be considered as part of this invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In a circuit breaker of the character described, the combination of an operating mechanism having two positions of repose one of which occurs when the circuit breaker is in its circuit closed position and the other of which occurs when the circuit breaker is in its open circuit position, separate means for retaining said operating mechanism in each of said positions of repose, means for releasing each of said retaining means under predetermined conditions of operation, whereby said operating mechanism may cause said circuit breaker to operate through a predetermined cycle of circuit opening and reclosing operations, and a single timing means operatively connected to each of said retaining means adapted to delay the release of said operating mechanism by either of said retaining means after the occurrence of said predetermined conditions.

2. In a circuit breaker of the character described, the combination of an energy storing spring, an operating mechanism driven by said energy storing spring and having two positions of repose one of which occurs when the circuit breaker is in its circuit closed position and the other of which occurs when the circuit breaker is in its open circuit position, separate retaining means for holding said operating mechanism against the action of said energy storing spring in each of said positions of repose, means for rendering said retaining means inoperative under predetermined circuit conditions, whereby said energy storing spring will be free to drive said operating mechanism and operate said circuit breaker through a circuit opening and circuit reclosing operation, and a single timing means operatively connected to control each of said retaining means adapted to introduce a time delay in the release of said retaining means immediately following the operation of said last means due to the occurrence of said predetermined circuit conditions.

3. In a circuit breaker having a movable contact of the character described, the combination of a contact operating mechanism having two positions of repose one of which occurs when the contact is in a circuit closed position and the other of which occurs when the contact is in an open circuit position, separate means for retaining said contact operating mechanism in each of said positions of repose, means for releasing said retaining means under predetermined conditions of operation, whereby said contact operating mechanism will cause said contact to operate through a predetermined cycle of successive circuit opening and reclosing operations, and a single timing means operatively connected to each of said retaining means, whereby a time delay will be introduced in the operation of said contact immediately preceding the release of said contact operating mechanism by either of said retaining means upon the occurrence of said predetermined conditions.

4. In a circuit breaker of the character described, the combination of a stationary contact, a movable circuit completing contact adapted when operated to engage and disengage said stationary contact, operating mechanism for controlling the operations of said movable contact, said operating mechanism comprising an energy storing spring capable of operating said movable circuit completing contact through a number of circuit opening and circuit reclosing operations, a latching mechanism for holding said movable circuit completing contact in a circuit closed position, electromagnetic means responsive to current conditions upon the circuit through the circuit breaker for releasing said latching mechanism, means for temporarily holding said movable contact in a circuit open position after its release by said latching mechanism, and a single timing means associated with said electromagnetic means and with said last means, whereby a time delay will precede each circuit opening and each circuit reclosing operation of said movable circuit completing contact following a release of said latching mechanism by said electromagnetic means.

5. In a circuit breaker of the character described, the combination of a stationary contact, a movable circuit completing contact adapted when operated to engage and disengage said stationary contact, operating mechanism for controlling the operations of said movable contact, said operating mechanism comprising an energy storing spring capable of operating said movable circuit completing contact through a number of

circuit opening and circuit reclosing operations, a latching mechanism for holding said movable circuit completing contact in a circuit closed position, electromagnetic means responsive to current conditions upon the circuit through the circuit breaker for releasing said latching mechanism, means for temporarily holding said movable contact in a circuit open position after its release by said latching mechanism, and a single timing means associated with said electromagnetic means and with said last means adapted to introduce a time delay in each circuit opening operation of said movable contact following an operation of said electromagnetic means and to restrain said temporary holding means to thus delay each circuit reclosing operation of said movable circuit completing contact.

6. In a timing device for a reclosing circuit breaker of the character described, the combination of cooperating circuit controlling contacts, a crank arm operatively connected to control the operation of said circuit controlling contacts, energy storing means for operating said crank arm through a plurality of operating movements, latching means for holding said crank arm in a position to retain said cooperating contacts in a closed circuit position, electromagnetic means for rendering said latching means inoperative, a stop means for holding said crank arm in a position to retain said cooperating contacts in an open circuit position, means operative to move said stop means out of holding relation with said crank arm when in contact therewith, and a single timing means operable to introduce a time delay in the release of said latching means by said electromagnetic means and a release of said crank arm by said stop means, whereby in the event of a continuing fault or overload upon the circuit through the circuit breaker said crank arm will operate to open and reclose the circuit through said cooperating contacts with a delayed time interval immediately preceding each operative movement thereof.

7. In a timing device for a reclosing circuit breaker of the character described, the combination of cooperating circuit controlling contacts, a crank arm operatively connected to control the operation of said circuit controlling contacts, energy storing means for operating said crank arm through a plurality of operating movements, latching means for holding said crank arm in a position to retain said cooperating contacts in a closed circuit position, electromagnetic means for rendering said latching means inoperative, a stop means for holding said crank arm in a position to retain said cooperating contacts in an open circuit position, means operative to move said stop means out of holding relation with said crank arm when in contact therewith, and a single timing means operatively connected to said magnetic means and to said stop means adapted to introduce a time delay in the release of said latching means by said electromagnetic means and also a release of said crank arm by said stop means, whereby in the event of a continuing fault or overload upon the circuit through the circuit breaker said crank arm will operate to open and reclose the circuit through said cooperating contacts with a delayed time interval immediately preceding each operative movement thereof resulting from a release of said crank arm by said latching means or said stop means.

8. In an automatic reclosing circuit breaker of the character described, the combination of a movable contact member adapted to engage a cooperating stationary contact and establish a circuit therethrough, an operating mechanism adapted to move said movable contact member into and out of engagement with said cooperating stationary contact, a latch controlled abutment adapted to hold said movable contact member in its closed circuit position, an electromagnetically responsive armature for releasing said latch controlled abutment, a magnetic field producing coil energized by current flowing through the circuit breaker adapted under abnormal current conditions to attract said electromagnetically responsive armature and release said latch controlled abutment and permit a circuit opening operation of said movable contact member by said operating mechanism, a movable abutment adapted to stop said movable contact member in an open circuit position, means for moving said movable abutment out of holding relation with said movable contact when the movable contact is in its circuit open position to permit a circuit reclosing operation of said movable contact, and a single timing means for delaying the operation of said electromagnetic responsive armature and the movement of said movable abutment, whereby the release of said movable contact upon the occurrence of an overload and the subsequent reclosing operation of said movable contact will be independently controlled by said single timing means.

9. In an automatic reclosing circuit breaker of the character described, the combination of a movable contact member adapted to engage a cooperating stationary contact and establish a circuit therethrough, an operating mechanism adapted to move said movable contact member into and out of engagement with said cooperating stationary contact, a latch controlled abutment adapted to hold said movable contact member in its closed circuit position, an electromagnetically responsive means adapted under abnormal current conditions to release said latch controlled abutment and permit a circuit opening operation of said movable contact member by said operating mechanism, a movable abutment adapted to stop said operating mechanism with said movable contact member in a circuit open position, means for moving said movable abutment out of stopping relation with said operating mechanism when the movable contact is in its circuit open position, a single timing means for delaying the operation of said electromagnetic means and the movement of said movable abutment, and a geared one-way driving connection between said timing means and said electromagnetic means and between said timing means and said movable abutment, whereby the release of said movable contact upon the occurrence of an overload and the subsequent reclosing operation of said movable contact will each be independently controlled by said single timing means.

10. In an automatic reclosing circuit breaker of the character described, the combination of a movable contact member adapted to engage a cooperating stationary contact and establish a circuit therethrough, an operating mechanism adapted to move said movable contact member into and out of engagement with said cooperating stationary contact, a latch controlled abutment adapted to hold said movable contact member in its closed circuit position, an electromagnetically responsive means adapted under abnormal current conditions to release said latch controlled abutment and permit a circuit opening operation of said movable contact member by said operat-

ing mechanism, a movable abutment adapted to stop said operating mechanism with said movable contact member in a circuit open position, means for moving said movable abutment out of stopping relation with said operating mechanism when the movable contact is in its circuit open position, an escapement-type timing means for delaying the operation of said electromagnetic means and the movement of said movable abutment, and a geared driving connection between said timing means and said electromagnetically responsive means and between said timing means and said movable abutment, the ratio of said driving connections being such that said timing means may operate to provide different or equal time intervals of delay in the operations of said movable contact member by said operating mechanism.

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