

[54] SWITCHGEAR WITH SINGLE DRIVE TO BOTH CHARGE CLOSING SPRING AND RACK CONTACT CARRIER

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[52] U.S. Cl. 200/153 SC, 185/40 R

[51] Int. Cl. H01h 3/30

[58] Field of Search.....200/153 SC, 34; 185/40 R, 185/40 B; 335/76, 77

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Primary Examiner—Robert K. Schaefer
Assistant Examiner—Robert A. Vanderhye
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] ABSTRACT

Truck mounted miniaturized switchgear adapted to be removably placed in a switchboard for connection to busses located in the switchboard comprising a truck frame and circuit interrupter elements mounted on a second frame telescopically movable with respect to the truck frame. The circuit interrupter elements are opened by a spring on the occurrence of predetermined circuit condition and the removal of a retaining latch structure. The spring is recharged after opening and may be automatically recharged while the contacts are closed in preparation for the next opening. A rotatable lever or crank is used to charge the spring and motor means may be provided for operating said rotatable lever. The contacts are trip free in that the spring may be moved toward discharge position while it is in the process of being charged. The same motor with other connections is utilized to drive the racking member which moves the telescoping frame carrying the circuit interrupter elements with respect to the truck frame.

7 Claims, 44 Drawing Figures

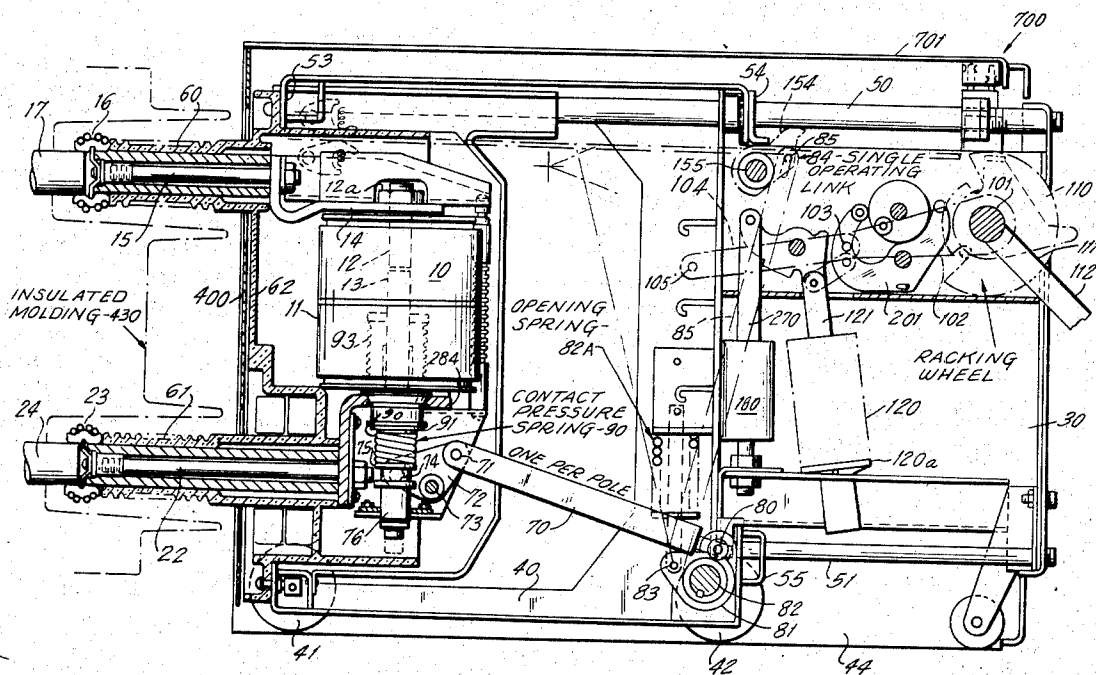


FIG. 1-

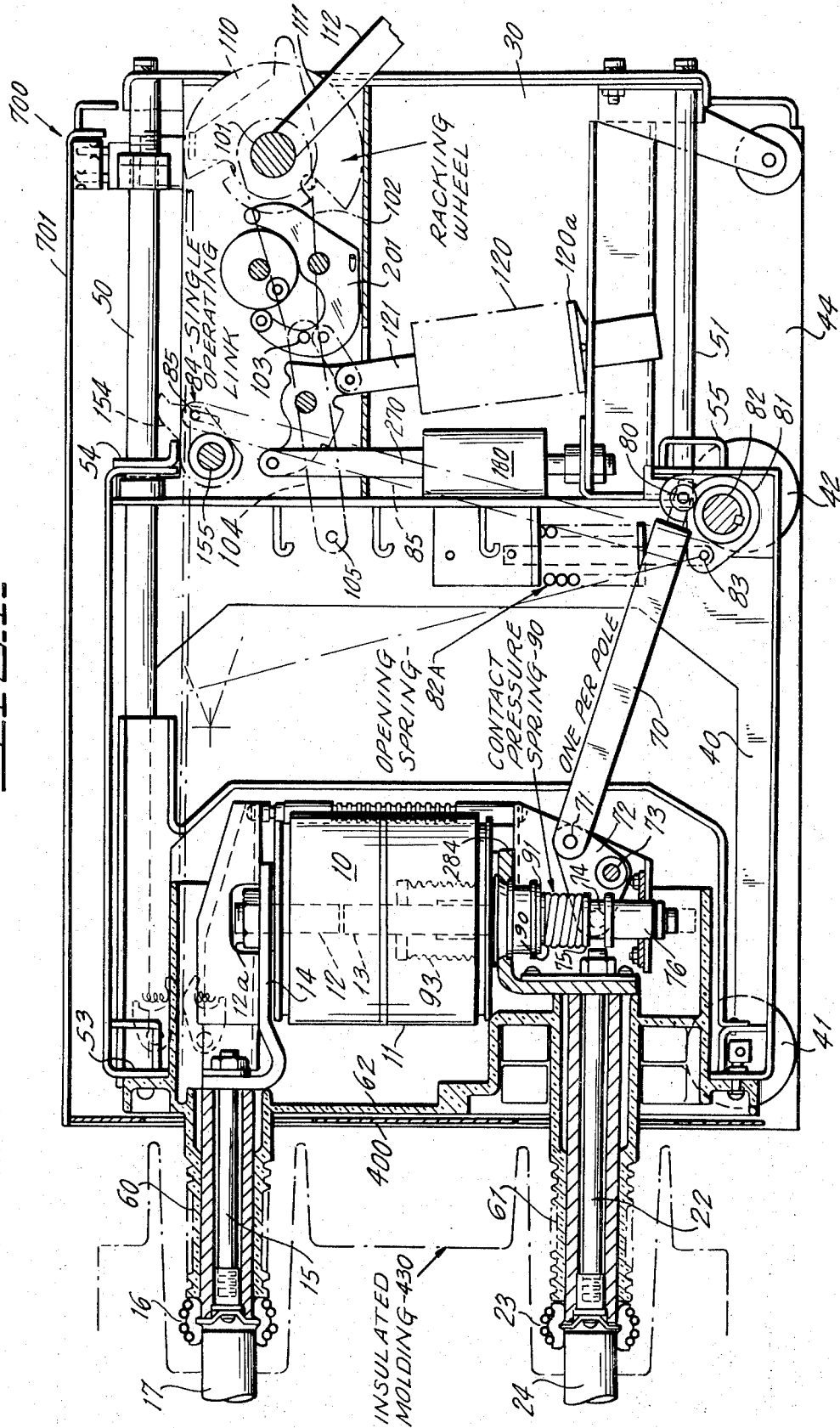


FIG. 2.

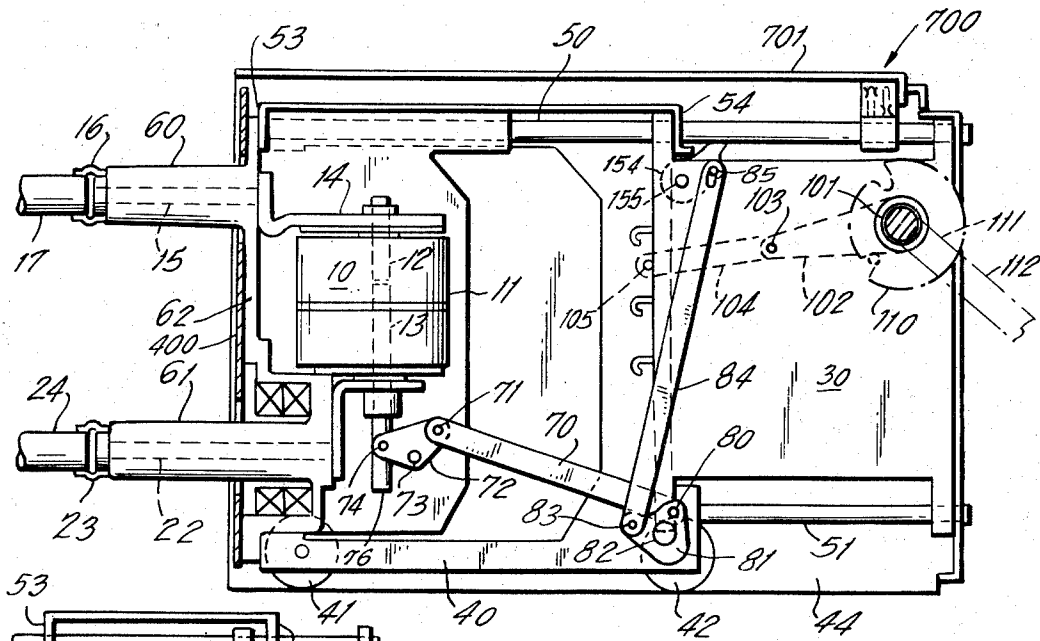


FIG. 3.

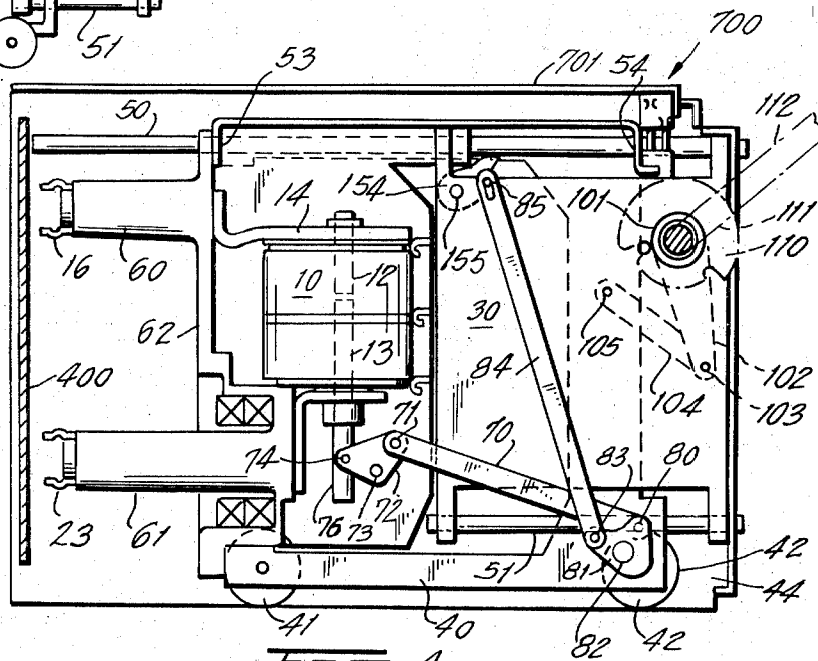
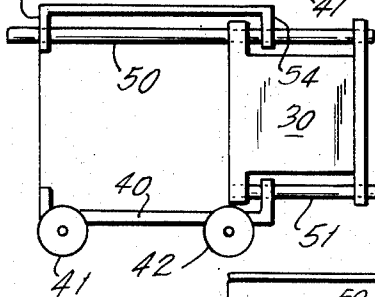


FIG. 4.

FIG. 5.

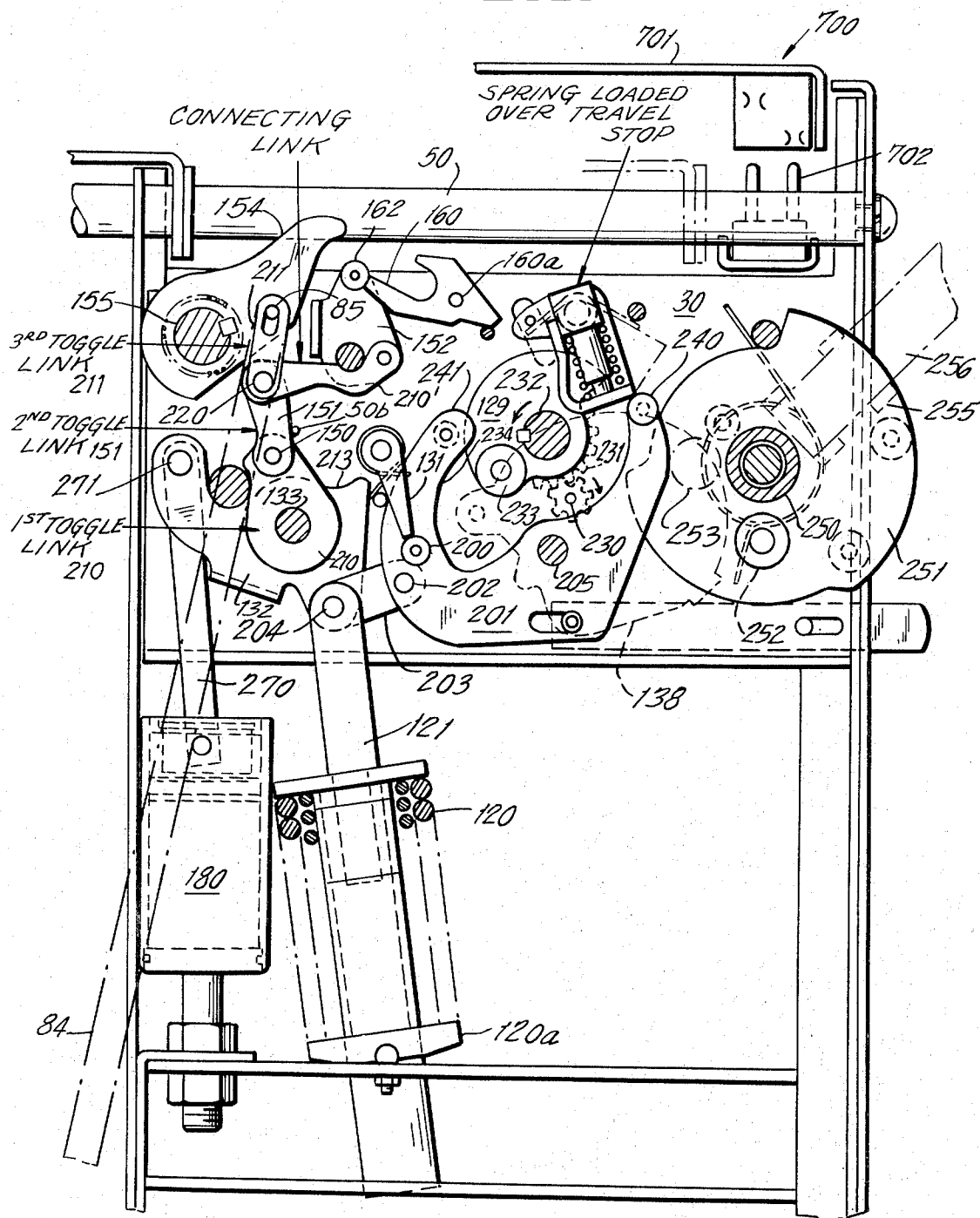
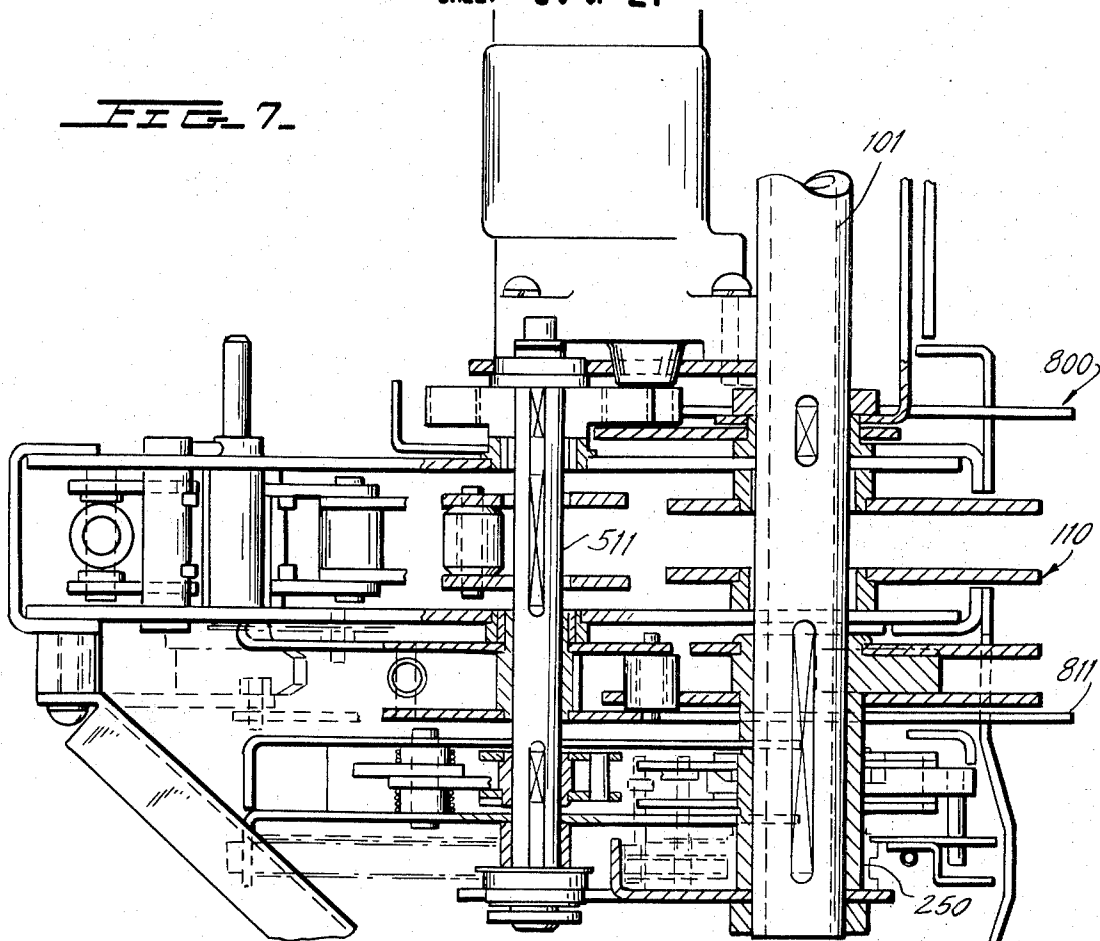


FIG. 7.



LUG TO PREVENT RELEASE OF
RACKING LEVER UNLESS
BREAKER IS OPEN

CLOSED POSITION

DETENT TO HOLD TRIP
FREE WHEN RACKING
LEVER IS RELEASED

FIG. 6.

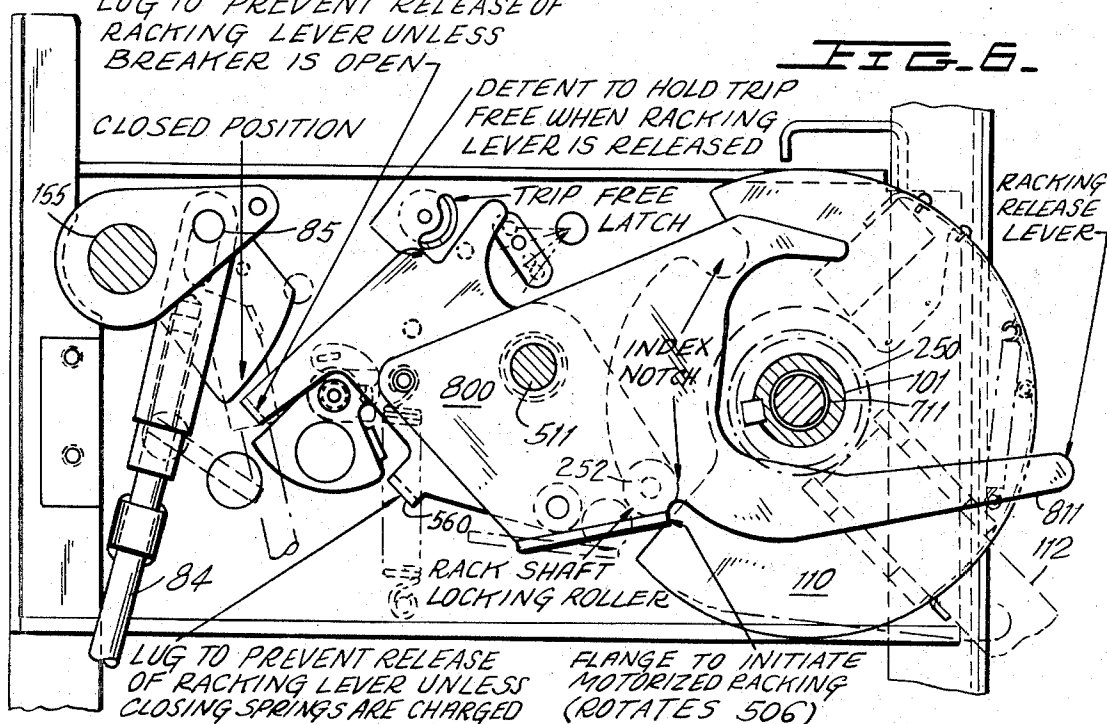
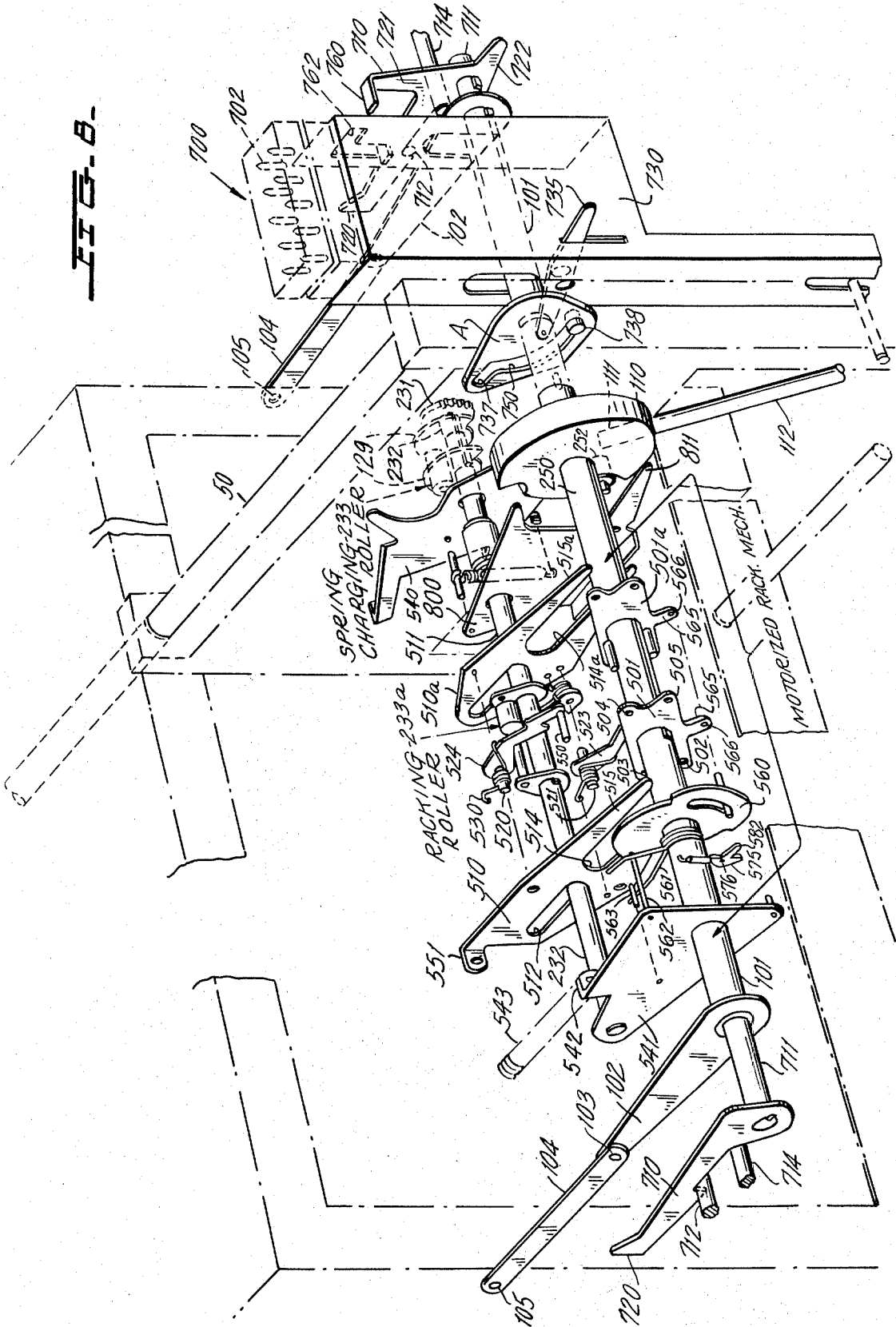
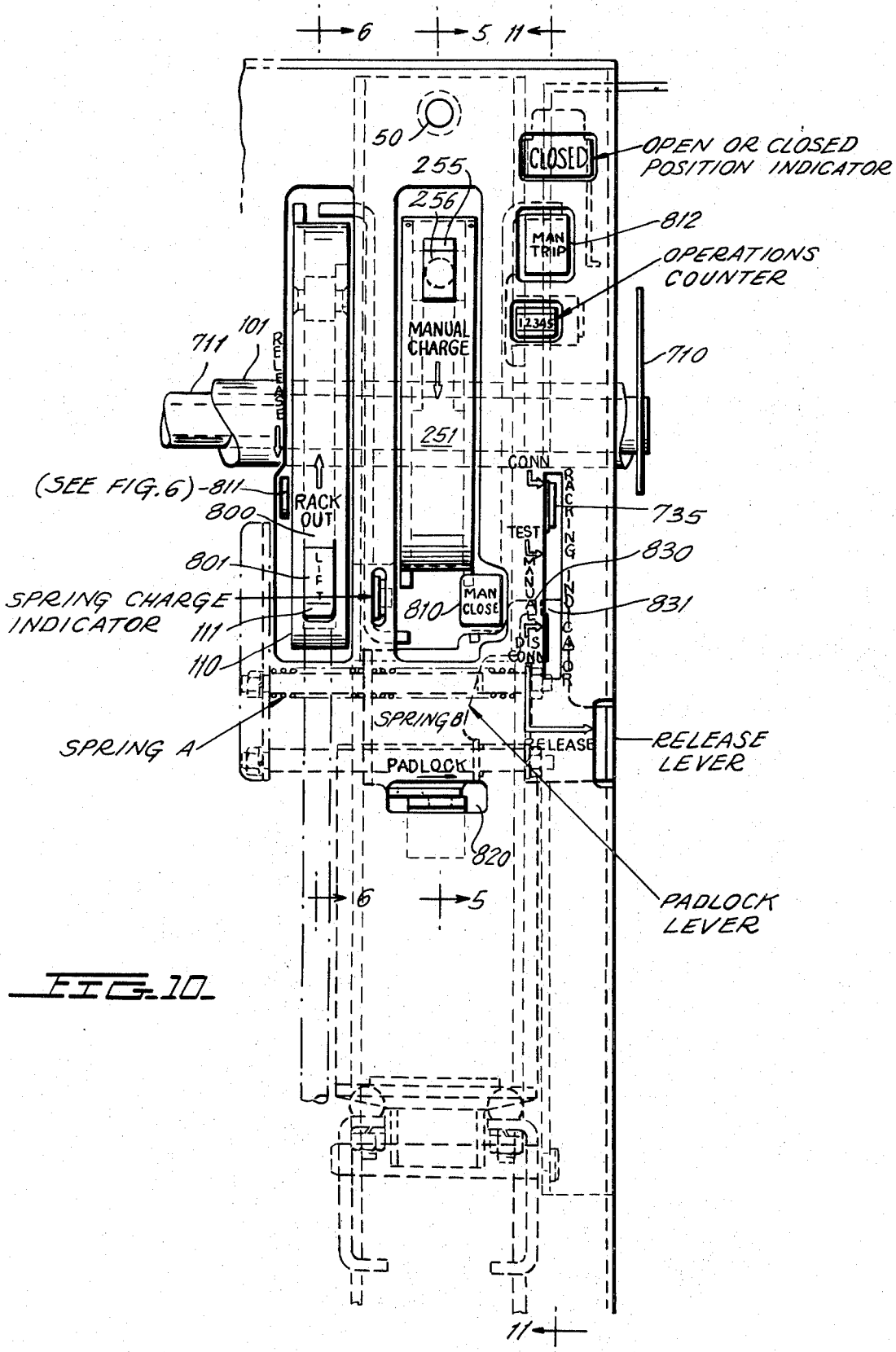


FIG. 8.





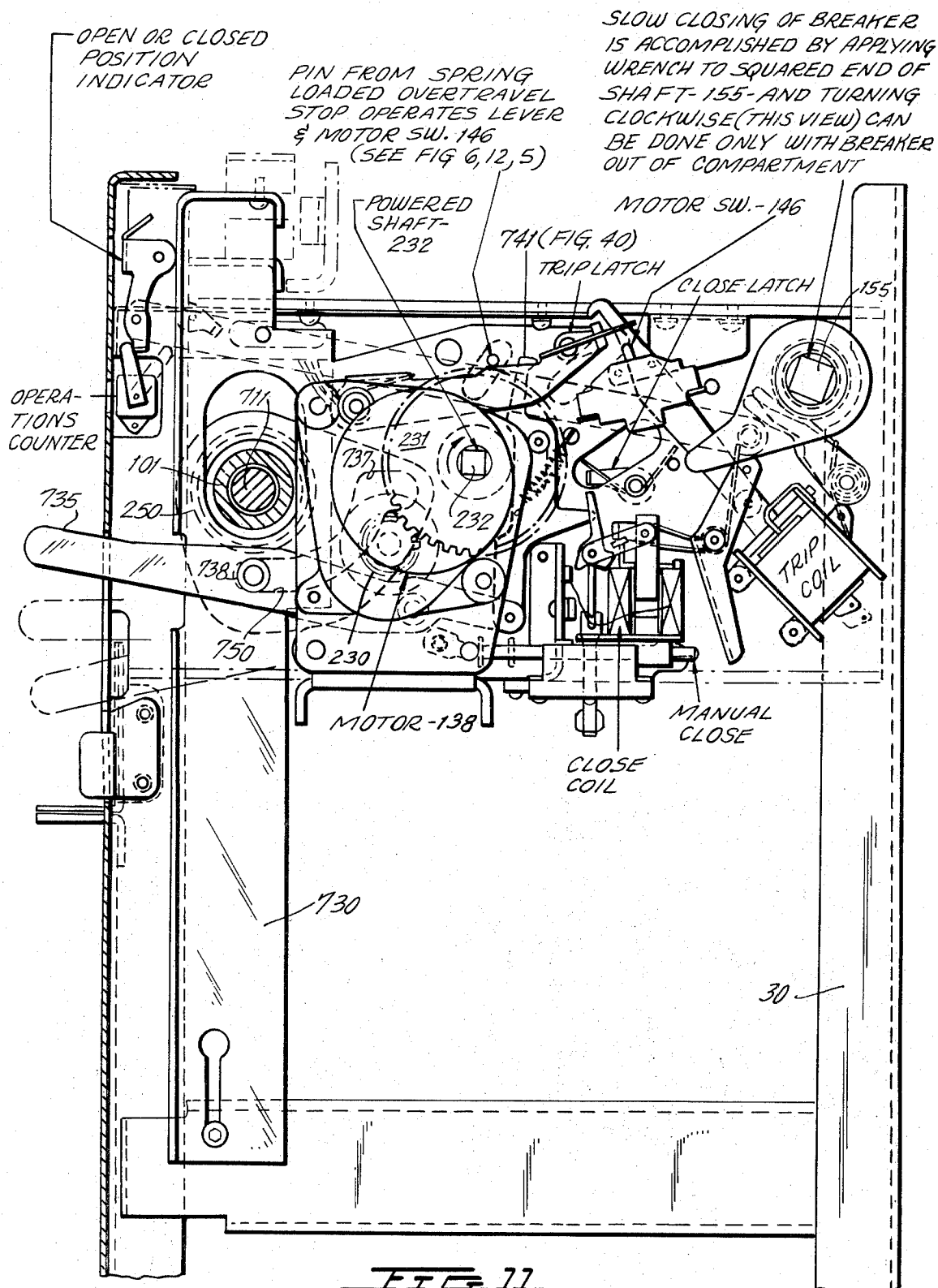


FIG. 12-

*TRIP-FREE POSITION OF MECHANISM
BREAKER OPEN-SPRINGS DISCHARGED-
MOTOR STARTED*

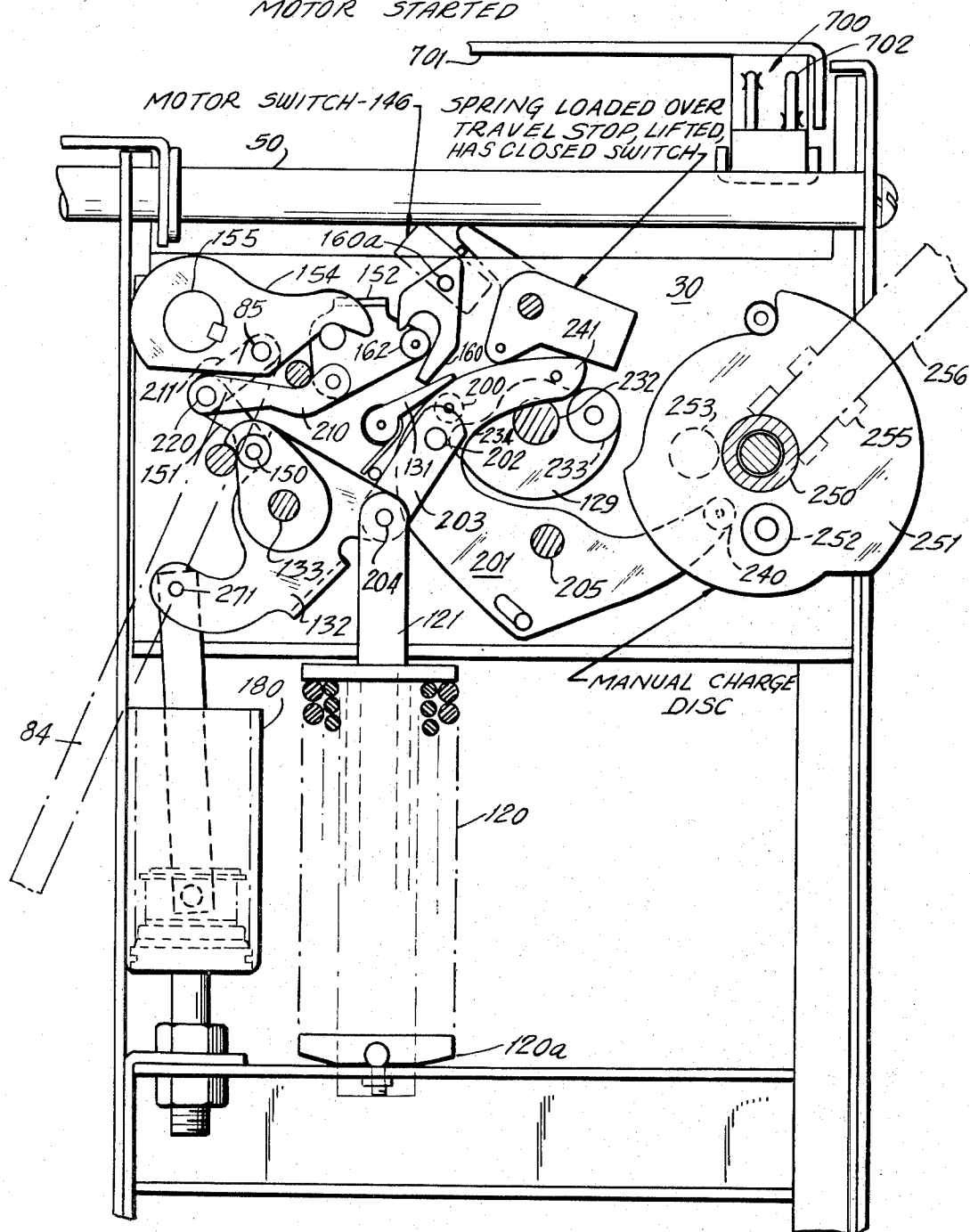


FIG. 14

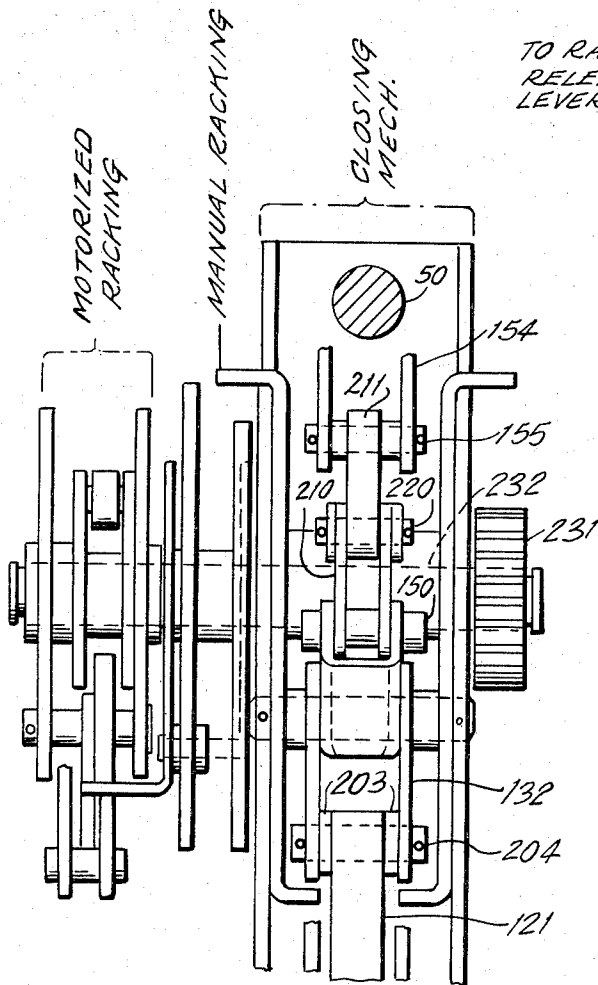


FIG. 13

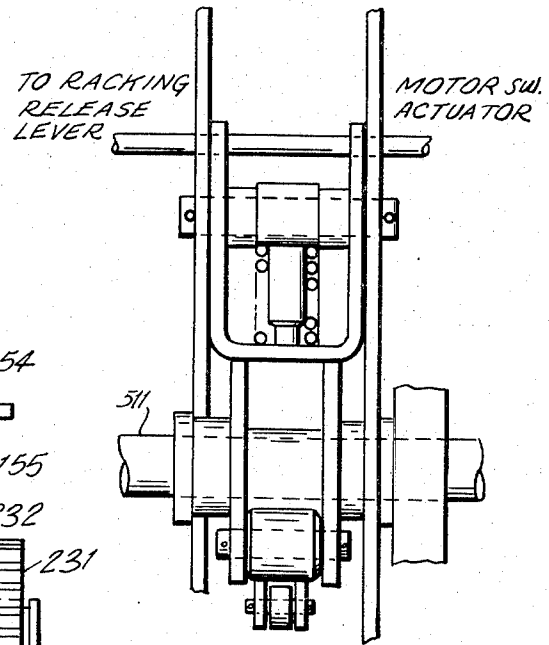
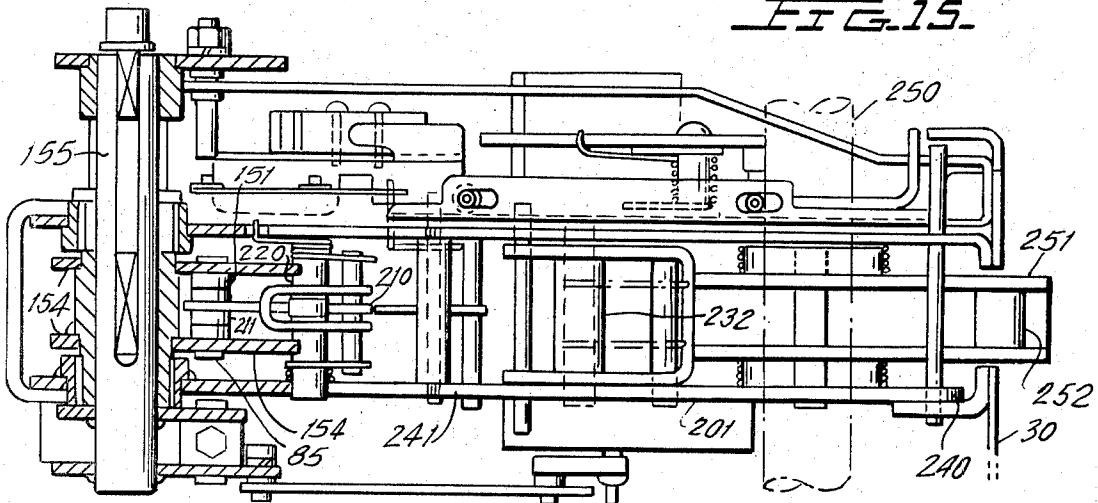


FIG. 15



SPRING ABSORBS
COASTING ENERGY
AND REPOSITIONS
MOTOR CRANK
OF POSITION
OF FIG. 17a

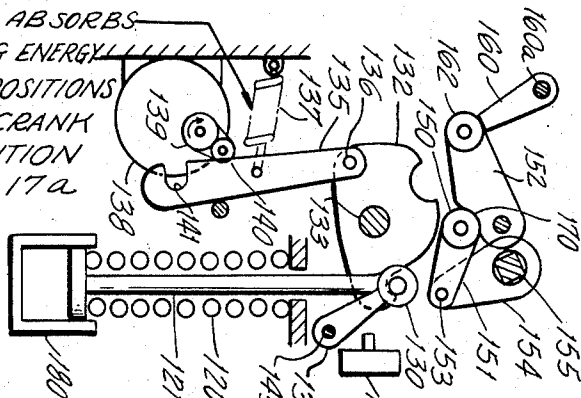


FIG. 16d.
MOTOR COASTING
STOPPED

MOTOR CRANK
LEAVES LINK
IN FULLY
CHARGED
POSITION

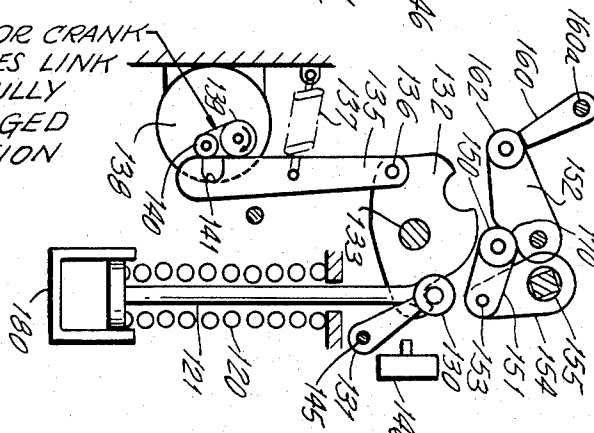


FIG. 16c.
BREAKER CLOSED
SPRINGS RECHARGED
MOTOR STARTING
TO COAST

MOTOR CRANK CAN
ENGAGE CHARGING
LINK ONLY IN
SPRING
DISCHARGED
POSITION

NOTCH
FOR
MOTOR
CRANK
ROLLER

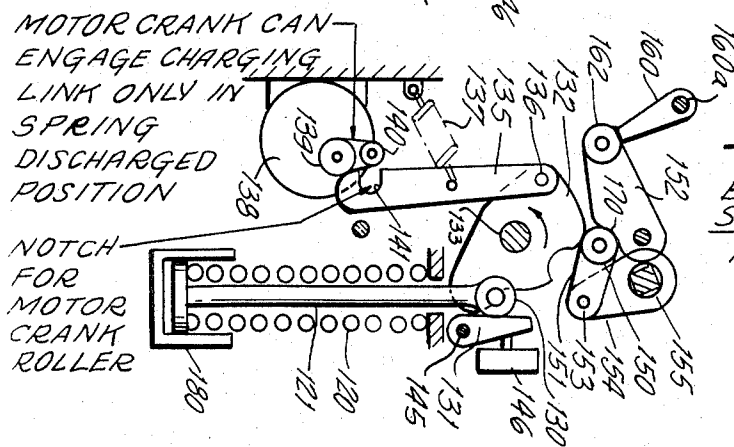


FIG. 16b.
BREAKER CLOSED
SPRINGS DISCHARGED
MOTOR STARTS

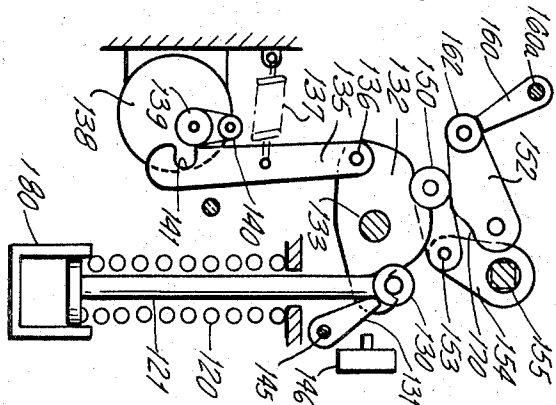


FIG. 16a.
BREAKER OPEN
SPRINGS CHARGED

FIG. 17.

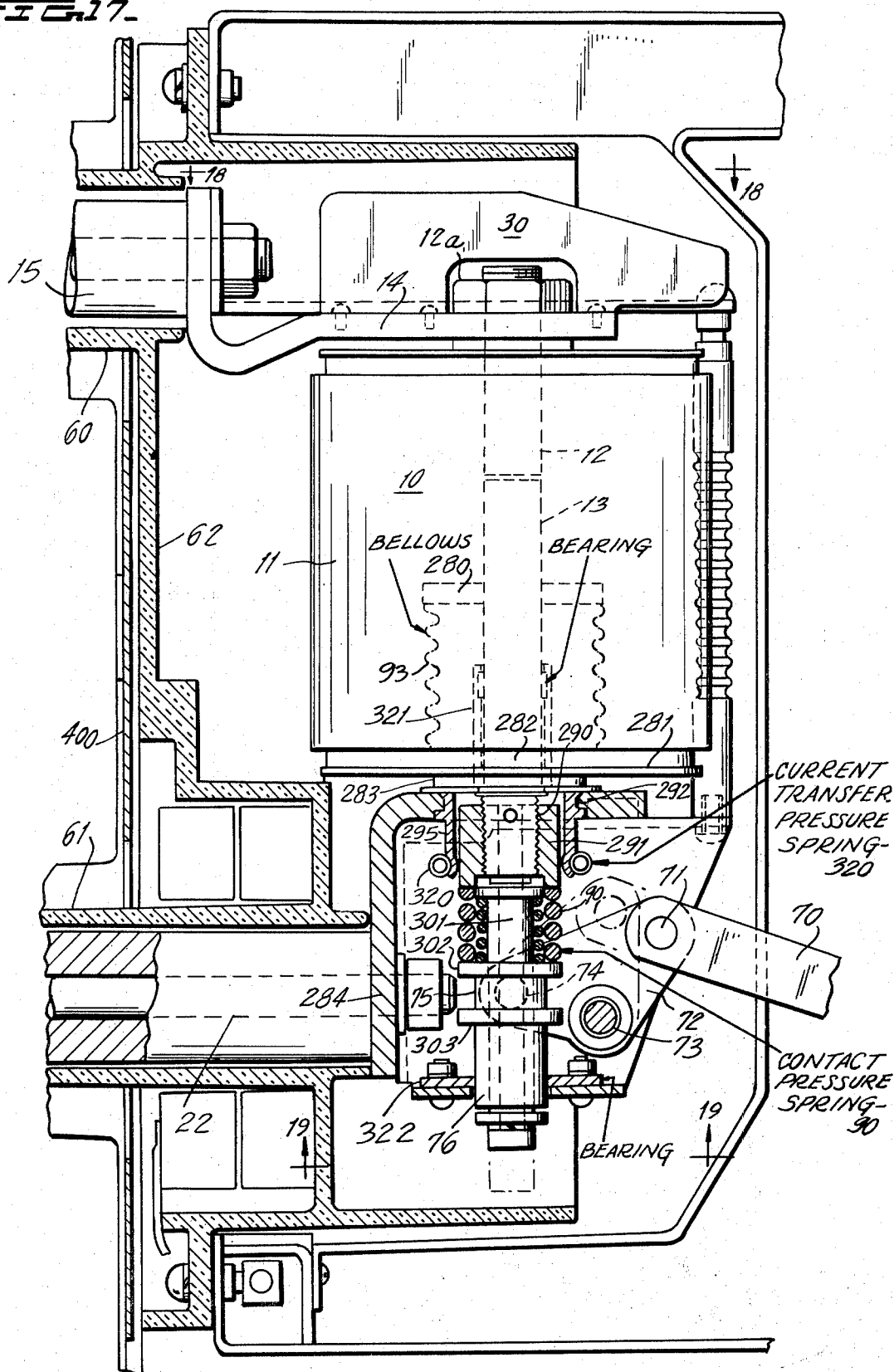


FIG. 18.

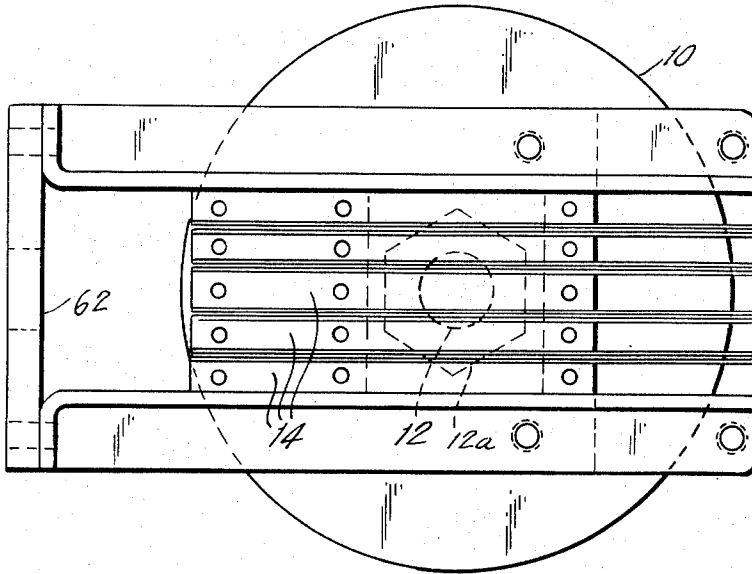


FIG. 19.

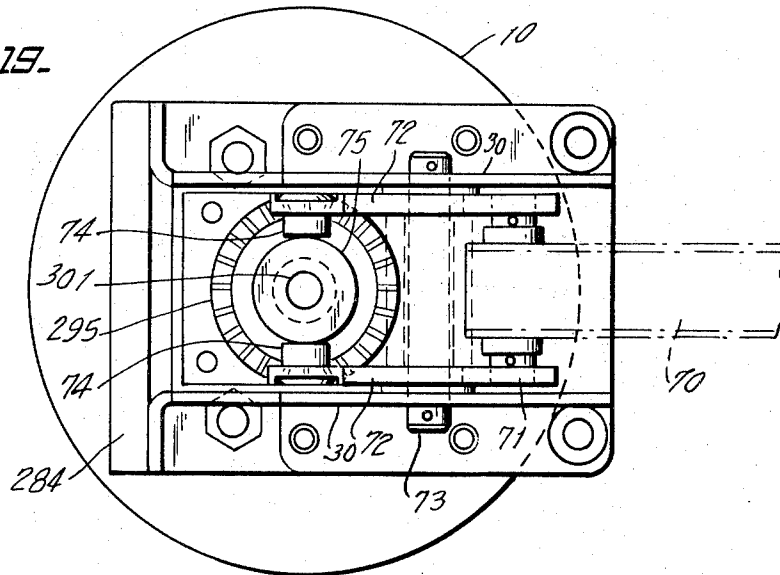


FIG. 20.

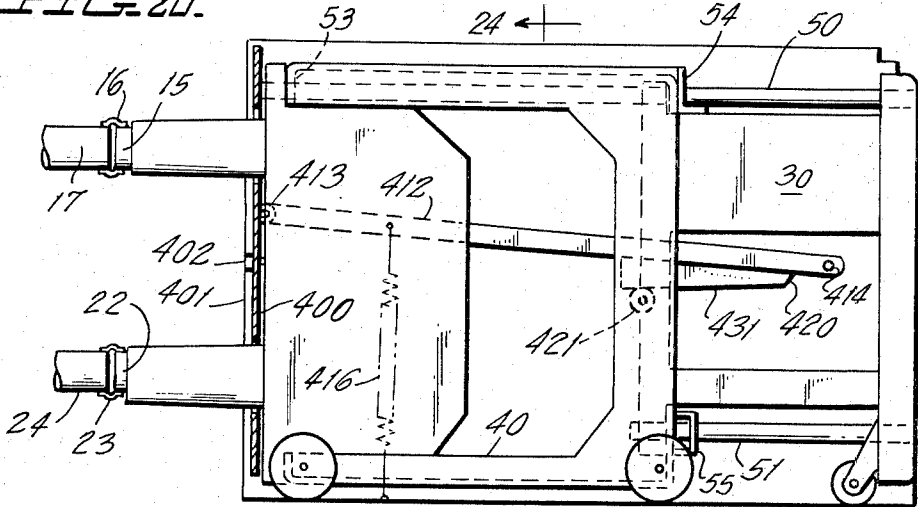


FIG. 21.

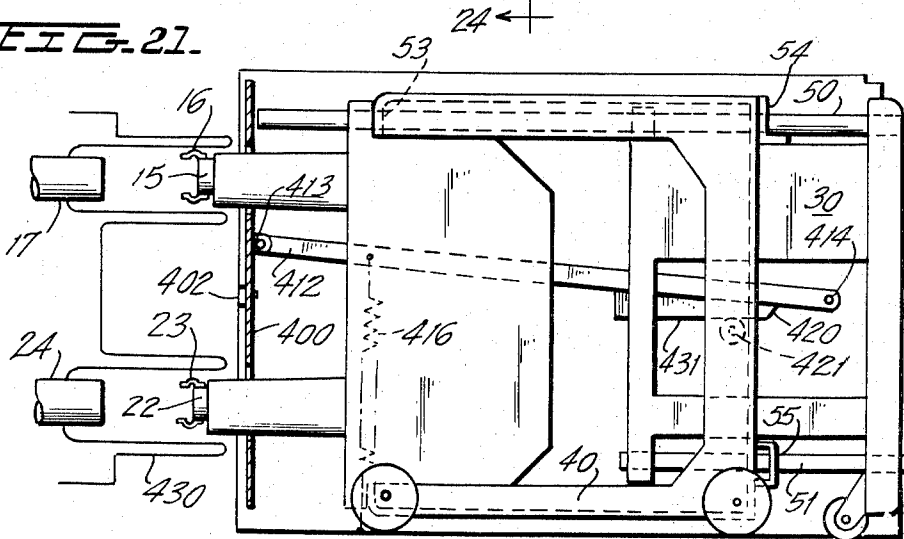


FIG. 22.

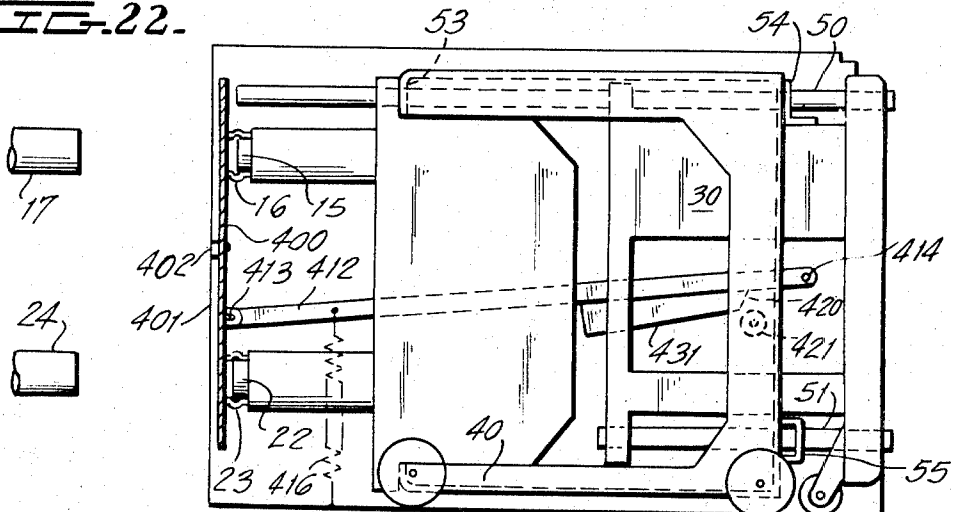


FIG. 23.

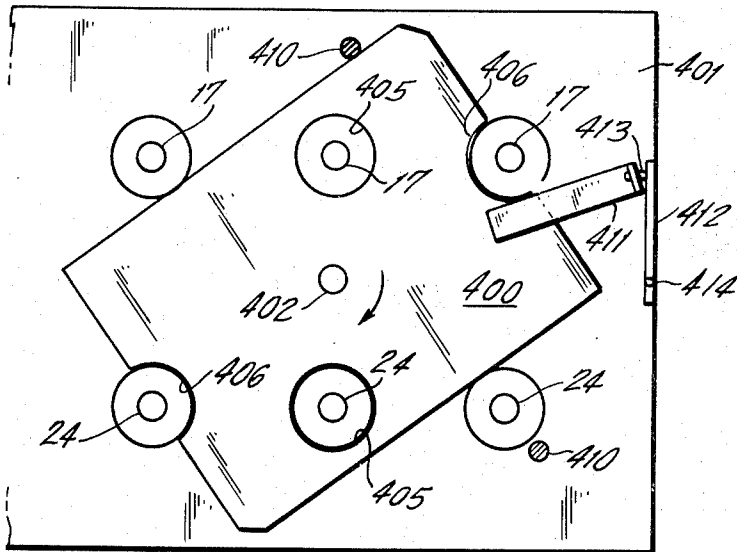
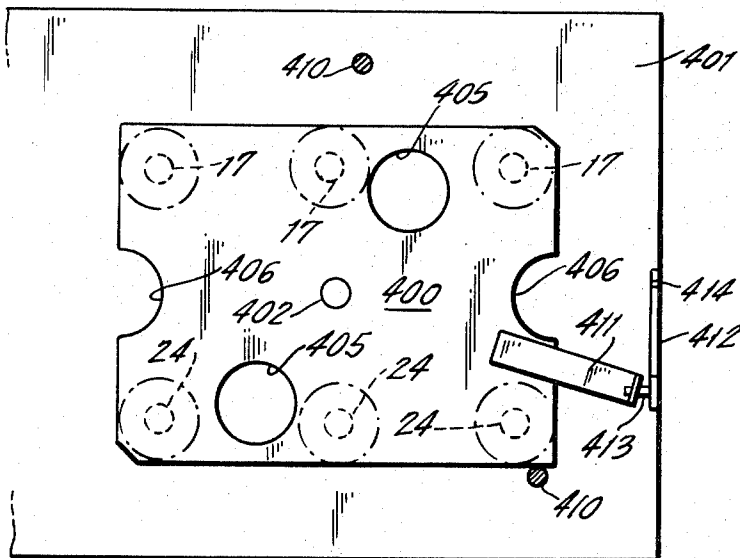


FIG. 24.



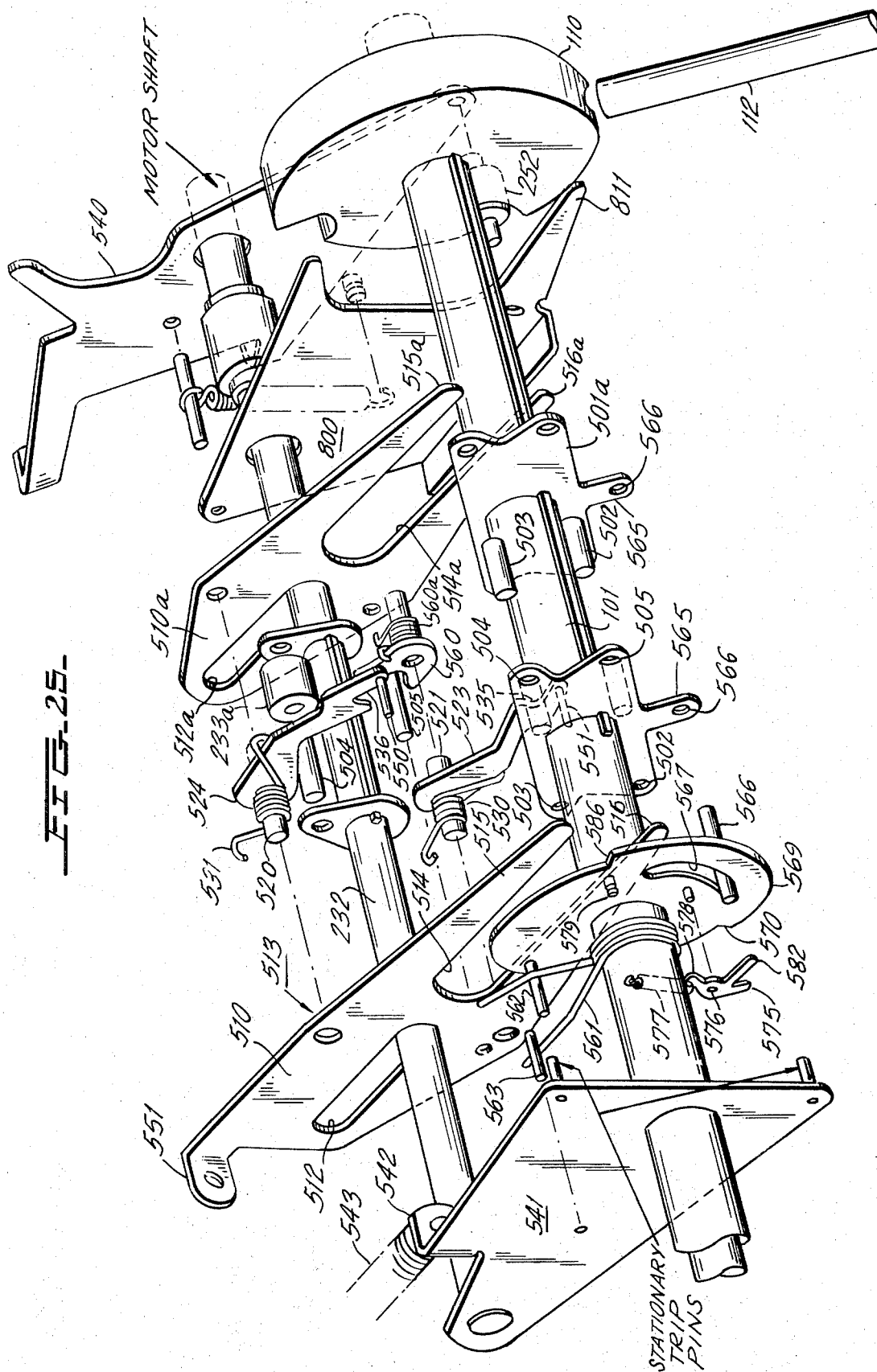


FIG. 26.

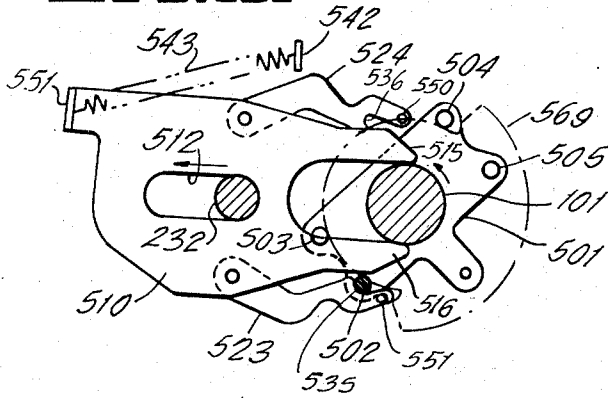


FIG. 33.

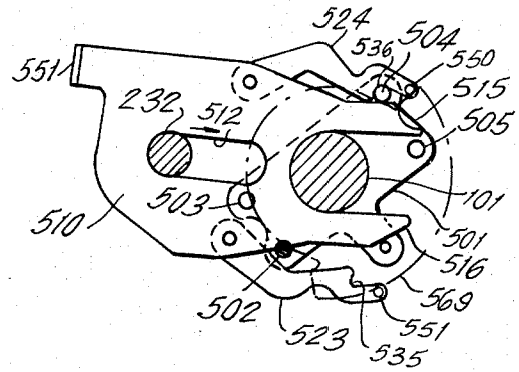


FIG. 27.

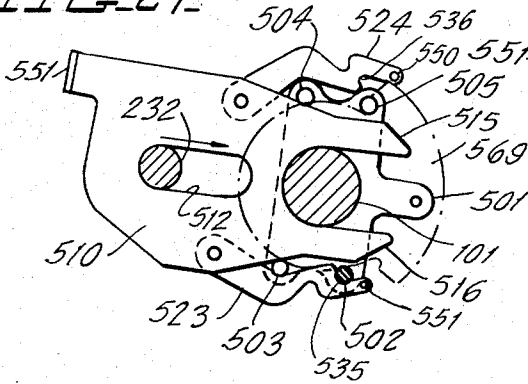


FIG. 32.

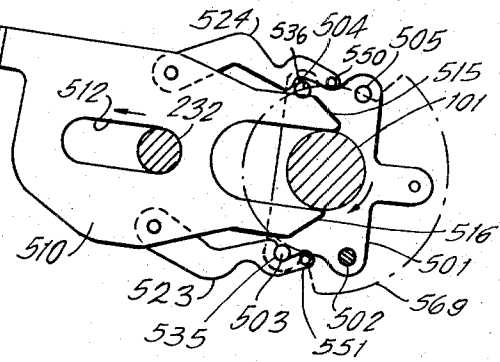


FIG. 28.

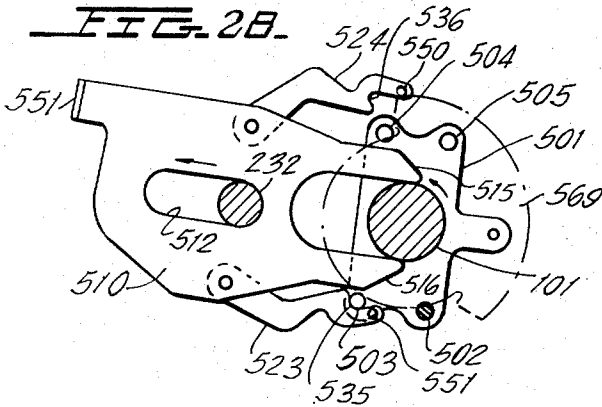


FIG. 31.

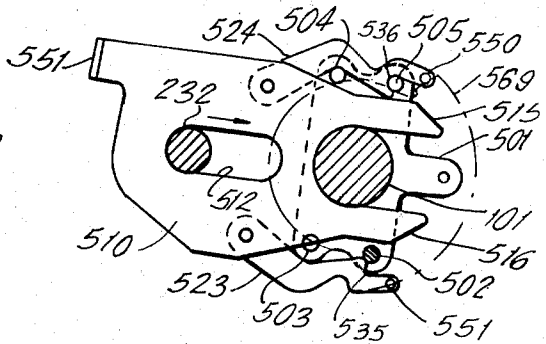


FIG. 29.

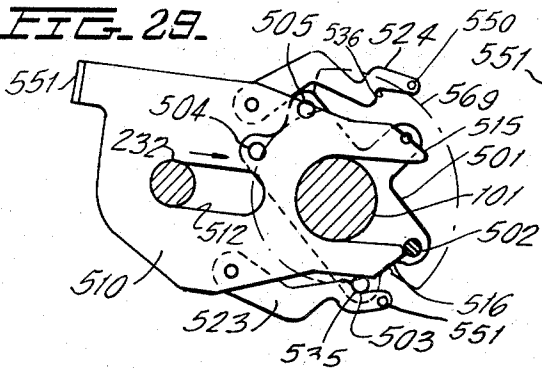
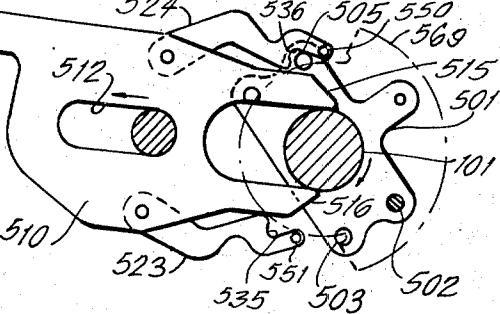
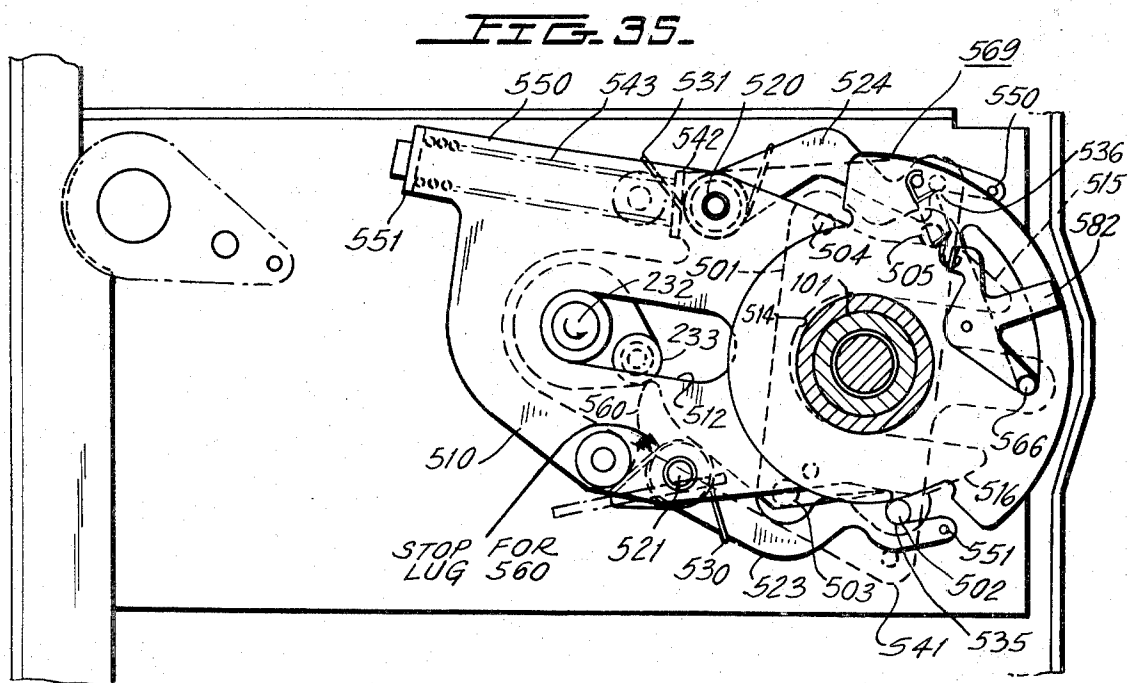
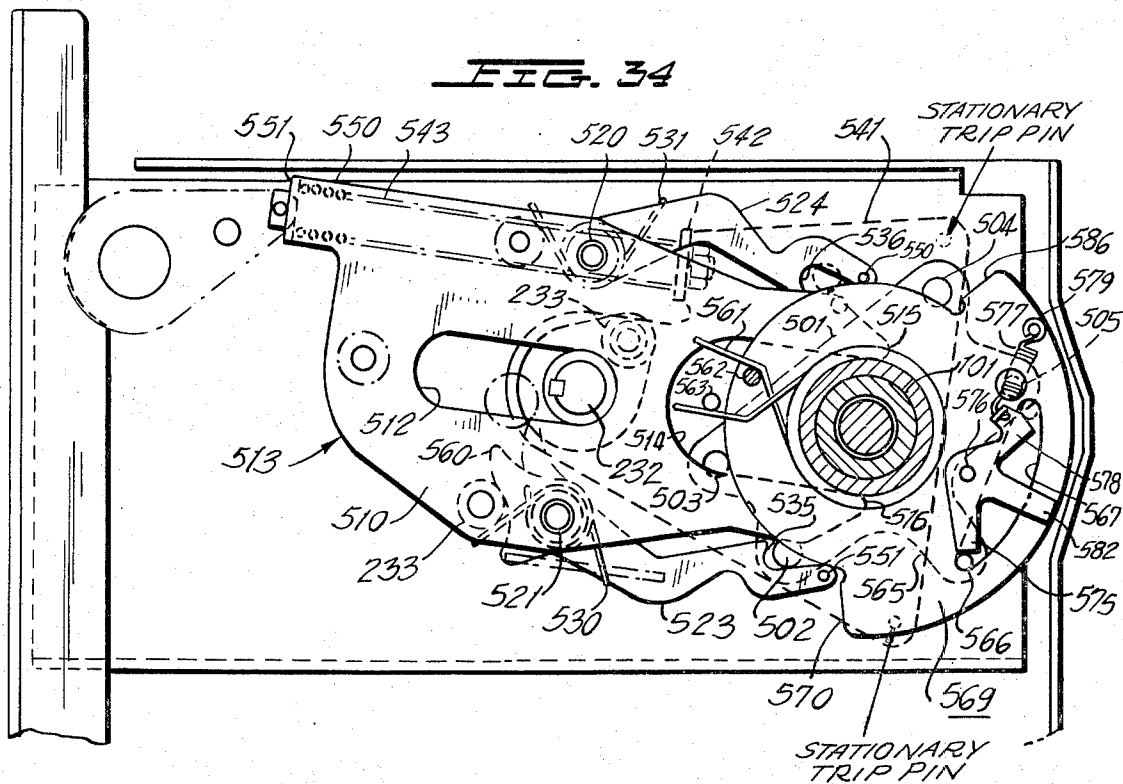


FIG. 30.





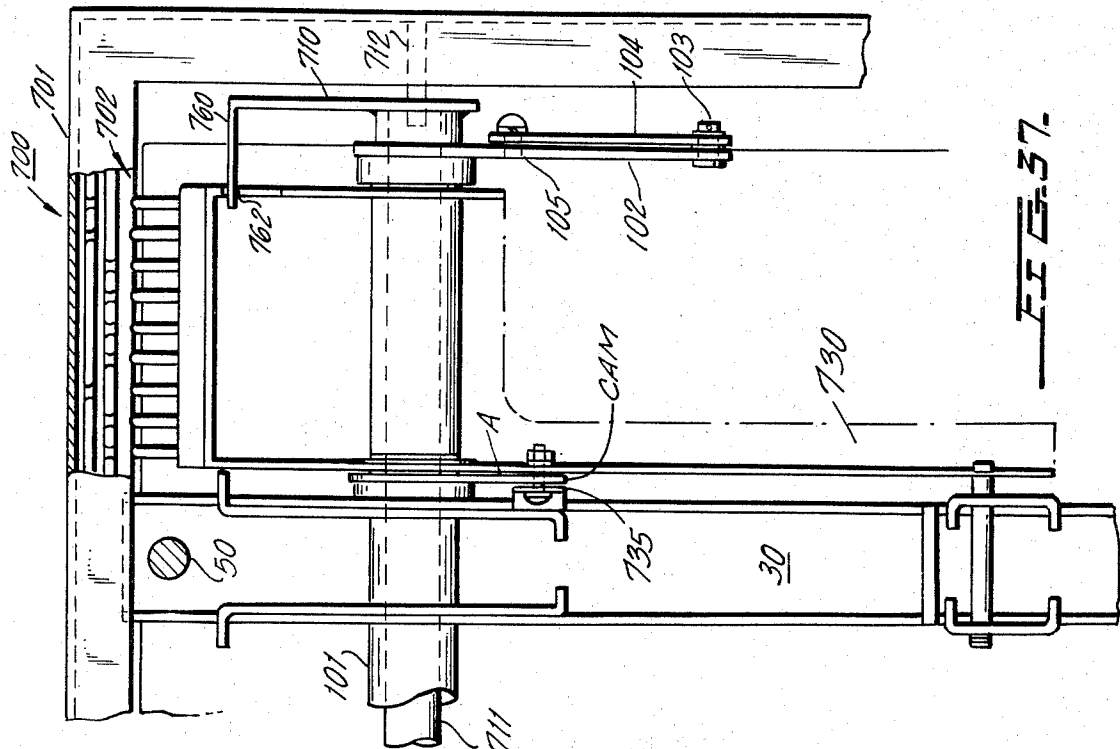


FIG. 37.

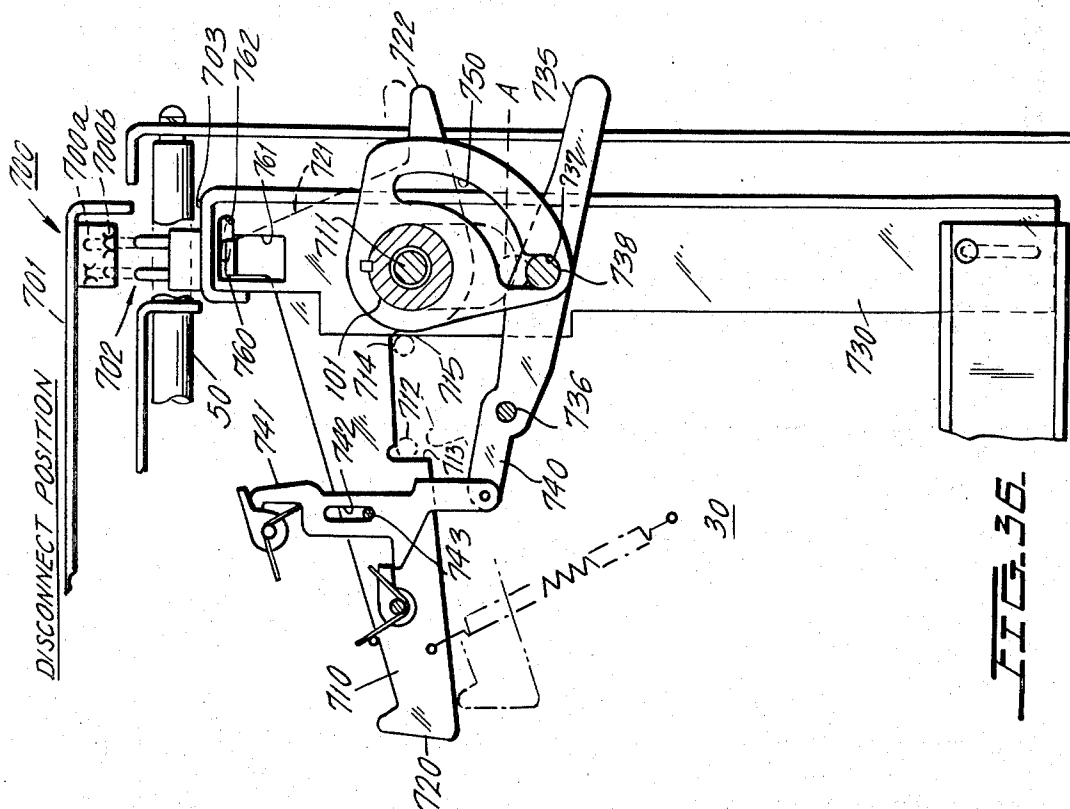


FIG. 38.

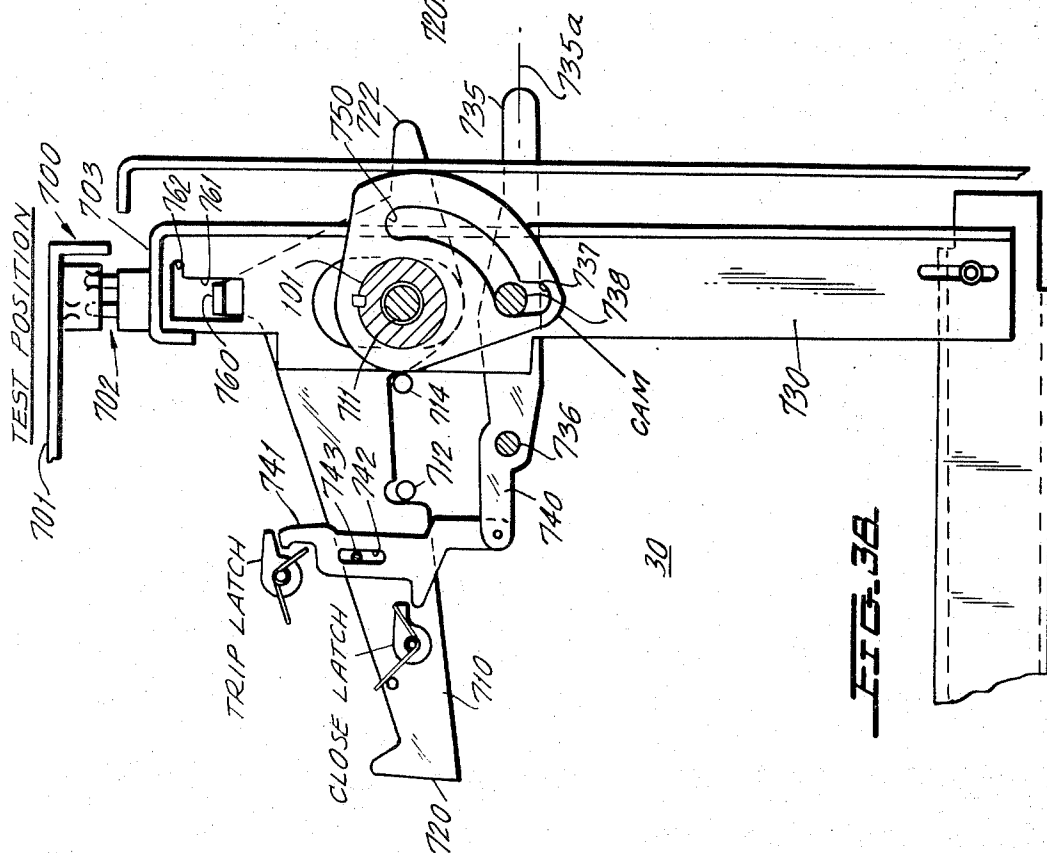
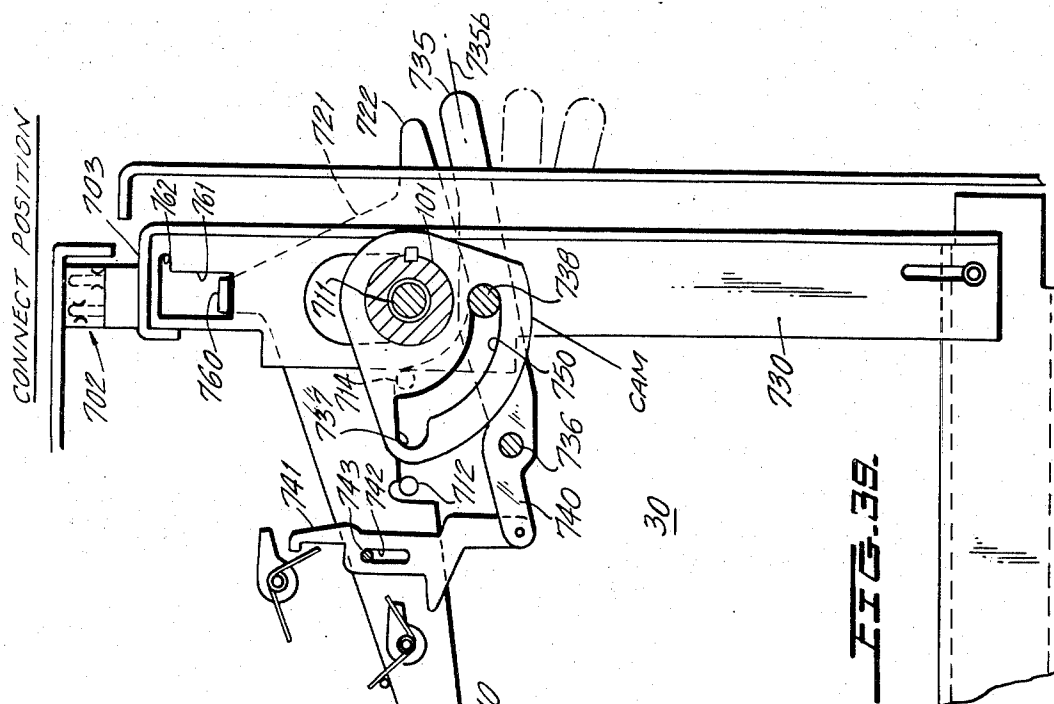


FIG. 40.

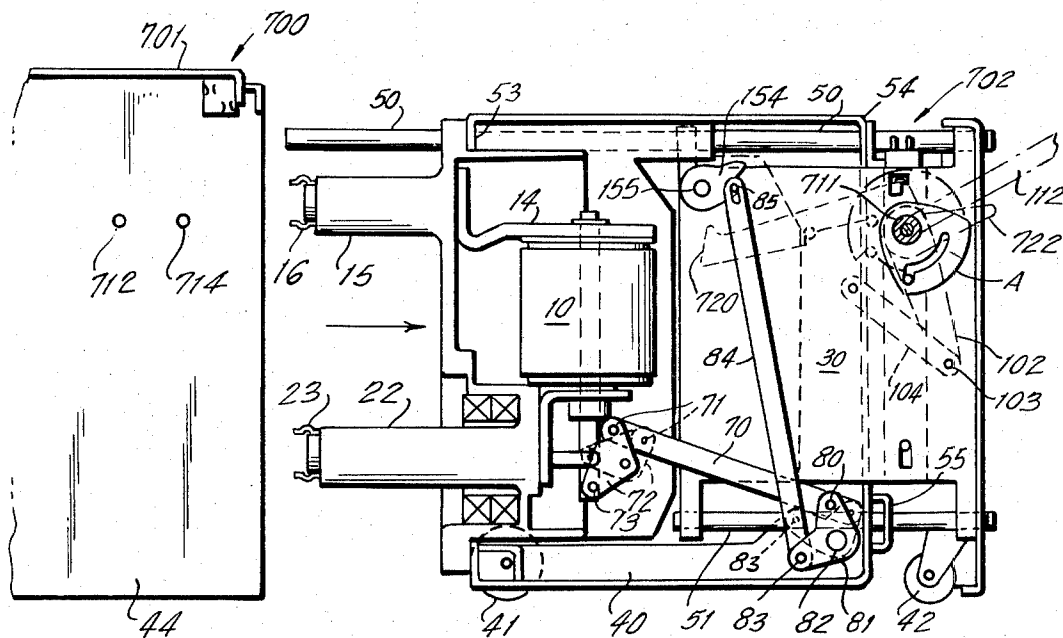
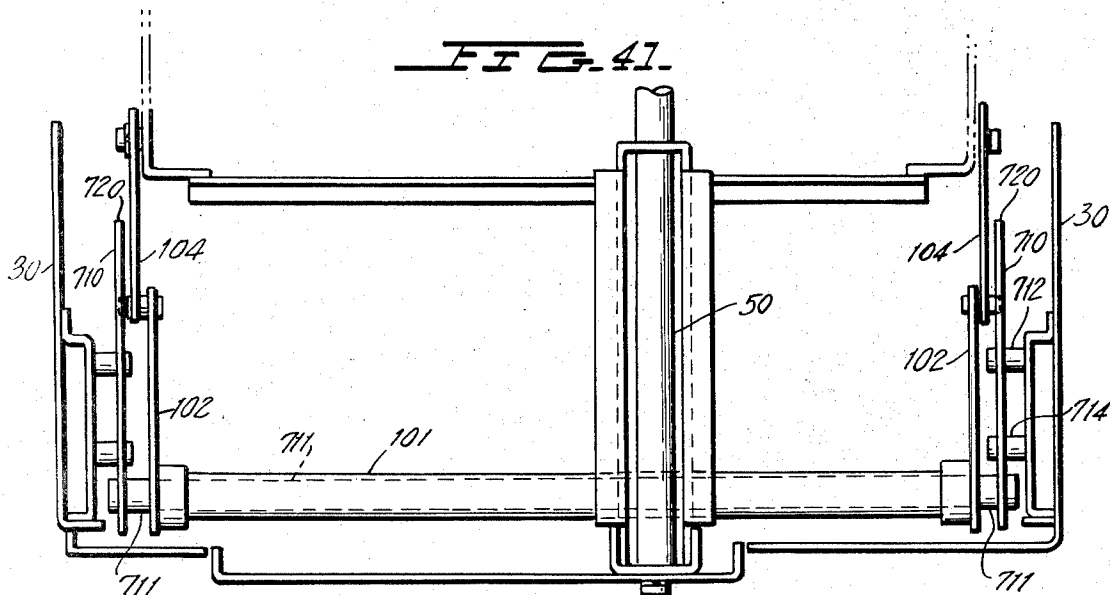


FIG. 41.



SWITCHGEAR WITH SINGLE DRIVE TO BOTH CHARGE CLOSING SPRING AND RACK CONTACT CARRIER

The present invention relates to telescoping withdrawal switchgear and circuit breakers for minimum size compartments and more particularly relates to a miniature high voltage circuit breaker for utilization in a compartment in which the interrupters and operating mechanism will completely utilize the available compartment space. For this purpose the operating mechanism and the current conducting mechanism are so arranged that when it is desired to withdraw the current conducting mechanism from a connected to a test position the section of the unit which carries the current conducting mechanism will telescope with respect to and around the operating mechanism thereby making it possible to reduce the size of the entire switching or circuit breaker mechanism and therefore to reduce the size of the compartment and of course to reduce the size of the entire switchboard and installation.

By the construction and novel elements hereinafter described it is possible to arrange a 15KV line breaker so that it may be completely housed in cubicle having dimensions 28 inches high, 37 inches deep and 36 inches wide for a 3 pole circuit breaker.

In addition, the present invention relates to modular switchgear which is so arranged that the various parts and elements thereof may be interconnected in a switchboard in selected arrangements and combinations.

Essentially the circuit breaker structure is arranged so that it may be inserted and withdrawn from the compartment as a whole and is therefore mounted on appropriate rolling or wheel devices. The circuit breaker structure itself is mounted on two platforms which may telescope or slide with respect to each other. One portion of the circuit breaker structure including the contact elements and the current carrying elements are mounted on a truck which is separated from the mounting for the operating elements. The mounting for the operating elements is so arranged that the truck carrying the contact members and current carrying members may telescope with respect thereto and thereby, when disconnected, approach the operating parts closely.

Since the current carrying elements of the circuit breaker structure, on their own truck, are disconnected from the bus in the manner hereinafter described when the truck carrying the same is moved toward the operating section and telescopes therewith, electrical clearance in this disconnected position is not necessary between the circuit breaker current carrying elements and the operating parts.

When the circuit breaker current carrying elements are fully racked into connected position, appropriate electrical clearance is provided between the circuit breaker contacts and current carrying elements on the one hand and the operating parts on the other hand so that no danger to the operator exists.

A further object of this invention is, in a miniature high voltage circuit breaker, to provide a spring charging system for charging the spring which closes the contacts of the interrupter and thereby provide a stored energy mechanism in which the closing springs are charged in one continuous effort by the charging motor. This is done without the noisy additional elements

of pawl and ratchet drives and without the complication of release clutches of any kind between the motor and springs. Existing ratchet and pawl systems are noisy in charging and are noisy on closing of the interrupter when the spring crank arms go past bottom dead center onto the so-called bonus angle from which they reverse and slam the ratchet back onto the pawls. This so-called bonus angle represents excess spring energy not used in closing the breaker which often limits the life of the mechanism by this abuse of the ratchet; in such cases if the ratchet wheel, when it reverses, catches one of the still moving charging pawls, it reverses the charging pawl abruptly and with it the motor gear train and armature. This can result in motor gear and bearing damage. Ratchet systems are also noisy when the closing springs go past top dead center on charging and fall with considerable impact on the prop latch. This prop latch impact is also a substantial factor in the endurance of the mechanism. Such ratchets, pawls and crank arms are also comparatively expensive to machine. The single stroke charging system of the present invention eliminates all of the above mentioned noise impact motor abuse and production cost faults of the ratchet and pawl systems.

A further object of the present invention is the provision of simplified means for motorized racking of the interrupter elements of the circuit breaker from a connected to a disconnected position whereby the energization of a motor will, through appropriate linkages during such energization, effect the racking operation. Such linkages and connections being so arranged so that in the fully connected and fully disconnected condition of the interrupter elements with the bus or other contacts in the compartment, the linkages and connectors will be disengaged.

Another object of the present invention includes the simplified arrangement of connections between the vacuum interrupter and the operating mechanism therefor so that this connection will maintain its integrity whether or not the circuit interrupter elements are telescoped with the operating mechanism and whereby current transfer between the vacuum interrupter contacts and the current conducting leads is simplified.

Another object of the present invention is provision of an interlock between the circuit breaker truck and the compartment so that the truck cannot enter the compartment except in the withdrawn position of the interrupter elements, and cannot leave the compartment unless the interrupter elements are in that same condition, and whereas secondary or auxiliary contacts may be controlled in accordance with the inserted or test position of the circuit interrupter elements; also wherein the movement of the interlock which permits full withdrawal from the compartment of the entire circuit breaker structure necessitates complete withdrawal from contact arrangement from second or auxiliary contacts.

Still another object of the present invention is the provision of shutter or closure means in the compartment for opening or closing access to the stationary conductors leading to the buses, in accordance with the racked in or racked out condition of the circuit interrupter elements; a simplified cam operated lever being provided for operating the said shutter in accordance with the operation of the telescoping circuit interrupter carrying carriage.

The foregoing and other objects of this invention will become apparent in the following description and drawings in which:

FIG. 1 is a side view partly in section and partly broken away of the novel miniature high voltage circuit breaker with the contact members and current carrying members fully racked into operative position showing the relative positioning and placement of the various parts of the entire circuit breaker mechanism.

FIG. 2 is a view corresponding to that of FIG. 1 showing the same structure in the same racked in position of FIG. 1 with certain of the details omitted so that the telescoping operation, which may more readily be seen in FIGS. 3 and 4, may be understood.

FIG. 3 is a schematic side view showing the manner in which the circuit breaker contact and current carrying elements of the miniature high voltage circuit breaker mounted on their own truck may be integrated, controlled and positioned with respect to the frame which carries the operating mechanism.

FIG. 4 is a view corresponding to that of FIG. 2 showing the racked out position of the circuit breaker contact and current carrying elements, demonstrating the manner in which the truck carrying these elements may telescope with respect to the frame which carries the operating mechanism.

FIG. 5 is a side view partly in cross-section of the mechanism for operating the circuit breaker contacts of the circuit breaker of FIGS. 1 to 4 with the springs charged and the breaker closed.

FIG. 6 is an enlarged view of a portion of the operating mechanism showing the manual racking and interlocking.

FIG. 7 is a top plan view, partly in section of the operating mechanism showing the manual and electrical racking.

FIG. 8 is an expanded schematic view of the manual and electrical racking mechanism including also elements set forth in later figures comprising not only racking mechanism, but also motorized racking mechanism, interrupter operating mechanism, auxiliary contact operation and latching of the truck in the compartment.

FIG. 9 is an expanded schematic view showing the operating elements of FIGS. 5 and 7 for closing and opening the circuit breaker interrupter contacts.

FIG. 10 is a front view of the escutcheon plate at the front of the circuit breaker mechanism showing the various elements which are used in connection with the operation of the circuit breaker.

FIG. 11 is a further view of the operating mechanism of the circuit breaker showing the relationship of the electrical control features including the motor, the motor cut-off switch, the closing solenoid and the tripping solenoid.

FIG. 12 is a side view of the interrupter contact closing and opening mechanism with the springs discharged, the circuit breaker open and in trip free condition.

FIG. 13 is a detail of the motor switch actuating structure for operating the spring charging mechanism of the interrupter contacts.

FIG. 14 is a vertical plan view of parts of the operating mechanism and their relationship to the escutcheon plate of FIG. 10.

FIG. 15 is a top view of the operating mechanism of FIG. 5.

FIGS. 16a, 16b, 16c, 16d are successive schematic views of the operation of the interrupter contacts from the condition in which the circuit breaker is open with the closing springs charged through discharge of the closing springs to close the interrupter contacts to recharge of the closing springs.

FIG. 17 is a more detailed view partly in cross-section, partly in phantom, of the interrupter of FIG. 1.

FIG. 18 is a view taken on line 19—19 of FIG. 18 looking in the direction of the arrows.

FIG. 19 is a view taken on line 19—19 of FIG. 18 looking in the direction of the arrows.

FIG. 20 shows the miniature high voltage circuit breaker with the operating elements on frame 40 racked into fully operative current controlling condition corresponding to the position of FIG. 1.

FIG. 21 shows the same structure with the operative elements on frame 40 partly racked out and partly telescoped with the operating mechanism.

FIG. 22 shows the circuit breaker on the moving frame 40 fully racked out in a fully telescoped position corresponding to the position of FIG. 4.

FIG. 23 is a view taken from line 23 of FIG. 20 showing the shutter mounted in the open position so that there is access from the movable disconnect into the stationary disconnect and would therefore correspond to the position which is obtainable in FIG. 20.

FIG. 24 is a view similar to that of FIG. 23 taken from line 24 of FIG. 23 showing the shutter mounted in the closed position, in a position which corresponds to FIG. 22.

FIG. 25 is an expanded view in perspective of the operating element of the motorized and manual portions of the racking arrangement.

FIG. 26 is a diagrammatic view showing the motorized operating elements in the connected or racked in position of the circuit breaker.

FIG. 27 is a similar diagrammatic view showing the initiation of the racking out operation.

FIG. 28 is a similar view showing a further step in the racking out operation.

FIG. 29 is a similar view showing the completion of the racking out operation for the circuit breaker elements to the test position.

FIG. 30 is a similar diagrammatic view showing the motorized operating elements in the racked out or test position of the circuit breaker.

FIG. 31 is a similar diagrammatic view showing the initiation of the racking operation.

FIG. 32 is a side view partly in cross-section of the operating element of the motorized racking operation of FIGS. 25 to 31 showing a continuation of the racking-in operation.

FIG. 33 is a view similar to that of FIG. 32 showing the completion of the racking-in operation to the connected position. The components then reset to the positions shown in FIG. 26.

FIG. 34 is a side view partly in cross-section of the operating elements of the motorized racking operation of FIGS. 25 to 33, showing a position corresponding to the diagrammatically illustrated position of FIG. 26.

FIG. 35 is a view similar to that of FIG. 36 showing, however, a position of the elements corresponding to that of FIG. 27.

FIG. 36 is a side view partly in section showing the secondary contact interlock and truck to compartment interlock.

FIG. 37 is a front view of the structure of FIG. 34.

FIGS. 38 and 39 are views corresponding to that of FIG. 38 showing different positions of the interlock elements thereof.

FIG. 40 is a side view in section showing the entire composite circuit breaker apparatus withdrawn from the compartment.

FIG. 41 is a top view of the forward end of the truck mounted circuit breaker structure of FIG. 38.

Referring first to FIGS. 1, 2 and 4, the circuit breaker structure is a vacuum type of circuit breaker now well known in the art in which a vacuum-tight housing 11 encloses and supports a stationary contact 12 and a moving contact 13. The connections to the interrupter 10 are specifically described in connection with FIGS. 17, 18 and 19. It is sufficient for the present to note that stationary contact 12 is electrically connected to the rigid connector 14 which in turn is connected in any suitable manner as by the nut 12a to upper or load back disconnect contact 15. The upper back disconnect 15 is provided with suitable contact fingers 16 in a manner now well known in the art when the circuit breaker structure is in the position shown in FIG. 1 to electrically engage the stationary back disconnect contact 17 in the compartment the said back disconnect contact 17 being connected to a load bus.

The movable contact 13 is a plunger type contact electrically connected to the conductive support 284 by the means described in connection with FIGS. 17, 18 and 19 the support 21 is connected to the lower disconnect contact 22 which is similar to the upper back disconnect contact 15; the contacts 23 of the lower back disconnect contact 22 are engageable with the lower stationary back disconnect contact 24 which is connected to the line bus. The circuit is then made from back disconnect contact 17 to the circuit breaker upper back disconnect contact 15 stationary contact 12 in the vacuum housing 11 then to the movable contact 13, the lower disconnect contact 22, the contacts 23 and the lower stationary disconnect contact 24. While in the view of FIGS. 2 and 4 a single circuit breaker is shown, it is obvious that the circuit breaker may be set up and in the present embodiment is intended to be set up as a three pole circuit breaker in which the operating mechanism carrying frame 30 will, through the connecting link 84, hereinafter described, and the jack shaft 82 which is common to and runs through all of the three poles of the breaker structure thereby operating the three poles simultaneously.

Each of the poles is provided with the structure thus far described including the vacuum interrupter 10 and the back disconnect structures 15 and 22. The three pole circuit breaker arrangement including vacuum interrupters 10 are carried on the frame 40 which is truck mounted on wheels 41, 42 at the front and back of the frame so that they may roll; thus the frame 40 as a whole may roll with respect to frame 30 which carries the operating mechanism.

The circuit breaker back disconnect contacts of the breakers 10 are racked out with the frame 40 to disconnect the upper and lower back disconnect contacts 15 and 22, when the frame is moved to the position shown in FIG. 4.

TELESCOPING WITHDRAWAL CIRCUIT BREAKER

The frame 40, as may readily be seen from FIG. 4,

telescopes with respect to the frame 30 of the operating mechanism. The frame 30 is fixed in position by hooks 710 engaging appropriate elements 712, 714 on the opposite side walls 44 of the compartment as will be hereinafter described in connection with FIGS. 34 and 37 and 8 so that during the racking operation from the connected position of FIG. 1 to the disconnect position of FIG. 4 the operating mechanism on the frame 30 is for all practical purposes to be regarded as integrated with the compartment and switchboard in which the compartment is located.

Since the frame 30 is thus fixed, the circuit breaker structure on the moving frame 40 moves with respect to the frame 30 and hence with respect to the compartment wall 44. It is guided in its movement by the slide arrangement which is more clearly seen in FIG. 3 but appears in FIGS. 1 to 4; that is the frame 30 carries the upper side 50 (see also FIGS. 5, 8, 12, 14, 20, 21, 22, 38, 39) and the lower side rod 51. The frame 40 carrying the circuit breaker is provided with the slide member 53 at the upper rear portion of the frame and the slide member 54 at the upper front of the frame 40 which slides on the upper slide bar 50 carried by the operating mechanism frame 30. The lower portion of the circuit breaker frame 40 is provided with a slide 55 which slides on the lower guide bar 51 on the frame 30.

It may thus be seen that when the racking mechanism is operated the circuit breaker structure on frame 40 may be moved from the position of FIG. 1 to the position of FIG. 4 telescoping with respect to the operating mechanism of frame 30.

Since, in the telescoped position of FIG. 4 the circuit breaker back disconnect contacts 15 and 22 are fully disconnected there is no need at this position of the circuit breaker mechanism to isolate the operating mechanism, there being no danger of any flashover to the operating mechanism. This is especially so since the stationary back conductors 17 and 24 remain in their original position within the stationary insulated bushings 60 and 61 on the back wall 62 of the compartment and covered by the shutter 400 (of FIGS. 20 to 24).

The mechanical connection for the operating mechanism on frame 30 to the truck mounted interrupter elements on frame 40 in order to operate the circuit interrupter 10 is made through the insulated operating link 70 which engages pin 71 on the bell crank lever 72 on pivot 73. The bell crank lever 72 at the end opposite the pin 72 is provided with the pins 74 which engage the clevis 75 of the extension 76 of the moving contact 13 of the interrupter 10. The specific operation of the interrupter 10 by bell crank lever 72 is described in connection with FIGS. 18, 19 and 20.

Consequently the movement of the link 70 to the right with respect to FIG. 1 will rotate the bell crank lever 72 to raise the moving contact 13 into engagement with stationary contact 12 and the movement of the link 70 to the left will operate the bell crank lever 72 to open the contacts 13. The operating link 70 may be centrally located to operate the center pole or may be provided in duplicate on each side to be operated by bell crank levers 81 (hereinafter described) keyed to a single jack shaft 82 which is common to all the poles of the circuit breaker.

The end of the operating link 70 opposite its connection to the bell crank lever 72 is connected at pin 80 to bell crank lever 81 which is keyed to jack shaft 82 on frame 40. The opposite end of the bell crank lever is

connected by pin 83 to the link 84 which is the driving link in the operating mechanism for operating the circuit breaker. The driving link 84 in the operating mechanism frame is connected at its upper end 85 so that it may react appropriately to the closing spring 120 (FIG. 5) and respond to the latch system as hereinafter described in connection with FIGS. 5, 9 and related figures.

The moving contact plunger 13-76 is biased toward the stationary contact 12 in the closed position by the compression spring 90 captured between the upper portion of the clevis 75 on the external portion of the moving contact plunger 76 and the base 91 of the moving contact plunger 13. Vacuum interrupter 10 contains a bellows 93 which is connected to the plunger 13 within the interrupter housing 11 in order to maintain the vacuum despite the fact that the plunger 13-76 must slide in and out of the housing. This is more specifically described in connection with FIGS. 17, 18 and 19.

When, therefore, the link 84 is permitted to rise it rotates the bell crank lever 81 thereby pulling the link 70 to the right, rotating the bell crank lever 72 clockwise and moving the contact plunger 13 up to the closed position where it engages the stationary interrupter contact 12. When the link 84 is released so that it no longer retains the contact in the closed position, then the opening compression spring 82a drives the bell crank 81 down to open the contacts, rotating the bell crank lever 72 counterclockwise, pushing the link 70 to the left, rotating the bell crank lever 81 counterclockwise and pulling down the operating link 84.

RACKING INTO AND OUT OF TELESCOPING POSITION TO DISCONNECT AND CONNECT THE BACK CONTACTS

As pointed out above, the operation of the link 84 to close the contact 13 and the release of the link 84 to permit the contact 13 to open with respect to stationary contact 12 are more specifically described in connection with FIG. 5. In FIGS. 1, 2 and 4 the racking shaft 101 may be seen. The racking shaft is a through shaft in the operating mechanism frame 30. The racking shaft 101 is provided on each side thereof with a crank 102 keyed to shaft 101 and connected by the pin 103 to the link 104 which is connected to the pin 105 on the interrupter frame 40. The crank 102 and link 104 are in toggle relationship.

The two racking positions of the swinging link 84, FIG. 1, are symmetrically arranged so that the closing mechanism will operate the interrupter contacts equally when the circuit breaker is in the connected position or in the test position. This is necessary so that the operation of the circuit breaker while in the test position may be checked with appropriate assurance that its subsequent operation when racked in will be the same.

When the racking shaft is rotated counterclockwise from the position of FIG. 2 to the position of FIG. 4, the crank 102 and link 104 on each side move to the closed toggle position shown in FIG. 4 thereby resulting in the racking out of the interrupter carrying frame 40. When the racking shaft 101 is rotated clockwise from the position of FIG. 4 to the test position of FIG. 2 then the interrupter carrying frame 40 is moved also from the position of FIG. 4 to the position of FIGS. 1 and 2 into the fully connected position. The racking shaft is pro-

vided with a handle receiving member 110 keyed thereto, having an opening 111 therein to receive a removable handle 112. Therefore the racking shaft 101 may be rotated to move the interrupters from the position of FIGS. 1 and 2 to the position of FIG. 4 by inserting the handle 112 in the opening 111 of the handle member 110 and lifting the handle as shown by comparison of FIGS. 2 and 4. Similarly the circuit breaker interrupter elements may be racked into connected position by a reverse operation in which the handle 112 is inserted in the opening 111 of the handle member 110 and the handle 112 lowered from the position of FIG. 4 to the position of FIGS. 1 and 2 (See also FIG. 9).

By this means therefore a full telescoping arrangement is provided for the truck elements of the circuit interrupter and back disconnect contacts mounted on the truck 40 so that they may approach the operating mechanism and overlap and surround elements of the frame 30.

The only operative connection between the operating mechanism on frame 30 and the interrupter elements on frame 40 is the link 84 which operates the interrupter elements. The link 84 in turn operates as previously described on the three links 70 which are housed in the interrupter mechanism frame 40.

As will be seen from a comparison of FIGS. 1 and 2 on one hand and FIG. 4 on the other hand, the link 84 is free to swing alongside the operating mechanism. Thus, the interrupter on frame 40 may cooperate with any type of operating mechanism on frame 30 and vice versa in accordance with the modular concept above disclosed.

TELESCOPING ARRANGEMENT AND MODULAR CONCEPT

It should be borne in mind that, for this purpose, the ability of the driving link 84 on the operating mechanism to swing as shown from the position of FIGS. 1 and 2 to the position of FIG. 4 permits the telescoping arrangement to occur. By isolating this link 84, any interrupter device on frame 40 which will respond to the movement of the driving link to close may be substituted for the interrupter on frame 40, and any operating mechanism utilizing a swinging link (or a link which may shift its position) while still being operatively connected through bell crank lever 81 to an interrupter contact drive link, such as link 70, may be substituted for the operating mechanism shown. This makes possible the modular arrangement in which various types of interrupters may be used in connection with various types of operating mechanisms.

The opening spring is part of and associated directly with the frame; the closing operation as well as the latch arrangement which resists the opening spring and the controls for the latch are in the operating mechanism on the telescoping frame. Hence, the telescoping and modular arrangements are both made possible.

A specific operating system which achieves the foregoing functions will now be described:

SPRING CLOSING DEVICE FOR THE INTERRUPTER, SPRING CHARGING MEANS THEREFOR AND LATCH AND TRIP STRUCTURES IN THE OPERATING MECHANISM

Reference is first made to the diagrammatic and highly schematic views of FIGS. 16a, 16b, 16c, 16d

which illustrate the principle but do not show the actual structure (this structure is more fully explained in connection with FIG. 9 and related Figures).

FIG. 16a shows the circuit condition of the closing springs with the circuit breaker open but the closing springs charged. The closing spring 120 has been compressed by the spring charging link 121. The roller 130 is resting on the latch 131. Since the roller 130 is carried by the charging link 121, it supports the closing spring 120 in compressed condition. Roller 130 rides on the bell crank lever 132 which rotates on pin 133. The spring 120 has been operated to the charged position by the counterclockwise rotation of bell crank lever 132. The said bell crank lever 132 also constitutes a cam member with varying cam surfaces; it is rotated counterclockwise for this charging operation by link 135 connected thereto by pin 136. Link 135 is pulled upward by the spring 137. The charging motor 138 drives the crank 139 clockwise carrying the roller 140. When the roller 140 has entered the notch 141 of the drive link 135, it pulls this link down thereby rotating the bell crank cam lever 132 counterclockwise and thereby effecting the charging operation. When the spring charging operation is completed, the latch 131 which is spring biased counterclockwise on the stationary mounting pin 145 moves under the roller 130 to support the spring in charged position thereby moving away from the motor limit-switch 146 and opening the circuit to the motor 138. The motor then coasts to a stop to the position where the roller 140 on driving crank 139 is at the position of FIG. 16a, ready for the next charging operation.

The top of bell crank lever 132 is a cam, and as will be seen, a roller 150 on link 151 is supported between the cam surface of link 152 and the top cam surface of crank lever 132. Link 150 is connected at pin 153 to crank arm 154 on the jack shaft 155 (see also FIG. 2) which operates the operating link 84 of the circuit breaker. The circuit breaker at this point is open but the roller 150 on the end of link 151 is fixed in position between the cam link 152 and the top of the cam surface of the bell crank lever cam 132. The cam lever 152 is fixed in position by the trip latch 160.

Both the closing latch 131 and the trip latch 160 on its pivot shaft 160a (FIGS. 16, 5, 9 and 12) may be operated by manual means hereinafter described or by remote control means as well as, in the case of the trip latch 160, by any appropriate overcurrent means.

Since the cam lever 152 is fixed in position by the latch 160, now when the latch 131 is removed from its supporting position on the roller 150 of spring arm 121 which holds the spring 120 compressed, the spring arm 121 may now be driven to the left by the spring 120. The roller 150 then rotates the bell crank lever 132 clockwise and because of the cam surface, pushes the roller 150 from the position shown in FIG. 16a to the position shown in FIG. 16b where the roller 150 engages the detent 170 in the cam latch arm 152.

This causes a rotation of the closing crank 154, the jack shaft 155 and consequently an upwardly directed force on the operating lever 84 which causes the circuit breaker to close.

Referring now to FIG. 16c, it will be seen that the forces on the link 151 against the detent 170 of latch link 152 are in a direction such that the roller 150 is detented in position by the latch link 152 which in turn is held by the trip latch 160. Consequently when the in-

terrupter is closed, even though the compression spring is operated from the discharged position of FIG. 16b to the charged position of FIG. 16c and the cam bell crank lever 132 is no longer in supporting position for the roller 150, the roller 150 is nevertheless held latched in position by the combination of latch lever 152 and latch 160. Therefore, the opening spring 82a for the circuit breaker acting through bell crank lever 81, link 84 and the jack shaft 82 cannot operate since it is ultimately stopped by the engagement of roller 162 with the latch 160. This maintains the link 84 in position and the circuit breaker closed.

The circuit breaker therefore remains closed until it is otherwise tripped as hereinafter described while nevertheless the spring charging cycle may now proceed from the discharge position of FIG. 16b to the charged condition of FIG. 16c.

With the charging spring in compressed position ready to close or in uncompressed condition after having completed the closing operation, the circuit breaker is nevertheless trip free since on the occurrence of any overload condition the removal of latch 160 by motion clockwise around its mounting pin 160a will permit the latch link 150 to rotate clockwise and thereby permit the latch roller 162 to leave the detent 170 permitting the jack shaft 155 to rotate to the position shown in FIG. 16a, thereby permitting the operation link 84, link 70 and their associated bell crank levers to rotate in response to the force of the opening spring 82a of FIG. 1 which pulls the plunger contact 13 in the interrupter 10 down to open position.

Consequently the circuit breaker is trip free at any point during the closing operation, during the charging of the spring and during discharge of the spring.

This provides a single stroke charging action; a single motion of the motor driven crank serves to charge the closing spring.

In order to absorb excess energy of the spring when it discharges to close the circuit breaker, an appropriate dash pot 180 is provided.

As above mentioned, the foregoing description is purely schematic and with respect to the schematic drawings 16a-d, the actual structure is shown in FIGS. 5, 9, and 12 in various positions of operation with some of the details appearing in FIGS. 13, 14 and 15. FIG. 9 is an over-all expanded view in perspective. FIG. 5 shows the position of the elements with the circuit breaker contacts in the closed position. FIG. 12 shows the position of the elements with the circuit breaker contacts in the open position. The compression spring 120 on its base 120A is connected so that the spring rod 121 is urged upwardly. The upward force of the spring on spring rod 121 is resisted by the latch 131 on latch roller 200 on operating cam 201. Operating cam 201 is connected to the spring rod 121 by pin 202, link 203 and pin 204 which also connects the spring rod 121 to the bell crank cam 132. When the latch 131 is removed from its blocking position on roller 200 then the bell crank operating cam 201 hereinafter described may freely rotate about its pivot 205 as spring rod 121 may now rise. This results in a counterclockwise rotation of bell crank lever cam 132 on its pivot 133. Cam pin 150 on the upper end of the first toggle link 210 is held in the position shown in FIG. 5 while cam lever 201 is correspondingly rotated on its pivot 205. The pin 150 is connected to latch toggle 151 comprising toggle links 210, 211. The end of toggle link 211 is connected

to the operating crank 154 of the shaft 155 to operate the circuit breaker contacts to closed position when the crank arm 154 is turned counterclockwise by pulling up the operating link 84.

As the pin 150 at the end of link 210 of toggle 151 is moved upwardly by the detent element 213 of bell crank lever cam 132 the toggle 151 is pushed upwardly, that is the center pin 220 of toggle 151 is guided by the connecting link 210' attached to the trip roller carrier 152, the circuit breaker contacts reach the closed position; the upward push on toggle link 211 causes the crank 154 and the shaft 155 to rotate in a counterclockwise direction to the position of FIG. 5 thereby pulling the operating link 84 up and thus operating the interrupter contacts 13 toward the closed position in engagement with contact 12. The toggler is then supported in its closed position by the trip latch 160. Thereafter, the closing spring may be recharged as shown in FIG. 5 even with the contacts closed. The racking release lever 811 drives pin 506 (See FIG. 9) to collapse the toggle as hereinafter described.

FIG. 12 shows the condition of the parts with the circuit breaker contacts open, operating crank 154 and the operating link 84 in the down position with the spring now discharged; the toggle 151 is now broken thereby permitting the circuit breaker to trip by the latch 160; the trip free position of the circuit breaker being shown.

In order to charge the spring, closing cam 201 must be rotated counterclockwise about its pin 205. This results in driving the link 203 from the position shown in FIG. 12 back to the position shown in FIG. 5 and since the closing spring rod 121 is connected to the cammed lever 132, thereby fixing its position, this must necessarily result in the downward movement of the link 203 and spring charging rod 121 from the position of FIG. 12 to the position of FIG. 5 until the latch 131 engages the latch roller 200 on the moving cam lever 201.

The cam lever may be rotated by a motor connected to the pinion 230 which drives the gear 231, in turning driving the shaft 232 which carries the crank 129 and cam roller 233.

As will be seen by a comparison of FIGS. 5 and 12 the rotation of the cam roller 233 against the inner surface 234 of cam 201 will cause the cam 201 to rotate about its pivot 205, thereby charging the spring 120 by moving down the spring arm 121. At the completion of the charging operation, the cam roller 233 coasts to the position of FIG. 12 where it is free from both arms of the cam lever 201. At this point the cam roller coasts into the spring loaded overtravel stop which brings it to a halt and resets it to the position shown in FIG. 12 where it is ready for a recharging signal. The roller 233 cannot then get past this stop until the springs 120 are discharged and the cam 201 lifts this stop out of the way as shown in FIG. 12. Lifting this stop actuates the motor switch FIG. 9 and the motor will start recharging the springs. The stop and thereby the motor switch are held up engaged by the concentric part of plates 129 until the plates 129 have reached the fully charged position of FIG. 5. When this position is reached the overtravel stop drops down off the concentric part of plates 129 as shown in FIG. 5 and the motor switch cuts off the motor which then begins to coast again until the roller 233 again hits the overtravel stop.

This manner of stopping the cam roller 233 and its arm and thereby stopping the motor so that the cam

roller may not coast to an interfering position and will remain in the correction position for another charging operation is an essential element of the single stroke charging system.

The roller 233 cannot be stopped immediately after it has charged the spring; it must be allowed to coast and decelerate and then be stopped by the spring loaded overtravel stop (FIG. 12) that has dropped down into the path of travel of the roller, cutting off the motor switch while roller 233 is still approximately 180° away from its final stop position.

The spring-loaded stop (FIG. 12) must be moved out of the way of roller 233 before the motor starts either for spring charging or racking.

The stop (FIG. 12) is lifted out of the way by the discharge of the closing springs (FIG. 12) or by release of the racking release lever (FIG. 6). Lifting this spring loaded stop starts the motor (FIG. 9). The spring loaded stop is then held up as the springs are charged by the outer edge of the cam roller carrying plates (FIG. 9), which also act as a timing cam, until the charged position of FIG. 5 is reached and the spring loaded stop can drop down to shut off the motor and block roller 233 as it coasts toward the stop.

The cam lever 201 may also be rotated manually in order to charge the spring manually. Since the motor operated charging roller 233 is in the position shown in FIG. 12 in the fully charged or in the uncharged position of the spring, the cam lever 201 may be rotated about its pivot 205 by a distance equal to that between the cam lobes 240 and 241.

The manual means for charging the spring comprises the shaft 250 mounted across the front of the frame 30 which carries the operating mechanism 251 and a cam roller 252. When the operating mechanism 251 is rotated clockwise from the position shown in FIG. 12, cam roller 252 moves from the solid line position shown in FIG. 5 to the dotted line position 253 shown in FIG. 5 and rotates the cam 201 to operate the closing spring operating link 121 exactly in the same manner as previously described in connection with FIG. 5 and the motor mechanism for charging the spring.

This manual operation is obtained by arranging the crank wheel 251 freely on the shaft 250 so that it has an opening 255 in which the operating handle 256 may be placed. The dash pot 180 previously described in connection with FIG. 17a is shown at FIGS. 5 and 12. In this case, the dash pot 180 is connected by the link 270 to a pin 271 on the cam lever 132 which is, of course, connected to the spring operating rod 121 and serves to absorb the shock and the excess energy of the operation of the spring.

The escutcheon plate of FIG. 10 shows the access opening for handle 256 to charge the closing springs.

INTERRUPTER STRUCTURE AND CURRENT TRANSFER

FIGS. 17, 18 and 19 show the novel portions of the miniature high voltage circuit breaker as it relates to the interrupter 10 itself which includes the stationary contact 12, the moving contact 13. As previously pointed out, the moving contact has a bellows 93 connected to a sealing sleeve 280 carried thereby. The bellows 93 is connected at the bottom wall 281 of the vacuum interrupter housing by a vacuum type seal therewith so that the movement of the movable contact

plunger 13 through the opening 282 in the bottom wall will not result in contamination of the vacuum condition within the housing 11 of the vacuum interrupter 10. The vacuum interrupter 10 is supported by an annular insulator 283 and is secured to the rigid connector strap 284 which, in turn, is connected to the lower back disconnect contact 22. The moving contact plunger 13 is secured in any suitable manner as by, for instance, screw threads 290 to an exterior plunger 291. The strap 284 is provided with an opening 292 through which the exterior plunger 291 may pass and the periphery of this opening is provided with spring contact elements 295 arranged annularly of the contact plunger extension 291, so that effective contact can at all times be made between the moving contact plunger 13 and the connecting strap 284. An extension 301 of the plunger is provided with a ring 302 secured thereto and another ring 303 which together form the clevis 75 previously referred to which is slidably mounted on plunger extension 291. Plunger 13 and extensions 291 and 301 move as a unit. Clevis 75 slides along this unit to compress spring 90. Only contacts 295 transfer current to the moving plunger extension 291. Annular contact spring 320 acts as a current transfer pressure spring engaging and squeezing contact 295 against plunger extension 291. Extension 291 is threaded into and hence a part of moving contact plunger 13.

The operating pin previously described in connection with FIG. 1 engages the clevis on both sides; the operating bell crank lever is basically a two piece member with the pin 74 projecting from each side thereof so that when the circuit breaker is to be closed upward movement of the pin 74 will operate the clevis 75. Raising the clevis 75 will compress the spring 90. As previously described the arm 70 which operates the bell crank lever 72, which in turn operates the pins 74 which engage the clevis, is latched in position through its connection bell through crank lever 81 to operating link 84 which in turn is connected to elements which engage the latch (see also FIG. 19).

Consequently when the plunger 13 is raised to the position shown in FIG. 17, the circuit breaker is closed. On release of the holding force which is transmitted to the link 70 and bell crank lever 72, the opening spring 82A (FIG. 1) will now drive the plunger 13 down to the open position. The stationary contact 12 is supported in the upper wall 30 of the housing 11 of the interrupter and there connected to the rigid connection strap 14 which is, in turn, connected to the movable back disconnect contact 15. The garter spring 320 maintains contact pressure between contacts 295 and the plunger assembly 13-291-301. Spring 90 maintains contact pressure between contacts 12 and 13 when the circuit breaker is closed.

By the means herein described, the minimum number of current transfer joints are used to minimized heating. The straight line guiding of the moving contact 13 prevents damage to the bellows 93 and insures full seating of the internal contact surface in the vacuum interrupter. The contact pressure spring 90 is placed as close as possible to the gap between contacts 12 and 13 with a minimum amount of added material between the springs and the contact gap. This spares the stationary housing 11 for the vacuum interrupter and especially the stationary contact extra abuse from the inertia of material of any kind added between the contact pressure springs and the contact gap. Such material would

otherwise be brought to an abrupt halt by the stationary vacuum interrupter contact on closing. The rigidity of the mounting and actuating assembly minimizes contact bounce on closing and rebound on opening.

The vacuum housing 11 is mounted to the copper conductor 284 which in turn is bolted to the incoming lower disconnect 22. The stationary contact 12 is bolted to the outgoing copper conductor 14 which is connected to the upper disconnect 15. The moving contact plunger 13 has a threaded external end on which is mounted the copper bushing 291 which is then clamped by the washer, the long bushing, and the long bolt which enters a tapped hole in the external end of the moving plunger 13. The floating bushing with the actuation groove or clevis 75 forces the copper bushing and the moving contact 13 upward through the captive contact pressure spring 90. The floating bushing is held assembled by the limit washer. The moving contact and spring assembly are guided by the widely spaced bearings 321 inside the housing 11 and the lower stationary bearing 322 which is secured to the frame.

SHUTTER FOR STATIONARY DISCONNECTS IN COMPARTMENT

In order not only to facilitate the operation of the device, but to make absolutely certain that the bus is not available when the interrupter and its elements are racked out to the test position, there is provided a shutter 400 against the back wall 401 of the compartment. Thus, shutter is arranged to block access to the stationary back connection studs 17 and 24 when the interrupter is disconnected. (See FIGS. 20 to 24).

The shutter 400 is mounted as previously described on the back wall 401 of the compartment being pivotal on a stud 402 carried by the back wall of the compartment. The shutter 400 is provided with openings 405 and notches 406, 406 which as shown in the open position of the shutter FIG. 24 corresponding to that of FIG. 20, there is full access to the back disconnects 17 and 22. Obviously, the showing in FIGS. 23 and 24 are for a three-pole circuit breaker arrangement with the upper disconnects and lower disconnects 17 and 22 respectively being each repeated so that there are three of each. It will be obvious that when the shutter 400 is in the position shown in FIG. 24 which corresponds to the position of FIG. 22, all of the disconnects 17 and 22 are blocked. When the shutter is rotated approximately 60° in a counterclockwise direction, then the notches 406, 406 register with the lower left and upper righthand disconnects; the openings 405, 405 register with the upper and lower middle disconnects and the upper lefthand corner and lower righthand corner of the shutter clear the upper left and lower righthand disconnects.

The back wall is provided with stop members 410 which locate the shutter in the closed and open positions. The shutter is provided on the right side with respect to FIGS. 23 and 24 with an extension 411 rigidly connected thereto. The extension 411 is connected to the operating lever 412 by pin 413 so that when 412 is raised, the shutter is moved to the open position of FIG. 23. When the lever 412 is lowered, the shutter is moved to the shut-off position of FIG. 24. The lever 412 at the end opposite its connection to pin 413 is pivotally mounted on pin 414 secured to the right side wall of the housing of the compartment (FIGS. 23 and 24). A tension spring 416 is connected between the bottom of the

compartment and the lever 412 biasing the lever to a downward position. The operating lever 412, since it is therefore biased down is biased toward the shutter closed position of FIG. 24, so that unless the circuit interrupter is racked in, the shutter will be moved to the closed or shut-off position. The operating lever 412 is provided with a cam surface 420 which operates against a pin 421 mounted on the frame 40 of the circuit interrupter. In the position shown in FIGS. 22 and 24, the pin 412 is clear of the cam 420 on the lever 412. Consequently, the spring 416 rotates the shutter to the down or closed position about the pivot 402. As the circuit breaker is racked in from the position of FIG. 22 to the position of FIG. 21, the pin 421 moves against the cam surface 420 thereby raising the lever 412 and rotating the shutter from the position shown in FIG. 24 to the position shown in FIG. 23. Cam surface 420 is an extremely short cam surface with a steep angle so that the initial movement toward the insertion position from the position of FIG. 22 toward the position of FIG. 21 will promptly raise the shutter in time for the disconnect contact elements 16 and 23 to enter the openings into which the connection studs 17 and 24 project. Thereafter the pin 421, by riding under the secondary cam element 431 will, as shown in FIGS. 21 and 20, as well as FIG. 23, maintain the shutter in the open or access position.

By this means, therefore, it is seen that as the interrupting elements are racked out, the shutter will be moved into closed position and just as the circuit breaker interrupter elements begin to be racked in and before the moving contact elements 10 and 23 being to enter the bushings 430, the shutter will be moved out of closed position.

The initial travel of the interrupter section toward connected position will therefore serve to move the shutter from the closed to the open position.

Since the moving contacts 16 and 23 are slightly more than an inch and a half away from the shutter in the racked out position of FIGS. 22 and 24, the cam surface 420 must be so arranged that it will operate in the first one and a half inch of travel of the frame 40; this is the reason for the steepness of the slope of the cam surface 420. However, it should be noted that the shutter is a balanced member with only the spring 416 and the weight of the lever 412 providing a force opposing the movement of the pin 424 against the cam surface 420. Therefore, this initial movement of the relatively much heavier circuit interrupter element will not be impeded by the need for moving the shutter from the closed position of FIG. 24 to the open position of FIG. 23.

MOTORIZED RACKING ARRANGEMENT

The racking arrangement, that is, the operation of shaft 101 in order to operate the toggle 102, 103, 104 to rack the circuit breaker in and out has been described generally in connection with FIGS. 1, 2 and 4. It is shown in detail in the expanded view of FIG. 25. It is explained diagrammatically in sequence in FIGS. 26, 27, 28, 29, 30, 31, 32 and 33. The entire operation may also be understood from the complete expanded view of FIG. 8.

FIG. 26 shows the racked in position of the elements. FIG. 27 shows the initiation of the racking-out operation. FIG. 28 shows a further step in the racking-out operation. FIG. 29 shows the completion of the rack-

ing-out operation for the circuit breaker elements to the test position. FIG. 30 shows the racked out position of the elements. FIG. 31 shows the initiation of the racking-in operation. FIG. 32 shows a further step in the racking-in operation; and FIG. 33 shows the completion of the racking-in operation to the connected position.

Referring specifically to FIGS. 25 to 33 (but see also FIGS. 8 and 34), the racking shaft 101 which may be manually operated by the racking handle 112 of FIGS. 1, 2 and 4 is provided with a drive plate consisting of a pair of parallel and similar plates 501, 501A, which are keyed to the racking shaft 101 and also interconnected by the four corner pins 502, 503, 504, 505 which extend between them. It will be obvious therefore that when the plate 501 is rotated counterclockwise from the connected position of FIG. 26 to the disconnect or test position of FIG. 30, the racking shaft 101 will correspondingly be rotated and the toggle 102, 103, 104 of FIGS. 1, 2 and 4 will be moved toward collapsed position to effect a racking out of the interrupter elements of the circuit breaker.

Correspondingly, when the racking plate 501, 501A is rotated in a clockwise direction from the position of FIG. 30 through the positions of FIGS. 31, 32, 33, back to the position of FIG. 26, the toggle will be extended and the interrupter elements of the circuit breaker will be racked in to the connected position.

The same motor which charges the closing spring (described in connection with FIGS. 5, 12 and 15) is used for the racking operation, it being obvious that once the spring has been charged, the operation of the motor shaft 232 by pinion 230 (FIG. 5) will no longer affect the operation of the closing spring 120 of FIG. 5.

The means for operating the racking plate 501, 501A includes the slide 510 of FIGS. 25 to 33. The slide 510 is arranged for movement back and forth on the motor shaft 232 which is received in the horizontal slot 512 of slide 510 of the slide and slot 512a of slide 510a. The forward end 513 of the slide is supported by the open slots 514 and 514a defined by the extensions 515, 515a and 516, 516a of the slide 510 and sliding on the racking shaft 101, which in this case serves only as a means for supporting and guiding the slide 510 and does not control its operation.

The slide 510 consists of two similar plates 510 and 510A which are appropriately connected together primarily by the mounting pins 520, 521 for the lower operating fingers 523 and the upper operating fingers 524. The fingers 523 and 524 are mounted on the pins 520 and 521 between the plates so that they may rotate on the pins under the guidance of the apparatus as hereinafter described.

The lower fingers 523 are provided with the biasing spring 530 around pin 521 to drive the fingers upwardly. The fingers 524 are provided with the biasing spring 531 around the pin 520 to drive the fingers 524 in a downward position. The fingers 523 and 524 are provided respectively with detents 535 and 536; detent 535 may engage the lower pins 502, 503 of the racking plate and detent 536 on the upper finger 524 may engage the pins 504 and 505 of the racking plate 501, 501A. Stationary plates 540, 541 are supported by the shafts 101 and 232.

Plate 541 is provided with reentrant support 542 for supporting the spring return element 543 and providing

a bearing surface therefor: That is, when the slide 510 is moved to the right, the compression spring 543 in the housing 550 on slide 510 is compressed by the end 551 of the housing 550 which moves with the plates forming the slide 510, the said spring being compressed against the stationary element 542 of the stationary plate 541. Therefore, when the driving force on the slide 510 is released, the spring will return the slide.

It will thus be seen, particularly from FIGS. 26, 27 and 28, that the slide 510 moves to the right with respect to said figures under control of motor driven roller 233. Then, on release of the driving force, the spring 543 returns the slide 510 back to the position of FIG. 28 where the slide 510 is located and positioned by the righthand end of the slots 512, 512a engaging the shaft 232.

The pin 521 of the slide 510, 510A which supports the lower finger 523 also carries a rotatable lug 560 directed rearwardly thereof. The roller 233 driven by the motor as shown in FIG. 33 engages the trailing end of the lug 560 to drive the slide 510 from the position of FIG. 26 to the position of FIG. 27. The lug is spring biased by spring 560A to the position shown in FIG. 34. However, when the slide reaches the advanced position, as for instance that of FIG. 33, the continuation of movement of the roller 233 will clear the lug 560 and permit it to move to the left with slide 510. Lug 560 is made rotatable to permit engagement of the motorized racking feature only when desired by the movement of the lower flange on lever 811 of FIG. 6. This initiates a racking operation only when desired by raising the lug 560 into the path of roller 233. This is necessary since the roller 233 moves whenever the motor is running, as, for instance, in the spring charging operation.

For the purpose of ensuring exact movement of the slide 510, the positioning thereof at the forward end of its stroke is therefore positively controlled by the travel of the roller 233 pushing lug 560 clockwise against its top (FIG. 33).

It will be obvious from an examination of FIGS. 26, 27, 28 and 29 that the movement from the connected to the test or racked-out position requires two back and forth movements of the slide 510. In both of these movements, the upper fingers 524 are disengaged from and do not contact the pins 504, 505 of the racking plate 501, 501A. This is controlled by cam means hereinafter described. During such movement, the detents 535 of the lower fingers 523 successively contact and move first the pin 502 of the racking plate 501. This is clearly shown in FIGS. 26, 27, 28 and 29.

When the motor is operated to move the slide 510 to the right, the detent 535 of finger 523 on the slide 510 engages first the pin 502. The movement of the slide to the position of FIG. 27, where it is stopped by the roller 233 leaving the lug 560, serves to rotate the racking plate 501 and the racking shaft 101 through an angle which is half the rotation required of the racking shaft 101 to perform the racking operation. At this point, the continued rotation of the driving roller 233 disengages it from the driving lug 560 of the slide and the spring 542, which has been compressed during this operation, is now free to return the slide 510 to its original position as illustrated in FIG. 28. Thereafter, on the next movement of the slide 510 from the position of FIG. 28 to the position of FIG. 31, the detent 535 of the lower finger engages the pin 503, and on the movement of the slide 510 under the influence of the motor driven roller

233, moves the slide from the position of FIG. 28 to the position of FIG. 29, thereby performing the second half of the angle of rotation necessary to rotate the racking shaft 101 to the full racked-out position corresponding to FIG. 4. With the circuit interrupter now racked out the next initiation of the motorized racking sequence will result in the detent 536 of the upper finger 524 engaging pin 505 to drive the racking plate 501 and the shaft 101 from the position of FIG. 32 to the position of FIG. 31 which is half of the angle of rotation needed to rack in the circuit interrupter. The slide 510 will then be released, as previously described, to return to the driving position whereupon on the next operation of the slide 510, it will engage the pin 504 of racking plate 501 to rotate the racking shaft 101 back to the racked in or connected position shown in FIG. 26.

It should be noted that separate motor-driven rollers 233 and 233a are used respectively for spring charging and for racking.

The racking is initiated by operation of lever 811 (FIG. 6) which rotates lug 560 into the path of travel of roller 233. Lever 811 can be moved only after the springs are charged and the breaker is open (FIG. 6); the lever 811 must be moved to restart the motor.

The same drive motor is used for spring charging and for racking. The lug 560 is, in effect, the clutch which effects the connection between the motor and racking mechanism. The operation of charging and racking cannot be performed simultaneously and is prevented by lug 560 (FIG. 6). The same limit switch 146 (FIG. 9) is used for both operations.

As previously described, the fingers 523 and 524 must be so arranged that the finger 524 will be disengaged from driving operation with pins 504, 504 of the racking plate 501 during the movement from the connected position of FIG. 26 to the racked-out or test position of FIG. 29. Similarly, fingers 523 and their detents 535 must be disengaged from pins 502 and 503 during the movement of the breaker from the test position of FIG. 29 through positions of FIGS. 30 and 31, back to the connected position of FIG. 26. For this purpose, camming pin 550 is provided at the lead end of finger 524 remote from its pivot, and camming pin 551 is similarly provided at the lead end of the lower finger 523, remote from its pivot. The detents 536 and 535 of the fingers 524 and 523, as previously pointed out, engage their respective pins 502-3-4-5 between the plates 501, 501A. Pin 550 of the upper finger 524 extends beyond the finger 524 so that with the racking plate in the position shown in FIG. 26, the pin 550 of the upper finger 524 first strikes the side of racking plate 501, thereby lifting the finger up so that the detent 536 is initially out of the path of the pins 504, 505 (FIG. 26). Similarly, when racking in, the pin 551 of the lower finger 523 when the racking plate 501 is in the position of FIG. 30, first strikes the side of the racking plate, FIG. 30, so that finger is lifted down and away, so that in subsequent movement through the positions of FIGS. 30 and 31, back to the position of FIG. 26, the lower finger 523 will have no effect on and will not come into contact with the pins 503, 502.

These camming pins 550 and 551 therefore defeat the operation of the springs 530, 531 which drive the fingers toward operating position so that only the finger which is to perform the operation may engage its respective pins.

It will be obvious that the trailing, left-hand side of the racking plate 501, 501A may be appropriately curved and shaped to guide the pin 550 or 551 to initiate the movement of the associated finger 524, 523 out of operative position. As a supplement to this shaping, there is provided a camming wheel 569 which is loosely mounted on the racking shaft 101 and is under the control of the pin carried in openings 566 of extensions 565 of racking plates 501, 501A, the latch 582 and spring 561, depending on the location of the plates 501 (FIG. 34).

Wheel 569 is provided with a centering spring 561 which surrounds the racking shaft 101 and engages a pin 562 on wheel 569 and a stationary pin 563 (supported on plate 541). The racking plates 501, 501A are provided with an extension 565 which supports the pin 566 between them, the said pin 566 riding in the slot 567 of the cam wheel 569. When the finger 524 has completed its movement driving the pins 504, 505 from the position of FIG. 30 through the position of FIG. 1, back to the position of FIG. 26, the cam wheel 569 has rotated with plates 501 driven by pin 566 pushing against latch 582 (FIGS. 33, 34) which is mounted on cam 560; the finger 524 has been free to operate the pins 504 and 505, while the finger 523, during the forward movement toward the right, with respect to FIG. 30, of the slide 510, is in a position where the pin 551 will first ride down the side of the racking plate 501 adjacent the pin 503, and then ride down the camming surface 570 of the cam plate 569 and thus be lifted clear of the pins 502, 503 of the racking plate 501.

The cam wheel 569 is maintained in this position by the leg 578 of latch 582 which is rotatably mounted on the pivot 576 on the cam wheel 569. The latch is also provided with a tension spring 577 engaging the leg 578 thereof and the pin 579 also mounted on the cam wheel 569. The latch leg 578, driven by pin 566 has served to maintain the cam wheel 569 in the position shown in FIG. 30 in relation to plates 501. Thus, the centering spring 561 is tensioned, tending to drive the cam plate counterclockwise to the alternate position where it will cause the pin 550 on the finger 524 to rise up out of operative position, but is prevented from doing so by the latch arrangement.

As the racking plate 501 completes its rotation from the position of FIG. 30 through FIG. 31, back to the position of FIG. 33, the lower stationary trip pin mounted on plate 541 strikes the tail 582 of the latch and disengages the latch, whereupon the centering spring 561 now moves the cam wheel 569 to the alternate position indicated in FIGS. 26 and 34. The opposite leg 578 of the latch is now in engagement with the pin 566 as shown in FIG. 34. Racking toward the disconnect position will result in the pin 566 pushing the leg 575 and with it the cam 569 in a counterclockwise direction until latch 582 is released by the upper stationary pin (FIG. 34).

With the camming wheel 569 now in the alternate position indicated by the dotted lines 584 (FIG. 37) the movement of the slide 511 to operate the racking mechanism will result in movement from the connected position of FIG. 26 to the full disconnect of FIG. 29, with the finger 523 engaging successively the pins 503 and 502 as shown in FIGS. 27, 28 and 29, while the pin 550 on the upper finger 524 will first ride up the upper rear side of the plate 501, 501A and then on the camming surface 586 of the cam wheel 569.

By this means a simplified motor-driven operation is provided for the racking shaft 101 shown in FIGS. 1, 2 and 4. This motor operative means does not interfere with the manual operation as shown by means of the handle 112 and handle receiver 110 on the racking shaft 101.

In operation, switch 146 (FIG. 9) is closed to start the motor which drives the rollers 233 (and 233a) and the lug 560 is rotated into the path of roller 233a. The operation, as far as the motor and the slide 510 are concerned, is then the simple operation of driving the slide 510 from the position of FIG. 26, which is the connected position, to rotate the shaft 101 through half the angle needed for racking-out to the position of FIG. 27. The roller 233 then leaves the driven lug 560, comes around once more to pick up the slide 510 which has been returned by the compression spring 543. The roller then picks up the lug 560 and drives the slide 510 from the position of FIG. 28 to the position of FIG. 29, completing the rotation of the racking shaft 101 through the angle needed to move the interrupter mechanism from the operative or racked-in position to the test position. The motor is then stopped by the switch 146 when the racking release lever 811 (FIG. 6) drops into the proper index notch on wheel 110. The closing latch (FIG. 6) is then unblocked so that the springs can close the breaker and the trip latch is permitted to reset. If the springs close the breaker at this time, the motor is again started by the same switch, through actuation of the same spring loaded overtravel stop as shown in FIG. 12, being lifted by the plates 241.

Thereafter, when racking-in is to occur from the test position of FIG. 30 through to the position of FIGS. 31, 32 and 33 to the connected position of FIG. 26, the motor is energized once more and the motor driven roller 233 then operates the slide from the position of FIG. 30 to the position of FIG. 31. The slide then returns once more to a position shown in FIG. 32 and the further operation of the motor drives the racking shaft from the position of FIG. 32 back to the position of FIGS. 33 and 26. Again, the motor is stopped at this point, with the interrupter fully racked-in.

The various indication devices available to the operator are shown in the escutcheon plate of FIG. 10. It should be noted that in FIG. 6, the clockwise motion of lever 811 that initiates the electrical racking, and that unlocks the racking shaft 101, can be accomplished by manually depressing the protruding end of lever 811, momentarily, or this lever can be operated from a remote location by including a small solenoid, not shown, which will pull this lever down.

SECONDARY CONTACT ACTUATION AND COMPARTMENT INTERLOCK

Referring to FIGS. 36-41, the stationary elements of the secondary contacts at 700 are mounted on the top wall 701 of the compartment or housing. The movable elements 702 of the secondary contacts are mounted on support 703 carried by the frame 30 of the operating mechanism. As previously pointed out in connection with FIGS. 1 to 4, the operating mechanism, with the interrupter frame 40 in racked-out position, may be trucked out of the compartment. However, the operating mechanism must be connected to and integrated with the compartment mechanically, so that while the circuit breaker is being racked from connected into disconnected position, no part of the mechanism may be

moved from the compartment. Also, the operating mechanism must be so integrated with the compartment that when the interrupter elements are in test position, the operating mechanism remains integrated with the compartment and is incapable of movement with respect thereto.

Only after the interrupter element of the circuit breaker has been racked to the disconnect position, and only after all of the movable contact elements 702 of the secondary contacts have been removed from engagement with the stationary contact elements 700 in the compartment, may the entire unit be removed from the compartment.

FIGS. 36 and 37 show these integrating and interlock elements with all of the elements in the disconnect or test position of the circuit interrupter. When the operating mechanism is located in the compartment, a hook 710 rotatably mounted on the shaft 711, carried by the main frame 30 of the operating mechanism, engages the stationary pin 712 on the side wall of the compartment, that is, the section 713 of the hook engaging the pin 712, prevents removal of the operating mechanism from the compartment. An additional pin 714 is provided on the compartment. Section 715 of the hook engages this additional pin and determines the limit of inward movement of the operating mechanism into the compartment. Thus, the pins 712 and 714, cooperating with the surfaces 713 and 715 of the hook, accurately position the operating mechanism in the compartment. It should be pointed out that the parts are so arranged that when the entire unit is withdrawn from the compartment, the hook 710 is in the position shown in FIG. 36. This position of the hook would obtain if an attempt were made to insert the structure in the compartment when the circuit breaker interrupter mechanism happens to be in the connected position, the hook 710 is so arranged that it is locked in the position shown in FIG. 36 when the interrupter elements are in any position other than the disconnect position shown.

Therefore, since the entire mechanism must be prevented from entering the compartment with the circuit breaker interrupter elements in any condition other than the disconnected position, which could result in a dangerous condition and possible damage to the operator, the hook 710 is locked down by the operating mechanism as hereinafter described when the circuit breaker is in any condition other than the disconnected position. When the circuit breaker structure is outside the compartment, and an attempt is made to insert the same in the compartment, the surface 720 of the hook 710 will engage the pin 714 nearest the entry to the compartment and block the full entry of the structure. A pair of hooks 710 are provided, one on each side, cooperating with similar pins 712 and 714 on each side wall of the compartment. The hooks are connected to and operate together on shaft 711, being keyed thereto. Shaft 711 is provided with a crank arm 721 keyed thereto, and an extension 722 of the crank arm 721 may be depressed to raise the hook. Again, this can only be done as above pointed out, with the interrupter elements in the disconnected position, and the movable secondary contacts 702 removed from their engagement with the stationary secondary contacts 700.

A slide 730 is provided to operate the movable secondary contacts 702. This slide 730 is so arranged that certain of the secondary contacts 700A may be disconnected, the slide moving to a half position when the cir-

cuit breaker is moved from the fully connected to the disconnect position.

Thereafter, the slide 730 may be moved down further to separate the movable contacts 700A from stationary contacts 700B in order to enable the circuit breaker to be completely removed from the compartment.

The slide is operated by a lever 735, which is rotatably mounted on pin 736 carried by the frame of the operating mechanism. The lever 735 is provided with an opening 737 which engages the pin 738 on the slide. The opening 737 is sufficiently larger than the pin 738 so that the rotary movement of the lever 735 may be translated into vertical movement of the slide 730.

It will be obvious that with the lever 735 in the position shown in FIG. 38, the slide has been moved to a position where the movable secondary contacts 702 are fully disengaged from the stationary secondary contacts 700. When the lever 735 is moved to the position 735A, that is, the disconnect or test position, then the movable contacts 702 have been raised to an intermediate position where certain of the stationary contacts 700B are engaged. From the test position of FIG. 38 to the connected position of FIG. 39, the contacts 702 are raised by the clockwise motion of the racking shaft 101 (as previously described). The racking shaft 101 has, keyed to it, a cam plate which lies between the slide 730 and the lever 735, and actuates the pin 738, which is mounted on the slide. Thus, the pin and the slide can be actuated between the test and connected positions, only by rotation of the racking shaft 101 and not by manual actuation of the lever 735. Between the test and connected positions therefore, the lever 735 is serving only as a pointer to indicate the racking position. (See FIG. 10). The contacts 700A can be moved manually by lever 735 through position 735b only between the test and disconnected positions (FIGS. 38 and 36) by virtue of the cam on shaft 101 presenting a vertical travel slot 737 in these positions. Also, with lever 735 and pin 738 in the disconnected position (FIG. 36), it is clear that the racking shaft 101 and the cam cannot be rotated, since the pin 738 is down in the vertical travel 737 of slot 750 of the cam. This prevents rotating the racking shaft toward the connected position without first raising the contacts 700A to the test position of FIG. 40; nothing can therefore get out of phase. The lever 735 is held by suitable detents in the disconnected or test positions (FIG. 10), so that it will not wander between these positions.

The lever 735 is a bell crank lever having an extension 740 engaging the vertical slide 741 which has a slot 742 enabling it to be guided on the pin 743. Any attempt to move the lever 735 from the test position of FIG. 38 (735A) to the full disconnect position to enable the circuit breaker to be pulled out, will result as the lever 735 moves through position 735b (FIG. 39) in the raising of the slide 741 to operate the trip latch of the breaker and the closing latch, which obviously are rotated. This is done so that the breaker can be withdrawn from the compartment only when the closing and opening springs are in a disarmed condition. The control is such that when the circuit breaker interrupter elements are fully racked in, the lever 735 and the slide 730 are locked in a full up position with all of the contacts 700-702 engaged. When the circuit breaker in the compartment is moved to the test position, the slide has been moved to an intermediate posi-

tion where certain of the moving contacts 702 engage the contacts 700B.

When the operation is completed to the test position, FIG. 38, and it is now desired to remove the circuit breaker from the compartment, the hook 710 cannot be raised for this purpose unless the slide is in the full down position shown. This position for blocking the hook is clear on FIG. 38. The hook 710 has an extension 760 which enters the slot 761 of the slide 730 and is prevented by the sides of the slot 761 from being rotated to disengagement from the pin 712. When the slide 730 and its associated contacts are in the full down or disconnected position, FIG. 36, the extension 760 may enter the notch 762 of the slide thereby permitting the hook to be raised by depressing the finger 722. The slide cannot be moved to this full down position unless the interrupter elements are in the full test position, and the hook therefore cannot be raised unless both events occur, that is, the interrupter elements are in the full test position and the secondary contacts 702-700 are fully disconnected (FIG. 36).

An examination of FIG. 10, the escutcheon plate, will facilitate a recapitulation of the various operations:

The manual racking is accomplished at position 800 where the hole 111 in the racking wheel 110, mounted on the racking shaft 101 of FIGS. 1, 2 and 4, is covered by a sliding cover 801. The cover 801 is provided with a switch, not shown, which disconnects the motor. The tab 801 is lifted to clear the hole 111 for insertion of the racking handle. It will be obvious that the position shown is one for the fully racked-in position of the circuit interrupter, the handle inserted in the hole 111 is lifted for the rack-out position.

Electrical racking for operating the motor is accomplished by moving down the switch handle 811 which starts the motor. Means may be provided to operate the handle 811 remotely by a solenoid. The manual charging handle 256 of FIG. 5 is inserted in the opening 255. A downward movement of the handle in the opening 255 will move this opening 255 and the charging wheel 251 down to charge the closing springs. The operating mechanism for controlling the disconnects and the handle 735 appears at the right-hand side of the escutcheon plate of FIG. 10, indicating the three positions. The position shown in FIG. 10 is the connected position of the interrupter elements. The manual close button 810 releases the latch 131 of FIG. 5. Remote control operation may be provided by appropriate electrical and solenoid connections for operating the manual close button (FIG. 10). The padlock arrangement 820 is used for locking the circuit breaker racking mechanism to maintain the breaker in a selected position. The manual trip button 812 operates the latch 160 and may, of course, be remote controlled (FIG. 10).

Projection 830 on padlocking lever blocks movement of lever 735 between test and disconnect when padlock lever is moved to the right to insert padlock. Motion of this lever also moves release lever assembly on which it is mounted. This means that the racking release lever 811 is again blocked, as described below.

Thus, in conjunction with the cam positioning of lever 735 (FIG. 39) the breaker can be positively padlocked in any racking position, connect, test or disconnect.

Projection 831 blocks motion of lever 735 between test and disconnected positions unless release lever below is pulled to the right.

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

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

1. In switchgear; a first frame and a second frame; said first frame being reciprocally movable with respect to said second frame between two limiting positions; driving means on said second frame for effecting said reciprocal motion of said first frame with respect to said second frame; said driving means including a rotatable shaft carried by said second frame and extending normal to the path of reciprocal movement of said first frame with respect to said second frame; said shaft being unidirectionally rotatable; and a connection between said shaft and said first frame driving said first frame in one direction when said first frame is at one limiting position and in an opposite direction when said first frame is at the other end of said limiting positions; said first frame carrying a movable contact and a complementary contact; a closing spring for driving said movable contact into engagement with said complementary contact; means for charging said closing spring; a connection from said first mentioned shaft and said closing spring for charging said closing spring, said first mentioned shaft being operable on the discharge of said spring to recharge said spring; means for defeating the connection between said shaft and said frame to maintain said frame at one of the said limiting positions for reciprocal movement.
2. The switchgear of claim 1 in which said spring being movable between a charged condition and a discharged condition; a member connected to said spring and movable in a first direction to charge said spring; said member being movable by said spring when said spring moves from a charged to a discharged position; a first latch; said first latch being engageable with said member to retain said member and said spring in position when said spring is in charged condition; and driving connections between said member and said movable contact; said member when moving from the charged to the discharged positions of said spring and member acting through said driving connections to drive said movable contact into engagement with said complementary contact; a second latch located in and acting upon a portion of said driving connections; said second latch acting on said driving connections to maintain said movable contact in engagement with said complementary contact upon initial engagement thereof; means responsive to conditions including current conditions through said contacts to release said second latch and disestablish the driving connection.

tions between said member and said movable contact and to permit the first means to drive said contact to open position; said second latch, on separation of the movable contact from the stationary contact, reengaging said portion of said driving connection and reestablishing the driving connection between said member and said movable contact;

and means for charging said spring when the spring and member have been moved to the discharged condition of said spring;

said spring charging means including a rotatably mounted lever pivotally connected, at a point remote from the point of rotation thereof, to said member;

rotation of said lever in one direction moving said member in a direction to charge said spring;

said first latch, on completion of said movement of said member engaging said portion of said member and retaining said member and spring in charged condition.

3. The switchgear of claim 2 in which said spring and member are movable from the discharged condition to the charged condition thereof while the contacts are engaged and the movable contact is supported in engaged position by the engagement of said second latch with said driving connection,

said spring and member being also movable from the discharged condition to the charged condition thereof while the contacts are disengaged.

4. The switchgear of claim 3 in which a further reciprocally rotatable shaft extends on an axis substantially normal to the axis of said lever;

linkage connecting said reciprocally rotatable shaft to said lever;

rotation of said shaft acting through said linkage to rotate said lever.

5. The switchgear of claim 4 in which a motor is provided;

the first mentioned unidirectional shaft being driven by said motor;

a rotatably mounted camming lever connected to said linkage for said first mentioned lever and operable on rotation of said camming lever to rotate said first mentioned lever to drive said member and spring from a discharged to a charged condition thereof;

a crank arm on said first mentioned shaft and a cam roller on said crank arm engageable with said camming lever.

6. The switchgear of claim 5 in which the motor is unidirectional and means are provided responsive to the movement of the member and spring to charged condition to halt said motor;

said first mentioned unidirectional shaft and motor being thereby halted after a single revolution of said first mentioned unidirectional shaft and cam roller carrying arm;

said first mentioned unidirectional shaft and cam roller carrying arm being halted in a position where the cam roller is out of engagement with the camming lever;

said member and spring being free to move to the discharged condition thereof on and before completion of said single revolution of said first mentioned unidirectional shaft and cam roller carrying arm.

7. In switchgear, a movable contact and a complementary contact; first means for driving said movable contact into engagement with the complementary contact and second means for driving said movable contact out of engagement with said complementary contact;

said first means comprising a closing spring;

said spring being movable between a charged condition and a discharged condition;

a member connected to said spring and movable in a first direction to charge said spring;

said member being movable by said spring when said spring moves from a charged to a discharged position;

a first latch;

said first latch being engageable with said member to retain said member and said spring in position when said spring is in charged condition;

and driving connections between said member and said movable contact;

said member when moving from the charged to the discharged positions of said spring and member acting through said driving connections to drive said movable contact into engagement with said complementary contact;

a second latch located in and acting upon a portion of said driving connections;

said second latch acting on said driving connections to maintain said movable contact in engagement with said complementary contact upon initial engagement thereof;

means responsive to conditions including current conditions through said contacts to release said second latch and disestablish the driving connections between said member and said movable contact and to permit the first means to drive said contact to open position; said second latch, on separation of the movable contact from the stationary contact, reengaging said portion of said driving connection and re-establishing the driving connection between said member and said movable contact;

and means for charging said spring when the spring and member have been moved to the discharged condition of said spring;

said spring charging means including a rotatably mounted lever pivotally connected, at a point remote from the point of rotation thereof, to said member;

rotation of said lever in one direction moving said member in a direction to charge said spring;

said first latch, on completion of said movement of said member engaging said portion of said member and retaining said member and spring in charged condition;

a reciprocally rotatable shaft extends on an axis substantially normal to the axis of said lever;

linkage connecting said reciprocally rotatable shaft to said lever;

rotation of said shaft acting through said linkage to rotate said lever;

a motor;

an additional shaft driven by said motor;

a rotatably mounted camming lever connected to said linkage for said first mentioned lever and operable on rotation of said camming lever to rotate said first mentioned lever to drive said member and

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spring from a discharged to a charged condition thereof;
a crank on said additional shaft and a cam roller on said crank arm engageable with said camming lever;
said motor being unidirectional, and means responsive to the movement of the member and spring to charged condition to halt said motor;
said shaft and motor being thereby halted after a single revolution of said shaft and cam roller carrying arm;
said shaft and cam roller carrying arm being halted in a position where the cam roller is out of engagement with the camming lever;
said member and spring being free to move to the discharged condition thereof on and before completion of said single revolution of said shaft and cam roller carrying arm,

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said switchgear having a first frame;
said first frame carrying said contacts, a part of said driving connections and said first mentioned contact opening means;
said switchgear also having a second frame, said second frame carrying said spring and its associated member and the remainder of said driving connections,
said first frame being reciprocally movable into and out of said second frame;
driving means on said second frame connected to said first frame for effecting said reciprocal motion of said first frame;
said motor being mounted on said second frame and means for establishing a driving operation between said motor and said driving means.

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