Oct. 4, 1949. J. M. WALLACE ET AL 2,483,602

CIRCUIT BREAKER

Filed Jan. 25, 1945

Fig. 1.

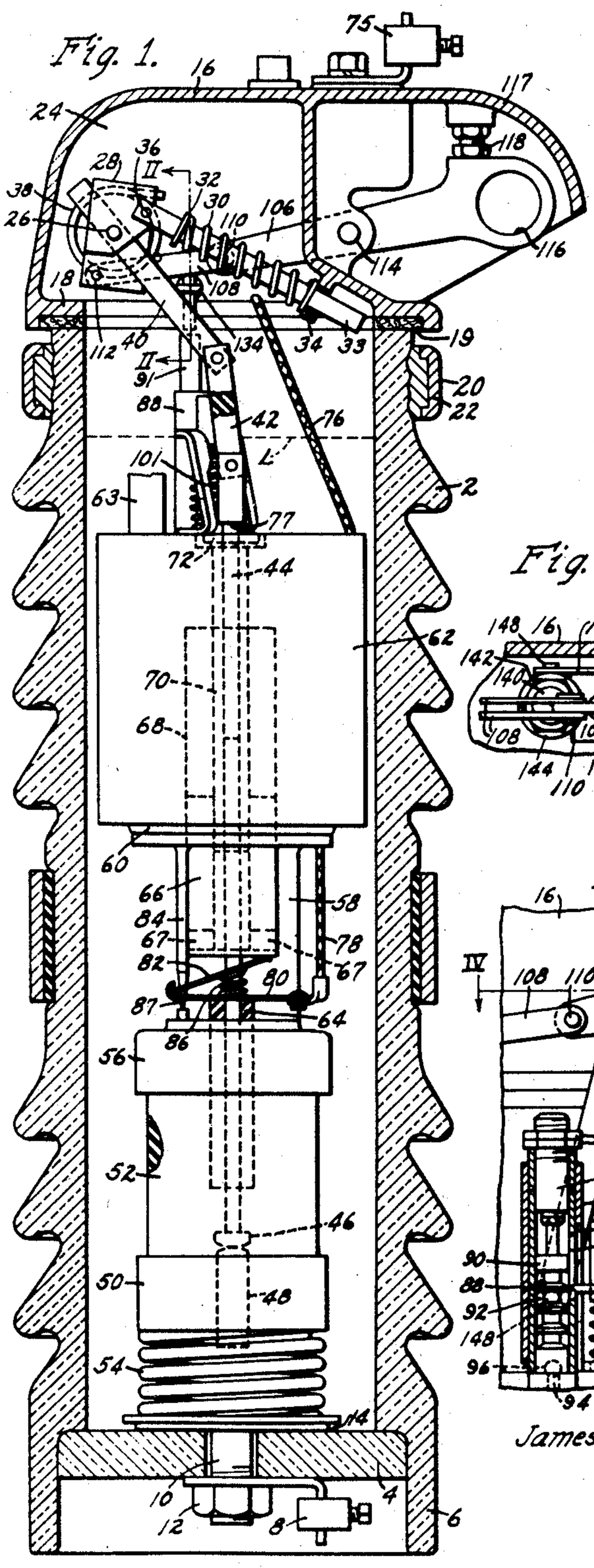


Fig. 2.

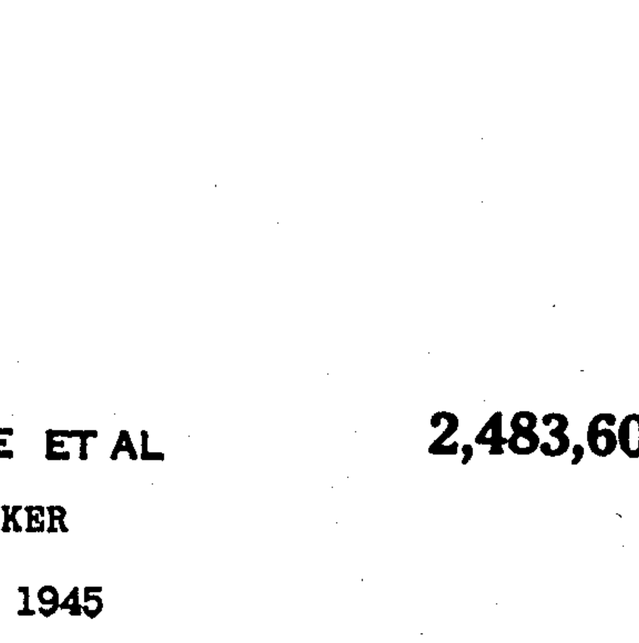


Fig. 4.

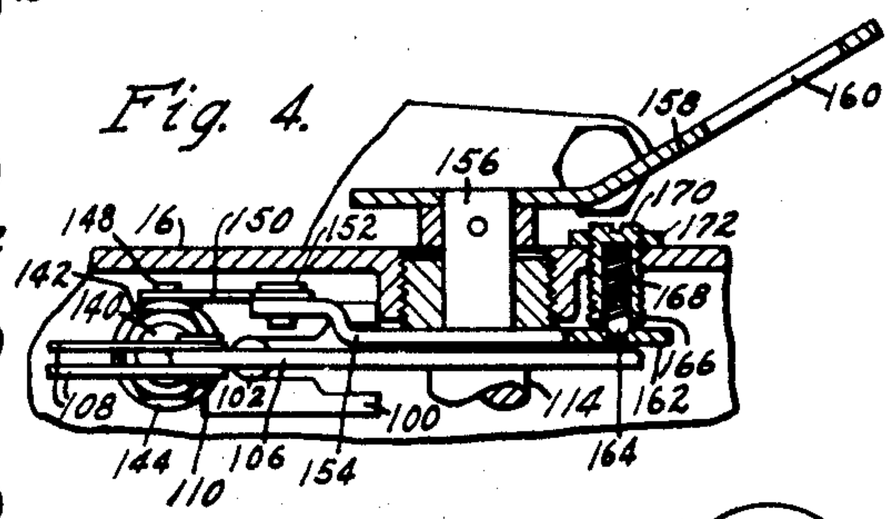
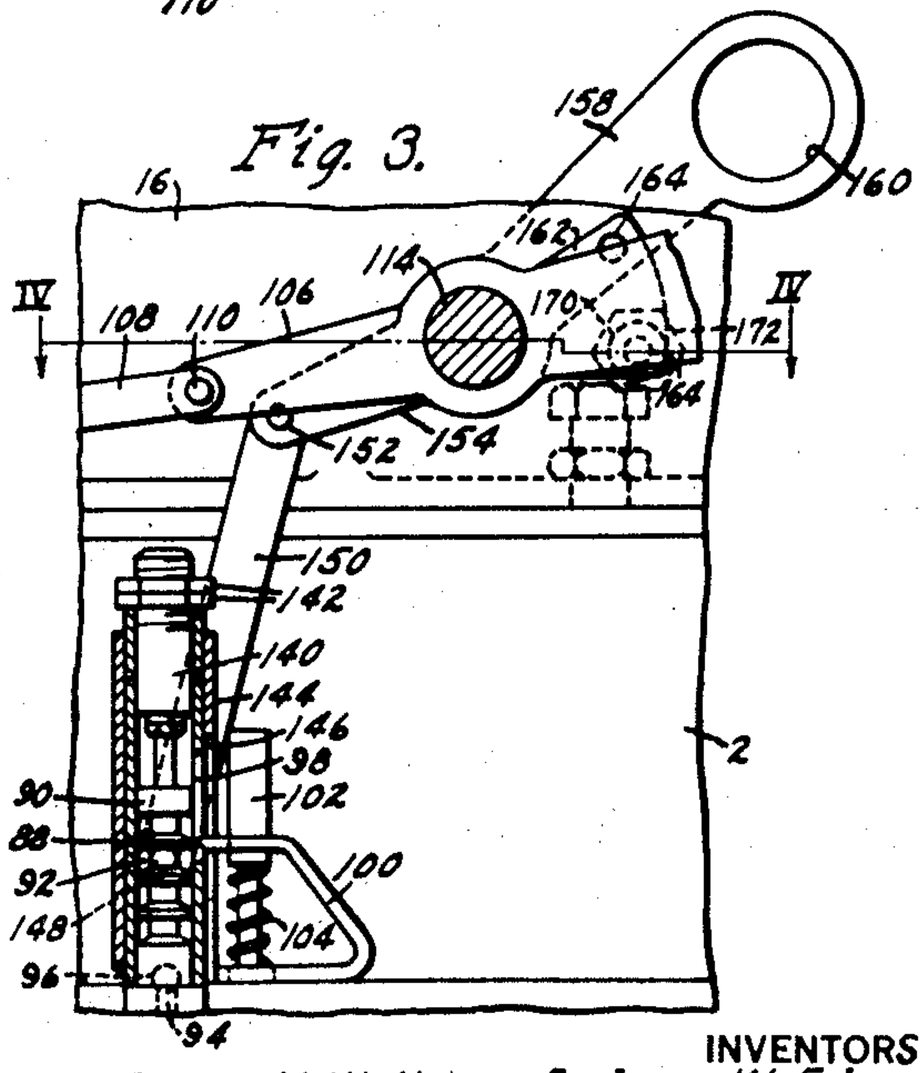


Fig. 3.



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CIRCUIT BREAKER

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4 Claims. (Cl. 200—89)

1

This invention relates generally to electric circuit interrupters, and especially to automatic reclosing circuit breakers.

In distribution circuits, where it is common practice to do work on the line conductors when energized, it is important, for safety considerations, that the circuit interrupter protecting the circuit operate to deenergize the circuit being worked on immediately when a short circuit occurs. It is also important for safety reasons that such a circuit interrupter does not reenergize the circuit. One way of protecting circuits of this type is by the use of repeating fuses, and with this type of protective equipment the dangers mentioned above may be avoided when working on the circuit by removing all the fuses of the repeating fuse structure but one.

A more modern apparatus for protecting circuits of the type described is the small automatic reclosing circuit breaker, and the main object of this invention is to provide novel means for selectively preventing automatic reclosing of such a breaker.

A more specific object of this invention is to provide for an automatic reclosing circuit interrupter which operates in response to an overload to open and reclose the circuit a predetermined number of times and then automatically remain open, with manually selective means for causing said interrupter to remain open after a single circuit interrupting operation.

Automatic reclosing circuit breakers of the type described are usually provided with some type of normally inactive lockout means adapted to be actuated by an integrating or counting means in response to a predetermined number of successive circuit interrupting operations of the breaker, for preventing reclosure of the breaker contacts. The integrating or counting means is preferably of a type which automatically resets if the overload condition clears, and the breaker therefore remains closed before opening said predetermined number of times, which results in lockout occurring only when the aforesaid predetermined number of circuit interrupting operations occurs in rapid succession.

Another object of this invention is to provide an automatic reclosing circuit breaker of the type described having lockout means actuated by integrating means only after a plurality of circuit interrupting operations, with novel manually operable means for selectively causing operation of said lockout means in response to a first circuit interrupting operation of said breaker.

These and other objects of this invention will

2

become more apparent upon consideration of the following detailed description of preferred embodiments thereof when taken in connection with the attached drawing, in which:

Figure 1 is a longitudinal section taken through the casing of a circuit interrupter embodying this invention, with most of the parts within the casing being shown in elevation;

Fig. 2 is a partial enlarged sectional view of the mechanism of the breaker shown in Fig. 1, taken substantially on the line II—II of Fig. 1;

Fig. 3 is a partial sectional view of a modified form of the invention applied to a breaker, such as that shown in Fig. 1; and

Fig. 4 is a partial sectional view taken substantially on the line IV—IV of Fig. 3.

This invention is disclosed as being embodied in an automatic reclosing circuit breaker construction which, in general, is like that disclosed in J. M. Wallace Patent No. 2,333,604, on a Circuit interrupter, issued November 2, 1943 to the same assignee of this invention, and many of the parts of the breaker disclosed herein are identical with corresponding parts of the breaker illustrated in this patent. The breaker is illustrated herein as being enclosed in a tubular casing 2 of insulating material, such as porcelain or the like, with the lower end thereof being closed by an end wall 4 suitably secured within tubular casing 2 in any desired manner, such as by cementing or the like, at a location spaced somewhat from the lower end of casing 2 to provide for a protective flange 6 integral with the casing extending beyond end wall 4. Flange 6 is adapted to conceal a lower terminal 8 for the breaker, which terminal is secured by a nut 12 to a terminal bolt 10 which passes through a substantially central opening provided in end wall 4. Terminal bolt 10 is provided with a head 14 adapted to be seated on the inner side of end wall 4.

The upper end of casing 2 is adapted to be closed by a cover casting structure 16 having an integral flange 18 adapted to be seated on the upper end of casing 2, with packing material 19 interposed therebetween. Cover casting 16 may be secured to casing 2 in any desired manner, preferably by bolts or the like (not shown) connecting the casting with an anchor ring 20 secured to the upper end of casing 2 as by cast metal or the like 22.

Cover casting 16 is provided with a hollow portion forming a space 24, across which extends a shaft 26 with the ends of the shaft rotatably mounted in opposite walls of the cover casting.

A generally U-shaped spring support 28 has the legs thereof pivotally mounted on shaft 26, and the spring support is biased in a counterclockwise direction, as viewed in Fig. 1, by a compression spring 30 reacting between a flange 32 provided on a rod 33 pivotally connected to one leg of the spring support as at 36, and an ear 34 integral with the cover casting. Ear 34 is apertured for slidably receiving rod 33. Spring support 28 is normally prevented from rotating in a counterclockwise direction under the influence of spring 30 by toggle levers 106 and 108 which are connected together by a knee pivot pin 110, with lever 108 pivotally connected to one leg of spring support 28 as by a pivot pin 112, and with the other toggle lever 106 being pivotally mounted on the casting as by a stub shaft 114. Toggle lever 106 is extended beyond shaft 114 to provide a handle portion at the exterior of hollow space 24 having a hookeye 116 at the outer end thereof. Toggle levers 106 and 108 are normally held at an overcenter position by engagement of the outer end of lever 106 with an adjustable stop bolt 118 mounted beneath a hood portion 117 integral with the cover casting.

Shaft 26 within hollow space 24 of the cover casting is also adapted to support a contact closing spring 38 having the ends thereof reacting against the bight portion of spring support 28 and against an actuating crank 40 also pivotally mounted on shaft 26, in a manner to bias crank 40 in a clockwise direction as viewed in Fig. 1. Actuating crank 40 is operatively connected with a contact rod 44 by connecting links 42 of insulating material, such, for example, as fiber or the like. Contact rod 44 extends downwardly through casing 2 and is provided at a lower end with a contact head 46 adapted in the closed circuit position to engage a fixed contact 48 secured in a cap 50 for a tubular interrupter housing 52. Cap 50 of the interrupter housing is adapted to be electrically connected with lower terminal 8 by means of a coil compression spring 54 of some resilient conducting material, such as a copper alloy, as this spring reacts between head 14 of terminal bolt 10, and cap 50.

The tubular interrupter housing 52 is of an insulating material, such as fiber or the like, and is provided with a cap 56 for its other end which has integral therewith one or more supporting plates 58, which, in turn, are connected with a solenoid supporting frame 60. The solenoid supporting frame is, in turn, suspended from cover casting 16, as by one or more supporting posts 63. By this means, it will be observed that all of the parts mounted within casing 2 are supported from cover casting 16, so as to be insertable or withdrawable from casing 2 with cover casting 16, as a unit.

The solenoid supporting frame 60 is adapted to support solenoid coil 62 which is annular in form so that contact rod 44 extends substantially centrally therethrough, and at the point where actuating rod 44 extends through top cap 56 of the interrupter housing, it is provided with a sleeve 64 to enlarge the area of the contact rod at this point, and this sleeve may also be of insulating material, in order to insulate the rod from cap 56. A generally cylindrical solenoid core 66 is slidably mounted on contact rod 44 above sleeve 64, and is provided with a bottom wall and with side vent opening 67 adjacent the bottom wall. Solenoid core 66 is slidably mounted within a dashpot cylinder 68 formed within coil 62, and contact rod 44 is provided

with an actuating sleeve 70 thereon having a flanged head 72 at the upper end of the sleeve, for a purpose to be described.

Solenoid coil 62 is connected in series in the circuit through the breaker between terminal 8 at the lower end thereof, and a terminal 75 secured on cover casting 16. This circuit through the breaker proceeds from terminal 75 through the cover casting and through a conductor 76 secured thereto to coil 62, and from the coil by way of a flexible conductor 78 to a supporting plate 80 secured on contact rod 44 at the upper end of sleeve 64, and thence through the contact rod to fixed contact 48, end cap 50, spring 54, and terminal bolt 10 to the lower terminal 8.

Supporting plate 80 on contact rod 44 is adapted to pivotally support a latch plate 82 at one end, and this latch plate is provided with an aperture for receiving the contact rod while permitting pivotal movement of the plate, and is also provided with a second aperture for receiving latch rod 84 stationarily mounted between cap 56 of the interrupter chamber and solenoid supporting frame 60. A light coil compression spring 86 is provided for normally biasing latch plate 82 away from supporting plate 80. It will be noted that latch rod 84 is provided at its lower end with a reduced area portion 87 for a purpose to be described.

In operation, upon the passage of currents through the interrupter above a predetermined magnitude, solenoid coil 62 is energized sufficiently to attract core 66 upwardly until the bottom wall thereof engages actuating sleeve 70 to raise the sleeve until its flange 72 engages shoulder 77 on the actuating rod, to then separate contact head 46 from fixed contact 48. There is some time delay before the contacts are separated, due to the dashpot action of core 66 within dashpot cylinder 68, inasmuch as all these parts are adapted to be submerged in an insulating liquid which may fill casing 2 up to level L. As soon as the contacts are separated however, an arc is formed within interrupter chamber 52, and this acts to build up pressure within the chamber and force contact head 46 away from fixed contact 48 by the piston-like action of the contact rod. As contact rod 44 is moved upwardly away from fixed contact 48, reclosing spring 38 is stressed. However, when the arc is finally extinguished within interrupter chamber 52 by attenuation thereof and by the arc-extinguishing action of the liquid within the chamber, reclosing spring 38 is prevented from immediately reclosing the contacts due to the action of latch plate 82 in binding on latch rod 84 under the influence of its spring 86. The latch plate can be released only by movement of solenoid core 66 downwardly into engagement with the free end of the latch plate. This downward movement of core 66 is quite slow, however, due to its dashpot action in sleeve 68. Accordingly, it will be apparent that downward movement of contact rod 44 will be delayed until core 66 engages latch plate 82, and thereafter downward movement of the contact rod will be substantially at the same rate as the core until the reduced area part 87 of latch rod 84 is reached, when latch plate 82 will no longer be effective to bind on the rod, so that the final movement of contact head 46 into engagement with fixed contact 48 will be unrestrained, and consequently quite rapid. Preferably, provision is made, as disclosed in the above-mentioned Wallace patent, for flushing arc chamber 52 of

gases and other impurities during reclosing of the breaker contacts.

The circuit breaker may be manually opened and closed whenever desired, by the use of a hook stick inserted in hookeye 116 of toggle lever 106, and pulling downwardly to rotate this lever in a clockwise direction and move knee pivot pin 110 overcenter, thus permitting spring 30 to rotate spring support 28 in a counterclockwise direction, carrying with it actuating crank 40, to lift contact head 46 away from fixed contact 48. With the parts in this position, spring 30 will hold the contact separated, and they may be manually reclosed by rotating lever 106 in the opposite direction into engagement with the stop bolt 118. This will obviously move toggle levers 106 and 108 back overcenter, and permit closing spring 38 to move contact rod 44 downwardly at a rate determined by the downward movement of the core 66, as previously explained.

In order to limit the number of closely successive circuit interrupting operations of the breaker in the event a continuing fault occurs, there is provided integrating means similar to that shown in the previously mentioned Wallace patent, comprising a cylindrical sleeve 88 mounted on solenoid casting 60, and having a piston 90 therein provided with a plurality of notches 92. The lower end of sleeve 88 is provided with an inlet opening 94 (Fig. 3) controlled by a ball check valve 96 to permit flow of liquid solely into the lower end of the sleeve. Cylindrical sleeve 88 is also provided with a side opening 98, through which one leg of a U-shaped pawl 100 is adapted to move to engage one of the notches 92 in piston 90. Pawl 100 is provided with a slot 101 through the top leg and the bight portion thereof for receiving a guide rod 102, and the upper end of contact rod 44. The lower leg of pawl 100 is apertured for receiving guide post 102, and the pawl is normally held at the position shown by a coil compression spring 104 reacting between a shoulder on the guide post and the lower leg of the pawl.

In operation, each time a circuit interrupting operation occurs, flange 72 on actuating sleeve 70 is lifted an amount sufficient to cause pawl 100 to tilt so that the upper leg thereof moves into engagement with a notch 92 of integrating piston 90, to lift the piston a predetermined amount. As piston 90 is lifted, a corresponding amount of liquid is drawn into the lower part of sleeve 88. Upon reclosure of the breaker following any circuit interrupting operation, if the fault has cleared so that the contacts remain closed, piston 90 will gradually sink back to its original position. This return of piston 90 to its original position is necessarily slow, due to the relatively tight fit thereof in sleeve 88, and the necessity of displacing liquid drawn into the lower end of the sleeve past the relatively small clearance between the piston and sleeve. However, if the breaker immediately reopens, pawl 100 will engage the next lower notch 92 in the piston, and raise the piston a further amount, since the piston has not had time to return to any appreciable extent toward its original position. After a predetermined number of closely successive circuit interrupting operations of the breaker, extension 91 of integrating piston 90 will have been raised a sufficient distance to engage toggle lever 108 and move the toggle levers overcenter and permit spring 30 to rotate spring support 28 in the manner previously described to prevent reclosing of the breaker contacts. This open condition of the breaker contact is clearly indicated at the exterior of the casing because the outer end of lever 106 with hookeye 116 will be disposed below hood 117, to thus indicate that a manual reclosing is necessary.

It is preferred that the breaker interrupt the circuit three times in close succession before toggle levers 106 and 108 are moved overcenter to maintain the contacts separated, as it has been found that most faults will clear themselves after one or two circuit interruptions and reclosures. However, as previously pointed out, for safety reasons it is desired at times that reclosure be prevented even after the first circuit opening interrupting operation, and for this purpose there is provided associated with cover casting 16, a control shaft 120 extending through an opening 130 provided in a side wall of the cover casting, having a handle 122 at the outer end of shaft 120, and a flange 124 at the inner end of the shaft. A light coil compression spring 126 is adapted to react between flange 124 of the control shaft and a supporting plate 128 secured to the cover casting, to continuously bias shaft 120 in a direction inwardly of the cover casting. The inner end of control shaft 120 is flattened as at 134 and apertured for slidably receiving a plunger rod 136 having stop pins 138 at opposite ends thereof, for preventing escape of plunger 136 from the aperture in end 134 of the control shaft. Cover casting 16 is provided with an integral flange 132 adjacent control shaft 120 for a purpose to be described.

In the position of control shaft 120 shown in full lines in Fig. 2, it is biased by spring 126 to its innermost position defined by a pin 129 in the shaft, wherein plunger 136 is held at a position intermediate and in alignment with extension 91 of integrating piston 90 and toggle lever 108. It will be apparent therefore that in this position of control shaft 120 a first circuit interrupting operation of the breaker will advance integrating piston extension 91 sufficient to engage plunger 136 and move it to throw toggle levers 106 and 108 overcenter and thus cause spring 30 to maintain the contacts separated. Plunger 136 is, in effect, a motion transmitting member inserted between integrating piston 92 and the toggle levers. When it is desired that the breaker operate in its normal manner, that is, to proceed through a predetermined number of circuit interruptions and reclosing operations before the contacts are conditioned to be held open by spring 30, it is merely necessary to withdraw the control shaft 20 by its handle 122, and to rotate the shaft until handle 122 engages flange 132, as shown in dot and dash lines in Fig. 2.

According to the embodiment of the invention disclosed in Figs. 3 and 4, instead of interposing a motion transmitting plunger between the integrating piston and the toggle levers, manually controllable means is provided for advancing the integrating piston so that the contacts will be maintained separated after a first circuit opening of the breaker. In this embodiment of the invention, integrating piston 90 is provided with an extension 140 having its outer end threaded for receiving stop nuts 142. A control sleeve 144 is telescoped over sleeve 88, and is slotted as at 146 to align with opening 98 in sleeve 88. A control link 150 is pivotally connected with sleeve 144 as at 148, and has its other end pivoted at 152 to a control lever 154 secured on a stub shaft 156 extending through the adjacent side wall of cover casting 16. The outer reduced end 156 of shaft

114 has secured thereto a control handle 158, having a hookeye 160 in its outer end. Control lever 154 is extended at the opposite side of shaft 156 to provide a segmental portion 162 having spaced apertures 164 therein for cooperation with a ball detent 166. Detent ball 166 is biased outwardly into engagement with segmental portion 162 by a coil compression spring 168 housed within a threaded cup member 170 which is threaded in an opening in cover casting 16, and held at an adjusted position by a lock nut 172.

With the control handle 158 at the position shown in Fig. 3, it will be apparent that the circuit breaker will operate in a normal manner as previously described, to cause integrating piston 90 to move toggle links 106 and 108 overcenter so that the contacts are held separated only in response to a predetermined number of a plurality of closely successive circuit interrupting operations. However, when it is desired for safety purposes that the breaker contacts remain open after a first circuit interrupting operation, the control lever 158 is moved in a clockwise direction, as viewed in Fig. 3, to a position wherein detent ball 166 engages with the other aperture 164 in extension 162 of lever 154, to thus raise control sleeve 144 into engagement with nuts 142 on the integrating piston and raise the piston to a position closely adjacent toggle lever 8. Detent ball 166 will thus hold lever 154 in a position wherein extension 140 of integrating piston 90 is just out of contact with toggle lever 108, so that upon the occurrence of a circuit interrupting operation, pawl 100 will engage the lowermost notch of the integrating piston and raise it into engagement with toggle lever 108 to move the lever overcenter, and thus permit spring 30 to maintain the contacts separated.

This invention thus provides manually operable control means for an automatic reclosing circuit breaker, for preventing such automatic reclosure. This may be accomplished with the structures herein disclosed where an integrating means is employed to move a toggle overcenter to release a spring for holding the contacts separated, by either, (1) providing an arrangement for manually selectively interposing motion transmitting means between the integrator and toggle mechanism so as to cause the toggle mechanism to be moved overcenter by the integrator sooner than it normally would be, preferably on the first circuit opening operation, or (2) providing an arrangement for manually selectively advancing the integrator so as to obtain the same result. The structure illustrated in Figs. 3 and 4 is preferred inasmuch as nuts 142 on the piston provide an adjustment for the amount the piston can be manually advanced, the ball detent 166 provides a means for holding the manual control handle in either of its two positions. Although it is preferred that the manually controllable means have but two positions, one in which the breaker operates normally a predetermined plurality of times in close succession before the contacts are maintained separated, and another position at which reclosure is entirely prevented, it is apparent that the manual control means may be employed to permit one or two reclosures, or any number less than the normal number of closely succeeding reclosing operations by adjusting the length of plunger 136 in the embodiment of Fig. 2, or by adjusting stop nuts 142 of the embodiment in Figs. 3 and 4.

Having defined preferred embodiments of the invention, as required by the patent statutes, it is

desired that it be understood that this invention is not to be limited to these particular embodiments inasmuch as it will be apparent, especially to persons skilled in the art, that many modifications and changes may be made in these particular structures without departing from the broad spirit and scope of this invention. Accordingly, it is desired that the invention be interpreted as broadly as possible in accordance with the definitions contained in the following claims.

We claim as our invention:

1. In a circuit interrupter of the type having separable contacts, and having provisions for automatically separating said contacts to interrupt the circuit in response to a predetermined circuit condition and for automatically closing said contacts following a circuit interrupting operation, the combination of normally inactive means adapted when actuated to prevent automatic reclosing of said contacts, integrating means adapted to be advanced a predetermined amount in response to each circuit interrupting operation and when advanced a predetermined greater amount by a predetermined number of a plurality of successive circuit interrupting operations being engageable with said reclosure preventing means to actuate the same, and manually operable means for selectively reducing the travel of said integrating means necessary to actuate said reclosure preventing means by introducing motion transmitting means between said integrating means and reclosure preventing means so that said integrating means may be caused to actuate said reclosure preventing means in response to a predetermined circuit interrupting operation in advance of the last one of said predetermined number of circuit interrupting operations.

2. In a circuit interrupter of the type having separable contacts, and having provisions for automatically separating said contacts to interrupt the circuit in response to a predetermined circuit condition and for automatically closing said contacts following a circuit interrupting operation, the combination of normally inactive means adapted when actuated to prevent automatic reclosing of said contacts, integrating means adapted to be advanced a predetermined amount in response to each circuit interrupting operation and when advanced a predetermined greater amount by a predetermined number of a plurality of successive circuit interrupting operations being engageable with said reclosure preventing means to actuate the same, means mounted for movement to and away from a position wherein at least a part thereof is in the path of movement of said integrating means for transmitting movement from said integrating means to said reclosure preventing means, and a movable operating handle for moving said motion-transmitting means to and away from said position so that said integrating means may be caused to actuate said reclosure preventing means in response to a predetermined circuit interrupting operation in advance of the last one of said predetermined number of circuit interrupting operations.

3. A circuit breaker comprising, separable contacts, overload-responsive means for automatically separating said contacts to interrupt the circuit in response to overloads on the circuit, means for automatically closing said contacts following a circuit interrupting operation, means for counting closely successive operations of said breaker and automatically preventing closing of

the breaker in response to a predetermined number of such operations, movably mounted altering means having a manually operable part for selectively moving said altering means to and from one position where said altering means has no effect on operation of said breaker, and a second position where said altering means is moved to such a location where it mechanically cooperates with said counting means for causing said counting means to prevent closing of the breaker in response to a number of breaker operations less than said predetermined number.

4. A circuit breaker comprising, separable contacts, overload-responsive means for automatically separating said contacts to interrupt the circuit in response to overloads on the circuit, means for automatically closing said contacts following a circuit interrupting operation, counting means actuated by said breaker to be advanced a predetermined amount during each cycle of a circuit opening and closing operation of said breaker, means providing for slow return movement of said counting means so that said counting means will be advanced a predetermined amount greater than said first-mentioned predetermined amount only in response to a predetermined number of closely successive circuit interrupting operations, means conditioned by said counting means when the latter has been advanced said greater amount to prevent automatic

closing of said contacts, and manually operable means operatively connected with said counting means for advancing said counting means independently of breaker operation, and means preventing return movement of said counting means in response to advancement by said manually operable means, whereby thereafter said contacts will be prevented from closing automatically in response to a number of closely succeeding operations thereof less than said predetermined number.

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