AUTOMATIC RECLOSING CIRCUIT BREAKERS

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This invention relates generally to automatic reclosing circuit breakers, and particularly to reclosers as have closely successive circuit-interrupting operations with different time characteristics.

In connection with automatic reclosing circuit breakers, it is customary to provide for one or more substantially instantaneous openings followed by delayed openings having inverse time-current characteristics. Such delayed characteristics have hitherto been provided by utilizing a dashpot structure wherein the movable core of a solenoid coil moves in an oil-filled chamber which is vented into the interior of the breaker container, and varying the effective size of the vent.

One object of this invention is to provide in an automatic reclosing circuit breaker for using a sealed dashpot structure for delaying operation of the breaker.

Another object of the invention is to provide in an automatic reclosing circuit breaker for using a normally ineffective sealed dashpot time-delay structure, and for utilizing leakage magnetic flux to render the time-delay structure effective during opening of the breaker.

Yet another object of our invention is to provide in an automatic reclosing circuit breaker for utilizing a normally ineffective sealed dashpot time-delay structure, and utilizing a magnetic means for rendering the time-delay structure effective only after a predetermined number of closely successive substantially instantaneous openings.

It is also an important object of our invention to provide in an automatic reclosing circuit breaker for utilizing an operation counter for positioning a magnetic shunt to retard movement of a dashpot time-delay mechanism after a predetermined number of substantially instantaneous openings.

These and other objects of this invention will become more apparent upon consideration of the following detailed description of a preferred embodiment thereof, when taken in connection with the attached drawings, in which:

Figure 1 illustrates a substantially central vertical sectional view of a circuit breaker embodying this invention, and Fig. 2 is a sectional view taken along the line II—II of Fig. 1.

The invention is illustrated on the drawing as being embodied in one form of automatic reclosing circuit breaker, with the particular breaker herein illustrated being more particularly described and claimed in the co-pending application of J. M. Wallace et al., Serial No. 8044, filed February 13, 1948, on Circuit Interrupters, which is assigned to the same assignee as this invention.

This circuit breaker is mounted in a metal tank 2 having a closed bottom wall and an open top and adapted to be filled with a liquid up to the level L, preferably an arc-extinguishing liquid such as oil or the like. Preferably, the tank is lined at least over the bottom wall and up to a point adjacent the open top of the container with a liner 3 of insulating material such as fiber, or the like.

The upper end of tank 2 is provided with an outwardly extending flange 4 on which the flange 8 of a cover casting 6 is adapted to be seated, preferably, with a gasket 10 interposed therebetween. Flange 8 of cover casting 6 may be provided with an integral lip 12, and the cover may be secured to the tank in any desired manner, such as by bolts (not shown) extending through openings in cover flange 8 and secured to suitably formed brackets on the tank.

The breaker contacts, arc-extinguishing structure, and the contact-actuating mechanism are all adapted to be supported in tank 2 from cover casting 6 by means of a plurality of integral supporting lugs 16 (only one of which is shown) depending from the top wall of the cover casting and adapted to engage spaces or sleeves 18 of insulating material suitably secured to supporting lugs 16 and to an upper supporting plate 20. A lower supporting plate 22 may be supported from plate 20, so that a solenoid coil 24 may be mounted between supporting plates 20 and 22, with the central opening in the coil aligned with openings provided in plates 20 and 22. Supporting plates 20 and 22, together with bolts (not shown) securing them together, are of a magnetic material, such as iron or the like, to complete a magnetic circuit of low reluctance outside of solenoid coil 24, which terminates at opposite ends of the central opening through the coil in which the working air gap of the coil is located. Upper plate 20 may be provided with a peripheral groove 23 for providing an effective magnetic air gap 25 for a purpose which will be explained hereinafter. The groove 23 may be filled by an insert of a non-magnetic material such as brass or the like.

Spaced stationary contacts 26 of the breaker are supported within an insulating tube 28 at the lower end thereof, and on opposite sides of the tube, respectively. Tube 28 which may be of any desired insulating material, such as fiber or the like, is supported at its upper end from plate 22 by supporting brackets 30 which are welded or otherwise secured to plate 22, and have screws for securing tube 28 thereto, with the upper end of tube 28 being closely adjacent to, but spaced from plate 22. Stationary contacts 26 are each mounted on its own supporting bracket 32, with each bracket having a U-shaped portion for receiving the lower edge of the tube 28 and being secured thereto as by a bolt 34. Tube 28 has opposed vent openings 35 in opposite sides, located directly above stationary contacts 26, respectively.

A movable bridging contact 36 for engaging the contacts 26 is mounted on an insulating contact-actuating rod 44 by a pivot 38. The upper end of contact-actuating rod 44 has connecting links 46 of insulating material pivoted thereon as by a pivot pin 48, with the upper ends of these connecting links mounted on a common pivot pin 50 for a pair of toggle levers 52 and 54. Toggle levers 52 and 54 are both formed of sheet material, with lever 54 being bent to substantially channel form with outwardly extending flanges 56 adapted to be received at the free ends thereof in recesses 58 provided in the spaced downwardly depending fingers of an angled supporting bracket 60 which, in turn, is secured as by a screw 64 to a lug 62 integral with the cover casting.

A coil tension spring 63 has one end hooked into an opening provided in toggle lever 52, and has the opposite end thereof hooked over an integral spring support on the cover casting. Toggle lever 52 has an integral hook portion 55 passing through an opening in lever 54 to limit separation of the levers.

It will be observed that in the closed circuit position of the breaker illustrated on the drawing, the line of action of toggle spring 63 is below the pivot supporting recesses 58 for toggle lever 54, and, accordingly, the
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toggle spring 68 acts to bias bridging contact 36 into engagement with stationary contacts 26 of the breaker, under a predetermined pressure. However, as soon as contact-operating rod 44 moves upwardly to separate the bridging contact from the fixed contacts of the breaker, toggle lever 54 will pivot about recesses 58, and the line of action of toggle spring 68 will thus be caused to approach that pivot point, so that in response to a very small contact separation the line of action of toggle spring 68 will pass through pivot recesses 58, which is the on-center position of the resilient toggle arrangement comprising toggle levers 52 and 54 and toggle spring 68. As a practical matter, the opening movement of the contacts necessitates that toggle move toggle levers 52 and 54 to the on-center position mentioned above may be made very small, in one actual device being on the order of one-quarter of an inch. When toggle levers 52 and 54 reach their on-center position referred to above, further relative movement of the two toggle levers in the same direction is prevented because the upper edge of toggle lever 52 engages the base of the central channel formation of toggle lever 54. Moreover, since the point at which toggle spring 68 is hooked into lever 52 then substantially coincides with recesses 58 in which toggle lever 54 pivots during contact-opening movement, it is to be expected that the remainder and major part of contact-opening movement will occur substantially unimpeded by toggle spring 68.

Substantially the reverse of the above operation occurs when contact-operating rod 44 moves downwardly to close the circuit from the full-open contact position, because during the first and major part of contact-closing movement, levers 52 and 54 will be in engagement, so that such movement will be unimpeded by toggle spring 68. However, as soon as pivot 50 passes below a line drawn from the remote end of toggle spring 68 through pivot recesses 58 for link 54, toggle spring 68 is effective to move the toggle levers toward the position shown in Fig. 1, and the force exerted by toggle spring 68 thus tending to close the contacts, will continue to increase as toggle levers 52 and 54 move further away from their on-center positions. Solenoid coil 24 previously mentioned is adapted to be energized under certain conditions for automatically opening the circuit breaker contacts. The central opening through coil 24 preferably is provided with a cylindrical sleeve 74 in which a solenoid core 76 is adapted to be slidably mounted. Instead of mounting the solenoid core directly in the sleeve 74, it may be disposed within a cylindrical casing 75 which comprises an inner cylinder 77 which slidably receives the rod 44, and an outer cylinder 78 which is slidably disposed in the sleeve 74. Caps 79 and 80 cover and connect the cylindrical casings 75 and 77 at each end to seal the core 76 therein. The core 76 is disposed to fit relatively snugly between the two casings. In order to provide a dashpot time-delay action for movement of the core 76 in the casing 75, a suitable fluid such as oil or one of the silicones, may be sealed therein. A spring 81 normally biases the core 76 to the bottom of the casing. An orifice 82 may be provided through the core for passage of the fluid, thus permitting rapid reset of the core to the position shown, and a washer 83 may be disposed in connection therewith to provide a one-way valve for preventing passage of the fluid through the orifice during upward movement of the core in the casing. A collar 85 may be secured to the actuating rod of the casing to resist against opening the breaker under the influence of the core 76.

In order to sometimes permit the core 76 to push the casing 75 ahead of it and effect instantaneous opening of the breaker, and to sometimes require the core to work slowly against the dashpot action of the fluid in the casing 75, means such as the magnetic shunting lever 86 may be provided for holding the casing stationary while the core 76 slowly forces its way upwardly therein, until the gap between it and the upper supporting plate 20 is reduced sufficiently that the force exerted by it is sufficient to overcome the magnetic attraction for the shunting lever 86.

With a view to rendering the shunting lever 86 effective only after a predetermined number of substantially instantaneous openings, a counting mechanism may be provided, comprising a cylinder 83 mounted on the plate 20 and having a movable piston 89 disposed therein with an extension 90 at the upper end of a reduced section 91 having a plurality of spaced flanges 92. The lower end of cylinder 83 is closed except for a vent 93 and ball check 94 which permits rapid movement upwardly, but only relatively slow downward movement of piston 89. A lever 95 having a pawl 96 thereon for engaging the different flanges 92, successively, on closely successive operations, is disposed to be actuated by the collar 85, for stopping the piston 86 upwardly each time the breaker opens.

The shunting lever 86 has a slot 87 for receiving the rod 44, and may be pivotally supported on the plate 20 by a pivot 97 and non-magnetic hinges 98. Springs 99 normally bias the shunting lever 86 upwardly in a counter-clockwise direction as indicated in Fig. 1. The piston 89 has a cam surface 100 thereon for actuating a cam lever 101 in a clockwise direction after a predetermined number of closely successive openings, which lever is separately pivotally mounted on pivot 97 and is spring connected to the shunting lever 86 by springs 103 so as to be resiliently connected thereto for overcoming the bias of springs 99 and actuating the lever 86 in a clockwise direction when cam lever 101 is moved counterclockwise by piston 89 moving upward, to bridge groove 23 whence it will be held against a spacer 103 of non-magnetic material during an opening operation, and magnetic leakage flux 69 will then be passed through the gap 77 and 75 and providing for dashpot action of core 76 to delay subsequent opening of the breaker.

The circuit through the circuit breaker thus far described may now be traced from the point where it enters tank 2 through one of a pair of terminal bushings 106 (only one being shown), with each bushing being secured to cover casting 6 and each being provided with a conductor element which extends through the bushing, and proceeds by conductor 107 directly to one fixed contact 26 of the breaker. When the contacts are in engagement, the circuit then proceeds through bridging at fixture 76 to fixed contact 26, and then by way of a conductor 108 to one terminal of solenoid coil 24. The other terminal of coil 24 is adapted to be connected by a conductor 109 to the conducting means in the other terminal bushing. It will be apparent that solenoid coil 24 is connected in series in the circuit through the circuit breaker so as to be energized at all times an amount dependent upon the value of the load current flowing in the circuit.

For any given rating of circuit breaker, solenoid coil 24 is designed to become sufficiently energized when the load current in the circuit exceeds its rating. To attract core 76 and move it upwardly within sleeve 74. Assuming the magnetic shunt is positioned as shown, core 76 will move rapidly upwardly, pushing the casing 75 bodily ahead, because of the necessity for first displacing the liquid in casing 75 above the core through the relatively small clearance between the core and sleeves 77 and 78, before the core can move in or relative to the casing. Accordingly, the core 76 and casing 75 move together as a unit, and movement of the core will not be slowed up by the aforesaid dashpot action. Therefore, a substantially instantaneous opening characteristic is obtained, when the casing 75 strikes the shunting lever 86, moves it in the counter-clockwise direction, and hence causes lever 86 to actuate collar 85 upwardly, at which time contact-actuating rod 44 will
5 start to move upwardly. As soon as actuating rod 44 moves upwardly, the force exerted by toggle spring 68 begins to decrease and in a very short distance has substantially no value at all, so that the remaining major part of the circuit-opening movement of bridging contact 36 occurs extremely rapidly due to the increasing pull on the core 76 as the air gap 20 is reduced. In any case, it is apparent that toggle levers 52 and 54 will be moved to their on-center position in the manner previously described, and bridging contact 36 will be moved to its full-circuit open position.

When the breaker contacts have attained their full-open circuit position, the parts associated therewith are initially biased to retain bridging gravity. Accordingly, the return movement will be relatively slow until pivot point 50 moves below the line of action of toggle spring 68 when toggle levers 52 and 54 are in engagement, whereupon bridging contact 36 will be rapidly moved to effect a snap-action closing of the breaker contacts by toggle spring 68.

In order to provide for maintaining the breaker contacts separated and to also provide for manual operation, spring means are provided for holding the breaker contacts open in response to the occurrence of a predetermined number of closely succeeding circuit-interrupting operations, which means can be manually actuated. This means comprises a toggle lever 110 having a slot 105 at one end thereof for receiving a pin 111 mounted between spaced supporting arms 112 integral with cover casting 6. The other end of toggle lever 110 is pivoted, as by a pivot pin 113, to the adjacent end of a second toggle lever 114, and this, in turn, is mounted on a pivot pin 116 intermediate its ends on cover casting 6. A slot 120 is provided through the cover casting 6 for receiving the other end of toggle lever 114 which acts as a manual operating handle at the exterior of the circuit breaker casing, being provided with a hook eye 122 in its outer end. A coil compression spring 124 is mounted on toggle lever 110 and rests between washers mounted on the toggle lever, one of which engages supporting pin 111, and the other of which engages a shoulder located adjacent pivot 113. Normally, toggle levers 110 and 114 are held with pivot 113 below the center-line connecting pins 111 and 116, with the outer end of lever 114 positioned in and beneath the adjacent flange 56 of toggle lever 54. Accordingly, if it is desired to manually open the circuit breaker contacts, a hook stick or similar operating member may be inserted in hook eye 122 of toggle lever 114 and pulled downwardly to rotate the toggle lever in a counterclockwise direction about its supporting pivot 116 to move toggle levers 110 and 114 out of their center in an upward direction, and in doing this, the common pivot pin 113 engages the adjacent flange 56 of toggle lever 54 and moves it upwardly in a counterclockwise direction, thus carrying contact-actuating rod 44 with it to separate bridging contact 36 from stationary contact 26. The contacts will be held open by spring 124 which maintains toggle levers 110 and 114 in their upper overcenter position. With the breaker contacts maintained at their open circuit position following the manual circuit-opening operation described above, it will be apparent that the outer end of toggle lever 114 projects below hood 126 of cover casting 6 so as to provide a readily visible indication that the breaker contacts are maintained at an open circuit position. It will further be apparent that the breaker contacts may be closed only by manual operation of toggle lever 114 in the opposite direction, that is, by exerting an upward force on the outer end of the toggle lever to rotate it in a clockwise direction to move it and toggle lever 110 back overcenter to the position illustrated on the drawing. This manual operation of toggle lever 114 does not directly close the breaker contacts, but merely permits closure of the contacts in the manner previously described, that is, initial closing movement of the contacts being due to the bias of gravity, until bridging contact 36 is closely adjacent stationary contacts 26, when toggle spring 68 is moved below its on-center position and suddenly becomes effective to finally move the contacts into engagement rapidly.

With the parts of the circuit breaker at their normal positions illustrated in Fig. 1, it will be apparent that when upon a predetermined overload the circuit breaker operates to open the circuit, the upper end of casing 75 being unrestrained, solenoid member 76 will be moved upwardly together very rapidly, since shunting lever 86 is not in a position to resist movement of the casing, and consequently the initial circuit-opening operation of the breaker will occur substantially instantaneously as hereinbefore described. During such an initial fast circuit-opening operation it is apparent that contact rod 44 and the parts which move with this rod will be moving at a relatively high speed.

As solenoid core 76 and casing 75 move upwardly on such a first circuit-opening operation, collar 85 will be carried upwardly, and will thus carry the free end of pawl lever 95 upwardly with it to move pawl member 96 into engagement with the upper one of flanges 92 on integrating piston 89, and carry the piston upwardly a predetermined distance throughout opening movement of casing 75. Integrating piston 89 is not, however, carried upwardly a distance sufficient to have cam surface 109 engage lever 101, so that the magnetic shunting lever 86 remains in the position shown.

When the breaker recloses following such a first fast circuit-interrupting operation, such reclosure will also occur extremely rapidly, because there is no dashpot action due to the fact that the casing 75 moves freely in the sleeve 74, and the core 76 does not move relative to the casing 75 during such opening. Accordingly, the first opening and reclosing of the circuit breaker contacts will both occur substantially instantaneously with but little time delay interposed, due to the slight drag of casing 75 in displacing the oil through which it moves. During reclosing of the breaker at the first time, integrating piston 89 is left at the position to which it was advanced, since pawl member 96 is free to disengage the circular flanges 92, and if the breaker remains closed, integrator piston 89 will slowly reset to the position shown in Fig. 1, this resetting movement being relatively slow due to the necessity of displacing liquid drawn into the lower end of cylinder 88 by advancement of piston 89 during the opening operation, past the relatively small clearance between cylinder 88 and piston 89. This means, of course, that if an overload appears on the circuit at a later time, the breaker contacts will then be substantially instantaneously opened and closed in the manner described above.

If the breaker immediately reopens after a first opening and reclosing operation, pawl member 96 this time will engage the next lower circular flange 92 on the integrator piston 89, so that the integrator piston is moved further upward. Inasmuch as the cam surface 100 of the integrator piston 89 does not actuate lever 101 sufficiently to appreciably depress the magnetic shunt 85 to a point where it will be held down by leakage flux from the coil 24, until toward the end of its upward movement, this second closely successive circuit-opening operation will, like the first, occur substan-
tially instantaneously, with no delay due to dashpot action of cylinders 74, 77, and 78, and core 76. Springs 102 permit the lever 101 to be withdrawn by the cam surface 100 while the shrinking lever 86 is held in an upward position by the casing 75. On the succeeding reclosing operation, the casing 75 and core 74 will return freely to the position shown, so that this reclosing operation will not be delayed. This second reclosing operation will result in leaving piston 89 at the further advanced position described above, from which it eventually will rest in the manner previously described if the breaker remains closed, so that an overload appearing on the circuit at a later time will result in the breaker operating in the manner described above for the first and second closing time-delaying circuit-opening and closing operation. However, in the event the overload continues after the second closely succeeding circuit-opening and closing operations, the breaker will again open, and this time the opening operation will be delayed, since the magnetic shunting lever 86 is now depressed against the spacer 103 by lever 101. When the coil 24 is energized, the shrinking lever 86 is now held down by magnetic leakage flux from the coil, particularly across the groove 23, and prevents upward movement of the casing 75. The core 76 thereupon slowly moves upwardly in the casing against the dashpot action of the fluid therein and the reset spring 81. When the core reaches some advanced position of travel in which the air gap between it and the upper plate 20 is sufficiently reduced, the core and casing 75 will at first move together, the casing acting to force the magnetic shunt away from the upper plate 20 and against the collar 35 to effect separation of the bridging contact 36 from the stationary contacts 26. The opening of the contacts is assisted by the spring 81, which is compressed and releases its stored energy by expanding and assisting in forcing the casing upward relative to the core, so long as current flows in the coil 24.

The reclosing operation of the breaker following the third opening will not be delayed, since the casing 75 returns freely to its original position as shown, with the core in it. The core is quickly reset in the casing, for the valve 83 acts to permit ready passage of fluid as the core is forced downwardly in the casing by the spring 81. Inasmuch as such third opening operation results in further advance of integrator piston 89 to a position where it still actuates the lever 101 in a clockwise direction against the action of spring 102 for biasing the magnetic shunt into time-delaying position, the breaker may then continue to open and reclose if the overload continues, with each opening being further delayed by the dashpot action of casing 76 in dashpot casing 75, until finally pawl member 96 advances integrator piston 89 an amount sufficient to cause the upper extension 99 thereof to engage extension 129 of toggle lever 110, and move this lever upwardly overcenter so that toggle spring 124 will maintain the contacts separated in the manner previously described. It is thus apparent that toggle levers 110 and 114 will be automatically moved upwardly overcenter to maintain the breaker contacts separated, only in response to a predetermined number of closely successive circuit-opening and closing operations, usually four such operations; however, in the event a lesser number of closely successive opening and closing operations occur, the integrating mechanism will reset and the breaker contacts will be automatically held open only when the aforesaid predetermined number of opening and closing operations occurs in close succession. Obviously, after the breaker contacts have been automatically actuated to a position where they are held open by toggle spring 124, they can be reclosed only by manual operation of toggle lever 114 in the manner previously described.

In the preferred sequence of operations leading to the breaker contacts being maintained in open circuit position mentioned above, that is, a sequence of four operations, it will be apparent that with the apparatus described above, the first two opening operations will occur substantially instantaneously in a clockwork manner and the second opening operation will be delayed with an inverse time-current characteristic due to the dashpot action of core 76 in dashpot casing 75. Moreover, the reclosing times in any such sequence of four closely successive opening and closing operations will all be substantially instantaneous closing operations being delayed only slightly by the action of casing 75 as it moves through the oil in the tank.

From the above description and the accompanying drawing, it will be apparent that we have provided a new and novel construction for automatic reclosing circuit breakers. By using a sealed time-delay dashpot structure, different fluids may be used therein for obtaining different time delays, regardless of the particular fluid used in the circuit breaker tank. The accuracy of the time-delay device may be improved as it may be manufactured as a separate integral element. By eliminating practically all dashpot action on the instantaneous operations, the speeds of such openings can be increased. The sealed unit is impervious to dirt and the like, and can be used with reclosing breakers of either the air or oil type.

Having described a preferred embodiment of the invention in accordance with the patent statutes, it is desired that this invention be not limited to this particular structure inasmuch as it will be apparent, particularly to persons skilled in the art that many modifications and changes may be made in this particular structure without departing from the broad spirit and scope of the invention. Accordingly, it is desired that the invention be interpreted as broadly as possible and that it be limited only as required by the prior art.

We claim as our invention:

1. In a circuit interrupter, separable contacts, electroresponsive means responsive to an overload on a circuit to cause separation of said contacts, said means including a movable core and a dashpot member movable relative to the core, means biasing said contacts to close following a separation, and magnetic means responsive to energization of the electroresponsive means by said overload restricting movement of said dashpot member to render the dashpot means effective to delay separation of said contacts.

2. An automatic reclosing circuit breaker comprising separable contacts, electroresponsive means including a movable core operable in response to an overload on a circuit to effect separation of said contacts, time-delay means having a part normally freely movable with the core to permit substantially instantaneous separation of said contacts and movable relative to the core, said time-delay means including a part actuated in response to said overload to engage and restrain said part of the time-delay means to render the delay means effective to delay movement of said core to effect separation of said contacts.

3. An automatic reclosing circuit breaker comprising separable contacts, means including a core movable in response to an overload on a circuit to effect separation of said contacts, means operable to automatically close said contacts, and means including a magnetic element actuated during a circuit-opening and closing operation to engage and prevent movement of said member, said magnetic element being activated in response to an overload so as to render said delay means effective only after reclosure of said contacts to delay the next circuit-opening operation.

4. In an automatic reclosing circuit breaker, separable contacts, means including a movable core automatically
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responsive to overloads on a circuit for causing separation of said contacts, means responsive to a circuit-interrupting operation to automatically close said contacts, and normally ineffective time-delay means normally movable with said core, and means including a normally ineffective cam and a lever operated thereby actuated during a circuit-opening and closing operation and a magnetic member operable in response to an overload to prevent movement of said means movable with said core and render said time-delay means effective only after retraction of the contacts to delay the next closely succeeding circuit-opening operation, said last-mentioned means being disposed to reset to a normally ineffective position upon the lapse of a predetermined time after a circuit-opening and closing operation without a subsequent circuit-opening operation.

3. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means including a core movable in response to an overload to effect separation of said contacts, means automatically closing said contacts following a separation, time-delay means having a movable dashpot casing disposed about and biased relative to said core, and means operative to restrict movement of said dashpot casing and delay movement of said core in response to a particular number of separations of said contacts.

6. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means including a movable core member operable in response to an overload on a circuit to interrupt said circuit by separating said contacts, means automatically closing said contacts after a circuit-interrupting operation, time-delay means having a movable casing in which the core moves with a dashpot action and which normally moves with the core and the electroresponsive means, and magnetic means having a releasable part operable by magnetic flux from the electroresponsive means to engage and to substantially limit movement of said casing to utilize the dashpot action of the core in the casing to delay separation of said contacts after a predetermined number of operations of the electroresponsive means.

7. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means including a movable core responsive to an overload on a circuit to effect separation of said contacts, means biasing said contacts to close following a separation, normally ineffective time-delay means having a movable element with a motion-delays connection with the movable core, and magnetic means having a part actuated by magnetic flux from the electroresponsive means operable during operation of said electroresponsive means to engage and restrict movement of said element and render the delay means effective to delay movement of said core.

8. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means including a core of magnetic material operable in response to an overload current in a circuit to effect separation of said contacts and interrupt said circuit, said contacts being biased to reclose following such a separation, time-delay means having an element normally freely movable with said core, said element being disposed in motion-retarding relation with said core for relative motion of said core and element, and magnetic means operable in response to energization of said electroresponsive means a predetermined number of times to engage and impede movement of said element thereby permitting only delayed movement of said core.

9. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means responsive to an overload on a circuit to effect separation of said contacts, said electroresponsive means including a movable magnetic core and said contacts being biased to reclose, time-delay means having a member disposed in delayed motion relation with respect to the core and normally movable with said core, normally ineffective magnetic means operable to an operating position to engage and prevent movement of said member during an overload only, and means including a member actuated in response to a predetermined number of closely succeeding contact-separating operations to bias the aforementioned means to a position.

10. An automatic reclosing circuit breaker comprising, separable contacts, means biasing said contacts together, electroresponsive means including a movable core operable in response to an overload on a circuit to effect separation of said contacts to interrupt said circuit, normally ineffective time-delay means having a movable fluid container in which said core is movably disposed, said container being normally movable with the core in response to movement of said core for effecting separation of said contacts, and magnetic means operable in response to leakage flux from said electroresponsive means to engage and prevent movement of the container so as to render the time-delay means effective only until the core moves relative thereto in the container a predetermined amount.

11. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means having a movable core operable in response to an overload on a circuit to effect separation of said contacts to interrupt said circuit, time-delay means including an elongated longitudinally movable container in which said core is movably disposed, said core providing a relatively snug fit in said container and said container having therein a fluid which the core must displace as it moves there-through, means biasing the core relative to the container, magnetic means operable in response to an overload to engage and prevent movement of the container until the core moves relative thereto a sufficient distance to increase the force it exerts to overcome the effect of said magnetic means, biasing means normally rendering the magnetic means ineffective, and means including counting means operable in response to a predetermined number of closely succeeding circuit interruptions to actuate and render the magnetic means effective when said number of closely succeeding circuit interruptions have occurred.

12. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means including a core movable in response to an overload to effect separation of said contacts, said contacts being biased to reclose following separation, time-delay means including a casing for said core movable with said core and movable relative to the core with a dashpot action, and means operable in response to magnetic flux from the electroresponsive means to engage and prevent movement of said casing of said time delay means to delay movement of said core.

13. An automatic circuit breaker comprising, separable contacts, electroresponsive means including a magnetic core movable in response to an overload to effect separation of said contacts, normally ineffective time delay means movable relative to the core with a delayed action, means operable to engage and limit movement of said time delay means, and counting means having a predetermined advanced in response to a predetermined number of closely successive operations of said core for actuating said limiting means to make said limiting means effective and locking said contacts separated on different ones of said core operations.

14. An automatic reclosing circuit breaker comprising, separable contacts, electroresponsive means including a magnetic core movable in response to an overload to effect separation of said contacts, means biasing said contacts to reclose after separation, normally ineffective time delay means having a movable dashpot, a member movable with respect to said core with a dashpot action and normally biased relative to said core, normally ineffective magnetic means operable to engage and restrain movement of said member to render said time delay
means effective during an overload, and counting means having a part advanced in response to a predetermined number of circuit interruptions to effect operation of the restraining means to render it effective.

15. An automatic reclosing circuit breaker comprising, 5 separable contacts, electroresponsive means including a magnetic core operable in response to an overload to effect separation of said contacts, means reclosing said contacts following separation, movable dashpot means normally ineffective to delay movement of said core, 10 normally inoperative magnetic means operable to engage and restrain movement of the dashpot means during an overload only, and counting means operable in response to a predetermined number of closely successive contact separating operations of said core to actuate and render 15 the magnetic means operable.

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