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CIRCUIT BREAKER OPERATING MECHANISM WITH INTERMEDIATE SLOT IN CONTACT ARM

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FIG. 2.

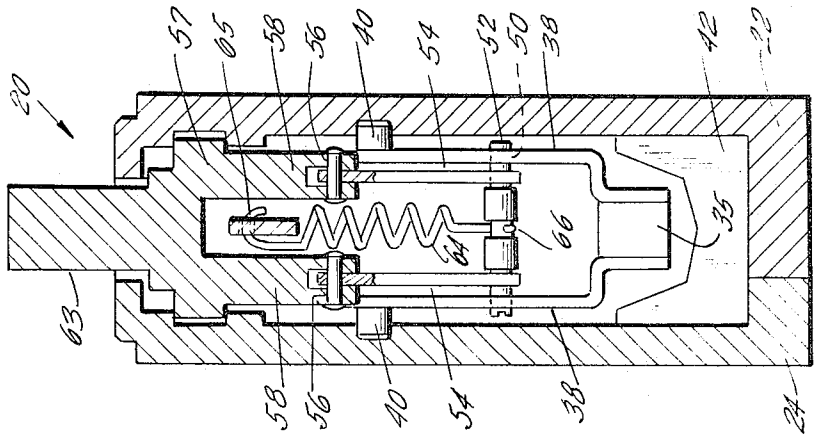

FIG. 1.

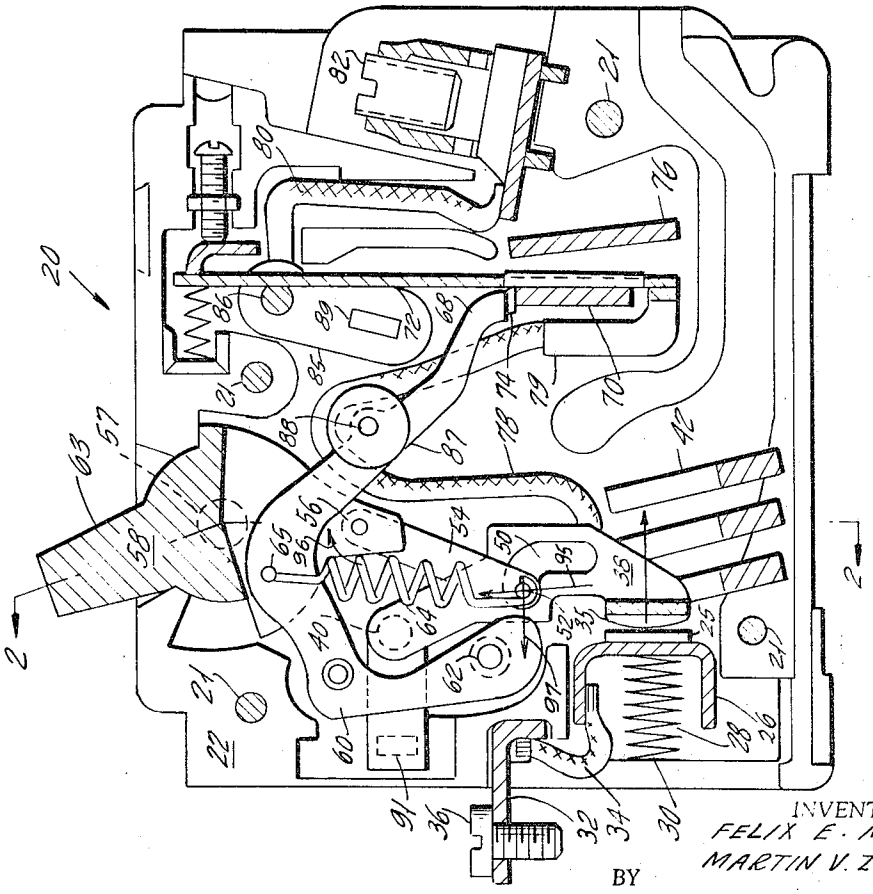

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FIG. 5.

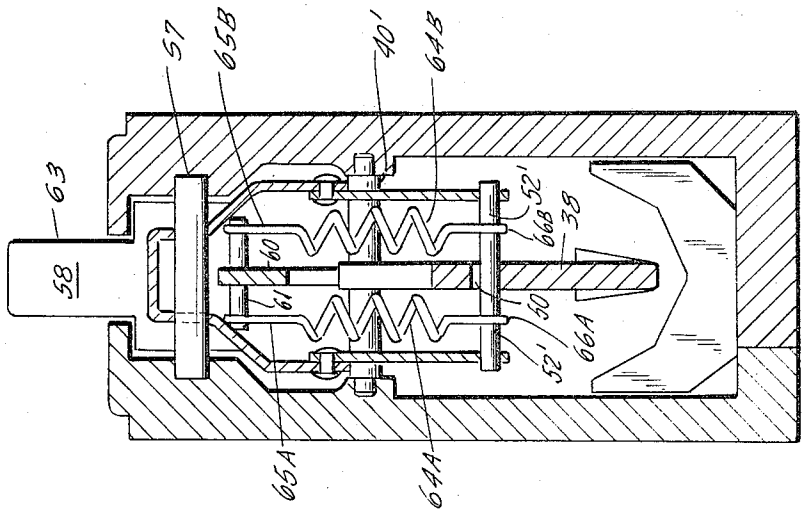

FIG. 4.

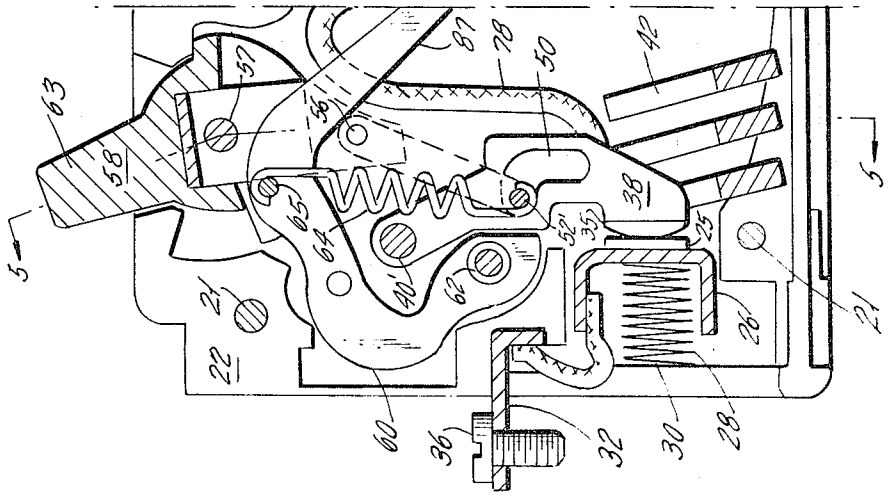

FIG. 3.

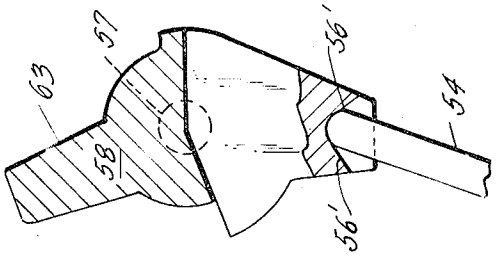

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FIG. 8.

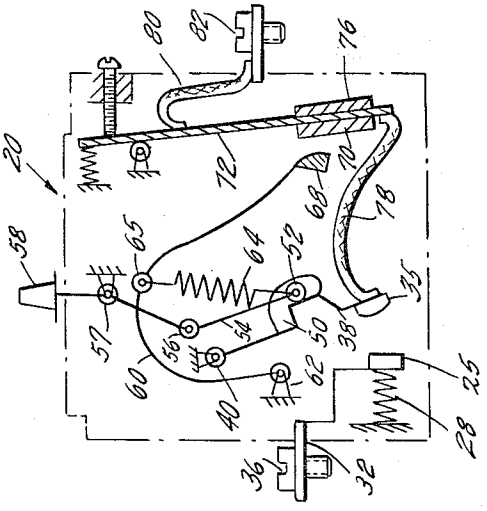


FIG. 11.

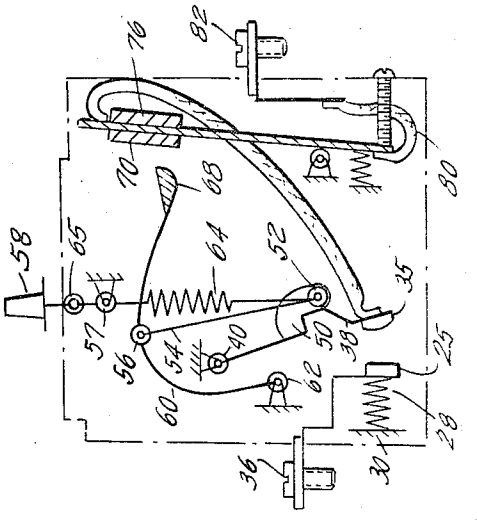


FIG. 7.

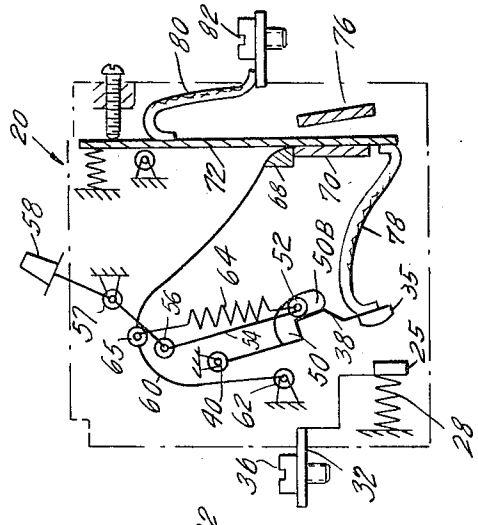


FIG. 10.

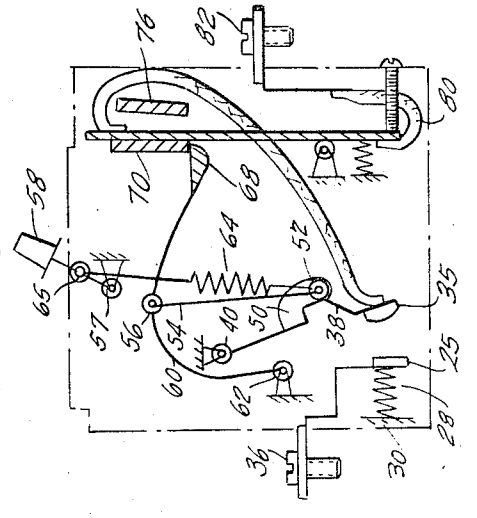


FIG. 5.

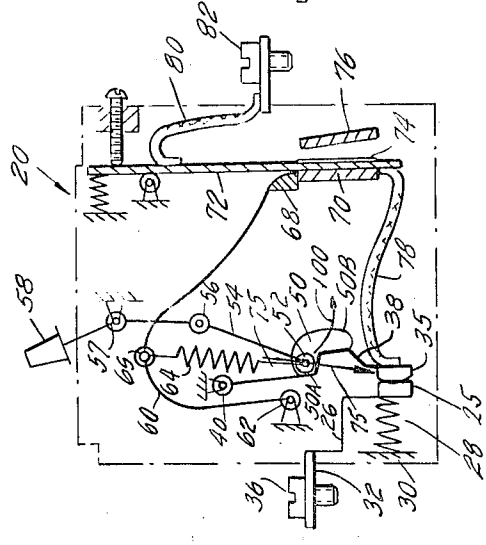
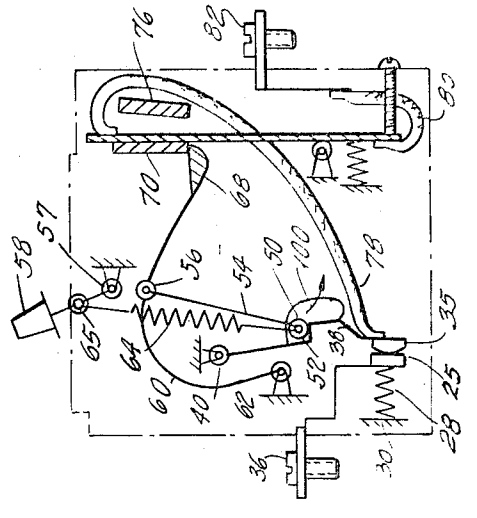


FIG. 9.



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CIRCUIT BREAKER OPERATING MECHANISM WITH INTERMEDIATE SLOT IN CONTACT ARM

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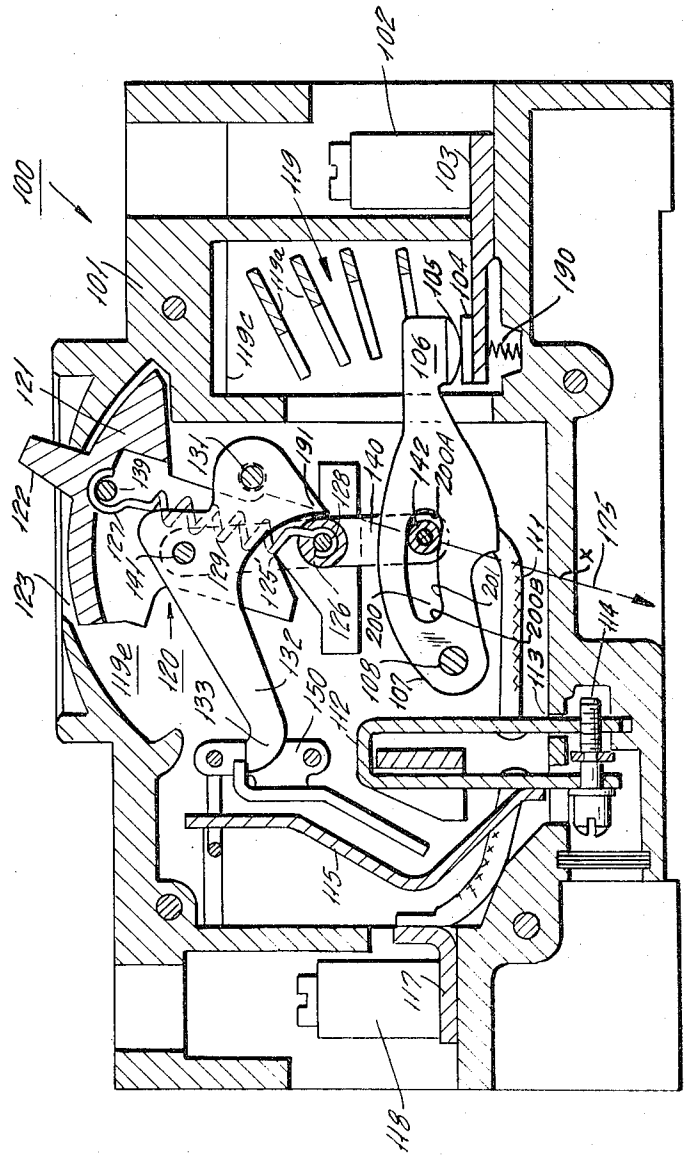
FIG. 12.



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CIRCUIT BREAKER OPERATING MECHANISM WITH INTERMEDIATE SLOT IN CONTACT ARM

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FIG. 14.

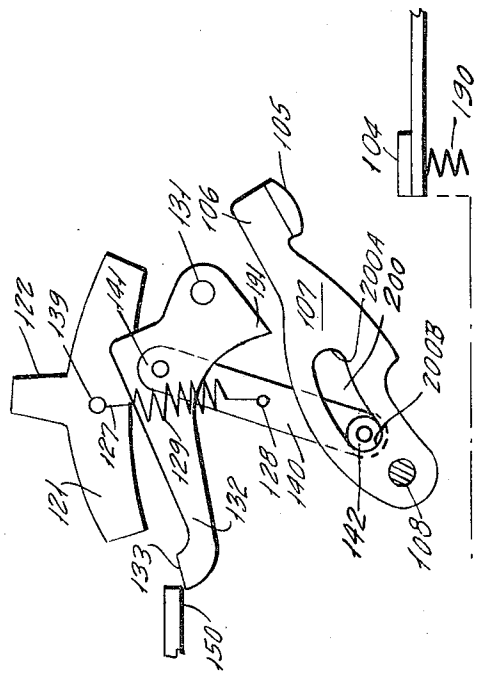

FIG. 15.

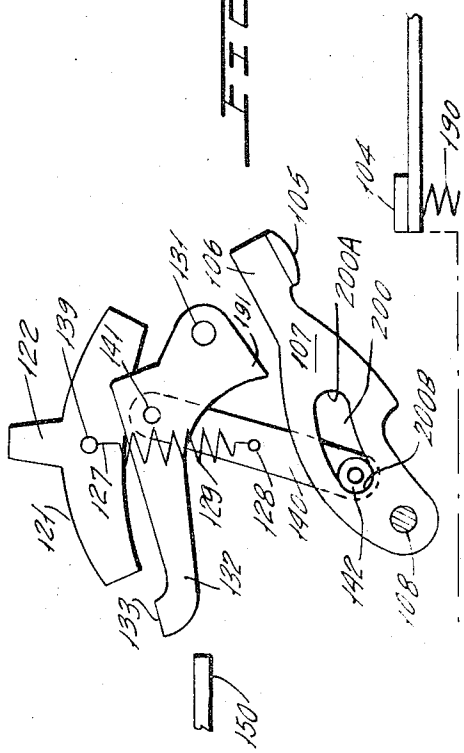

FIG. 13.

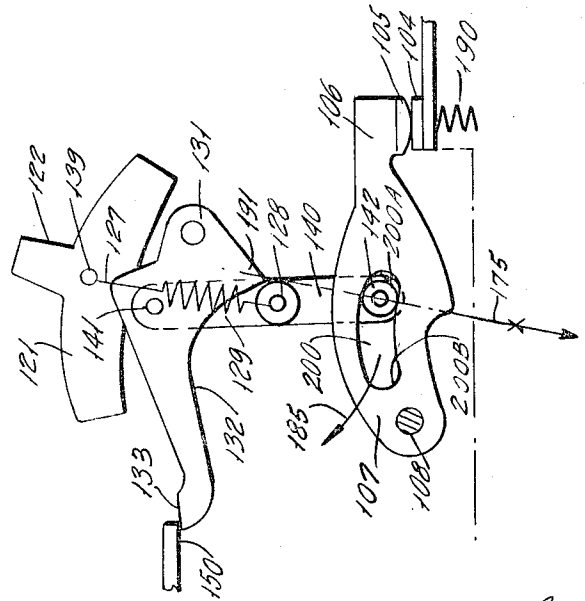

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FIG. 17.

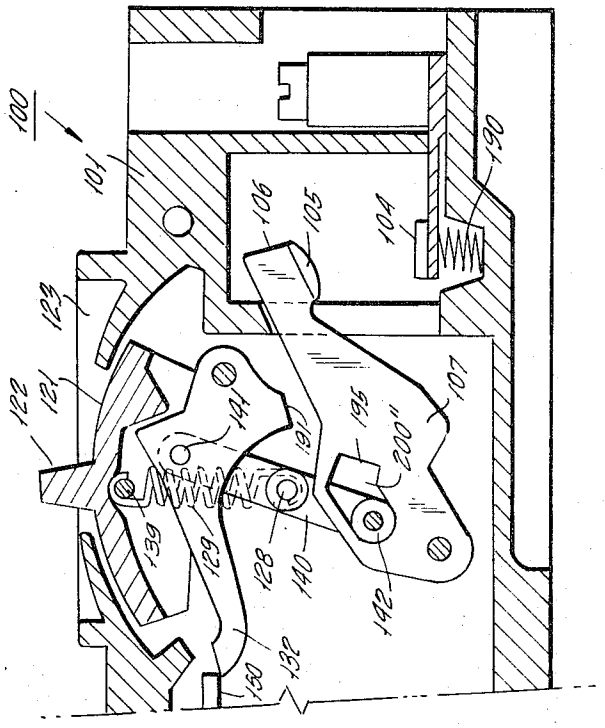
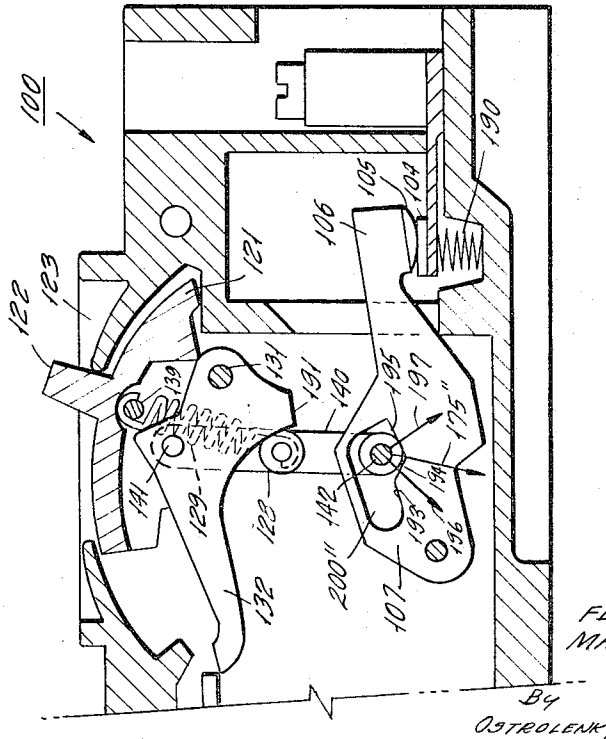


FIG. 16.



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United States Patent Office 3,293,397
Patented Dec. 20, 1966

3,293,397

CIRCUIT BREAKER OPERATING MECHANISM WITH INTERMEDIATE SLOT IN CONTACT ARM

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Filed Jan. 15, 1965, Ser. No. 425,710
10 Claims. (Cl. 200—153)

This invention relates to circuit breakers, and more particularly to circuit breakers having a novel toggle linkage arrangement in conjunction with a quick make-break overcenter mechanism to provide operating in a substantially more efficient and reliable manner than presently available devices. Further, such improved operation is achieved utilizing the general arrangement of existing structure, while only necessitating a minor modification thereof.

Present-day circuit breakers are normally provided with both a manually operable and automatic trip mechanism, for rapidly moving the cooperating contacts between their engaged and disengaged positions. It has been found that under some short-circuit conditions the contacts exhibit a blow-off effect which, in inducing separation of the contacts, will detract from the desired operation of the current responsive automatic trip mechanism. Failure to properly inhibit the blow-off movement of the contacts under such short-circuit conditions can result in inadequate protection of the load circuit, as well as serious damage to the circuit breaker device.

Our invention provides a novel toggle arrangement for counteracting and substantially eliminating the separating effect of blow-off force on the contacts during such short-circuit conditions, while still providing quick make-break operation thereof. Advantageously, we provide such features in conjunction with conventional types of commercially available circuit breaker mechanisms. As, for example: that shown in U.S. Patent No. 2,996,589 to F. E. Myers entitled, "Pivoted Bimetal"; or the general type of two-link toggle mechanism shown in U.S. Patent No. 2,932,706 to A. Bodenschatz, entitled, "Hold-Open and Anti-Rebound Latches," or the modifications thereof shown in U.S. Patent No. 3,155,802 to E. R. Wortmann entitled "U-Shaped Cradle for Circuit Breaker," and U.S. Patent application, Serial No. 285,970 filed June 6, 1963, in the name of M. V. Zubaty and Menickella entitled, "Quick-Make Overcenter Mechanism for Circuit Breaker," all of which are assigned to the assignee of the instant invention. Further, we require only a minimum change of the overall structural arrangements shown therein. Thus, the advantageous objectives of our invention are achieved without requiring extensive re-design, re-tooling or modification of existing assembly techniques and, therefore, provide an economically practical solution to the problem of inhibiting contact blow-off.

We achieve these objectives by the provision of a novel interconnection between the contact carrying arm and circuit breaker operating mechanism. The contact carrying arm is stationarily pivoted to the circuit breaker housing and includes an intermediate slot of a predetermined configuration. A linkage arm is provided which is pivoted at one end to the On-Off operating mechanism, and has a roller at its opposite end for translation within the intermediate slot of the contact carrying arm. The path traversed by the contact carrying arm and the movable contact thereof will be determined by the slot configuration, whereby it is interconnected to the movement of the linkage arm. The contact arm slot configuration in conjunction with the linkage arm will act as a toggle linkage with the slot being analogous to a lower toggle link and the linkage arm being the upper toggle link of said toggle linkage arrangement. Rapid movement of the linkage arm is provided by an overcenter spring.

As a particularly advantageous feature of our invention a lock-in toggle is provided which serves to substantially inhibit contact blow-off. In the past such blow-off forces have been principally resisted by the force of the operating springs. It has been found that the blow-off forces are oftentimes of a sufficient magnitude to counteract the contact pressure provided by the operating springs, and hence permit undesirable contact separation. By providing a lock-in toggle the tendency of the contacts to blow-off is effectively limited by resistance to movement offered by the toggle linkage, with such resistance further serving to generate a reaction force tending to urge the contacts closer together. More specifically, in the various embodiments of our invention the tendency of the contacts to blow-off will establish a force within the contact arm which is transmitted to the linkage arm via the intermediate slot. This force then tends to urge the linkage arm in a direction dictated by the locking of the toggle. The urging of the linkage arm in this latter direction actually corresponds to movement of the contact arm into closer engagement with its cooperating stationary contact. The forces of contact blow-off will thus be transmitted to the toggle linkage in a novel manner which serves to generate a reaction force effectively opposing such movement. Thus, we provide a simplified quick-make, break mechanism having the advantages of a locked toggle arrangement to inhibit contact blow-off but eliminating an additional toggle link through the use of the slot within the contact carrying arm. Accordingly, we achieve high speed interruption with a minimum increase of operating members, and hence complexity and cost of fabrication.

In one embodiment of our invention, utilizing the general circuit breaker arrangement shown in aforementioned U.S. Patent 2,996,589, the contact carrying arm which was previously pivoted to the manual handle member, is now stationarily pivoted within the housing of the molded case circuit breaker. The additional linkage member is interconnected between the slot now provided in the contact carrying arm and the manual handle member, to form an upper toggle. The end of the linkage member which is connected to and movable within the slot is also connected to one end of the main operating spring member, the other end of which is connected to the releasable cradle in overcenter relationship with respect to the upper toggle linkage. (In a modification thereof, the arrangement of the releasable cradle and operating handle connections may be interchanged. That is, the operating spring member will be connected between the end of the linkage within the slot and the operating handle, while the other end of said additional linkage member will be pivotally mounted to the releasable cradle.) In either arrangement, movement of the manual operating handle or the unlatching of the releasable cradle will rapidly switch the overcenter relationship of the upper toggle and main operating spring to rapidly move the opposite end of the toggle link (that movable within the contact carrying arm slot). The latter movement will then be transmitted to the contact carrying arm as determined by the predetermined slot configuration, so as to effect the desired movement of the contacts thereof between their On and Off positions.

By comparing this embodiment of our invention to the previous arrangement shown in aforementioned U.S. Patent No. 2,996,589, it is seen that all we require is the addition of a simple linkage member and a minor rearrangement of the existing parts to accommodate said linkage member, thereby achieving a substantially enhanced

mode of operation with only a minimum additional expenditure.

In another embodiment of our invention, based on a modification of the general type of operating mechanism shown in aforementioned U.S. Patent Number 2,932,706, the two-link toggle mechanism thereof is now replaced by the simplified toggle linkage. The linkage includes a link member, one end of which is movable within the novel slot of the contact carrying arm (which serves as the other link) and the other end of which is pivotally mounted to the releasable cradle member. The operating spring member is interconnected between the manual handle and an intermediate region of the newly added linkage member, and is in overcenter relationship with respect to the interconnection of the toggle linkage member and the circuit breaker operating mechanism. This embodiment preferably avoids the addition of a lower link and the various structural members previously provided to insure proper movement thereof. The slot is so configurated in conjunction with the location of the other operating member, such that the forces of contact blow-off will generate a reaction force tending to urge the contacts closer together. Hence, such reaction forces will serve to inhibit the separated apart movement of the contacts responsive to said blow-off forces. Further, by suitably shaping the slot configuration, a hold-closed or locked-type toggle arrangement may be realized.

It is, therefore, seen that the basic concept of our invention resides in providing an improved operating mechanism for a circuit breaker structure, wherein a novel toggle arrangement in conjunction with a predetermined slot configuration of the contact carrying arm inhibits contact blow-off and advantageously provides a locking of the toggle linkage in the On position. The extreme simplicity of structure whereby we provide this advantageous mode of operation has made our invention particularly applicable in conjunction with presently available mass-produced types of molded case circuit breakers of the general type shown in aforementioned U.S. Patents Nos. 2,996,589 and 2,932,706.

It is therefore seen that a principal object of our invention is to provide a novel operating mechanism for a circuit breaking device.

Another object of our invention is to provide a novel operating mechanism for a circuit breaker device which incorporates an overcenter toggle arrangement in conjunction with a predetermined slot configuration of the contact carrying arm for transmitting the movement of the operating mechanism to the cooperating contacts.

A further object of our invention is to provide a circuit breaker device which includes a novel toggle arrangement for preventing contact blow-off under short-circuit conditions.

An additional object of our invention is to provide such a circuit breaker device wherein the toggle linkage members thereof are locked in their On position and will effectively resist the tendency of the contacts to blow-off.

Still another object of our invention is to provide for a novel operating mechanism in conjunction with an existing type of circuit breaker unit wherein a minor modification of the linkage arrangement thereof provides increased protection against contact blow-off forces.

Still a further object of our invention is to provide a circuit breaker construction wherein the movement of the operating mechanism is transmitted to the contact-carrying arm via a novel slot configuration which functions as a lower toggle in conjunction with a toggle linkage member connected and movable therein.

These as well as other objects of our invention will readily become apparent upon and in consideration of the following drawings in which:

FIGURE 1 is a side elevation of one form of a circuit breaker of the general type shown in aforementioned U.S. Patent No. 2,996,589, but modified in accordance with our invention, and in the On condition.

FIGURE 2 is an end view, shown partially in cross-section along line 2—2 of FIGURE 1.

FIGURE 3 shows an alternate arrangement for pivotally mounting the linkage member to the operating handle, in conjunction with the general arrangement shown in FIGURES 1 and 2.

FIGURE 4 is a side elevational view corresponding to FIG. 1 but showing a somewhat modified version for heavy duty operation.

FIGURE 5 is an end cross-sectional view along line 5—5 of FIGURE 4 showing the placement of dual operating springs for such heavy duty application.

FIGURE 6 schematically illustrates the operation of the circuit breaker mechanism shown in above FIGURES 1 through 5, in the On condition.

FIGURES 7 and 8 schematically correspond to FIGURE 6, but show the circuit breaker operating mechanism in the manual Off and trip conditions, respectively.

FIGURES 9 through 11 schematically show an alternate embodiment of the basic operating mechanism shown in the above figures in the On, manual Off, and Trip conditions, respectively.

FIGURE 12 is a sectional elevational view of another embodiment of our invention shown in conjunction with the basic operating mechanism of aforementioned U.S. patent application 285,970, and shown in the On position.

FIGURES 13 through 15 schematically show the operation of the circuit breaker operating mechanism of FIGURE 12, in the On, manual Off, and Trip conditions, respectively.

FIGURES 16 and 17 show a modification of the general type of operating mechanism shown in FIGURE 12 wherein still another slot configuration is utilized to achieve a locking toggle arrangement.

Referring now to the figures, and particularly to FIGS. 1 and 2, circuit breaker **20** thereof is shown as a single phase device and is of the general construction described in detail in aforementioned U.S. Patent 2,996,589. In addition, stacks of such single phase circuit breakers may be mounted together and appropriately interconnected for interphase operation thereof, as is well understood in the art and is fully explained in aforementioned U.S. Patent No. 2,996,589.

Briefly, circuit breaker **20** comprises a molded housing formed of base section **22** and cover **24**, respectively, with the cover **24** being secured to base **22** by rivets **21** (cover **24** being removed in FIG. 1 to reveal the internal components thereof). A stationary contact **25** is mounted to a generally U-shaped member **26** which is biased to the right as shown in these figures by spring member **28**, one end of which abuts housing formation **30** and the other end of which abuts U-shaped member **26**; spring member **28** being provided for achieving firm contact pressure between stationary contact **25** and movable contact member **35**. U-shaped member **26** is, in turn, connected to the external circuit terminal **32** via pigtail **34**. The external circuit terminal **32** is illustratively shown as a bolt type terminal, whereby bolt member **36** thereof is connected to the line side of the circuit in a well known manner. Alternatively, a recessed female stab terminal may be provided within the molded housing for plug-in operation.

Movable contact **35** is mounted to the lower end of a bifurcated movable contact carrying arm **38** which is stationarily pivoted at its opposite end **40** to a suitable housing formation. Parallel plate slotted arc extinguishing means **42** is operatively positioned to receive and extinguish electric current arc drawn between contact **25** and **35**. The current carrying path through the circuit breaker **20** begins at the line terminal **32** thereof, to the conductor **34**, U-shaped member **26**, and stationary contact **25**. The path then continues from movable contact member **35** to bifurcated contact carrying arm **38**, pigtail connector **78**, conductive member **79**, bimetallic con-

trol member 72, braided member 80, and load terminal 82.

In accordance with the novel structural arrangement of our invention, contact carrying arm 38 includes an intermediate slot 50 of predetermined configuration which receives a roller member 52 secured to the lower end of an additional linkage means 54. The provision of the roller insures low frictional engagement and, hence, reliable operation of toggle 54 within the slot configuration. The opposed end of said linkage means is pivotally mounted to manual operating member 58, as by the provision of separate pin members 56. Alternatively, the upper end of the toggle link 54 may be pivoted to operating handle 58 by the inclusion of pivot pockets 56', as shown in FIGURE 3, and in the general manner that the contact carrying arm of the mechanism shown in aforementioned U.S. Patent No. 2,996,589 had been previously pivoted to the manual operating member. Hence, this arrangement would permit utilization of a handle operating member 58 with the same configuration shown in that patent, thereby further minimizing the need for additional tooling. Manual operating member 58 is pivoted about 57 and has an externally projecting portion 63 which forms a handle for the manual On, Off operation of the circuit breaker 20.

The operating mechanism for bringing about the engagement and disengagement of the operating contacts 25, 35 further comprises a releasable cradle 60, which is stationarily pivoted at one end thereof at base protrusion 62. An operating spring member 64 has one end thereof, 65, tied to cradle 60 at a point intermediate the ends thereof, while the other end 66 of operating spring 64 is tied to roller member 52, which rides within slot 50 of the contact carrying arm 38. Manual operating member 58 and linkage member 54 constitute a toggle arrangement having a knee at their interconnection 56 which is an over-center relationship with respect to operating spring member 64 and, as shown in FIGURE 1, urges roller end 52 into the upper left portion of slot 50, to provide engagement of contact 25, 35.

The free end of cradle 60 comprises latch tip 68 which is engageable by latching member 74 of magnet 70 appropriately secured to elongated bimetallic members 72. Magnet 70 cooperates with armature 76 for the releasing of the latched engagement of members 74 and 68 responsive to the calibrated overload condition. That is, the heating up of the bimetallic member 72 or the attraction of magnetic member 70 will release the latched inter-engagement of 74 and 68, in the well known manner, to then provide disengagement of the contacts, in a manner to be subsequently discussed in conjunction with schematic FIGURE 8.

For heavy duty operation, the single operating spring member 64, as shown in FIGURES 1 and 2, may be replaced by dual spring members 64A, 64B, as shown in FIGURE 5. The upper ends 65A, 65B of the operating spring member 64A, 64B respectively, are secured to cradle 60 by the provision of pivot pin 61 transverse thereto. Likewise, the lower ends 66*a*, 66*b* of the respective operating spring members are secured to roller 52' which is within slot 50 of the contact carrying arm 38. Note that in this arrangement the previously shown bifurcated contact carrying arm has been replaced by a single member secured to pivot pin 40'.

Reference is now made to FIGURE 6 with respect to the operation of the mechanism discussed above. FIGURE 6 is a schematic representation of the operating components as shown in FIGURE 1, and wherein identical numerals are utilized to indicate their corresponding components. In the contact On position, the toggle arrangement formed by the interconnection of manual operating member 58 and link 54 will have the knee thereof 56 in overcenter relationship to the right with respect to operating spring 64. Hence, the roller end 52 of link 54 will be urged to the left as shown in these

figures, whereby it will be in region 50A of slot 50, having a resultant force along line 75. Advantageously, the toggle is locked in this position by the shape of the slot configuration such that operating spring 64 does not furnish the contact pressure between cooperating contacts 25, 35. Hence, the additional spring member 28 is provided to urge contact 25 to the right, as shown in these figures, and hence into firm engagement with its cooperating movable contact member 35. In this arrangement (with the toggle and hence the contacts locked in the On position), separated apart movement of the contacts, induced by blow-off forces therebetween, will be transmitted to the interengagement of roller 52 and slot 50 directly opposed to resultant force 75 and will be resisted by a reaction force tending to actually urge the contacts closer together. For an explanation of the establishment of this reaction force, reference is again made to FIGURE 1, wherein the force of blow-off, as transmitted to the interengagement of roller 52 and slot 50, is shown by arrow 95. This will tend to move the toggle knee at 52 to the left. Thus, the forces of blow-off are transmitted to linkage arm 54 in a manner tending to cause rotation of that member about its pivot 56 as shown by arrow 96. Since point 56 will be maintained stationary by the handle itself, this force will tend to move the lower end 52 of toggle link 54 in the direction shown by arrow 97, with such urging of 52 being transmitted to contact arm 38 via slot 50 in a direction tending to move its contact 35 into closer engagement with stationary contact 25. Thus, the locked toggle reacts to contact blow-off in a manner more effectively resisting separation of the contacts than the heretofore known structures, wherein the operating spring furnished the resistance to such contact blow-off.

Reference is now made to FIGURE 7 to illustrate the operation of the members corresponding to the manual Off position. Manual operating member 58 is rotated about its pivot 57 such that its lower extension pivoted to 56 to form the toggle knee of toggle linkage 58, 54 will now be moved up to the left. As soon as the toggle knee 56 passes through the center position of operating spring 64, the continued operation thereof is extremely rapid, to the manual Off position indicated in FIGURE 7. During this movement, the roller end 52 of linkage 54 will traverse an arcuate path as shown by arrow 100, with such movement being transmitted to the contact carrying arm 38 in accordance with the slot configuration 50. As shown, the slot is so shaped that said movement of end 52 to slot location 50B will effect rapid disengagement of contacts 25, 35. Further, during said movement, slot 50 is analogous to a toggle link which cooperates with linkage 54 so as to provide a lower toggle linkage which has roller end 52 as the knee thereof. That is, we advantageously provide such an additional toggle linkage for rapid make-break operation by merely the addition of a predetermined slot configuration within the contact carrying arm 38.

Reference is now made to FIGURE 8 with respect to the operation of the circuit breaker mechanism into the automatic Trip position. When latch member 70 is moved to the right responsive to either the deflection of bimetallic member 72 or the attraction of magnetic members 74, 76, the release of latch tip 68 will rapidly pivot cradel 60 about its stationary pivot 62 under the influence of operating spring 64, thereby simultaneously moving spring 64 relative to the location of knee 56 of the upper toggle linkage arrangement. As soon as spring 64 switches its overcenter relationship with respect to knee 56, said upper toggle linkage arrangement begins to rapidly collapse by the movement of linkage arm 54 about knee 56, such that its lower end 52 traverses the arcuate path 100. This provides rapid disengagement of the cooperating contacts 25–35 by virtue of the transmission of the motion of lower toggle end 52 to the contact carrying arm 38 via the configuration of slot 50, as in the general

manner discussed with respect to manual operation thereof.

Referring back to FIGURE 1, should it be desired to provide multi-phase operation of the circuit breaker mechanism, a trip lever 85 pivoted at 86 is engaged by a roller 87 secured to cradle 60 at 88. Engagement of trip lever 85 by roller 87 forces trip lever 85 counterclockwise about its pivot 86, thereby moving a common trip tie bar 89 interconecting the trip units of the individual phase circuit breakers in the conventional manner. Alternatively, multi-pole tripping could also be realized by providing only one operating mechanism and latch on a tripper bar, with outboard contact arms 38 being tied together as at dotted member 91, or at the contact arm bearing 40' as shown in the heavy duty embodiment of FIGURES 4 and 5.

Reference is now made to FIGURES 9–11, which schematically show a slightly varying form of the general arrangement above discussed in conjunction with FIGURES 6–8. For the sake of brevity, the discussion thereof will be limited to the manner in which this arrangement differs therefrom. Basically, wherein previously the upper end 56 of toggle linkage 54 had been connected to the manual operating member 58, said upper end 56 is now connected to the releasable cradle operating member 60. Conversely, wherein the upper end 65 of operating spring 64 had been previously connected to releasable cradle 60, it is now connected to an appropriate point on manual operating member 58. Hence, in moving from the On position of FIGURE 9 to the manual Off position of FIGURE 10, handle 58 is rotated about pivot 57, thereby directly switching the overcenter relationship of operating spring 64, relative to the pivot 56 of the toggle link 54. As soon as the overcenter position is passed, the roller end 52 of link 54 will rapidly traverse the arcuate path shown by 100, thereby pivoting contact carrying arm 38 about its stationary pivot 40, as determined by the configuration of slot 50, so as to effect the rapid disengagement of cooperating contacts 25, 35. Similarly, release of the latched engagement of members 68, 70 (with the bimetallic and magnetic latch now being reversed, compared to that previously shown) will effect counterclockwise rotation of releasable cradle 60 about its stationary pivot 62 to relocate pivot 56 relative to operating spring 64. As soon as the overcenter position of knee 56 is passed relative to operating spring 64, it will rapidly move roller end 52 of link 54 within the arcuate path shown by arrow 100, with such motion being transmitted to contact carrying arm 38 to effect movement about its stationary pivot 40, as determined by the slot 50 configuration.

Reference is now made to FIGURE 12, which shows an alternate embodiment of our invention in conjunction with the basic operating mechanism of aforementioned U.S. patent application 285,970. The operating components thereof are maintained within a suitably configurated molded case housing 101, with there being a cooperating cover member (not shown) to provide an enclosed housing in the well known manner. The current path to the circuit breaker 100 comprises a source terminal 102 and a bus conductor 103 to stationary contact 104. Stationary contact 104 is engageable by movable contact 105, which is mounted on the rigid forward section 106 of contact arm 107. Contact blade 107 is pivotally mounted at its opposed end 108, as by a pin or suitable member secured to housing base section 101. The intermediate region of contact arm 107 contains a slot 200 of predetermined configuration, which, as will be subsequently discussed below and in a manner similar to that discussed above in conjunction with our other embodiments, serve to provide the novel toggle linkage arrangements of our invention. The current path then continues from contact arm 107 via pigtail 111 to U-shaped conductive member 112 suitably secured to the housing member by the slot 113 and fastening member 114. The U-shaped conductive member 112 is in turn connected near its opposite end to bimetallic member 115, and to a pigtail member 116, the other end of which is connected to a rigid conductor 117 upon which load terminal 118 is rigidly secured. Hence, by operating the contact arm 107 between its opened and closed position, the aforementioned current path through the circuit breaker 100 will be selectively opened and closed as desired.

The circuit breaker molded case housing 101 is provided with a suitable cavity 119*c*, which houses an arc chute arrangement 119 comprised of a plurality of arc plates 119*a* positioned and secured within the cavity 119*c* and designed to provide a tortuous path for any arc contained therein, to effect arc extinguishment in the well known manner. Housing 101 is also provided with a suitable cavity 119*e* designed to house the components of the manual operating mechanism 120. The manual operating mechanism 120 is comprised of an operating handle 121 having a projection 122 extending through a suitable opening 123 of housing 101. A releasable cradle member 132 is pivoted near its right end by a pivoted means 131 suitably secured to housing 101 in any appropriate manner. The other end of cradle 132 comprises a trip latch tip 133 which cooperates with tripping means 150 to provide automatic tripping action of the circuit breaker 100 responsive to the release of the latched engagement between latch tip 133 and tripping means 150, in the well known manner.

In accordance with the novel structural arrangement of our invention, a toggle linkage member 140 is pivoted at its upper end 141 to an intermediate region of releasable cradle 132. Its lower end has a roller member 142 secured thereto, which is pivoted to and movable within slot 200 of the movable contact arm 107. The operating spring means 129, which may be either a single spring arrangement or a dual spring arrangement (as shown in aforementioned U.S. patent application 285,970) is secured at its upper end 127 to a pin member 139 of manual operating handle 121. Its lower end 128 is secured to an intermediate pin 126 located along the length of toggle link member 140.

In the On condition shown in FIGURE 12, the operating spring member 129 is under substantial tension, and overcenter to the right of 141 whereat toggle link 140 is pivoted to cradle 132. This causes roller end 142 to be positioned at 200A within intermediate slots 200 of contact arm 107 as shown.

In the On position, intermediate pin member 128 of toggle link 140 abuts stop 191 of releasable cradle 132. Toggle member 140 will be in a locked condition established by the arc of the lower convex surface 201 of slot 200. Slot 200 is analogous to the arc of a lower toggle having a fixed center at imaginary point X. Hence, the force of inter-engagement will be transmitted via toggle linkage member 140 and contact carrying arm 107, in the direction shown by arrow 175, which passes through the center of roller 142. As shown, the direction of this force is from the right of the upper toggle pivot 141, or in a locking direction to keep the cooperating contacts 104, 105 closed responsive to blow-off forces. Contact pressure in this embodiment is not obtained by main operating spring 128, but by the use of an auxiliary compression spring 190, which is deflected corresponding to the contacts being in their On position.

Reference is now made to FIGURE 13 which schematically shows the operating components in the On condition of FIGURE 12 and wherein identical numerals are utilized to indicate corresponding components. To move to the manual Off position of FIG. 14, manual operating member 121 is rotated counterclockwise, thereby moving upper end 127 of operating spring means 129

in an arcuate path such that it is in opposed overcenter relationship with respect to the pivotal interconnection **141** formed of toggle link **140** and releasable cradle member **132**. As soon as this overcenter position is reversed, the line of action of the spring **129** causes rapid movement of toggle link **140** thereby effecting translation of its roller end **142** along the arcuate path shown by arrow **185**. The movement of roller end **142** is transmitted to contact carrying arm **107** via the predetermined slot configuration **200** to position 200B, so as to cause rotation of contact carrying arm **107** about its pivot **108** to its Off position. It should be realized that in this movement slot **200** will serve as a lower toggle linkage member in conjunction with toggle link **140** forming a toggle linkage combination having a knee at their interconnection **142**. That is, we again advantageously provide a toggle interconnection of the movable contact arm, by the provision of a predetermined slot configuration **200** within the contact carrying arm **107**, and its operation with toggle link **140**.

Reference is now made to FIGURE 15 with respect to operation of circuit breaker **100** to the automatic Trip condition. Tripping is effected upon the released engagement of latch tip **133** in the well known manner. Operating spring **129** is now free to cause clockwise rotation of cradle member **132** about its stationary pivot **131**. This in turn moves the upper pivot **141** of link **140** to the right of the center line of spring **129**. As soon as pivot **141** changes its overcenter position with respect to operating spring **129**, the subsequent movement of link **140** provides a rapid tripping action to the position schematically shown in FIGURE 15. As before, the lower end **142** of link **140** will again traverse the arcuate path shown by arrow **185**, so as to effect disengagement of cooperating contacts **104**, **105** as said movement is transmitted to contact carrying arm **107** by virtue of the slot configuration **200**.

Reference is now made to schematic FIGURES 16 and 17 which show still a further slot configuration in conjunction with the general operating components of FIGS. 12–15, and wherein corresponding members have accordingly been given identical numerical designations. Slot **200″** is now formed of adjacent surfaces **193–5** at its lower end, wherein roller **142** of toggle link **140** rides. In the contact On position shown in FIG. 18, roller end **142** is captivated at the junction of surfaces **194**, **195**, thereby providing two components of force transmission therebetween, **196**, **197** respectively. These forces are each perpendicular to surfaces **194**, **195** and have a resultant shown by line **175″**, corresponding to force **175** of the previously discussed embodiment. Blow-off induced forces between contacts **104**, **105** will be transmitted in the direction along line **175″** but in the opposite direction. Hence, these forces will be in the locking direction, to thereby keep the contacts closed. If desired, stop **191** may be removed from cradle **132**, so that contact pressure would be a function of the force of roller **142′** against the surface **195**, with compression spring **190** being provided only for wiping action of the contact.

It is therefore seen that we provide an improved operating mechanism for a circuit breaker, wherein a novel toggle linkage arrangement is formed by modifying an existing type structure in conjunction with a novel slot configuration within the contact carrying arm to prevent contact blow-off, and provide rapid make-break action.

Although in the foregoing specification, the instant invention has been described in conjunction with preferred embodiments, many variations and modifications will now become apparent to those skilled in the art, and it is preferred therefore that the instant invention be limited not by the specific disclosure contained herein but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows.

1. A circuit breaker comprising a pair of cooperating contacts and an operating mechanism connected to one of said contacts for moving said one contact into and out of engagement with the other of said contacts; said operating mechanism including a contact arm carrying said one contact at one end thereof and pivotally mounted at the other end thereof; said contact arm including an intermediate slot of predetermined configuration; a linkage arm having a first and second end; said first end connected to and movable within said intermediate slot; said second end pivotally mounted to a first operating member of said operating mechanism; said linkage arm and contact arm defining a linked connection having a knee which translates within said intermediate slot; operating spring means interconnected between said linkage arm and a second operating member of said operating mechanism in overcenter relationship with respect to said linkage arm; movement of one of said operating members between first and second positions rapidly switching the overcenter relationship of said linkage arm relative to said operating spring; said first end of said linkage arm translating between an On and Off position corresponding to said switching of the overcenter relationship; the motion of said linkage arm transmitted to said contact arm by the translation of its first end within said intermediate slot; said predetermined slot configuration dimensionally related to the movement of said linkage arm to effect predetermined movement of said one contact carried by said contact arm into and out of engagement with said other contact responsive to movement of said linkage arm between said On and Off positions; one of said operating members being a releasable cradle; latch means for restraining said cradle in a reset position; said operating spring means urging said cradle to a tripped position; the other of said operating members being a manually operable member having an externally extending portion and an inwardly projecting portion movable along an arcuate path between manual On and Off positions.

2. A circuit breaker comprising a pair of cooperating contacts and an operating mechanism connected to one of said contacts for moving said one contact into and out of engagement with the other of said contacts; said operating mechanism including a contact arm carrying said one contact at one end thereof and pivotally mounted at the other end thereof; said contact arm including an intermediate slot of predetermined configuration; a linkage arm having a first and second end; said first end connected to and movable within said intermediate slot; said second end pivotally mounted to a first operating member of said operating mechanism; said linkage arm and contact arm defining a linked connection having a knee which translates within said intermediate slot; operating spring means interconnected between said linkage arm and a second operating member of said operating mechanism in overcenter relationship with respect to said linkage arm; movement of one of said operating members between an On and Off position rapidly switching the overcenter relationship of said linkage arm relative to said operating spring; said first end of said linkage arm translating between an On and Off position corresponding to said switching of the overcenter relationship; the motion of said linkage arm transmitted to said contact arm by the translation of its first end within said intermediate slot; said predetermined slot configuration dimensionally related to the movement of said linkage arm to effect predetermined movement of said one contact carried by said contact arm into and out of engagement with said other contact responsive to movement of said linkage arm between said On and Off positions; one of said operating members being a releasable cradle; latch means for restraining said cradle in a reset position; said operating spring means urging said cradle to a tripped position; the other of said operating members being a manually operable member having an externally extending portion and an inwardly projecting portion movable along an arcuate path between

manual On and Off positions; said contacts when in their engaged condition being subject to blow-off forces tending to induce disengagement thereof; means for transmitting said blow-off forces to said linkage arm and receiving a reaction force therefrom opposing the tendency of said contacts to disengage.

3. A circuit breaker comprising a pair of cooperating contacts and an operating mechanism connected to one of said contacts for moving said one contact into and out of engagement with the other of said contacts; said operating mechanism including a contact arm carrying said one contact at one end thereof and pivotally mounted at the other end thereof; said contact arm including an intermediate slot of predetermined configuration; a first toggle link having a first and second end; said first end connected to and movable within said intermediate slot; said second end pivotally mounted to a first operating member of said operating mechanism to form a first toggle means having a first toggle knee at said pivotal interconnection; operating spring means interconnected between said first toggle link and a second operating member of said operating mechanism in overcenter relationship with respect to said first toggle knee; movement of one of said operating members between an On and Off position rapidly switching the overcenter relationship of said first toggle knee relative to said operating spring; said first end of said toggle link having an On and Off position corresponding to said switching of the overcenter relationship of said first toggle knee; the motion of said toggle link transmitted to said contact arm by the translation of its first end within said intermediate slot; a second toggle means comprising said intermediate slot and said first link means as the cooperating members thereof; the interconnection of said first end of said toggle link and said intermediate slot forming a second toggle knee; said predetermined slot configuration dimensionally related to the movement of said second toggle knee to effect predetermined movement of said one contact carried by said contact arm into and out of engagement with said other contact responsive to switching between said On and Off positions; one of said operating members being a releasable cradle; latch means for restraining said cradle in a reset position; said operating spring means urging said cradle to a tripped position; the other of said operating members being a manually operable member having an externally extending portion and an inwardly projecting portion movable along an arcuate path between manual On and Off positions; means for locking said toggle means in said On position; said first end of said first toggle link having a roller in engagement with said slot and establishing a resultant force in a first direction; blow-off induced separated apart movement of said cooperating contacts generating a reaction force within said toggle means when in said locked condition, which is transmitted back to said slot to provide a force in a second direction, substantially opposed to said first direction whereby the locking of said toggle means inhibits contact blow-off.

4. An operating means for use in a molded case circuit breaker having a stationary contact and cooperating movable contact; said operating means comprising a pivotally mounted contact arm carrying said movable contact; said contact arm having an intermediate slot of predetermined configuration; a toggle means comprising a first link, having a first end connected to and movable within said intermediate slot; overcenter means and a releasable cradle operatively connected to said toggle means for rapidly moving said toggle means between an On and Off position; said toggle means when in said On position locating said first end at a first location within said intermediate slot, and when in said Off position locating said first end at a second location within said intermediate slot; the path traversed by said first end within said slot between said first and second locations defining the movement of said contact arm movable contact into and out of engagement with said stationary contact.

5. An operating means for use in a molded case circuit breaker having a stationary contact and cooperating movable contact; said operating means comprising a pivotally mounted contact arm carrying said movable contact; said contact arm having an intermediate slot of predetermined configuration; a toggle means comprising a first link, having a first end connected to and movable within said intermediate slot; overcenter means rapidly moving said toggle means between an On and Off position; said toggle means when in said On position locating said first end at a first location within said intermediate slot, and when in said Off position locating said first end at a second location within said intermediate slot; the path traversed by said first end within said slot between said first and second locations defining the movement of said contact arm movable contact into and out of engagement with said stationary contact; said overcenter means comprising a second end of said first link pivotally mounted to a first operating member; operating spring means interconnected between said first toggle link and a second operating member in overcenter relationship with respect to said pivotal interconnection; one of said operating members being a releasable cradle; latch means for restraining said cradle in a reset position; said operating spring means urging said cradle to a tripped position; the other of said operating members being a manually operable member having an externally extending portion and an inwardly projecting portion movable along an arcuate path between an On and Off position.

6. A molded case circuit breaker comprising a housing, enclosing at least one pair of cooperating contacts; a contact arm having a first end, second end and an intermediate slot of predetermined configuration; said first end pivotally mounted to said housing and said second end carrying one of said contacts a releasable cradle member pivotally mounted to said housing; latch means for restraining said cradle member in a reset position; operating spring means urging said cradle to a tripped position, and a manually operable member pivotally mounted to said housing for operating said cooperating contacts into and out of engagement; a toggle link having a first and second end; said second end pivotally connecting to one of said members; said first end connected to and movable within said intermediate slot to form a toggle linkage knee having said slot as a lower link and said toggle link as an upper link; said operating spring means having a first end connected to said toggle link and a second end connected to the other of said members, and in overcenter relationship with respect to said toggle link; the path traversed by said first end of said toggle link within said intermediate slot defining the pivotal movement of said contact arm about said first end, whereby said contact carrying second end traverses a predetermined path into and out of engagement with its cooperating contact.

7. A molded case circuit breaker as set forth in claim 6 wherein said second end of said toggle link is pivotally mounted to an inwardly projecting extension of said manually operable member, and said second end of said operating spring means is connected to said cradle member; said manually operable extension of said manually operable member, and said second end of said operating spring means is connected to said cradle member; said manually operable member moving its point of pivotal connection with said toggle link in an arcuate path between On and Off positions in opposed overcenter locations in relation to said operating spring means.

8. A molded case circuit breaker as set forth in claim 6 wherein said second end of said toggle link is pivotally connected to said cradle member and said second end of said operating spring means is to an inwardly projecting extension of said manually operable member; said manually operable member moving said operating spring means in an arcuate path, between On and Off positions in opposed overcenter locations relative to said operating spring means.

9. A molded case circuit breaker comprising a housing, enclosing at least one pair of cooperating contacts; a contact arm having a first end, second end and an intermediate slot of predetermined configuration; said first end pivotally mounted to said housing and said second end carrying one of said contacts a releasable cradle member pivotally mounted to said housing; latch means for restraining said cradle member in a reset position; operating spring means urging said cradle to a tripped position, and a manually operable member pivotally mounted to said housing for operating said cooperating contacts into and out of engagement; a toggle link having a first and second end; said second end pivotally connecting to one of said members to form a first toggle linkage knee having said member as an upper link and said toggle link as a lower link; said first end connected to and movable within said intermediate slot to form a second toggle linkage knee having said slot as a lower link and said toggle link as an upper link; said operating spring means having a first end connected to said toggle and a second end connected to the other of said members, and in overcenter relationship with respect to said first toggle linkage; the path traversed by said first end of said toggle link within said intermediate slot defining the pivotal movement of said contact arm about said first end, whereby said contact carrying second end traverses a predetermined path into and out of engagement with its cooperating contact; means for locking said toggle linkage in said On position when said contacts are in engagement; auxiliary means other than said operating spring means for maintaining firm engagement of said cooperating contacts when in said On position.

10. A molded case circuit breaker comprising a housing, enclosing at least a pair of cooperating contacts; a contact arm having a first end, second end and an intermediate slot of predetermined configuration; said first end pivotally mounted to said housing and said second end carrying one of said contacts; a releasable cradle member pivotally mounted to said housing; latch means for restraining said cradle member in a reset position; operating spring means urging said cradle to a tripped position, and a manually operable member pivotally mounted to said housing for operating said cooperating

contacts into and out of engagement; a toggle link having a first and second end; said second end pivotally connecting to one of said members to form a first toggle linkage knee having said member as an upper link and said toggle link as a lower link; said first end connected to and movable within said intermediate slot to form a second toggle linkage knee having said slot as a lower link and said toggle link as an upper link; said operating spring means having a first end connected to said toggle and a second end connected to the other of said members, and in overcenter relationship with respect to said first toggle linkage; the path traversed by said first end of said toggle link within said intermediate slot defining the pivotal movement of said contact arm about said first end, whereby said contact carrying second end traverses a predetermined path into and out of engagement with its cooperating contact; said second end of said toggle link is pivotally connected to said cradle member, and said second end of said operating spring means is to an inwardly projecting extension of said manually operable member, said manually operable member moving in an arcuate path between On and Off positions in opposed overcenter locations relative to said operating spring means; said first end of said toggle link having a roller in engagement with said slot and establishing a resultant force in a first direction; blow-off induced separated apart movement of said cooperating contacts transmitting a force to said toggle link; means for locking said toggle link in a position corresponding to said contacts being in their engaged condition; said toggle link, when in said locked condition resisting blow-off induced movement thereof in a manner establishing a reaction force substantially opposed to said first direction, whereby the locking of said toggle linkage means inhibits contact blow-off.

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