Sept. 4, 1956 R. M. SMITH 2,761,930

CIRCUIT RECLOSER

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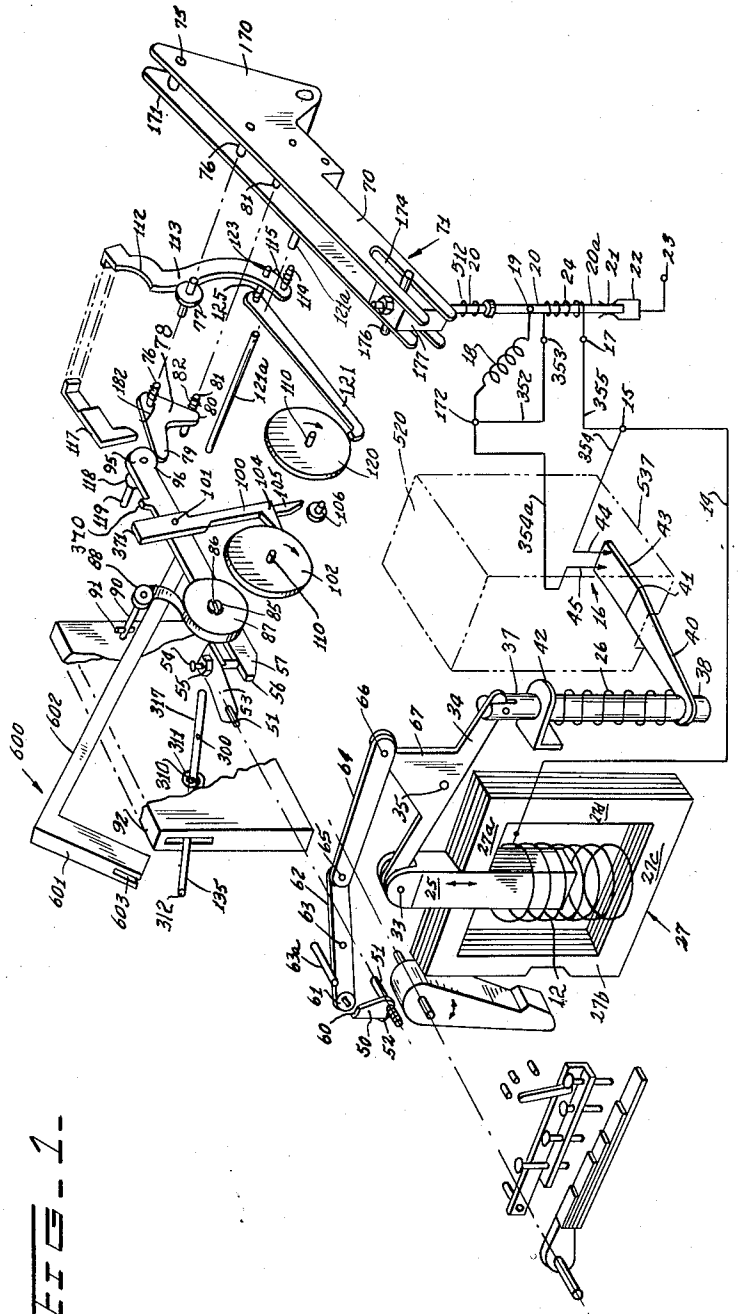


FIG. 1.

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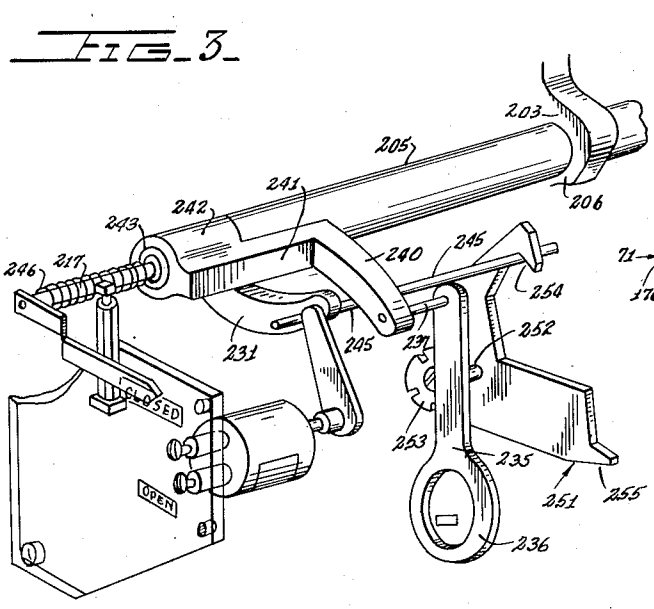
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CIRCUIT RECLOSER

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FIG. 3.



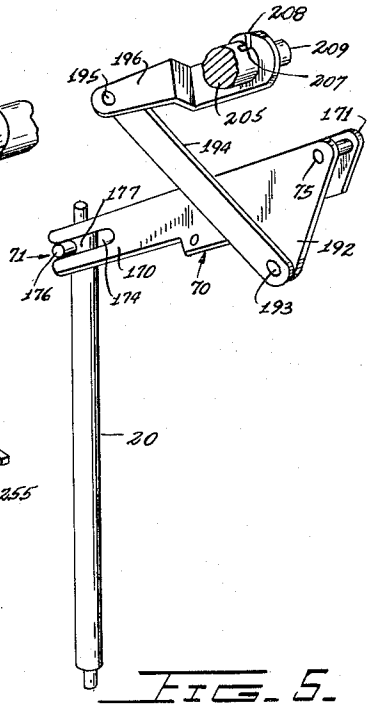


FIG. 2.

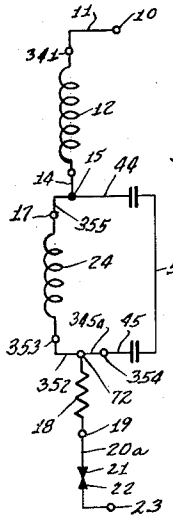


FIG. 4.

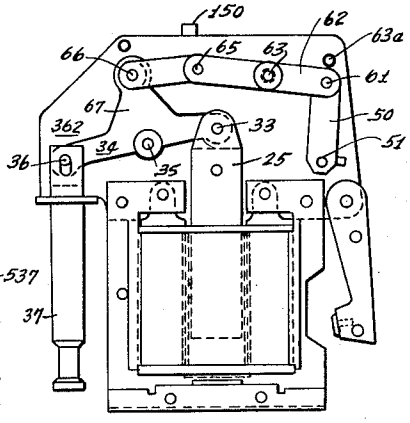
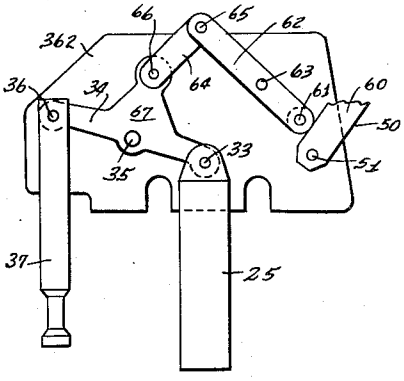


FIG. 5.



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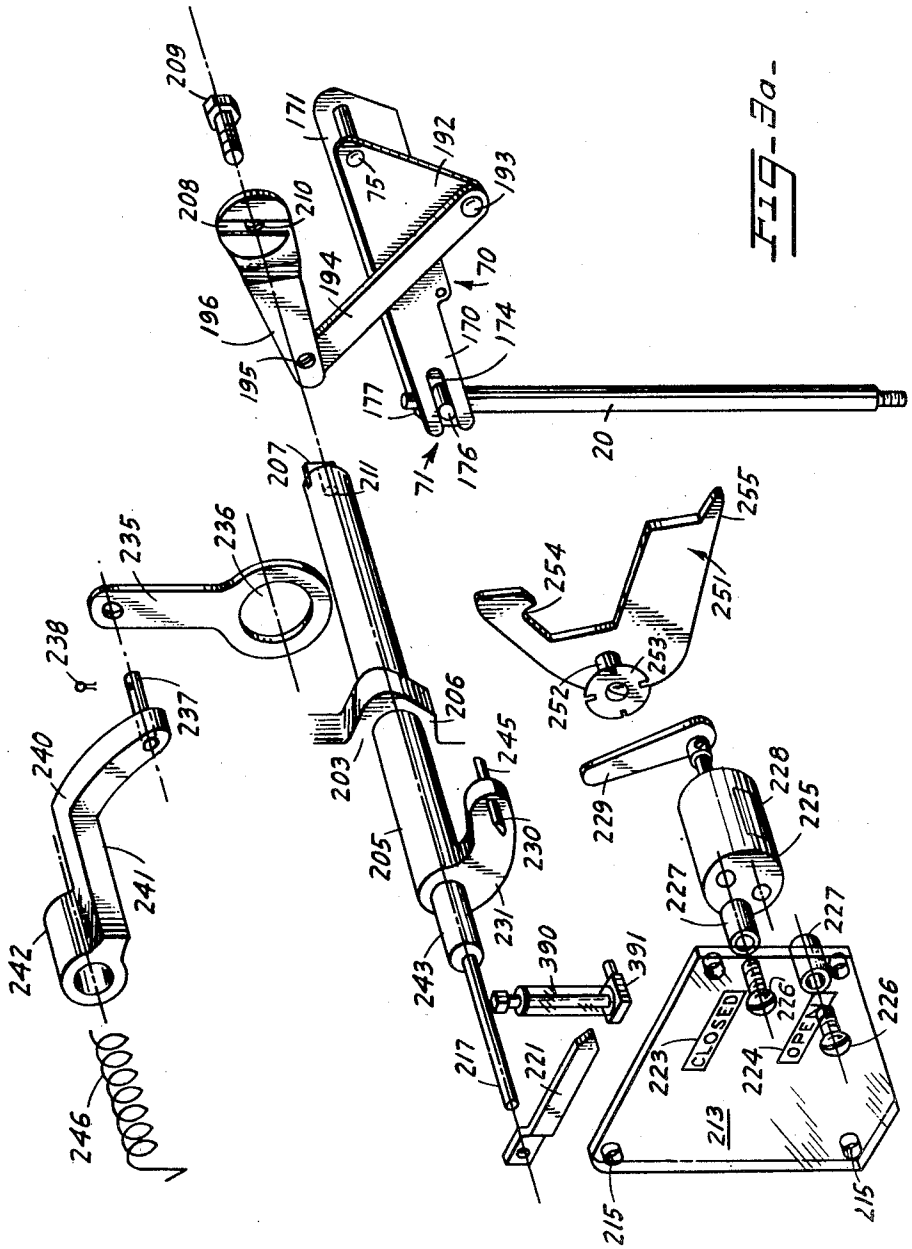


FIG. 3a.

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CIRCUIT RECLOSER

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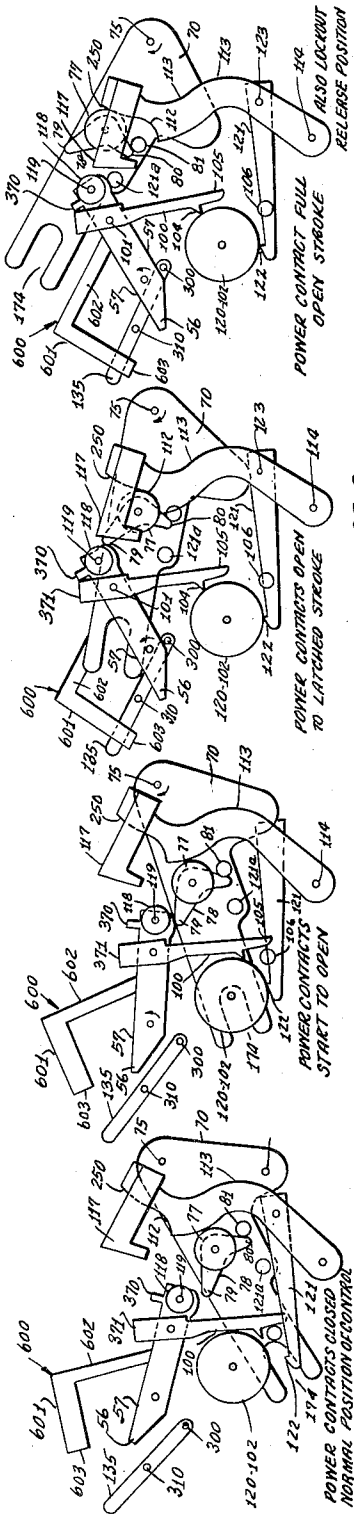


FIGURE 6

FIGURE 7

FIGURE 8

FIGURE 9

FIGURE 10

FIGURE 11

FIGURE 12

FIGURE 13

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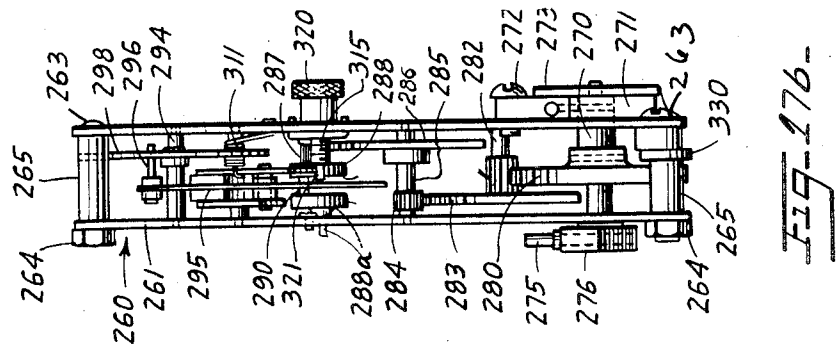


FIG. 17b.

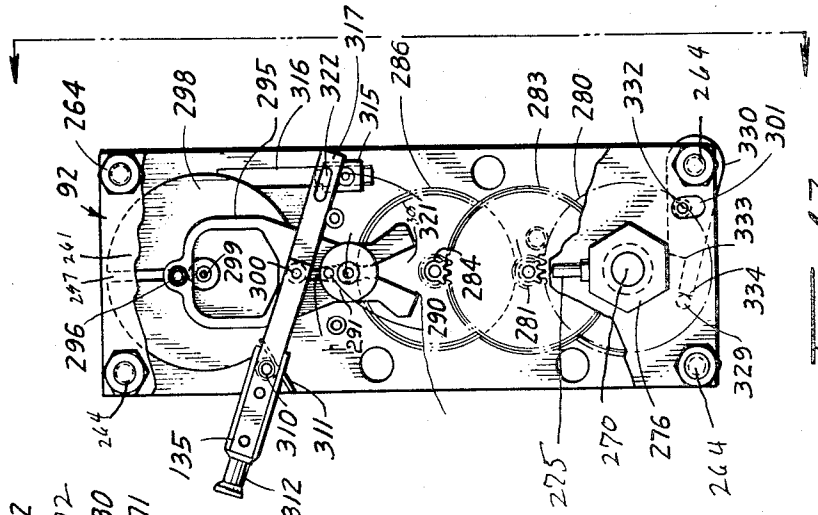


FIG. 17a.

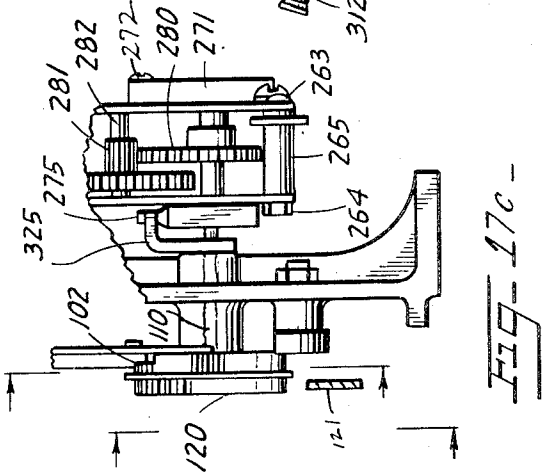


FIG. 17c.

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CIRCUIT RECLOSER

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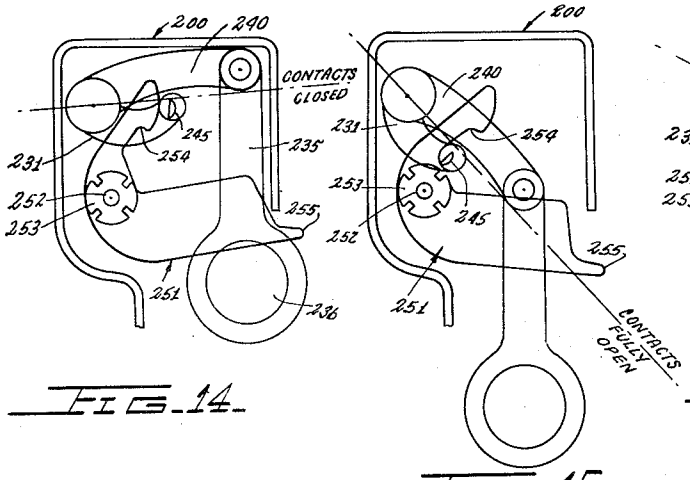


FIG. 14.

FIG. 15.

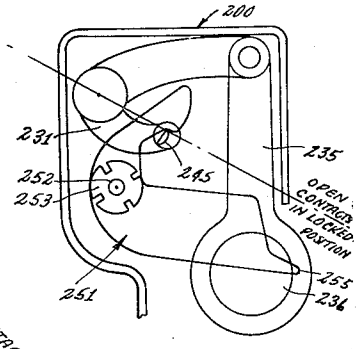


FIG. 16.

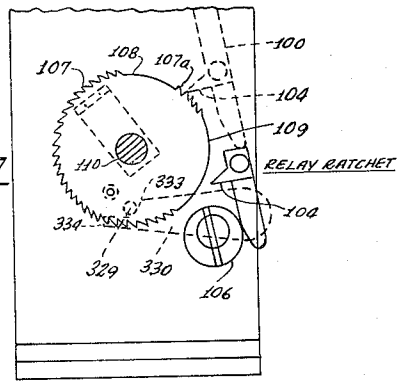


FIG. 18.

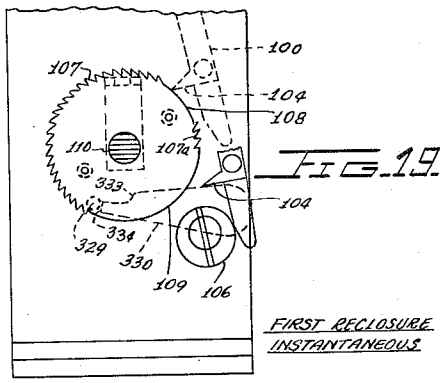


FIG. 19.

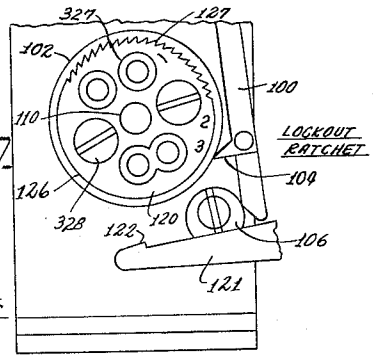


FIG. 20.

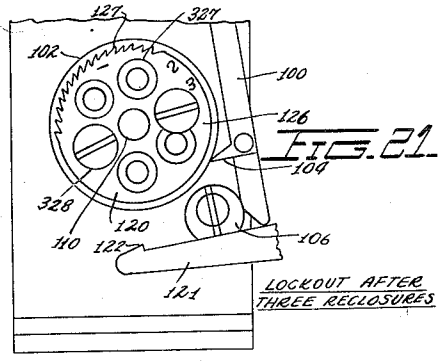


FIG. 21.

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CIRCUIT RECLOSER

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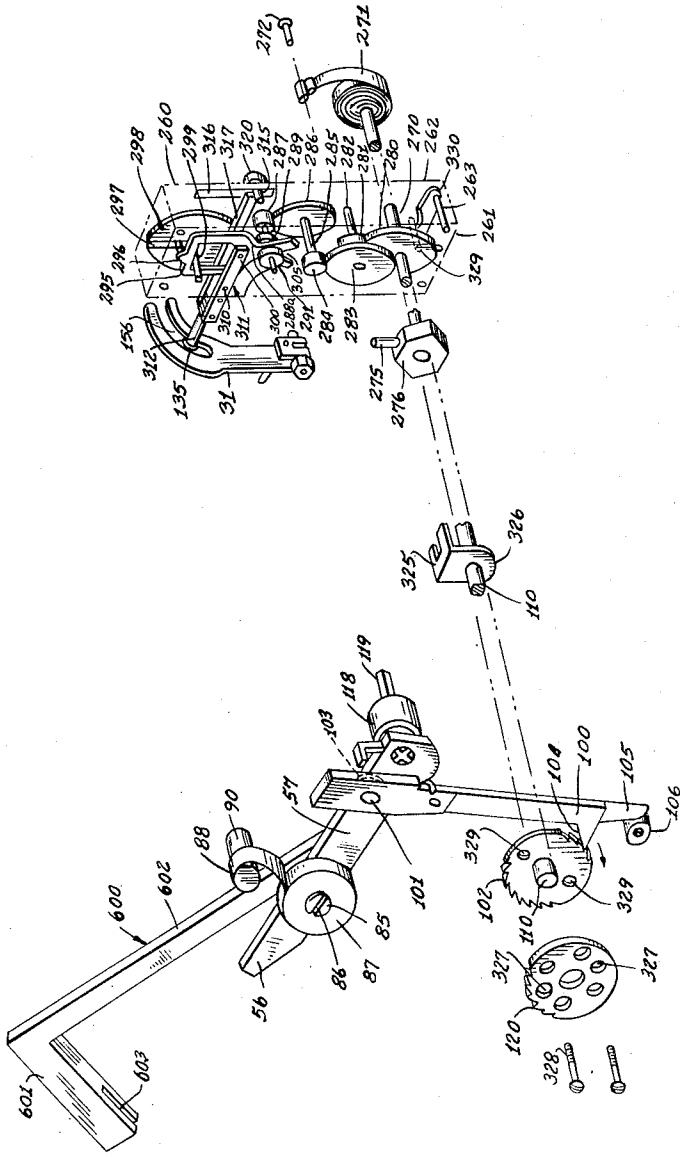


FIG. 17

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United States Patent Office 2,761,930 Patented Sept. 4, 1956

2,761,930

CIRCUIT RECLOSER

Roy M. Smith, Jeannette, Pa., assignor, by mesne assignments, to I-T-E Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application December 13, 1950, Serial No. 200,546

8 Claims. (Cl. 200—108)

My present invention relates to automatic reclosers, that is, the type of electrical switch gear arranged to open and reclose a number of times on fault current and to lock open after a predetermined number of openings within a limited period of time.

More particularly, my invention is an improvement of the structure shown in Patents Nos. 2,118,355, 2,167,665, Re. 22,872, and 2,443,260 and is especially an improvement on the structure shown in application Serial No. 113,371, filed August 31, 1949.

The structure shown in application Serial No. 113,371, filed August 31, 1949, incorporates a timing mechanism and a primary latch which after a predetermined number of tripping and reclosing operations within a limited period of time will lock the recloser in contact separated position called lock-out. Physically lock-out is the result of the opposition of two pawls which prevents the movement of the timer mechanism and thus prevents the unlatching of the principal lock-out latch.

The recloser is placed in lock-out release position by pulling down on the pull ring and holding it in its extreme downward position for fifteen seconds. This operation will release the opposition of the two ratchet pawls and permit the timer to reset to its original position. While the timer mechanism is resetting, the main contacts are held separated by the manual force on the pull ring.

After fifteen seconds has elapsed so that the timer mechanism has returned a good portion of the distance to its original position, the pull ring is released and allowed to return to its original position.

This action brings into effect a manual release lever which acts as an auxiliary latch in place of the primary latch.

To return the recloser from the lock-out release position to the normal contact closed position, the manual release lever is manually moved to permit release of the auxiliary latch and permits the contacts to close under the force of a closing spring.

Thus, the procedure requires three steps to effect normal recloser condition after lock-out occurs. It requires not only a great deal of effort on the part of the operator but has chance of possible incorrect operation if the operator fails to hold the pull ring down long enough to allow the timer mechanism to reset.

My present invention for instantaneous lock-out release will reduce the effort required of the operator, reduce the chance of incorrect operation and also reduce the length of time required for the entire operation. The addition of a bell crank lever to the timer arm is so positioned that when the timer arm is rotated the bell crank lever will be effective in permitting the timer mechanism to reset to its original position with no time delay.

Thus, when the operator wishes to release the recloser from lock-out, a pull on the pull ring will permit the timer mechanism to reset instantly. This eliminates the necessity of holding the pull ring down for a period of fifteen seconds.

Accordingly, an object of my invention is to reduce the time required for lock-out release from fifteen seconds to one second.

Another object of my invention is to provide means whereby a recloser may be released from lock-out with a minimum amount of effort from the operator.

A still further object of my invention is to provide lock-out release means whereby the possibility of incorrect operation is eliminated.

Still another object of my invention is to provide instantaneous lock-out release means which will permit the timer mechanism to operate without a time delay and thus permit the entire operation from lock-out to normal contact closed position to be performed in a matter of a second or two.

Figure 1 is an exploded schematic view in perspective of those operating elements of the automatic circuit recloser and shows the novel bell crank lever rigidly attached to the timer arm to permit instantaneous lock-out release.

Figure 2 is a circuit diagram showing the circuit connections between the operating elements of the novel automatic recloser.

Figure 3 is a view in perspective of operating parts contained outside the housing directly connected to the elements shown in Figure 1.

Figure 3*a* is a schematic view in perspective exploded in two directions showing the operating elements of Figure 3 of the automatic circuit recloser.

Figure 4 is a view of the opposite side of the control coil and its associated parts.

Figure 5 is a schematic view corresponding to that of Figure 4 but showing the trip position of the control coil.

Figures 6–13 are schematic views showing the successive positions of the latching mechanism and novel bell crank arm release of the associated timer mechanism.

Figures 6–9 are relative to opening operation of the contacts, whereas Figures 10–12 are descriptive of reclosing and time delayed opening operations.

Figure 13 schematically shows the position of these control elements in the lock-out condition after a specific number of openings and reclosures have occurred.

Figure 9 is also descriptive of the position of latches and novel bell crank arm and associated timer for the novel release after lock-out to permit reclosure.

Figures 14, 15, and 16 are schematic views showing the position of the external operating elements of Figure 3 for different conditions of the automatic recloser.

Figure 17 is an expanded view showing the connections of the timer ratchets to the timing mechanism and timer arm and also illustrates the relation of the novel bell crank arms with respect to the timer mechanism.

Figure 17*a* is a side view with part of the cover removed of the timing mechanism of Figure 17 for use in connection with the control elements of my novel automatic circuit recloser.

Figure 17*b* is an end view of the timing mechanism of Figure 17*a*.

Figure 17*c* is a fragmentary view of the timing mechanism corresponding to the lower position of Figure 17*b* and including the ratchet element shown in Figure 17.

Figures 18 and 19 illustrate schematically the operation of the time delay ratchet.

Figures 20 and 21 illustrate schematically the operation of the lock-out ratchet.

Referring first to Figures 1 and 2, there is here shown schematically the novel automatic recloser which is essentially a circuit breaker so arranged that it is biased closed and may be opened by an opening coil 24, the

armature 20 of which carries the movable contact 21, the opening operation being against the bias of the closing spring 512.

Portions of the figures not herein specifically described are described more fully in the above-mentioned application Serial No. 113,371, filed August 31, 1949.

I. *Interior operating parts*

The operating mechanism which controls the opening movement and also time delays the reclosure and which mechanically defeats the closing spring after a predetermined number of reclosures is all shown schematically in Figure 1.

All of the elements of Figures 1 and 2, except, of course, the external terminals 10 and 23 as well as other elements are contained within a casing, the operating elements of Figure 1 being located in the operating chamber of the casing and the moving contact plunger of the stationary main contact and the operating coil being positioned in a lower chamber below the upper operating chamber.

Ia. Circuit connections and general operation

During normal operations, the electrical elements of the recloser are connected in series with the power line at terminals 10, 23 which is to be protected by the recloser. This circuit extends from terminal 10, conductor 11, terminal 341, through winding 12 of the control magnet 27 to terminal 13, conductors 14, terminal 15, contacts 44 and 45 bridged by switch operating member 537, conductor 354*a* to connector 172 and pigtail 18, to rod 20, stationary contact 21, 22 to the power line terminal 23.

It will be noted that with contact 43 bridging the contacts 44, 45 the operating coil 24 is by-passed so that normally substantially no current flows through and, therefore, there is substantially no loss due to current flowing in this winding. However, the windings of control magnet 12 are connected in series with the power line and are, therefore, energized by line current. On predetermined energization of the control magnet 12, in response to a fault current in the power line, lever 40 which carries contact 43 is moved as will hereinafter be described to open the bridge across contacts 44, 45, thereby inserting the winding of operating coil 24 in series with the winding of control coils 12 and the power line. Coil 24 is now energized in response to the fault current to operate its rod or armature 20 to contact disengaged position.

Following separation of the main contacts 21 and 20*a* in response to fault current, the arc which is formed on the opening of the circuit at that point is extinguished and results in de-energization of the operating coil 24. Thereupon the closing spring 512 hereinafter described drives the plunger 20 down to re-establish current carrying connections between the main movable contact 20*a* and the main stationary contact 21.

The operating mechanism shown schematically in Figure 1 is designed to provide appropriate controls for circuit opening operations and for the reclosing operations so that successive reclosing operations may take place with a desired time delay interval between them and so that the plunger 20 may be locked in the up or disengaged position after a predetermined number of reclosing operations.

Ib. Control coil and associated armatures

The control coil 12 is arranged so that in response to a fault current of predetermined value in the circuit which is protected, the control coil will be sufficiently energized to move solenoid armature 25 and thus to open the control switch 16 to which it is connected.

The control coil 12, therefore, is the initial operating coil of the entire system. Control coil 12 is essentially a solenoid coil surrounding the armature 25 which is normally biased above the coil by compression spring 26 in the manner hereinafter described.

The armature 25 is preferably a laminated iron structure, a portion of which forms together with the laminated magnetic rectangular plates 27*a* and 27*b* and with 27*d* and 27*c*, magnetic paths for the flow of flux in response to energization of the control coil 12.

Ibi. Connection of control coil armature and toggles to control switch

The upper end of armature 25 is connected by pin 33 to the lever 34 which is pivotally mounted on the stationary pivot 35. The opposite end of the lever 34 is connected by pivot 36 to the connecting rod 37. The lower end of connecting rod 37 is connected by pin 38 to the control switch operating lever 40.

Control switch operating lever 40 is pivotally mounted on the pivot 41. Compression spring 26 compressed between the stationary collar 42 and the end of lever 40 at pivot 38 surrounds the connecting rod 37.

Compression spring 26 drives the lower end of connecting rod 37 and, therefore, the left-hand end of control switch lever 40 downwardly, thereby pulling down the right-hand end of lever 34, lifting up the left-hand end of lever 34 and exerting an upward initial bias on pin 33 and armature 25. Spring 26 by this means normally maintains the armature 25 in the raised position partly outside of the control coil 12 as shown in Figures 1 and 4.

The right-hand end of the control switch lever 40 is provided with the contact section 43 normally bridging the stationary contacts 44, 45 of the control switch 16 and being held in bridging engagement therewith by the compression spring 26 which drives the left-hand end of lever 40 down as previously described.

On energization of control coil 12 to a sufficient value, armature 25 is moved, rotating lever 34 in a counterclockwise direction around pivot 35 and raising the connecting rod 37 upwardly against the bias of compression spring 26.

This results in a clockwise rotation of lever 40 and the movement of the bridging contact 43 away from the stationary contacts 44 and 45 of the control switch 16.

Accordingly, the current value at which the control coil 12 will be energized sufficiently to attract the armature 25 may be determined by the compression of compression spring 26 and may, if desired, (but not preferably) be calibrated by making collar 42 adjustable.

Ibii. Control coil calibration

An opening latch 50 is keyed to or mounted on the rotatable pin 51, the opening latch 50 being spring biased in a clockwise direction with respect to Figure 1 toward latching position by the coil spring 52.

Pin or shaft 51 carries the lug 53 secured thereto and rotatable therewith, which lug carries at its outer end the pick-up calibrating screw 54 which is adjustably mounted in the lug 53 for upward and downward movement on rotation of the screw 54 and which may be locked in the adjusted position by the lock nut 55.

The lower end of the pick-up calibrating screw 54 bears against the forward end 56 of the timer arm 57. The opening latch 50 is provided with the latching detent 60 so arranged that it provides a detent or ledge against which the roller 61 at the end of lever 62 may bear.

Lever 62 is pivotally mounted on the stationary pin 63. The end thereof opposite the roller 61 is in toggle relation with the link 64, being connected thereto by the knee pin 65. The opposite end of toggle 62—65—64 is connected by pin 66 to the upwardly extending arm 67 of the lever 34.

When, therefore, the armature 25 is attracted downwardly by energization of the control coil 12 to rotate the lever 34 in a counterclockwise direction, it not only must compress the spring 26 but also must operate against the holding force of the latch 50 so that the toggle 62—65—64 may collapse to the position shown in Figure 5.

The armature 25, therefore, cannot be pulled down by coil 12 unless the roller 61 bearing against the latching

detent **60** displaces the opening latch **50** in a counterclockwise direction with respect to Figure 1 or in a clockwise direction with respect to Figure 5.

The pick-up calibrating screw **54** bearing against the forward end **56** of the timer arm **57** determines the angular position of the pin **51** and the opening latch **50** thereby determining the degree to which the latching detent **60** of the opening latch **50** underlies the roller **61** at the end of toggle **62—65—64**. Pin **63***a* bearing on the top surface of lever **62** ensures that roller **61** will ride in latching detent **60**.

The degree to which the detent **60** underlies the roller **61** determines the initial force required to displace the opening latch **50** in order to permit the armature **25** to be moved down by coil **12**. The greater the displacement of the opening latch **50** in a counterclockwise direction (with respect to Figure 1) the less force required to push the roller **61** off the latching detent **60** to rotate the opening latch **50** from the position of Figure 4 to the position of Figure 5.

The greater the adjustment of the latch **50** in a counterclockwise direction with respect to Figures 4 and 5, the greater the force required for this displacement.

Accordingly, the adjustment of pick-up calibrating screw 54 which determines this initial angular displacement of the opening latch **50** determines the force and hence the over current condition required before initiation of operation of the apparatus.

When, however, this displacing force is reached, armature 25 is pulled down by control coil **12**; roller **61** of toggle **62—65—64** rolls off the latching detent **60** and against the side of the opening latch **50**; the opening latch 50 is rotated in a clockwise direction to the position of Figure 4 while toggle **62—65—64** collapses to the position of Figure 5; the connecting rod **37** is raised; switch operating lever **40** is rotated, and bridging contact 43 moves out of engagement with the stationary contacts 44 and 45 of the control switch **16**.

With the control switch **16** thus opened, the full current passes through the operating coil **24** which attracts the plunger **20**, pulling it upwardly and separating the main movable contact **21** from the main stationary contact **22** to open the circuit.

The upper end of the plunger **20** is connected to the operating arm **70** by the yoke connection **71** in such manner that the upward movement of plunger **20** must necessarily result in upward rotation of operating arm **70** and downward movement of the plunger **20** must necessarily result in downward rotation of the operating arm **70** and vice versa.

Operating arm **70** is rotatably mounted on the stationary pivot **75** at the end opposite its connection at **71** to plunger **20**.

Operating arm **70** carries intermediate its ends and extending transversely with respect thereto the pin **76** on which are rotatably mounted the main latch roller **77** and the pawl **78**. Pawl **78** is essentially a bell crank lever in form having a timer arm engaging leg **79** for engagement with arm **57** in the manner hereinafter described and a downwardly extending positioning leg **80**.

Also rigidly attached to the operating arm **70** is a pin **121***a* extending transversely thereto. The pin **121***a* is located above the lock-out pawl arm **121** and below the timer arm **57** for movement thereof as will hereinafter be described.

In the normal at rest position of the operating arm **70** shown schematically in Figure 6, the positioning leg **80** of pawl **78** is driven by coil spring **82** against the stop pin **81** carried by the operating arm **70**.

The timer arm 57 as is shown in Figure 1 is provided with a slotted pin **85** receiving the end **86** of coil spring **87**. Coil spring **87** is wound around the slotted pin **85** and the outer end **88** thereof is connected to the stationary pin **90** carried in a lug **91** extending from the side of the timing mechanism housing **92**.

Coil spring **87** is so adjusted that the timer arm **57** in the normal closed circuit position of the apparatus is substantially horizontal. When the timer arm **57** is rotated in a counterclockwise direction with respect to Figures 1 and 6, the coil spring **87** is tensioned tending to rotate the timer arm **57** back toward the substantially horizontal position.

Timer arm **57** has a rearward extension **95** with a rounded under surface **96** which will be engaged by the upper surface of leg **79** of pawl **78** when the operating arm **70** begins to rise (compare Figures 6 and 7) during the upward movement of the plunger **20**.

Rigidly mounted on the upper surface of the timer arm **57** is a bell crank lever **600** with arms **601** and **602**. The arm **602** of crank lever **600** is rigidly attached to the side of timer arm **57**. The opposite arm **601** is provided with a slot **603** which is shaped to enclose the reduced section **312** of timer adjustment arm **135** when sufficient clockwise rotation is imparted to timer arm **57**.

Bell crank arm **600** is positioned to rotate the timer adjustment arm **135** about the pivot **310** against bias of coil spring **311**. This counterclockwise rotation imparted to the arm **135** will raise the point **300** which acts as a fulcrum point for the timer mechanism **92**. Lowering this point **300** will permit the timer to run at a more rapid speed as will hereinafter be described.

As the operating arm **70** rises, the pawl **78** lifts the rear end **95** of the timer arm **57** rotating the timer arm as above described and thereby lifting the time delay pawl lever **100** which is connected by the pin **101** to the timer arm **57** between the pin **85** and the end **95** of the timer arm **57**.

Time delay pawl lever **100** is biased in a clockwise direction toward the time delay toothed ratchet **102** as shown in Figure 17 by the coil spring **103**. Time delay pawl lever **100** is provided with the pawl tooth **104** which bears against the time delay circular ratchet **102**.

Lever **100** is also provided with the extension **105** below the pawl tooth **104** having a cammed surface which bears against the pin **106** carried by the housing **92** of the timer mechanism and which in the normal at rest position of the operating mechanism with the switch contacts closed maintains the pawl tooth **104** out of engagement with the surface of the time delay ratchet **102** as shown in Figures 6 and 17.

Pin **106** is rotatable and is cam-shaped to provide adjustment of the disengaging point of pawl **100**.

When, however, the operating arm **70** is raised about its pivot **75** owing to the lifting up of the plunger **20** by the operating solenoid coil **24** and pawl **78** thus lifts the end **95** of the timer arm **57**, the time delay pawl lever **100** is lifted; and as soon as its extension **105** clears the pin **106**, coil spring **103** drives the pawl tooth **104** against the surface of the time delay ratchet **102**.

This is shown diagrammatically by a comparison of Figures 7 and 8.

The pawl tooth **104** of the time delay pawl lever **100** rides up the surface of the time delay ratchet **102** without rotating the same owing to the curvature of the teeth **107** of the ratchet **102** (see also Figures 18 and 19) and also owing to the fact that certain portions **108**, **109** may be made smooth and without the teeth **107** for purposes hereinafter more specifically described.

Ic1. *Reclosing time delay*

From the description thus far, it will be apparent that in response to a predetermined fault current, control magnet **12** was energized opening the shunt switch around operating magnet coil **24**. Coil **24** was then energized in response to the fault current and the circuit breaker contacts opened instantaneously. The contacts are latched in open position. At the same time energy was stored in a spring **512** which, now under control of a time delay mechanism, operates to release the principal latch.

Contacts **20***a* and **21** are opened in an arc chamber

in which the resultant arc following circuit interruption is extinguished. The operating magnet coil 24 is de-energized and the plunger 20 is now operable under action of a biasing spring 512 to reclose contacts 20*a*, 21 as soon as the time delay releases the latch.

The ratchet 102 is keyed to the timer shaft 110 which is under the control of the timing mechanism within the timing mechanism housing 92. Assuming that the first reclosure is to be delayed, then the teeth 107*a* (Figure 18) of ratchet 102 are so positioned that the pawl tooth 104 will engage the teeth 107*a* at the upper limit of movement of the timer arm 57, lever 100 and pawl tooth 104 as shown in Figure 10.

Figure 9 shows the fully open position before reclosure starts. Timer arm 57 is held up by pin 121*a*.

At this time, the leg 79 of pawl 78 has been moved through a sufficient arc by rotation on pin 76 to disengage the curved under surface 96 of the rear extension 95 of the timer arm 57 (Figure 8) and the end 95 of the timer arm 57 is released to move downward and hence the time delay pawl lever 100 begins to descend as indicated in Figure 10.

It will be observed that during the first instants of contact separation, noted in Figures 7 and 8, the timer arm and its associated bell crank arm 600 are rotated counterclockwise. When the operating parts are in the position of Figure 8, the keyway or slot 603 of the bell crank arm 601 surrounds the timer adjustment arm 135 but has not rotated this unit.

As the operating parts move from the position of Figure 8 to the contact full open position of Figure 9, the bell crank arm 600 forces the timer adjustment arm 135 to rotate about its pivot 310. As the operating parts move to the position where time delay reclosing starts (Figure 10), the force from the bell crank arm 600 on the timer adjustment arm 135 is removed. This allows the biasing spring 311 to return the arm 135 to the neutral position of Figures 6 and 10.

It should be observed that the lapse of time between movement of the timer adjustment arm from the neutral position of Figure 8 to the position of Figure 9 and then back to the neutral position of Figure 10 comprises a very small percentage of the entire time required for initial opening and closing and is accomplished in less than one cycle or two one-hundreths of a second.

Since the timer run out time will always be of the magnitude of several cycles, this duration of time is insufficient to have an appreciable influence on the time of return of the timer mechanism for the second and subsequent reclosings.

Thus, the descent at the position indicated in Figure 10 is delayed by the timing mechanism in timing mechanism housing 92 which controls the rotation of shaft 110 and timing arm 57 cannot move instantaneously back to its original position under the influence of coil spring 87 but returns with a timed movement determined by the speed at which the timing mechanism in housing 92 permits the pawl tooth 104 to drive the time delay ratchet 102.

The main latch roller 77 seats in the latching detent 112 just prior to the disengagement of pawl end 78 from timer arm end 96 as shown in Figure 8. The principal latch 113 constitutes a lever arm pivotally mounted on the stationary pin 114 and biased toward the main latch roller 77 by the coil spring 115.

When the main latch roller 77 carried by the operating arm 70 which is connected at 71 to the plunger 20. therefore, seats in the latching detent 112, the operating arm 70 and the connected plunger 20 are locked in the up position as shown in Figure 10.

This latching operation is accomplished by making the up stroke of plunger 20 and arm 70 sufficient to lift latch roller 77 above latching detent 112 high enough to ensure that pawl 78 will disengage the timer arm 57 (see Figure 9). Latch roller 77 then moves down slightly with arm 70 and plunger 20 to rest on detent 112 as noted in Figure 10.

As previously pointed out, a compression spring 512 has been compressed by the upward movement of plunger 20 to bias the plunger 20 downwardly to the position in which contacts 20*a* and 21 will engage. This compression spring is, however, defeated by the interengagement of the main latch roller 77 with the latching detent 112 of the principal latch 113.

The principal latch 112 has a U-shaped extension 117 arranged in the path of movement of roller 118 carried on pin 119 at the rear end 95 of the timer arm 57.

As the timer arm 57 returns toward its original position under the influence of coil spring 87 and delayed by the time delay mechanism in housing 92 which acts through the time delay pawl lever 100 on timer arm 57, a device such as roller 118 engages the end of the U-shaped extension 117 of the principal latch 113 and pushes the latch 113 back far enough so that the latching detent 112 moves out from under the main latching roller 77 permitting the reclosing spring 512 to drive the plunger 20 and the operating arm 70 down to effect re-engagement of contacts 20*a* and 21 as in Figure 12.

Accordingly, it is the return movement of the timing arm 57 which disengages latch 113 from the main latching roller 77 and the time delay which operates on the timer arm 57 determining the degree to which reclosure will be delayed.

The timing mechanism may, therefore, be adjusted to any desired speed and this adjusted speed will be effective to control the return movement of the timing arm 57, which in turn will control the unlatching of the operating arm 70 and the plunger 20.

After the completion of the clockwise rotation of timer arm 57 the curved extension 105 of the reclosing time delay pawl lever 100 moves against the pin 106 to move the pawl tooth 104 out of engagement with the teeth 107 or 107*a* of the time delay ratchet as the case may be (Figure 18).

At this time, the timing mechanism which was wound up by the rotation of ratchet 102 by timer arm 57 in a clockwise direction with respect to Figures 1, 6 to 13 and 18 will now be free to rotate the time delay ratchet 102 and its shaft 110 back to the original or neutral position.

This return movement of the timer shaft 110 and the time delay ratchet 102 will, however, be under the control of the timing mechanism. The time for the return of the time delay ratchet 102 will not necessarily be the same as was required for the original movement. In the first place, the spring 87 which causes the forward movement and the spring in the timer which causes the return movement are of different strengths and in addition the return movement is always at the same rate, which is the slowest speed of operation of the timer. On the other hand, the forward movement, which consists of two parts, is at a slow rate for the first portion of its travel. This rate is not necessarily the same as under the return portion since a much heavier spring is operated. In addition, the second portion of travel in the forward direction is under the influence of the heavier spring and at a variable rate of operation depending on the magnitude of the short circuit current.

If this return movement is completed before the next opening operation, then the next opening operation occurs as if it were the first opening operation of a series and the first and subsequent reclosures will occur as if they were the first of a series.

If, however, this return movement has not been completed before the next opening operation, then on the next opening operation, pawl 104 will engage teeth 107 of the time delay ratchet 102 at a position angularly displaced from the first engagement. The main latch roller 77 will be engaged and held by the latch 113 and the timer arm 57 will again descend under the control, however, of the timing mechanism in housing 92 translated to the

timer arm through the timer shaft **110**, ratchet **102**, and lever **100**.

If the next opening of the circuit breaker occurs before the timing mechanism in housing **92** has had an opportunity to begin to return the ratchet **102** and shaft **110** back toward the initial position, then the return of the timing arm **57** under the control of the time delay mechanism will add cumulative angular rotation to ratchet **102** and shaft **110**.

By adjusting a stop in the timer mechanism **92**, it is possible to relocate the normal or reset portion of the timer and, therefore, the time delay ratchet **102**. If this is done, the flat spot is moved in a counterclockwise direction (Figure 19) as shown in Figure 18, and then the detent **104** engages with a tooth and thus provides the full five seconds delay on the first reclosure due to the influence of the timer.

Ich. *Lock-out*

It is essential in the operation of the novel circuit recloser that the contacts be locked open after a predetermined number of reclosing operations.

Thus, in the event the initial cause for opening of the contacts was some transient fault in the line, the recloser may close and remain closed. An example is the case of some accidentally maintained arcing over at an insulator on the line owing to an unusual transient condition, in which case momentary interruption of current occasioned by one opening and reclosure of the contacts will result in extinguishment of the arc which will not then ordinarily reignite owing to the fact that the ionized gases would normally be blown away or otherwise cooled. This will also be the case if wires have accidentally swung together in a high wind.

Moreover, if some relatively high resistance member has caused the fault, the first or second reclosure of the automatic recloser may serve to burn away the cause of the fault and the automatic recloser contacts should then remain closed to maintain the circuit after the fault has been burned away.

If, however, the opening of the contacts resulted from a true short circuit condition which will not be cleared by repeated openings and closings of the automatic recloser, it then becomes essential to lock the automatic recloser open. This is the principal reason for making the angular movements of the time delay ratchet **102** and the timer shaft **110** cumulative on rapidly repeated reclosures.

After a predetermined number of such reclosures as after the second or third reclosure, this cumulative rotation of the reclosing time delay ratchet **102** and the timer shaft **110** may be utilized to bring a lock-out mechanism into operation.

The lock-out mechanism comprises a lock-out ratchet **120** on the timer shaft **110** co-axial with but spaced from the reclosing time delay ratchet **102** and a lock-out pawl lever **121** having a pawl tooth **122** and connected at its opposite end by pin **123** to the principal latch **113**.

A coil spring **125** biases the lock-out pawl lever **121** upwardly so that the pawl tooth **122** bears against the surface of the lock-out ratchet **120**. The lock-out ratchet **120**, as is seen in Figures 20 and 21, is smooth at **126** over a substantial portion of its surface and is provided with teeth **127** over another portion of its surface.

In the original condition of the elements, after a first opening, the pawl tooth **122** engages the smooth section **126** of the surface of the lock-out ratchet **120** whenever the latch **113** is in latching engagement with the roller **77**.

After a repeated number of reclosures, however, resulting in cumulative rotation of the timer shaft **110**, time delay ratchet **102** and lock-out ratchet **120**, the teeth **127** of the lock-out ratchet **120** move into position to be engaged by the pawl tooth **122** on the next opening operation when the latch **113** next moves to a position where it receives and holds the latch **77**.

When on an opening operation the latch **113** engages the roller **77** to lock the operating arm **70** and plunger **20** in the up position and when the pawl tooth **122** engages the teeth **127** of the lock-out ratchet **120**, remembering that the ratchets **102** and **120** are rotated in a clockwise direction with respect to Figures 18 and 20 as the timer arm descends, the teeth **127** are so curved that they will be locked by the pawl tooth **122** for such clockwise rotation and the pawl tooth **122** on the lock-out pawl lever **121** will prevent such further rotation by the timer shaft **110** and ratchets **102** and **120**.

Hence, the timer arm **57** and its pawl lever **100** cannot now descend and the automatic recloser mechanism is now locked out as shown in Figure 13. This is true since, as pointed out above, it is the descent of the timer arm that is necessary to push the principal latch **113** away from the latching roller **77**; and the timer arm cannot now descend.

The lock-out ratchet **120**, as hereinafter described, may be made angularly adjustable about the shaft **110** so that the angular position of shaft **110** at which the teeth **127** move into conjunction with the pawl tooth **122** may be determined or set in accordance with the number of reclosures to be had before the lock-out position is reached.

The interlock arrangement definitely does not permit lock-out with the main contacts closed. A pin **121***a*, rigidly mounted on the operating arm **70**, will hold the lock-out pawl **122** away from the lock-out ratchet **120**.

When the contacts **20***a* and **21** open, on the lifting of the plunger and operating arm **70**, then, as stated hereinbefore, the control coil **12** is de-energized and spring **26** returns the control switch **16** and the control armature **25** back to their original positions with the control unit returning from the position of Figure 5 back to the position of Figure 4. Owing to the fact that the end **95** of timer arm **57** is raised, the forward end **56** of the timer arm **57** is lowered and thus it moves away from the pick-up calibrating screw **54**.

Consequently, coil spring **52** may now drive the opening latch **50** to a position where its detent **60** locks under the roller **61** of toggle **62—65—64**. The latching detent **60** owing to the fact that the pick-up calibrating screw **54** at this point has nothing to rest on because of the lowering of end **56** of the timer arm **57** moves sufficiently under the roller **61** so that it absolutely locks the roller **61** and so that the roller **61** cannot push the opening latch **50** out for a tripping operation.

Energization of control coil **12** after closing of contacts **20***a*—**21** by descent of plunger **20** after release of latch roller **77** cannot now pull down the armature **25** to reopen the control switch **16** until the timer arm **57** completes its full return to its original position.

At this time, thereby permitting the reopening time delay hereinafter described to be effective, the end **56** of the timer arm **57** lifts the pick-up calibrating screw **54** to rotate lug **53**, pin **51**, and latch **50** back to the calibrated position at which the control coil **12**, if properly energized, will pull down the armature **25** with sufficient force to cause the roller **61** to push the latch **50** aside.

As previously pointed out, after the timer arm **57** in its return movement under the control of the time delay ratchet **102** causes the latch **113** to release the main latch roller **77**, the closing spring hereinafter described closes contacts **20***a* and **21** to re-establish the flow of current through the automatic recloser.

At this time, the switch **16** has been closed establishing a by-pass for the operating coil **24** and, therefore, the contacts remain closed. This reclosing of the circuit breakers occurs before the end **56** of the timer arm **57** has reached the pick-up calibrating screw **54**.

Accordingly, the latch **50** and its detent are so located under the roller **61** at this point that the control coil **12** cannot pull down the armature **25** to open control switch **61**.

With the latch **50**, therefore, locking the roller **61**, the

circuit breaker cannot at this time trip after the first reclosing operation even though a fault current may exist which would normally have energized coil **12** sufficiently to attract the armature **25** and open the switch **16**. Such attraction of the armature **25** to open the switch **16** cannot occur until the end **56** of the timer arm **57** lifts the pick-up calibrating screw **54** after a time delay to rotate the latch **50** to a position where the roller **61** may push it aside to permit collapse of toggle **62—65—64** and thereby permit the attraction of the armature **25** and opening of switch **16**.

From the above, it will now be clear that the present invention provides time delay for each reclosing operation and for each opening operation following the first instantaneous opening operation.

Both time delays are achieved with the same timing mechanism and with individual latches.

Inasmuch as reclosing is by spring operation, a first latch **112** locks the contacts in disengaged position. The time delay after a predetermined interval releases this first latch to permit fast spring reclosure of the contacts.

Since reopening is by magnet operation, a second latch **60** locks the armature of the control magnet which in turn controls the energizing circuit of the operating magnet. The time delay after a predetermined interval releases this second latch to effect energization of the operating magnet resulting in fast magnet opening of the contacts.

Although the latter latch is on the armature of the control magnet, which is preferable because the toggle **62—65—64** permits a light latch **60** to lock against a strong pull, the net effect is to lock plunger **20** against movement. Accordingly, the latch can be located anywhere in the mechanical or electrical system which controls movement of plunger **20** including a latch on plunger **20**, it being understood that release of the latch would be controlled by the time delay mechanism.

Both the reclosing and reopening time delays are provided to automatically give the circuit time to correct the fault conditions if they can be corrected.

II. *The timing mechanism and associated timer adjustment arm*

A timer adjustment arm **135** is provided to allow adjustment for more rapid operating of the timer. The timing mechanism in housing **92** is so arranged that as the timer adjustment arm **135** is moved downwardly, the ratchets **102**, **120** and timer shaft **110** may rotate more freely and when this arm is moved down all the way, the ratchets **102**, **120** and the timer shaft **110** rotate substantially free of any time delay as will hereinafter be described.

The function of the timing mechanism in housing **92** has already been referred to. It is sufficient here to point out once more that it controls the rotation of the timer shaft **110** by the timer arm **57** in one direction to delay the return of the timer arm **57** back to its original position.

After reclosure has occurred, it returns the timer shaft **110** and its associated ratchets **102** and **120** back to their original position with a time delay period determined by the relative strength of spring **271** hereinafter described, restoring the timer shaft **110** and its associated elements back to their original position if the automatic recloser remains closed following its reclosure.

The housing **92** for the timing mechanism **260** of Figure 17 comprises essentially a pair of parallel plates **261** and **262**.

The main operating shaft **270** of the time mechanism **260** rotates in appropriate bearings in plates **261**, **262** extending transversely thereto. The portion of the main operating shaft **270** extending through plate **261** carries the connecting pin **275** extending through the hexagonal member **276** mounted on the shaft **270** and through registering openings in the hexagonal member **276** and the shaft **270** so that rotation of the main operating shaft **270** will result in angular movement of the main operating pin **275** and vice versa.

Gear **280** on the main operating shaft **270** is connected to pinion **281** on the arbor **282** caried between plates **261** and **262**. Gear **283** on the arbor **282** is connected to pinion **284** on arbor **285** also carried between plates **261** and **262**. Gear **286** on arbor **285** is connected to pinion **287** on cam shaft **288**. Cam shaft **288** is the escapement shaft of the timing mechanism.

Cam shaft **288** carries at its inner end the disc **289** connected by the eccentric transverse cam pin **290** to the disc **291**, which in turn is connected to the opposite end of the cam shaft **288***a*.

As the cam shaft **288**, **288***a* is rotated by the gear train **280—281—283—284—286—287**, the cam pin **290** describes a circle at a radius from the main axis of the cam shaft **288**, **288***a*. The escapement lever **295** is provided at its upper end with an escapement pin **296** registering in the escapement slot **297** of the escapement wheel **298**.

The escapement wheel **298** is mounted on arbor **299** which is rotatable in appropriate bearings between plates **261** and **262**. The fulcrum of escapement lever **295** is the pin **300** carried by the timer adjusting arm **135**. The lower end of the escapement lever **295** is provided with a flaring slot **305** wider toward its lower end and narrow at its upper end, the axis of the slot **305** extending along a line through the fulcrum **300** and the escapement pin **296**.

Slot **305** surrounds the cam pin **290**. As the main operating shaft **270** of the timer is rotating in one direction, it winds up the main spring **271**. At the same time, through the gear train **280—281—283—284—286—287**, it rotates the cam shaft **288** and the cam pin **290**. With the cam pin **290** resting in the narrow portion of the flaring slot **305**, the escapement lever **295** is rotated back and forth around the fulcrum **300**.

The escapement pin **296** of the escapement lever **295** entering the escapement slot **297** of the escapement wheel **298** causes the escapement wheel **298** to oscillate back and forth.

The time delay thus obtained is a function of the inertia of the escapement wheel **298** and the escapement lever **295** which, owing to the eccentric movement of the cam pin **290**, must move in one direction, come to rest, move in an opposite direction, come to rest once more, and repeat this operation continuously as the main operating shaft **270** of the timing mechanism is rotated.

The inertia of these elements thus provides the time delay. Similarly, when the exterior rotative force on the main operating shaft **270** of the timing mechanism is released, the main spring **271** rotates the elements in an opposite direction to reset the operating shaft **270** back to its original position, being delayed, however, by the escapement lever **295** and the escapement wheel **298**, the inertia of which owing to constant change of direction of movement must be overcome at each change of direction of movement.

It will be obvious that the longer the period of each oscillation of escapement lever **295** and escapement wheel **298**, the greater the time delay and the shorter the period of oscillation, the smaller the time delay.

For this purpose, the fulcrum **300** is made shiftable vertically. With the fulcrum **300** in the lower position, full time delay is achieved.

As the fulcrum **300** is raised, the flared portion of the slot **305** moves into registry with the cam pin **290** so that the cam pin **290** oscillates the lever **295** only at the right and left extreme position, its rotation thereby oscillating it through a shorter period. This period decreases as the flared portion of the slot **305** which registers with the cam pin **290** is widened by raising of the fulcrum **300** of the escapement lever **295**.

In addition to the decreased period of oscillation, the power ratio of escapement pin **296** with respect to escapement wheel **298** is increased since as the fulcrum **300** of

the escapement lever **295** is raised, the escapement pin **296** rises in slot **297** of the escapement wheel to an increased distance away from the pivot **299** of the escapement wheel.

Consequently, the net inertia of the escapement wheel **298** is decreased or rather the net effect of inertia owing to the increase in the power ratio above referred to is decreased.

When the fulcrum **300** is raised to a point where the full flared portion of the flaring slot **305** registers with the cam pin **290**, the cam pin **290** does not engage the escapement lever at all during its rotation and operating shaft **270** may rotate even in response to external force or in response to its spring **271** free of the time delay effected by the escapement lever **295** and escapement wheel **298**.

To accomplish the shift in fulcrum **300** which varies the time delay afforded by the timing mechanism **260**, the timer adjustment arm **135** which carries the fulcrum **300** is pivotally mounted on the cross pin **310** carried between plates **261** and **262**. A coil spring **311** biases the end of the timer adjustment arm which carries the fulcrum **300** downwardly. The outer end of timer adjustment arm **135** has the reduced diameter section **312** which receives the slot **603** of the bell crank lever **600**.

As the bell crank lever **600** is rotated in a manner hereinbefore mentioned and hereinafter described to move the end **312** of the timer adjustment arm **135** down, the fulcrum **300** of the escapement lever **295** is raised to decrease the time delay afforded by the timing mechanism **260**.

When the bell crank arm **600** does not pull down the timer adjustment arm **135**, then the conditions prevail in which full time delay is achieved.

An adjustable stop member **315** riding in slot **316** is provided against which the inner end **317** may rest to predetermine the maximum time delay. The higher the adjustable stop **315** is raised, the shorter the maximum time delay period and, therefore, the faster the reclosing operation.

Thus, the stop **315** of clamping screw **320** determines the maximum time delay of the timing mechanism **260** while the bell crank lever **600** positioned on operating arm **135** in response to force on the pull ring **236** (hereinafter described) determines the variation from this maximum time delay in the manner previously described.

By this means, therefore, a simplified timing mechanism is provided which will time delay the rotation of operating shaft **270** in one direction by an exterior force and which will correspondingly time delay the return of operating shaft **270** to its original position under the influence of the main spring **271**.

IIb. *Lock-out reset elements*

After the lock-out position previously described in connection with Figure 1 and illustrated schematically in Figure 12 is reached, it becomes necessary to release the parts of the automatic circuit recloser so that they may be placed in circuit once more after appropriate inspection of the line has been made.

The parts provided so that the automatic recloser may be placed in operation after the interior parts have been locked out, in the position of Figure 13, will now be described in connection with Figures 3, and 14 to 16.

As seen now in Figures 3 and 14 to 16, the plate **170** of operating arm **70** is provided with a downwardly directed extension **192** carrying the pin **193** to which is connected the link **194**. The opposite end of link **194** is connected by pin **195** to the crank **196**.

In Figure 3 the position of link **194** and crank **196** is shown for connection to the exterior parts in the exterior housing **200**. The exterior operating shaft **205** passes through a bearing **206** in wall **203**. The end of the shaft **205** is provided with the extended key **207** registering in the key way **208** at the end of the crank **196** opposite the pin **195**. A bolt **209** passing through an opening in the end of crank **196** also enters a threaded opening in the inner end of the exterior operating shaft **205**.

Thus, the exterior operating shaft **205** is connected to the operating arm **70** in such manner that when the operating arm **70** and plunger **20** are raised, the end **195** of crank **196** will correspondingly be raised, thus rotating the shaft **205** in a clockwise direction with respect to Figures 3 and 14–16.

After the automatic recloser has been locked open in a manner previously described by operation of the lock-out ratchet **120** in cooperation with the lock-out pawl lever **121**, it becomes necessary to reset the automatic recloser so that it may close after the fault which caused the locking open has been repaired.

For this purpose, a reset link **235** terminating in the ring **236** is provided, the said reset lever being rotatably mounted on the pin **237** and being secured in place by a cotter pin. Pin **237** extends from the crank arm **240** which is an extension of cross arm **241** mounted on the sleeve **242**.

Sleeve **242** is in turn rotatably mounted on section **243** of reduced diameter of the exterior operating shaft **205**. Cross arm **241** of the sleeve **242** extends above the crank arm **231** and crank arm **240** of cross arm **241** extends above pin **245** which pin is rigidly attached and transverse to the side of crank arm **231**.

A coil spring **246** maintains the crank arm **240** and the reset link **235** in the up position even though shaft **205** is rotated so that crank **231** moves down as shown in Figure 16.

When now after a lock-out of the automatic reclosing mechanism as shown schematically in Figure 13 after the desired number of reclosures has occurred, it becomes necessary to reset the mechanism. The end of a hooked stick is inserted in ring **236** of the reset link **235** and the reset link **235** is pulled down. This pulls down the crank **240** in the cross arm **241** causing the sleeve **242** to rotate about section **243** of exterior operating shaft **205**.

The crank **240** bearing on pin **245** pulls down the crank **231** rotating the shaft **205** further in a counterclockwise direction and lifting the plunger **20** and the operating arm **70** from the lock-out position of Figure 13 to the lock-out release position of Figure 9. This lifts the latch roller **77** off the latching detent **112** in the principal latch **113** and up to the recessed portion **250** of the principal latch **113**.

When the recloser is released from lock-out by pulling down on ring **236**, the latch roller **77** is lifted up off of latching detent **112** to the upper portion of principal latch **113**. However, the principal latch **113** does not move forward during this operation since the upper section has a contour which is a radius from pivot **75** so that the latch roller merely rolls up the radius section. This construction is desirable so that the principal latch **113** will move when the latch roller moves back down towards detent **112**. This construction assures more positive latching action. Also, as the operating arm **70** is moved from the lock-out position of Figure 13 to the lock-out release position of Figure 9, the transverse pin **121***a* engages the lower surface of the timer arm **57** and rotates this arm counterclockwise.

Thus, when the recloser is reset from lock-out, the detent **370** of arm **57** strikes against the upper portion **371** of pawl **100**, causing it to rotate in a clockwise direction around its pivot **101** (from Figure 13 to Figure 9) which disengages the detent **104** from the teeth of the time delay ratchet **102**. The time delay ratchet **102** and lock-out ratchet **120** are then free to return to their normal reset position under the influence of reset spring **271**. This action is possible because pawl **100** has been disengaged from time delay ratchet **102** and the teeth on lock-out ratchet **120** are so shaped that they will slip by detent **122** on lock-out pawl **121** in the reset direction.

The end 95 of the timer arm 57 is provided with the reentrant extension 370 which in the lock-out release position shown in Figure 13 will bear against the upper end 371 of the reclosing time delay pawl lever 100 to drive the reclosing time delay pawl lever 100 away from the reclosing time delay ratchet 102 in order to permit resetting of the timing mechanism back to its original position.

The timing mechanism is now released so that it may return the timer shaft 110 carrying the reclosing time delay ratchet 102 and the lock-out ratchet 129 back to the original position of Figures 20 or 21 as the case may be.

The resetting of the timing mechanism back to its original position is accomplished with no intentional time delay. The downward force on the pull ring 235 lifts the operating arm 70 and timer arm 57 as hereinbefore described and also rotates the bell crank arm 600 from the lock-out position of Figure 13 to the lock-out release position of Figure 9.

By means of the engagement between keyway 603 and the reduced section 312, the bell crank arm 600 is able to rotate the timer adjustment arm 135 about its pivot 310 against the bias of spring 311. This lifts the fulcrum 300 of the escapement lever 295 and permits the cam pin 290 to enter the wide portion of the flaring slot 305. As hereinbefore mentioned, this movement of parts permits the timer mechanism 260 to operate independent of the escapement wheel 298 and thus allows the shaft 110 on associated ratchet wheels 102 and 120 to return to their normal position with no time delay. The length of time thus required to return the ratchet wheels 102 and 120 to their normal position is less than one second. If the bell crank lever 600 were not attached to engage the timer adjustment arm 135, the return of the ratchet wheels 102 and 120 to normal position under time delay action would be of the order of fifteen seconds.

The hooked stick inserted in the ring 236 of the reset lever 235 need not be held down any appreciable length of time. Experience has proved that the timer mechanism 260 can reset the shaft 110 to its normal position if the pull ring is merely pulled down and reclosed without any intentional length of time held in the down position. That is, a normal downward force on the pull ring will usually result in a lapse of one second, the period required to reset the timer mechanism 260, with intentionally holding down the pull ring 235.

When the pull ring 236 is pulled in the downward position, it not only raises rod 20 and releases the time delay pawl 100, as described previously, but also it latches the recloser in the open position mechanically. This is accomplished by latch 251 engaging with pin 245, as shown in Figure 3. When pull ring 236 is pulled down, the extension of pin 237 beyond the upper end of pull ring 236 engages with the upper surface of the lower leg of lock-out latch 251, causing it to be rotated around its pivot 252. The detent 254 is then positioned to engage with pin 245 on arm 231 and thus hold the mechanism in the open position. The recloser is then finally released from lock-out by releasing the latch 251 by means of a switch stick pushed up against the under surface or against the extension 255.

Thus, the entire period of time to change the position of the recloser parts from the lock-out position of Figure 13 to the lock-out release position of Figure 9 and then to the normal contact closed position of Figure 6 is only a few seconds and is accomplished with no time delay due to timer mechanism 260. When it is desirable to open the recloser manually and cause it to stay open, a switch stick is inserted in ring 236 and it is pulled down. The recloser is then latched open by means of latch 251 as described above. The recloser can then be reclosed by pushing up against latch 251 and unlatching detent 254 from pin 245.

It should be noted that the main difference in reclosing the recloser is that when it is latched open mechanically from the outside, it is only necessary to unlatch the recloser by pushing up on latch 251. However, when the recloser locks open electrically on the inside, the reclosing operation consists of two parts. First, the pull ring is pulled down and then released which will allow the lock-out ratchet to reset, and second, to push up on latch 251 to release the mechanical latch, which was operated during the first part of the resetting action.

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

I claim:

1. In a circuit recloser comprising a movable contact and a complementary contact said movable contact having a closed position and open position; a fault responsive magnet operated when a fault current flows therein for operating said movable contact to its open position; a timer arm a connection from said movable contact to said timer; said timer being movable from a first position to a second position on movement of said movable contact to open circuit position; a timing mechanism; means controlled by said timer for returning the timer arm from the second position to the first position; an adjusting arm for said timing mechanism for varying the rate of operation of said time mechanism between slow operation and fast operation; a member on said timer arm a manual control for said member; said member when operated by said manual control being engageable with said adjusting arm to move said adjusting arm toward fast operation of said timing mechanism.

2. In a circuit recloser comprising a movable contact and a complementary contact said movable contact having a closed position and open position; a fault responsive magnet operated when a fault current flows therein for operating said movable contact to its open position; a timer arm a connection from said movable contact to said timer; said timer being movable from a first position to a second position on movement of said movable contact to open circuit position; a timing mechanism; means for returning the timer arm from the second position to the first position; an adjusing arm for said timing mechanism for varying the rate of operation of said time mechanism between slow operation and fast operation; a member extending from said timer arm; said timer arm being movable to a third position further removed from said first position than said second position a manual control for said member, said member when operated by said manual control engaging said timer adjusting arm in said third position of said timer arm and moving said timer adjusting arm to the position for fast operation of said timer arm.

3. In a circuit recloser comprising a movable contact and a complementary contact said movable contact having a closed position and open position; a fault responsive magnet operated when a fault current flows therein for operating said movable contact to its open position; a timer arm a connection from said movable contact to said timer; said timer being movable from a first position to a second position on movement of said movable contact to open circuit position; a timing mechanism; means for returning the timer arm from the second position to the first position; means for locking said timer arm in said second position; said means also locking said timing mechanism against operation; an adjusting arm for said timing mechanism for varying the rate of operation of said time mechanism between slow operation and fast operation; a member extending from said timer arm; said timer arm being movable to a third position further removed from said first position than said second position; said third position releasing said timer arm

from said locking means and releasing said timing mechanism to permit it to operate a manual control for said member; said member when operated by said manual control engaging said timer adjusting arm in said third position of said timer arm and moving said timer adjusting arm to the position for fast operation of said timer arm.

4. In a circuit recloser comprising a movable contact and a complementary contact said movable contact having a closed position and open position; a fault responsive magnet operated when a fault current flows therein for operating said movable contact to its open position; adjustable timing mechanism a connection from said timing mechanism to said movable contact to bring said timing mechanism into operation by a movement of the movable contact to open position to time delay reclosing of said movable contact; apparatus operable after at least one opening movement of said movable contact to lock said movable contact in open position; apparatus for releasing said movable contact from said locking apparatus; a timing mechanism adjusting member; a connection from said adjusting member to said releasing apparatus said timing adjusting member being operated by said releasing member on release of said movable contact from said locking apparatus to increase the speed of operation of the timing mechanism.

5. In a circuit recloser comprising a movable contact and a complementary contact; time delay apparatus connectable to said movable contact to delay movement thereof from the open to the closed position said time delay apparatus having a movable member to prevent the timing operation of said time delay apparatus; releasable locking apparatus for maintaining said movable contact in an electrically locked open position; a first and second manual means to effect contact re-engagement when moved from a first to a second position, said first manual means when moved from said first to said second position operating said movable member for defeating the operation of said time delay means so that movement of said second manual means from said first to said second position will insure contact reengagement.

6. In a circuit recloser comprising a movable contact and a complementary contact, said movable contact having a closed position and open position, a fault responsive magnet operated when a fault current flows therein for operating said movable contact to its open position, a timer arm, a connection from said movable contact to said timer, said timer being movable from a first position to a second position on movement of said movable contact to open circuit position; a timing mechanism; means controlled by said timer for returning the timer arm from the second position to the first position; an adjusting arm for said timing mechanism for varying the rate of operation of said time mechanism between slow operation and fast operation; a member operable by said timer arm; said member when operated by said timer arm being engageable with said adjusting arm to move said adjusting arm toward fast operation of said timing mechanism.

7. In a circuit recloser comprising a movable contact and a complementary contact; said movable contact having a closed position and open position; a fault responsive magnet operated when a fault current flows therein for operating said movable contact to the open position; a timer arm; a connection from said movable contact to said timer; said timer being movable from a first position to a second position on movement of said movable contact to open circuit position; a timing mechanism; means controlled by said timer for returning the timer arm from the second position to the first position; an adjusting arm for said timing mechanism for varying the rate of operation of said time mechanism between slow operation and fast operation; a member operable by said timer arm; said timer arm being movable to a third position further removed from said first position than said second position; said timer arm operable to move said member into engagement with said timer adjusting arm when said timer arm is moved to said third position; said member effective to move said timer adjusting arm to the position for fast operation of said timer arm when said member is in engagement with said adjusting arm.

8. In a circuit recloser comprising a movable contact and a complementary contact; said movable contact having a closed position and open position; a fault responsive magnet operated when a fault current flows therein for operating said movable contact to the open position; a timer arm; a connection from said movable contact to said timer; said timer being movable from a first position to a second position on movement of said movable contact to open circuit position; a timing mechanism; means controlled by said timer for returning the timer arm from the second position to the first position; means for locking said timer arm in said second position; said means also locking said timing mechanism against operation; an adjusting arm for said timing mechanism for varying the rate of operation of said time mechanism between slow operation and fast operation; a member operable by said timer arm; said timer arm being movable to a third position further removed from said first position than said second position; said third position releasing said timer arm from said locking means and releasing said timing mechanism to permit it to operate; said member when operated by said timer arm in said third position engaging said timer adjusting arm and moving said timer adjusting arm to the position for fast operation of said timer arm.

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