Dec. 5, 1933. C. THUMIM 1,938,408

SWITCH OPERATING MECHANISM

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Fig. 1.

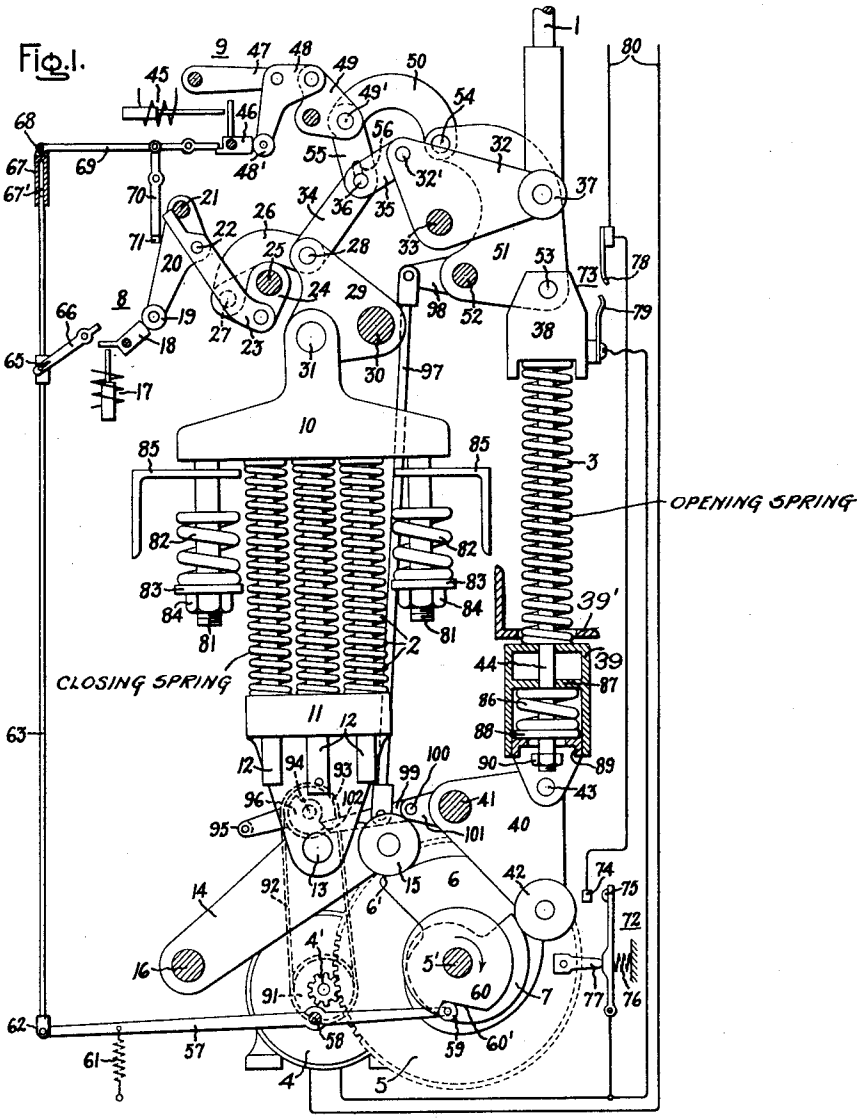

Fig. 2.

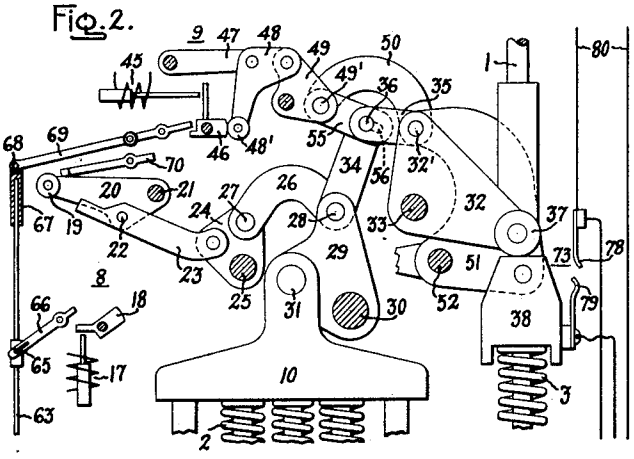

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Fig. 4.

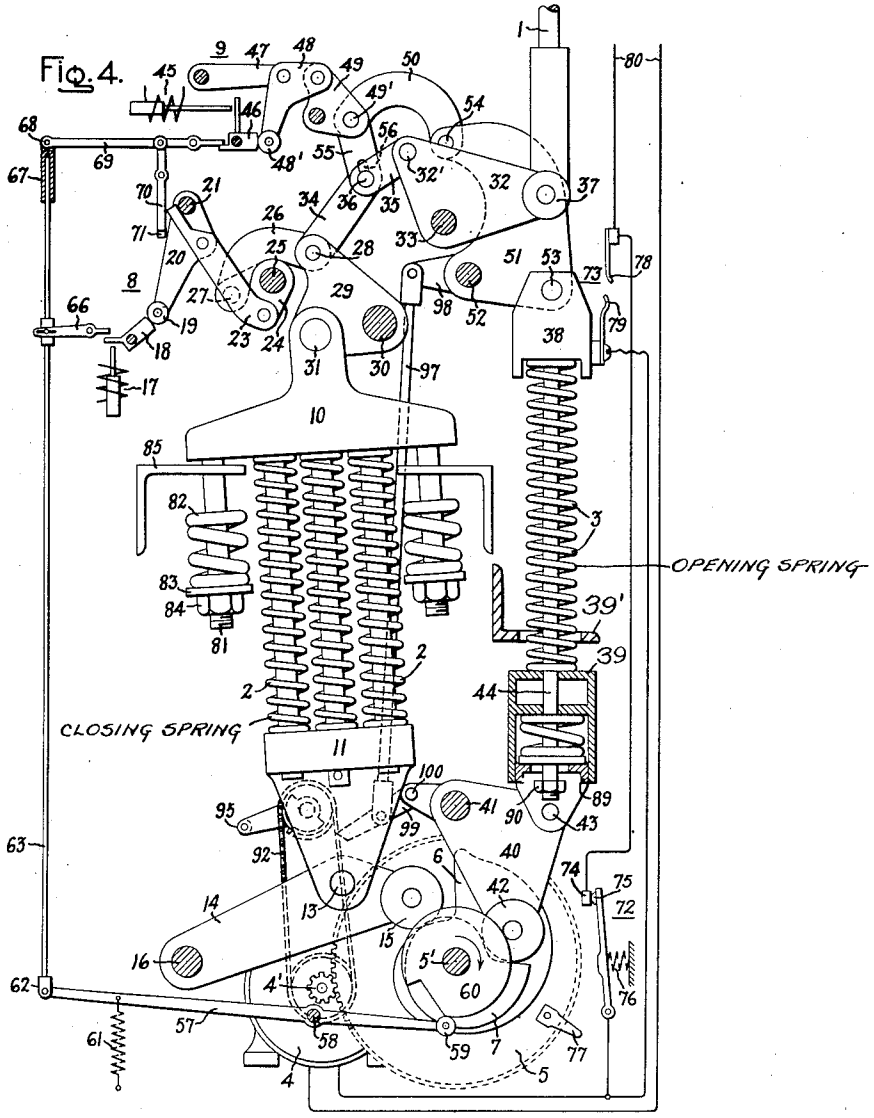
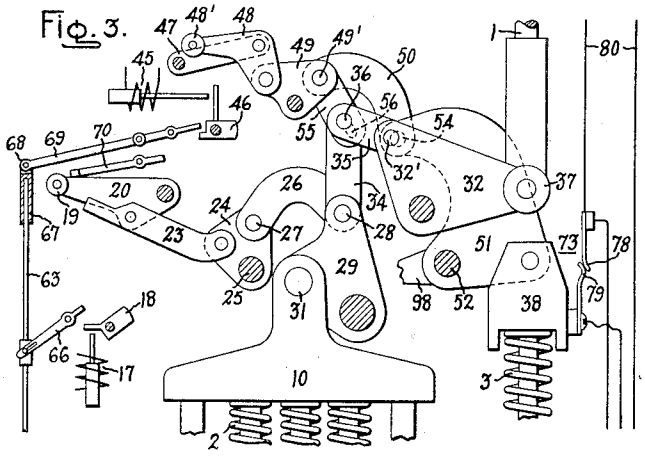


Fig. 3.



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UNITED STATES PATENT OFFICE

1,938,408

SWITCH OPERATING MECHANISM

Carl Thumim, Philadelphia, Pa., assignor to General Electric Company, a corporation of New York

Application September 4, 1931. Serial No. 561,215

12 Claims. (Cl. 200—92)

My invention relates to switch operating mechanism, more particularly to opening and closing mechanisms for large capacity circuit breakers.

A principal object of my invention is the provision of an improved switch-operating mechanism of the energy storing type which shall be positive and reliable in operation and rugged in construction.

A further object is the provision of improved interlocking means in a mechanism of the aforesaid type insuring a predetermined sequence of operation throughout an operating cycle.

In accordance with my invention the circuit-breaker opening and closing operations are independently controlled by separate energy storing devices, as strong compression springs, the springs being operatively connected through cam mechanism or the like to motive means for the purpose of effecting an energy storing operation on the springs. The springs, which may be designated as the opening and closing springs, are held in the charged or compressed positions thereof by corresponding latching and tripping means, which are in turn separately controlled to release the springs and cause opening or closing of the circuit breaker as the case may be. For the purpose of insuring proper sequence of operation of the mechanism, the tripping means controlling the release of the opening and closing springs are associated with mechanical interlocking means arranged so that neither spring may be tripped during the spring charging operation, which may be effected simultaneously on both springs, and also that release of the closing spring to close the breaker must occur prior to release of the opening spring.

My invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawings, Fig. 1 is an elevational view, partly in section, of switch-operating mechanism embodying my invention in the fully spring-charged open circuit position thereof; Fig. 2 is a partial view of the mechanism shown in Fig. 1 in the closed circuit position thereof; Fig. 3 is a similar view showing the mechanism in the open circuit position prior to resetting of the trip and latching means; and Fig. 4 shows the mechanism in the open circuit position at the beginning of the spring charging operation with the latch and tripping means reset.

Referring to Fig. 1, the circuit breakers (not shown) are operatively connected in any well known manner to the switch operating rod 1 so that downward vertical movement of the rod effects circuit closing and corresponding upward movement causes opening of the circuit. Circuit breakers of the type to which the present invention is applicable are large and massive in construction so that both the opening and closing operations require great force. Particularly is this true of the closing operation wherein the massive linkage and contact structure must be moved into position against compression of the usual springs (not shown) associated with the breaker mechanism. Although the circuit breaker contacts may be normally biased towards open circuit position, it is essential that a powerful initial accelerating force be applied if the contacts are to be separated within the few cycles required in the case of a short circuit.

The switch-operating rod 1 is arranged to be actuated, in a manner hereinafter described, by a set of powerful closing springs 2 and an opening spring 3, the springs 2 and 3 being operatively connected to the electric motor 4 through suitable reduction gearings 4' and 5 and cams 6 and 7 respectively, the gear 5 and cams 6 and 7 being mounted on a common shaft 5'. Energization of the motor 4 in a predetermined manner causes clockwise rotation of the cams 6 and 7 and charging of the closing and opening springs so that subsequent release of the springs is effective to actuate the switch rod 1.

For the purpose of restraining the closing and opening springs in the charged or energy storing position until the switch rod 1 is to be actuated, the springs 2 and 3 are individually related to the latching and tripping means 8 and 9 respectively, the arrangement being such that actuation of the trip 8 causes release of the closing springs 2 and downward or circuit closing movement of the switch rod 1 and actuation of the trip 9 causes simultaneous release of the switch rod 1 and opening spring 3 which produces a strong accelerating force to move the switch rod 1 upwardly to open circuit position.

Referring more particularly to the closing springs, there are provided relatively movable opposing blocks 10 and 11 between which the springs 2 are seated. The lower block 11 is provided with suitable openings through which extend in sliding relation the spring guide rods 12 which are secured to the upper block 10. The

block 11 is pivotally connected as at 13 to a lever 14 provided at its free end with a roller 15 bearing on the actuating face of the cam 6 and pivoted at its other end at 16 to the stationary frame (not shown). It is apparent that counter-clockwise movement of the lever 14 by the cam 6, assuming the block 10 to be stationary, causes the block 11 to move upwardly with respect to guide rods 12 and to compress springs 2. The block 10 is held stationary when the springs 2 are compressed by the tripping and latching means 8 above referred to, the block 10 being operatively connected through toggle linkages to the means 8. The tripping and latching means comprise a tripping solenoid 17 and a latch or prop 18 arranged to be engaged by a roller 19 carried at the free end of a toggle link 20. The link 20, having a stationary pivot 21, forms one portion of the tripping toggle whose common pivot is at 22 uniting the link 20 to the link 23. The tripping toggle 20—23 is connected to the block 10 by a crank 24 having a fixed pivot 25, a curved link 26 pivotally connected as at 27 to a crank 24, and as at 28 to a crank 29 which is likewise mounted on a fixed pivot 30 and is pivotally connected to the block 10 at 31. In the charged position of the springs 2 as illustrated in Fig. 1 the block 10 is held stationary by the underset toggle 20—23 and toggle 24—26, movement of the prop 18 in a clockwise direction causing collapse of the toggles under the bias of springs 2. The consequent clockwise rotation of the crank 29 transmits corresponding movement to the crank 32 having a fixed pivot 33, through collapsible thrust-transmitting structure including the links 34 and 35 which are pivotally united by pin 36. The crank 32, hereinafter referred to as the closing crank, is pivotally connected to the switch rod 1 and is provided with a roller 37 forming the lower extremity of the rod 1.

The opening spring 3, which is likewise mounted between a pair of relatively movable bearing blocks 38 and 39, is charged by counter-clockwise rotation of the crank 40 pivotally mounted on the frame at 41 and provided with a roller 42 bearing on the actuating face of the cam 7. The crank 40 is pivotally connected as at 43 to a flange forming part of the bearing block 39 which is provided with suitable apertures through which the spring guide rod 44 extends in sliding relation thereto. Assuming that the upper block 38 is held stationary, counter-clockwise rotation of the crank 40 is effective to raise the block 39 and compress the opening spring 3. As in the case of the closing springs, the opening spring is likewise held in the charged position by the tripping and latching means 9 comprising the tripping solenoid 45 and latch 46 arranged to be biased in a clockwise direction by the solenoid 45. The tripping toggle 47—48, which is held in underset position by the latch 46 as in the previous instance, is connected to the block 38 by a linkage comprising crank 49, curved link 50 and crank 51. The crank 51, which rotates about the stationary pivot 52 is pivotally connected at its shorter lever arm as at 53 to the block 38, and at its longer lever arm at 54 to the link 50. The roller 37 forming the lower end of the switch rod 1 is directly in alignment with the block 38 and abuts the upper surface of the block when the mechanism is in the closed circuit position as illustrated in Fig. 2. As in the case of the opening trip toggle, actuation of the latch 46 in a clockwise direction by its actuating solenoid 45 releases the roller 48' causing collapse of the toggle 47—48 due to the forces exerted by the circuit breaker on switch rod 1 and by the spring 3 which rotates the crank 51 in a counter-clockwise direction and urges the switch rod 1 upwardly towards open circuit position.

A connection, for a purpose hereinafter explained, is provided between the tripping toggle 47—48 and the pivot pin 36 joining the thrust links 34 and 35 comprising a link 55 having a slot 56 in which the pin 36 is free to slide. This lost motion connection is necessary by reason of the relative lengths of lever arms of the cranks 51 and 32.

In apparatus of this character it is essential that the operation be carried out in a predetermined sequence. For example, it should be impossible to trip either the opening or closing springs during the spring charging operation and to trip the opening spring prior to tripping of the closing spring. Energization of the motor to recharge the springs should likewise be prevented except in the case where the circuit breaker is open and both springs discharged.

For this purpose there is provided positive mechanical interlocks for precluding tripping of the springs except in a predetermined order, and auxiliary switches for controlling energization of the motor. The mechanical interlocking means comprises a lever 57 pivotally mounted as at 58 and provided at one end with a roller 59 bearing on the actuating face of the interlock controlling cam 60 which is mounted on the shaft 5'. The lever 57 is normally biased as by spring 61 into engagement with the cam surface and is connected through a pin connection 62 to a rod 63 mounted for vertical reciprocal movement in a stationary guide. The rod 63 is connected through a pin and slot connection 65 to a pivoted locking lever 66 associated with the latch 18 and is in sliding engagement through a lost motion connection with a member 67. A pin connection 68 connects the member 67 with the pivoted locking lever 69 which is associated with the latch 46. The rod 63 abuts the end of a recess 67' in member 67 in which it slides after a certain upward movement to cause rotation of the lever 69 to its locking position whereas lowering of the rod 63 is ineffective by itself to change the position of said locking lever.

In the position illustrated in Fig. 1, the interlock actuating lever 57 engages the low side or notch 60' of the interlock cam 60 so that the rod 63 is biased downwardly by the spring 61 and the locking lever 66 permits free actuation of the latch 18. In this position the rod 63 is lowered within the recess 67', the locking lever 69 being maintained in its locking position by a pivoted prop 70. When the latch 46 is locked out by the lever 69, it will be noted that energization of the solenoid 45 is ineffective to cause release of the opening spring.

In order that the locking lever 69 shall be released only after release of the closing springs, the prop 70 is provided with an offset lug 71 directly in the path of the toggle link 20. It will be apparent that collapse of the toggle 20—23 as indicated in Fig. 2 in response to release of the closing spring causes the link 20 to rotate the prop 70 in clockwise direction to release the locking lever 69 which in turn rotates in a counter-clockwise direction under the influence of gravity or suitable biasing means to the position illustrated in Fig. 2.

The auxiliary switches controlling energization of the motor 4 comprise a limit switch 72 controlled in accordance with the positions of the spring charging and interlocking cams, and a switch 73 controlled in accordance with the position of the opening spring block 38. The limit switch 72 comprises a stationary contact 74 and a pivotally mounted contact 75 normally biased, as by spring 76, towards closed position. Suitably mounted on the gear 5 is a lug 77 arranged to bias contact 75 to open position when the cams are in the position shown in Fig. 1. The auxiliary switch 73 comprises a fixed contact 78 and a contact 79 carried by the block 38 arranged so that the contacts are in engagement, as illustrated in Fig. 3, when the opening spring is released. It will be noted that the switch 73 is in shunt with limit switch 72 so that energization of the motor from the supply source 80 may be effected by closing either switch 72 or 73.

In order to reduce or minimize the impact due to release of the closing and opening springs, there are provided suitable shock absorbing means, as buffer springs. To this end the block 10 has secured thereto a pair of depending bolts 81 on which a pair of buffer springs 82 are mounted. The springs seat at one end on the disks 83 held in position by the nuts 84 and are arranged to engage the stationary guide members 85 when the block 10 is projected upwardly a predetermined distance by the springs 2. The buffer for the opening spring comprises a spring 86 seated between a portion 87 of the block 39 and a disk 88 slidable with respect to the guide rod 44 and abutting an annular shoulder 89 likewise forming part of the block 39. When the spring 3 is released, the guide rod 44 which is carried upwardly by the block 38 engages the disk 88, by means of nut 90, thereby transmitting the opening impact after a predetermined upward movement of the block 38 to the buffer spring 86 and to the stationary stop 39'.

The operating cycle of the mechanism is as follows:

When the mechanism is in the spring charged open circuit position illustrated in Fig. 1 the motor circuit is open through both auxiliary switches 72 and 73, and the interlocking means through the locking lever 69, locks out the tripping latch of the switch rod 1 and opening spring 3. The latch 18 of the closing spring is however operative and when it is desired to close the circuit breakers, the operator, through a suitably arranged push button control or the like, energizes the solenoid 17 to release the latch 18 and cause collapse of the toggle 20—23. When this occurs the closing springs 2, which are supported by the roller 15 on the cam 6, project the block 10 upwardly with a powerful thrust to cause straightening of the toggle 35—55 and clockwise rotation of crank 32, lowering the switch rod 1 to the closed circuit position shown in Fig. 2. It will be noted that during clockwise rotation of the crank 32 the pin 49' connected to the link 55 is held stationary so that links 35 and 55 operate as a thrust toggle.

The closed circuit position of the mechanism wherein the closing springs are discharged and the opening spring still charged is shown in Fig. 2. It will be noted that immediately after actuation of the closing tripping toggle, the opening spring latch is no longer locked out and release of the opening spring may take place. This is true even though the closing operation has not been completed since the initial collapse of the closing spring toggle 20—23 actuates the prop 70 and releases the locking lever 69. The mechanism is therefore mechanically trip-free after initiation of the circuit closing operation and electrically trip-free when the circuit breaker contacts engage.

In the event that the opening spring is tripped during the circuit closing operation, the pin 49' is released by tripping of the latch 46 and moves counterclockwise out of its thrust transmitting position so that the energy of the springs 2 is dissipated by the buffer springs 82. By this arrangement wherein the link 55, through the pin 36, maintains the links 34, 35 in thrust-transmitting position while the opening spring is held latched, the application of the closing force to the switch rod 1 is immediately removed in response to trip-free action so that the switch rod is not subjected to severe impact by the opening spring when it is released. Since the upper block 38 of the opening spring has a short travel as compared with the opening stroke of the switch rod 1, this short travel being for the purpose of applying a large accelerating force to the switch rod during the initial opening movement, the opening spring 3 during trip-free action may not engage the switch rod 1, the energy in that case being dissipated by the buffer spring 86.

With the mechanism in the second position of the cycle, that is as shown in Fig. 2, the switch rod 1 which is lowered to the completely closed circuit position abuts the opening spring block 38 through the roller 37. In this position the opening spring 3 is in readiness to exert a powerful upward opening thrust on the switch rod 1 in response to actuation of the latch 46 by the tripping solenoid 45. It will be apparent that the tripping solenoid 45 may be controlled in any well known manner in response to abnormal circuit conditions or by a push button circuit, and manually controlled means for actuating the latch 46 may likewise be employed.

The third position of the cycle wherein the opening spring has been released is shown in Fig. 3. On release of the latch 46, the opening spring 3 causes collapse of the tripping toggle to the position shown and simultaneous counterclockwise rotation of the cranks 51 and 32 initially accelerating the opening movement of the switch rod 1. Since the lever arm of crank 51 connected to pin 54 is greater than the corresponding lever arm of crank 32 connected to pin 32', the pin 49' moves counter-clockwise at a greater rate than pin 32'. To compensate for this difference the pin and slot connection between link 55 and pin 32' permits the toggle to stretch during the above described operation. After the accelerating force has been applied the usual circuit breaker springs complete the circuit opening operation without difficulty.

It will be noted that the spring 3 in discharging moves the contact 79 of the auxiliary switch 73 into engagement with contact 78 thereby completing a temporary circuit through the motor 4. It will likewise be noted that the springs of the mechanism are completely discharged and the toggles in the collapsed released positions thereof, the cams 6 and 7 still being in the first position shown in Fig. 1. When the circuit is completed through the

auxiliary switch 73 however the cams, which are mounted on the common shaft 5' connected to the large gear 5, are rotated slowly in a clockwise direction with the result that both rollers 15 and 42 very shortly fall from the corresponding high sides of the cams to the low sides as shown in Fig. 4. This causes lowering of the closing and opening springs and stretching of the toggles to the original reset position shown in Fig. 1. Lowering of the opening spring block 38 consequently breaks the circuit at the auxiliary switch 73 but initial rotation of the gear 5 has in the meantime moved the lug 77 out of engagement with the limit switch contact 75 so that the motor circuit is completed through this switch for the remainder of the spring charging operation.

The aforesaid initial rotation of the cams likewise brings the roller 59 of the interlock lever 57 to the high side of its cam 60 thereby causing elevation of the rod 63 and movement of the locking levers 66 and 69 to their respective locking positions so that neither the closing nor opening latches may be tripped.

The cams charging the closing and opening springs may be of any suitable design and are preferably of the constant power output type. As the gear 5 is slowly rotated in a clockwise direction by its driving motor, the rollers 15 and 42 are gradually elevated to the high sides of the respective cams until they have reached the position shown in Fig. 1 wherein the gear 5 has completed a whole revolution. When this position has been reached the lug 77 again opens the motor circuit through the contacts 74 and 75, overtravel of the motor mechanism due to inertia being prevented by a bump or high point 6' on the cam 6. This arrangement serves to bring the mechanism to a stop due to the large force required further to compress the closing springs 2. It will likewise be noted that a complete revolution of the cams brings the interlock cam 60 to its original position wherein the roller 59 drops into the notch 60'. The resulting lowering of the rod 63 unlocks the closing spring latch 18, the prop 70 however holding the locking lever 69 in its locking out position.

It will be noted that the switch-operating mechanism above described, as designed, provides for the usual operating requirements, as trip-free operation, and likewise through its interlocking system insures a predetermined sequence of operation so that even an unexperienced or careless operator cannot damage the mechanism. For example, it is impossible for the operator to release the closing spring before the charging operation is complete or to energize the motor circuit until both springs have been discharged. Premature release of the closing spring would cause but incomplete closure of the breaker contacts, and severe burning of the same during the final closing which would obviously take place at very low speed. In the event that the motor circuit were energized after the closing spring had discharged, the roller 42 of the opening spring in riding over the high side of the cam would drop onto the low side of the cam with such force that damage to the cam or other part of the mechanism might result. Furthermore, locking out the opening spring until release of the closing spring insures a complete cycle of operation since it is essential that the circuit breaker be open during charging of the springs.

In case of failure of the driving motor, suitable means, as a ratchet (not shown), may be associated with the gear 5 for the purpose of preventing reverse rotation of the cams. Manually operated means of any suitable type may be provided for completing charging of the springs.

There is shown, by way of example, in Figs. 1 and 4 one form of manual operating means which may be used in case the motor is not available. The arrangement comprises a differential linkage operatively connected to the opening spring 3 so that overcharging of the opening spring beyond the point shown in Fig. 1 is prevented. The manual operating means for rotating the spring charging cams preferably comprises a chain and sprocket connection, the sprocket wheel 91 being mounted on a shaft which may be detachably keyed to an extension of the main pinion shaft 4'. The sprocket wheel 91 is connected through the chain 92 to the sprocket wheel 93 which is mounted on a shaft 94 on which is keyed the operating crank 95. Likewise keyed to the shaft 94 is a locking member 96 comprising an abutment arranged to be blocked in a manner hereinafter described to prevent rotation of the crank 95 in a direction charging the springs. It will be apparent that counter-clockwise rotation of the crank 95 causes clockwise rotation of the spring charging and interlocking cams in the manner previously described.

For the purpose of convenience in use the sprocket wheel assembly may be mounted on a suitable frame which may be attached to the exterior of the mechanism frame and arranged to engage an extension of the pinion shaft 4'.

The blocking means for rendering inoperative the manual operating means when the springs are fully charged comprises a differential linkage connected by a rod 97 to both the lower and upper opening spring cranks 40 and 51 respectively. The rod 97 at its upper end is pivotally connected to an arm 98 keyed to the shaft 52 and operating in unison with the crank 51, and at its lower end to a link 99. The link 99 is pivotally connected at 100 to an arm 101 which is likewise keyed to the shaft 41 and moves as a unit with the crank 40. The free end of the link 99 is provided with a beveled face 102 arranged to engage a coacting abutment on the locking member 96 preventing further rotation thereof.

In the spring-charged position shown in Fig. 1 the link 99 is raised so that it blocks further spring charging operation and prevents riding of the cam rollers over the high faces of the cams. When the opening spring is tripped in the usual manner, the interlocking means heretofore described insuring proper sequence of operation, the consequent counter-clockwise rotation of crank 51 lowers the rod 97 and link 99 so that the crank 95 is no longer blocked. Initial rotation of the cams, as in the previous instance, permits the cam rollers to drop onto the low faces of the cams, resetting the toggles so that the springs are ready for recharging. During the resetting operation the cranks 40 and 51 obviously move in unison in clockwise direction causing movement of the arms 98 and 101 in the same direction. Even though the link 99 is moved upwardly to a certain extent the rod 97 maintains the outer or blocking end of the link 99 in a position too low to interfere with the abutment on member 96. Accordingly the springs may be recharged to the position shown in Fig. 1 wherein the differential linkage again blocks further operation of the crank 95.

It should be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. Switch-operating mechanism comprising a switch actuating rod, closing and opening springs operatively related to said rod, cam structure storing energy in said springs, tripping means releasing the energy in said springs for actuating said switch rod, and means actuated in accordance with the position of said cam structure positively locking said tripping means during said energy storing operation.

2. Switch-operating mechanism comprising a switch actuating rod, closing and opening springs operatively related to said rod, cams effecting individual charging of said springs, tripping means individual to the closing and opening springs for releasing the same and causing actuation of said switch rod, and mechanical interlocking means actuated in accordance with the positions of said cams locking out said tripping means during said spring charging operation.

3. Switch-operating mechanism comprising switch closing and opening springs, a plurality of cams, one of said cams arranged to charge said closing spring and another to charge said opening spring, latching means individual to said springs holding the same in charged positions, tripping means individually associated with said latching means for releasing said springs, and interlocking means related to another of said cams locking out said latching means during the spring charging operation so that release of said springs during said operation is precluded, said interlocking means at the completion of said charging operation rendering operative the closing spring latch while maintaining inoperative the opening spring latch.

4. Switch-operating mechanism comprising switch closing and opening springs, means charging said springs, latching means individual to said springs holding them in charged positions, and tripping means individually related to said latching means causing release of said springs, said opening spring latching means operatively connected by a thrust transmitting member to said closing spring so that release of said opening spring latching means permits trip-free operation of the switch during discharge of the closing spring.

5. Switch-operating mechanism comprising switch closing and opening springs, means charging said springs, latching and tripping means individual to each spring for separately releasing the same, and thrust transmitting structure including a toggle for effecting the switch closing operation upon release of said closing spring, one portion of said toggle connected to the opening spring-tripping and latching means arranged so that the mechanism is trip-free during release of said closing spring.

6. Switch-operating mechanism comprising switch closing and opening springs, means charging said springs, latching means individual to said closing and opening springs holding the same in the charged positions thereof, interlocking means controlled in accordance with the position of said springs, said interlocking means preventing release of said latching means to release said springs during charging thereof, said interlocking means rendering operative said closing spring latching means when said springs are fully charged, a member restraining said interlocking means to lock out the opening spring tripping means, and means associated with said closing spring actuating said member and rendering operative said opening spring latching means immediately upon actuation of said closing spring latching means.

7. In switch-operating mechanism including switch closing and opening springs and means charging said springs, interlocking means insuring predetermined sequence of release of said springs comprising a locking member actuated in accordance with the position of said spring charging means, said member controlling release of said closing spring, a second locking member having a lost motion connection with said first member and controlling the release of said opening spring, a prop restraining said second member in locking position independently of said first-named member, said first-named member being in an inoperative position and said second member in a locking position when both of said springs are charged for precluding actuation of said opening spring prior to said closing spring, and means actuated immediately upon release of said closing spring moving said prop and causing said second member to move to an inoperative position permitting release of said opening spring.

8. Switch-operating mechanism comprising switch closing and opening springs, a plurality of cams individually charging said springs, a motor actuating said cams, latching and tripping means individual to said springs controlling the release thereof, a limit switch actuated in accordance with the position of said cams deenergizing said motor when said springs are charged, and means preventing overtravel of said cams after deenergization of said motor comprising a high point on one of said cams.

9. Switch-operating mechanism comprising switch closing and opening springs, a plurality of cams individually charging said springs, a motor actuating said cams, toggle structure individual to said springs restraining the same in the charged positions thereof, latching and tripping means associated with said toggle structures separately releasing said springs, a limit switch controlled in accordance with the position of said cams deenergizing said motor when said springs are charged, said springs reacting on the high sides of said cams in the deenergized position of the motor, interlocking means preventing release of the opening spring prior to release of the closing spring, and a second switch associated with said opening spring energizing said motor upon release of said opening spring, the consequent actuation of said cams by said motor permitting lowering of the springs towards the low sides of said cams thereby stretching said toggles and resetting said latching means.

10. Switch operating mechanism comprising switch closing and opening springs, means charging said springs, latching means individual to said springs holding them in charged positions, tripping means individually related to said latching means causing release of said springs, and collapsible thrust transmitting means including a lost motion connection operatively interconnecting said closing spring and said

opening spring latching means arranged so that said opening spring is trip-free during release of said closing spring.

11. Switch operating mechanism comprising a switch operating rod, a closing spring operatively connected by collapsible thrust transmitting structure to said rod, means for charging said closing spring, latching means for holding said spring in charged position, tripping means associated with said latching means for causing release of said spring and closing movement of said switch rod, a second latching means operatively connected through a lost motion connection to said collapsible structure for maintaining the same in thrust transmitting position, and separate tripping means associated with said last-named latching means for causing collapse of said thrust transmitting structure and trip-free operation of said switch rod during release of said closing spring.

12. Switch operating mechanism comprising a switch operating rod, switch closing and opening springs, means charging said springs, latching means individual to said springs holding them in charged positions, tripping means individually related to said latching means causing release of said springs, a toggle connection between said closing spring and switch operating rod, and a link interconnecting said opening spring latching means and said toggle arranged to hold said toggle in thrust-transmitting position, actuation of said opening spring tripping means causing collapse of said toggle and trip-free movement of said switch operating rod during release of said closing spring.

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