April 8, 1958 J. A. FAVRE 2,829,737

STORED ENERGY OPERATING DEVICE

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Fig. 1.

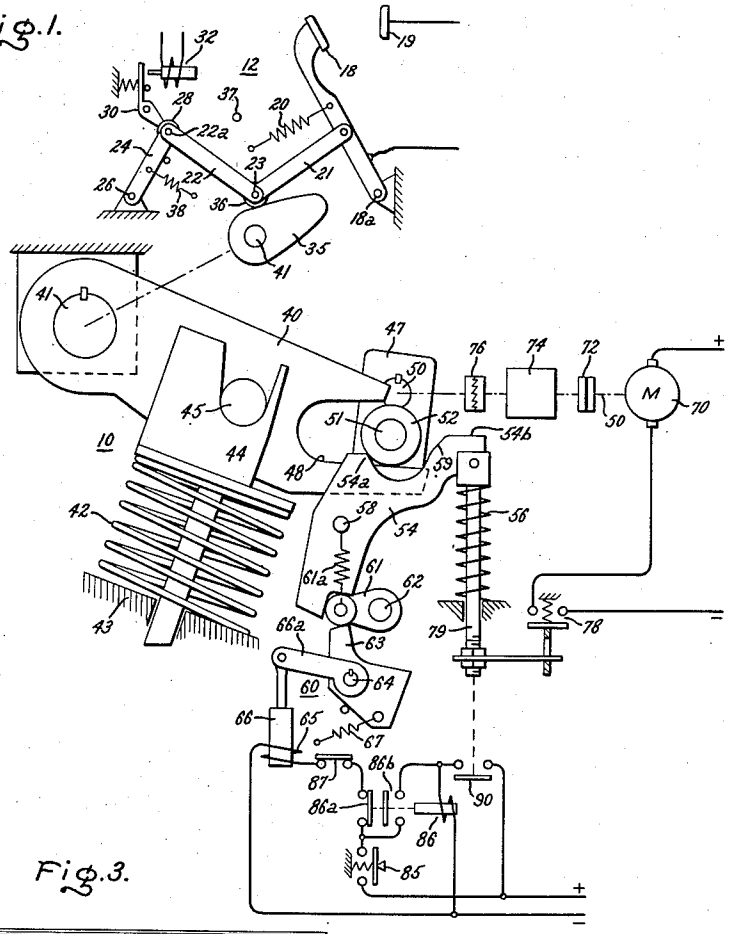
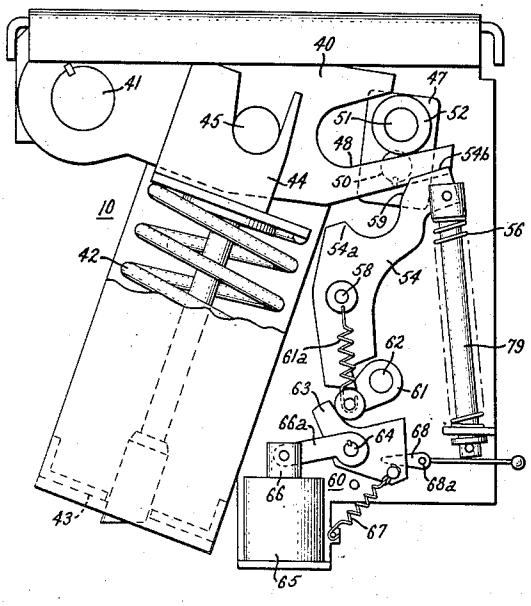


Fig. 3.



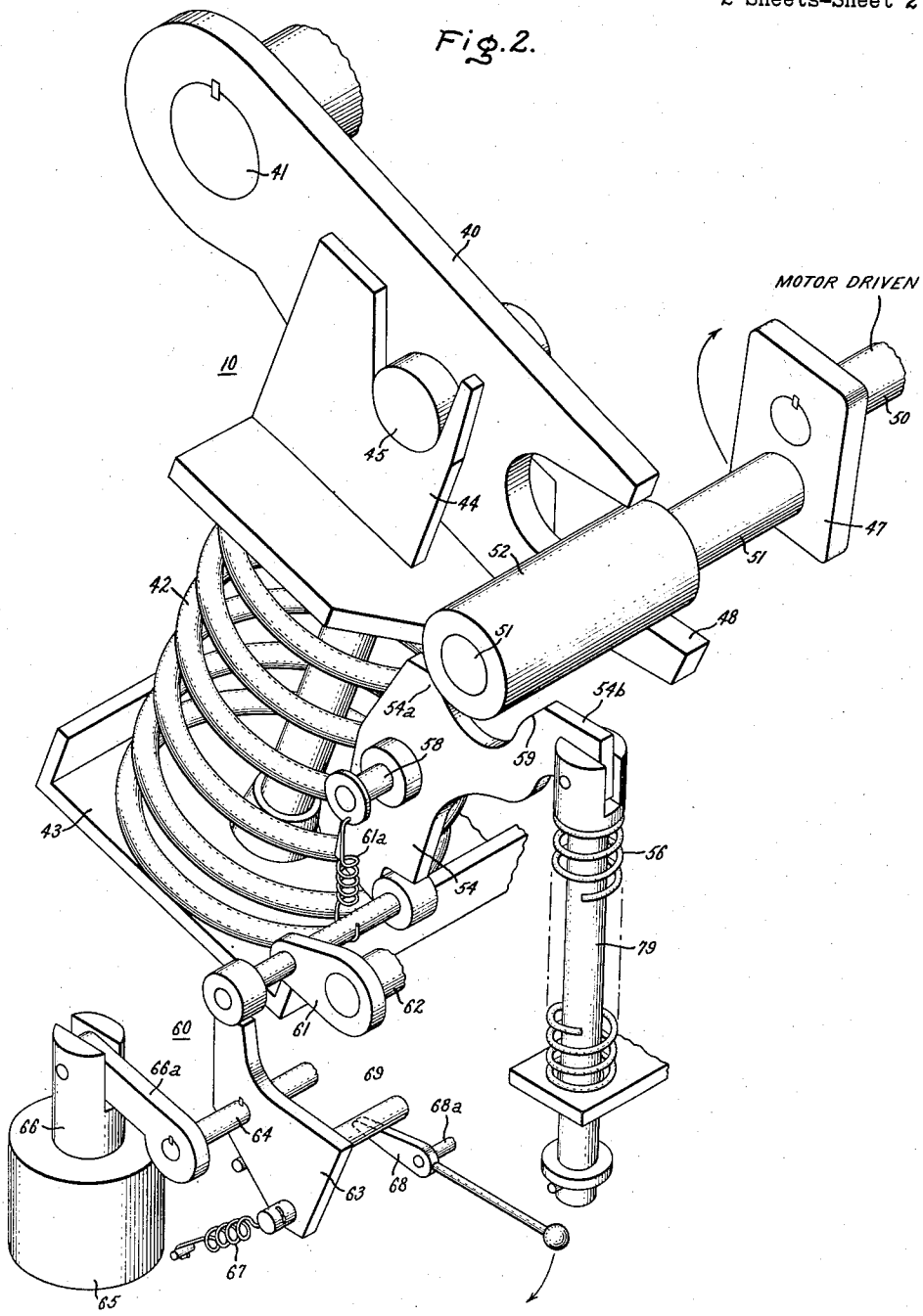
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Fig. 2.



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2,829,737

STORED ENERGY OPERATING DEVICE

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Application February 14, 1957, Serial No. 640,178

10 Claims. (Cl. 185—37)

This invention relates to a stored-energy operating device and, more particularly, to a stored-energy operating device which is especially suited for high-speed closing and reclosing of large electric circuit breakers.

The invention is more specifically concerned with improvements in the general type of stored-energy device disclosed and claimed in my Patent No. 2,674,345, assigned to the assignee of the present invention. The operating device disclosed in the aforementioned patent comprises a heavy compression spring which is charged by the action of a small electric motor rotating a spring-controlling member toward a dead-center position with respect to the spring. Rotation of the controlling member is continued until it reaches a predetermined position past dead-center, where it is held by suitable latch means. When the latch means is released, the heavy compression spring, which then has been charged, quickly discharges, and this discharging action is utilized to produce closing of a circuit breaker.

A disadvantage of the patented device is that, if by chance, the spring-controlling member should be stopped short of its latched position and within the angle of repose in the region of dead-center, then subsequent release of the latching means would have no effect on the spring. The spring would be stalled due to its inability in this position to overcome the opposing forces of static friction. As a result, the spring would be ineffective to produce closing of the circuit-breaker in the desired manner, at least until otherwise discharged.

Another disadvantage of the patented device is that it relies for its successful operation upon the latched or blocked position of the controlling member being located beyond the angle of repose for the operator. Otherwise, the above-described stalling of the spring would take place upon release of the latch means. The problem which results from locating the latched position beyond the angle of repose is that in such location the heavy spring, which is then fully charged, is exerting a large force on the latch means. This not only severely stresses the structural parts of the latch means but also necessitates the use of relatively large forces in order to subsequently release the latch means.

Accordingly, an object of my invention is to provide a stored-energy operator of this general type in which release of the latch means consistently produces immediate spring discharge, even in those cases where the spring-controlling member had been stopped short of its latched or blocked position and within the angle of repose of the operator.

Another object is to construct the operator in such a manner that it is possible to locate the above-described overcenter latching position within the angle of repose.

Another object is to construct the stored-energy device in such a manner that the latch which restrains the spring in charged position can be released by a force of relativity low magnitude.

In carrying out my invention in one form, I charge a main spring by driving a rotatable spring-controlling member toward a dead center position with respect to the spring. Rotation of the spring-controlling member is continued until it is carried past geometric dead-center. Upon movement of the spring-controlling member into a predetermined position past dead center, the spring acts to discharge and thereby to further rotate the spring-controlling member. Such further rotation is blocked, however, by a stop member which is held in a blocking position by suitable releasable latch means. Release of the latch means renders the stop member ineffective to block said further rotation and also brings into operation an auxiliary spring. This auxiliary spring acts through the stop member to drive the spring-controlling member through said predetermined position past dead-center, whereupon the main spring then acts to discharge and further rotate the spring-controlling member.

For a better understanding of my invention, reference may be had to the following specification taken in connection with the accompanying drawings, wherein:

Fig. 1 is a diagrammatic representation of a circuit-breaker operating system including a stored-energy operating device embodying one form of my invention.

Fig. 2 is an enlarged perspective view of the stored-energy operating device shown in Fig. 1 with the parts thereof being shown in the same operative positions as shown in Fig. 1.

Fig. 3 is an enlarged side-elevational view of the operating device with the parts thereof shown in operative positions different from those of Fig. 2.

Referring now to Fig. 1, the stored-energy operator is shown at 10, and the circuit-breaker which it is designed to close is shown at 12. This circuit breaker 12 can be of any suitable conventional type and is, accordingly, shown in schematic form only.

As shown in Fig. 1, the circuit breaker 12 comprises a pair of relatively-movable interrupting contacts 18 and 19. One of these contacts 18 is pivotally mounted at 18*a* and is biased to the open-circuit position shown by a suitable spring 20. Closing forces are transmitted to the movable contact 18 by a conventional trip-free operating mechanism which comprises a pair of toggle links 21 and 22 pivotally joined together by a knee 23. One of the toggle links 21 is pivotally connected at its opposite end to movable contact 18, whereas the other of the toggle links 22 is connected by a pivot pin 22*a* to the upper end of a guide link 24. This guide link 24 is pivotally supported at its lower end on a fixed fulcrum 26. The pivot pin 22*a* carries a latch roller 28 which cooperates with a suitable trip latch 30. So long as the trip latch 30 remains in the latched position shown, the toggle 21, 22 is capable of transmitting thrust to the movable contact 18. Thus, when the knee 23 is lifted from the position shown in Fig. 1, the toggle 21, 22 is extended and drives the movable contact 18 toward the closed-circuit position.

This lifting of the knee 23 is accomplished by the action of a suitable rotatable cam 35 cooperating with the usual roller 36 which is mounted at the knee 23. When this cam 35 is rotated counterclockwise from its position of Fig. 1, it lifts the knee and produces closing in the manner described hereinabove. Preferably, the cam 35 is arranged to drive the toggle 21, 22 slightly overcenter and against a stop 37 so that the movable contact will be held in closed-circuit position even when the cam 35 is returned to its original position of Fig. 1.

Should the latch 30 be tripped when the breaker is closed, or even during the closing stroke, the toggle 21, 22 will be rendered inoperative to transmit thrust to the movable contact 18. As a result, the opening spring 20 will be free to drive the movable contact 18 to its open-circuit position. A suitable resetting spring 38 cooperates with the guide link 24 to reset the mechanism to the latched position after it has been tripped. The above-

described tripping of the latch 30 is accomplished in response to predetermined electrical conditions by relying upon a suitable solenoid 32.

For driving the cam 35 counterclockwise to produce the above-described closing of the circuit-breaker 12, the stored-energy operating device 10 is relied upon. Referring to Figs. 1 and 2, this operating device 10 comprises a pivotally-mounted lever 40 which is keyed to a drive shaft 41. The drive shaft 41 is rotatably mounted in conventional bearings and is suitably coupled to the cam 35. Thus, when the lever 40 is driven counterclockwise from its position of Fig. 1 or Fig. 2, it acts through the cam 35 to produce circuit-breaker closing.

For imparting such counterclockwise closing motion to the lever 40, a heavy compression spring 42 is provided. This compression spring 42 reacts at its lower end against a stationary abutment 43 and at its upper end against an adapter 44 which is pivotally coupled to the lever 40 through a transverse pin 45 carried by the lever 40. The compression spring 42 is releasably held in a charged position, which is shown in Fig. 1, by means of a rotatable spring-controlling crank 47 coacting with a cam surface 48 formed at the outer end of the pivotal lever 40. The controlling crank 47 is mounted for overcenter action with respect to the compression spring 42, and when the crank 47 releases the lever 40 (in a manner soon to be described), the compression spring 42 quickly discharges and drives the lever 40 counterclockwise to close the breaker.

Referring to Figs. 1 and 2, the spring-controlling crank 47 is keyed to a rotatable shaft 50 and comprises a transversely projecting crank pin 51 located at its outer end. Carried on the crank pin 51 is an antifriction roller 52 which is freely rotatable thereon but is suitably restrained against axial movement thereon. One portion of this roller 52 engages the cam surface 48 of the lever 40, whereas another portion is disposed to engage a projecting portion 54*a* of a stop member 54. As will soon appear more clearly, the stop member 54 is releasably latched in the position of Fig. 2 and is operable, so long as held in this position, to block clockwise motion of the crank 47 beyond the position of Fig. 2.

In the position of Figs. 1 and 2, the crank 47 is located beyond dead-center with respect to the line of action of the compression spring 42, but only slightly therebeyond, and preferably still within the angle of repose. By the term "angle of repose" is meant that angular distance in the region of geometric dead-center within which the spring 42 provides insufficient rotational force component to overcome the opposing static friction. Assuming then that the crank 47, as shown in Figs. 1 and 2, is within the angle of repose, it would be necessary in order to initiate discharge of the spring 42 to further rotate the crank 47 in a clockwise direction through the outer limit of the angle of repose. Assuming no interference from the stop member 54, the main spring 42 would then be free to discharge and close the breaker. A suitable overrunning clutch 76 assures that no significant forces opposing spring discharge will be transmitted through the crank shaft 50.

For rotating the crank 47 clockwise through this outer limit of the angle of repose, I provide an auxiliary, or kick-off, spring 56, which is coupled to one end of the stop member 54. This auxiliary spring 56 is a compression spring tending to rotate the stop member 54 counterclockwise about its supporting pivot 58. The auxiliary spring is normally restrained from so rotating the stop member 54 by releasable latching means 60 (soon to be described). When, however, the latching means 60 is released, the auxiliary spring 56 responds by rapidly driving the stop member 54 in a counterclockwise direction. A cam surface 59 formed on the upper portion of the stop member 54 transmits this motion to the crank pin 51 with sufficient impact to promptly drive the crank 47 clockwise beyond the angle of repose, whereupon the main spring 42 quickly discharges. In this chain of events, the projecting portion 54*a* of the stop member 54 offered no opposition to such discharge inasmuch as it had been rotated out of the path of the crank pin roller 52 by the auxiliary spring 56. Because of its action during the above-described starting operation, the member 54 will occasionally be referred to hereinafter as a "starter member." It will be apparent that the starting forces transmitted through this member 54 from the auxiliary spring 56 act through a line of action which is angularly spaced from the line of action of the main spring 42.

The latching means 60 comprises a prop 61 against which the lower end of the stop member 54 abuts. The prop 61 is rotatable about a pivot 62 but is held in an elevated, undercenter position by a latching cam 63 seated beneath the prop 61. When the latching cam 63 is pivoted in a counterclockwise direction about the axis of its mounting shaft 64, it moves out of supporting relationship with the prop 61. As soon as this occurs, the stop member 54 becomes free to rotate in a counterclockwise direction brushing aside the prop 61. This allows the auxiliary spring 56 to discharge and produce the operations described above. A light tension spring 61*a* biasing the prop 61 toward its position of Figs. 1 and 2 is utilized to aid in subsequent resetting of the latch means 60.

For pivoting the latching cam 63 counterclockwise so as to effect the above-described release of the latching means 60, a solenoid 65 is provided. When this solenoid 65 is energized, it drives its armature 66 downwardly. This produces counterclockwise rotation of a lever 66*a*, which is keyed to the shaft 64, and thereby produces the desired counterclockwise movement of the latching cam 63, which is also keyed to the shaft 64. A suitable resetting spring 67 is coupled to the latching cam 63 for resetting the latching cam to its position of Figs. 1 and 2 at an appropriate instant after the solenoid 65 is subsequently deenergized.

Release of the latching means 60 can also be effected manually. To this end, a manually operable lever 68 pivoted at 68*a* is provided. When this lever is pivoted in a clockwise direction, it acts against a pin 69, carried by the latching cam 63, to produce counterclockwise tripping movement of the latching cam 63.

After the main spring 42 has discharged to produce the above-described closing of the circuit breaker 12, the spring is recharged by means of a suitable unidirectional motor 70. This motor 70 is connected to the crank 47 through a slip clutch 72, reduction gears 74, and the overrunning clutch 76. These latter components may be of any suitable conventional type and are, therefore, shown in schematic form only. Preferably, however, they correspond to similar components depicted in my U. S. Patents 2,674,345 and 2,667,076, which are assigned to the assignee of the present invention. The primary purpose of the overrunning clutch 76 is to assure that the desired high-speed discharge of the main spring 42 will not be impeded by the inertia of the reduction gears 74 or the armature of motor 70. To this end, the overrunning clutch 76 permits the main spring 42, in discharging, to drive the crank 47 clockwise independently of the reduction gears 74 and the motor armature. As shown in my aforesaid patents, suitable pawl and ratchet means are associated with the reduction gears 74 to insure against back-tracking of the crank 47.

For energizing the motor 70 to initiate recharging action, a normally-open switch 78 connected in series with the motor is provided. The movable contacts of this switch 78 are preferably actuated by a control rod 79 connected to the stop member 54 and, accordingly, they are closed as soon as the stop member 54 initiates discharge of the main spring 42. The motor 70 thereupon begins to operate but does not overtake the crank 47 until the crank has decelerated near the end of the closing stroke. When this occurs, the motor acts to continue the clockwise rotation of the crank 47 and thereby to recharge the then-discharged main spring 42, as will

soon be described. Fig. 4 shows the position of the crank 47 as this recharging action is beginning.

Considering now a spring-charging operation—when the crank 47 is driven clockwise by the motor 70 from the position of Fig. 3, it acts through the roller 52 and the cam surface 48 to force the lever 40 downwardly, thereby compressing the main spring 42. As this action progresses and the crank 47 approaches a lower dead-center position with respect to the main spring 42, the roller 52 on the crank pin 51 engages a follower surface 54*b* formed on the stop member 54. Thereafter, continued clockwise movement of the crank 47 drives the stop member 54 clockwise about its pivot 58, thus compressing the auxiliary spring 56 and, in effect, resetting the stop member 54 toward its initial position of Fig. 1. After a predetermined amount of such clockwise resetting movement of the stop member 54, the latching mechanism 60 is free to reset underneath the stop member 54. Thereafter, continued clockwise movement of the crank 47 carries the roller 52 off of the follower surface 54*b*, and the latching mechanism 60 acts through the stop member 54 to hold the auxiliary spring 56 charged. The position of the stop member 54 when it has been latched in place by the latching mechanism 60 is shown in Figs. 1 and 2.

The above-described charging operation is terminated by opening the energizing circuit for the motor 70 at an instant which is appropriate for assuring latching of the stop member 54. To this end, the switch control rod 79 opens the motor-controlling contacts 78 when the stop member 54 nears the end of its clockwise movement. Thereafter, the crank 47 coasts into its final position shown in Figs. 1 and 2.

This final position, as previously indicated, is beyond geometric dead-center relative to the main spring 42, but only slightly there beyond and preferably within the angle of repose. As a result, the static friction which is present is alone sufficient to hold the main spring in the charged position of Figs. 1 and 2. Accordingly, the main spring 42 is then exerting no material force upon the stop member 54 or upon the latching mechanism 60. This is highly desirable not only because of the low stresses imposed upon the latching mechanism 60 but also because it enables me to utilize a relatively small solenoid (65) for subsequently releasing the stop member 54. The main spring 42, in effect, produces no frictional forces which oppose the subsequent latch-releasing action of the solenoid 65.

The primary purpose of the projection 54*a* formed on the stop member 54 is to assure that the crank 47 is not unintentionally driven clockwise past the position of Figs. 1 and 2. For example, if the crank 47 coasted excessively after motor cut-off, or, if for any reason, the motor cut-off switch 78 failed to open in the desired manner, the projection 54*a* would block movement of the crank 47 past the position of Figs. 1 and 2. The slip clutch 72, which is connected between the motor 70 and the gear train 74, assures that excessive forces are not transmitted from the motor to the stop member 54 when the crank engages the stop member. To this end, the slip clutch slips, or yields, in a well-known manner when the forces being transmitted therethrough reach a predetermined maximum safe level.

After the operating device 10 has been driven into the position of Figs. 1 and 2, closing of the circuit-breaker can again be initiated in the same manner as previously described. That is, the latching mechanism 60 can be released by the solenoid to allow the auxiliary spring 56 to drive the stop member 54 into engagement with roller 52. This quickly carries the crank 47 through the outer limit of the angle of repose, at which time the main spring 42 is free to discharge and produce breaker-closing.

An important advantage of my disclosed operating device 10 resides in the fact that the main spring can be successfully discharged even if the crank 47 had been previously stopped short of the position of Figs. 1 and 2. In this regard, so long as the crank roller 52 had been stopped at any point between the projection 54*a* and the surface 54*b* of the stop member, the main spring can still be successfully discharged. This follows from the fact that the auxiliary-spring 56 is capable of driving the crank 47 through the angle of repose irrespective of the precise initial position of the crank roller 52, provided, of course, that this initial position is clockwise beyond the surface 54*b* of the stop member 54.

In vew of this relatively wide range of acceptable initial positions, it will be apparent that the motor cut-off point during a charging operation is not highly critical. Minor variations can be tolerated in the point at which such cut-off occurs without materially affecting a subsequent discharging operation.

Proper electrical control of the spring-releasing solenoid 65 is obtained by relying upon a suitable X—Y control scheme. This control scheme, which is shown diagrammatically in Fig. 1, comprises a closing-control switch 85 connected in series with the coil of solenoid 65 across a suitable source of control power. This switch 85 may be operated either manually or by suitable condition-responsive means. Also connected in series with the coil of solenoid 65 are the normally-closed contacts 86*a* of an anti-pump relay 86 and the contacts 87 of a breaker auxiliary switch. This auxiliary switch is a so-called "*b*" switch, that is, its contacts 87 are closed when the circuit breaker 12 is open and are open when the circuit breaker 12 is closed.

Assume first that the breaker 12 and its operating device 10 are in the position of Fig. 1 and that it is desired to close the breaker. The closing-control switch 85 is first operated to closed position, and this establishes an energizing circuit for the solenoid 65 which extends from one terminal of the power source, through the contacts 86*a*, 87, and the coil of solenoid 65, to the other terminal. Upon energization, the solenoid 65 releases the latch means 60 and allows the auxiliary spring 56 to actuate the stop member 54 to initiate breaker-closing discharge of the main spring 42. Such actuation of the stop member 54 closes a normally-open cut-off switch 90 coupled to the stop member, and this results in the establishment of an energizing circuit for the anti-pump relay 86. The relay 86 responds by opening its normally closed contacts 86*a* and closing its normally-open contacts 86*b*. Closing of the contacts 86*b* establishes a seal-in circuit for the anti-pump relay 86, which holds this relay 86 in its operated position so long as the closing control switch 85 is held closed. This seal-in circuit extends from the plus terminal, through the switch 85, the contacts 86*b*, and the coil of the anti-pump relay 86 to the other terminal.

When the motor 70 completes its charging operation (in the manner previously described), the cut-off switch 90 returns to its open position of Fig. 1. If, at this time, the attendant should still be holding the closing control switch 85 closed, the aforementioned seal-in circuit through the contacts 86*b* will be maintaining the anti-pump relay 86 energized. So long as the relay 86 remains energized in this manner its contacts 86*a* remain open thereby preventing another operation from being initiated by the closing-control switch 85 so long as such switch is held closed. It is necessary to first reopen the closing-control switch 85 before another breaker-closing operation can be initiated. Thus, pumping is effectively prevented.

As pointed out hereinabove, I prefer to locate the normal blocked position of the spring-controlling crank 47 within the angle of repose so as to reduce the loading on the latching mechanism (60) and so as to enable the latch to be released by a relatively small solenoid. If these factors are not controlling, then the normal blocked position can be located slightly beyond the outer limit of

the angle of repose, and the device will still operate in a similar manner. In such arrangements, if the crank 47 is unintentionally stopped slightly short of its normal blocked position and within the angle of repose, the starter means 54, 56 will act to initiate spring discharge upon release of the latching means 60, thereby assuring against stalling of the spring.

In those applications in which it is desired to effect automatic reclosing of the above-described circuit breaker, the closing control switch 85 is arranged to close automatically in response to a breaker-opening operation, thereby initiating an automatic reclosure. Circuits for providing the desired control over the closing-control switch 85 are well-known, and reference may be had to Stewart Patent 1,943,096, assigned to the assignee of this application, for an example of such a circuit.

It may be desirable in certain of these reclosing applications to delay the automatic reclosing operation until a predetermined interval of time has elapsed after circuit-breaker opening. Such a delay can be provided in this general type of operating device by utilizing the motor 70, instead of the auxiliary spring 56, for initially driving the spring-controlling crank 47. In such a modified arrangement, the initial position of the spring-controlling crank 47 would be within the angle of repose. Additionally, in this modified arrangement, the auxiliary spring 56 would be of such a size that it would provide insufficient force to drive the spring-controlling crank 47, but would merely have sufficient power to drive the unlatched stop member 54 into engagement with the spring-controlling crank 47. Such movement of the stop member 54 would move the projection 54*a* out of blocking position with respect ot the spring-controlling crank 47 and would also close the motor-energizing switch 78. Upon energization, the motor 70 would drive the spring-controlling crank 47 through the outer limit of the angle of repose, whereupon the main spring 42 would discharge to produce circuit-breaker closing.

This modified arrangement produces a delay in reclosing which is dependent upon the speed at which the motor drives the crank 47 and upon the distance which the crank is initially spaced from the outer limit of the angle of repose. By a suitable choice of these two quantities, a desired delay in reclosing can be obtained.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead-center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring-controller into a predetermined position past said dead-center position, a movable stop member coacting with said spring-controller, releasable latch means for holding said stop member in a position for blocking said further rotation of the spring-controller, release of said latch means rendering said stop member ineffective to block said further rotation, auxiliary spring means acting through said stop member upon release of said latch means for driving said spring-controller through said predetermined position past dead-center whereupon said main spring then acts to discharge and further rotate said spring-controller.

2. The combination of claim 1 in which said stop member is provided with means forming a follower surface through which charging forces are transmitted from said spring-controller to said auxiliary spring upon movement of said spring-controller adjacent said dead-center position, said latch means acting until released to hold said auxiliary spring charged.

3. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead-center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring-controller into a predetermined position past said dead-center position, a movable stop member coacting with said spring-controller, releasable latch means for holding said stop member in a position for blocking said further rotation of the spring-controller, release of said latch means rendering said stop member ineffective to block said further rotation, and auxiliary spring means acting through a line of action which is angularly spaced from that of said main spring for driving said rotatable spring-controller through said predetermined position past dead-center position in response to release of said latch means.

4. In a stored energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead-center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring controller in response to rotative movement of said spring controller into a predetermined position past said dead center position, a pivoted starter member coacting with said spring controller, auxiliary spring means biasing said starter member into a position wherein said starter member is adapted to receive resetting forces from said spring-controller during movement of said spring controller adjacent said dead center position, said starter member being provided with follower means through which said resetting forces act to pivot said starter member in a direction to charge said auxiliary spring means, latch means operable after a predetermined charging of said auxiliary spring means for holding said starter member in a position wherein said auxiliary spring means is charged, stop means for blocking movement of said spring controller through said predetermined position past said dead center position, said auxiliary spring acting in response to release of said latching means to impart through said starter member forces which drive said spring controller through said predetermined position past dead center, and operation-initiating means for releasing said latching means and for rendering said stop means ineffective to block said spring controller.

5. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead-center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring-controller through the outer limit of the angle of response in the region of said dead-center position, a movable stop member coacting with said spring-controller, releasable latch means for holding said stop member in a position for blocking movement of said spring-controller beyond said angle of repose, release of said latch means rendering said stop member ineffective to block said spring-controller, auxiliary spring means acting through said stop member upon release of said latch means for driving said spring-controller through the outer

limit of said angle of repose whereupon said main spring then acts to discharge and further rotate said spring-controller.

6. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead-center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring-controller through the outer limit of the angle of repose in the region of said dead-center position, a movable stop member coacting with said spring-controller, releasable latch means for holding said stop member in a position for blocking movement of said spring-controller beyond said angle of repose, release of said latch means rendering said stop member ineffective to block said spring-controller, and auxiliary spring means acting through a different line of action than said main spring for driving said spring-controller through the outer limit of said angle of repose in response to release of said latch means.

7. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring controller through the outer limit of the angle of repose in the region of said dead center position, stop means arranged to block movement of said spring-controller before the spring-controller moves through the outer limit of the angle of repose, thus holding said spring in a charged condition, discharge-initiating means operable to render said stop means ineffective to block said spring-controller, and means for driving said spring-controller through the outer limit of said angle of repose upon operation of said discharge-initiating means.

8. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means including a motor for driving said rotatable spring-controller, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring-controller through the outer limit of the angle of repose in the region of said dead center position, stop means arranged to block movement of said spring-controller before the spring-controller moves through the outer limit of the angle of repose thus holding said spring in a charged condition, discharge-initiating means operable to render said stop means ineffective to block said spring-controller, and means for causing said motor to drive said spring-controller through the outer limit of said angle of repose upon operation of said discharge-initiating means.

9. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring controller through the outer limit of the angle of repose in the region of said dead center position, stop means arranged to block movement of said spring-controller before the spring-controller moves through the outer limit of the angle of repose thus holding said spring in a charged condition, discharge-initiating means operable to render said stop means ineffective to block said spring-controller, and auxiliary spring means acting through a different line of action than said main spring for driving said spring-controller through the outer limit of said angle of repose upon operation of said discharge-initiating means.

10. In a stored-energy operating device, a main spring, a rotatable spring-controller mounted for over-center action with respect to said main spring, means for transmitting charging forces to said main spring in response to rotation of said spring-controller toward a dead-center position with respect to said spring, said spring acting to discharge and thereby further rotate said spring-controller in response to rotative movement of said spring-controller into a predetermined position past said dead-center position, stop means arranged to block said further rotation of the spring-controller, thus holding said spring in a charged condition, discharge-initiating means operable to render said stop means ineffective to block said spring-controller, and auxiliary spring means acting in response to operation of said discharge-initiating means to drive said spring-controller through said predetermined position past dead-center whereupon said main spring then acts to discharge and further rotate said spring-controller, said auxiliary spring means acting through a different line of action than said main spring.

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