United States Patent

[11] **3,549,843**

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[21] Appl. No. **757,561**
[22] Filed **Sept. 5, 1968**
[45] Patented **Dec. 22, 1970**
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[54] **CIRCUIT BREAKER OPERATING MECHANISM**
12 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **200/153,** 335/73, 335/190
[51] **Int. Cl.** **H01h 3/42**
[50] **Field of Search** ..... 200/153.8, 153.12, 153.13; 335/73, 190, 74, 77, 21(cursory), 22; 74/569

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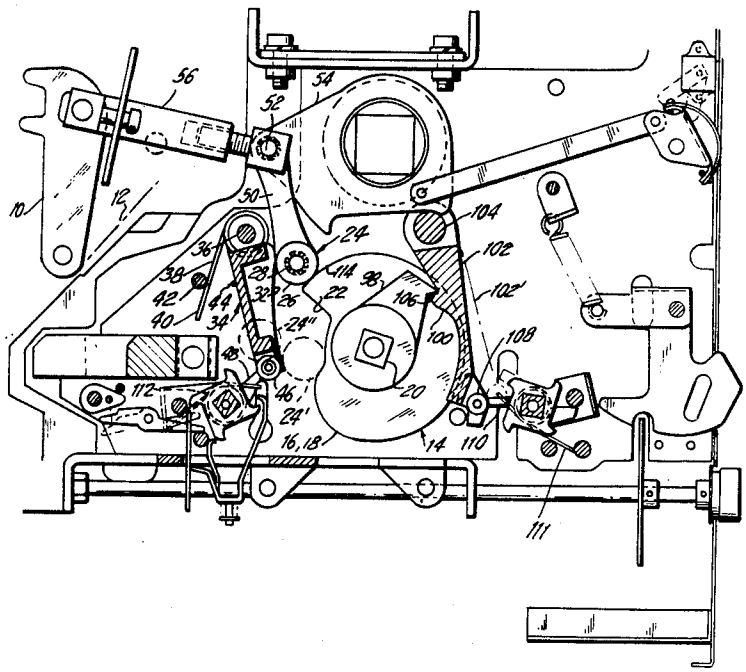
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ABSTRACT: Operating mechanism for moving circuit breaker contacts to their closed circuit position and for maintaining the contacts in their closed circuit position, which mechanism includes a spring-operated, rotatable cam member which, together with a defeatable guiding mechanism, controls the movement of a cam follower which, in turn, controls the movement of a cam follower which, in turn, controls the movable contact of the circuit breaker.

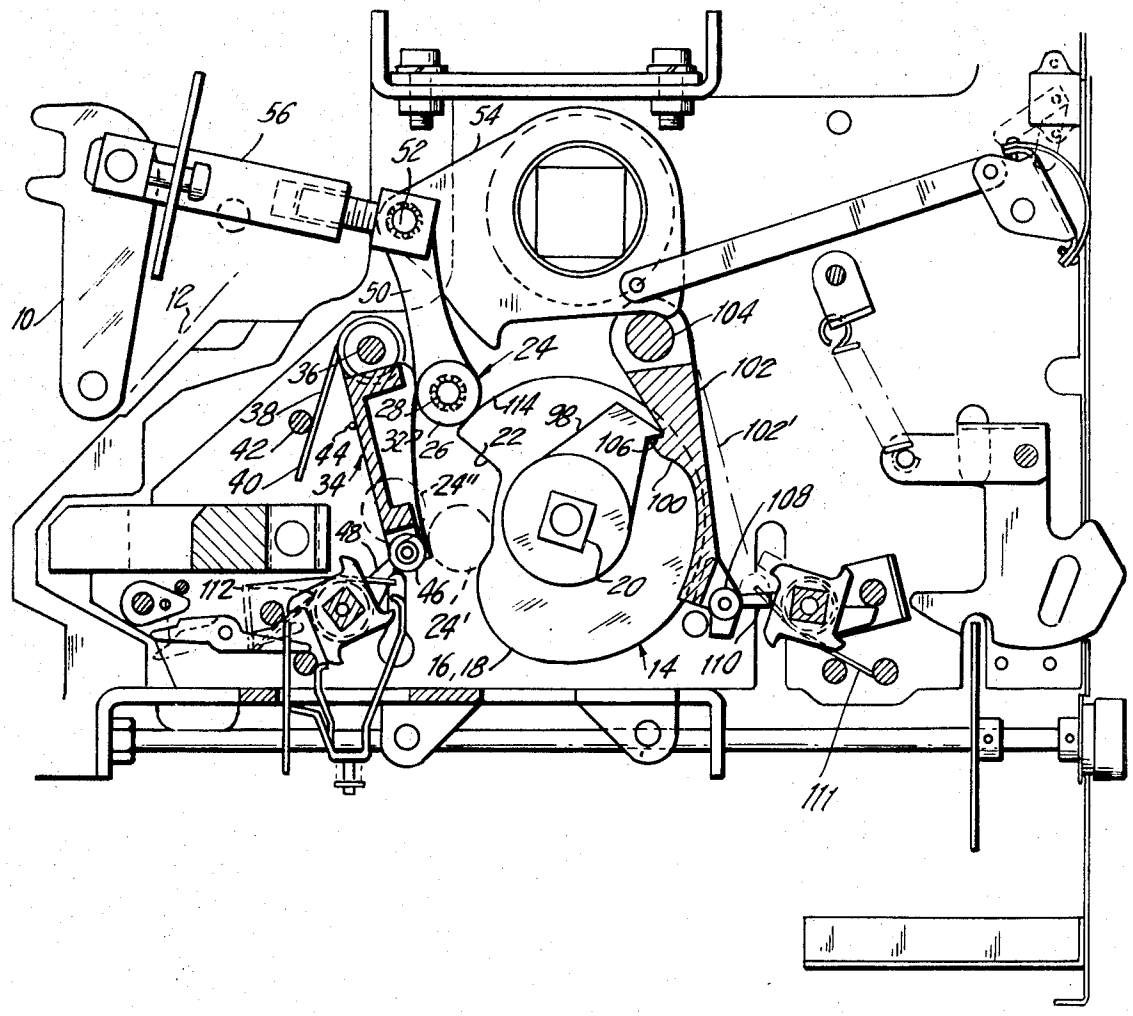


PATENTED DEC 22 1970

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SHEET 1 OF 4

FIG. 1



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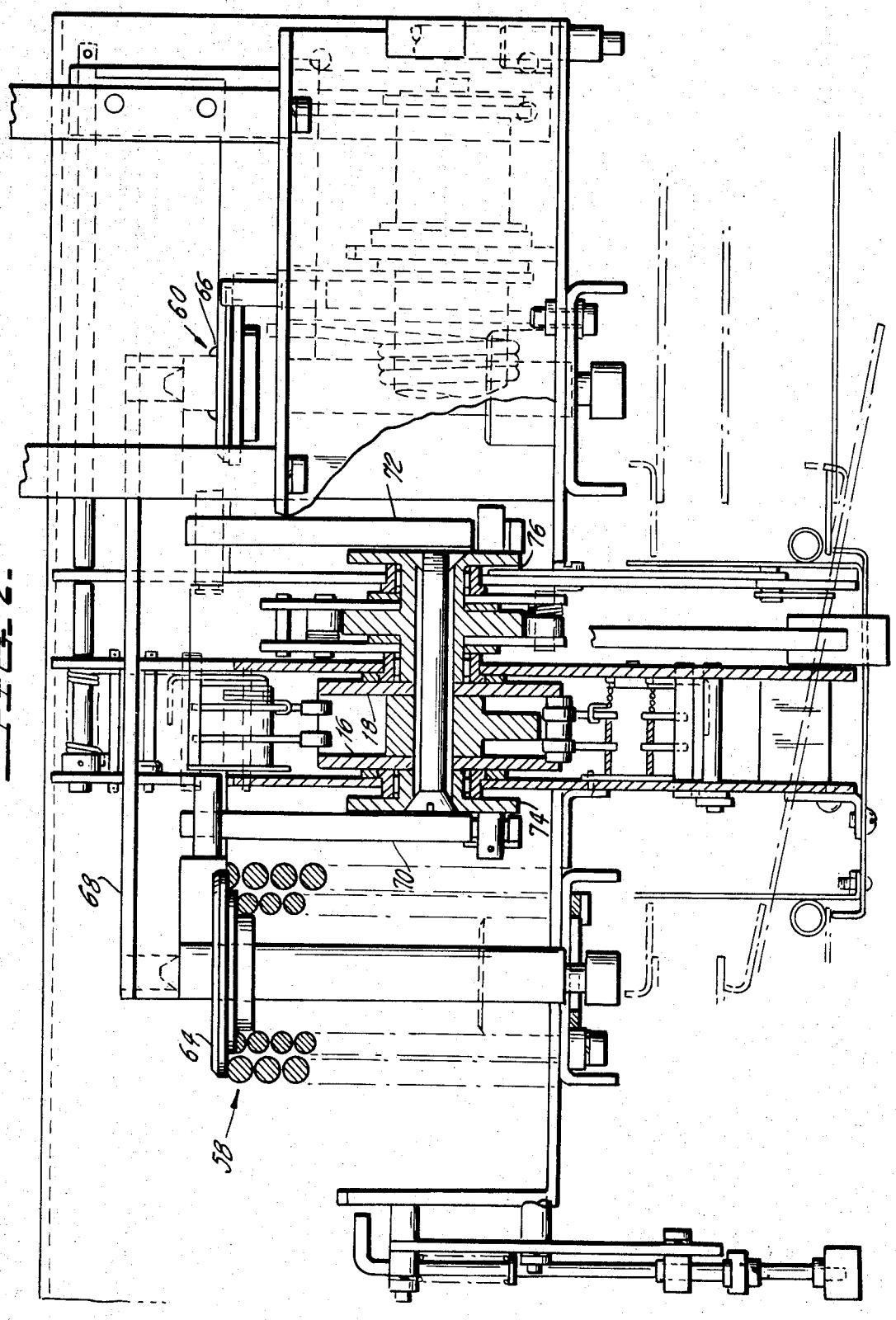


FIG. 2.

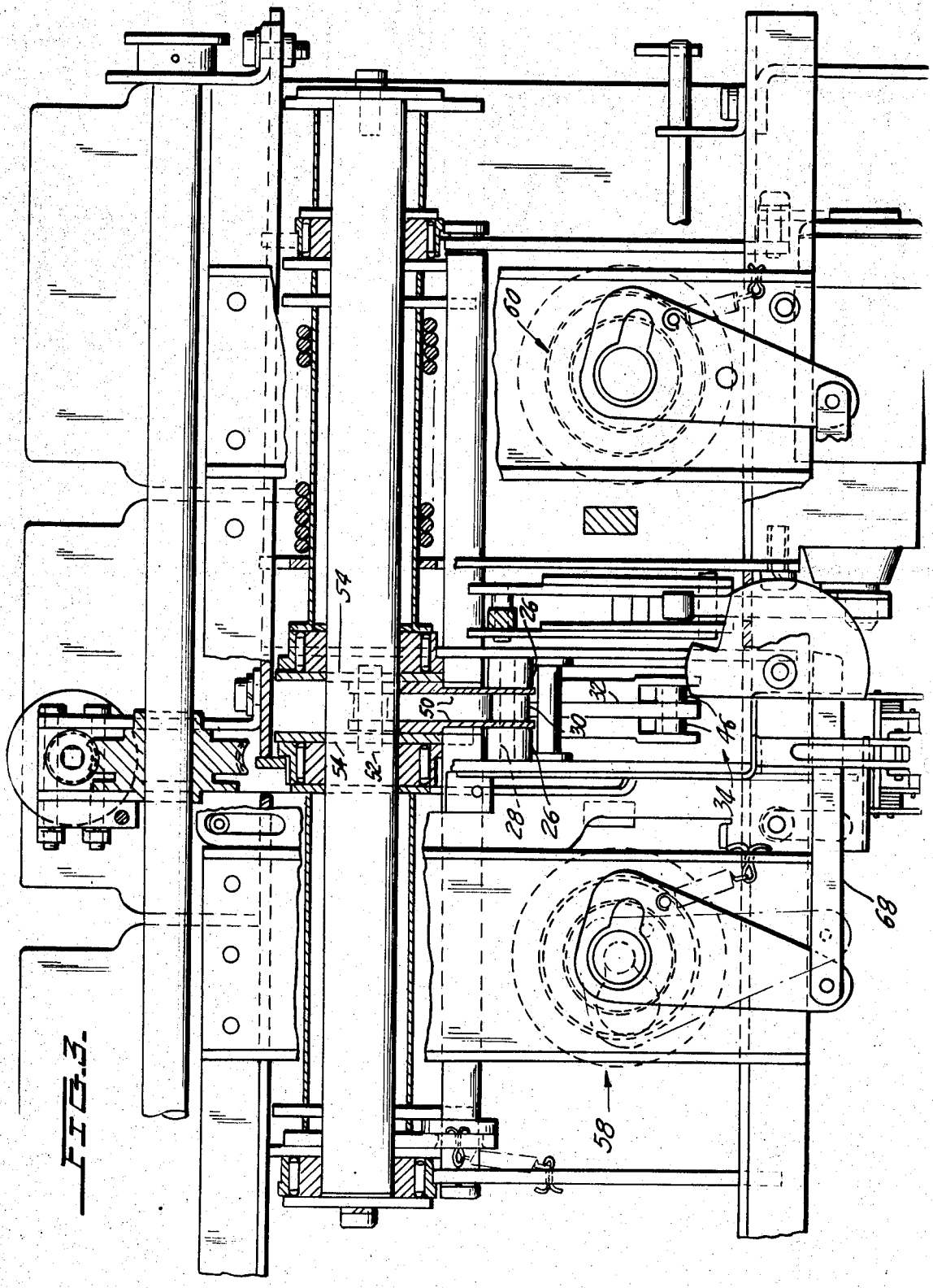
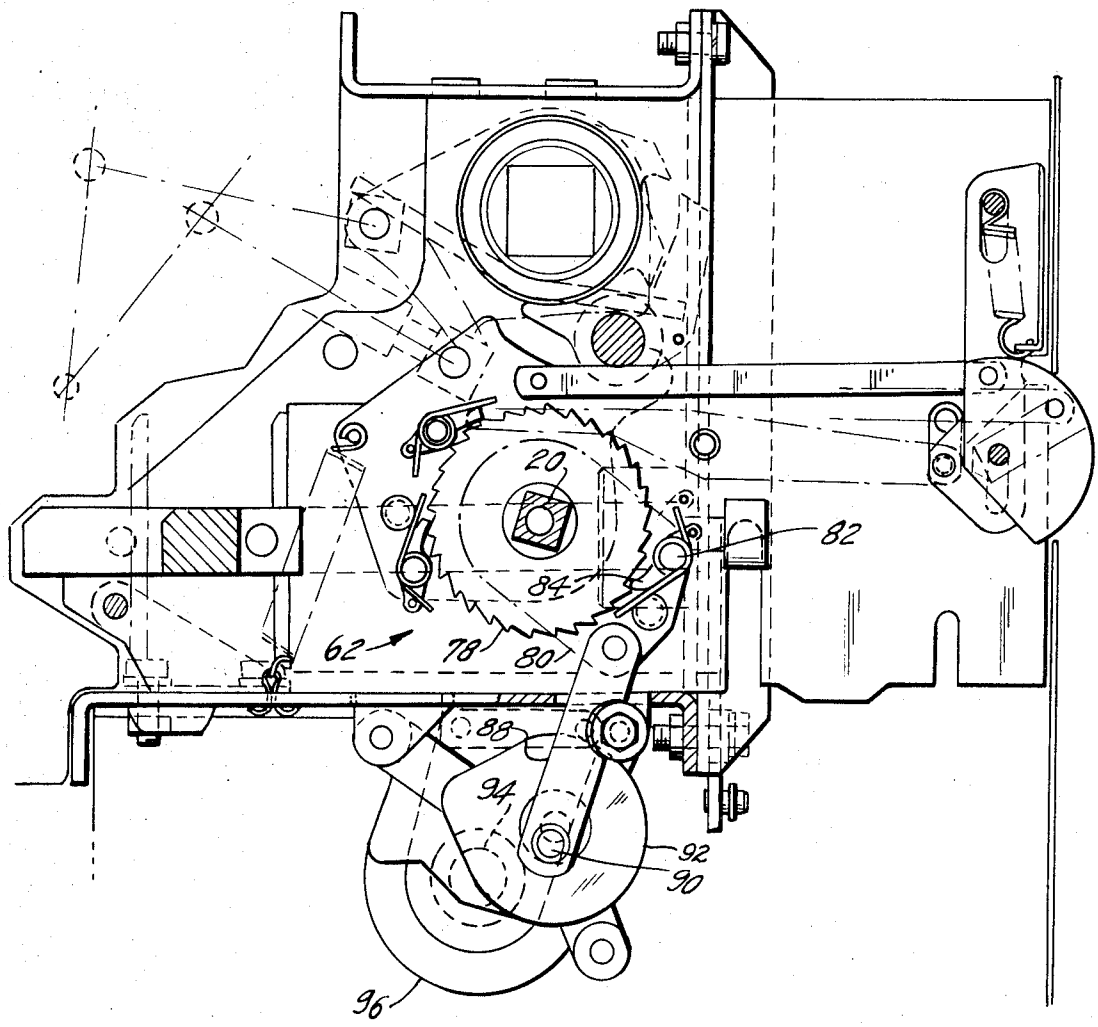


FIG. 3.

FIG. 4.



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CIRCUIT BREAKER OPERATING MECHANISM

This invention relates to circuit breakers, and more particularly relates to the operating mechanism of circuit breakers which controls the various movements of the movable contacts thereof between their open circuit and closed circuit positions.

As well known in the art, a conventional circuit breaker includes at least one pair of contacts which are separable in response to the occurrence of an overvoltage or short circuit fault condition to interrupt the flow of current therethrough. In such circuit breakers some type of operating mechanism must also be provided to close the contacts after the fault-initiated interruption has been cleared.

Several types of closing mechanisms are known, one type employing the discharge of a closing spring to rapidly snap the circuit breaker contacts to their closed circuit position, and another common type using the mechanical output of a high energy solenoid to snap the contacts closed. Regardless of which mechanism is being employed, there has always been required a certain amount of time at the end of the closing stroke for a spring-loaded prop latch to drop into place to hold the contacts closed. That is, in conventional circuit breakers energy expanded in closing the movable contacts is simultaneously utilized to charge or compress an opening spring which will be subsequently discharged to open the contacts upon the occurrence of a fault. Thus there is a need for a prop latch of some type to maintain the contact in its closed circuit position against the bias of the now-charged opening spring. A serious drawback with this type of system however is that there is always the possibility that the prop latch will not drop into place quickly enough to maintain the contacts in their closed circuit position. This situation can come about because of natural drift in mechanical tolerances or from a weak prop latch spring, or from an extremely quick closing operation which permits the contact to rebound toward its open circuit position before the prop latch has a chance to act.

A second type of mechanism used to maintain circuit breaker contacts in their closed circuit position uses an overcenter spring-biased toggle mechanism which holds the mechanism closed once the line of action of the toggle passes overcenter However, with this type of mechanism, after the toggle passes overcenter it must slam up against a stop and thereby runs the risk of being bounced back overcenter whereby the circuit breaker contacts will revert to their open circuit position. Furthermore, such toggles are also subject to damage from the continual impact they must absorb with each closing operation.

In contradistinction, the instant invention is directed to a circuit breaker closing mechanism which eliminates the various drawbacks prevalent in the prior art systems. Specifically, the instant invention utilizes the very closing cam, which in the prior art is simply used to drive the circuit breaker contacts, as the means for holding the circuit breaker contacts in their closed circuit position. In this manner, and as will be further described, such systems as prop latches or overcenter toggle latches are completely eliminated while at the same time the possibility of the circuit breaker inadvertently opening is virtually eliminated.

In a preferred embodiment of the instant invention, the closing mechanism includes a spring driven closing cam having a recess portion within which resides a cam follower directly linked to the circuit breaker contacts. A defeatable cam follower guide assembly is located adjacent the cam member, such that when the closing springs are discharged and the cam member rotated, the cam follower will be guidingly driven from a first position which corresponds to circuit breaker open position to a second position in which the circuit breaker contacts will be driven to their closed circuit position. Once the cam follower reaches the second position and the contacts are closed, the outermost peripheral portion dwell of the cam together with the internal surface of the guide arrangement positively maintain the cam follower in its second position such that the contacts remain positively closed. In the event of a fault requiring a circuit interruption, the aforementioned defeatable guide arrangement becomes freely pivotable such that the cam follower is free to drop to its first position during which time the circuit breaker contacts revert to its open circuit condition.

As a particularly advantageous feature of the instant invention, the closing mechanism hereof is trip-free in operation. That is, should the closing mechanism be in the process of closing the circuit breaker contacts, when a fault occurs, the aforementioned defeatable guide arrangement will rotate away from its guiding location with respect to the cam follower, whereby the breaker contacts may be snapped open despite the fact that the closing mechanism is continuing to drive the cam member through its cycle of operation.

Accordingly, it is an object of the instant invention to provide an operating mechanism for closing the movable contacts of a circuit breaker and for maintaining the contacts in their closed circuit position without the necessity of utilizing a prop latch or overcenter toggle mechanism prevalent in the prior part.

Another object of the instant invention is to provide such an operating mechanism for circuit breakers which utilizes the driving cam member thereof to maintain the circuit breaker contacts in their closed circuit position.

Another object of the instant invention is to provide such an operating mechanism for a circuit breaker which employs a defeatable guide arrangement which cooperates with a driving cam to move the circuit breaker contacts to their closed circuit position and which guide arrangement, when defeated, permits the circuit breaker contacts to revert to their open circuit position.

Yet another object of the instant invention is to provide such an operating mechanism for circuit breakers which is trip free in operation such that an opening operation may occur even though the closing mechanism has begun a cycle of operation.

These and other objects of the instant invention and a further understanding thereof may be had by referring to the following description and drawings, in which:

FIG. 1 shows a view, partly in section, of the closing mechanism of the instant invention;

FIG. 2 is a view illustrating the manner in which the closing spring of the closing mechanism of the instant invention is linked to the driving cam thereof;

FIG. 3 is a view, partly in section, illustrating the cooperation of various elements of the instant invention; and

FIG. 4 illustrates the mechanism for charging the driving springs of FIG. 2.

Turning to FIG. 1, there is shown the closing mechanism of the instant invention which utilized to drive a movable contact arm 10 between its open circuit position, schematically illustrated by the phantom line 12, and the closed circuit position (shown in solid) with respect to a stationary contact (not shown). Although only one contact arm 10 has been illustrated, it will be appreciated that the instant invention has application in a multiphase circuit breaker having a plurality of pairs of separable contacts in which case suitable interconnecting linkage would be utilized to effect simultaneous operation.

The operating mechanism includes a closing cam 14 which, as best seen in FIG. 2, actually comprises two cams 16 and 18 having the configuration shown in FIG. 1 which are mounted for rotation on a common shaft 20. The cams 16 and 18 include recess portions 22 which cooperatively engage, in a manner to be further described, a cam follower arrangement generally indicated 24 which is linked to the movable contact arm 10 in the following manner.

As best seen in FIG. 3, the cam follower arrangement 24 comprises a pair of closing rollers 26 carried by a common pin 28 and between which is rotatably mounted a latch roller 30. As will be explained in greater detail, the latch roller 30 rests against and is guided in movement by an internal guide surface 32 (see FIG. 1) extending from a rotatable guide member 34 pivotally mounted for rotation on a fixed pivot point 36. The

guide member 34 is normally biased in a counterclockwise direction by a tension spring 38, one end 40 of which bears against the fixed stop 42 while the other end of which, 44, engages the guide member 34.

At its opposite end, the guide member 34 is bifurcated (FIG. 3) and carries a pair of twin latch rollers 46 which normally rest on trip latches 48 (FIG. 1) so as to maintain the guide member 34 in the solid line position of FIG. 1. As will be explained in greater detail, rotation of the trip latch 48 in a clockwise direction as viewed in FIG. 1, frees the guide member 34 for rotation in a clockwise direction.

The cam follower arrangement 24 including the closing rollers 26, the common shaft 28, and the latch roller 30 are carried on a pair of links 50 which are connected by pin 52 to the jackshaft 54 which in turn is directly linked to the circuit breaker movable contacts 10 through insulating push rod 56.

As will be explained, rotation of the cam 14 drives the cam follower arrangement 24 from a first position illustrated in phantom at 24', to a second position (the solid line position of FIG. 1) during which movement, through the links 50 and 56, the movable contact 10 will be moved from its open circuit to its closed circuit position illustrated in FIG. 1.

The energy for driving the cam 14 is derived from a pair of closing springs 58, 60 (see FIGS. 2 and 3) compressed by a charging mechanism 62 (see FIGS. 2 and 4) of the step ratchet type, to be further described. The movable ends 64 and 66 of the closing springs 58 and 60, respectively, are connected by a slide bar 68 which in turn are connected by connecting rods 70 and 72 to crank arms 74 and 76 which are mounted on the common shaft 20 which carries the cam 14. Thus discharge of the closing springs 58 and 60 will rotate the crank arms 74 and 76, respectively, which in turn will rotate the shaft 20 to rotate the cam member 14.

The mechanism 62 for charging the closing springs 58 and 60 is best seen in FIG. 4 and includes a ratchet wheel 78 also mounted on the common shaft 20. Adjacent the ratchet wheel 78, but freely rotatable on shaft 20, is a driving pawl carrier 80 which at one pivot point 82 thereon carries a driving pawl 84 while at another pivot point 86 thereof is mounted one end of a link 88, the opposite end of which is mounted on a crank arm 90 carried offcenter of a cam 92 geared to the output shaft 94 of a motor 96. Energization of the motor rotates the crank arm 90 which in turn reciprocates the driving pawl carrier 80 to reciprocate the driving pawl 84 which in turn steps the ratchet wheel 78 to rotate the shaft 20 which in turn compresses the closing springs 58 and 60 through the crank arms 74 and 76, connecting rods 70 and 72, and the slide bar 68. The compression of springs 58 and 60 continues until connecting rods 70 and 72 pass just overcenter with respect to crank arms 74 and 76 at which time, by appropriate control circuitry, the motor 96 is deenergized. Since the connecting rods 70 and 72 pass overcenter with respect to crank arms 74 and 76, the compressed springs 58 and 60 would immediately discharge, and continue to rotate crank arms 74 and 76, but for the latching mechanism described immediately below.

Turning to FIG. 1, since the cam 14 is also mounted on shaft 20, it will experience the same movement as crank arms 74, 76. However, the common shaft 20 also carries a lever 98 which, just after rods 70, 72 pass overcenter engages a latch surface 106 such that the latch surface 106 prevents the charged closing springs 58 and 60 from rotating the cam 14 any further in the clockwise direction.

The latch surface 106 is carried on a latch lever 102 pivotally mounted at 104. The opposite end of the latch lever 102 carries trip rollers 108 normally held in the solid line position of FIG. 1 by a closing latch 110 biased to the position shown by spring 111. The closing latch 110 can be rotated clockwise against spring 111 to free the trip rollers 108 (and hence the latch lever 102) by manual or electrical means (not shown).

Assuming that the circuit breaker contacts 10 are in a closed circuit position of FIG. 1, and further assuming that the closing springs 58 and 60 have been previously charged in the manner described above, a complete cycle of circuit breaker operation might be described as follows. The occurrence of an overvoltage or short circuit in the line being protected by the circuit breaker energizes appropriate circuit monitoring systems (not shown) which in turn cause the clockwise rotation of the trip latch 48. (Alternatively a system may be provided to initiate the tripping operation by an operator's manual direction.)

Rotation of the trip latch 48 in a clockwise direction frees the latch rollers 46 such that the guide member 34 is free to be rotated against the bias of spring 38 in a clockwise direction about pivot point 36 in response to the downward movement of the cam follower arrangement 24 which occurs when the opening spring (not shown) snaps the movable contact 10 from the closed circuit position to the open circuit position (as the jackshaft 54 rotates counterclockwise). Under the bias of spring 38, the guide member 34 then swings back to the right in FIG. 1 allowing the trip latch 48 to return to its latching position under the influence of a small return spring 112.

The quick return of the guide member 34 to the solid line position of FIG. 1 allows the guide surface 32 thereof to guide the now falling cam follower 24 into the recess portion 22 of the cam 14 to the final resting position illustrated at 24'. When the cam follower arrangement 24 reaches the position 24', the contact 10 will be in the phantom position 12 and the breaker will be open.

To close the circuit breaker contact 10, mechanical or electrical means (not shown) are actuated to rotate the closing latch 110 in a clockwise direction whereby rollers 108 are freed, and the latch lever 102 will be urged by the biased lever 98 to the phantom line position 102'. As soon as the latch surface 106 moves out of the path of movement of lever 98, the closing springs 58 and 60 are free to discharge whereby, through the aforementioned described linkage, the cam 14 will be rapidly rotated in the clockwise direction.

During the initial portion of the revolution of the cam 14, the cam follower arrangement 24 will be guided by the guide surface 32 of the guide member 34 from the phantom position 24' to the solid line position indicated at 24 which in turn through the links 50 and 56 will rapidly snap the contact 10 to its closed circuit position. The closing springs will continue to discharge until the cam 14 has completed a 180° revolution. Then the motor is reenergized to continue rotating the cam 14 clockwise and recharging the springs until the lever 98 once again catches the latch surface 106 which has been returned to its latching position under the bias of spring 111 which, through latch 110, urges the latch lever 102 clockwise about pivot point 104 and at the same time allows the closing latch 110 to reset behind the rollers 108.

It will be appreciated that once the cam follower arrangement 24 reaches the solid line position of FIG. 1, and because of the then constant peripheral diameter 114 of the cam member 14, as it is rotating, the cam follower 24 will be positively retained in the solid line position of 24 and unable to return to its phantom position 24'. Thus retaining action is effected because of the narrowing restriction formed by the surface portion 114 of the cam and the internal guide surface 32 of the guide member 34. Thus the instant invention makes possible the retention of the circuit breaker in its closed circuit position without the necessity of a prop latch or overcenter toggle mechanism prevalent in the prior art.

As noted previously, the mechanism of the instant invention is also trip free in operation. That is, if the mechanism is in a closing cycle when a fault is detected in the circuit, it is imperative that the breaker contacts be allowed to revert to their open circuit position and not close into the fault. To this end, it will be appreciated that should a fault occur while closing is taking place, the trip lever 48 will rotate clockwise and free the guide member 34 for rotation in the clockwise direction. Thus the cam follower arrangement 24 in moving from its first position 24' toward its solid line position 24 will not travel directly between these points. Instead with the guide member 34 free to rotate, the cam 14 urges the cam follower 24 to a

third position illustrated in phantom at 24'' allowing the contact 10 to revert to its open circuit position under the influence of the opening springs (not shown) independently of the continuing clockwise rotation of the cam 14.

Thus there has been described a circuit breaker operating mechanism which controls the movement of a circuit breaker contact between its open circuit and closed circuit position and which retains the circuit breaker in its closed position without the necessity of prop latches or overcenter toggle mechanisms commonly used in the prior art. The mechanism of the instant invention is relatively simple, reliable and also permits trip-free operation.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, only by the appending claims.

I claim:

1. In a circuit breaker having a contact movable between an open circuit and closed circuit position, the improvement comprising an operating mechanism for moving said contact between its open circuit and closed circuit positions and for maintaining said contact in its closed circuit position, said operating mechanism comprising:

rotatable cam means;

driving means connected to said cam means for rotating said cam means in response to a predetermined command signal;

cam follower means riding on said cam means, said cam follower means linked to said contact for movement therewith, said cam follower means being movable between a first position in which said contact occupies its open circuit position and a second position in which said contact occupies its closed circuit position.

rotation of said cam means for a predetermined portion of a revolution moving said cam follower means between its first and second position;

whereby said contact will be moved between its open circuit and closed circuit position;

said cam follower guide means cooperating with said cam means and said cam follower means for guiding said cam follower means in its travel between its first and second position and for retaining said cam follower means in its second position;

said cam follower guide means being defeatable in response to the occurrence of a tripping operation in said circuit breaker, defeat of said cam follower guide means permitting said cam follower means to move between its second and first position such that said contact is free to be moved between its closed and open circuit position; and

wherein said cam follower means is movable between its said first position and a third position which is out of the normal path of travel of said cam follower means when said cam follower guide means is defeated by the occurrence of a tripping operation within said circuit breaker while said cam means is driving said cam follower means from its first toward its second position; whereby said circuit breaker can be tripped even during a contact closing operation.

2. In the circuit breaker of claim 1, wherein said cam means is rotated through a complete revolution after the occurrence of said predetermined command signal.

3. In the circuit breaker of claim 1, wherein said cam means includes a recess portion thereof which receives said cam follower means when said cam follower means is in its first position, rotation of said cam means for said predetermined portion of a revolution camming said cam follower means to its second position along the outermost circumference dwell of said cam means.

4. In the circuit breaker of claim 1, wherein said cam means also includes a dwell portion thereof which holds said cam follower means when said cam follower means is in its said second position; rotation of said cam means for the remaining recharging portion of a revolution preventing said cam follower from returning to its said first position.

5. In the circuit breaker of claim 3, and further including guide means pivotally mounted adjacent said cam means along the path of movement of said cam follower means, said guide means movable between a first position in which a surface thereof forces said cam follower means to move between its first and second position in response to rotation of said cam means, and a second position which permits said cam follower means to fall from its said second position to its said first position in said dwell, said second position of said guide means further permitting said cam follower means to move to a third position away from the influence of said cam means.

6. In the circuit breaker of claim 5, and further including trip means for permitting said guide means to be moved between its said first and second positions.

7. In the circuit breaker of claim 5, wherein said cam means is rotated through a complete revolution after the occurrence of said predetermined command signal such that said recess portion will be returned to its initial location to await receipt of said cam follower means in the event said guide means should be moved from its first to its second position to permit said cam follower means to fall from its said second position along said outermost circumference of said cam means.

8. In the circuit breaker of claim 7, wherein said driving means includes operating springs, the discharge of which rotates said cam means.

9. In the circuit breaker of claim 8, and further including charging means for charging said operating springs, said charging means including a motor operated driving pawl which continuously steps a ratchet wheel which is linked to said operating spring.

10. In the circuit breaker of claim 9, and further including defeatable latch means for maintaining said operating springs in their charged condition, defeat of said latch means in response to said command signal allowing said operating springs to discharge and rotate said cam means.

11. In the circuit breaker of claim 10, wherein said cam means is mounted on the same shaft as said ratchet wheel and said latch means cooperates with said cam means to retain said springs in their charged condition.

12. In the circuit breaker of claim 11, wherein said latch means is returned to its latching position prior to the time said cam means has rotated a complete revolution whereby rotation of said cam means will be positively limited to only one revolution for each discharge of said operating springs.