Oct. 21, 1969 H. R. SHAFFER ET AL 3,474,363

MOTOR OPERATOR FOR CIRCUIT BREAKER

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FIG. 1.

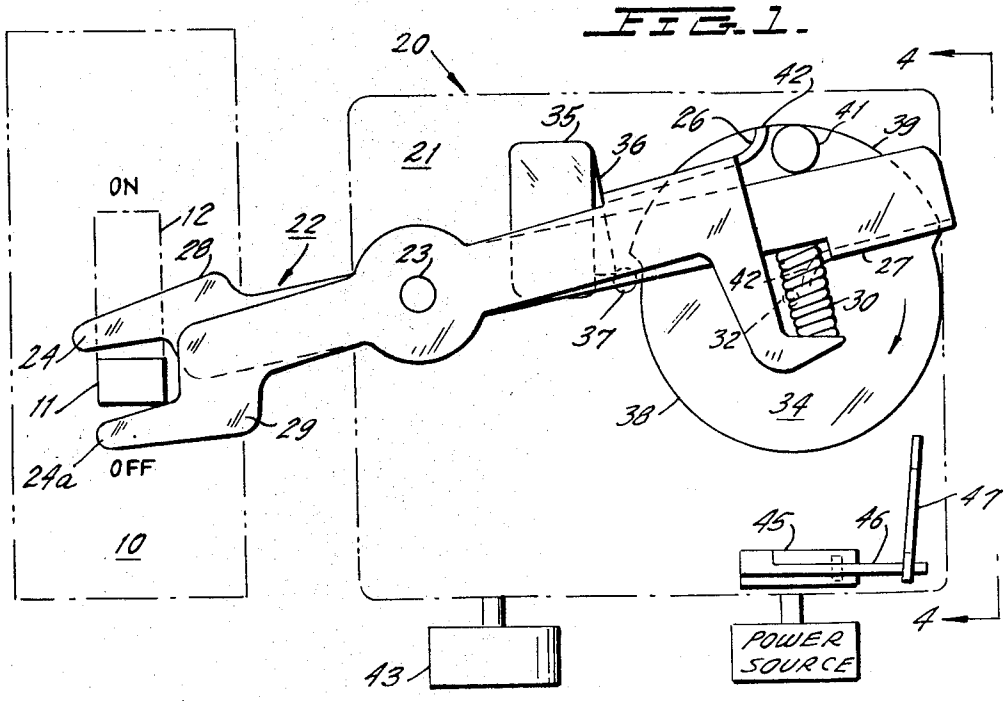
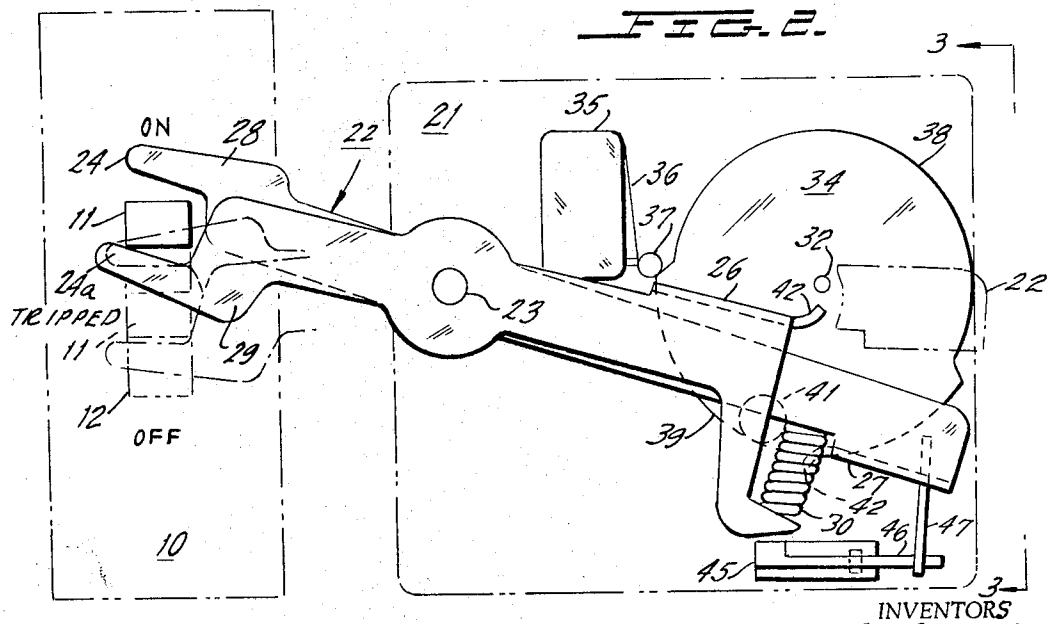


FIG. 2.



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FIG. 3.

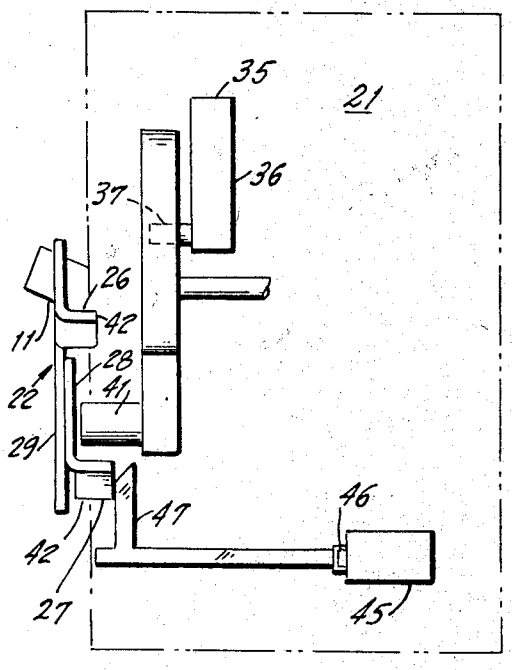


FIG. 4.

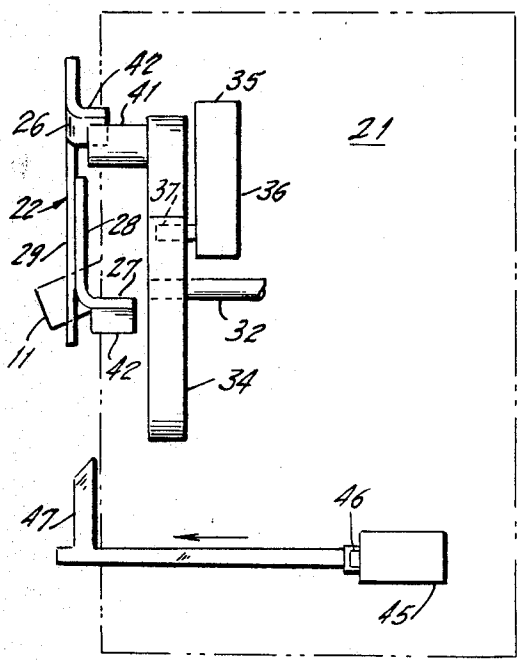
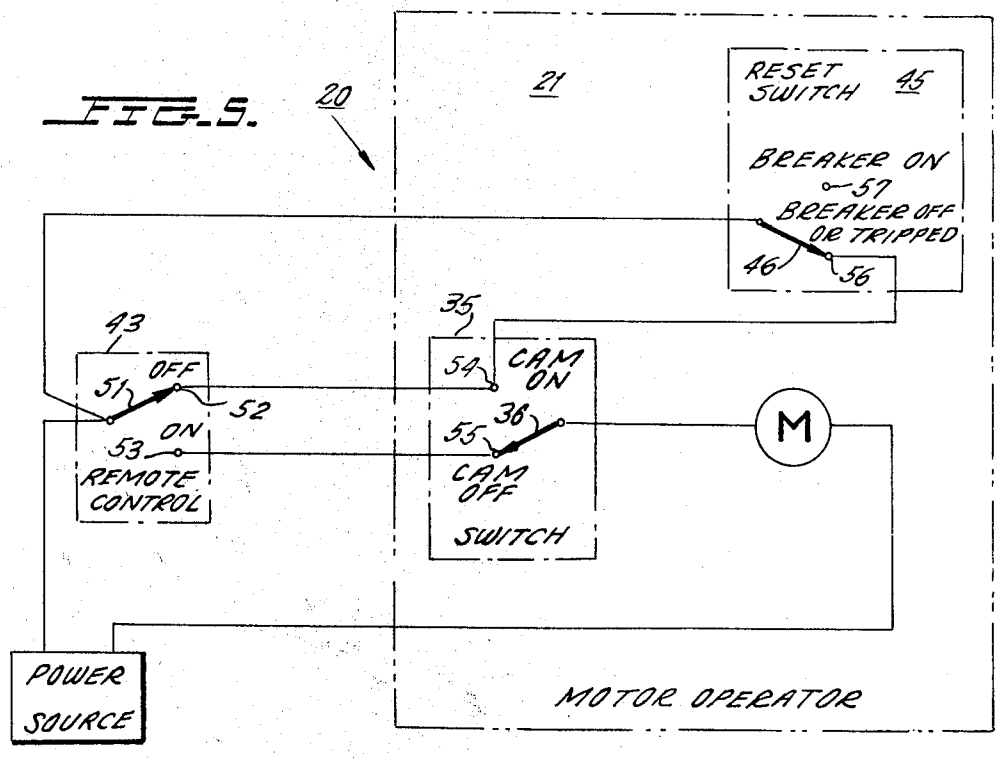


FIG. 5.



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FIG. 6

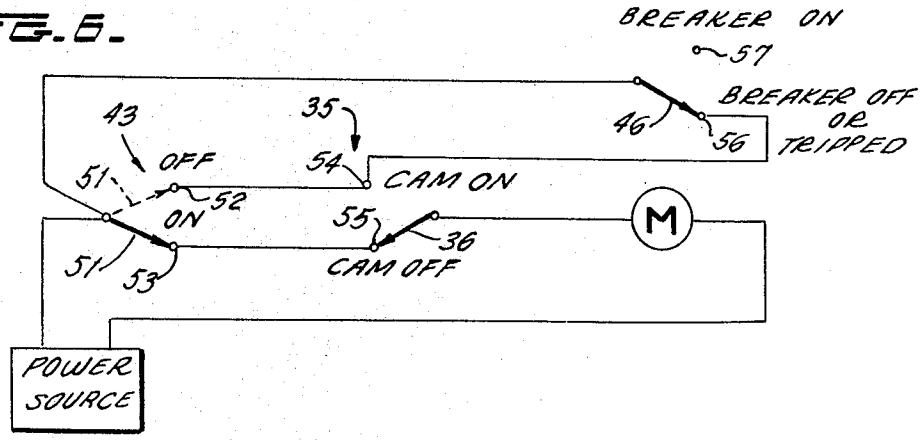


FIG. 7

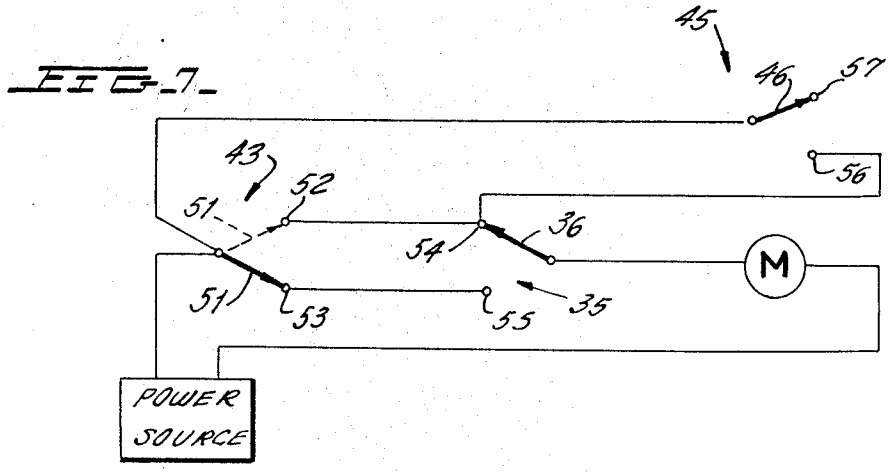
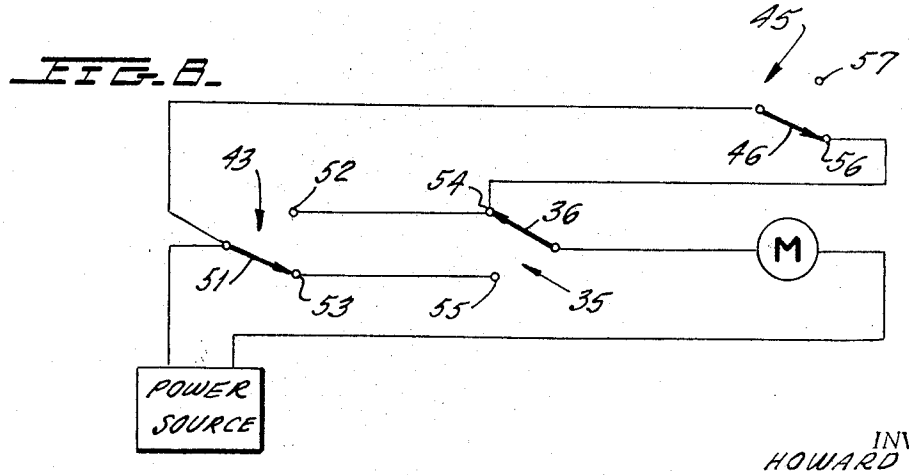


FIG. 8



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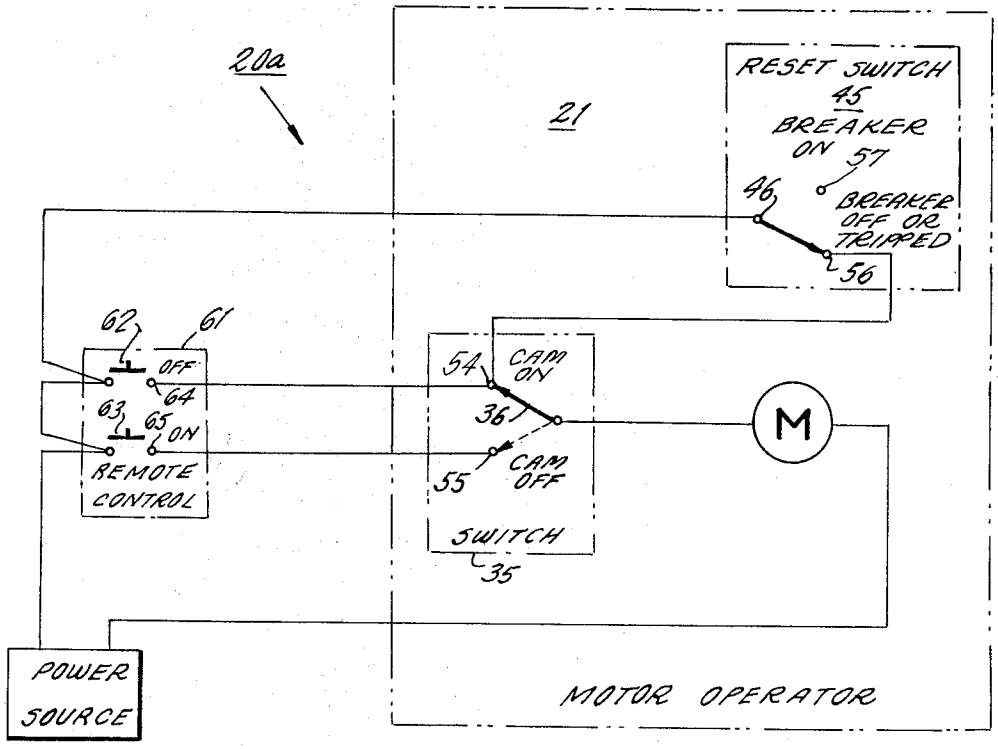
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FIG. 9.



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United States Patent Office

3,474,363

Patented Oct. 21, 1969

3,474,363

MOTOR OPERATOR FOR CIRCUIT BREAKER

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Filed Aug. 21, 1967, Ser. No. 662,160

Int. Cl. H01h 3/42

U.S. Cl. 335—73

8 Claims

ABSTRACT OF THE DISCLOSURE

A uni-directional motor having a rotatable shaft; a cam attached to and radially spaced from the shaft; an arm pivotally mounted on a support and having cam followers thereto attached; as the cam rotates it engages either one or the other of the cam followers; in engaging the first of the cam followers, it moves the pivotally mounted arm clockwise and in engaging the other of the cam followers, it moves the pivotally mounted arm counterclockwise; a circuit breaker handle being connected with the pivotally mounted arm and being movable by the arm between its "on" and "off" and between the "trip" and "off" positions as the arm pivots; a cam operated switch mechanism for actuating the motor for rotation; a remote control switch device for actuating the motor; and an automatic reset switch for permitting the motor to operate to cause reclosing of the circuit breaker from the "trip" position.

This invention relates to a motor operated circuit breaker mechanism and, more particularly, to a means for connecting a uni-directional motor to a circuit breaker for remote operation of the circuit breaker, wherein the operating handle of the circuit breaker can be freely manually operated without interference from the motor or the means connecting the motor to the circuit breaker.

A circuit breaker is usually operable by a handle which is manually movable between two extreme positions, a circuit breaker "on" and "off" position. The breaker has an automatic tripping mechanism and when the circuit breaker is automatically tripped, the operating handle automatically moves to an intermediate "trip" position. To reclose the breaker, its handle must be moved first to the "off" position to reset the circuit breaker operating mechanism and then to the "on" position completing circuit breaker reclosing. For an example of a circuit breaker of this type, see U.S. Patent No. 2,996,589, issued on Aug. 15, 1961, to Felix Myers, entitled "Pivoted Bimetal" and assigned to the assignee of the instant invention.

In order to operate a circuit breaker from a remote position, it is common practice to mount adjacent a circuit breaker a motor having an operating mechanism which is connected to the circuit breaker operating handle. Both uni-directional and reversible direction motors have been employed for this purpose. Uni-directional motors are preferred because of their simplicity. However, in the prior art, uni-directional motors have required elaborate clutch mechanisms to permit manual operation of the circuit breaker without interference with the movement of the handle by the operating mechanism. A person manually operating a prior art circuit breaker must exert a force to overcome both the biasing force exerted by the circuit breaker mechanism itself and the resistance of the clutch mechanism to movement. In addition, the motor used in conjunction with the remotely operable circuit breaker must be stronger, and thus more expensive, to overcome the drag exerted by the clutch mechanism. Prior art devices have also required elaborate brake mechanisms to prevent over-travel of the mechanism moving the circuit breaker handle, thereby to prevent unnecessary stresses from being applied repeatedly to the handle which causes premature breakdown of the circuit breaker.

A reversible direction motor arrangement is costly and still requires clutch and brake mechanisms.

Examples of prior art arrangements are found in U.S. Patent Nos. 2,864,912, 2,864,911, 2,870,288, 2,912,046, 2,354,135, and 2,228,466.

The present invention overcomes the drawbacks of the prior art by providing a motor operable from a remote point, which motor is uni-directional and is connected to the circuit breaker operating handle by a mechanism which precludes the necessity for providing either a clutch mechanism for permitting manual operation of the handle itself, or a braking mechanism to prevent over-travel. Additional advantages obtained from the mechanism of the present invention are that the unit is free to be operated manually at all times and that the position of the circuit breaker handle does not interfere with proper motor operation. An over-travel device is provided to protect the circuit breaker operating handle from unnecessary stresses due to over-travel of the breaker handle operating mechanism. The over-travel protection precludes the mounting dimensions from being critical, which saves considerable time in positioning of the mechanism of the instant invention with respect to a circuit breaker.

The present invention employs a pivotally mounted arm having one end in engagement with the manually operable handle of the circuit breaker.

On the other side of the pivot of the arm is positioned two cam followers, which are engaged one at a time, by a cam to be described. The cam moves the first cam follower to pivot the arm clockwise and moves the other cam follower to pivot the arm counterclockwise. Movement of the arm in one direction moves the breaker handle to the "on" position and movement of the arm in the other direction moves the breaker handle to the "off" position.

To prevent any harm from befalling the circuit breaker operating handle due to over-travel of the cam followers and, hence, of the portion of the arm in engagement with the operating handle, the pivotally mounted arm is comprised of two elements, pivoted at the pivot of the arm, and each of which holds one of the cam followers. Each element terminates in a prong. The prong of one element is positioned on one side of the handle and the prong of the other element is positioned on the other side of the handle, whereby as the handle is moved in a direction only one of the prongs is exerting a force on it.

The two elements of the arm are joined by a spring or other biasing means which can be compressed but is biased to a stretched condition. The cam followers and prongs are arranged so that when the cam follower on one of the elements is being engaged by the cam to pivot the arm, the prong on the other element engages the breaker handle. If the cam causes one cam follower to overtravel in one direction, the handle stops at the end point of its movement, halting the prong on the one element, which prong was causing the handle to move, and thus halting that element. The over-traveling cam follow and arm element, in continuing to travel, compresses the spring. Hence, the spring or biasing means absorbs the force of over-travel and the handle is not unduly stressed.

A uni-directional motor is provided having a drive shaft to which is mounted a cam disc. A substantial segment of the cam disc, approximating a semi-circle, is part of a circular disc having a first diameter and the remaining segment of the cam disc is formed from a circle having a second diameter, greater than the first diameter. The disc has thereto secured a cam for engaging each of the cam followers. As the disc is rotated, the cam en-

gages one or the other of the cam followers to pivot the arm either clockwise or counterclockwise.

The cam is positioned on the cam disc such that when the motor is not operating the cam is spaced away from both of the cam followers, whereby the circuit breaker operating handle may be operated manually without the cam, the motor or the remotely controllable mechanism interfering with the operation of the handle.

Positioned adjacent the cam disc is a switch, which is moved between two positions by the edge of the two radii cam disc. The switch is connectable in series with the motor for causing the same to rotate to cause movement of the operating handle.

A remote control device electrically connectable in series with the cam switch and with the motor is provided. The remote control switch may be moved between an "on" and an "off" position, at both of which positions the motor is caused to operate to move the operating handle of the circuit breaker, respectively to the circuit breaker "on" or "off" positions.

In one embodiment, the remote control switch is a maintained contact switch, such as a toggle type switch, with the movable switch arm remaining in constant contact with one or the other of the switch "on" or "off" contacts.

Another embodiment of remote control switch is comprised of a momentary contact switch having two movable bridging contacts one of which, when moved to a closed position, completes the "on" circuit in the remote control switch; and the other of which, when moved to a closed position, completes the "off" circuit in the remote control switch. Both bridging contacts are normally open.

An automatic reset switch may be provided for automatically returning the operating handle to the "reset" position after the circuit breaker has been tripped and the operating handle has been moved to the "trip" position by a fault current passing through the circuit being protected. The automatic reset switch is connectable in series with the motor for causing the same to be activated. The reset switch is positioned and adapted to be moved by the pivotable arm, whereby when the pivotable arm is moved to the "trip" position by movement of the operating handle, the reset switch is operated to cause automatic reset.

With a maintained contact control switch, in the event the circuit breaker is tripped, and an automatic reset switch has been provided, and the remote control switch remains at the "on" position, the cam is rotated first to move the arm and hence the operating handle to the "off" position which resets the circuit breaker mechanism and then to move the arm, and hence, the operating handle, to the "on" position, which recloses the circuit breaker contacts. If the remote control switch is in the "off" position, the cam is rotated only to move the arm and the operating handle to the "off" position, which resets the circuit breaker mechanism and may be called the "reset" position.

With a momentary contact remote control switch which remains open at the "on" and "off" positions until manually operated, the cam is rotated to move the arm, and hence the operating handle, to the "reset" position, which relatches the circuit breaker mechanism. The remote control switch must be manually operated to complete the "on" circuit for the cam to rotate the arm and the operating handle to the "on" position, which closes the circuit breaker contacts.

Accordingly, it is a primary object of the present invention to provide a remotely controllable motor operated mechanism for operating a circuit breaker.

It is another object of the present invention to provide such a mechanism which employs a uni-directional motor.

It is another object of the present invention to provide such a mechanism which permits manual operation of the operating handle of the circuit breaker without interference by the remotely controllable mechanism.

It is a further object of the present invention to eliminate the necessity for a complicated clutch mechanism for permitting manual operation of the circuit breaker operating handle.

It is another object of the present invention to provide such a mechanism which employs a cam device to operate upon a pivotally mounted arm which, in turn, operates upon the operating handle of the circuit breaker.

These and other objects of the present invention will become apparent after a reading of the following description of the accompanying drawings in which:

FIG. 1 is a plan view of the mechanism of the present invention showing a circuit breaker operating handle in the "off" or "reset" position;

FIG. 2 is a view in the direction of FIG. 1 showing the mechanism of the present invention when the operating handle is in the "on" position, and showing, in phantom lines, the position of the pivotally mounted arm of the mechanism of the instant invention when the circuit breaker handle is in the "tripped" position;

FIG. 3 is a view in the direction 3—3 of FIG. 2 showing the pivotally mounted arm of the mechanism of the instant invention and its interaction with the circuit breaker handle, the reset switch and the cam on the cam disc;

FIG. 4 is a view in the direction 4—4 of FIG. 1;

FIG. 5 schematically illustrates the electric circuitry of the remotely operable mechanism of the instant invention when the mechanism is at rest in the "off" position of FIG. 1 and when the remote control switch has maintained contacts;

FIG. 6 schematically illustrates the circuitry of the remotely operable mechanism of FIG. 5 at, and shortly after, it is in the position of FIG. 1 and while it is moving toward the "on" position of FIG. 2;

FIG. 7 schematically illustrates the circuitry of the mechanism of FIG. 5 when the mechanism is at rest in the "on" condition of FIG. 2 and, in phantom, illustrates the circuitry shortly after it has been moved to cause the return of the mechanism to the "off" position;

FIG. 8 schematically illustrates the circuitry of the mechanism of FIG. 5 immediately after the circuit breaker has been tripped, as illustrated in phantom in FIG. 2, and shows the circuitry during the entire reset operation until the mechanism reaches the static condition of FIGS. 2 and 7, in the "on" position; and

FIG. 9 schematically illustrates the electric circuitry of the remotely operable mechanism of the instant invention, including a momentary contact remote control switch, after the breaker has been tripped.

Referring to the figures, and particularly to FIG. 1, a circuit breaker **10** is provided having an operating handle **11** which protrudes through the casing of the breaker **10**. The handle is movable through slot **12**, by means exterior to the breaker **10**, between an "off" and an "on" position, where the circuit breaker contacts are, respectively, disengaged or engaged within the circuit breaker. The interior mechanism of such a circuit breaker is well known in the art and is not here shown. For an example of a circuit breaker interior having an operating handle **11**, see U.S. Patent No. 2,996,589. In the event that the circuit breaker contacts are tripped apart due to a fault current passing through the circuit being protected, the operating handle **11** moves to an intermediate "trip" position, shown in phantom in FIG. 2, between the "on" and the "off" position. To reclose the circuit breaker in order that it might again respond to a fault current through the circuit being protected, the operating handle **11** must be moved by a means exterior to the circuit breaker **10**, first to the "off" position, which relatches the circuit breaker trip mechanism, and then to the "on" position, which reengages the circuit breaker contacts. The present invention relates to a mechanism for remotely controlling the operation of the circuit breaker operating handle from the "on" to the "off" position, or vice versa, and from the "trip" position to the "off" position.

The mechanism 20 comprises a support 21 for all of the elements of the mechanism, including the motor described below. An arm 22 is pivotally mounted on pivot 23 to support 21. The arm has a means comprising prongs 24, 24*a*, which form a notch, for engaging the operating handle 11 of the circuit breaker.

To the arm 22 are attached two cam followers 26 and 27 for being engaged by the hereinbelow described cam 41. The cam followers 26 and 27, as can be seen in FIG. 3, extend toward the support 21, thereby to enable the cam 41 to engage them. The cam followers 26 and 27 are so positioned that when cam follower 27 is engaged and force is applied to it by cam 41, the arm 22 is pivoted clockwise about pivot 23, thereby causing prong 24*a* to move handle 11 toward the "on" position. The manner of operation will be described in greater detail below. As will become apparent, cam followers 26, 27 are so positioned that no matter what position they are placed in, proper operation of the instant invention will occur.

Arm 22 may be comprised of separate elements 28 and 29, both of which elements are pivoted at pivot 23. The separate elements are provided to prevent damage to the circuit breaker 10 due to over-travel in either direction of the arm 22 as a result of its being operated by the motor, in a manner described below. Cam follower 27 is attached to element 28 and cam follower 26 is attached to element 29.

Prong 24 is an integral part of element 28 and prong 24*a* is an integral part of element 29. A biasing means, such as spring 30, joins the elements 28 and 29 to absorb the stresses of over-travel. Spring 30 is adapted to be loaded by being compressed. Operation of the over-travel protection means will be considered below.

A unidirectional motor M, not shown in FIG. 1, but schematically shown in FIGS. 5–8, is supported from support 21. The motor is of a type well known in the art which is activated by an electric power source. Upon being activated, the motor drive shaft 32 is caused to rotate unidirectionally clockwise, as viewed in FIGS. 1 and 2. Attached to the motor drive shaft 32 and supported above the mechanism housing 21 is a cam disc 34 which is rotatable clockwise by the operating shaft 32 of the motor.

Adjacent the edge of the cam disc 34 is positioned a movable switch arm 36 which has a roller 37 that rolls along the edge of the cam disc 34. The switch arm 36 is movable between two positions by cam disc 34, as will be described.

Cam disc 34 is comprised of two segments of a circle each having a different radius. When segment 38, having a smaller radius, is adjacent roller 37 (FIG. 1), switch arm 36 is in a first or "cam off" position and when segment 39, having a larger radius, is in engagement with roller 37 (FIG. 2), switch arm 36 is in a second or "cam on" position. While disc 34 is shown as being comprised of two segments, the disc may be comprised of a greater plurality of segments, alternate ones of which would have a greater or lesser radius. The speed of rotation of disc 34 would be appropriately adjusted to permit operation, as described below, of the mechanism of the present invention.

Connected with the cam disc 34 is cam 41 which is comprised, in the illustrated embodiment, of a projection fixedly attached to the cam disc 34 at approximately the center of the arc of the greater radius segment 39 of cam disc 34. Referring to FIGS. 3 and 4, cam 41 is sufficiently short to avoid its contacting elements 28 or 29 of arm 22. However, it is tall enough to engage cam followers 26 and 27 which project toward cam disc 34. As cam 41 rotates clockwise due to rotation of disc 34, it engages and either slides or rolls along either cam follower 27 or cam follower 26. The cam followers each have a curved end portion 42 off which the cam 41 slides when it reaches the end of the cam follower. The cam followers 26, 27 are of a sufficient length toward their ends 42 that cam 41 presses on each of them for a sufficient period that the arm 22 is enabled to move the operating handle either to the "on" or to the "off" position. The length of cam followers 26, 27 is predetermined and end portions 42 are so positioned that cam 41 will not drive the cam followers and, hence, the arm 22 an excessive distance in either direction, which would apply excessive pressure on the operating handle 11 and would cause premature breakage of the circuit breaker or of its casing.

A remote control switch 43 of a single-pole, double-throw type, well known in the art, is provided which is connected to the motor, in a manner to be described in conjunction with FIG. 5, for causing the motor to rotate shaft 32, thereby to cause movement of the operating handle 11 to either of the "on" or "off" positions. Switch 43 has maintained contacts. In another form of the invention, to be described in conjunction with FIG. 9, a remote control switch 61 is shown having momentary engagement contacts.

An automatic reset switch 45 also of a single-pole, double throw type, well known in the art, may be provided if it is desired to have the mechanism 20, which uses a remote control switch with maintained contacts, reset the circuit breaker 10 in the "on" position after the breaker has tripped as a result of a fault current passing through the circuit being protected. The reset switch has a switch arm 46 movable between two positions. An operating member 47 is provided for engagement with arm 22. As can be seen in FIGS. 1 and 4, when the circuit breaker operating handle 11 is in the "off" position, arm 22 is out of engagement with operating lever 47. Referring to FIGS. 2 and 3, when the circuit breaker operating handle is in the "on" position (as shown in solid line in FIG. 2), arm 22 is in engagement with lever 47. If the circuit breaker operating handle is moved to the "trip" position, shown in phantom in FIG. 2, arm 22 is out of engagement with operating lever 47. Referring to FIG. 3, when arm 22 is in engagement with operating lever 47, operating lever 47 is depressed and switch arm 46 is moved to a first position. Referring to FIG. 4, when arm 22 is out of engagement with operating lever 47, lever 47 is no longer depressed, thereby permitting switch 45 to be in a second position, giving rise to results described below.

Refer to FIG. 5 which schematically illustrates the electrical interconnection of the various components of the mechanism of the present invention. The power source leads to the remote control switch 43, which has a switch arm 51 that is operable between two positions. When switch arm 51 closes the connection between the power source and contact 52, a signal is sent, as described below, to move the operating handle to the "off" position of FIG. 1. When switch arm 51 is moved to connect the power source to contact 53, a signal is given to move the operating handle 11 to the "on" position of FIG. 2, as described below.

Contacts 52 and 53 of the remote control switch are, respectively, connected with contacts 54 and 55 of the cam operated switch 35. When the lesser radius segment 38 of cam disc 34 is adjacent roller 37, as shown in FIG. 1, switch arm 36 is in the "cam off" position and connects the motor M to contact 55 within switch 35. When the greater radius segment 39 of disc 34 engages roller 37, switch arm 36 is moved to its "cam on" position and the motor is connected with contact 54.

If it is desired to provide automatic reset of the circuit breaker to "on" when it has tripped, reset switch 45 is provided. The power source is connected to reset switch arm 46 which is movable between contacts 56 and 57. Arm 46 is in engagement with contact 57 when the breaker is in the "on" position as shown in solid line in FIG. 2 and in FIG. 3. Arm 46 engages contact 56 when the breaker is moved to the "off" position of FIGS. 1 and 4 or the "tripped" position shown in phan-

tom in FIG. 2. In these positions, the arm 22 (FIGS. 1 and 2) is out of engagement with switch lever 47.

Operation of the mechanism of the instant invention will now be described. Referring to FIGURES 1 and 5, the mechanism of the instant invention is shown in a static condition where the circuit breaker operating handle is in the "off" position. Note that the remote control switch arm 51 is in engagement with contact 52 which indicates that the person operating the remote control switch desires that the circuit breaker operating handle 11 be in the "off" position. In FIGURE 1, the roller 37 is adjacent the smaller radius segment 38 of cam disc 34 and, therefore, in FIGURE 5, the switch arm 36 is in engagement with contact 55 of switch 35. Accordingly, there is no complete circuit joining the power source and the motor M, whereby the motor does not operate.

Referring to FIGURES 1 and 6, the operator of the remote control switch 43 now desires that the circuit breaker operating handle 11 be moved from the "off" to the "on" position. He moves the remote control switch arm 51 so that it closes a circuit through contact 53. Motor M is now in a complete circuit with the power source and it begins to rotate disc 34. Referring to FIGURE 1, as disc 34 rotates clockwise, cam 41 engages cam follower 27 and continued rotation of disc 34 causes cam 41 to bear upon cam follower 27, pivoting arm 22 about pivot 23, thereby moving handle 11 toward the "on" position. Just as handle 11 arrives at the "on" position, cam 41 slides free of end 42 of cam follower 27 (see FIGURE 2) and arm 22 ceases to be pivoted clockwise by cam 41. The operating handle 11 is now in the "on" position.

Referring to FIGURES 2 and 7, immediately after cam 41 separates from cam follower 27, greater radius segment 39 of disc 34 contacts roller 37 and arm 36 of cam switch 35 moves to the "cam on" position in contact with contact 54. The completed circuit between the motor M and the power source is broken and the motor stops, thereby halting the rotation of disc 34 and cam 31.

Referring to FIGURE 7, when it is desired to return the handle 11 to the "off" position of FIGURE 1 from the "on" position of FIGURE 2, remote control switch arm 51 is moved, as shown in phantom in FIGURE 7, into engagement with contact 52 to the "on" position. Motor M is again in a complete circuit with the power source and begins to rotate. Cam 41 engages cam follower 26 and as cam 41 rotates, it causes arm 22 to pivot counterclockwise to the "off" position of FIGURE 1. Just as arm 22 reaches its position of FIGURE 1, cam 41 separates from cam follower 26 and arm 22 halts. The greater radius segment 39 of disc 34 moves out of engagement with roller 37 of switch 35 and lesser radius segment 38 moves adjacent roller 37, whereby switch 35 moves from the "cam on" position with arm 36 in contact with contact 54, as shown in FIGURE 7, to the "cam off" position with arm 36 in contact with contact 55, as shown in FIGURE 5. Motor M is disconnected from the power source and halts so that handle 11 remains stationary in the "off" position.

The reset switch 45 plays no role in the remotely controlled movement of handle 11 between the "off" and the "on" positions. Accordingly, if automatic reset of the contacts after tripping of the circuit breaker is not desired, the reset switch may be eliminated.

It is assumed that automatic reset of the circuit breaker is desired. As was noted above, in FIGURES 2 and 7, the circuit breaker handle 11 is shown in a static condition, with the motor M being electrically disconnected, and the operating handle 11 being in the "on" position. Note that the contact arm 46 of the reset switch 45 engages contact 57 and is in the "breaker on" position. Note further that the remote control switch arm 51 is in contact with contact 53 and that the remote control switch operator desires that the circuit breaker remain in the "on" position.

Assume that a fault current has been detected by the circuit breaker, that the cooperating contacts of the circuit breaker have been tripped apart, and that the operating handle 11 of the circuit breaker has been moved to its intermediate or "tripped" position shown in phantom in FIGURE 2. Note in the phantom lines in FIGURE 2, that the arm 22 has been moved, due to the tripping movement of handle 11, from being in engagement with lever 47 of switch 45 to being out of engagement with lever 47. As shown by a comparison of FIGURES 7 and 8, the movement of arm 22 from its solid to its phantom line position in FIGURE 2 has caused switch arm 46 of reset switch 45 to be moved from being in engagement with contact 57, in the "breaker on" position, to being in engagement with contact 56 in the "breaker off" or "breaker tripped" position. With the reset switch 45 being in the condition shown in FIGURE 8, a circuit is completed between the power source and the motor M. Included in the circuit is the power source, switch arm 46, contact 56, contact 54, switch arm 36 and motor M.

Referring to FIGURE 2, as motor M is actuated, disc 34 begins to rotate clockwise and cam 41 thereto secured engages cam follower 26, which urges arm 22 counterclockwise, which, in turn, moves operating handle 11 to the "off" position shown in FIGURE 1. As shown in FIGURE 1, as soon as arm 22 has moved handle 11 to the "off" position, cam 41 rotates free of end 42 of cam follower 26 and arm 22 no longer applies force to operating handle 11. At the same time, switch arm 36 moves from the "cam on" position of FIGURES 2 and 8, where it is in engagement with contact 54, to the "cam off" position of FIGURES 1 and 6, where it is in engagement with contact 55.

The remote control switch has never been moved by the operator from the "on" to the "off" position, whereby remote control switch arm 51 is in engagement with contact 53. Accordingly, when cam 41 releases cam follower 26, the electric circuitry of the mechanism 20 is in the condition shown in FIGURE 6. The motor M is still in a complete circuit with the power source and disc 34 continued to rotate. Operating handle 11 is then moved to the "on" position of FIG. 2 as has been fully described above in connection with FIGS. 2, 6 and 7.

If, on the other hand, the operator has moved remote control switch 43 to the "off" position, where switch arm 51 is in engagement with contact 52, as shown in dotted lines in FIG. 6, once disc 34 has rotated to its position of FIG. 1, switch 35 is in the "cam off" position and the motor M is no longer in a complete circuit with the power source, whereby the arm 22 and handle 11 stay at the "off" or breaker "reset" position.

Referring to FIG. 9, identical elements to those shown in FIGS. 5–8 are identically numbered. The mechanism 20*a* differs from mechanism 20 of FIGS. 5–8 in that the maintained contact remote control switch 43 is replaced with momentary contact switch 61. Switch 61 has bridging contacts 62 and 63 which are normally in the open position as shown in FIG. 9, and which may be biased open but which are manually operable closed to close their respective contacts 64 and 65, closing, respectively, the circuits to contacts 54 and 55 of cam switch 35. Contacts 62, 63 may be replaced with a single bridging contact (not shown) intermediate switch contacts 64, 65 which is movable into engagement with either of these contacts, but is biased away from both. When one or the other of contacts 62, 63 is held manually closed, it operates in the same fashion as contact arm 51 when it is in engagement, respectively, with one of contacts 52, 53 in FIGS. 5–8.

If automatic reset of the circuit breaker is desired but with the circuit breaker remaining in the "off" position instead of returning to the "on" position as described above, it is best to employ the remote control switch 61 of the momentary contact type. The normal resting position of switch 61 would have both contacts 64, 65

disengaged. Therefore, a fault current tripping the circuit breaker causes switch arm **46** of switch **45** to engage contact **56** and the motor is energized through contact **54** and switch arm **36**. As the motor operates the circuit breaker to its "off" position and switch **35** is operated to the "cam off" position by cam **34**, switch arm **36** disengages from contact **54** and engages contact **55**, electrically disconnecting the motor M from the power source since switch arms **62**, **63** of switch **61** are not in engagement with either of contacts **64**, **65**. Therefore, the breaker mechanism is reset and the breaker remains in the "off" position until the remote control switch operator moves switch contact **63** to engage contact **65** to turn the circuit breaker to the "on" position.

By the simple mechanism shown in FIG. 1, therefore, a uni-directional motor may be used with a remote control device for operating a circuit breaker to move the operating handle of the circuit breaker and hence the circuit breaker mechanism itself, to any of the circuit breaker operating positions.

As noted above, arm **22** is comprised of elements **28** and **29**, which are joined at pivot **23** and by biasing means or spring **30**, to prevent damage to the circuit breaker **10** and to the circuit breaker handle **11** by over-travel of the arm **22**. If the breaker **10** and mechanism **20** are properly positioned with respect to each other cam **41** should rotate free of cam followers **26**, **27** just as the handle **11** has reached its extreme positions. But if the breaker **10** and mechanism **20** are not positioned exactly, as is difficult in the field, or if the cam **41** is not released at the proper moment, there will be over-travel of arm **22**.

The over-travel device of the invention operates as follows. If cam follower **26** attached to element **29** of cam **22**, is pivoted too far counterclockwise by cam **41**, prong **24** on element **28** is prevented by breaker handle **11** from pivoting, and the relative movement of element **29** with respect to element **28** is absorbed by compression of spring **30**, without undue stress being applied to handle **11**.

Similarly, if cam **41** pivots cam follower **27** on element **28** too far clockwise, prong **24***a* on element **29** is prevented from pivoting too far by handle **11** and the relative movement between elements **28** and **29** is absorbed by compression of spring **30**, without undue stress being applied to handle **11**.

For a further important feature of the present invention, refer to FIGS. 1 and 2, and note that when operating handle **11** and mechanism **20** are in a static condition, in either the "off" or the "on" positions of the circuit breaker, the cam **41** is out of engagement with both of the cam followers **26** and **27**. If instead of operating the circuit breaker handle **11** from a remote point, it is desired to manually operate handle **11**, the handle **11** may be manually operated to any of its positions without having cam **41** or any other structrue interfere with the movement of operating handle **11** and arm **22**. Thus, when operating handle **11** is operated, it is not necessary to overcome any obstructive forces exerted by the motor M. No complicated clutch mechanism is required, as in the prior art, to permit the circuit breaker handle **11** to be manually operated without interference from the motor. Thus greater simplicity in manufacture can be achieved. Furthermore, the manual operator of the handle **11** need not exert an excessive force to overcome both the natural resistance to operation of the circuit breaker handle **11** and the resistance of the complex clutch mechanism to movement.

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

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

1. In an operator for a circuit breaker, said circuit breaker having an operating handle,
said operator comprising,
an arm having engaging means for engaging said operating handle;
a support; a pivot on said support; said arm being pivotally mounted on said pivot, whereby said arm is pivotable to operate the handle of the breaker;
a motor means for rotating a cam support in a first direction;
a cam support connected to said motor means;
a cam mounted on said cam support for being rotated and for engaging cam followers;
the improvement comprising,
said arm comprising a first and second element;
said first and said second elements being connected together by a biasing means;
said engaging means on said arm comprising,
said first arm element having thereto attached a first prong means for engaging one side of said operating handle and said second element having thereto attached a second prong means for engaging the other side of said operating handle;
a first cam follower connected to said first element and a second cam follower connected to said second element;
one of said cam followers being positioned to be engaged by said cam as said cam rotates, such that said arm is pivoted in one direction to move said handle to a first position, and the other of said cam followers being positioned to be engaged by said cam as said cam rotates, such that said arm is pivoted in the opposite direction to move said handle to a second position;
actuating means connected with said motor means for actuating said motor means to rotate said cam, thereby to pivot said arm; means for deactuating said motor means when said handle reaches either of said first and said second positions;
said cam followers being so positioned that when said first cam follower is being engaged by said cam, said second prong means is engaging the circuit breaker operating handle; and when said second cam follower is being engaged by said cam, said first prong means is engaging the circuit breaker operating handle.

2. In an operator for a circuit breaker, said circuit breaker having an operating handle,
said operator comprising,
an arm having engaging means for engaging said operating handle;
a support; a pivot on said support; said arm being pivotally mounted on said pivot, whereby said arm is pivotable to operate the handle of the breaker;
a motor means for rotating a cam support in a first direction;
a cam support connected to said motor means;
a cam mounted on said cam support for being rotated and for engaging cam followers;
the improvement comprising,
a first and a second cam follower connected to said arm;
one of said cam followers being positioned to be engaged by said cam as said cam rotates, such that said arm is pivoted in one direction to move said handle to a first position, and the other of said cam followers being positioned to be engaged by said cam as said cam rotates, such that said arm is pivoted in the opposite direction to move said handle to a second position;
actuating means connected with said motor means for actuating said motor means to rotate said cam, thereby to pivot said arm; means for deactuating said motor means when said handle reaches either of said first and said second positions;

said first cam follower being so shaped and of such a length that said cam ceases to engage said first cam follower when said operating handle has been moved into said first position;

and said second cam follower is so shaped and of such a length that said cam ceases to engage said second cam follower when said operating handle has been moved into said second position;

whereby said handle of the circuit breaker is manually operable without interference from said cam and said motor means.

3. In the operator of claim 2, the improvement further comprising,

said arm comprising a first and second element; said first and said second elements being connected together by a biasing means;

said first cam follower being connected to said first element and said second cam follower being connected to said second element;

said first arm element having thereto attached a first prong means for engaging one side of said operating handle and said second element having thereto attached a second prong means for engaging the other side of said operating handle;

said cam followers being so positioned that when said first cam follower is being engaged by said cam, said second prong means is engaging the circuit breaker operating handle and when said second cam follower is being engaged by said cam, said first prong means is engaging the circuit breaker operating handle.

4. In an operator for a circuit breaker, said circuit breaker having an operating handle,

said operator comprising,

an arm having engaging means for engaging said operating handle;

a support; a pivot on said support; said arm being pivotally mounted on said pivot, whereby said arm is pivotable to operate the handle of the breaker;

a motor means for rotating a cam support in a first direction;

a cam support connected to said motor means;

a cam mounted on said cam support for being rotated and for engaging cam followers;

the improvement comprising,

a first and a second cam follower connected to said arm;

one of said cam followers being positioned to be engaged by said cam as said cam rotates, such that said arm is pivoted in one direction to move said handle to a first position, and the other of said cam followers being positioned to be engaged by said cam as said cam rotates, such that said arm is pivoted in the opposite direction to move said handle to a second position;

actuating means connected with said motor means for actuating said motor means to rotate said cam, thereby to pivot said arm; means for deactuating said motor means when said handle reaches either of said first and said second positions;

said cam support having thereto connected first and second switch engaging means which are moved past a first switch as said cam support rotates;

said means for actuating said motor means comprising,

a first switch for being engaged by said first and said second switch engaging means; said first switch being operable to a third position when engaging said first switch engaging means and being operable to a fourth position when engaging said second switch engaging means; said first switch being connected to said motor means, on the one hand;

a remote control device having a first and a second contact; said first switch being connected with said first contact of said remote control device when said first switch is in said third position, thereby connecting said motor means with said first contact of said remote control device, and being connected to said second contact of said remote control device when said first switch is in said fourth position, thereby connecting said motor means with said second contact of said remote control device;

a power source connected to said remote control device and to said motor means;

said remote control device being operable to a fifth position wherein said power source is connected to said first contact thereof and to a sixth position wherein said power source is connected to said second contact thereof;

a reset switch connected to said remote control device and being operable to a seventh position, where said reset switch breaks a circuit in which it is positioned, and to an eighth position, where said reset switch is connected to said first switch when said first switch is in said third position;

means for actuating said reset switch connected with said arm; said arm being movable by the circuit breaker handle to a trip position, intermediate said first and said second positions of said handle, when the circuit breaker trips; said reset switch actuating means on said arm operating said reset switch to its said eighth position when said arm is moved by said handle into said trip position.

5. In the operator for a circuit breaker of claim 4, the improvement further comprises,

said cam support comprises a cam disc and said first and said second switch engaging means comprise, respectively, a first segment of said disc having an edge at a first radius of said disc, and a second segment of said disc having an edge at a second radius of said disc; said second radius being greater than said first radius;

said cam disc being rotatable past said first switch.

6. In the operator for a circuit breaker of claim 4, the improvement further comprises,

said first cam follower being so shaped and of such a length that said cam ceases to engage said first cam follower when said operating handle is in said first position;

and said second cam follower being so shaped and of such a length that said cam ceases to engage said second cam follower when said operating handle is in said second position;

whereby the handle of the circuit breaker is manually operable without interference from said cam and said motor means.

7. In the operator for a circuit breaker of claim 6, the improvement further comprises,

said first element having thereto attached a first prong means for engaging one side of said operating handle and said second element having thereto attached a second prong means for engaging the other side of said operating handle;

said cam followers being so positioned that when said first cam follower is being engaged by said cam, said second prong means is engaging the circuit breaker operating handle and when said second cam follower is being engaged by said cam, said first prong means is engaging the circuit breaker operating handle.

8. In an operator for a circuit breaker, said circuit breaker having an operating handle, said operator comprising,

an arm having first means for engaging the operating handle of the circuit breaker;

a support; a pivot on said support, said arm being pivotally mounted on said pivot, whereby said arm is pivotable to operate said handle between a first and a second position;

a second and a third means connected to said arm;

a motor means for moving a fourth means against said second and third means;

a fourth means connected to said motor means for engaging said second and third means;

one of said second and third means being positioned to be engaged by said fourth means, whereby said fourth means is adapted to move the one of said second and third means in a first direction such that said arm is pivoted so that said handle is operated to said first position and the other of said second and third means being positioned to be engaged by said fourth means, whereby said fourth means is adapted to move the other of said second and third means in a second direction such that said arm is pivoted so that said handle is operated to said second position;

the improvement comprising,

actuating means connected with said motor means for actuating said motor means, whereby said fourth means is moved to operate said handle to said first and said second position;

means for deactuating said motor means when said handle reaches either of said first and said second positions;

said fourth means having thereto attached a first and a second switch engaging means;

a first switch for being engaged by said first and said second switch engaging means; said first switch being movable to a third position when engaging said first switch engaging means and being movable to a fourth position when engaging said second switch engaging means; said first switch being connected to said motor means;

a remote control device having a first and a second contact; said first switch being connected with said first contact of said remote control device when said first switch is in said third position, thereby connecting said motor means with said first contact of said remote control device, and being connected to said second contact of said remote control device when said first switch is in said fourth position thereby connecting said motor means with said second contact of said remote control device;

a power source connected to said remote control device and to said motor means;

said remote control device being operable to a fifth position wherein said power source is connected to said first contact thereof and to a sixth position wherein said power source is connected to said second contact thereof;

a reset switch connected to said remote control device and being movable to a seventh position where said reset switch breaks a circuit in which it is positioned and to an eighth position, where said reset switch is connected to said first switch when said first switch is in said third position;

means for actuating said reset switch connected with said arm; said arm being movable by the circuit breaker handle to a trip position, intermediate said first and said second positions of said handle, when the circuit breaker trips; said reset switch actuating means operating said reset switch to its said eighth position when said arm is moved by said handle into said trip position.

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