

May 17, 1966

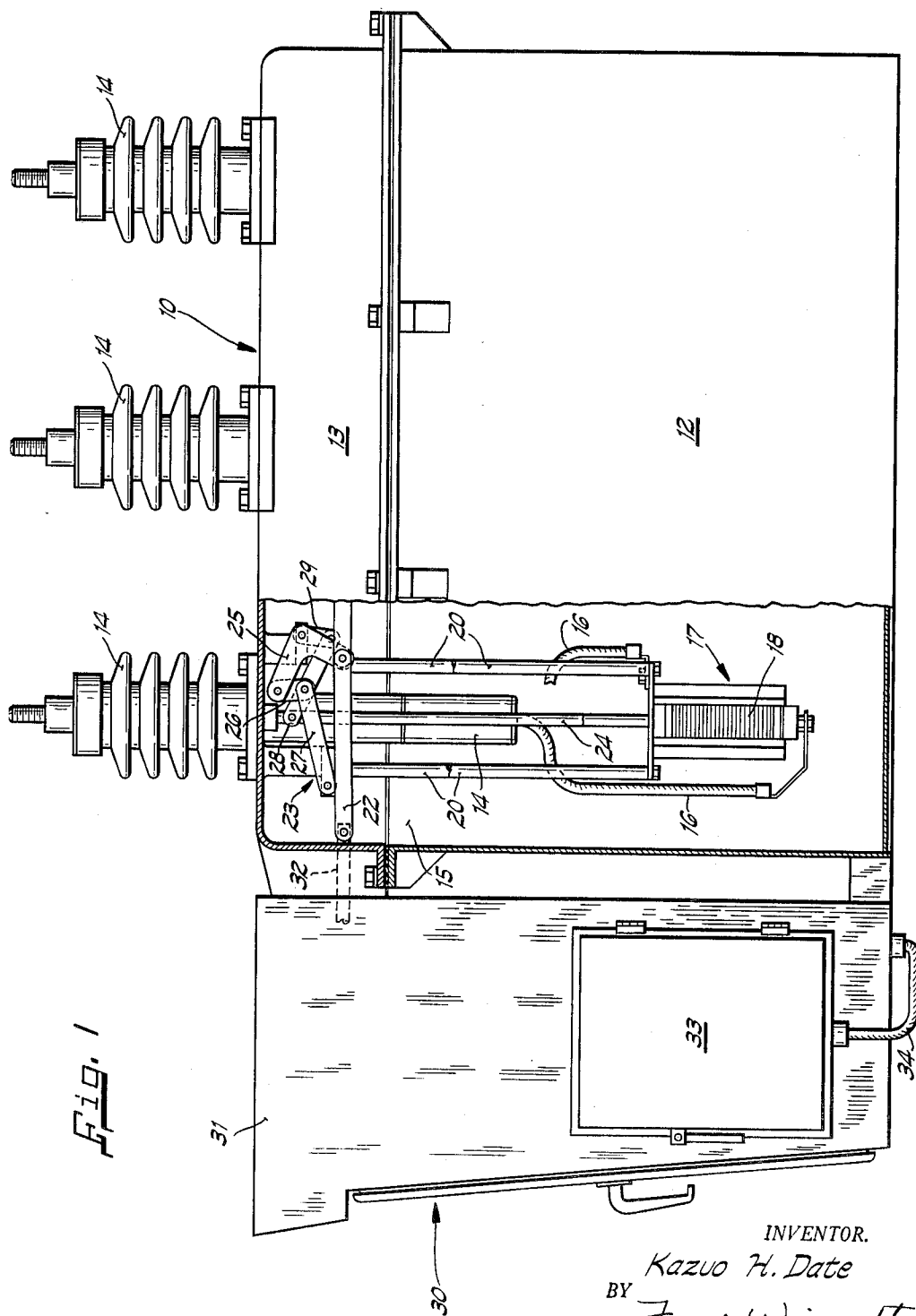
K. H. DATE

3,251,963

REPEATING CIRCUIT INTERRUPTER

Filed June 12, 1963

4 Sheets-Sheet 1



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REPEATING CIRCUIT INTERRUPTER

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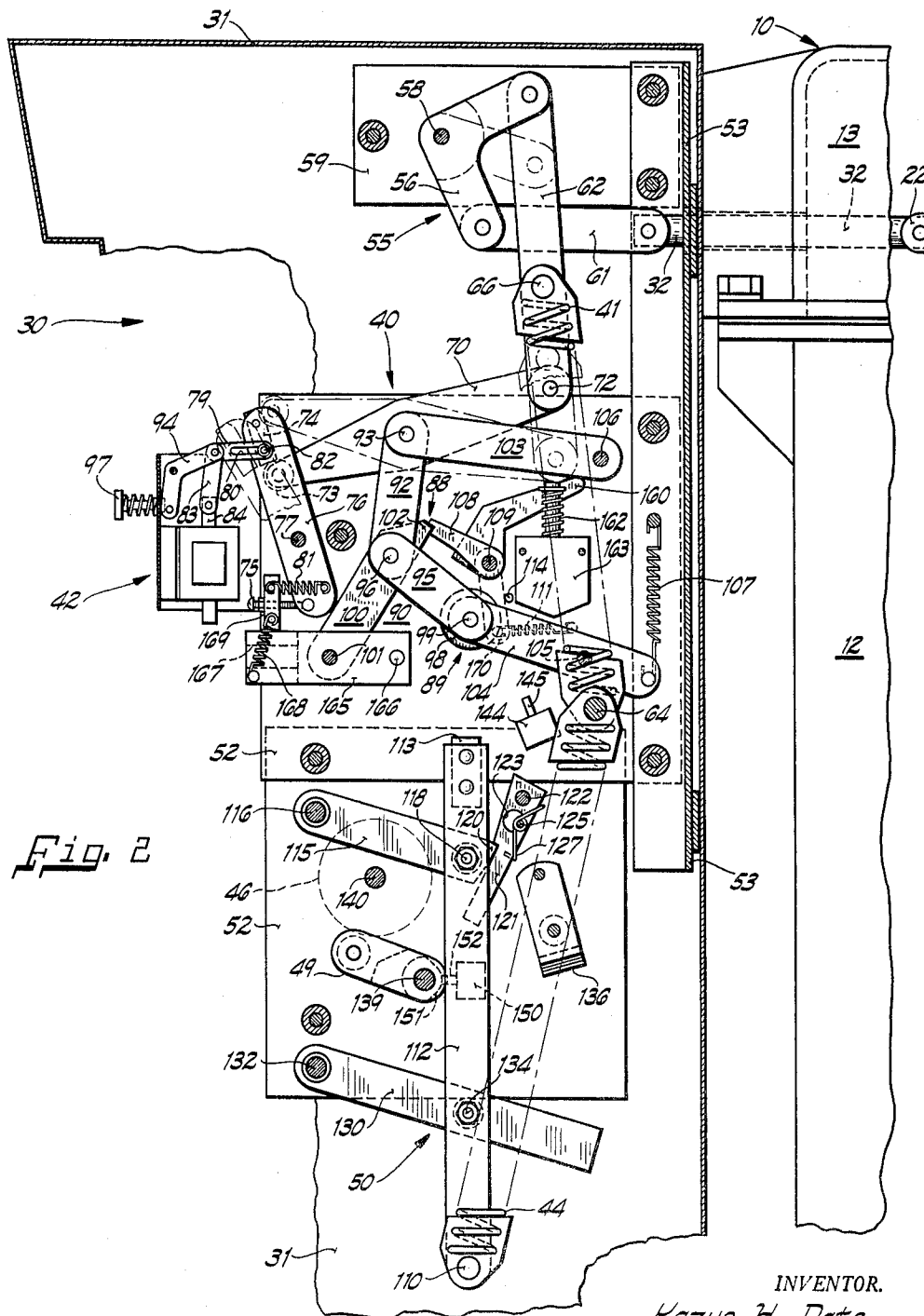


Fig. 2

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REPEATING CIRCUIT INTERRUPTER

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Fig. 3

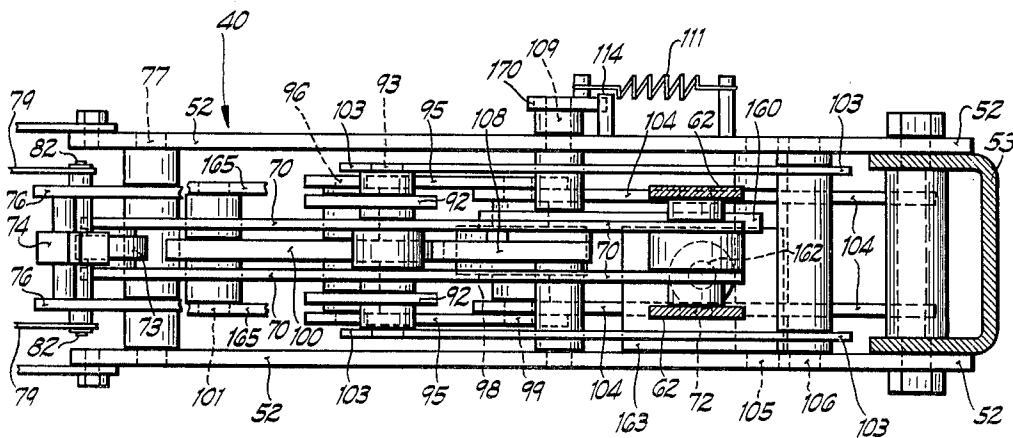
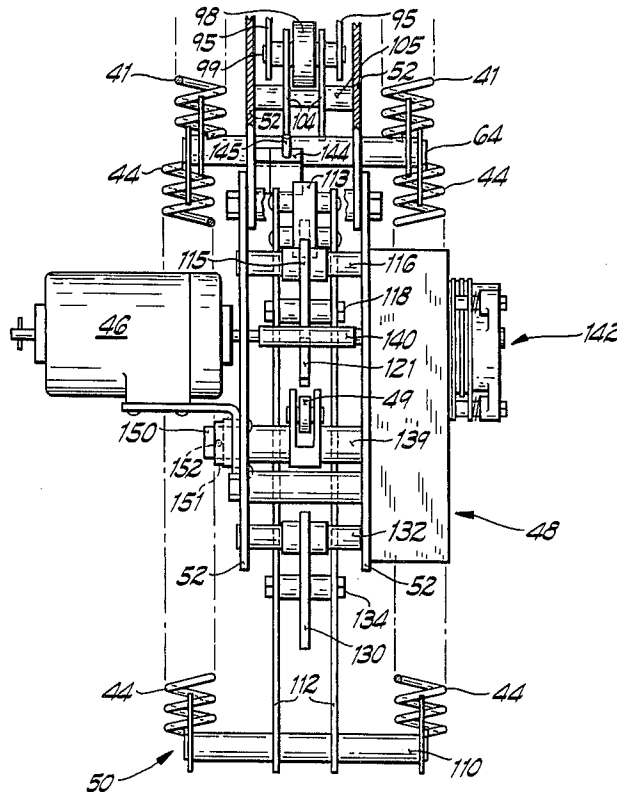


Fig. 4

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4 Sheets-Sheet 4

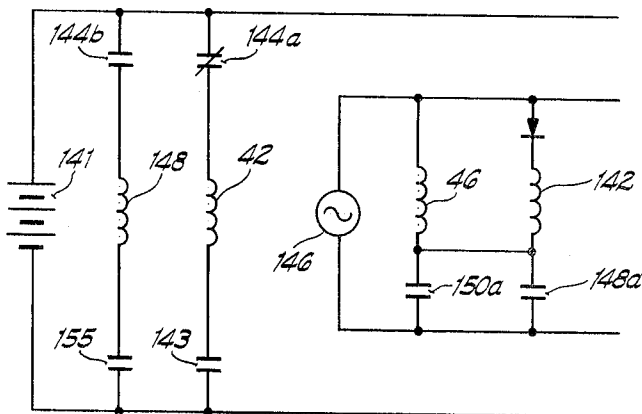
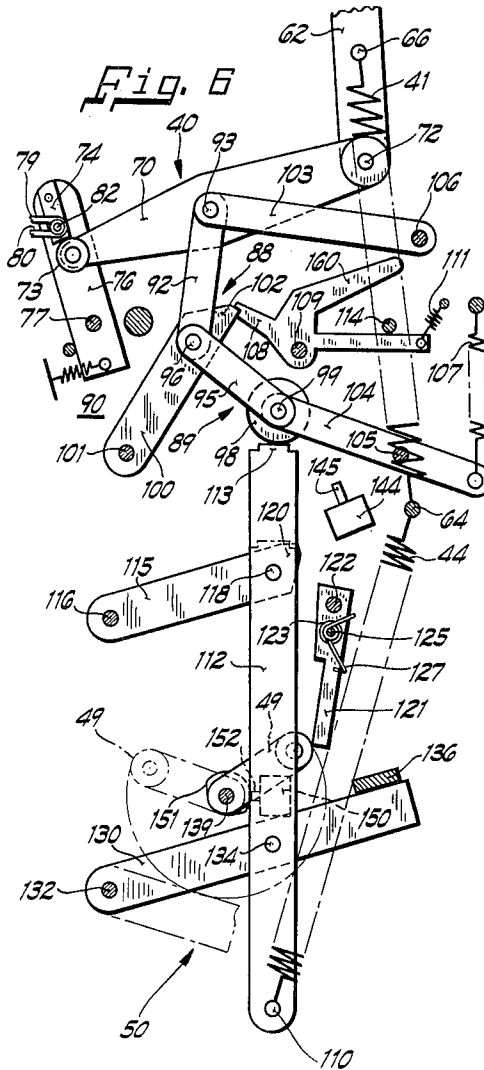
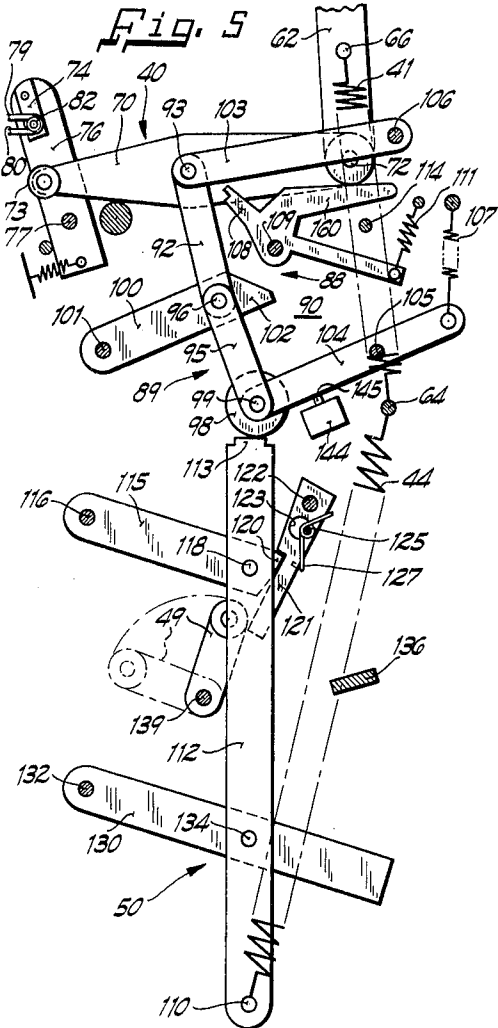


Fig. 7

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3,251,963

REPEATING CIRCUIT INTERRUPTER

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Filed June 12, 1963, Ser. No. 287,439

16 Claims. (Cl. 200-92)

This invention relates to repeating circuit interrupters and more particularly to an operating mechanism for repeating circuit interrupters.

It is an object of the invention to provide a new and improved motor-operated actuating mechanism for a repeating circuit interrupter.

A further object of the invention is to provide a switch-operating mechanism having a collapsible linkage assembly and an opening spring wherein the linkage assembly remains in a rigid condition until after the switch has reached an open position so that none of the initial spring force is required to collapse the linkage mechanism.

It is another object of the invention to provide a circuit breaker operating mechanism having a switch closing spring which operates to latch the circuit breaker's main contacts and to extend an opening spring wherein a double toggle mechanism is provided between the closing and opening springs whereby the closing spring leverage will increase as the closing spring is charged so that the force exerted on the opening spring will be relatively uniform even though the closing spring force diminishes.

Another object of the invention is to provide a motor-operated mechanism for a circuit interrupter wherein the motor is initially free from the opening and reclosing springs of the operating mechanism so that there is little motor load upon the initiation of a switch closing operation.

These and other objects and advantages of instant invention will become more apparent from the detailed description thereof taken with the accompanying drawings in which:

FIG. 1 is a side elevation view, with parts broken away, of a circuit breaker incorporating the instant invention;

FIG. 2 is a side elevational view of the circuit breaker operating mechanism;

FIG. 3 is a front elevational view of a portion of the circuit breaker operating mechanism illustrated in FIG. 2;

FIG. 4 is a top plan view of a portion of the operating mechanism illustrated in FIG. 2;

FIGS. 5 and 6 schematically illustrate the operation of the switch operating mechanism according to the instant invention; and

FIG. 7 shows the motor control circuit for the mechanism of FIG. 2.

Referring now to the drawings in greater detail FIG. 1 shows a polyphase repeating circuit interrupter designated generally by the reference numeral 10 and having a tank 12 provided with a cover 13 which supports porcelain terminal bushings 14 for connection to line wires, not shown. The bushings 14 extend interiorly of tank 12 and beneath the surface of a suitable dielectric fluid 15, such as oil, which substantially fills the tank 12. A phase conductor 16 extends from the lower end of each of the bushings 14 to connect with their associated phase contacts 17, which are disposed in a suitable arc interrupting assembly 18 suspended from the cover 13 by insulating stringer members 20.

An operating link 22 extends lengthwise of the tank 12 and beneath the cover 13 and is connected to a crank assembly 23 associated with each phase and each of which engages the upper end of an insulating rod 24 which extends downwardly into the interrupting assembly 18 of each phase to engage the movable portion of the

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contacts 17 so that said contacts in each phase may be simultaneously opened.

The crank assembly 23 is constructed and arranged to translate horizontal straight line movement of the link 22 into vertical straight line movement of the rod 24 and includes a bell crank 25 pivotally mounted on the cover 13 and coupled at one end to the link 22 and at its other to the rod 24 through links 26, 27, 28, and 29. It will be apparent from FIG. 1 that upon movement of link 22 toward the left, crank 25 will pivot counterclockwise to move rod 24 downwardly and close contacts 17 and that upon movement of link 22 toward the right, crank 25 will pivot clockwise to move rod 24 upwardly and open contacts 17.

An operating mechanism 30 according to the instant invention is disposed in a metallic housing 31 suitably affixed adjacent one end of the tank 12. As seen in FIG. 1, an operating shaft 32 extends from the housing 31 through the end of the tank cover 13 for engagement with the operating link 22 so that the latter may be actuated by the operating mechanism 30. A control 33 for initiating the various opening and closing operations of the circuit interrupter 10 is disposed within a separate metallic housing and is electrically connected to the mechanism 30 by a cable 34. As will be understood by those skilled in the art, many types of controls, suitable for use with the circuit breaker 10 are well known, and accordingly, the control 33 will not be discussed in detail. For a more complete description of a circuit breaker control capable of use with the disclosed circuit breaker, reference is made to co-pending application Serial No. 136,352, filed September 6, 1961, and assigned to the assignee of the instant invention.

Referring now to FIGS. 2 and 3 and 4, the operating mechanism 30 is shown to include a latch assembly 40 for holding the operating shaft 32 in a switch closed position against the influence of a pair of opening springs 41. A trip solenoid 42 is provided for releasing the latch assembly 40 so that the operating shaft 32 is free for reciprocating movement under the influence of springs 41 to a switch open position. After a switch opening operation, a pair of closing springs 44 provide energy for simultaneously moving the switch operating shaft 32 in a switch closed direction, resetting the latch mechanism 40 and extending the opening springs 41. The energy for extending the springs 44 is provided by a motor 46 which is coupled to the opening springs 44 through a gear train 48, an operating arm 49 and a linkage assembly 50. The operating mechanism 30 is supported by a pair of parallel plates 52 which are rigidly affixed to the cover 13 with bolts thru welded channel and plate assembly 53.

The operating mechanism 30 also includes a crank assembly 55 for coupling the opening springs 41 to the operating shaft 32 and having a bell crank 56 pivotally mounted on a shaft 58 extending between a pair of support plates 59 affixed to the housing back plate 53. One leg of the bell crank 56 is connected by a link 61 to the end of the operating shaft 32 and the other leg thereof is connected by a link 62 to the upper end of the opening springs 41. It can be seen from FIG. 2 that upward movement of the link 62 will rotate bell crank 56 counterclockwise to force the end of operating shaft 32 toward the right and into a switch closed position. On the other hand, downward movement of the link 62 will rotate bell crank 56 clockwise to move the end of shaft 32 toward the left and into a switch open position.

Referring still to FIGS. 2 and 3, it can be seen that the lower end of the opening springs 41 are anchored to a rod 64 extending between the plates 52 and their upper ends are connected to a pin 66 which also pivotally engages a lower portion of link 62. The opening

springs 41, which are shown in their charged condition in FIG. 2 tend to contract thereby rotating the bell crank 56 clockwise to move the operating shaft 32 into a switch open position.

FIGS. 2 and 4 also show the latch assembly 40 to include a pair of parallel rocking levers 70 which are pivotally connected at one end to the lower end of the link 62 by a pin 72. The other ends of the levers 70 carry a roller 73 which is engageable with a latch member 74 carried between a pair of latch links 76 pivotally mounted between plates 52 by a pin 77 and which are held against a stop 75 by a spring 81. An elongate U-shaped member 79 is connected at one end to the latch links 76 by slots 80 and pins 82 and at its other end to a link 83 connected to the plunger 84 of solenoid 42. A bell crank 94 also connects a manual trip button 97 to the other end of link 79.

The latch assembly 40 also includes a double toggle or collapsible linkage assembly 90 consisting of a first collapsible toggle linkage 88 and a second collapsible toggle linkage 89. The first toggle linkage 88 consists of a first pair of toggle links 92 pivotally connected at their upper ends by a pin 93 to the rocking levers 70 at a point intermediate pin 72 and the roller 73. Linkage 88 also includes a latch link 100 pivotally mounted at one end on a fixed pin 101 and pivotally connected adjacent its other end to the links 92 by a knee pin 96. Also carried by the link 100 adjacent the pin 96 is a latch tip 102. In order to limit the movement of levers 70 and linkage 88, a link 103 is connected at one end to a fixed pin 106 and at its other to the knee pin 93.

The second collapsible toggle linkage 89 includes a pair of links 95 connected at one end to the knee pin 96 and which carry a second knee pin 99 at its other end which rotatably supports a roller 98. One end of each of a pair of links 104, which are pivotally mounted about a fixed pin 105, are also connected to the knee pin 99 and are urged counterclockwise by springs 107 engaging their other ends.

The closing springs 44 are connected at their upper ends to the fixed rod 64 and at their lower ends to a rod 110 which is affixed to the lower ends of a pair of elongate closing links 112 which extend upwardly toward the latch mechanism 40 and which carry a closing member 113 at their upper ends for impaction with the roller 98. A latch link 115 is pivotally mounted at one end by a pin 116 extending between plates 52 and is pivotally connected adjacent its opposite end to the closing links 112 by a pin 118. Latch link 115 also has a latch tip 120 on its end adjacent pin 118 for engaging catch member 121.

The opening springs 44, which are shown in FIGS. 2 and 3 in their extended condition, tend to contract and move the operating rods 112 upwardly, but this is prevented by the engagement of the latch tip 120 with the catch member 121 which is pivotally mounted on a shaft 122 and has an aperture 123 adjacent the shaft 122 for engaging a stop pin 125 which limits rotational movement thereof. A sear spring 127 also engages the pin 125 and the member 121 to urge clockwise rotation thereof.

In order to insure substantially straight line movement of closing links 112, a guide link 130 is pivotally connected at one end to closing links 112 by a pin 134 at its other end around a fixed shaft 132 extending between plates 52. A stop member 136 is affixed to one of the plates 52 and lies in the pivotal path of the link 130 to arrest upward movement of the closing links 112 during a closing operation.

As seen in FIG. 3 the output shaft 140 of motor 46 extends through the gear reduction mechanism 48 for engagement by an electromagnetic brake 142 whose operation will be discussed more fully hereinbelow. The output shaft 139 of the gear reduction mechanism 48 carries the operating arm 49 so that said arm will be ro-

tated clockwise as viewed in FIG. 2 upon energization of the motor 46.

Referring again to the latch mechanism 40, it can be seen in FIG. 2 that when the opening spring 41 is extended, it tends to collapse the toggle linkages 88 and 89 but this is prevented by a catch member 108 which is pivotally mounted on a shaft 109 between the plates 52 and which is urged toward latching engagement with the latch tip 102 of link 100 by a spring 111 which urges catch member 108 toward counterclockwise rotation against a stop 114. Because the linkage 90 is held rigid by catch 108 links 70 tend to rock clockwise about their pivotal connection 93 with the upper ends of toggle links 92 but this movement is prevented by engagement between the roller 73 and the latch member 82.

The catch 108 also has an angularly shaped release arm 160 disposed below the pin 72 carried by the lower end of links 62 and constructed and arranged to be impacted thereby when the opening springs 41 substantially reach their fully contracted position as will be explained more fully hereinbelow. Also located for impaction by the pin 72 is the plunger 162 of a shock absorbing dash-pot 163.

FIG. 2 shows the operating mechanism 30 when the circuit breakers main contacts are in their closed position. Should a trip signal be received by the solenoid 42, its plunger 84 will move downwardly thereby rotating latch lever 76 counterclockwise about shaft 77 to move the latch member 74 out of blocking engagement with the roller 73 carried on the end of the rock lever 70. The catch member 108, however, remains in latching engagement with the latch tip 102 of the latch link 100 so that the collapsible linkage 90 remains in rigid condition. As a result, the pivotal connection 93 between the upper end of the toggle links 92 and the rock lever 70 momentarily becomes a fixed pivot point for said rock lever and the latter rocks thereabout in a clockwise direction under the influence of the opening springs 41 from its position shown by full lines in FIG. 2 to its position shown by phantom lines. This moves the link 62 downwardly to open circuit breaker's main contacts.

It can be seen from the foregoing that upon the initial tripping action of the operating mechanism, the opening springs 41 act directly on the rock lever 70 and the link 62 without expending any force to collapse the linkage 90 or to overcome the inertia of any other links, or the restraining force of any spring members. As a result, the opening action of the springs 41 is substantially uninhibited by the operating mechanism 30 and the circuit breaker's contacts 17 are thereby free to open at a relatively rapid rate.

After circuit breaker contacts 17 have substantially reached their fully open positions, the operating mechanism 30 will be in its position shown by phantom lines in FIG. 2 whereupon the lower end of contact link 62 will strike the catch release arm 160 as the opening spring 41 continues to contract thereby forcing the catch 108 to pivot clockwise against the influence of spring 111 to release the latch tip 102 of link 100 whereby the linkage 90 collapses under the influence of spring 107. After the collapse of the linkage 90, the operating mechanism 30 is in its position shown in FIG. 5. It will be noted that the latch lever 76 has returned to its unpivoted position in preparation for a re-latching operation since the solenoid 42 becomes de-energized when the main contacts are opened.

After the linkage 90 has collapsed, and the operating mechanism 30 is in its unlatched position with the closing springs 44 extended, the motor 46 will begin rotating to move the driver 49 clockwise as viewed in FIG. 5 from its phantom position to its full position, whereupon it will engage the catch member 121 to rotate it out of latching engagement with the latch tip 120 of link 115 thereby freeing the closing rods 112 for upward movement as the closing spring 44 contracts.

As the closing rods 112 move upwardly, the closing

member 113 carried at their upper ends strikes the roller 98 causing the toggle linkages 88 and 89 to begin straightening. This forces the rocking lever 70 to move upwardly until the roller 73 carried by its left end, as viewed in FIG. 6, engages the latch 74 whereupon rocking lever 70 will begin rotating about roller 73 to extend the opening springs 41 and to release the catch member 108 so that the latter may return to its latching position relative to the latch tip 102. When the closing springs 44 reach their contracted position, shown in FIG. 6, the linkage 90 will again be in its rigid condition, the springs 41 will be fully extended and the circuit breaker's main contacts will be closed.

It will be appreciated that as the closing springs 44 contract, the amount of force they can exert on the collapsible linkage 90, the opening springs 41 and the circuit breaker's contact mechanism will decrease. On the other hand, as the opening springs are extended by the closing springs 44, the amount of force required increases. This situation is relieved without unduly increasing the size of the closing springs 44 by the double toggle collapsible linkage 90 because as a collapsible toggle linkage is moved toward a straight or toggle condition, the force required to continue this motion decreases. Thus, as seen in FIG. 5, when the closing springs 44 are fully extended and a maximum spring force is available, both toggle linkages 88 and 89 are in a collapsed condition. As the closing springs approach their fully contracted condition and the opening springs 41 approach their fully extended condition, as shown in FIG. 6, both of the toggle linkages 88 and 89 will be substantially straight so that only a minimum force will be required to place these linkages in toggle. It can therefore be seen that the use of the double toggle mechanism 90 provides the greatest leverage when the closing springs 44 are able to exert the least force and when the greatest force is required to extend the opening springs 41.

When the operating mechanism 31 is in the position shown in FIG. 6 the opening springs 41 will be in a position to open the main contacts should a trip signal be received even though the motor 46 has not completed cycling and even though the closing springs 44 are not extended. It will thus be appreciated that opening energy is available immediately after a closing operation. It will also be appreciated that the mechanism 30 is trip free in that during a closing operation, the rock lever 70 will not begin pivoting in switch closing direction until the roller 73 engages the latch 82. Thus if a trip signal is received to rotate the latch lever 76 counterclockwise, the rock lever 70 will immediately release for movement toward open position under the influence of springs 41 even though the closing links 112 are still moving upwardly.

After the motor 41 has engaged the catch 120 to release the closing rods 112, it will continue to rotate the operating arm 49 clockwise until it engages the driving lever 130 whereupon said lever will be forced to rotate clockwise as viewed in FIG. 6 thereby drawing the closing link 112 downwardly and extending the closing springs 44. This downward movement will continue until the latch tip 120 on the latch lever 115 engages the catch member 121 to latch the closing springs 44 in their extended condition as shown in FIG. 2.

FIG. 7 shows the trip coil and motor operating circuits for the operating mechanism 30. Here the coil of the trip solenoid 42 is shown connected to a D.C. source 141 through a first pair of normally open contacts 143 which are operated by the control 33 in the manner discussed in the aforementioned application and a second pair of normally closed contacts of a plunger switch 144, which is shown in FIG. 2 to have a plunger 145. When the toggle links 104 are in their latched position shown in FIG. 2, the contacts 144a are closed and when the links 104 are in their unlatched position shown in FIG. 5 the plunger 145 is engaged and the contacts 144a are open.

From the description thus far, it will be evident that when the control 33 senses an abnormal condition in the circuit being protected and closes contacts 143, the trip solenoid 42 will be energized to initiate a switch opening operation in the manner described hereinabove. When circuit breaker's main contacts are fully opened and toggle links 104 are in their collapsed position, the contacts 144 will be opened to de-energize the trip coil 42.

The motor 46 and the brake 142 are shown connected in parallel to each other and to an alternating current source 146 through the normally open, parallel connected contacts 148a of a relay 148 and 150a of a switch 150. The relay 148 is shown in FIG. 7 to be connected across the D.C. source 141 through normally open contacts 155 which are operable by the control 33 and the normally open contacts 144b of the plunger switch 144 which are open when links 104 are in their latched position shown in FIG. 2 and which are closed when said links are in their tripped position shown in FIG. 5.

Switch 150 is shown in FIG. 2 to be disposed adjacent the motor shaft 140 which is provided with a cam 151 engageable with the plunger 152 of switch 150. When the circuit breaker is in its latched position with the opening springs 41 and the closing springs 44 fully extended, the plunger 152 will be on the recessed portion of the cam 151 and contacts 150a will be open. After the motor 46 has rotated to the point where the driver 49 just impacts the catch 121 the plunger 152 will move to the elevated portion of cam 151 whereupon contacts 150a will close. The elevated portion of cam 151 is so proportioned that the plunger switch 150 will remain closed until the motor 46 has completed a full cycle whereupon the plunger 152 will again move to the depressed portion thereof and the contacts 150a will open.

It will thus be appreciated that when the main contacts are in their tripped open position and the control 33 closes the contacts 155 to initiate a switch closing operation, the relay 148 will be energized to close contacts 148a. This energizes the motor 46 and the brake 142. As the motor begins operating and the closing links 112 begin moving upwardly, the plunger 152 of switch 150 will move to the elevated portion of the cam 151 so that the motor 46 and the brake 47 remain energized through contacts 150a after the relay 148 is de-energized by the opening of contacts 144b which occurs when toggle links 104 begin moving into their rigid condition. Thus the motor 46 will continue cycling until it reaches its initial position whereupon contacts 150a will open.

Referring again to FIG. 2, a manual closing lever 165 is pivotally mounted intermediate its ends on the fixed pin 101 and carries a transversely extending pin 166 at one end and has a crank bar recess 167 formed in its other end. In addition a spring 168 holds the other end of lever 165 against a stop 169. After the linkage assembly 90 has collapsed the link 100 is adjacent the pin 166 so that counterclockwise rotation of lever 165 will force the collapsible linkage 90 into its latched position to close the contacts 17.

The lever 165 can also be employed for manually releasing the linkage 90 at a relatively slow rate of speed for purposes of visual inspection. This is accomplished by rotating the lever 165 until the pin 166 engages the link 100 whereupon the arm 170 may be engaged to rotate the catch member 108 clockwise out of blocking engagement with the linkage 80 so that the force of the opening springs is taken up by the lever 165. The lever 165 is then permitted to rotate clockwise at the desired rate of speed.

While only a single embodiment of the invention has been illustrated and described, it is not intended to be limited thereby but only by the scope of the appended claims.

I claim:

1. A circuit breaker having switch means, resilient

switch opening means coupled to said switch means, collapsible linkage means, operating means connected to said switch opening means and movably connected to said collapsible linkage means, said operating means having a first position relative to said linkage means wherein said resilient switch opening means is charged and said switch means is closed, first means for holding said linkage means in a rigid condition, second means engagable with said operating means to prevent movement thereof out of its first position relative to said linkage means to maintain said resilient switch opening means charged and said switch means closed, release means for said second means operable to free said operating means for movement out of its first position so that said switch means may be moved to an open position by said switch opening means, said first means being operable to initially hold said collapsible linkage means in rigid condition as said operating means moves relative thereto and operable after said switch means has opened to free said collapsible linkage means, and switch closing means for placing said collapsible linkage means in rigid condition to close said switch means and to charge said resilient switch opening means.

2. A circuit breaker having main switch means, resilient switch opening means coupled to said main switch means, operating means connected to said switch opening means for charging the same, collapsible linkage means pivotally coupled to said operating means, first means for holding said linkage means in a rigid condition, a second means engageable with said operating means to prevent the pivoting thereof relative to said linkage means to maintain said resilient means charged and said main switch means closed, release means for said second means so that said operating means is freed for pivotal movement relative to said linkage means to free said main switch means for movement to its open position by said resilient switch opening means, said first means being initially operable to hold said linkage means in its rigid condition as said operating means pivots relative thereto and being releasable after said main switch means has opened to free said collapsible linkage means, and switch closing means for placing said collapsible linkage means in rigid condition to close said main switch means and to charge said resilient means.

3. A circuit breaker having main switch means, opening spring means coupled to said main switch means, lever means connected to said opening spring means for charging the same, collapsible linkage means pivotally coupled to said lever means, first latch means for holding said linkage means in a rigid condition, second latch means engageable with said lever means to prevent the pivoting thereof around its point of connection with said linkage means to maintain said opening spring means charged and said main switch means closed, release means for said second latch means so that said lever means is freed for pivotal movement about said linkage means to free said main switch means for movement to its open position by said opening spring means, said first latch means being initially operable to hold said linkage means rigid as said lever means pivots relative thereto, said opening spring means being operable to release said first latch means after said main switch means has opened to free said collapsible linkage, and switch closing means for placing said collapsible linkage means in rigid latched condition to close said main switch means and to charge said opening spring means.

4. A circuit breaker having main switch means, opening spring means coupled to said main switch means, a rock lever connected adjacent one end to said opening spring for charging the same, first and second pivotally connected toggle link means, one of said toggle link means also being pivotally connected to said rock lever adjacent its other end, a first latch means for holding said toggle link means in a rigid condition, a second latch means engaging said rock lever to prevent the rocking

thereof around its pivotal connection with said one toggle link means to maintain said opening spring charged and said main switch means closed, release means for said second latch means so that said rock lever may be freed for pivotal movement about its pivotal connection with said one toggle link means, said opening spring means being operable to release said first latch means and free said toggle link means after said main switch means has opened, and switch closing means for placing said first and second toggle link means in rigid latched condition to close said main switch means and to charge said opening spring means.

5. A circuit breaker having main switch means, an opening spring coupled to said main switch means, a rock lever connected adjacent one end to said opening spring for charging the same, first and second toggle links pivotally connected by a knee pin, one of said toggle links being pivotally connected to said rock lever adjacent its other end, a first latch means for holding said pair of toggle links in a rigid condition, a second latch means engageable with said rock lever adjacent its other end to prevent the rocking thereof around its pivotal connection with said one toggle link to maintain said opening spring charged and said main switch means closed, electroresponsive latch release means for said second latch means so that said rock lever may be freed for pivotal movement about said one toggle link, said opening spring being effective to move said first latch means out of latching engagement with said toggle links after said rock lever has pivoted through a predetermined angle and said switch means has opened, and switch closing means for placing said toggle link means in rigid latched condition to close said main switch means and to charge said opening spring means.

6. A circuit breaker having main switch means, opening spring means coupled to said main switch means, first collapsible linkage means coupled to said opening spring means, second collapsible linkage means having one end engaging said first linkage means and operable when placed in a rigid condition to move said first linkage means into a rigid condition, first latch means for holding said first and second collapsible linkage means in a rigid condition to maintain said opening spring charged and said main switch means closed, means for effecting the release of said first latch means so that said main switch means is opened, switch closing means operable in a first direction to place said second linkage means in rigid latched condition, closing spring means urging said closing means toward movement in said first direction, second latch means for holding said closing means against movement in said first direction and said closing spring means in a charged condition, trip means for releasing said closing means whereby to place said first and second collapsible linkage means in their rigid latched conditions to close said main switch means and to charge said opening spring means as said closing spring means discharges, and motor means for releasing said trip means to initiate a switch closing operation and for moving said switch closing means into its latched position after a switch closing operation and to recharge said closing spring means.

7. A circuit breaker having main switch means, opening spring means coupled to said main switch means, first and second toggle links pivotally connected by a first knee and pin to form a first collapsible linkage and having an end coupled to said opening spring means, third and fourth toggle links connected by a second knee pin to form a second collapsible linkage and having one end engaging said first knee pin, first latch means for holding said first and second collapsible linkages in a rigid condition to maintain said opening spring means charged and said main switch means closed, means for effecting the release of said first latch means so that said main switch means is opened, an elongated switch closing member movable longitudinally into engagement with said

second knee pin to place said first and second collapsible linkages in their rigid latched condition, closing spring means urging said closing member toward engagement with said second knee pin, second latch means disposed adjacent said switch closing member for holding said closing member away from said linkage means and said closing spring means in a charged condition, trip means for releasing said closing member for engagement with said second knee pin whereby to place said collapsible linkages in their rigid latched position to close said main switch means and to extend said opening spring means, motor means for moving said trip means into engagement with said second latch means to initiate a switch closing operation and for moving said switch closing member into its latched position after a switch closing operation and to charge said closing spring means.

8. A circuit breaker having main switch means, opening spring means coupled to said main switch means, collapsible linkage means coupled to said opening spring means, first latch means for holding said linkage means in a rigid condition to maintain said opening spring charged and said main switch means closed, release means for said first latch means operable to release said collapsible linkage, switch closing means operable upon movement in a first direction to place said collapsible linkage means in its rigid latched conditions, closing spring means urging said closing means toward movement in said first direction, second latch means for holding said closing means against movement in said first direction and said closing spring means in a charged condition, motor means for releasing said closing means to place said linkage means in its rigid latched condition to close said main switch means and to charge said opening spring means, said motor means including an operating member normally disengaged from said second latch means, said motor means being operable to rotate said operating member into engagement with said second latch means to initiate a switch closing operation, said motor means also being operable after a switch closing operation to rotate said operating member into engagement with said switch closing means to move the latter into its latched position and to charge said closing spring means.

9. A circuit breaker having main switch means, opening spring means coupled to said main switch means, lever means connected to said opening spring for charging the same, first collapsible linkage means pivotally coupled to said lever means, second collapsible linkage means having one end engaging said first collapsible linkage means, first latch means for holding said first and second collapsible linkage means rigid, second latch means engageable with said lever means to prevent the pivoting thereof around its connection with said first collapsible linkage to maintain said opening spring charged and said main switch means closed, release means for said second latch means so that said lever means may be freed for pivotal movement about said first collapsible linkage, said opening spring means being operable to release said collapsible linkage means after said main switch means has opened, switch closing means operable upon movement in a first direction to place said collapsible linkage means in their rigid latched conditions, closing spring means urging said closing means toward movement in said first direction, third latch means for holding said closing means against movement in said first direction and said closing spring means in a charged condition, trip means for releasing said closing means to place said first and second linkage means in their rigid latched position to close said main switch means and to charge said opening spring means as said closing spring means discharges, motor means for releasing said trip means to initiate a switch closing operation and for moving said switch closing means into its latched position after a switch closing operation and to recharge said closing spring means.

10. A circuit breaker having main switch means, opening spring means coupled to said main switch means, a rock lever connected at one end to said opening spring means, a first pair of pivotally connected toggle links and having an end of one pivotally coupled to said rock lever, a second pair of pivotally connected toggle links having an end of one engaging the pivotal connection of said first pair of toggle links, first latch means for holding said first and second pair of toggle links in a rigid condition, second latch means engaging the other end of said rock lever to prevent the rocking thereof around the end of one of said first pair of toggle links to maintain said opening spring extended and said main switch means closed, release means for said second latch means so that said rock lever may be freed for pivotal movement about its pivotal connection with said first pair of toggle links, said opening spring means being operable to release said first and second pair of toggle links after said main switch means has opened, an elongated switch closing member movable longitudinally into engagement with the pivotal connection of said second pair of toggle links to place said first and second pair of toggle links in rigid latched condition, closing spring means urging said closing member toward engagement with said second pair of toggle links, third latch means for holding said closing member away from said second pair of toggle links and said closing spring means in a charged condition, trip means for releasing said closing member to place said first and second pair of toggle links in their rigid latched position, to close said main switch means and to extend said opening spring means as said closing spring means discharges, motor means for rotating said trip means into engagement with said third latch means to initiate a switch closing operation and for moving said switch closing member into its latched position after a switch closing operation and to charge said closing spring means.

11. A circuit breaker having main switch means, resilient switch opening means coupled to said main switch means, collapsible linkage means coupled to said main switch means and said switch opening means, latch means for holding said linkage means in a rigid condition to hold said resilient switch opening means charged and said main switch means closed, latch release means, electroresponsive switch closing means, and a pivotally mounted manual closing lever engageable with said collapsible linkage and operable upon pivotal movement in one direction to place said linkage in its rigid condition, pivotal movement of said manual closing lever in said one direction after said linkage has been latched in its rigid condition being operative to prevent the collapse thereof upon the release of said latch means so that said linkage may be collapsed at a controlled rate of speed upon pivotal movement of said lever in an opposite direction.

12. A circuit breaker having switch means, opening spring means coupled to said switch means, first latch means for holding said switch means in closed position, collapsible linkage means coupled to said switch means, second latch means for holding said collapsible linkage means in a rigid condition to maintain said opening spring means charged and said switch means closed, means for effecting the release of said first latch means so that said switch means is opened said first latch means being initially operable to hold said collapsible linkage means rigid as said switch means opens, means for effecting the release of said second latch means after said switch means has opened, and switch closing means operable to place said linkage means in a rigid latched condition and to close said switch means and to charge said opening spring means.

13. A circuit breaker having main switch means, opening spring means coupled to said main switch means, operating means means connected to said opening spring means for charging the same, collapsible linkage means coupled to said operating means, first means for holding

said linkage means in a rigid condition, second means engageable with said operating means to prevent movement thereof relative to said linkage means to maintain said opening spring means charged and said main switch means closed, release means for said second means so that said operating means is free for movement relative to said linkage means, and means for releasing said first means after said main switch means has opened to free said collapsible linkage means, switch closing means including a normally charged closing spring means dischargeable after a switch opening operation to place said collapsible linkage means in rigid latched condition and close said main switch means and to charge said opening spring means, and means for recharging said closing spring means after an opening operation.

14. A circuit breaker having switch means, operating means coupled to said switch means, resilient switch opening means coupled to said operating means, first holding means for holding said operating means in a switch closed position, collapsible linkage means coupled to said operating means, second holding means for holding said collapsible linkage means in a rigid condition, means for effecting the release of said first holding means so that said switch means is opened, means operable after the opening of said switch means to release said second holding means so that said linkage means collapses, switch closing means operable to place said linkage means in a rigid held position and to place said operating means in its switch closed position, resilient switch closing means urging said closing means toward operation in a switch closing direction, third holding means for holding said closing means against operation by said resilient switch closing means and for holding said resilient switch closing means in a charged condition, release means for releasing said closing means to place said collapsible linkage means in a rigid condition to close said switch means and to charge said resilient switch opening means.

15. The circuit breaker set forth in claim 14 and including electromotive means operable after a switch opening operation for releasing said third holding means to initiate a switch closing operation and for returning said switch closing means to its held position after a switch

closing operation and to recharge said resilient switch closing means.

16. A circuit breaker having switch means, resilient switch opening means coupled to said switch means, first collapsible linkage means coupled to said resilient switch opening means, second collapsible linkage means coupled to said first linkage means and operable when placed in a rigid condition to move said first linkage means into a rigid condition, first holding means for holding said first and second collapsible linkage means in a rigid condition to maintain said resilient switch opening means charged and said switch means closed, means for effecting the release of said first holding means so that said main switch means is opened, switch closing means operable in a switch closing direction to place said second linkage means in a rigid held condition, resilient switch closing means urging said closing means toward movement in said switch closing direction, second holding means for holding said closing means against movement in said switch closing direction and said resilient switch closing means in a charged condition, release means for releasing said closing means to place said first and second collapsible linkage means in a rigid held condition to close said main switch means and to charge said resilient switch opening means as said resilient switch closing means discharges, and electromotive means for actuating said release means to initiate a switch closing operation and for moving said switch closing means into its held position after a switch closing operation and to recharge said resilient switch closing means.

References Cited by the Examiner

UNITED STATES PATENTS

1,938,408	12/1933	Thumin	200—92
2,994,805	8/1961	Nash	200—108 X
3,009,034	11/1961	Barkan	200—89

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