June 20, 1944. J. M. WALLACE 2,352,048

CIRCUIT INTERRUPTER

Filed Jan. 16, 1941 2 Sheets-Sheet 1

Fig. 1.

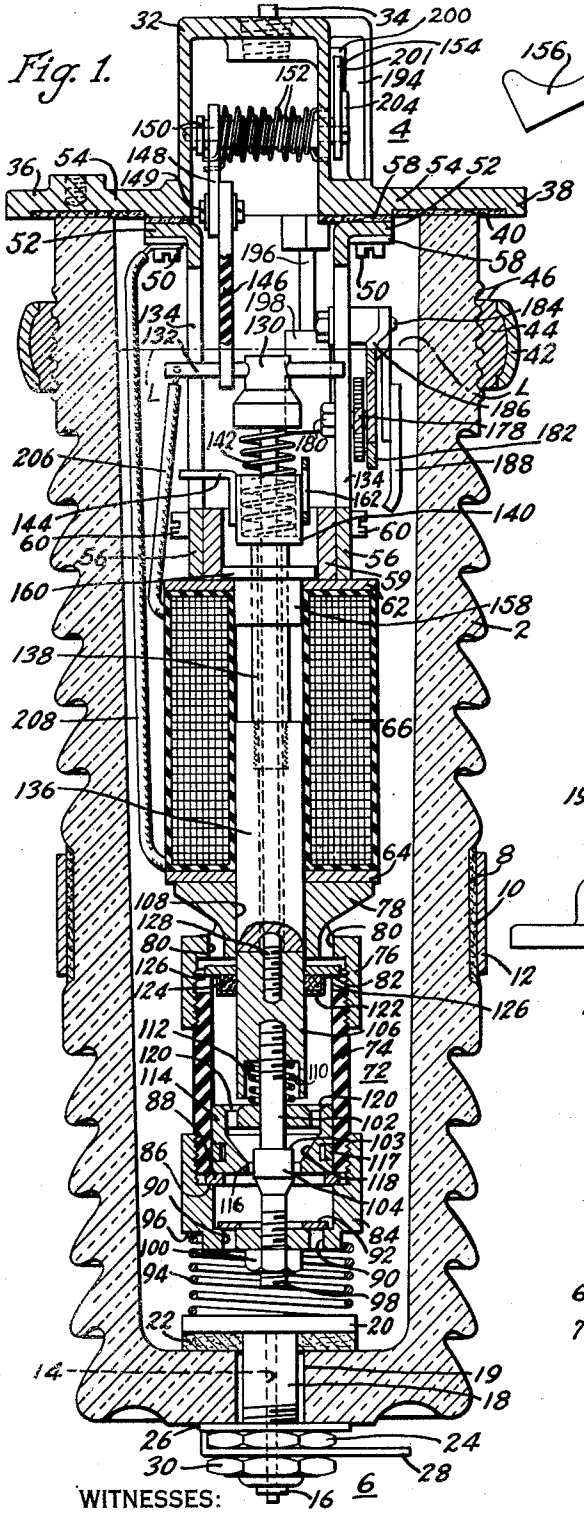


Fig. 2.

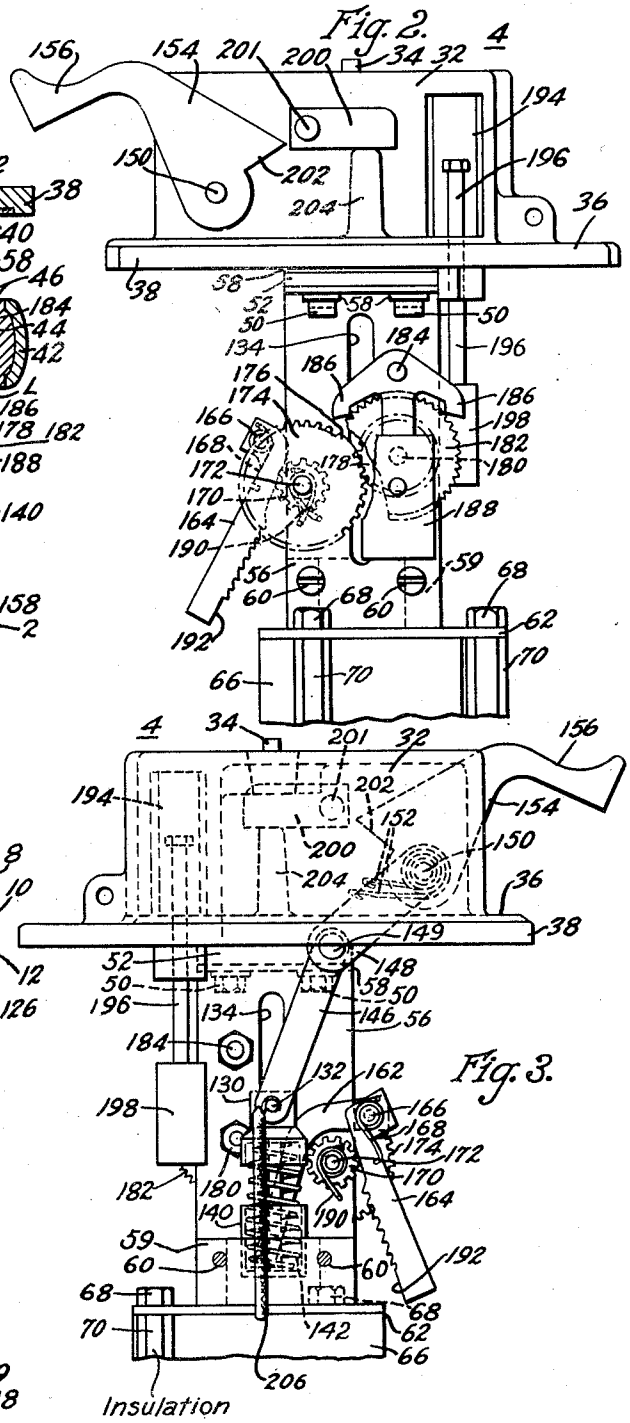



Fig. 3.

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CIRCUIT INTERRUPTER

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Fig. 4.

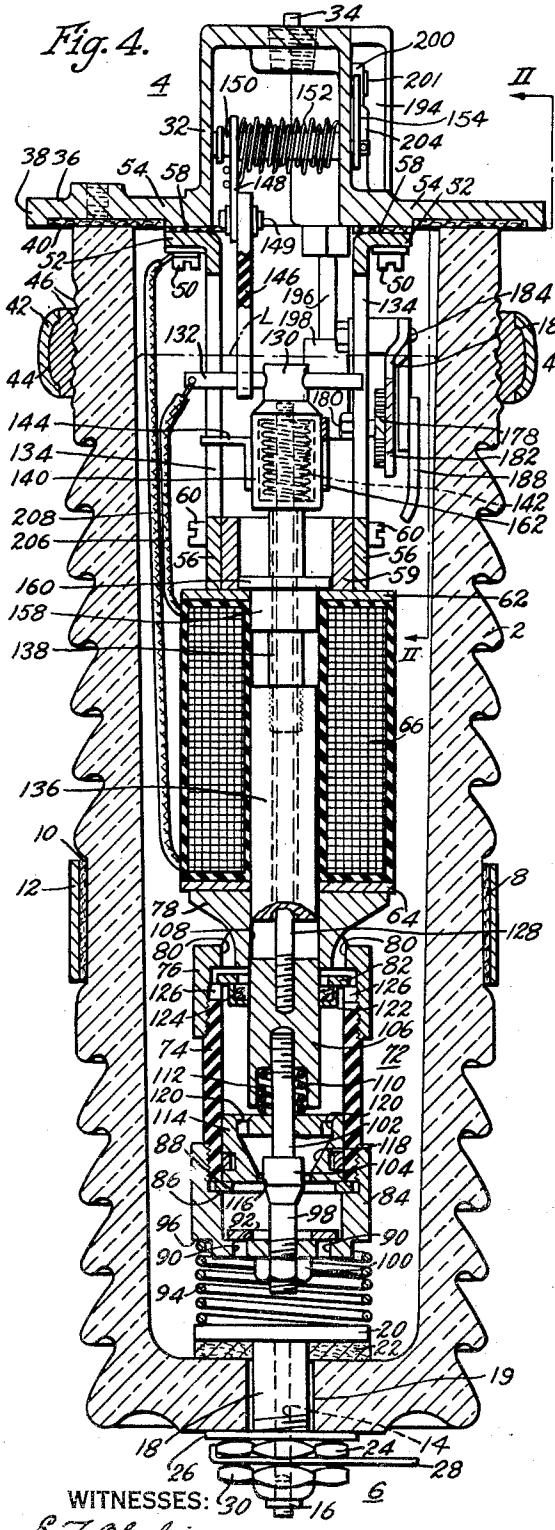
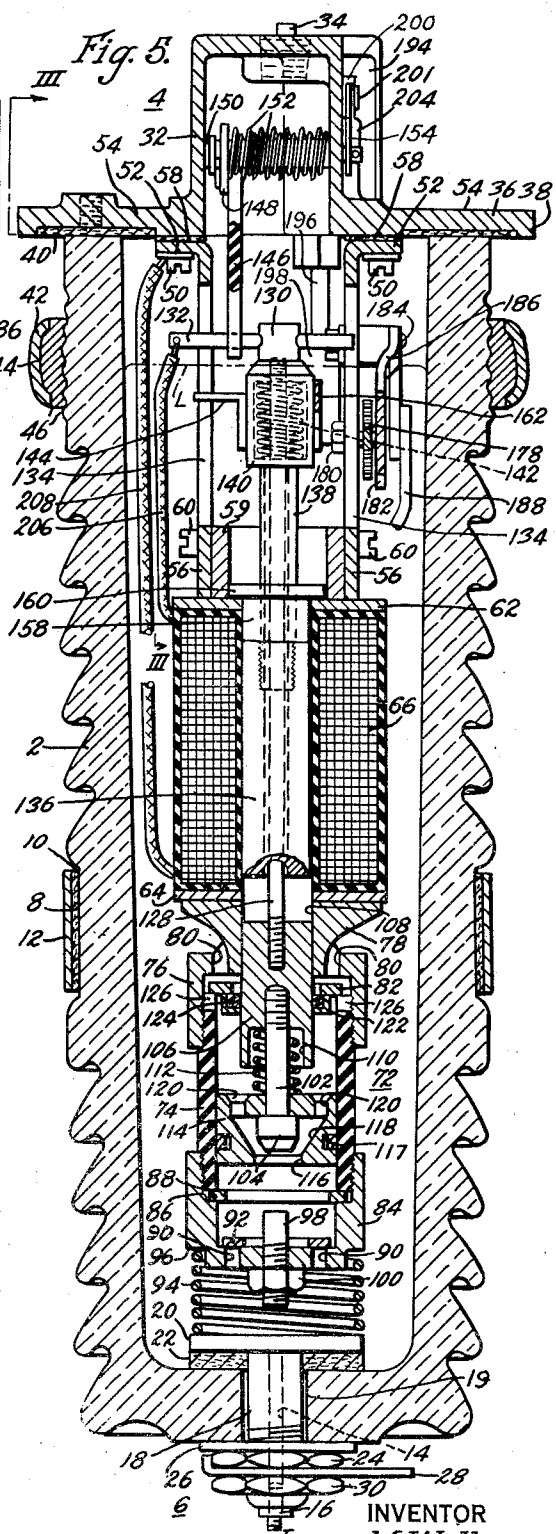


Fig. 5.



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# UNITED STATES PATENT OFFICE

2,352,048

## CIRCUIT INTERRUPTER

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Application January 16, 1941, Serial No. 374,684

39 Claims. (Cl. 200—89)

This invention relates generally to circuit interrupters, and more specifically to circuit breaker constructions.

Although this invention will be herein specifically disclosed in connection with one form of automatic reclosing liquid breaker, wherein it has certain specific novel cooperation providing new and useful results, it will be apparent that the invention is also useful in other types of circuit breakers.

In circuit breakers of the automatic reclosing type, it is highly desirable to provide for a definite time delay between the automatic opening and reclosing of the breaker contacts. In the past some current responsive means has generally been employed to automatically separate the breaker contacts, and complete separation of the contacts could be accomplished by fluid pressure generated by the arc. Obviously, in such breakers the amount of separation of the contacts may vary with the current interrupted, and where the reclosing time is dependent upon the contact separation, this will vary, and may at low current values, produce an objectionable fluttering of the contacts.

Accordingly one object of this invention is to provide a novel circuit breaker of the type described which will have a substantially constant time delay period between the automatic opening and reclosure of its contacts irrespective of the current interrupted.

Another object of this invention is to provide in a circuit breaker of the type described, an arrangement of parts whereby the means for delaying automatic reclosure of the breaker contacts is conditioned substantially entirely by the electroresponsive means for separating the contacts, but before separation thereof.

Another object of this invention is to provide in a circuit breaker of the type described, novel arc extinguishing means operable to aid in extinguishing the arc drawn following predetermined contact separation.

Another object of this invention is to provide novel fluid directing means for a circuit interrupter which is adapted to open the circuit in an insulating fluid.

Another object of this invention is to provide in a circuit breaker of the type described, novel time delay means for controlling a circuit reclosing operation, and which is operative in response to a predetermined number of successive circuit interrupting operations to lock the contacts open.

Another object of this invention is to provide a novel circuit breaker construction which is relatively compact in form yet efficient in operation and economical to manufacture.

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

Figure 1 is a substantially central sectional view of a circuit interrupter embodying this invention.

Fig. 2 is a partial elevational view of the interrupter operating mechanism with the casing removed.

Fig. 3 is a partial elevational view of the opposite side of the mechanism shown in Fig. 2, with one of the supports therefor removed.

Fig. 4 is a view similar to Fig. 1, but illustrating the interrupter at an initial stage in a circuit interrupting operation, and

Fig. 5 is also a view like Fig. 1 but showing the interrupter at a succeeding stage in the interrupting operation.

Referring to the drawings wherein there is illustrated a preferred form of the invention in the form of a circuit breaker contained in an insulating tubular casing 2, which may be of any desired insulating material such as porcelain, glass or the like. The casing 2 has a closed bottom and an open top. The open top is provided with an upper terminal cover assembly 4, and the closed bottom of the casing is provided with a lower terminal assembly 6, and an intermediate portion of the casing has a substantially cylindrical wall portion 8 upon which is mounted a cushioning sleeve 10 of rubber, fiber or the like, and a supporting bracket 12 is adapted to be secured thereto for supporting the breaker in operative position.

The lower terminal assembly 6 is mounted at the closed bottom portion of insulating casing 2 by means of a bolt 18, extending through an aperture 19 in the closed end of casing 2, and the bolt is provided with a large disk-like head portion 20 positioned within the casing 2, with packing material 22 interposed between the head 20 and the adjacent inner surface of the insulating casing 2. The bolt 18 and head 20 may be of any desired conducting material such, for example, as copper or a copper alloy such as brass, and the packing material 22 is preferably a material which is resistant to oil, such, for example, as cork, fiber or synthetic rubber. Bolt 18 has a bore 14 therethrough, the outer end of which is closed by a threaded plug 16 for the purpose of draining casing 2 when desired. The bolt 18 is secured in po-

sition by a nut 24 drawn up on the bolt against a washer 26 positioned between the nut 24 and the outer wall of the casing 2. A terminal strap 28 may be also secured to the bolt 18, as by means of a second nut 30 as shown.

The upper terminal assembly 4 is in the form of a cover for the open end of casing 2, which not only acts as a cap or cover for the casing, but, as will be hereinafter more fully explained, also acts as a support for the circuit interrupter proper and its operating mechanism, when in operative position within the casing 2, with the cover secured over the open end thereof. It will be observed that the cover 32 is provided with a transversely extending relatively hollow portion for the reception of certain parts of the circuit breaker operating mechanism, and the top wall of which is provided with a threaded aperture for the reception of a correspondingly threaded filler plug 34 so that the supply of arc extinguishing fluid within casing 2 may be renewed when necessary. Cover 32 includes a peripheral flange portion 36 adapted to seat on the upper end walls of casing 2, and this flange has at its outer edge a downwardly turned lip portion 38, to aid in properly positioning the cover on casing 2. Packing material 40 is interposed between the cover and casing 2, and this material is preferably of a composition like the packing material 22. Cover 32 is secured to the casing by means of a support 42 fixedly mounted on the outside of casing 2. The support 42 is in the form of an annular ring which is substantially channel-shaped in cross-section with the channel facing the outer surface of casing 2. The annular support 42 is secured to casing 2 by cast metal or the like 44 which is poured in between support 42 and the outer casing wall so as to enter within the channel of support 42, and between corrugations 46 provided on the outer surface of the casing to securely anchor the support 42 thereto. Cover 32 is preferably secured to the support 42 by bolts extending through a plurality of spaced ears (not shown) integral with cover 32 and support 42.

The insulating casing 2 may be of any desired shape and cross-section, preferably circular as shown, so that the hollow portion of cover 32 previously described, extends substantially diametrically of the casing, and so that segmental portions of cover flange 36 extend inwardly over the open end of the casing as shown at 54. Secured to these segmental portions 54 of cover flange 36, are spaced supporting plates 56 having angularly bent ends 52, insulatingly secured to the segments 54 of cover flange 36, as, for example, by machine screws 50, or the like. To insulate supporting plates 56 from the cover, insulating washers 58 are preferably interposed between the screws, supporting plates and cover, and the screws themselves may be provided with insulating bushings. The insulating washers 58 and bushings may be of any desired insulating material such as fiber or a synthetic resin material. As shown, the supporting plates 56 extend substantially parallelly downwardly in tubular insulating casing 2, and the lower ends thereof are secured to and maintained in spaced relation by a spacer block 59, for example, as by screws 60.

A solenoid coil supporting plate 62 is secured to the supporting block 59 in any desired manner, for example, as by welding or the like, for cooperation with a spaced supporting plate 64 to support therebetween a solenoid coil 66. The supporting plates 62 and 64 are preferably secured in spaced relation against the ends of solenoid coil 66 by spaced through bolts 68 (Figs. 2 and 3) passing through ears formed integral with the supporting plates. The through bolts 68 may have spacing sleeves 70 provided thereon intermediate plates 62 and 64, to prevent drawing up the bolts too tightly on the solenoid coil.

Circuit interrupting means 72 is preferably secured to the lower supporting plate 64 as shown on the drawings, and this interrupting means includes an interrupting chamber formed by a tube 74 of insulation material such, for example, as fiber or the like, and having an upper end tubular fitting 76 threadedly engaged with the upper end of the tube. The upper tubular fitting 76 is provided with a reduced intermediate portion, and an outwardly flared supporting portion 78 adapted to engage and be secured to lower solenoid coil supporting plate 64, for example, as by welding or the like. As shown, the tubular fitting 76 is provided with a plurality of circumferentially spaced outlet passages 80 for connecting the interior of insulating tube 74 with the interior of casing 2 at a point adjacent the reduced section of tubular fitting 78. These outlet passages 80 are controlled by a disk valve member 82, positioned at the inner ends of the passages 80 in a manner to be hereinafter more fully described.

Interrupter casing 74 is provided at the outer or lower end thereof with an end cap structure 84 threadedly engaged with the lower end of the tube. The lower cap structure 84 is provided adjacent the threaded portion thereof with a shoulder 86 for clamping against the adjacent end of insulating tube 74, an annular stop ring 88 for limiting movement of a liquid director 114. The bottom wall of cap 84 is provided with a plurality of circumferentially spaced inlet passages 90 controlled by a check valve plate 92, so that liquid may be admitted from casing 2 into insulating tube 74, whenever the pressure in the casing exceeds that within insulating tube 74. The outer end of the end cap 84 is somewhat reduced in section to provide a shoulder 96, on which is seated one end of a coil compression spring 94 the other end of which bears against head 20 of terminal bolt 18. Spring 94 is preferably of a resilient conducting material. The end wall of interrupter chamber end cap 84, is provided with a substantially central threaded aperture to receive a threaded fixed contact member 98, which may be locked in an adjusted position, for example, as by a lock nut 100.

The movable contact structure provided in interrupter casing 72, includes a relatively short contact rod 102 having an enlarged contact portion 104 tapered at the outer end thereof for engagement with fixed contact 98. The short contact rod 102 is threaded into a correspondingly threaded bore in a contact supporting rod 106 of relatively large diameter, slidably mounted in a substantially central bore 108, provided in the tubular fitting 76 for the upper end of interrupter casing 72. The lower end of contact supporting rod 106 is provided with a countersunk bore 110 for the reception of one end of a coil compression spring 112, which is adapted to seat on the liquid director 114.

The liquid director 114, as shown, is substantially cylindrical in form with a hollow central portion, provided with an enlarged outlet passage 116 concentric with the enlarged portion 104 of contact rod 102. From the outlet passage 116 the interior of liquid director 114 flares outwardly as at 118, to communicate adjacent the periphery thereof with a plurality of spaced inlet

passages 120, which are positioned on the upper end wall of the liquid director to be unobstructed by the enlarged supporting rod 106. The upper wall of the liquid director is also provided with a substantially central aperture closely, slidably fitting on contact rod 102, to provide for a lost motion between the liquid director and contact rod.

As previously stated, a valve plate 82 is provided at the upper end of the interrupter chamber for controlling outlet passages 80. This valve plate 82 is preferably provided with an integral, angular flange 122 forming with the valve plate an annular groove chamber for the reception of packing material 124, to frictionally relate the valve plate to contact supporting rod 106. The upper end of insulating tube 74 of the interrupting chamber is preferably notched at 126, so that the valve plate 82 cannot operate to close the upper end of insulating tube 74, when in a lower position.

In the operation of the parts thus far described, and referring to Fig. 1 of the drawings, it will be seen that because of the lost motion connection between liquid director 114 and contact rod 102, that in the closed position of contacts 104 and 98, spring 112 will be compressed and the liquid director 114 will be maintained against stop ring 88, with the outlet passage 116 thereof positioned substantially above the outer end of contact rod 102. Now, upon separation of contacts 98 and 104, that is, assuming contact 104 to be moved upwardly in the interrupting chamber, it is apparent that the contacts will separate, and contact rod 102 will move a distance corresponding to the distance between the upper wall of the liquid director and shoulder 103, on the contact rod, without causing any movement of the liquid director. As soon as the contacts separate, an arc will be drawn and the fluid pressure generated by the arc due to decomposition of the arc extinguishing fluid, will cause check valve plate 92 to be seated on and close inlet passages 90 leading to the interrupter chamber, and furthermore upward movement of rod 106 will carry valve plate 82 upwardly and close off the outlet passages 80. As soon, therefore, as the contacts separate and a pressure is built up in the interrupter casing 72, the casing automatically seals itself so that the pressure is then operative to aid in separating the contacts by exerting a force on the contact supporting rod 106, to move it and the contact 104 outwardly relative to the interrupter chamber in a piston-like manner. It should also be noted that no attempt is made to move the liquid director to force streams of arc extinguishing liquid into the arc path, until an arc of predetermined length has been established. As soon as shoulder 103 on the contact rod engages the upper end wall of the liquid director 114, the liquid director is moved with the contact rod to cause a flow of liquid into the inlet passages 120 thereof, and converging to outlet passage 116, which, because of the lost motion described above, between the liquid director and contact, will now be positioned adjacent the tapered end portion of the enlarged end 104 of the contact rod to direct the liquid at an angle through the arc path as shown in Fig. 5. It should be noted that the liquid director 114 closely slidably fits insulating tube 74 of the interrupting chamber, and is even provided with a piston ring 117 fitting into a slot formed in the outer surface of the liquid director, so that when the director is moved upwardly all of the liquid displaced above the director is forced into and through the arc path. This construction of liquid director forms a particularly efficient method of directing displaced liquid into and through the arc path, and the lost motion connection with respect to the moving contact provides a structure where it is unnecessary to perform any work in circulating liquid through the arc until an arc of optimum length has been established.

As soon as the contacts have separated sufficiently to extinguish the arc formed, the contacts may be reclosed. As soon as contact supporting rod 106 starts its inward movement with respect to interrupter chamber 72, it carries valve plate 82 inwardly because of the frictional connection 124 therebetween, to open outlet passages 80 and permit any gases to exhaust from the upper end of the interrupter chamber. This exhaust of gases is aided by flow of fresh liquid from casing 2 under the force of gravity to unseat check valve 92 and flow into inlet passages 90, to provide a supply of clean, fresh arc extinguishing liquid at the point where it is most needed, that is, where the contacts actually separate. Continued movement of the contact into interrupting chamber 72, first causes engagement of liquid director 114 with stop ring 88, after which spring 112 is compressed until contact portion 104 engages with the fixed contact 98.

The movable contact supporting rod 106 is adapted to be actuated by the elongated contact rod 128 of relatively small diameter, which is secured to rod 106 by having the lower end thereof threaded into a bore in the upper end of contact supporting rod 106. Elongated contact rod 128 extends upwardly through the center of solenoid coil 66 to a position adjacent cover 32, and has secured to the upper end thereof, in any desired manner, an inverted cup-shaped spring supporting structure 130. The spring supporting structure 130 may be secured to elongated rod 128, for example, as by a transverse guide pin 132 extending through the cup-shaped support 130, and rigidly secured to the upper end of the rod 128, for example, as by welding or the like. Transverse guide pin 132 is preferably of sufficient extent so that the opposite ends thereof may be received in guide slots 134 provided in the supporting plates 56. This is for the purpose of guiding the upper end of contact rod 128 in its movement, and for defining the limits of this movement and preventing rotation of the rod. Adjacent contact supporting rod 106, a solenoid core member 136, of any desired magnetic material, such for example as soft iron or the like, is slidably mounted on elongated rod 128, and has the upper end thereof provided with a threaded bore for securement to the threaded lower end of a connecting sleeve 138, also slidably mounted on connecting rod 128, and supports a cup-shaped spring support 140 complementary with respect to inverted cup-shaped support 130 on the upper end of contact rod 128. A coil compression spring 142 is adapted to have the opposite ends thereof seated in cup-shaped supports 130 and 140, respectively.

From the foregoing structure it can be seen that there is provided a lost motion connection between solenoid core 136 and the contact rod 128, and consequently movable contact 104. This connection is normally biased to one extremity of the relative movement, by the coil compression spring 142. There is secured to cup-shaped spring support 140 an angled guide bracket 144, one leg of

which extends into the guide slot 134 in one of the supporting plates 56, to prevent rotation of this spring support for a purpose which will become apparent.

The upper end of elongated contact rod 128, is coupled to a biasing and manually operable means, by a link 146 of insulating material, such as fiber or the like, pivotally mounted at one end on transverse guide pin 132, and pivotally mounted at the other end thereof to the outer end of a crank 148, for example, as by a pivot pin 149. Actuating crank 148 is supported on a shaft 150, mounted transversely of the hollow portion of cover 32, with one end of the shaft extending through one wall of the hollow portion to the exterior thereof. One or more coil springs 152, are adapted to be coiled about shaft 150, with one end of each spring anchored to the cover, and the other end thereof biasing crank 148 in a direction to move the contact rod 128, and consequently contact 104, into engagement with fixed contact 98. The outer end of operating shaft 150 has secured thereto a manually operable handle 154, provided with an angular extension 156, which may be engaged by a hook stick or the like.

The structure described above is for the purpose of automatically opening contacts 104 and 98 in response to predetermined circuit conditions, such, for example, as the occurrence of currents above the load rating of the breaker, and for thereafter automatically reclosing the contacts. Upon the occurrence of an overload in the circuit, solenoid coil 66 is operable to draw the core 136 upwardly into the coil, and the first portion of this movement is accomplished without any movement of movable contact 104, inasmuch as the contact is maintained in its closed position by coil springs 152 located in the cap, and because of the lost motion between solenoid core 136 and the movable contact. The first portion of the movement of the core is used merely in compressing the spring 142 between the core and contact rod. In other words, the core may move from the position shown in Fig. 1 to that shown in Fig. 4, wherein coil spring 142 is substantially entirely compressed without causing any movement of contact 104. Preferably, however, coil spring 142 is of such strength that prior to engagement of spring supports 130 and 140, the force exerted by spring 142 will be sufficient to overcome the bias exerted by operating springs 152 in the cover, to cause movement of contact 104 away from fixed contact 98. As soon as this occurs, an arc is formed in arc chamber 72 as previously described, and the pressure developed by the arc will aid in separating the contacts. Contact separation is also aided by the stressed spring 142, inasmuch as it will be observed that the force required to overcome the stress exerted by springs 152 will decrease as the contact rod moves upwardly, because the operating crank 148 will approach a position in which the component of the force exerted by connecting link 146 to strain coil springs 152 increases, that is, connecting link 146 and operating crank 148 approach a right angular relation. Separation of the contacts under the influence of solenoid coil 66 will be carried to the extent illustrated in Fig. 5 of the drawings. However, the movable contact may travel a further distance as explained above, by reason of the pressure exerted in interrupting chamber 72 and the stress exerted by compressed coil spring 142, and the lost motion connection between the solenoid core and contact supporting rod.

This overtravel of the movable contact beyond the point to which it is moved by the solenoid coil 66, may extend to the upper end of guide slot 134 formed in supporting plates 56. It will be noted that the upper end of the central bore through solenoid coil 66 is substantially closed by a closure plug 158, having a flange 160 adapted to seat on upper supporting plate 62. The plug 158 is of a magnetic material similar to movable core 136 and is adapted to complete the magnetic circuit through the center of coil 66 in cooperation with movable core 136. Closure plug 158 preferably is merely loosely fitted in the upper end of the bore through the coil, so that when the coil is energized sufficiently to draw movable core 136 into the coil, the closure plug 158 will be maintained in position and will attract the movable core 136 thereto. Obviously, the attraction of movable core 136 will cease when it engages closure plug 158 as shown in Fig. 5, and the contact rod may thereafter travel beyond the position shown in Fig. 5 and may even displace movable core 136 and core plug 158 upwardly, since such movement will be opposed only by the damping action of the magnetic field generated by coil 66. For a reason which will hereinafter become apparent, it is preferred that in any event the movable core 136 make a substantially full stroke under the influence of the magnetomotive force exerted by coil 66 through plug core 158, that is, to the position shown in Fig. 5 of the drawings, before the circuit is interrupted.

It will be noted that the cup-shaped spring support 140 on connecting sleeve 138, which in turn is secured to movable solenoid core 136, has secured thereto an angular shaped rack support 162, for pivotally supporting at the outer end thereof as at 166, a rack 164 having teeth formed along one edge thereof for cooperation with a pinion 170. As viewed in Figs. 2 and 3 of the drawings, the teeth on rack 164 are preferably inclined downwardly, and the rack is biased into engagement with pinion 170 by a spring 168 coiled about pivot 166, and having the respective ends thereof engaged with the rack and rack support, so that on upward movement of the rack it will slip over the teeth of pinion 170, but on downward movement of the rack it will drivingly engage pinion 170 to rotate the same. Pinion 170 is mounted on a shaft 172 extending across and rotatably mounted in supporting plates 56, and provided outside of one plate 56, with a gear 174 of larger diameter than pinion 170 also fixedly mounted on the shaft. The gear 174, as shown in Fig. 2, preferably has the teeth thereof interrupted to provide a solid portion 176 to limit rotation thereof to something less than 360° by engaging the teeth of the pinion meshing with gear 174. Shaft 172 is preferably biased for rotation in a clockwise direction as viewed in Fig. 2, by a spring 190 coiled about the shaft, and having the opposite ends thereof anchored, respectively, on pinion 170 and adjacent supporting plate 56. Gear 174 is adapted to mesh with a pinion 178 fixed to, or fixed on the same shaft 180, with a large escapement gear 182, which in turn is adapted to cooperate with an escapement member having spaced arms 186 adapted to alternately engage the teeth of escapement gear 182, and having a central depending arm to which is secured a weight 188, for damping movement of the escapement member. The escapement member is preferably pivoted to adjacent supporting plate 56, for example as by a pivot pin 184.

From the foregoing it is apparent that inasmuch as rack 164 is mounted on and movable with solenoid core 136, the rack will always be moved upwardly a minimum distance by the core, substantially that which the solenoid core 136 is moved under the influence of solenoid coil 66, that is, from the position shown in Fig. 1 to that shown in Fig. 5 of the drawings. This distance as previously explained is independent of movement of the contact rod, and insures engagement of rack 164 with pinion 170 of the escapement mechanism, each time the circuit breaker opens irrespective of the current value which is interrupted and the distance travelled by the movable contact. Thus it can be seen that each time the circuit is interrupted by solenoid 66 the teeth on rack 164 are raised a predetermined distance above pinion 170, so that as soon as the circuit is interrupted, and solenoid coil 66 deenergized, operating springs 152 are free to return the contact 104 into engagement with fixed contact 98. This movement, however, is delayed by engagement of rack 164 with pinion 170, which causes operation of the escapement mechanism until the end of the rack teeth is reached, whereupon springs 152 are free to quickly close contacts 98 and 104.

In a construction where the rack or other means for engagement with time delay closing mechanism, is mounted on the contact rod; at low current values it was possible that the rack or other time delay driving means might not even engage the time delay means, which would mean that the contacts would merely separate a slight amount and immediately close, causing a fluttering of the contacts and resultant burning thereof and deterioration of the arc extinguishing liquid. It is believed that it is clearly apparent from the foregoing that with the structure of this invention, wherein the rack 164 for driving the time delay means is mounted on the solenoid core, which is movable independently of the movable contact, a predetermined time delay between opening and reclosing of the contacts is positively insured, thereby clearly avoiding the possibility of obtaining any contact flutter with the resultant disadvantages thereof.

It will be noted that gear 174 of the escapement mechanism is normally maintained by spring 190 in the position shown in Fig. 2 of the drawings, by virtue of the spring bias causing engagement of the solid toothed portion 176 of the gear with pinion 178. Now assuming that the breaker contacts are opened as previously described; after interruption occurs and the contacts reclose, it is obvious that the rack 164 will rotate gear 174 in a counterclockwise direction, and move the solid portion 176 thereof a predetermined distance away from pinion 178. This distance is preferably somewhat less than 180° for a reason which will become apparent. Now, if the overload on the circuit has cleared when the contacts have reclosed, obviously spring 190 will move gear 174 in a clockwise direction, from the position to which it was advanced by gear 174, to its normal position shown in Fig. 2. This restoration of gear 174 will occur quite slowly because of the necessity of moving its escapement gear delayed by the escapement lever. However, in the event that the overload still remains on the circuit after the first reclosure of the contacts, they will immediately be reopened by solenoid coil 66, and before gear 174 has regained its normal position shown in Fig. 2, it will again be given an additional counterclockwise rotation by rack 164 in reclosing the contacts a second time. This will further advance the solid portion 176 of the gear, say, for example, to a position somewhat less than 360° from that shown in Fig. 2. This time the solid portion 176 will be advanced substantially into engagement with pinion 178. After the second reclosure of the contacts, in the event the fault has cleared, the gear 174 will be restored slowly to its normal position by spring 190. However, in the event the fault has not cleared after the second reclosure, the contacts will again be immediately reopened and a third reclosure will be blocked by engagement of solid portion 176 of gear 174 with pinion 178. From the foregoing, it is apparent that upon the occurrence of a permanent fault in the circuit, the breaker constituting this invention will be operable to interrupt the circuit a predetermined number of times, after which the contacts are locked in an open position.

Furthermore, each interruption of the circuit will be followed by a minimum predetermined time delay period before the contacts are reclosed, and in the event the fault clears upon reclosure of the contacts at any time prior to the predetermined number of reclosures, the lockout mechanism will be automatically reset so that if at any subsequent time a permanent fault occurs on the circuit, the breaker will be prepared to go through the same predetermined number of reclosures prior to locking the contacts thereof in the open circuit position.

After the breaker has operated automatically in response to a permanent fault to lock the contacts thereof in an open circuit position, the contacts may be reclosed by a manual operation, that is, by pulling operating handle 154 downwardly to raise the smooth portion 192 of rack 164 into engagement with pinion 170, and permit spring 190 to reset or move gear 174, in a clockwise direction, whereupon release of handle 154, will permit coil springs 152 to reclose the contacts in the manner already described.

As previously described, insulating casing 2 is adapted to be filled with an arc extinguishing liquid, such as, for example, oil up to the level indicated by the dot and dash line L. The hollow portion of cover 32 is preferably provided with a recess portion for receiving a sight glass 194 so that the oil level in the casing may be readily determined by observation, of the float rod 196, adapted to be visible through sight glass 194 when the oil is at a proper level. Float rod 196 is connected to a float member 198, which may be a sealed container or any other desired floating member. The cover is also provided with a locking member 200 pivotally mounted on the cover as at 201, and normally adapted to be positioned as shown in Fig. 2 on a support 204 integral with the hollow cover member. When it is desired to manually lock the circuit breaker contacts in an open position, for example, as when it is desired to work on the circuit, the operating handle 154 may be manually moved downwardly in a counterclockwise direction, and locking lever 200 may be pivoted to a position in which the free end thereof engages abutment 202, on operating lever 154, to lock it and the contacts in an open circuit position.

The electric circuit through the breaker extends from the lower terminal assembly 6 through conducting bolt 18, its enlarged head 20, coil compression spring 94 to end cap 84 of the interrupting chamber, fixed contact 98 to movable contact 104, movable contact support 106 and

elongated contact rod **128**, guide pin **132** and conductor **206** to solenoid coil **66**. The other terminal of solenoid coil **66** is connected to the breaker cover **32** by a conductor **208** secured to screw **50**. It can thus be seen that solenoid coil **66** is in series in the circuit through the breaker, and is designed so that for currents up to the rating of the interrupter, the electromagnetic force exerted thereby is insufficient to actuate movable core **136**, but on currents above this rating the core **136** will be drawn into the coil to open the contacts in the manner described above. It will also be obvious that opening the contacts and extinguishing the resultant arc within interrupter chamber **72**, will operate to deenergize solenoid coil **66** and permit springs **152** to reclose the contacts.

From the foregoing it is believed clearly apparent that there is herein disclosed a reclosing type of circuit breaker wherein a lost motion connection is provided, (1) between the current responsive contact opening means and the contacts themselves, and (2) between the movable contact and liquid directing means. This ensures a predetermined travel of the current responsive means each time an interrupting operation occurs, and the time delay reclosing means being responsive to the travel of the current responsive means, always provides a minimum predetermined time delay in reclosing the circuit breaker contacts. The lost motion connection between the movable contact and liquid director, insures optimum extinguishment of the arc, and quick initial opening of the contacts. This structure, together with a special solenoid construction, enables overtravel of the movable contact in its circuit opening movement beyond that to which it is moved by the current responsive means, to aid in extinguishing high current arcs. There is also herein disclosed novel means for permitting a predetermined number of closely successive reclosures of a circuit breaker upon the occurrence of a continuing fault in the circuit, after which the contacts are automatically locked in an open position, requiring a manual operation to restore the breaker to its normal operative condition. Any number of successive reclosures less than the predetermined number cannot effect a lockout of the breaker contacts, and the lockout mechanism is always restored, so that in the event of a continuing fault occurring thereafter, the breaker will still operate to reclose the circuit a required predetermined number of times automatically, prior to locking the contacts open. The circuit interrupter herein disclosed, together with all of its actuating and control mechanism, has the parts thereof assembled and arranged in a particular unitary construction supported from the cover for a liquid casing so as to be removable from the casing as a unit with the cover. Also, the breaker may be manually locked with its contacts in open circuit position when desired, and the operating handle **154** is available to serve as an indicator as to whether the breaker contacts are opened or closed.

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

I claim as my invention:

1. In an automatic reclosing circuit breaker, separable contacts, means biasing said contacts into engagement, current responsive means for separating said contacts while stressing said biasing means so that the latter is operative to automatically reclose said contacts when said current responsive means is not energized sufficiently to separate said contacts, a lost motion connection between said current responsive means and contacts, resilient means engaging said current responsive means and contacts so as to be stressed upon operation of said current responsive means to separate said contacts, and said resilient means being capable of being strained an amount greater than the amount of lost motion between said current responsive means and contacts.

2. In an automatic reclosing circuit breaker, separable contacts, means biasing said contacts into engagement, current responsive means for separating said contacts while stressing said biasing means so that the latter is operative to automatically reclose said contacts when said current responsive means is not energized sufficiently to separate said contacts, a lost motion connection between said current responsive means and contacts, and time delay means associated with said current responsive means so as to be actuated only by said current responsive means for delaying the action of said biasing means in moving said contacts into engagement.

3. In an automatic reclosing circuit breaker, a normally closed arcing chamber, separable contacts in said chamber, means biasing said contacts into engagement, current responsive means for separating said contacts, said contacts being mounted relative to said chamber in a manner to be further separated in response to pressure generated in said chamber by an arc, and a resilient lost motion connection between said current responsive means and contacts.

4. In an automatic reclosing circuit breaker, a normally closed arcing chamber, separable contacts in said chamber, means biasing said contacts into engagement, current responsive means for separating said contacts while stressing said biasing means so that the latter is operative to automatically reclose said contacts when said current responsive means is not energized sufficiently to separate said contacts, said contacts being mounted relative to said chamber in a manner to be further separated in response to pressure generated in said chamber by an arc, a lost motion connection between said current responsive means and contacts, and time delay means associated with said current responsive means for delaying the action of said biasing means in moving said contacts into engagement.

5. In an automatic reclosing circuit breaker, a slidably mounted contact rod having a contact portion adjacent one end thereof, a cooperating contact adapted to be engaged by said contact portion, means biasing said rod in a direction to cause engagement of said contact portion and cooperating contact to automatically reclose said contact portion and cooperating contact following a circuit interrupting operation, means for moving said rod and contact portion in an opposite direction to open the circuit including a slidably mounted actuating member adapted to have limited sliding movement relative to said

rod, resilient means adapted to be stressed between said rod and member when said member is moved in said opposite direction, said resilient means when stressed being of sufficient strength to overcome said biasing means, and said biasing means associated with said rod in a manner such that it will exert less force as said rod moves in said opposite direction.

6. In an automatic reclosing circuit breaker, a slidably mounted contact rod having a contact portion adjacent one end thereof, a cooperating contact adapted to be engaged by said contact portion, means biasing said rod in a direction to cause engagement of said contact portion and cooperating contact to automatically reclose said contact portion and cooperating contact following a circuit interrupting operation, means for moving said rod and contact portion in an opposite direction to open the circuit including a slidably mounted actuating member adapted to have limited sliding movement relative to said rod, resilient means adapted to be stressed between said rod and member when said member is moved in said opposite direction, and said biasing means associated with said rod in a manner such that it will exert less force as said rod moves in said opposite direction.

7. In an automatic reclosing circuit breaker, cooperating contact means, one of which is movable into and out of engagement with respect to the other of said contact means, resilient means biasing said movable contact means into engagement with the other of said cooperating contact means to automatically reclose said contact portion and cooperating contact following a circuit interrupting operation, means for separating said contact means including an actuating member movable relative to said movable contact means, resilient means adapted to be stressed between said actuating member and movable contact means to open the circuit, and said second mentioned resilient means being of such strength as to overcome the resistance of said first mentioned resilient means after it has been stressed a predetermined amount.

8. In an automatic reclosing circuit breaker, a slidably mounted contact rod having a contact portion adjacent one end thereof, a cooperating contact adapted to be engaged by said contact portion, means biasing said rod in a direction to cause engagement of said contact portion and cooperating contact to automatically reclose said contact portion and cooperating contact following a circuit interrupting operation, means for moving said rod and contact portion in an opposite direction to open the circuit including a slidably mounted actuating member adapted to have limited sliding movement relative to said rod, resilient means adapted to be stressed between said rod and member when said member is moved in said opposite direction, and time delay means associated only with said member for delaying the action of said biasing means in moving said contact portion into engagement with said cooperating contact.

9. In a circuit breaker, separable contacts, means biasing said contacts into engagement, current responsive means for separating said contacts, a lost motion connection between said current responsive means and contacts, time delay means associated with said current responsive means for delaying the action of said biasing means in moving said contacts into engagement, said time delay means having gear means associated therewith, and said current responsive means having a member movable therewith adapted to automatically drivingly engage said gear means at least during the first portion of its movement in a direction to close said contacts, and to become automatically disengaged prior to the end of said movement, said gear means including a gear having at least one wide tooth whereby said gear may be advanced a predetermined amount in one direction in response to a circuit closing operation of said contacts, means associated with said time delay means for biasing said gear for movement in an opposite direction, whereby in response to a plurality of closely successive reclosures of said contacts, said solid tooth portion will prevent rotation of said gear and maintain said contacts in an open circuit position.

10. In a reclosing circuit breaker, separable contacts, means for biasing said contacts into engagement, current responsive means for separating said contacts, time delay means associated with said current responsive means for delaying the action of said biasing means in moving said contacts into engagement, said time delay means having gear means associated therewith and said current responsive means having a member movable therewith adapted to automatically drivingly engage said gear means at least during the first portion of its movement in a direction to close said contacts and to become automatically disengaged prior to the end of said movement, said gear means including a gear having at least one wide tooth whereby said gear may be advanced a predetermined amount in one direction in response to a circuit closing operation of said contacts, means associated with said time delay means for biasing said gear for movement in an opposite direction, whereby in response to a plurality of closely successive reclosures of said contacts, said solid tooth portion will prevent rotation of said gear and maintain said contacts in an open circuit position.

11. In a circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid inlet and outlet passages for said chamber, valves for controlling said passages, means biasing said movable contact means into engagement with the other of said contact means, electro-responsive means for actuating said movable contact means out of engagement with said other contact means, and said contact supporting portion being associated with said outlet valve to open said valve in response to movement of said portion in a direction to close the circuit.

12. In a circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid directing means having a lost motion connection with respect to said movable contact means for directing a stream of liquid into the path of the arc, resilient means for biasing said directing means towards the other of said contact means, means biasing said movable contact means into engagement with the other of said contact means, stop means positioned to engage said liquid director prior to engagement of said contact means during closing movement thereof, and electroresponsive means for actuating said movable contact means out of engagement with said other contact means,

whereby upon energization of said electroresponsive means said contacts separate and said liquid director is actuated successively with a time interval between the actuation of each.

13. In an automatic reclosing circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid directing means having a lost motion connection with respect to said movable contact means for directing a stream of liquid into the path of the arc, resilient means for biasing said directing means towards the other of said contact means, means biasing said movable contact means into engagement with the other of said contact means to automatically reclose said contact means following a circuit interrupting operation, stop means positioned to engage said liquid director prior to engagement of said contact means during closing movement thereof, electroresponsive means for actuating said movable contact means out of engagement with said other contact means, whereby upon energization of said electroresponsive means said contacts separate, and said liquid director is actuated successively with a time interval between the actuation of each, and said movable contact biasing means being of greater strength than said liquid director biasing means so as to maintain the latter in a stressed condition when said contact means are in engagement.

14. In an automatic reclosing circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid directing means having a lost motion connection with respect to said movable contact means for directing a stream of liquid into the path of the arc, said liquid directing means including an apertured piston-like member, means for preventing the passage of liquid between the outer side of said piston and the wall of said chamber, resilient means for biasing said directing means towards the other of said contact means to automatically reclose said contact means following a circuit interrupting operation, means biasing said movable contact means into engagement with the other of said contact means, stop means positioned to engage said liquid director prior to engagement of said contact means during closing movement thereof, and electroresponsive means for actuating said movable contact means out of engagement with said other contact means, whereby upon energization of said electroresponsive means said contacts separate and said liquid director is actuated successively with a time interval between the actuation of each.

15. In a circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid inlet and outlet passages for said chamber, valves for controlling said passages, and said contact supporting portion being associated with said outlet valve to open said valve in response to movement of said portion in a direction to close the circuit.

16. In a circuit interrupter, an elongated substantially closed arc chamber adapted to contain an arc extinguishing liquid, said arc chamber having a uniform tubular cross-section, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one end wall of said chamber, liquid directing means in the form of an apertured piston member slidably mounted in engagement with the tubular walls of said chamber, said liquid directing means having a lost motion connection with respect to said movable contact means for directing a stream of liquid into the path of the arc, resilient means for biasing said directing means towards the other of said contact means, whereby in a circuit interrupting operation said liquid directing means is not actuated until said contacts have separated a predetermined distance.

17. In a circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid directing means having a lost motion connection with respect to said movable contact means for directing a stream of liquid into the path of the arc, said liquid directing means including an apertured piston-like member, means for preventing the passage of liquid between the outer side of said piston and the wall of said chamber, and resilient means for biasing said directing means towards the other of said contact means, whereby in a circuit interrupting operation said liquid directing means is not actuated until said contacts have separated a predetermined distance.

18. In combination, a liquid container having an open end and a closed end, a terminal on said closed end of the container, supporting means adapted to be detachably secured to said container adjacent the open end thereof and including a second terminal, said supporting means adapted to extend into said container to a point spaced from the closed end of said container, circuit interrupting means including separable contacts supported adjacent the free end of said supporting means, said contacts connected to said terminals, respectively, with the connection to said first-mentioned terminal comprising a yieldable conducting means, solenoid means for actuating said contacts mounted intermediate the ends of said supporting means, and mechanism mounted adjacent the other end of said supporting means for controlling operation of said contacts, whereby said interrupting means, solenoid means, and mechanism are removable as a unit with said supporting means from the open end of said container.

19. In a circuit interrupter, a substantially closed arc chamber, separable contacts in said chamber, electromagnetic means for separating said contacts including a movable core member and a solenoid coil, said core member operatively associated with at least one of said contacts, said solenoid coil having a bore and adapted to attract said core member into one end thereof, relatively stationary core means for said coil including a loosely fitting closure for the other end of said bore, whereby said movable contacts are adapted to be separated a predetermined distance by said electromagnetic means and are free to separate a further distance by displacement of said closure under the influence of fluid pressure developed by the arc drawn.

20. In a circuit interrupter, a substantially closed arc chamber, separable contacts in said chamber, electromagnetic means for separating

said contacts including a movable core member and a solenoid coil, said core member having a resilient lost motion connection with at least one of said contacts, said solenoid coil having a bore and adapted to attract said core member into one end thereof while stressing said connection, relatively stationary core means for said coil including a loosely fitting closure for the other end of said bore, whereby said movable contacts are adapted to be separated a predetermined distance by said electromagnetic means and are free to separate a further distance by displacement of said closure under the influence of fluid pressure developed by the arc drawn and the force exerted by said stressed connection.

21. In a circuit interrupter, a closed arc chamber, contacts in said chamber at least one of which is movable into and out of engagement with the other, said movable contact being movably mounted through a wall of said chamber so that pressure developed by an arc in said chamber will act to bias said movable contact in a direction away from the other of said contacts, electro-responsive means for moving said movable contact a predetermined distance away from the other of said contacts, a lost motion connection between said electro-responsive means and movable contact, means biasing said movable contact into engagement with the other of said contacts to automatically reclose the circuit after a circuit interrupting operation, time delay means associated with said current responsive means for delaying reclosure of said contacts, and means flushing said arc chamber in response to reclosing movement of said movable contact following a circuit interrupting operation.

22. In an automatic reclosing circuit interrupter, a closed arc chamber, contacts in said chamber at least one of which is movable into and out of engagement with the other, said movable contact being movably mounted through a wall of said chamber so that pressure developed by an arc in said chamber will act to bias said movable contact in a direction away from the other of said contacts, electro-responsive means for moving said movable contact a predetermined distance away from the other of said contacts, a lost motion connection between said electro-responsive means and movable contact, means biasing said movable contact into engagement with the other of said contacts to automatically reclose the circuit after a circuit interrupting operation, time delay means associated with said current responsive means for delaying reclosure of said contacts, and means flushing said arc chamber in response to reclosing movement of said movable contact following a circuit interrupting operation including an outlet passage for said chamber controlled in response to movement of said movable contact.

23. In an automatic reclosing circuit interrupter, a closed arc chamber, contacts in said chamber at least one of which is movable into and out of engagement with the other, said movable contact being movably mounted through a wall of said chamber so that pressure developed by an arc in said chamber will act to bias said movable contact in a direction away from the other of said contacts, electro-responsive means for moving said movable contact a predetermined distance away from the other of said contacts, a lost motion connection between said electro-responsive means and movable contact, means biasing said movable contact into engagement with the other of said contacts to automatically reclose the circuit after a circuit interrupting operation, time delay means associated with said current responsive means for delaying reclosure of said contacts, and fluid directing means having a lost motion connection with said movable contact for directing a stream of fluid into the arc, whereby said electro-responsive means is effective to separate said movable contact a predetermined distance from the other of said contacts independently of said fluid directing means to quickly initially separate said contacts prior to movement of said fluid directing means.

24. In a circuit interrupter, a closed arc chamber, contacts in said chamber at least one of which is movable into and out of engagement with the other, said movable contact being movably mounted through a wall of said chamber so that pressure developed by an arc in said chamber will act to bias said movable contact in a direction away from the other of said contacts, electro-responsive means for moving said movable contact a predetermined distance away from the other of said contacts, a lost motion connection between said electro-responsive means and movable contact, means biasing said movable contact into engagement with the other of said contacts to automatically reclose the circuit after a circuit interrupting operation, time delay means associated with said current responsive means for delaying reclosure of said contacts, fluid directing means having a lost motion connection with said movable contact for directing a stream of fluid into the arc, whereby said electro-responsive means is effective to separate said movable contact a predetermined distance from the other of said contacts independently of said fluid directing means to quickly initially separate said contacts prior to movement of said fluid directing means, and means flushing said arc chamber in response to reclosing movement of said movable contact following a circuit interrupting operation.

25. In a circuit breaker, an arc chamber which is closed at least during a circuit interrupting operation, separable contacts mounted in said chamber in a manner to be urged apart by any pressure developed by an arc in said chamber, electroresponsive means for separating said contacts to draw an arc and having a lost motion connection therewith, resilient means opposing relative movement of the parts of said lost motion connection, whereby the pressure generated by the arc in said chamber in cooperation with said resilient means will be effective to further separate said contacts independent of said electroresponsive means.

26. In a circuit breaker, an arc chamber which is closed at least during a circuit interrupting operation, separable contacts mounted in said chamber in a manner to be urged apart by any pressure developed by an arc in said chamber, electroresponsive means for separating said contacts to draw an arc and having a lost motion connection therewith, resilient means opposing relative movement of the parts of said lost motion connection, the extent of lost motion of said connection being less than the amount said resilient means is capable of being strained, whereby upon a circuit interrupting operation said electroresponsive means is actuated first and moves relative to said contacts while storing energy in said resilient means until the limit of lost motion is arrived at, then said contacts

are separated and the pressure generated by the arc in said chamber in cooperation with said resilient means will be effective to further separate said contacts independent of said electroresponsive means.

27. In an automatic reclosing circuit interrupter, separable contacts which are separable different distances apart dependent upon the value of the current to be interrupted, means biasing said contacts into engagement, electroresponsive means having a predetermined minimum travel for at least initiating separation of said contacts while stressing said biasing means so that the latter is effective to automatically reclose said contacts when said electroresponsive means is not energized sufficiently to maintain said contacts separated, and means associated with said electroresponsive means for delaying reclosure of said contacts, whereby reclosure of said contacts will always be delayed a predetermined minimum time irrespective of the distance said contacts are separated on a circuit interrupting operation.

28. In an automatic reclosing circuit breaker, an arc chamber which is closed at least during a circuit interrupting operation, separable contacts mounted in said chamber in a manner to be urged apart by any pressure developed by an arc in said chamber, electroresponsive means for separating said contacts to draw an arc and having a lost motion connection therewith, resilient means opposing relative movement of the parts of said lost motion connection, whereby the pressure generated by the arc in said chamber in cooperation with said resilient means will be effective to further separate said contacts independent of said electroresponsive means, means biasing said contacts closed to automatically reclose said contacts following a circuit interrupting operation, and means associated with said electroresponsive means in response to a circuit interrupting operation for delaying reclosure of said contacts for a predetermined minimum time irrespective of the amount of contact separation.

29. In a circuit breaker, a slidably mounted contact rod having a contact portion adjacent one end thereof, a cooperating contact adapted to be engaged by said contact portion, means biasing said rod in a direction to cause engagement of said contact portion and cooperating contact, means for moving said rod and contact portion in an opposite direction to open the circuit including an actuating sleeve member slidably mounted on said rod, spaced stop members limiting relative sliding of said sleeve on said rod, resilient means between said sleeve and one of said stop members so as to be compressed upon movement of said sleeve to separate said contacts, and one of said members having a depression receiving a portion of said resilient means to prevent overstressing of the latter.

30. In a circuit interrupter, an arc chamber which is closed at least during a circuit interrupting operation, a contact in said chamber, a contact rod slidably mounted through a wall of said chamber for movement into and out of engagement with said contact, an actuating sleeve slidably mounted on said rod outside said chamber, and means limiting relative sliding of said sleeve and rod, whereby said sleeve is operable to initially separate said contact rod from said contact, and thereafter said contact rod is movable independently of said sleeve in response to pressure generated by the arc in said chamber.

31. In a circuit interrupter, an arc chamber which is closed at least during a circuit interrupting operation, a contact in said chamber, a contact rod slidably mounted through a wall of said chamber for movement into and out of engagement with said contact, an actuating sleeve slidably mounted on said rod outside said chamber, means limiting relative sliding of said sleeve and rod, resilient means biasing said sleeve relative to said rod in a direction toward said contact, whereby said sleeve is operable to initially separate said contact rod from said contact, and thereafter said contact rod is movable independently of said sleeve in response to pressure generated by the arc in said chamber, and the bias of said resilient means.

32. In an automatic reclosing circuit interrupter, an arc chamber which is closed at least during a circuit interrupting operation, a contact in said chamber, a contact rod slidably mounted through a wall of said chamber for movement into and out of engagement with said contact, an actuating sleeve slidably mounted on said rod outside said chamber, means limiting relative sliding of said sleeve and rod, whereby said sleeve is operable to initially separate said contact rod from said contact, and thereafter said contact rod is movable independently of said sleeve in response to pressure generated by the arc in said chamber, means biasing said rod toward said contact to automatically reclose the circuit following a circuit interrupting operation, and means acting on said sleeve in response to a circuit interrupting operation for delaying reclosure of said contacts a predetermined minimum time, irrespective of the distance said contact rod separates from said contact upon a circuit interrupting operation.

33. In a circuit breaker, separable contacts, means for biasing said contacts into engagement, current responsive means for separating said contacts, time delay means for delaying the action of said biasing means in moving said contacts into engagement, said time delay means having gear means associated therewith and said contacts having a member movable therewith adapted to automatically drivingly engage said gear means at least during the first portion of its contact-closing movement and to become automatically disengaged prior to the end of said movement, said gear means including a gear having at least one wide tooth whereby said gear may be advanced a predetermined amount in one direction in response to a circuit closing operation of said contacts, means associated with said time delay means for biasing said gear for movement in an opposite direction, whereby in response to a plurality of closely successive reclosures of said contacts, said solid tooth portion will prevent rotation of said gear and maintain said contacts in an open circuit position.

34. In a circuit interrupter, a liquid container, a substantially closed arc chamber in said container below the liquid level therein, separable contacts in said chamber, liquid outlet and inlet passages for said chamber, valves responsive to pressure in said chamber for closing said passages and said valves being operable after a circuit interrupting operation to open said passages to permit fresh oil from said container to flush said chamber.

35. In a circuit interrupter, a liquid container, a substantially closed arc chamber in said container below the liquid level therein, separable contacts in said chamber, liquid outlet and inlet passages for said chamber, said inlet passage

being positioned at lower level in said container than said outlet passage, valves responsive to pressure in said chamber for closing said passages and said valves operable after a circuit interrupting operation to open said passages to permit fresh oil from said container to flush said chamber.

36. In a circuit interrupter, a liquid container, a substantially closed arc chamber in said container below the liquid level therein, separable contacts in said chamber, liquid outlet and inlet passages for said chamber, valves responsive to pressure in said chamber for closing said passages, said inlet valve comprising a check valve, and said outlet valve associated with one of said contacts in a manner to be opened in response to movement of said one contact toward the other to vent said chamber prior to reclosure of said contacts and permit the chamber to be flushed out.

37. In a circuit breaker, separable contacts, means biasing said contacts into engagement, current responsive means for separating said contacts, a lost motion connection between said current responsive means and contacts, and time delay means associated only with said current responsive means for delaying the action of one of said contact moving means in moving said contacts.

38. In a circuit interrupter, an arc chamber, separable contacts in said chamber, fluid inlet and outlet passages for said chamber, valves responsive to pressure generated by an arc struck in said chamber for closing said passages, and means causing said valves to open said passages to permit fresh arc extinguishing fluid to fill said chamber following a circuit interrupting operation.

39. In a circuit interrupter, a substantially closed arc chamber adapted to contain an arc extinguishing liquid, cooperating contact means in said chamber, one of said contact means including a supporting portion slidably mounted through one wall of said chamber, liquid directing means having a lost motion connection with respect to said movable contact means for directing a stream of liquid into the path of the arc, said liquid directing means including an apertured piston-like member slidably mounted in engagement with the walls of said chamber, and resilient means for biasing said directing means towards the other of said contact means, whereby in a circuit interrupting operation said liquid directing means is not actuated until said contacts have separated a predetermined distance.

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