Dec. 11, 1945. F. J. POKORNY 2,390,735

CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 1

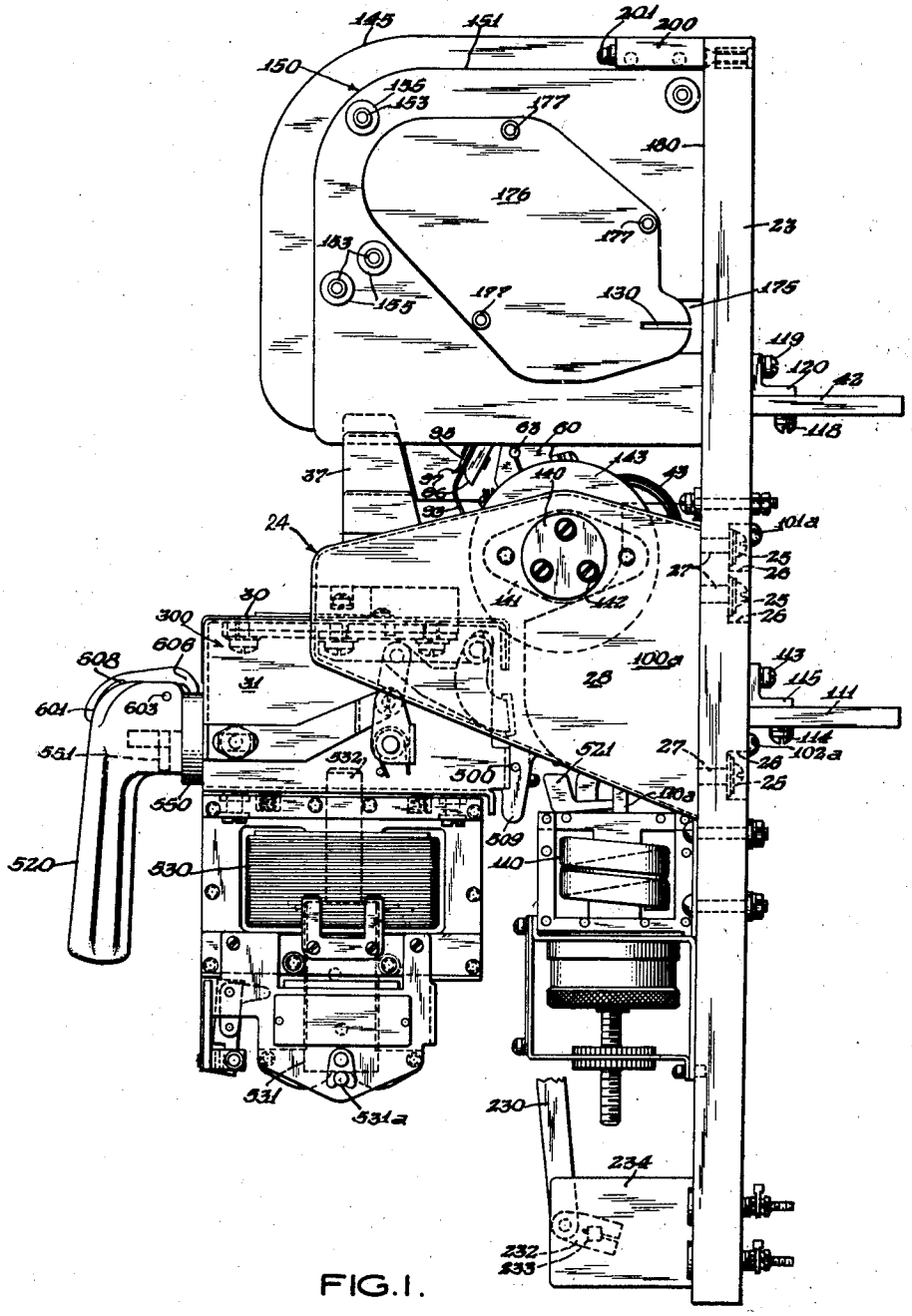


FIG. 1.

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CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 2

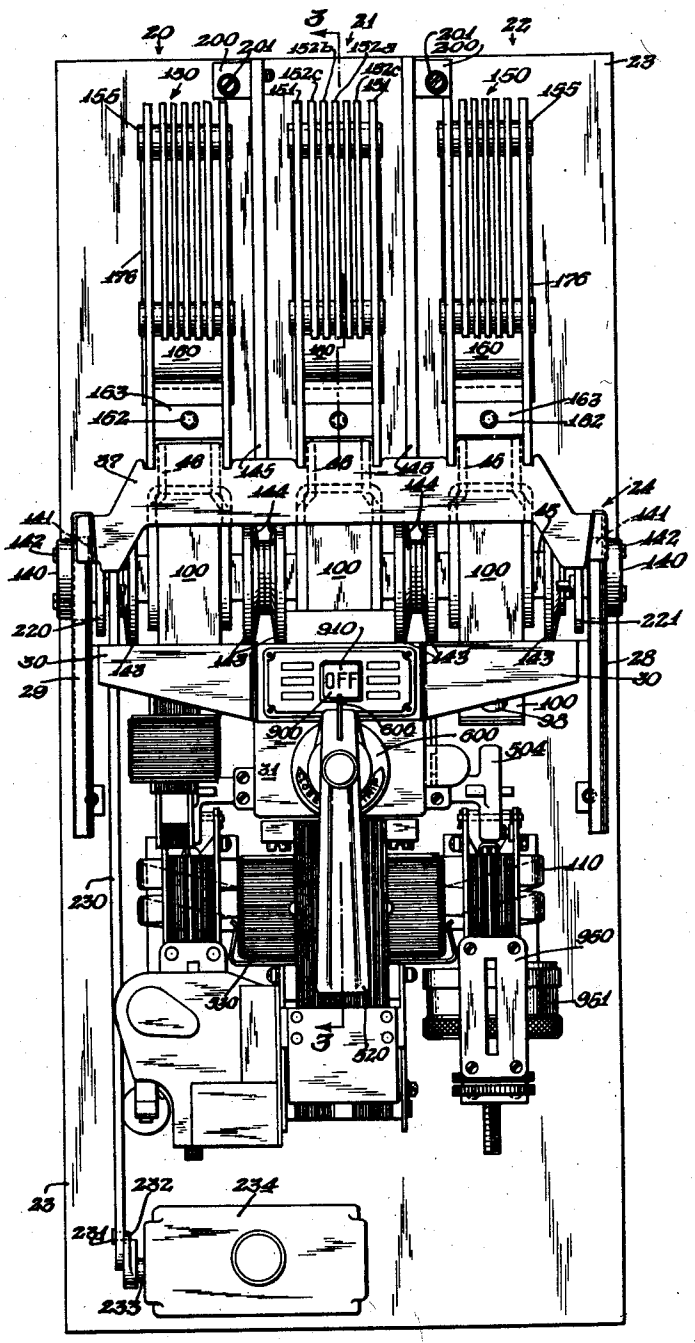


FIG. 2.

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CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 3

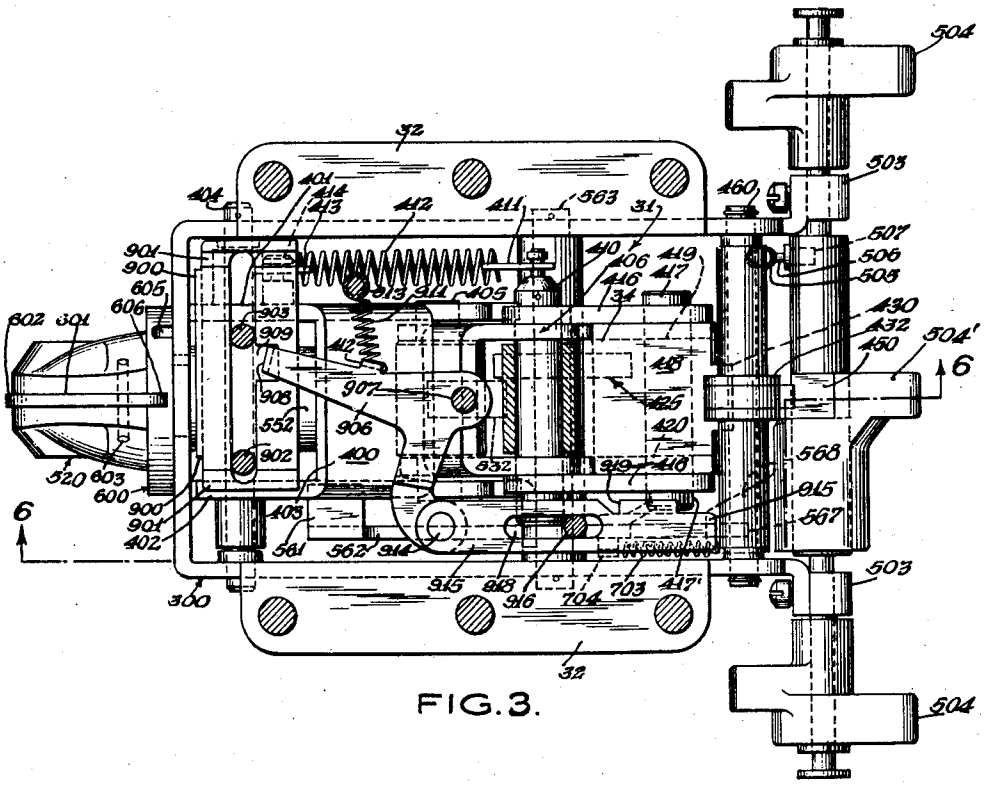


FIG. 3.

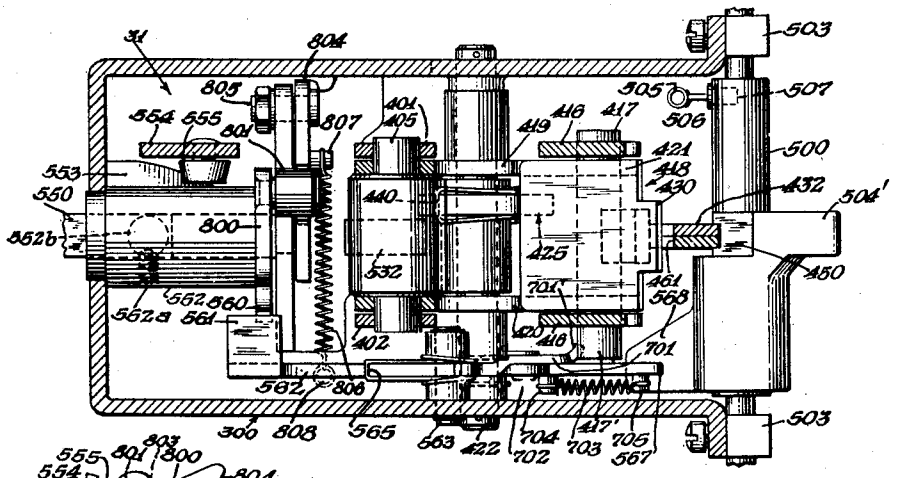


FIG. 4.

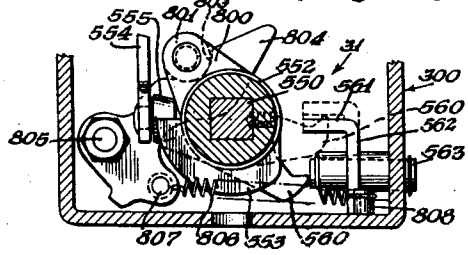


FIG. 5.

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CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 4

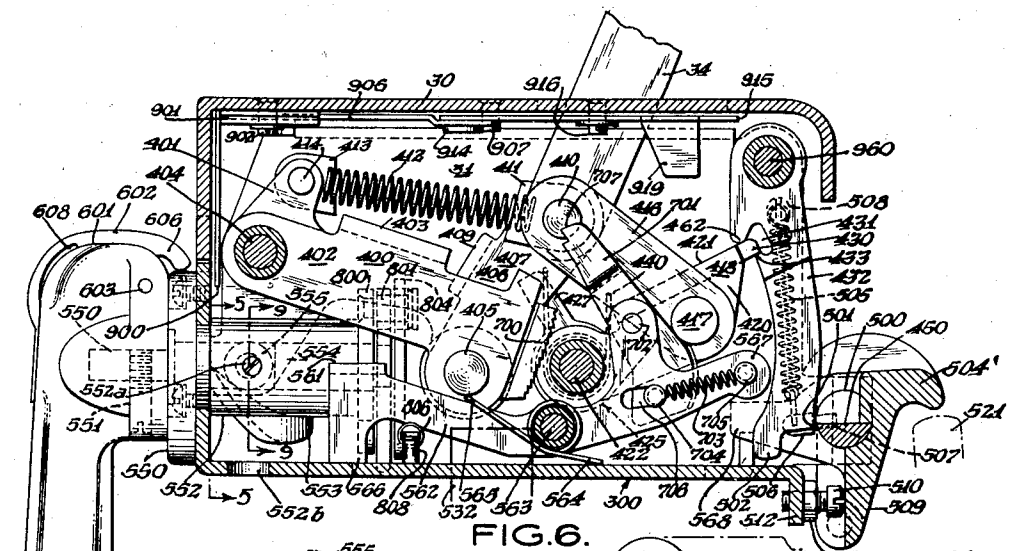


FIG. 6.

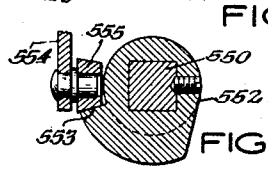


FIG. 9.

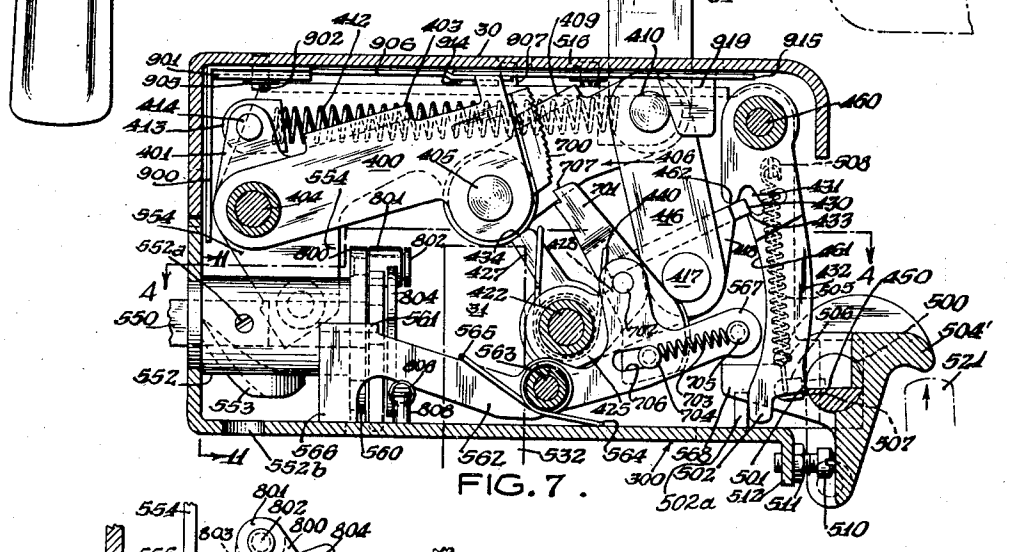


FIG. 7.

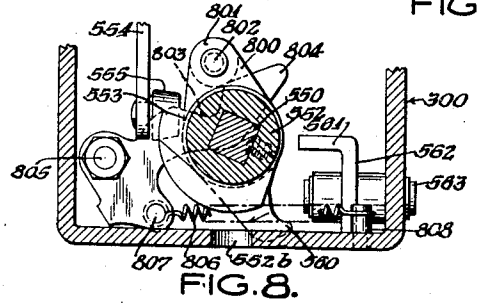


FIG. 8.

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CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 5

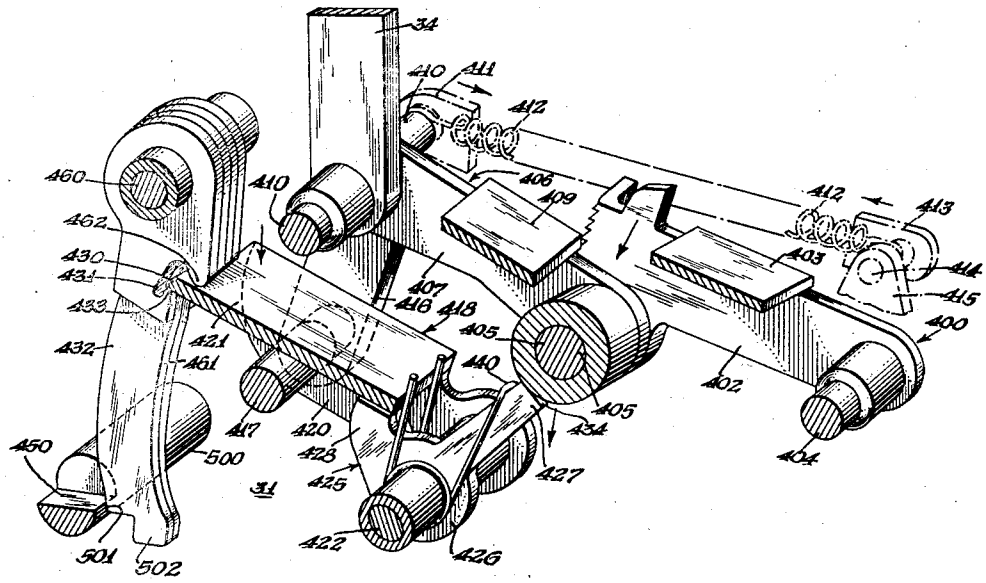


FIG.10.

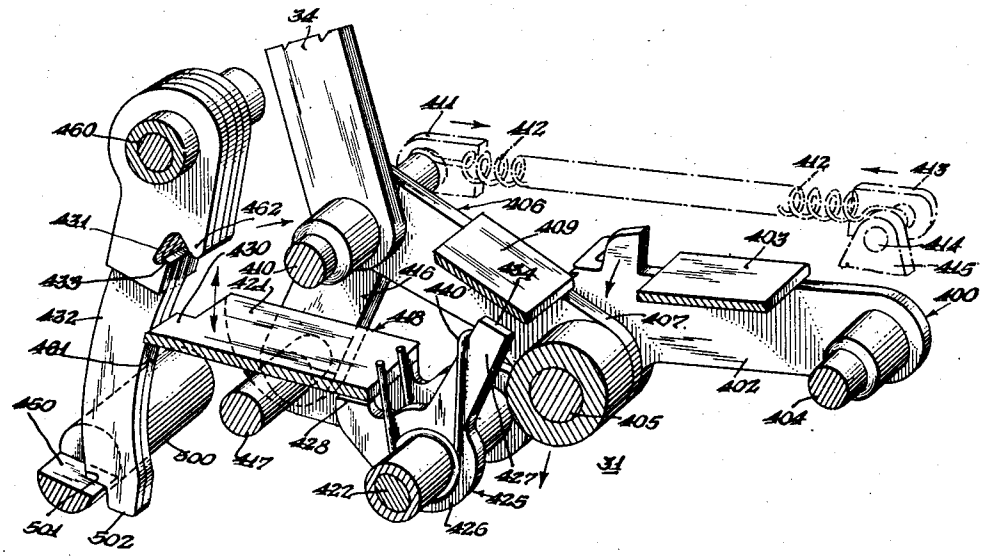


FIG.11.

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Dec. 11, 1945. F. J. POKORNY 2,390,735

CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 6

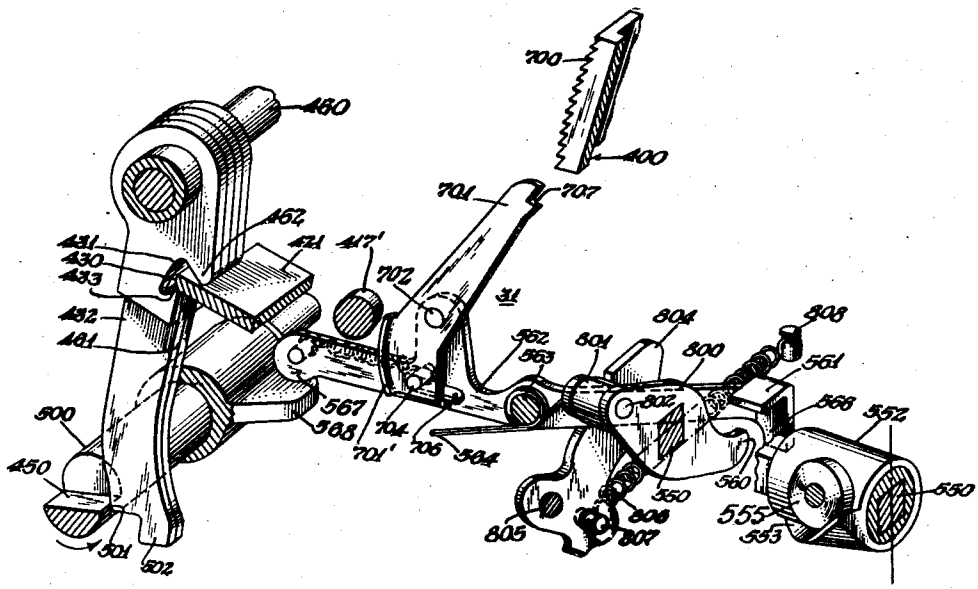


FIG. 12.

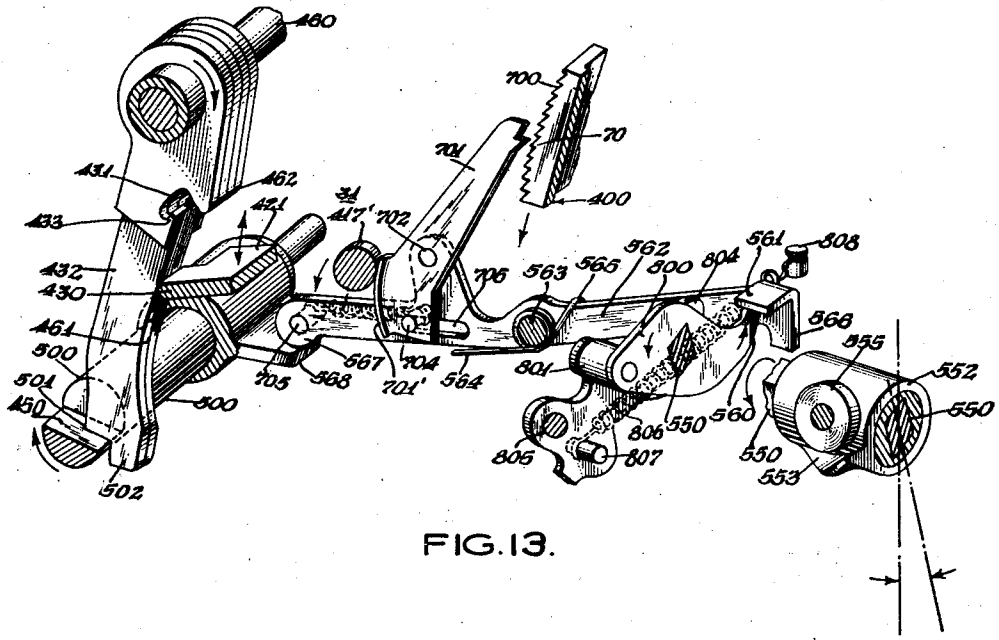


FIG. 13.

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Dec. 11, 1945. F. J. POKORNY 2,390,735

CIRCUIT BREAKER OPERATING MECHANISM

Filed June 10, 1940 7 Sheets-Sheet 7

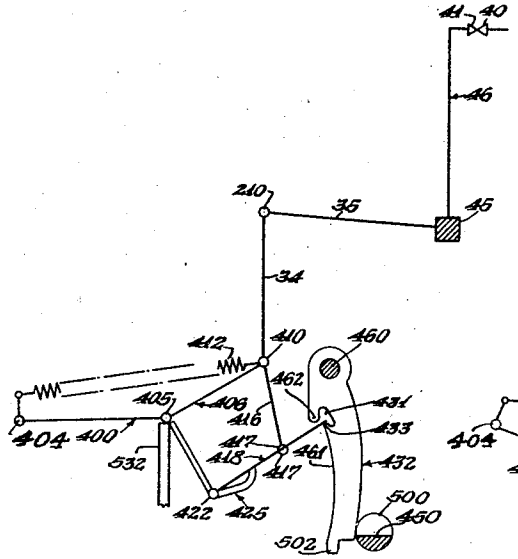


FIG. 14.

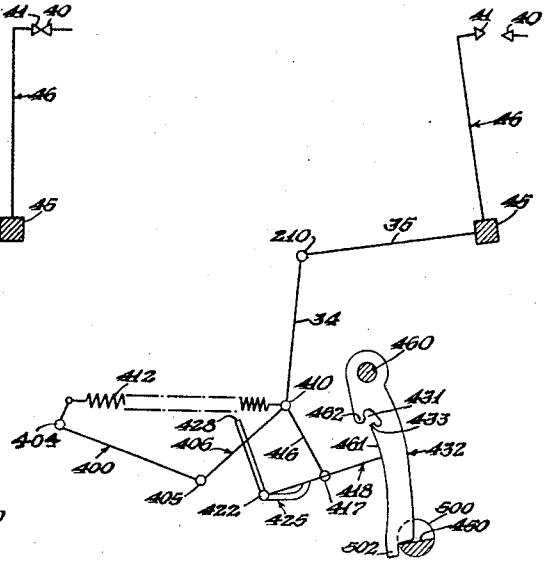


FIG. 15

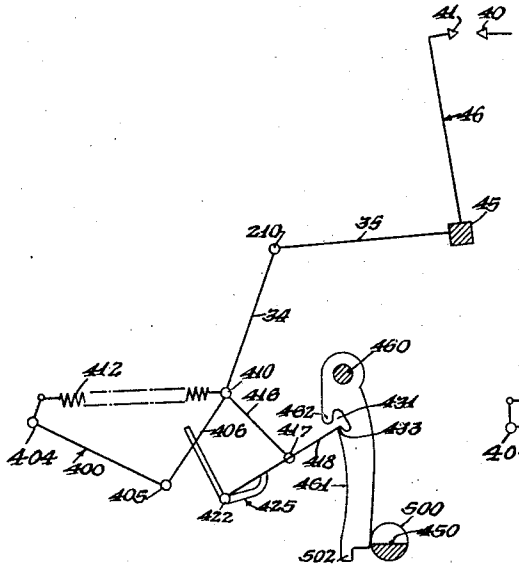


FIG. 16.

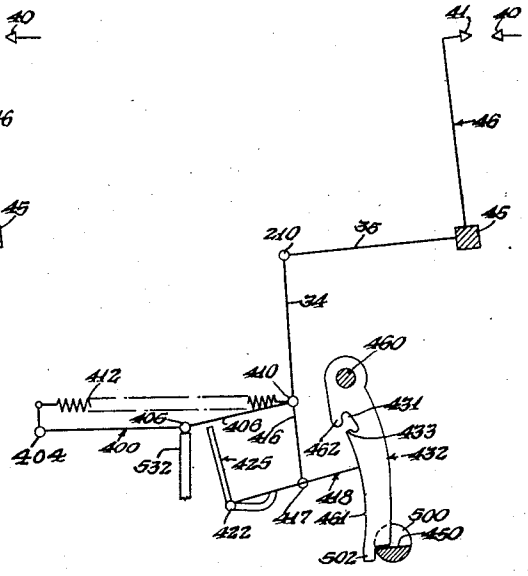


FIG. 17.

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Patented Dec. 11, 1945 2,390,735

UNITED STATES PATENT OFFICE

2,390,735

CIRCUIT BREAKER OPERATING MECHANISM

Frank J. Pokorny, Philadelphia, Pa., assignor to I. T. E. Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application June 10, 1940, Serial No. 339,682

12 Claims. (Cl. 200—89)

This invention relates to circuit breakers and operating mechanisms thereof, including closing and tripping mechanisms.

In the operation of circuit breakers, the efficiency of toggle arrangements for effecting tripping and closing of the contact members has long been recognized and has been employed in various combinations with different types of latching and tripping arrangements.

An important element of the present invention is to provide in connection with a toggle closing mechanism novel means whereby the movable contacts may be operated either manually or electrically in order to effect the closing operation; and correspondingly novel means whereby either a manual operation or an automatic electrically induced operation may selectively effect the tripping of the mechanism and the fast opening of the contacts.

An important element of toggle mechanisms is the latch or other engaging means which holds the same in predetermined locked position and which should be so designed as to obviate slipping during closing or any response to the jar of the solenoid or any other vibration, while at the same time being so constructed that a relatively small amount of work is required for tripping.

In the present invention the problem is solved not by the use of a single latch or trip alone but by a combination of latches: primarily by what we have termed a primary latch held in position by a secondary latch and engaging as well the tip of a latch lever. This apparent multiplication of latches does not, as might at first be suspected, increase the complexity of the mechanism but rather simplifies the operation and makes it possible to provide for an automatic resetting of the latches immediately after the actual tripping operation. In thereafter reclosing the circuit breaker the only operation necessary is the actual movement of the contact by the toggle means herein described.

An object of this invention, therefore, is, in a circuit breaker closing mechanism of the toggle type, the provision of a primary latch for engaging a suitable latch lever of the toggle mechanism and a secondary latch for maintaining the primary latch in latching position.

A second and equally important object of the present invention is the novel arrangement of the latch lever, the primary latch and the secondary latch in such a manner that the very process of tripping the contacts open sets the members in such position that the latches are automatically reset immediately after the tripping operation is completed.

It thus becomes important that the cooperation between the two latches in the first instance and between the primary latch and the latch lever be such that some movement of a portion of the toggle mechanism relative to these members have a resultant force effective to reengage these members while at the same time in no way impeding the tripping operation.

Accordingly, a further important object of the invention is the provision of means whereby relatively slight motions result in the initiation of the tripping operation and whereby the tripping operation itself results in the resetting of the engaging means or latches.

A further object of this invention is to provide primarily in connection with the toggle closing mechanism a back up trip which will serve automatically to trip the circuit breaker open as soon as any even slight reverse movement occurs during the closing operation.

There are many other objects and uses of the present invention and of the combinations and elements herein set forth. Many of them have already been pointed out. Many others will in part be apparent and where not intrinsically apparent will be pointed out in the following description and drawings, in which:

Figure 1 is a side elevation of the circuit breaker of my invention.

Figure 2 is a front view of the circuit breaker arrangement of Figure 1.

Figure 3 is a top view of the toggle mechanism for closing and opening the circuit breaker.

Figure 4 is a horizontal cross-sectional view taken on line 4—4 of Figure 7 showing the arrangement of the parts of the members of Figure 3 at different horizontal level within the toggle mechanism container.

Figure 5 is a cross-sectional view partly in elevation taken on line 5—5 of Figure 6.

Figure 6 is a cross-sectional view partly in elevation taken on line 6—6 of Figure 3 showing the position of the members when the contacts are open.

Figure 7 corresponds to Figure 6 but shows the position of the members when the contacts are closed.

Figure 8 corresponds to Figure 5 and is a cross-sectional view on line 8—8 of Figure 7, also showing a position of the members during a closing operation.

Figure 9 is a cross-sectional view on line 9—9 of Figure 6.

Figure 10 is a schematic view in perspective of the toggle and latch mechanisms of Figures 3, 4, 6 and 7 when the contacts are closed.

Figure 11 is a schematic view in perspective corresponding to the construction of Figure 10 but showing the toggle mechanisms during one instant of the tripping operation.

Figures 12 and 13 are schematic views in perspective showing the back-up trip mechanism and manual trip mechanisms and the combination thereof with the latching mechanisms of the members of Figures 3, 4, 6 and 7.

Figures 14, 15, 16 and 17 are diagrammatic representations of various steps in the operation of the toggle mechanism.

Referring now to Figures 1 and 2, I have here shown a three pole circuit breaker comprising the elements of the present invention. The circuit breaker consists of a group of pole units 20, 21, 22 (Figure 2) mounted on the face of an ebony, asbestos or slate panel 23 which forms the mounting plate of the entire circuit breaker arrangement.

Main supporting members

The main bracket or housing 24 which supports the operating members is secured to the panel 23 by means of screws 25, 25 the heads of which are recessed in openings 26, 26 in the back of the panel 23 and which pass through the perforations 27, 27 in said panel to engage the main bracket 24 (Figure 1).

As seen in Figures 1 and 2, the main bracket or housing preferably comprises two flanged side plates 28 and 29 which extend on each side of a horizontal shelf 30 to which they are welded. The operating mechanism 31 comprising the toggles and other elements hereinafter described in housing 300 is bolted to the lower side of the shelf 30.

Link 34 (Figure 7) connects the operating mechanism 31 to the lever 35 which is secured to the movable contact shaft 45 and is rotatable therewith. The movable contacts are operated into engagement with the stationary contacts on panel 23 when link 34 is raised and are biased toward open position by appropriate springs connected to contact shaft 45.

A bridge 37 of insulating material secured to the outer end of the main bracket 24 supports the outer end of the arc chutes 150.

Steel contact shaft 45 carries an arm 220 and 221 at each end. These arms carry studs, one of which, on each side, is connected to a contact opening spring which biases the shaft to open position. Another stud from one of the arms 220 may be connected to operate the vertical shaft 230 which operates auxiliary switch 234.

The rotation of the contact shaft 45 towards opening position will through the arm 220 and the stud 223 force the vertical link 230 downwardly. The vertical link 230 is connected by pin 231 to the crank 232 on the shaft 233 of the switch 234. The downward motion of the vertical link 230 will result in rotation of the crank 232 and will therefore result in rotation of the shaft 233 and in the consequent operation of the various contacts and other portions of the switch suitably connected to and actuated by shaft 233.

Such switch 234 may be used where, for instance, the circuit breaker is to be connected with automatic reclosing circuits when it is open and such relay will obviously be reset to its original position when the solenoid or manual closing mechanism hereinafter described rotates the contact shaft 45 towards closing position thus raising the insulated link 230 and operating the switch.

As has been above pointed out, preferably three contact arms 46 are mounted on this shaft, one for each pole of the circuit breaker as seen in Figure 2. On each side of each arm, there is cemented to the shaft insulation a Bakelite washer 143 which improves the pole to pole and pole to ground insulation.

As will be noted in Figure 2, the inter-pole washers are bevelled and flanged so that the bevelled and flanged portions 144 thereof are spaced apart so that an inter-phase barrier 145 secured to the panel may extend between them. The cooperation of these parts makes it impossible for any flexible conductors of adjacent poles to be drawn together during heavy current flow while at the same time any possibility of arcing over is obviated.

An important feature of the present invention is that the same structure may be used for single pole or multi-pole operation, that is, as seen for instance in the structure of Figure 2, the circuit breaker mechanism is so arranged that three poles are simultaneously operated by a single closing and tripping mechanism. The same type of structure may be so arranged as to take one, two or four poles or more.

The construction and operation of the arc chute 150 and arc extinguishing plates 151 in cooperation with the arcing contacts and blowout means are described in Patent No. 2,338,715.

Operating mechanism (closing and tripping)

An extremely important element of the present invention and of the combination herein set forth is the operating and tripping mechanism 31 (Figure 1). The elements of this operating and tripping mechanism are more clearly set forth in Figures 3 through 13, inclusive. The entire mechanism 31 itself, however, is contained within the housing 300 which is a steel box closed on the front, bottom and sides with flanges 32 at the upper edges of the sides so that it may be secured by the bolts 33 to the shelf 30 of the housing bracket assembly. The side walls of the housing 300 are pierced for the main stationary pins of the mechanism and the metal around the holes is extruded inwardly and reamed to obtain proper bearing for the pins.

Referring now more specifically to Figures 6 and 7, 10 and 11, the link 34 in each of these figures is the member which engages the actuating arm 35 of the contact shaft 45.

Figure 6 shows the position of each of the members of the operating and tripping mechanism when the circuit breaker is opened. Figures 7 and 10 show the position of each of the members when the contacts of the circuit breaker are closed. Figure 11 shows an intermediate momentary position of each of the members at the completion of the tripping operation, and an instant before re-set of the latches.

In the following description of the details of operation, references should be made as to each member to the drawings of Figures 6, 7, 10 and 11, while also the top view of Figure 3 and the horizontal cross sectional view of Figure 4 will aid in the understanding of the various operations.

In further aid of the following description, the diagrams of Figures 14 to 17 should be referred to. Figure 14 shows the closed position corresponding to Figures 7 and 10; Figure 16 shows the

open position corresponding to Figure 6; Figure 15 shows the position at tripping and immediately before latch re-setting, corresponding to Figure 11; and Figure 17 is a diagrammatic illustration of the trip-free position in the case of operation of the latches while the manual or solenoid closing member is in engagement.

The operating mechanism comprises a plurality of toggles so arranged that the knee pins or knuckle pins of each may be supported when the contacts are closed; but wherein the supports may be removed, permitting the contacts to open when the tripping operation is effected.

One of the toggles comprises an operating link 400 preferably, and for structural reasons, formed from two side plates 401 and 402, and a tie plate 403 extending between them for rigidifying purposes. The operating link 400 is rotatably mounted on the fixed pivot 404 which is rotatably carried in the perforations of the metal side walls of the outer casing.

The operating link 400 carries rotatably mounted therein between the side plates 401 and 402, the knee or knuckle pin 405.

Link 406 comprising also a pair of side plates 407 and 408 and a tie plate 409 for rigidifying purposes is rotatably mounted at one end thereof on the knee or knuckle pin 405.

The link 406 carries at the opposite end thereof the pin 410 which is rotatably mounted therein between the side plates 407—408 thereof. Pin 410 carries rotatably mounted thereon a lug 411 providing a means for securing one end of the tension spring 412 thereto. The opposite end of tension spring 412 is secured to a lug 413 which is rotatably mounted on a rivet head 414 which is carried by the upstanding lug 415 of the side plate 401 of the link 400.

The effect of the tension exerted by spring 412 between the points 414 and 410 is to collapse the toggle comprising links 400 and 406 to the position shown in Figure 6.

A third link 416 comprising a pair of independent side plates is rotatably mounted at one end thereof on the pin 410. The opposite end of the link 416 is rotatably connected to the pin 417 which is carried by the latch lever 418.

The latch lever comprises a pair of side plates 419 and 420 with a tie plate 421 therebetween. One end of the latch lever is rotatably mounted on the fixed pin 422 so that it is free to rotate thereon.

Pin 410 also rotatably supports one end of the connecting link 34, which extends between the operating mechanism and the actuating arm of the contact shaft. This link is a single wide member of phenolic insulation.

An abutment 425 is also rotatably mounted on the stationary pin 422. The abutment or main latch 425 comprises a V-shaped member having a center portion 426 which is pivotally mounted on the pin 422, an abutting or latching portion 427 adapted to engage a roller on the pin 405 in the manner hereinafter described, and a release portion 428.

The upper edge of release portion 428 is adapted to lie in engagement with the under side of tie plate 421 of the latch lever 418, so that any movement downward of the latch lever 418 will result in a clockwise rotation of the said portion 428 of the abutment 425 and will result in moving the abutting or latching portion 427 thereof out of engaging position.

A spring 440 is so arranged as to tend to yieldingly support the abutment member 425 so that the latching portion thereof 427 may always be in position to engage the roller 405.

Pressure of release portion 428 against the plate 421 of the latch lever limits the effect of the spring 440 and serves positively to position latching portion 427 in predetermined position.

When the link 400 is raised and the knee pin 405 of the toggle formed by the links 400—406 is therefore raised then since the link 416 (by means of its attachment between pins 410 and 417) prevents pin 410 from approaching closer to the pin 414, the only direction in which the link 406 may rotate by reason of the elevation of the pin 405 is in such a direction that the pin 410 moves counterclockwise with respect to pin 405.

In this manner, raising of the link 400 in any suitable manner results in an extension of the tension spring 412 (the members then assuming the position shown in Figs. 6 and 10) and in an increase of force tending to draw the pins 410 and 414 together, creating a tendency to collapse the toggle formed by links 406 and 400.

The members are arranged so that when the toggle formed by links 400—406 about pin 405 is in such position that the contacts of the circuit breaker are closed (as for instance in Figure 7), the toggle is just under center, that is the center of pin 405 does not reach a straight (imaginary) line drawn between the axes of the pins 404 and 410 and does not pass through such line.

In this way, this toggle is unstable even when set in the closed circuit position. When therefore, the supporting means herein described is removed from the toggle it will immediately collapse owing to the tendency of the tension spring 412 to draw the pins 410 and 414 together.

In the open circuit position and even in the closed circuit position, the pin 417 is a stationary one in that it is mounted on the latch lever 418 one end of which is fixed by its mounting on the pin 422 and the other end of which is fixed by the engagement of the latching tip 430 with the notch 431 of the primary latch 432.

Therefore during the closing operation the lower center of rotation of the link 416 is fixed and for this reason also the pin 410 is to some extent supported by the link 416.

This partial support of the pin 410 by the link 416 results in downward pressure upon the latch lever 418 in closed circuit position of Figures 7 and 10 thus resulting in pressure of the latch lever tip 430 upon the base 433 of the notch 431.

As the operating link 400 of the toggle 400—406 is raised, the roller 405 of the toggle comes in contact with the surface 434 of the abutment 425 and moves the same in a clockwise direction (with respect to Figures 6 and 7) out of the way so that the knee pin 405 may rise. After this pin has passed the area 434 of the abutment 425 then the spring 440 of the abutment pushes the abutment 425 in a counterclockwise direction (with respect to Figures 6 and 7) so that the member 428 of the abutment abuts against the tie plate 421 of the latch lever 418 and so that the abutting portion 427 is swung beneath the knee pin 405 of the toggle 400—406 (in the position shown in Figures 7 and 10) to support the same against the tendency of the tension spring 412 to pull the pins 414 and 410 together and thus collapse the toggle by driving down the knee pin 405.

Should the abutting or latching portion 427 of the abutment 425 be again rotated (clockwise with respect to Figure 7, or counterclockwise with respect to Figure 10) out of engagement with the pin 405, then the tension spring 412 will operate

in a manner hereinbefore described to collapse the toggle 400—406 and move the elements back again to the position shown in Figure 6.

The means by which this is accomplished includes the primary latch 432 and the secondary milled latch 450.

As above noted, when (Fig. 7) the toggle 400—406 is in the position for the closed contacts, the knee pin thereof has not passed through center. Likewise, the links 34 and 416 are in such relation to each other, that the pin 410 which constitutes a knee pin therebetween has also not passed through center. Consequently, owing to this instability any element which will cause any one of the toggles to collapse will cause all to collapse towards their original position as shown in Figure 6.

The knee pins of the toggle mechanisms are each supported in the closed circuit position; the knee pin 405 of the toggle 400—406 being supported by the abutment 425; and the knee pin 410 of the toggle 34—416 being supported in part by the stabilized position of the knee pin 405 and in part the stabilized position of the pin 417.

When support is removed from the latch lever 418 and it is allowed to drop under the substantially vertical downward pressure exerted thereon through the link 416 when in closed circuit position (Fig. 11), then as the tip 430 thereof drops, the tie plate 421 comes in contact with the portion 428 of the abutment 425 and causes the same to rotate (in a clockwise direction with respect to Figure 7) (or counterclockwise with respect to Figure 11) about the pin 422 thus removing the latch portion 427 of the abutment 425 from beneath the pin 405 and thus permitting the toggle 400—406 to collapse under influence of spring 412 to the position shown in Figure 6.

Collapse of this toggle also collapses the toggle 34—416 by causing the knee pin 410 thereof to be drawn by tension spring 412 towards the position shown in Figure 6.

As the link 416 is moved from the position shown in Figure 7 to the position shown in Figure 6 (and through the stage of Fig. 11), the contacts open and the pin 410 reaches the limit of its downward movement. Thereafter the link 416 exerts a slightly upward pull owing to the pull upon the pin 410 by the tension spring 412. This upward pull now exerted by the link 416 upon the latch lever 418 results in a rise once more of the latch lever and thus permits the spring 440 of the abutment to swing the abutment back to the original position as is again seen in Figure 6.

By reason of the fact, therefore, that a single element, to wit, the link 416, exerts a substantially downward vertical pressure upon the latch lever in the closed circuit position, and further by reason of the fact that after completion of the rapid opening movement, this downward pressure exerted by the link 416 is reversed and becomes an upward pull, latches may be designed to cooperate with the latch lever in such a manner as to selectively resist the downward force until they are released and to become automatically reset by reason of the upward movement.

Accordingly, we have here designed a combination of a primary 432 and a secondary latch 450 for accomplishing this important object.

By the means herein described, as the various links and members of the operating mechanism pass from the closed circuit to the open circuit position, the latches which have been tripped for the purpose of initiating this movement will automatically reset immediately after the end of the tripping operation so that the only operation required to again close the circuit breaker and hold it closed is a raising of the link 400 or in other words, a rotation of the link 400 counterclockwise (with respect to Figures 6 and 7) about the stationary pin 404.

The primary latch comprises a curved link 432 which is pivotally mounted on the stationary pin 460 and rotatable thereon. The member 432 has a front cam surface 461, the notch 431 hereinbefore described and the latch lever abutment 433 as well as the resetting toe 462. The primary latch 432 is restrained in latching position by the milled latch 450 hereinafter described that is, it is restrained against counterclockwise rotation (with respect to Figure 7).

Now, when the restraint against counterclockwise rotation of the primary latch 432 about its pin 460 is removed, then pressure of the tip 430 of the latch lever 418 upon the abutting portion 433 of the notch 431 of the primary latch 432 causes the latter to rotate about its pin 460 thus releasing the latch lever 418 and allowing the pressure thereon induced through the link 416 to cause it to drop.

This dropping or forcing down of the latch lever 416 swings the abutment 425 out of abutting position in the manner hereinbefore described, thus removing any support from the toggle mechanism 400—406, and thus permitting the pin 405 to drop because of the tension of the spring 412 which draws the pins 414 and 410 together.

The position as the dropping motion of the latch lever is completed is shown in the schematic perspective view of Figure 11 and of Figure 15. This position occupies the briefest possible instant of time during the tripping operation and is but one stage of a single continuous movement.

As the link 416 is swung about its pivot 417 on the latch lever 418, by reason of the drawing together of the pins 410 and 414 the contacts are opened and the limit of downward movement is reached. Then what previously has been pressure exerted through the link 416 becomes a pull thereon by reason of the pull of the spring 412. By reason of the mounting of the latch lever 418 upon the stationary pin 422, this pull on the link 416 and the pin 417 carried by the latch lever, now results in a rotation (counterclockwise with respect to Figure 7 and clockwise with respect to Figure 11) of the latch lever 418 thus raising the latch lever once more towards the position shown in Figure 6.

As the latch lever is thus pulled up, the pressure thereof against the cam surface 461 of the primary latch 432 prevents the resetting of this primary latch or the replacement thereof in its original position until the latch tip 430 of the latch lever 418 strikes the projecting toe 462 of the primary latch 432. The pressure of the upward movement of the latching tip 430 beneath the projecting toe 462 now causes a rotation of the primary latch 432 (clockwise with respect to Figure 7 and counterclockwise with respect to Figure 11) towards the resetting direction and towards the position, therefore, of Figure 6 so that the latch tip 430 enters the notch 431 and lies between the toe 462 and the abutment 433 of the notch 431 in preparation for any subsequent

closing operation or tripping operation which may be required of the circuit breaker.

An abutment 502a (Figure 7) is placed on the bottom wall of the housing to limit the rotation of the primary latch when the toe thereof is struck by the latch lever. The abutment 502 of the primary latch (which limits motion in the tripping direction in the manner hereinafter described) also limits the rotation of the primary latch during resetting by striking against abutment 502a when the toe 462 is raised by the tip of the latch lever.

It will thus be seen that immediately after the tripping of the primary latch 432 by reason of the removal of the restraining movement hereinafter described, the primary latch 432 is not permitted to rotate to its original position until the latch tip 430 of the latching lever 418 has actually entered the notch 431. This is by reason of the fact that the latch tip 430 operates against the cam surface 461 of the primary latch. But when the latch tip strikes the toe 462 of the primary latch then the very motion by which it enters the notch 431 causes it to rotate the primary latch to its original position and thus causes the restraining influence thereon to be reset.

The restraining influence heretofore referred to is, of course, the milled latch 450 and it should be understood that the milled latch 450 when tripped can therefore not return to its original latching position until after the primary latch 432 has been reset in its position.

As seen in the diagrammatic view of Figure 17, the mechanism is also trip-free, that is, disengagement of the latches will permit opening of the contacts even though the actuating members are engaged either by the solenoid or manually.

The milled latch 450 is actually a shaft 500 (see Figures 3, 10 and 11) having a portion 450 milled out, the milling being of a sufficient depth to permit the base or latch engaging portion 501 of the primary latch 432 to pass therethrough when the shaft 500 is rotated in the proper direction.

An abutment 502 of the bottom of the primary latch 432 lies adjacent the base or latching tip 501 of the primary latch 432 to limit the movement of the base of the primary latch into the milled latch 450 in the manner shown in Figure 14. The milled latch 450 and its shaft 500 is normally retained and biased towards the latching position of Figures 3, 7 and 10 by spring 505.

The shaft 500 is rotatably mounted in suitable bearings 503, 503 (cf. also Figure 3) and carries arms 504, 504 and 504' preferably of insulating material keyed thereto or molded thereon. The spring 505 which maintains the milled latch in suitable latching position is connected to a stud 506. Shaft 500 is tapped and drilled at 507, to receive the stud 506. The opposite end of this tension spring is passed through and thereby attached to an eye in the lug 508 screwed into a drilled and tapped hole in the side wall of the housing.

Arm 509, Figure 6, forming preferably an integral part of the insulating arm 504' abuts against the set screw 510 which may be set and locked by means of locking nut 511 in the downwardly depending flange 512 of the rear of the housing. This serves to limit the motion of the shaft 500 carrying the milled portion 450 so that it may rotate in response to the tension of spring 505 only enough to permit latching and so that it may not rotate clockwise (with respect to Figure 6) any further distance than that shown.

This milled latch 450 is thus of that variety generally known as a "dead center" latch wherein the force exerted by the latching tip 501 of the primary latch 432 does not tend to induce any movement of the latch 450 but is substantially directed towards the center thereof inducing a condition of stability.

When the shaft 500 is rotated counterclockwise (with respect to Figures 6 and 7) then it need not overcome any substantial force tending to impede its rotation, since the only impedance to such rotation is first the spring 505 which is merely sufficient to maintain the latch in locking position and the slight friction between the latching tip 501 of the primary latch and the side of the shaft 500.

Since this friction is exerted only slightly tangentially and hence does not tend substantially to impede rotation of the shaft 100, it is negligible, and any tripping action manually induced or automatically induced need merely be of sufficient movement to rotate the shaft 500 counterclockwise (with reference to Figures 6 and 7) in order to trip the entire mechanism.

Automatic tripping

This tripping action may be a result of the over current coil 110 (Figure 1) or of a movement of the manual arm 520 in the manner herein described. The over current coil 110 may, in a manner which is now well known in the art, actuate a tripping arm 521 (Figures 6 and 7) which may be attached in any suitable manner to a movable armature 110a of the over current coil.

As seen in Figure 1, the overcurrent coil 110 comprises a plurality of turns preferably of bar copper, the said coil being suitably connected in series between the lower connection stud 111 and the pig-tail terminal post 44.

The action of the over current coil is designed so that it is one tending to cause the tripping arm 521 to rise and strike the lever 504' keyed to the shaft 500 carrying the milled portion 450. This results in rotation of the shaft 500 of sufficient extent as shown in Figures 10 and 11 to cause the milled portion 450 to rotate so that its edge is below the latch tip 501 of the primary latch 432.

Whereupon the downward pressure of the tip 430 of the latch lever 418 in the manner hereinbefore described causes the primary latch 432 to rotate about its mounting 460 so that the latch tip 501 enters the milled portion 450 a sufficient distance to permit the latch lever 418 to drop in the manner shown in Figure 11 thus moving the abutment 425 in the manner hereinbefore described to permit the toggles to collapse under the influence of the spring 412 and to therefore permit the tripping and latch resetting operations hereinbefore described.

When the contacts are opened by means of the tripping operation, then the over current coil 110 is no longer energized, the tripping arm 521 associated with the over current coil 110 is no longer in its tripping position, the rise of the latch lever 418 to re-engaging position then forces the primary latch back to its original position and when the latch tip 501 of the primary latch 432 is no longer within the milled slot 450 of the shaft 500 then the spring 505 returns the shaft 500 to its original position and the entire mechanism has then passed from the closed stage shown in Figure 7 through the trip-

ping stage shown in Figure 11 into the contact-open-stage shown in Figure 6.

Solenoid closing

When the circuit breaker is in the open circuit position so that the toggle mechanisms thereof are in the position shown in Figure 6, then the closing operation may be effected by means of the closing solenoid 530 and its moving armature 531 (Figs. 1, 6 and 7). When the circuit is closed to the closing solenoid 530, in any suitable manner, then the closing armature 531 thereof will be raised.

When the closing coil 530 is energized and the armature 531 thereof is raised, then the rod 532, thereof is raised from the position shown in Figure 6 to the position shown in Figure 7.

The rod 532 is, as shown in Figure 6, immediately beneath the knee pin 405 of the toggle 400—406. The raising of the rod 532 by the energization of the closing solenoid causes a raising of the knee pin 405 of this toggle by engagement of the end of the shaft with a roller of the pin 405 as shown in Figure 7 until the knee pin roller pushes past the abutment 425 and then rests upon and is retained by the abutting portion 427 of the abutment 425.

Preferably, the closing coil is thereafter deenergized so as to allow armature 531 to return to lower position so that rod 532 does not impede the dropping of the knee pin 405 to the position shown in Figure 9 should a tripping operation occur.

The opening of the contacts, due to automatic tripping, is assured and rapid whether or not the solenoid is deenergized when a fault occurs. The resetting of the latches, however, cannot be completed until the falling of the plunger permits the spring 412, to force the pin down to its lower position.

The armature 531 of the solenoid and the housing thereof (cf. Figure 1) is so arranged that when forced downwardly the bottom of the armature will strike the steel pin 531*a*. This pin is supported only at the ends and is sufficiently elastic to provide an adequate shock absorber when violently contacted by the bottom end of the armature.

Manual closing

In the present invention, I contemplate also the utilization of a manual means for closing the circuit breaker, said manual means being operative to supplement the solenoid closing operation, both mechanisms being mountable in connection with the same circuit breaker and providing a selective manual or solenoid closing operation.

The manual operating lever 520 is keyed to the square shaft 550 by means of the screw 551. The square shaft 550 is inserted in the squared hollow portion of the cylindrical casting 552 and secured therein if desired by the screw 552*a* which may be inserted in the casting, access being obtained through the opening 552*b* in the bottom of the housing. The shaft 550 may be of any suitable length depending on whether or not a cover or casing is used for the circuit-breaker and may, with its handle, be rapidly interchanged, or it may be a removable shaft for use with many circuit-breakers. The cylindrical casting 552 carries thereon a helical cam 553. The operating arm 400 carries on a downwardly extending portion 554 thereof a roller 555 (see Figures 6, 7, 9 and 12).

The cylindrical casting 552, has a square hole broached through it. In the back part of this hole, there is secured a short square shaft by means of a set screw. The extreme back end of this shaft is turned round and bears in a hole in the arm bent up from the floor of the enclosure. This forms the back bearing for the casting.

Mounted on the square of this shaft between the bearing and the casting is the hand trip lever 300. The front end of the casting is turned down to bear in a hole in the front plate. The handle shaft 550 is a removable unit, so that it can be replaced by a different unit suitable for other types of control. These control shafts are held in the casting by a set screw.

A manual rotation of the lever 520 in a clockwise direction (with respect to Figures 2, 5 and 9) will result in a closing of the contacts. The helical cam 553 will raise the roller 555, thus raising the link 400 (cf. Fig. 8) the raising of the link 400 closing the contacts in the manner hereinbefore described.

Manual tripping

The manual lever 520 and the shaft 550 to which it is keyed also provides for a manual tripping where that is desired in addition to the automatic trip by means of the over current coil 110.

As is seen in Figure 8, the shaft 550 carries an arm 560 secured thereto. This arm 560 may cooperate with the bent-over flange 561 (Figures 5, 8, 12, 13 and also Figures 6 and 7) of trip lever 562 to provide a manual tripping of the circuit breaker. The trip lever 562 is rotatably mounted on the pin 563 and is restrained in the position shown in Figures 6, 7, and 12, by the coil spring 564, one end of which presses against the floor of the housing and the other end of which is bent-over at 565 to engage the trip lever beyond its fulcrum 563.

The trip lever 562 is provided with an abutment 566 which rests against the floor of the housing to provide a stop therefor. The trip lever has at the opposite end from the flange 561 a rounded portion 567 which may register with the arm 568 attached to the shaft 500. Any rotation of the trip lever 562 in a clockwise direction (with respect to Figures 6 and 7) will result in the forcing of the end 567 down onto the lever 568 thus causing a rotating of the shaft 500 against the influence of the spring 535 and thus rotating the milled portion 450 thereof to the tripping position shown in Figures 11 and 13.

The manual lever 520 when it is therefore rotated in a counterclockwise direction (with respect to Figures 2, 5 and 8) causes the arm 560 attached to the shaft 550 to bear against the flange 561 of the trip lever 562 and by raising that end of the trip lever 562 depresses the end 567 of the trip lever, thus rotating the shaft 500, bringing the milled latch portion 450 thereof into registry with the latching tip 501 of the primary latch 432 and permitting the tripping open of the circuit breaker in the manner described in connection with Figure 11 and as shown in Figure 13.

As is seen in Figure 2, the escutcheon plate 600 at the front of the circuit breaker may be suitably marked with the words "Close" and "Trip" to indicate the direction in which the manual lever 520 should be rotated in order to obtain the desired action.

Safety lock

This cooperation between the manual lever 520 and the arm 560 on the shaft 550 thereof with

the flange 561 of the latch lever 562 may be utilized for the purpose of locking the circuit breaker in open position to prevent unauthorized closing thereof.

As seen in Figures 1, 6, and 3, the top of the manual handle or lever 520 may be slotted at 601 to receive a locking bar 602 pivotally mounted upon the pin 603. A suitable spring may, if desired (although it is not essential), be arranged to bias this locking bar 602 so that the locking tip thereof 606 may be pressed against the circular portion 604 of the escutcheon plate 600. The circular portion 604 may have a notch or slot therein 605 as seen in Figure 3.

Rotation of the lever 520 in a counterclockwise direction (with respect to Figure 2) will cause the locking bar 602 to be rotated to such a position that the locking tip 606 may be forced into the notch or cut-out 605.

The rotation in this direction will also result in the tripping action by means of the trip lever 562. Should the manual lever 520 now be left in position where the tip 606 of the lock bar 602 is engaged in the notch 605, then the end 567 of the latch lever 562 will continue to be firmly pressed against the lever 568 and, as shown in Figure 13, will cause the latch 450 to be continuously in tripped position.

When the manual lever 520 is left in such a position that the arm 560 thereof continuously presses up the flange 561, then it will be impossible either manually or electrically to close the contacts.

The locking bar 602 has a slot 608 therein (Fig. 2) which is so arranged that when the locking tip 606 is depressed into the notch 605, the slot 608 comes into view. This slot is of sufficient width to permit the passing of the hasp of a padlock therethrough to prevent the depressing of that end of the locking bar and the raising of the locking tip 606 out of the notch 605. In this way, it becomes impossible for an unauthorized person not provided with a key to the particular lock to rotate the manual lever 520 to such position as will permit return of the milled latch 450 to its engaging position. This, of course, adds another extremely important safety factor in the use and operation of our circuit breaker.

Back up trip

In the operation of circuit breakers and circuit closing mechanisms, it is sometimes found that careless operators, when the circuit breaker has once been tripped, attempt to close the circuit breaker by only a partial closing operation. In order to prevent an operator from moving the contacts so that they just touch and open again, as is sometimes done to "inch" a motor, I therefore provide a back-up trip so arranged that any reversal of motion in the closing of the circuit breaker will result in a tripping open thereof and so that any attempt to move the contacts to such position that they just touch and no more will result in the tripping open of the circuit breaker.

This device (see more particularly Figures 12 and 13) consists of a set of ratchet teeth 700 mounted on one end of the link 400 and engageable by a pawl 701 pivotally mounted at 702 on the trip lever 562, and urged into engaging position by the tension spring 703 connected to the pin 704 attached to the pawl 701 and connected at the opposite end to the pin 705 on the trip lever 562.

The pin 704 rides in the slot 706 of the trip lever 562 which limits the motion of the pawl 701. During the upward movement of the closing lever 400, the tripping pawl is biased into engagement with the ratchet teeth and the ratchet teeth are so arranged that during this upward movement, they slide past the engaging portion 707 of the pawl 701. The lower surfaces of the ratchet 700 are so arranged, however, that any downward motion thereof will cause a depression of the pawl 701. During the closing operation, should the lever 400 reverse its movement, the downward movement of this lever will force the ratchet teeth 700 to press the pawl 701 downwardly (cf. Figure 13), thus pressing down the end 567 of the trip lever 562 by reason of the fact that the pawl is mounted on that side of the fulcrum 563, thus pressing the tripping end 567 of the trip lever against the lever 568, rotating the shaft 500 and causing the milled latch 450 to be rotated to tripped position.

In the closing operation, as the toggle pin 560 approaches the center line (in which the arms 400—405 tend to approach a straight line position) the movement of the pin 405 becomes relatively large as compared with that of the contact arm 46. It is, therefore, possible to allow the teeth then to move away from the pawl before the lever movement is completed, as seen in Figures 7 and 12.

During the closing movement and before this tripping action has occurred, the pawl 701 is in engagement with the ratchet teeth 700 to cause any even slight reverse movement to effect the tripping action of the trip lever 562. During the tripping operation, however, it is desirable to move the pawl 701 to such a position that it will not engage the ratchet teeth 700 so as not to impede the dropping of the link 400 and its associated pin.

Likewise, when upon the occurrence of a reverse movement during the closing operation, the ratchet teeth engage the pawl 701 to depress the trip lever and hence cause an automatic tripping in the manner above described; it must also be possible during the remainder of the tripping operation initiated by the reverse movement to move the pawl out of the way of the ratchet teeth.

Accordingly, the pawl 701 is provided at the bottom thereof with an inwardly bent flange 701'. This flange is arranged to coact with a roller mounted upon a pin 417' of the latch lever 418.

When a tripping of the circuit breaker occurs either by reason of a manual trip, the occurrence of an overload or by reason of a reversal of movement during closing, the latch lever will drop in the manner hereinbefore described. As the latch lever drops, the pin 417' above mentioned thereon, comes into contact with the flange 701' of the pawl 701 and the downward pressure of the pin upon this flange causes the pawl to rotate upon its mounting so that the engagement portion thereof swings away from the path of the ratchet teeth and permits the link 400 and its associated pin to descend without any impediment whatever.

Thus, upon the occurrence of a reversal of movement the pawl 701 is engaged with the ratchet teeth 700 only for a sufficient length of time to cause a depression of the trip lever for the tripping purposes hereinbefore described, and upon the dropping of the latch lever in response to this action, the pawl is, in the manner above described, disengaged from the ratchet teeth.

In spite of the fact that a reversal of movement during the closing operation thus results

in a tripping of the circuit breaker, the circuit breaker nevertheless is trip free in the manner shown in Figure 17 so that even though the link 400 is held in raised position either by the manual closing lever or by the solenoid closing armature, the latch lever may drop in response to an overload and thus permit the opening of the contact.

Handle reset

As is more clearly seen in Figures 5, 8, 12 and 13 the manual operating lever 520 may be arranged so that it will automatically return to neutral position immediately after either a tripping or closing operation has been effected therewith, that is immediately after any manual pressure has been removed therefrom. This means for returning the manual lever to neutral position comprises an arm 800 mounted on the shaft 550 and which may preferably and for purposes of economy be an extension of and formed integrally with the tripping arm 560. The arm 800 is provided with a roller 801 mounted on a stud 802. The rotatable bearing when the shaft and the manual operating lever 520 is in neutral position, registers with the notch 803 of the lock lever 804. The lock lever 804 is pivoted on the stud 805 and is urged into locking position by the spring 806 which engages a lug 807 on the locking lever 804 and the other end of which is engaged by a lug 808 struck up from the bottom of the housing. The set or neutral position is shown in Figure 5.

When the manual operating lever 520 is rotated towards closing position, then, as shown in Figures 5 and 8, the roller 801 of the arm 800 is rotated out of the notch 803 and towards the outer edge of the locking lever 804. This action causes a depression of the locking lever 804 and serves to increase the tension on the spring 806. When manual pressure is thereafter removed from the handle 520, then the normal tendency of the roller is to return to the notch 803 particularly since the locking bar 804 is caused to rise by reason of the spring 806.

Consequently, the tendency of the shaft 550 is to be rotated again to the neutral position shown in Figure 5 wherein the roller 801 may register with the notch and the manual lever 520 is then returned to neutral position. When the manual operating lever is rotated in the opposite direction for tripping purposes as shown in Figure 13, then the roller 801 again rides up out of the notch in the opposite direction but again tending to depress the locking arm 804 and therefore extend the spring 806 so that when manual pressure is again removed from the manual lever 520 its normal tendency is to return to the positions shown in Figures 5 and 2.

The notch is used to definitely fix the neutral position of the handle and to prevent the return of the handle beyond mid position as might occur if, after manual closing, the handle were released at the final closed position and allowed to move back under the influence of gravity and the spring. Excessive over travel would cause undesired tripping of the breaker.

Visual indicator

Owing to the fact that the manual lever 520 thus automatically returns to neutral position so that after the contacts have been closed they may be manually tripped or after the contacts have been tripped they may be closed, it becomes important that provision be made for some indication, preferably visual, of the contact position. Such visual indication of the contact position is provided by means of an indicator or flag 900 (Figures 3 and 2) mounted on a slider 901 and guided by two studs 902—903 suitably supported from the bracket shelf, the slider 901 being itself supported by suitable washers or other means 904—905.

A bell crank lever 906 is pivotally mounted upon a stud 907 also extending from the under side of the bracket shelf and comprises a bent over portion 908 engaging a slot 909 of the slider 901. Only a portion of the flag 900 is visible through an opening or window 910, the flag carrying "on" and "off" indications. A spring 911 attached by a lug 912 to the bell crank lever 906 and at the opposite end attached to a stud 913 of the under side of the bracket shelf normally biases the bell crank lever 906 to such position that it pushes the slider 901 over to a position where the flag 900 indicates an "off" position through the aperture 910. The bell crank lever is pivotally connected at 914 to a sliding link 915 which is slidably supported by the stud 916 extending from the under side of the bracket shelf and carrying a washer 917 for support, the stud 916 registering with the slot 913 in order to permit a reciprocal sliding movement of the link 915. The link 915 carries a bent over lug 919 extending downwardly therefrom.

When the circuit breaker is closed, so that the pin 410 of the toggle is raised and also pushed towards the back end of the circuit breaker, this knee pin strikes against the bearing surface 920 of the lug 919 and thus in its continuing backward movement pushes the link 915 backward, thus causing the bell crank 906 to rotate about its pivot 907 thus causing it to push the slider over in the direction indicated by the arrow so that the "on" signal of the flag 900 will be visible through the aperture 910.

When the pin 410 is thereafter caused to drop by a contact opening operation, then nothing will thereafter interfere with the tendency of the spring 911 to draw the bell crank lever 906 to its original position thus resetting the flag 900 to show the "off" indication through the aperture.

Hence, although the handle 520 returns to neutral position after a closing operation, the visual indicator above described indicates the condition of the circuit breaker.

General operation and arrangement

Various other elements may, of course, be utilized in connection with and as an integral part of the circuit breaker mechanism. Thus, for instance, as seen in Figure 2, a suitable time delay element 950 may be provided in connection with the over current coil 110 to permit the breaker to carry normal load above its trip setting for short periods of time. The specific details of the time delay elements are not herein discussed since they constitute no part of the present invention.

The various elements of the circuit breaker and the operation of each of the elements have been described in connection with the description of the members thereof. Each of the individual elements of the circuit breaker is in the present invention integrated with each of the other elements to form a unified integral operative whole.

The rotation of the manual operating lever in one direction causes the toggles to rise in the manner described, thus raising the link 34 ro-

tating the arm 35, rotating the contact shaft and closing the contacts.

The arcing contacts meet before the main contacts are in engagement with each other. Rotating the manual operating lever in the opposite direction trips the toggles in a manner hereinbefore described, and causes the contacts to separate, the arcing contacts separating after the main contacts and the arc being established between the arcing contacts only.

The arc immediately thereafter is transferred to the arcing horns, and swept up by the magnetic blow out into the arc quencher 150.

The closing solenoid 530 may be utilized instead of the manual operating lever to close the circuit breaker and automatic tripping may be substituted for tripping by the manual lever by the use of the over current coil 110.

The over current coil 110 responds to currents in excess of predetermined values passing through the circuit breaker and may be adjusted and calibrated for the particular rating of the transformer.

Solenoid trip coils may be utilized in connection with any of the levers of the shaft 500 to rotate the same when the coil is energized by any suitable remote control means and thereby provide a remote control non-automatic tripping operation.

The arrangement of all of the parts of the circuit breaker is such that asembly thereof is extremely simple.

The entire movable contact assembly may readily be disconnected from the remainder of the circuit breaker assembly by removing the bearings 140, Figure 2, from the ends of the contact shaft and removing the pin 210 from its connection between the arm 35 and the link 34 and pigtail.

And the entire toggle mechanism assembly may be readily removed for replacement and repair by means of the removal of screws 33. A solenoid mechanism may readily be added to a hand operated breaker in the field.

Assembly replacement and repair are thus greatly facilitated. Separation of the various parts for any purpose whatever is made easy and simple and the general arrangement of the members on the panel 23 facilitates the mounting of this panel in a switch board with other similar circuit breakers or other switch devices.

The arrangement (including that of the trip coil, closing coil, time delay element and associated switch) is extremely compact and is confined within the narrowest limits so that even when, as in the manner hereinbefore described, certain poles of the circuit breaker are removed in order to turn the three pole circuit into a one pole or two pole circuit breaker, there is nevertheless no substantial waste space and the same panel may be utilized to mount the circuit breaker in place upon the switch board.

As far as actual use is concerned, the operator need merely follow the signals on the front of the circuit breaker as shown in Figure 2, turning the lower portion of the handle 520 to the left to close the circuit breaker, and turning it to the right to trip it open. The circuit breaker may, as is also herein described, be connected to automatic relays which are set in operation by the opening thereof so that the closing of the circuit breaker may be a function of different conditions on the line such as arise in the load resistance or the existence of a predetermined voltage difference which may be caused to close a circuit to the solenoid closing member 530.

In general, therefore, I have devised a circuit breaker wherein the novelty lies not merely in the specific arrangement of the individual parts thereof, and not merely in the many extremely important novel constructions comprised therein, but also in the integration and arrangement of all of these parts so that they all operate as a single unit.

Although each of the elements herein described is by itself believed to be completely novel and although the arrangement of the various parts and the integration thereof as a single unit is believed to be of the essence of the present invention, nevertheless various modifications of either the individual members or of the arrangement of the parts may now be clear to those skilled in the art.

Accordingly, I prefer to be bound, not by the specific descriptions herein, but only by the appended claims.

I claim:

1. A movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact to opening position; a latch having a locking position for normally locking said contact in closing position and also having a tripped position; a toggle mechanism having a collapsed and a set position; link members for operating said movable contact, a direct mechanical connection from said toggle mechanism to said link members, a direct mechanical connection from said latch to said link members bipassing said toggle mechanism whereby either said latch or toggle members independently operates said movable contact to open position; means for tripping said latch to permit said spring means to operate said contact to open position, said toggle mechanism collapsing in response to the operation of said contact to its open position for resetting said latch in its set position; and means for resetting said toggle mechanism, with said latch in its set position, for operating said contact to circuit closing position.

2. A movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact to opening position; a latch having a set position for normally locking said contact in closing position and also having a tripped position; said latch including a milled shaft, a primary latch urged into tangential contact with said milled shaft by said contact mechanism, and a latch lever locked in said primary latch and operative on the angular rotation of said milled shaft for rocking said primary latch over the milled portion of said shaft, the rotation of said primary latch releasing said latch lever to effect movement of said contact to open position; a toggle mechanism comprising a single pair of links having a collapsed and a set position; means for tripping said latch to permit said spring means to operate said contact to open position, said toggle mechanism collapsing in response to the operation of said contact to its open position for engaging and resetting said latch in its set position; and means for resetting said toggle mechanism, with said latch in its set position for operating said contact to circuit closing position.

3. In a circuit breaker, a movable contact having a circuit closing and a circuit opening position; spring means or normally biasing said movable contact to open position; a latch for nor-

mally locking said contact in circuit closing position; means responsive to circuit conditions for tripping said latch to permit said spring means to operate said contact to open position; a toggle mechanism comprising a pair of links, a spring connecting the ends of said links and tending to collapse said toggle, a support under the opposite ends of said links for maintaining said links against collapse, said support being connected to said latch and being operative in response to a direct opening of said contact by said latch for thereafter removing said support from said toggle mechanism to effect a collapse thereof, said toggle mechanism on collapsing resetting said latch in its set position preparatory to the operation of said contact to circuit closing position; and means for operating said contact to circuit closing position through said toggle, said last mentioned means being effective to operate said contact to closing position only while said latch is in its set position.

4. In a circuit breaker, a movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact to circuit opening position; a latch mechanism for normally locking said contact in circuit closing position, said latch mechanism including a lever rotatable about a fixed pivot and mechanically connected to said movable contact; a toggle mechanism having a fixed pivot and mechanically connected to said movable contact; means responsive to circu conditions for releasing said latch for operation about its fixed pivot to permit said movable contact to operate to its open position; and means including said toggle mechanism operable about its fixed pivot for operating said contact to its circuit closing position whereby said circuit breaker is trip-free, said toggle being in its extended uncollapsed condition with said movable contact in circuit opening position.

5. In a circuit breaker, a movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact to circuit opening position; a latch mechanism for normally locking said contact in circuit closing position, said latch mechanism including a lever rotatable about a fixed pivot and mechanically connected to said movable contact; a toggle mechanism having a fixed pivot and mechanically connected to said movable contact; means responsive to circuit conditions for releasing said latch for operation about its fixed pivot to permit said movable contact to operate to its open position; means responsive to the opening of said contacts for collapsing said toggle about its fixed pivot, said toggle in collapsing resetting said latch in its locked position; and means including said toggle mechanism operable about its fixed pivot for operating said contact to its circuit closing position whereby said circuit breaker is trip-free.

6. In a circuit breaker, a movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact to circuit opening position; a latch mechanism for normally locking said contact in circuit closing position, said latch mechanism including a lever rotatable about a fixed pivot and mechanically connected to said movable contact; a toggle mechanism having a fixed pivot and mechanically connected to said movable contact; means responsive to circuit conditions for releasing said latch for operation about its fixed pivot to permit said movable contact to operate to its open position while said toggle mechanism remains in its extended uncollapsed condition; means controlled by said toggle for resetting said latch; means including said toggle mechanism operable about its fixed pivot for operating said contact to its circuit closing position whereby said circuit breaker is trip free.

7. In a circuit breaker, a movable contact having a circuit closing and a circuit opening position; spring means for normally urging said movable contact into circuit opening position; a latch for locking said contact against the action of said spring means; and a toggle mechanism for transmitting circuit closing operations to said movable contact, said toggle remaining in its extended uncollapsed condition when said movable contact moves from its closed to the open position; means whereby said latch controls the collapsing of said toggle mechanism; and means whereby said toggle mechanism controls the resetting of said latch.

8. In combination, a milled shaft; a pivoted primary latch in tangential contact with said milled shaft; a pivoted secondary latch engaging one face of said primary latch; said face having an arcuate curve with said pivot point of said secondary latch as a center when said primary latch is over the milled portion of said shaft; a locking notch in said primary latch for normally supporting said secondary latch lever; said secondary latch lever in said notch applying a rotating torque to said primary latch urging it over the milled portion of said shaft; said secondary latch rotating over said arcuate surface in an oscillating movement about its pivot and engaging a projection on said primary latch for applying a rotating torque in the opposite direction for withdrawing said primary latch from said milled shaft.

9. In combination, a milled shaft; a pivoted primary latch in tangential engagement with said milled shaft; and a secondary latch engaging said primary latch and operative on the rotation of said milled shaft to drive said primary latch into and out of said milled shaft.

10. In combination, a milled shaft; a pivoted primary latch in tangential engagement with said milled shaft; and a secondary latch engaging said primary latch and operative on the rotation of said milled shaft to drive said primary latch into and out of said milled shaft; a movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact into circuit opening position, said secondary latch being mechanically connected to said movable contact for permitting said contact to operate to open position when said primary latch has been driven over said milled shaft.

11. In combination, a milled shaft; a pivoted primary latch in tangential engagement with said milled shaft; and a secondary latch engaging said primary latch and operative on the rotation of said milled shaft to drive said primary latch into and out of said milled shaft; a movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact into circuit opening position, said secondary latch being mechanically connected to said movable contact for permitting said contact to operate to open position when said primary latch has been driven over said milled shaft; and a toggle mechanism collapsed by said secondary latch in its movement over said arcuate surface for reversing the direction of said

secondary latch to return it to its latching position.

12. A movable contact having a circuit closing and a circuit opening position, spring means for normally urging said movable contact to opening position; a latch having a set position for normally locking said contact in closing position and also having a tripped position; said latch including a milled shaft, a primary latch urged into tangential contact with said milled shaft by said contact mechanism, and a latch lever locked in said primary latch and operative on the angular rotation of said milled shaft for rocking said primary latch over the milled portion of said shaft, the rotation of said primary latch releasing said latch lever to effect movement of said contact to open position.

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