March 17, 1936. L. J. LINDE 2,034,146

CIRCUIT BREAKER OPERATING AND CONTROL MEANS

Original Filed Oct. 19, 1933 2 Sheets-Sheet 1

Fig. 1.

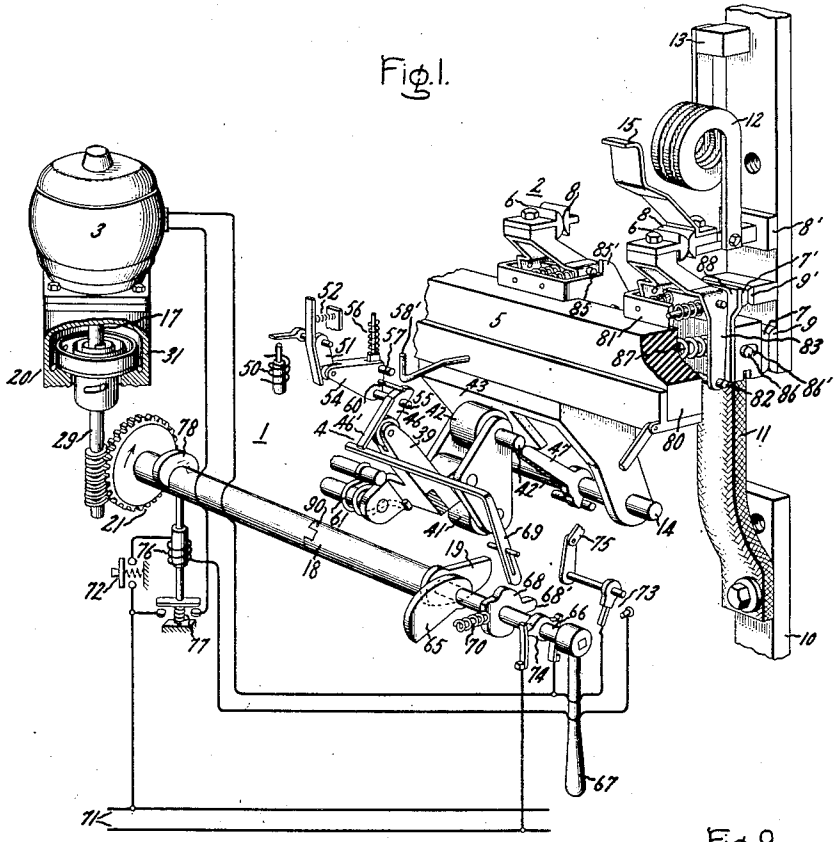


Fig. 2.

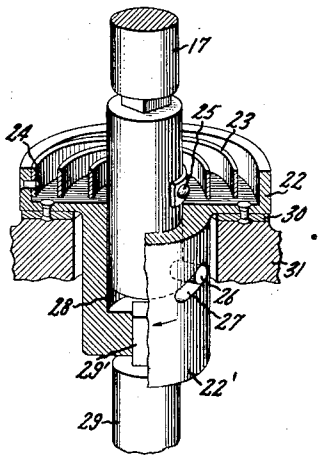


Fig. 3.

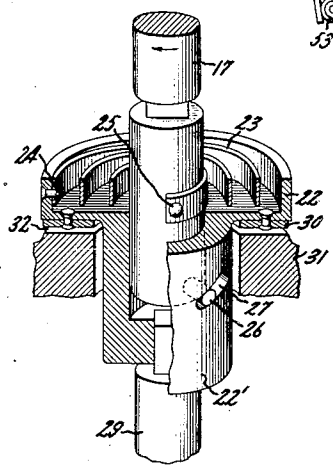
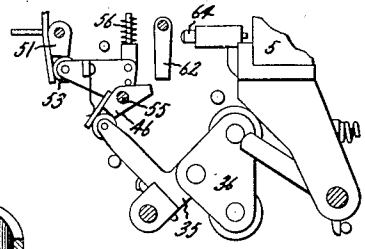


Fig. 9.



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CIRCUIT BREAKER OPERATING AND CONTROL MEANS

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Fig. 7.

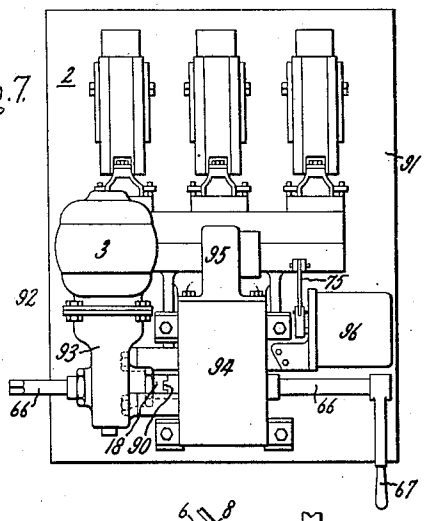


Fig. 8.

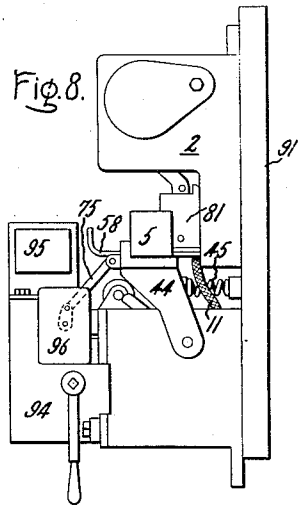


Fig. 4.

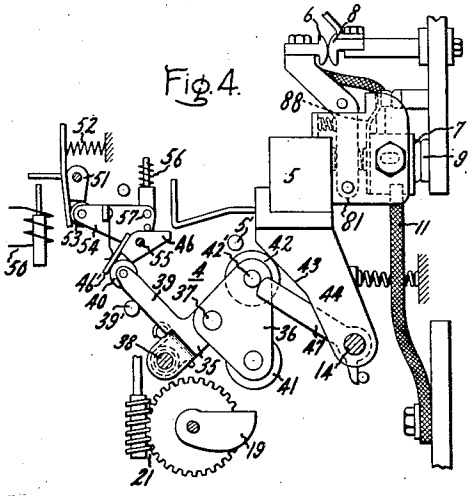


Fig. 5.

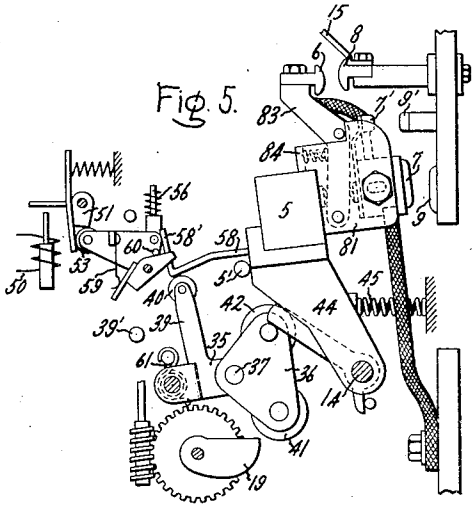
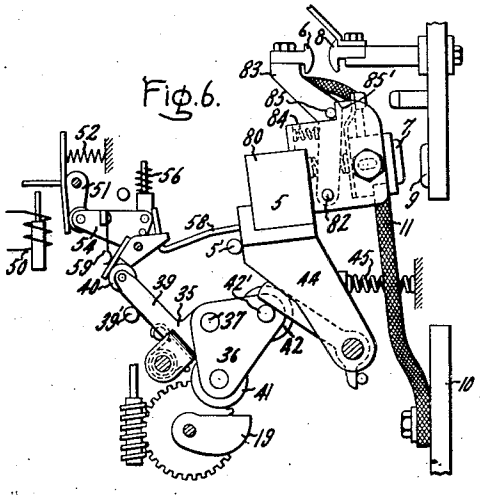


Fig. 6.



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UNITED STATES PATENT OFFICE

2,034,146

CIRCUIT BREAKER OPERATING AND CONTROL MEANS

Leonard J. Linde, Folcroft, Pa., assignor to General Electric Company, a corporation of New York

Original application October 19, 1933, Serial No. 694,282. Divided and this application September 22, 1934, Serial No. 745,078

6 Claims. (Cl. 175—375)

My invention relates to circuit breaker operating and control means, more particularly to motor actuated electric circuit breakers, and has for its principal object the provision of improved operating and control means for circuit breakers of the aforesaid type which shall be efficient and reliable in operation, simple and compact in design while permitting ready assembly or disassembly of the component parts, and rugged in construction.

This application is a division of my copending application, Serial No. 694,282, filed October 19, 1933, for Operating mechanism.

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

Referring to the drawings, Fig. 1 is a perspective view, partly in section, illustrating in detail an electric air circuit breaker and its associated operating mechanism embodying the present invention; Fig. 2 is a view, partly in section, of brake structure illustrated in Fig. 1 in the braking position thereof; Fig. 3 is a similar view of the brake structure in non-braking position; Fig. 4 is an elevational view of apparatus illustrated in Fig. 1 in the closed circuit position; Fig. 5 is a similar view illustrating the apparatus in open circuit position before the resetting operation is completed; Fig. 6 is a similar view of the apparatus illustrating the same in the completely reset position; Fig. 7 is an elevational front view of the assembled circuit breaker and operating mechanism unit, Fig. 8 is an elevational side view of the unit shown in Fig. 7, and Fig. 9 is a detailed view of a modified form of the resetting means.

Referring more particularly to Fig. 1, there is illustrated operating mechanism 1 for effecting predetermined travel of the movable element of an electric circuit breaker 2. The operating mechanism 1 generally comprises suitable motive means as an electric motor 3 and collapsible thrust transmitting means 4 which is operatively connected to the motor in a manner hereinafter described. The thrust transmitting structure 4 is likewise operatively connected to the movable element 5 of the circuit breaker.

The circuit breaker as shown is of the polyphase type, the circuit controlling contacts of each phase including (Figs. 1 and 5) movable arcing and main contacts 6 and 7, respectively, which are carried by the movable element 5, and coacting stationary contacts 8 and 9. The detailed construction of the circuit breaker which forms no part of the present invention will be described later.

The power circuit through the circuit breaker 2 includes in general a terminal member 10, a flexible braided conductor 11 composed of suitable conducting material as copper interconnecting terminal 10 and the movable contacts, the pairs of movable and stationary contacts 6—8 and 7—9, a magnetic blowout coil 12 and terminal 13. There are likewise included a pair of transfer or "burning" contacts 7' and 9' arranged in shunt with the main and arcing contacts.

Upon opening of the circuit breaker due to pivotal counterclockwise movement of the movable element 5 about a fixed shaft 14, separation of the main contacts 7 and 9 occurs prior to separation of the transfer and arcing contacts for confining arcing and burning upon opening of the circuit to the latter contacts. The arc extinguishing means may comprise any suitable arrangement, as an arcing horn 15 connected to the stationary arcing contact 8 and a magnetic blowout coil 12 which is connected in series in the power circuit between the stationary arcing contact 8 and terminal 13.

The operative connection between the motor 3 and the thrust transmitting structure 4 comprises a rotatable shaft 17 directly connected to the motor 3, and a rotatable shaft 18 on which is mounted an actuating cam 19 coacting with the thrust transmitting structure 4. The motor shaft 17 and the cam shaft 18 are interconnected by automatic brake structure 20 and suitable speed reducing gearing 21. Energization of the motor 3 effects rotation of the actuating cam 19 and a circuit closing operation on the circuit breaker 2 through the thrust transmitting structure 4 in a manner hereinafter described.

In mechanism of this character it is highly desirable that overrunning or over-travel of the actuating cam be prevented except within comparatively narrow limits so that the operating mechanism may be readily tripped, reset and reclosed, if necessary, without interference by the actuating cam. Heretofore upon deenergization of the motor the inertia of the moving parts made it very difficult to control the final position of the actuating cam. The problem of mechanical braking is complicated by the fact that energization of the motor must be continued to a certain point to insure positive closing of the circuit breaker and the braking operation must commence immediately upon deenergization in order

that the actuating cam shall be stopped shortly beyond the point where the circuit closing operation is completed.

For the purpose of braking the actuating cam immediately upon deenergization of the motor after the completion of the circuit closing operation, the brake structure 20 is designed so that a brake member is moved to a non-braking position in response to predetermined motor torque and is moved to a braking position in response to decrease of transmitted motor torque below said value. To this end the motor shaft 17 is connected to a brake member 22 by a resilient connection comprising a torsion spring 23 which is connected at one end as at 24 to the brake member 22 and at its other end as at 25 to the motor shaft 17. The shaft 17 likewise is provided with a limited lost motion connection with a hub-like extension 22' of the brake member comprising a pin and slot connection 26—27.

The brake member which comprises a disk or the like having an annular flange as illustrated for receiving the torsion spring 23 is provided with a centrally disposed recess 28 within which the lower end of the motor shaft 17 is freely positioned. Accordingly, it will be noted that the brake member 22 may both rotate and move axially with respect to the motor shaft 17 within certain prescribed limits.

The pin and slot connection 26—27 interconnecting the shaft 17 and brake member 22 is arranged so that the pin 26, which is secured to the driving shaft 17, rides in a diagonal slot 27 in the hub member 22' so as to cam the brake member 22 in a direction axially of the shaft 17 depending on the direction of rotation of said shaft. For the purpose of maintaining the brake member 22 in positive driving relation at all times to the driven shaft 29 which is directly connected to the actuating cam 19 through the reducing gearing 21, the shaft 29 is provided with a squared extension 29' slidably mounted within a corresponding aperture in the lower end of the hub member 22'. Accordingly, the brake member 22 is always positively connected to the actuating cam notwithstanding axial movement of the brake member.

The actual braking surface of the brake member 22 may comprise any suitable brake lining material secured as at 30 to the lower side of the brake disk. A fixed brake member 31 comprising part of the brake housing surrounds the hub member 22' and is provided with a brake surface 32 adapted to coact with the brake lining 30.

The operation of the above-described brake structure is as follows. When the motor 3 is deenergized or at rest as illustrated in Fig. 2 the spring 23, which is normally under torsion, tends to rotate the brake member 22 with respect to the motor shaft 17 in the direction indicated so that the brake member 22 is cammed downwardly, through the pin and slot connection 26—27, to engage the coacting fixed brake member 31. The spring 23 is designed so that it moves the brake member 22 to braking position when the torque transmitted by motor 3 decreases below a certain value. Due to the fact that brake member 22 is positively connected to the shaft 29, it will be apparent that movement of the brake member 22 to its braking position effects direct braking of actuating cam 19.

Immediately upon energization of the motor tending to rotate shaft 17 in the direction indicated, referring more particularly to Fig. 3, the torsion of spring 23 is opposed by the motor torque. When the motor torque overcomes the torsion of spring 23, the spring yields permitting rotation of shaft 17 with respect to brake member 22. After limited movement of the shaft 17 with respect to the brake member 22 the pin 26 engages the opposite end of the slot so as to constitute a direct and positive driving connection beween shaft 17, brake member 22 and shaft 29, movement of the pin to this position in the meantime causing camming of the brake member 22 upwardly to a non-braking position as clearly illustrated in Fig. 3.

While the motor transmits normal torque through shaft 17 the spring 23 is maintained flexed and under tension and the brake member is maintained in non-braking position. When, however, the motor is deenergized and the transmitted torque decreases to a certain value the opposing torque of the charged spring 23 causes camming of the brake member 22 downwardly to the braking position illustrated in Fig. 2. Accordingly, there is provided a direct positive drive between the motor and actuating cam when the motor is transmitting the required torque, and likewise an automatic and quick acting brake effective in response to decrease of the motor torque upon completion of the circuit closing operation directly to brake the actuating cam.

The thrust transmitting structure 4 operatively interconnecting the actuating cam 19 and the movable circuit breaker element 5 is of the so-called trip-free type and is adapted to be reset and latched independently of the cam 19. Referring more particularly to Figs. 4, 5, and 6, the thrust transmitting structure comprises toggle members 35 and 36 which are pivotally interconnected at 37. The toggle member 35 is provided with a fixed pivot 38 and an extension 39 having at its outer end a roller 40 coacting with latching and tripping means hereinafter described. The toggle member 36 comprises a triangularly shaped link pivotally supported at an intermediate point, as indicated at 37, by the member 35 and having rollers 41 and 42 mounted at opposite sides of said pivotal support. The roller 41 is arranged to be in the path of the actuating cam 19 when the circuit breaker is to be closed and the roller 42 is arranged to engage an inclined actuating face 43 of a pivoted supporting member 44 of the movable circuit breaker element 5. The member 44 which is pivotally mounted on shaft 14 is resiliently biased as by a compression spring 45 towards open circuit position.

The mechanism as illustrated by Fig. 4 is in the closed circuit position wherein the toggle 35—36 is overset so as to hold the element 5 in closed circuit position, the toggle being latched in this position by a pivoted latch member 46 engaging the roller 40. The latch 46 is provided with an extension 46' so as properly to position the latch with respect to the roller 40.

The toggle when latched as shown by Fig. 4 is maintained in an overset thrust-transmitting position by the fact that the reacting force of the circuit breaker is along the line of centers of pins 37 and 42' and that this line is slightly offset with respect to the fixed pivot 38. Accordingly, there is a clockwise movement acting on link 35 which in turn is restrained by latch 46 thereby rigidly positioning pivot 37. The inclined face 43 engaged by roller 42 is normal to the line of centers 37—42' so that link 36 is in dead-center position with respect to the toggle thrust.

For the purpose of preventing accidental movement of pivot 37 past the line of centers 38—42 due to vibration, thereby causing collapse of the toggle and opening of the circuit breaker, a prop 47 pivotally mounted on shaft 14 is arranged to drop behind and brace the pivot pin 42'.

The latch controlling and resetting means comprises an arrangement whereby a comparatively small tripping force is effected to release a charged spring or the like for causing positive and quick release of the main latch 46. In other words, the available tripping force, which may be comparatively small as in the case of alternating current trip coils, effects release of an intermediate energy-storing device as a spring charged trigger which in turn releases the main toggle controlling latch.

To this end the trip coil 50 coacts with a pivoted catch or latch 51 which is spring biased as at 52 so as normally to be engaged by a roller 53 carried by the trigger member 54. The trigger member 54, which is co-pivotally mounted at 55 with the latch 46, is resiliently biased as indicated at 56 in clockwise direction. The application of the spring tension at 56 is shown as slightly off-center with respect to the pivot 55 so that the spring force is available immediately to rotate the trigger member 54 clockwise upon releasing movement of catch 51. A pin 60 carried by the trigger 54 is arranged so that upon clockwise movement of the trigger the pin sharply strikes an extension of the latch 46 so as to rotate the same clockwise to the toggle releasing position.

It will, therefore, be apparent that a much greater relcasing force than that delivered by the trip coil 50 is available for releasing the latch 46 since the force required to maintain the spring 56 charged near its dead-center position with respect to pivot 55 is obviously comparatively small.

The resetting means for the latch and trigger arrangement above described is best illustrated by Figs. 5 and 6. The arrangement is such that immediately upon collapse of the main toggle 35—36 and circuit opening movement of the element 5, the trigger 54 is reset and the latch 46 positioned so that it is in readiness immediately to latch the main toggle when the roller 40 thereof returns to its initial position. The trigger resetting means may comprise any suitable arrangement as a member 58 carried by the element 5 and provided with an extension 58' arranged to engage the trigger 54 and rotate the same counterclockwise as illustrated in Fig. 5. Return of the trigger 54 to its initial position causes it to be latched by the catch 51 which is resiliently biased so that it snaps over the roller 53 as the same is rotated counter-clockwise. The resetting operation by the circuit breaker element 5 likewise recharges the spring at 56 by compressing the same against a fixed stop (not shown).

The positioning of the latch 46 for relatching the roller 40 of the main toggle is accomplished by means of a resilient connection, as a leaf spring 59, arranged between the trigger 54 and latch 46. As illustrated, the spring 59 is secured at one end to the trigger 54 and is flexed so as to engage at its other end the latch 46 and urge the same in counter-clockwise direction. The stop pin 60 limits the counter-clockwise rotation of latch 46.

In order further to increase the sensitivity of the tripping means, the toggle member 35 in riding under the latch 46 to its latched position may flex the spring 59 sufficiently so that the trigger spring at 56 is on dead center with respect to pivot 55. In this arrangement the tension of spring 59 is sufficient, upon releasing movement of catch 51, to move the trigger 54 clockwise off center so that the trigger is immediately snapped over to actuate the latch 46.

Immediately after collapse of toggle 35—36 and opening movement of the element 5, the toggle member 35 is urged counterclockwise from the position shown in Fig. 5 by a spring 61 until the extension 39 engages a stop 39'. When the toggle member 35 is returned to this position the latch 46 snaps over the roller 40 as illustrated by Fig. 6.

In this position the toggle member 36 may be rotated counter-clockwise about the restrained pivot 37 by the actuating cam 19 so that the roller 42 in riding along the inclined face 43 causes circuit closing movement of the element 5. The cam 19, which rotates clockwise to engage the roller 41, is designed to meet the operating characteristics of the circuit breaker so that the same may always be positively closed without difficulty. The brake mechanism above described is effective to stop rotation of cam 19 within a few degrees of rotation after circuit closing movement of the main toggle as illustrated in Fig. 4. The cam in this position is, therefore, free of the thrust transmitting structure and is likewise in a predetermined position for effecting a circuit closing operation by a single revolution thereof.

A modified form of the resetting device for the trigger 54 is illustrated by Fig. 9. In this arrangment the trigger 54 is returned to its latched position notwithstanding limited variations in the final open circuit position of the element 5. The element 5 which is biased by spring 45 against the stop member 5' may, due to friction of the apparatus and other causes, come to rest short of the stop member. In the arrangement shown in Fig. 9, an intermediate member 62 pivotally supported is adapted to be engaged by a buffer member 64 of the element 5. The member 62 is thereby swung clockwise into engagement with the trigger 54 resetting the same in the manner above described. In the present case, however, the final movement of the element 5 effects comparatively small movement of the trigger 54 due to the lengthening of the lever arm with respect to the pivot of member 62. Accordingly, the trigger 54 may be reset during the main part of the opening travel of the element 5, the trigger being unaffected by slight variations in the final position of said element.

In summarizing the operation of the mechanism, it may be briefly stated that the thrust transmitting toggle 35—36 is held in a thrust transmitting position, both in the closed circuit position illustrated by Fig. 4 and also during rotation of the toggle member 36 by the actuating cam 19, by the latch 46 which is in turn controlled by the spring charged trigger 54. The trigger is nicely balanced so that a comparatively small trip force is effective to actuate the same. The tripping impulse at the trip coil 50 actuates the catch 51 causing release of trigger 54 and consequent actuation of latch 46 with the result that the toggle 35—36 is no longer restrained in thrust transmitting position and collapses under the action of the circuit breaker opening spring 45 as illustrated by Fig. 5. Immediately upon opening, however, the element 5 through the resetting

means above described resets the spring charged trigger 54 which in turn through spring 59 positions the latch 46 for resetting so that the lower edge thereof is in the path of the toggle roller 40.

After collapse of the toggle 35—36 and opening of the circuit breaker, the toggle spring 61 throws the toggle from the position shown in Fig. 5 to that shown in Fig. 6 wherein the roller 40 engages the restraining face of latch 46. The mechanism is now in readiness for a closing operation which is accomplished by a single clockwise revolution of the actuating cam 19, returning the mechanism to the position illustrated in Fig. 4.

It will be noted that the mechanism is trip-free at all stages of its operation. That is, the occurrence of a tripping impulse during the camming operation causes actuation of the latch 46 in the usual manner and collapse of the toggle 35—36, the element 5 thereupon returning to open circuit position notwithstanding continued rotation of the cam 19. When the cam comes to rest the toggle spring 61 causes relatching of the toggle in the manner above described.

Where manual operation of the circuit breaker, either alone or in combination with the motor, is desired, an actuating cam 65 (Fig. 1) similar in design to cam 19 is mounted on a shaft 66 so as likewise to coact with the toggle roller 41. In the present instance the shaft 66, which is provided with an operating handle 67 at the outer end thereof, extends longitudinally through the hollow motor operated cam shaft 18 so that the handle 67 may be applied to the opposite end of the shaft where necessary. The operation of shafts 18 and 66 are entirely independent of each other.

The shaft 66 is provided with a tripping and positioning member 68 arranged to engage, as by extension 68', a guided member 69 coacting with the extension 46' of the main toggle latch. When tripping of the breaker by the manual means is desired the handle 67 is rotated counterclockwise (as viewed in Fig. 1) a short distance so that the member 69 is raised and the latch 46 actuated to release the toggle 35—36. A positioning spring 70 coacting with notches in the member 68 serves to maintain the shaft 66 in definite positions.

In Fig. 1 there is likewise illustrated a control system for insuring proper operation of the motor. The motor as shown is energized from a suitable source of power, indicated at 71, the motor control circuit including a push button control switch 72, circuit breaker limit switch 73, and manual control switch 74. When the manual operating means is in inoperative position and the element 5 of the circuit breaker is in open circuit position the manual switch 74 and the limit switch 73 are both closed. An interconnecting linkage 75 serves to operate the limit switch 73 in accordance with opening and closing movements of element 5.

The control circuit which includes a solenoid 76 may be completed by closing of the push button switch 72. Energization of solenoid 76 is in turn effective to close contacts 77 thereby completing the motor circuit through the manual switch 74. Shortly after closing of contacts 77 and energization of the motor, the push button 72 may be released since the plunger of solenoid 76 is mechanically sealed in contacting position by a cam element 78 mounted on shaft 18. The cam 78 seals in the contacts 77 only during normal travel of cam 19, the motor meanwhile being energized from the source 71 directly through contacts 77 and switch 74. Upon completion of the circuit closing operation the cam 78 permits the contacts 77 to be biased open thereby deenergizing the motor and stopping the actuating cam 19.

When the switch element 5 is closed the limit switch 73 is open preventing energization of solenoid 76 from source 77 through push button 72. In the case of trip-free operation the actuating cam 19 is rotated to its normal final position due to the sealing-in cam 78. When the manually operated cam 65 is rotated to operative position, the switch 74 is opened with the result that energization of the motor 3 from the source 71 is impossible.

The present invention is not limited to the specific type of circuit breaker shown, it being understood that the movable element 5 is equivalent to the movable element generally of a circuit breaker of either the air or oil type. The more detailed construction of the air circuit breaker illustrated is as follows:

As previously described the movable contacts of the circuit breaker are carried by the element 5 which includes the pivoted arm 44 on which is mounted an insulating cross-bar 80. Secured to the cross-bar are a plurality of contact supporting members 81, each member being channel-shaped as illustrated and forming a bearing at 82 for the pivot pin of an arcing contact support 83. Each contact support 83 is resiliently biased, as by springs 84, clockwise so as normally to urge the corresponding arcing contact point into engagement with its coacting contact. This movement is limited by a pin 85 adapted to engage a leg 85' forming a part of the member 81. The main current-carrying contacts 7 are mounted within the supports 81 for limited reciprocal movement, as by pin and slot connection 86—86'. The contacts 7 are biased by a spring 87 so as to provide resilient engagement of the contacts 7 and 9.

The transfer contacts 7' are connected to the corresponding contacts 7 by a flux conducting strip 88. Upon opening of the circuit, current through the main contacts 7 and 9 is first transferred to the contacts 7' and 9' in order to avoid burning at the main contacts. Heavy currents cannot be shunted directly to the arcing coils without some burning at the main contacts by reason of the inductance of the blowout coil.

The above described circuit breaker and operating mechanism are compactly assembled and designed so that each main component part may be assembled or disassembled as a unit with respect to the associated parts. In the present instance the motor 3 and brake structure 22 is assembled as a unit with respect to the shaft 29 by simply positioning the motor and brake unit above the shaft and sliding the hub 22' on the squared extension 29' of the shaft. The reducing gearing 21 and a portion of the shaft 18 are likewise removable as a unit by reason of a detachable interlocked connection dividing the shaft 18 into separate sections as indicated at 90. Upon disassembly, the reducing gearing and associated portion of shaft 18 are slidable longitudinally off the manually operated shaft 66 after removal of the motor and brake unit.

In view of the fact that the thrust transmitting structure 4 has no permanent connection with the movable element 5, it will be apparent that this portion of the structure including the actuating cam and the corresponding section of the cam shaft may be constructed and assembled as a unit with respect to the remainder of

the mechanism. The same likewise applies to the latch and trigger mechanism. A mechanism so designed is not only quickly and efficiently assembled but may be produced at comparatively low cost. That is, the component units may be individually constructed so that considerable time is saved as compared with the usual method of having a number of workmen assemble the entire apparatus in a single frame.

The complete circuit breaker and mechanism unit are illustrated by Figs. 7 and 8 wherein a panel **91** has mounted thereon the phase units of the circuit breaker **2** and the operating mechanism therefor including the motor and brake unit indicated at **92**, the reduction gearing unit indicated at **93** and the thrust transmitting and tripping and latching units indicated at **94** and **95**, respectively. An auxiliary switch unit including the limit switch is indicated at **96**. Starting with the motor and brake unit, the mechanism may be readily disassembled by units by merely loosening and removing the clamping bolts provided for securing together the casings of said units where indicated.

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

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

1. Operating and control means for an electric circuit breaker comprising a motor, a rotatable shaft operatively connected to said motor having means for actuating said circuit breaker, a relay for controlling said motor, means initially actuating said relay, and means related to said shaft for mechanically sealing said relay in motor energizing position during circuit closing operation.

2. Operating and control means for an electric circuit breaker comprising a motor, a rotatable shaft operatively connected to said motor having means for actuating said circuit breaker, a motor starting relay, a limit switch operatively related to said circuit breaker and connected in series with the energizing winding of said relay, means initially actuating said relay when said circuit breaker is in open position whereby said motor is energized, and means for mechanically sealing said relay in energizing position during the circuit closing operation.

3. Operating and control means for an electric motor operated circuit breaker comprising a motor, a rotatable shaft operatively connected to said motor coacting with structure for directly actuating said circuit breaker, a relay controlling energization of said motor, means for manually actuating said circuit breaker independently of said motor, and a control switch operatively connected to said manual means for deenergizing said motor when said manual means is in other than inoperative position.

4. Operating mechanism for an electric circuit breaker unit comprising a motor, a rotatable operating shaft driven by said motor, a circuit breaker actuating cam mounted on said shaft, a manually operated shaft mounted in part within and concentrically of said motor operated shaft, said manually operated shaft extending beyond the opposite ends of said motor operating shaft so as to be operable at each end and a second cam mounted on said manually operated shaft adjacent said motor operated cam for actuating the circuit breaker in a similar manner.

5. Operating mechanism for an electric circuit breaker comprising a motor, a rotatable shaft having a circuit breaker actuating cam mounted thereon, said shaft operatively connected to said motor, a manually operated shaft having a circuit breaker actuating cam, motor circuit controlling contacts carried by said manually operated shaft, a limit switch operatively connected to the movable element of the circuit breaker, a motor starting relay having an energizing coil connected in series with said limit switch and means carried by said motor operated shaft for sealing closed the contacts of said starting relay during the circuit closing operation of said cam.

6. Operating means for an electric circuit breaker comprising a motor, a rotatable shaft having a circuit breaker actuating cam mounted thereon, said shaft operatively connected to said motor, a motor starting relay having motor circuit controlling contacts, means initially actuating said relay for closing said contacts, and means related to said shaft for mechanically sealing closed said contacts during the circuit closing operation of said cam.

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