Aug. 21, 1945. H. D. DORFMAN 2,383,296

ENCLOSED CIRCUIT BREAKER

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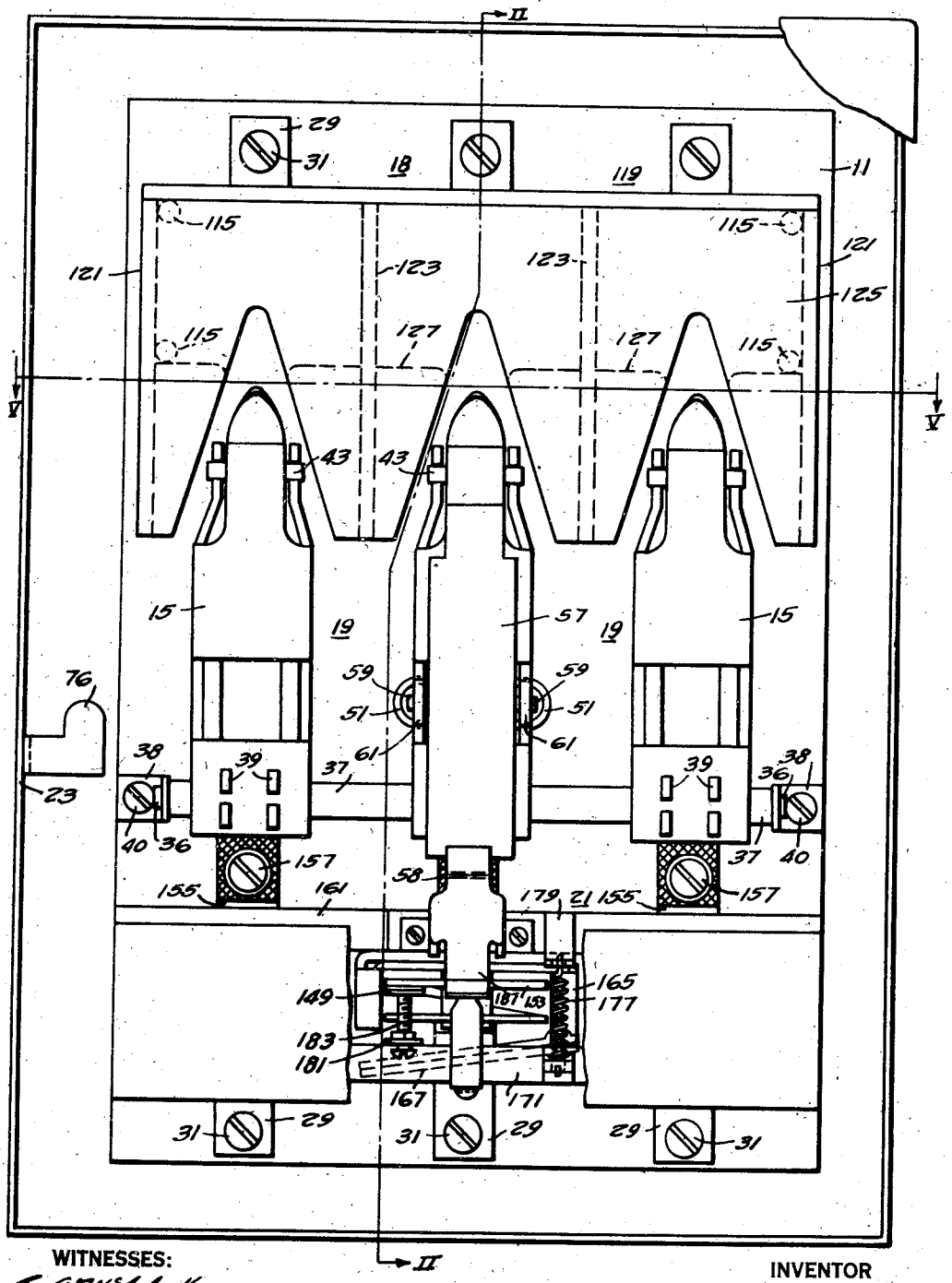


Fig. 1.

WITNESSES:

E. A. Wibberley

Paul McFarlane

INVENTOR

Hiller D. Dorfman

BY

F. W. Lyle.

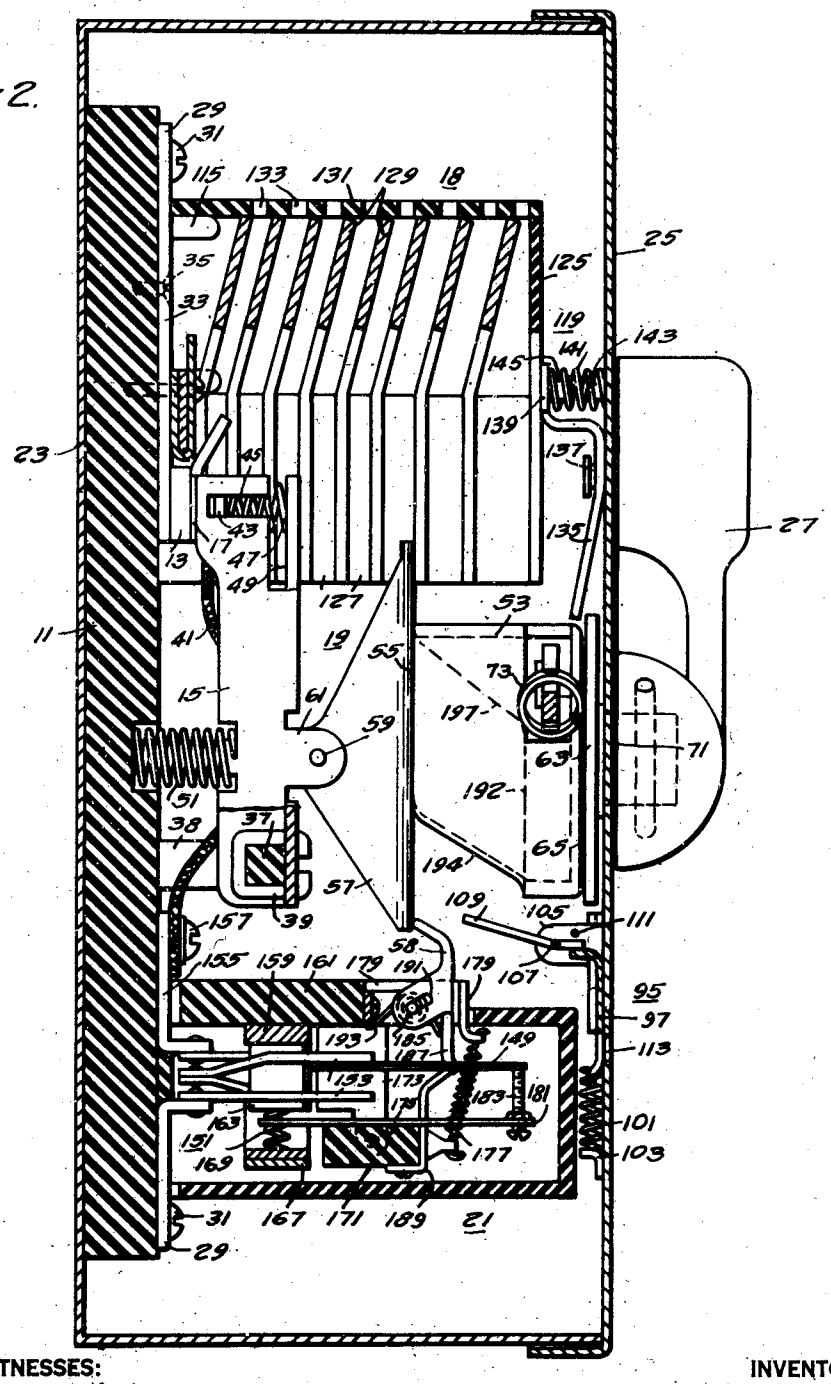
ATTORNEY

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ENCLOSED CIRCUIT BREAKER

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Fig. 2.



WITNESSES:

E. A. McCloskey.

Paul H. Harlow

INVENTOR

Hiller D. Dorfman.

BY

F. W. Lyle.

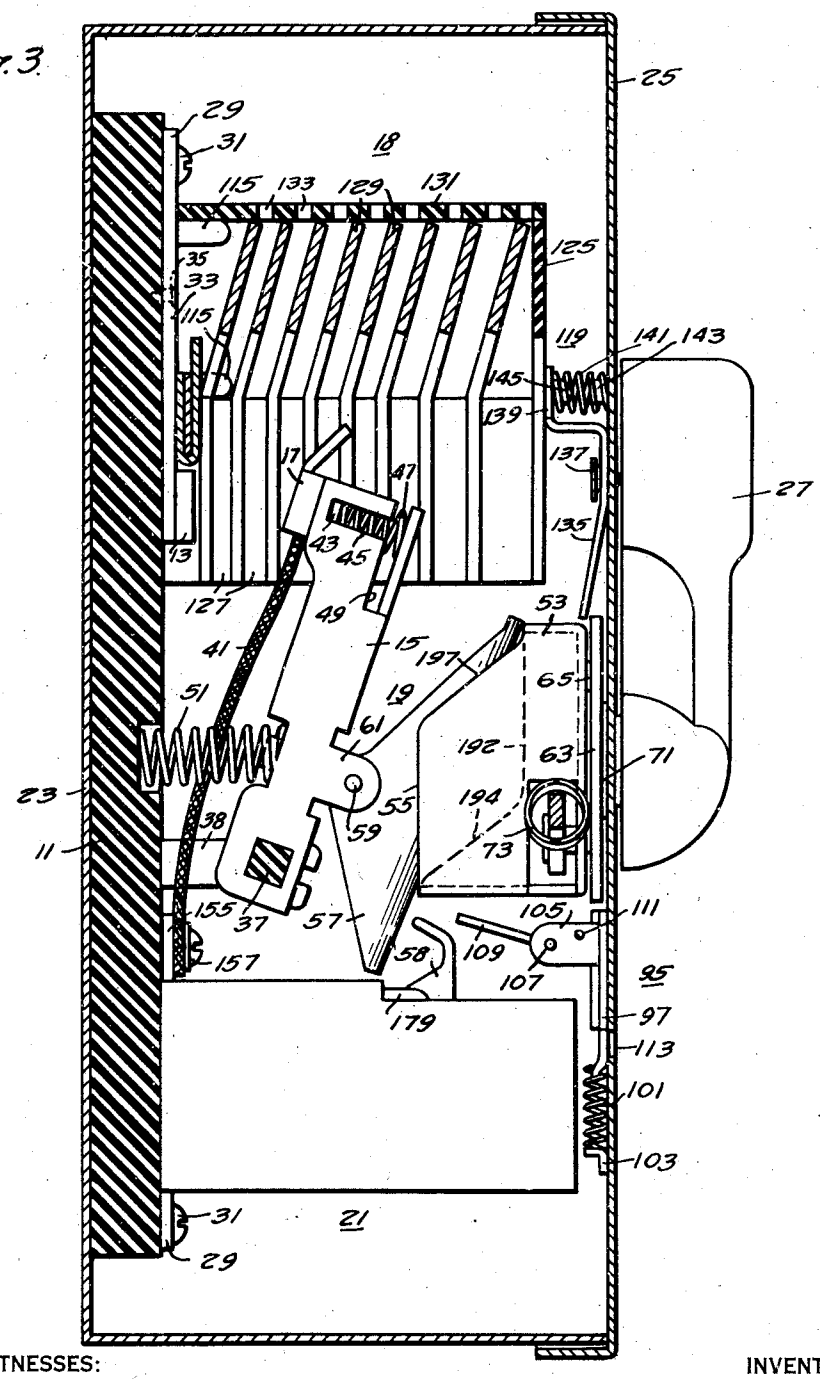
ATTORNEY

Aug. 21, 1945. H. D. DORFMAN 2,383,296

ENCLOSED CIRCUIT BREAKER

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Fig. 3.



WITNESSES:

E. A. McCloskey.

Paul A. Harlow.

INVENTOR

Hiller D. Dorfman.

BY

F. W. Leyh.

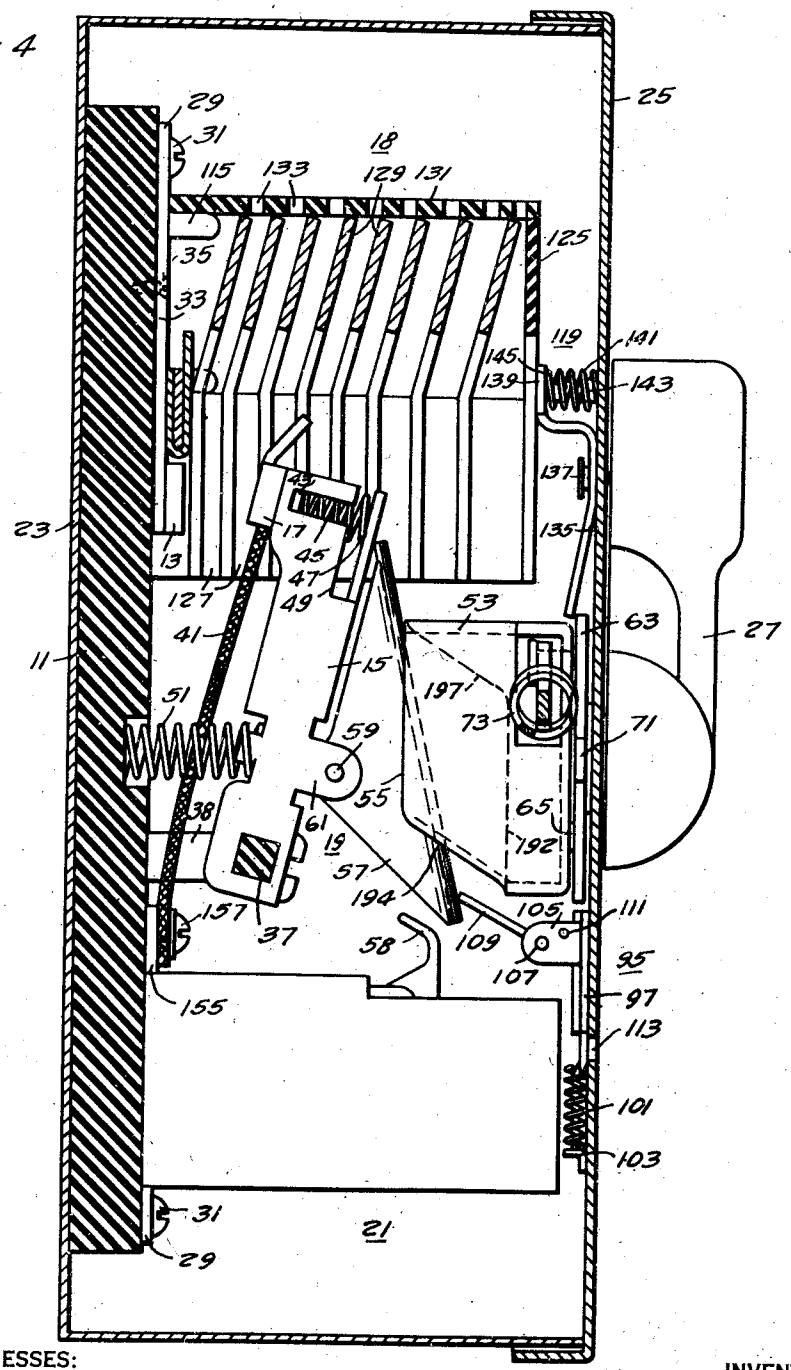
ATTORNEY

Aug. 21, 1945. H. D. DORFMAN 2,383,296

ENCLOSED CIRCUIT BREAKER

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Fig. 4



WITNESSES:

E. A. McCloskey.

Paul O. Harbaugh

INVENTOR

Hiller D. Dorfman.

BY

F. W. Lyle.

ATTORNEY

Aug. 21, 1945. H. D. DORFMAN 2,383,296

ENCLOSED CIRCUIT BREAKER

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Fig. 5.

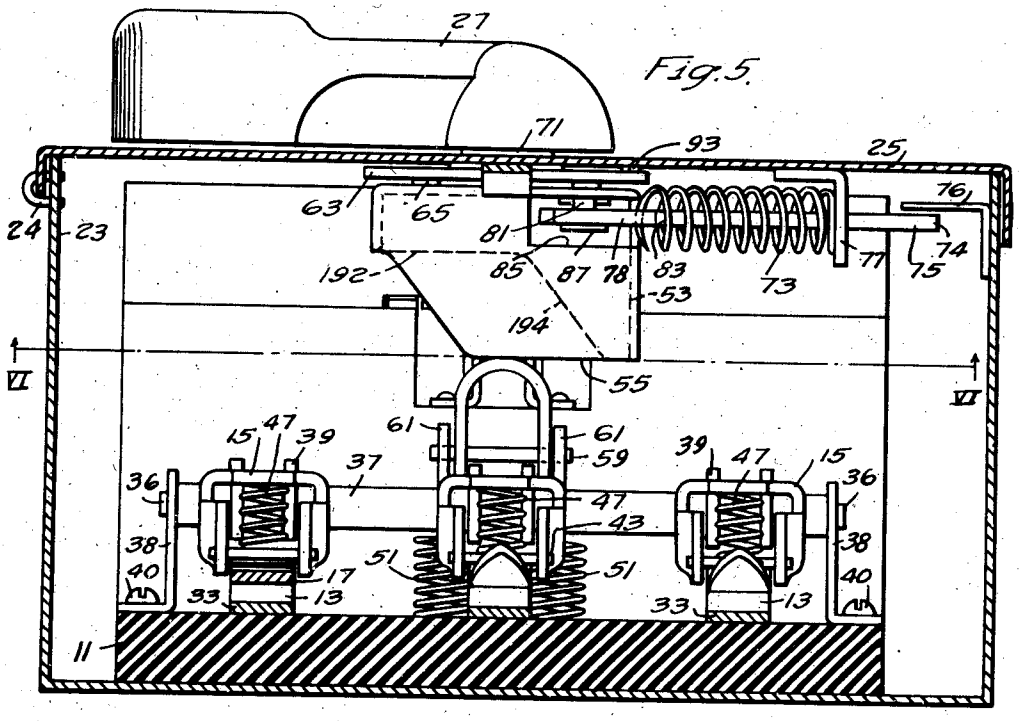
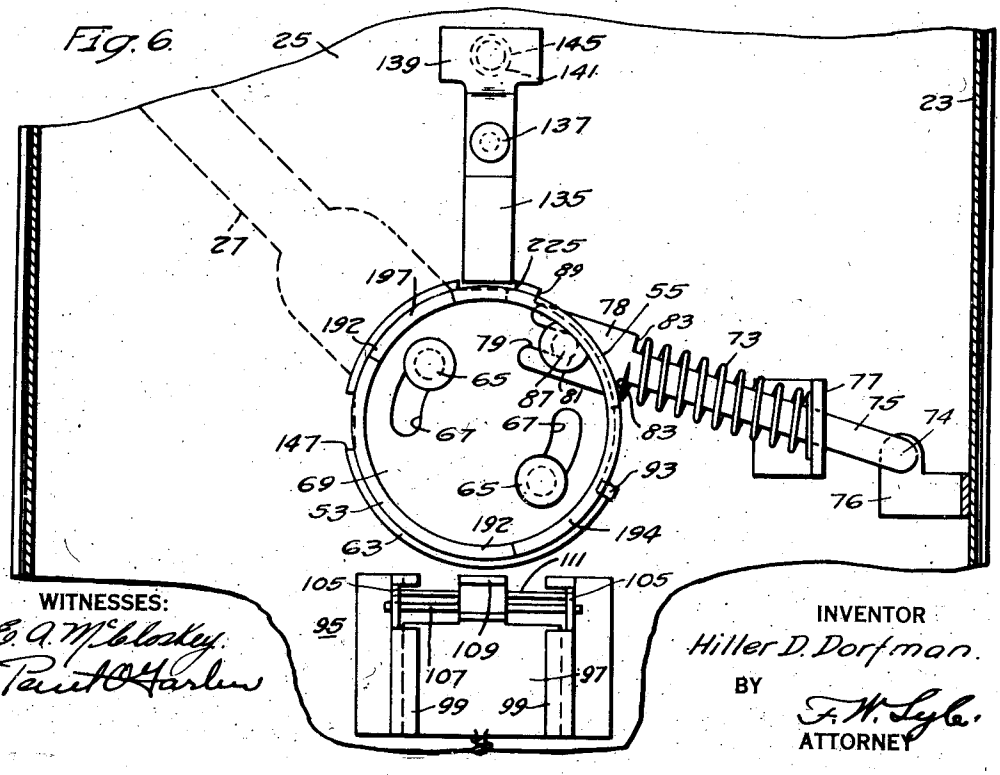


Fig. 6.



WITNESSES:

E. A. McCloskey.

Paul O. Harlow

INVENTOR

Hiller D. Dorfman.

BY

F. W. Lyle.

ATTORNEY

Aug. 21, 1945. H. D. DORFMAN 2,383,296

ENCLOSED CIRCUIT BREAKER

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Fig. 7.

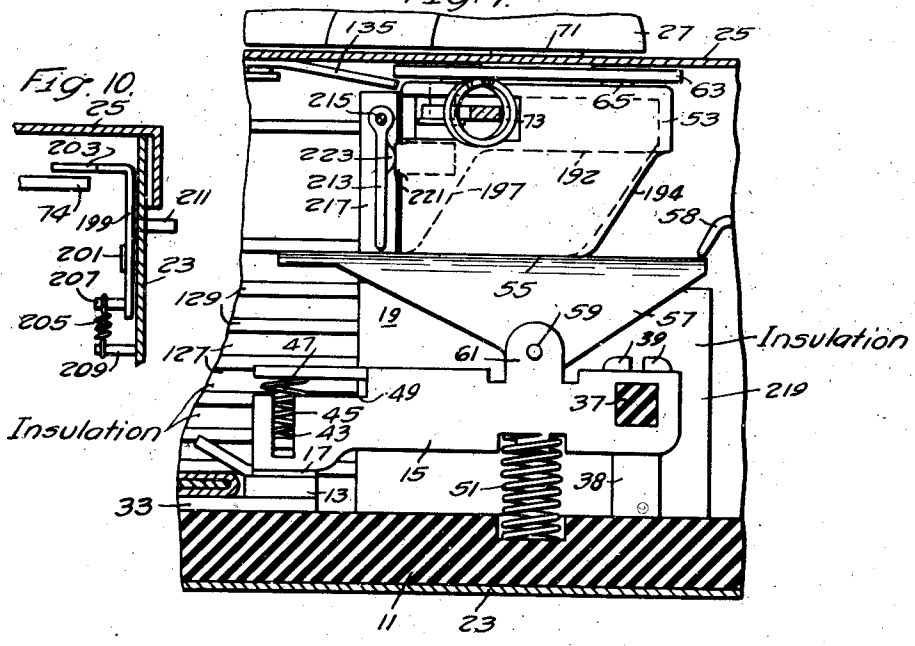


Fig. 10.

Fig. 8.

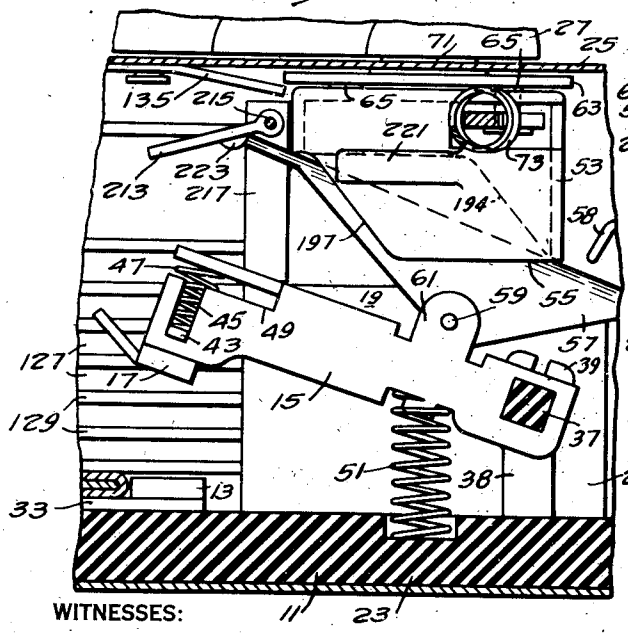
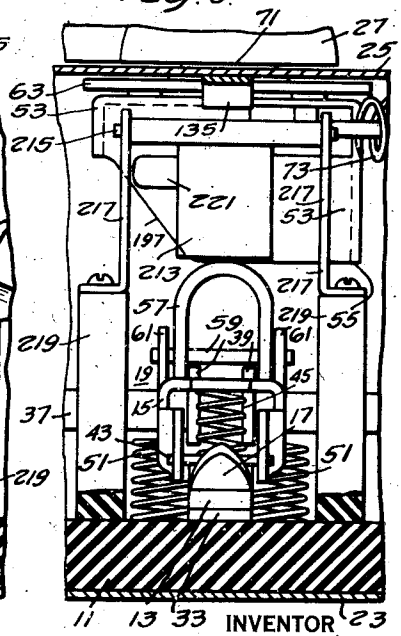


Fig. 9.



WITNESSES:

E. A. McLaskey.

Paul O. Harlow

INVENTOR

Hiller D. Dorfman.

BY

F. W. Lyle.

ATTORNEY

Patented Aug. 21, 1945 2,383,296

UNITED STATES PATENT OFFICE

2,383,296

ENCLOSED CIRCUIT BREAKER

Hiller D. Dorfman, Forest Hills, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application June 24, 1942, Serial No. 448,237

24 Claims. (Cl. 200—50)

The invention relates to circuit breakers and more particularly to automatically and manually operable circuit breakers of the industrial type which are mounted in a metal enclosing housing and operable manually by an operating handle on the enclosing housing.

One object of the invention is to provide an improved industrial circuit breaker mounted in an enclosing housing having an openable cover on which the manual operating means is mounted, the parts of the circuit breaker mechanism being readily accessible for inspection and removal when the cover of the enclosing housing is open.

Another object of the invention is the provision of an improved industrial type circuit breaker mounted in an enclosing housing having an openable cover and a manual operating mechanism mounted on the cover for manually operating the contacts with a snap action to open or to closed position.

Another object of the invention is the provision of an improved industrial type manually and automatically operable circuit breaker having a metal enclosing housing which constitutes the only enclosure for the elements of the breaker and wherein the manual operating means is mounted on the openable cover of the housing and the contact assemblage and the means for automatically opening the contacts are mounted within the housing.

Another object of the invention is the provision of an improved industrial type circuit breaker mounted in an enclosing housing having an openable cover, the circuit breaker having a removable unitary arc extinguisher structure and an interlocking means which prevents movement of the breaker operating handle to the "on" position when the arc extinguisher has been removed from the breaker.

Another object of the invention is the provision of a circuit breaker as described in the preceding paragraph, wherein the interlocking means also prevents movement of the operating handle to the "on" position when the cover is open.

Another object of the invention is the provision of a manually and automatically operable circuit breaker enclosed in a metal housing and embodying an improved trip free operating mechanism comprising a manual operating means mounted on the openable cover of the housing separably engageable with the remaining part of the mechanism which is mounted in the housing and accessible when the cover is open.

Another object of the invention is the provision of an enclosed circuit breaker having manual operating means mounted on the openable cover of the enclosing housing for opening and closing the contacts within the housing which are biased open and normally assume open position when the cover is open, an interlock normally preventing opening of the cover when the contacts are in closed position, means for defeating the interlock to permit opening of the cover with the contacts in closed position and means automatically effective to retain the contacts closed when the cover is opened by defeating the interlock.

Another object of the invention is the provision of an improved industrial type circuit breaker that is simple, safe and reliable in operation and inexpensive to manufacture.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof will be best understood from the following detailed description thereof when read in connection with the accompanying drawings, in which:

Figure 1 is a front elevational view of a three pole circuit breaker embodying the principles of the invention, with the cover of the enclosing housing partly broken away to more clearly show a portion of the breaker mechanism;

Fig. 2 is a vertical sectional view of the breaker shown in Fig. 1 and taken substantially on line II—II, of Fig. 1, the breaker being shown in the closed position;

Fig. 3 is a vertical sectional view of the breaker showing the breaker operating mechanism in its manually opened position;

Fig. 4 is a vertical sectional view of the breaker showing the operating mechanism in the automatically tripped open position;

Fig. 5 is a horizontal sectional view of the breaker taken substantially on line V—V, of Fig. 1, with the arc extinguisher removed;

Fig. 6 is a fragmentary sectional view taken on line VI—VI, of Fig. 5, and showing the inside of the hinged door or cover and showing the manual operating cam and interlocking mechanism.

Figs. 7, 8 and 9 are fragmentary detail views showing the breaker with a device added for restraining the contact means in closed position

when the door of the closure is opened by defeating the cover interlock; and

Fig. 10 is a fragmentary sectional view showing the cover interlock and the means for manually operating the interlock to permit opening of the cover when the breaker is in the "on" position.

Referring to the drawings, the circuit breaker is of the three pole type and comprises generally, a flat base 11 of molded insulating material, a plurality of stationary contacts 13, a plurality of movable switch members 15 carrying movable contacts 17 which cooperate with the stationary contacts 13, an arc extinguisher 18, and an operating mechanism indicated generally at 19 including a trip device indicated generally at 21. The base 11 is suitably secured to the back wall of a metal housing or casing 23. The casing is provided with a door or cover 25 hinged to a side wall of the casing 23 at 24 (Figs. 1 and 5). The casing 23 together with the door completely encloses the breaker mechanism with the exception of an operating handle 27 rotatably mounted on the door 25 and movable therewith when the door is opened and closed.

A plurality of end terminals 29 (Fig. 1) is mounted on the base 11 by means of screws 31, there being a terminal adjacent each end of each of the poles of the breaker.

Each of the stationary contacts 13 is mounted on the inner end of a corresponding conducting strip 33 secured to the base 11 by means of a screw 35, the outer end of the conducting strip 33 forming one of the upper end terminals 29.

Each movable switch member 15 comprises a channel-shaped frame rigidly secured to a tie bar 37 (Figs. 1 and 2) of insulating material by means of a strap 39, the ends of which pass through openings in the switch members and are bent over to form a rigid connection. Thus all of the switch members 15 are mechanically connected for simultaneous movement to open and close the contacts. The ends of the tie bar 37 have metal pivot pins 36 (Figs. 1 and 5) molded therein which are pivotally supported in brackets 38 secured to the base 11 by means of screws 40.

Each of the moving contacts 17 has secured thereto one end of a flexible shunt conductor 41 and a bar 43 is rigidly secured to the shunt conductor 41 and to the contact 17 by suitable means (not shown). The ends of the bar 43 extend into horizontal slots 45 in the side members of the channel shaped switch member 15. A spring 47 is compressed between the bar 43 and the outer portion of the switch member to provide contact pressure when the contacts are in the closed position. Vertical slots 49 intersecting the horizontal slots 45 provide a convenient means for assembling the contact 17 on the switch member 15. In this manner floating movable contacts are provided.

The movable contact assembly including the switch members 15 for all of the poles of the breaker is biased in a clockwise or opening direction (Fig. 2) by means of two springs 51 (Figs. 2 and 5) compressed between spring seats in the base 11 and recesses in the side portions of the switch member 15 for the center pole. The switch members 15 are normally restrained in the closed contact position against the bias of the springs 51 by a cylindrical cam member 53 rotatably supported on the door 25 and having a cam face 55 (Figs. 2 and 5) engaging the outer portion of a channel-shaped lever 57 near its upper end. The lower end of the lever 57 is normally restrained in the closed contact position (Fig. 2) by engagement with a latch member 58 forming a part of the trip device 21 which will be described later. The lever 57 is pivotally connected intermediate its ends to the switch member 15 for the center pole, by means of a pivot pin 59 which passes through suitable openings in ears 61 projecting outwardly from the side members of the center pole switch member 15, and through openings in the sides of the channel-shaped lever 57.

The cam member 53 is mounted on a disc 63 (Figs. 5 and 6) for movement therewith and also relatively thereto by means of a pair of headed studs 65 in the disc projecting through arcuate slots 67 in the end member 69 of the cam. The disc 63 is suitably secured to a shaft 71 (Figs. 2, 3, 4 and 5) rotatably mounted in the center portion of the door 25, and the shaft has a handle 27 secured to the outer end thereof on the outside of the door.

A spring 73 (Figs. 5 and 6) is provided for imparting snap acting movement to the cam member 53 when the cam is moved to open or close the circuit breaker. The spring 73 surrounds a link 75 having one end slidably supported in a bracket 77 secured to the casing door 25. The other end of the link 75 is enlarged as indicated at 78 and is provided with an open slot 79 engaging a stud 81 projecting inwardly from the end member 69 of the cam 53. The spring 73 is compressed between the bracket 77 and shoulder 83 formed by the enlarged end 78 of the link 75. An opening 85 is provided in the side of the operating cam 53 to accommodate the end of the link 75, and a head 87 on the stud 81 maintains the link in the cooperative relation therewith.

The right hand end 74 (Figs. 5 and 6) of the link 75 cooperates with an angular bracket 76 welded or otherwise suitably secured to the inside of the side wall of the casing to form a locking device which compels operation of the handle 27 to the "off" position to cause opening of the contacts before the door 25 can be opened. When the handle and consequently the disc 63 is rotated clockwise to the "off" position the link 75 pivots in a counter-clockwise direction about its point of engagement with the bracket 77 as a pivot, moving the end 74 of the link out of alignment with the bracket 76. The door 25 may then be opened. Conversely when the door is closed and the handle 27 is moved to its "on" position, the end 74 of the link 75 is positioned under the bracket 76 which then serves as a lock to prevent opening the door until the contacts are manually opened.

The rotary movement of the cylindrical cam 53 and of the handle 27 is limited, in both directions by the ends of a cutout portion 89 in the periphery of the disc 63 engaging a limit stop 93 (Fig. 5) projecting inwardly from the door 25 of the casing.

An indicating device designated generally at 95 (Figs. 2 and 6) is provided to visually indicate when the breaker is tripped open in response to abnormal current conditions. The indicating device comprises an indicator 97 slidable vertically between a pair of angle brackets 99 and the inside surface of the door 25. The indicator is biased in an upward direction (Fig. 2) by means of a spring 101 compressed between a bracket 103 secured to the door 25 and a projection on the lower end of the indicator. The brackets 99 are provided with inwardly extending ears 105 which support a pivot pin 107 upon which is pivotally mounted an indicator operating lever 109. One end of the

lever 109 cooperates with the formed-over end of the indicator 97 and the other end of the lever is adapted to be engaged by the lower end of the lever 57 when the breaker is tripped open, and the indicator lever 109 rotated in a clockwise direction to slide the indicator downwardly to indicating position (Fig. 4). When the handle is moved to the "off" position to reset the breaker mechanism, the spring 101 slides the indicator 97 upwardly and rocks the lever 109 counterclockwise, this restoring movement being limited by engagement of the outer end of the lever 109 with a limit stop 111. A sight opening 113 is provided in the door 25 through which the indicia on the indicator may be observed.

The arc extinguisher 18 is provided with three extinguishing compartments, one for each pole of the breaker, and is removable from the breaker for inspection or replacement. It is supported in position in the breaker by a plurality of dowel pins 115 (Figs. 1 to 6) projecting outwardly from the base 11. The arc extinguisher comprises a housing 119 (Figs. 1 and 2) of molded ceramic insulating material which includes end walls 121, barriers 123, and a front cover plate 125 molded together as a unitary structure. Molded integral with each of the end walls 121 and with each of the barriers or partitions 123 are spaced projections 127 which form slots into which are assembled stacks of slotted plates 129 of magnetic material. A top plate 131 of ceramic insulating material is secured to the housing 119 and is provided with a plurality of openings 133 in alignment with the spaces between the slotted plates 129 and through which the hot gases generated by the arc drawn by the rupture of the current may escape. The arc itself is drawn into the apices of the slotted plates where it is broken up into a plurality of short arcs and is quickly cooled and extinguished.

It is desirable to prevent closing of the contacts should the door 25 of the casing be closed when the arc extinguisher has been removed from the breaker. To this end an interlock is provided between the manual operating means and the arc extinguisher. This interlock comprises a lever 135 (Figs. 2, 3, 4 and 6) loosely supported on a headed stud 137 mounted on and projecting inwardly from the door of the casing. The upper end of the lever 135 is enlarged and formed to the left as indicated at 139 (Fig. 2) and is biased against the front cover plate 125 of the arc extinguisher by means of a coil spring 141 compressed between the door 25 and the portion 139 of the interlock lever 135. Pilot pins 143 and 145 are provided on the door and on the portion 139, respectively, to retain the spring in position. With the door 25 in its closed position, the spring 141 serves to hold the arc extinguisher firmly in position. The lower end (Fig. 2) of the lever 135 occupies a position beneath disc 63 substantially as shown in Fig. 2 when the door 25 is closed and the extinguisher is in mounted position.

Referring now to Fig. 6, it may be seen that the disc 63 is provided with a notch 147 in the periphery thereof which, when the handle 27 is in the "on" position, is displaced approximately 90° in a counterclockwise direction from the lower end of the lever 135. As previously described, it is necessary to move the handle 27 to the "off" position to disengage the link 75 from the locking bracket 76 in order to open the door. This movement of the handle rotates the disc 63 in the same direction (Fig. 6) and brings the notch 147 into alignment with the lever 135. When the door is opened, the spring 141 expands and rocks the lever 135 counterclockwise about its loose pivot on the stud 137 engaging the lower end of the lever in the notch 147 in the disc 63. The interlock lever 135 thus locks the handle in the "off" position when the door is open.

When the door is moved to its closed position the formed upper end of the lever 135 engages the front plate 125 of the arc extinguisher and continued movement of the door in closing direction rocks the lever 135 clockwise removing the lower end thereof from the notch 147. The handle 27 may now be rotated to its "on" position to effect closing of the breaker contacts. However, if the arc extinguisher was removed from the breaker and not replaced before closure of the door the lever 135 will not be disengaged from the notch 147 and in this position prevents movement of the handle to the "on" position to close the contacts when the arc extinguisher is not in its proper position in the breaker.

The trip device 21 (Fig. 2) includes a bimetal trip element 149 and an electromagnetic trip means indicated generally at 151 for each of the three poles of the breaker. Each of bimetal elements 149 is rigidly secured to one turn of an energizing winding 153 for the electromagnet 151 of the corresponding pole. One end of the winding 153 is secured to the inner end of the lower terminal 29 and the other end of said winding is secured to one end of a conductor 155 to the other end of which is secured the other end of the flexible shunt conductor 41 by means of a screw 157 which also serves to secure the conductor 155 to the base 11. In addition to energizing the magnet 151, the winding 153 serves as a heater for the bimetal element 149.

Each of the magnetic trip devices 151 comprises a U-shaped magnet core 159 secured to a horizontal panel 161 of insulating material suitably mounted on the base 11. A center core member 163 is secured to the portion of the U-shaped core 159 which lies adjacent the panel 161 and extends downwardly therefrom through the coils of the energizing winding 153. One leg of the U-shaped core member 159 is provided with downwardly projecting ears 165 (Fig. 1) upon which is pivotally supported an armature 167 which is biased to unattracted position away from the core member by means of a spring 169. One end of the spring is disposed in a spring seat (not shown) in the lower end of the center pole piece 163 and the other end bears against the armature 167.

A common trip bar 171 of molded insulating material extends transversely across the trip devices for all three poles of the breaker and is operable by any one of the bimetal elements 149, and also by any one of the electromagnetic trip means 151. The trip bar 171 is pivotally mounted on a pair of brackets 173 extending downwardly from the panel 161 by means of pins 175 molded into the ends of the trip bar and extending through suitable bearing openings in the brackets 173. The trip bar 171 is biased in a counterclockwise direction (Fig. 2) by means of a spring 177 which is connected between the trip bar and a yoke-shaped bracket 179 secured to the panel 161. The trip bar 171 is provided with three horizontally extending members 181 each having one end disposed in the path of movement of the armature 167 for its associated pole. The other ends of the members 181 carry

screws 183 adapted to be engaged by free ends of the bimetal elements 149.

The previously mentioned pivoted latch member 58 normally engages and restrains the lower end of the lever 57 to normally maintain the switch member 15 in closed contact position when the operating handle is in "on" position. The latch member 58 is pivotally and slidably mounted on a pivot pin 185 mounted in the legs of the yoke shaped bracket 179. The latch member 58 has a downwardly extending portion 187 which is normally engaged by a projection 189 secured to the trip bar 171. The latch member 58 is provided with a pair of slots 191 for pivotally and slidably engaging the pivot pin 185. A spring 193 coiled about the pivot pin 185 biases the latch member 58 in a counterclockwise direction (Fig. 2) and biases the lower end of the slots 191 in contact with the pin 185 as shown in Fig. 2.

When the breaker lever 57 is maintained in the closed contact position by the cylindrical cam 53 and the latch member 58, the operating springs 51 bias the latch member in a clockwise direction (Fig. 2). The latch member 58 is normally prevented from moving in a clockwise or releasing direction by engagement of the portion 187 thereof with the projection 189 on the trip bar. When the trip bar 171 is rotated in a clockwise direction to its tripping position either by the heating of any one of the bimetal elements 149 or by operation of any one of the electromagnetic trip means 151, it releases the latch member 58 which in turn releases the breaker lever 57 to effect opening of the contacts.

The operation of the circuit breaker is as follows: When the breaker is in closed circuit position as illustrated in Fig. 2 and an overload occurs in the circuit of any one of the poles, the bimetal element 149 of that pole becomes heated due to its intimate contact with the heater portion of the winding 153 of the affected pole. When the bimetal 149 is heated a predetermined amount, it deflects downwardly and operates the trip bar 171 in a clockwise direction to its tripping position. This movement of the trip bar releases the latch member 58 which effects release of the breaker lever 57.

Release of the breaker lever 57 is also effected by operation of the electromagnetic means 151 in response to a short circuit or a heavy overload occurring in the circuit of any one of the poles. Upon the occurrence of such a short circuit or heavy overload, the electromagnet 151 of the affected pole is energized an amount sufficient to attract the associated armature 167 to cause movement of the trip bar 171 to its tripping position and effect release of the lever 57.

The configuration of the cam face 55 of the cylindrical cam 53 is such that with the handle 27 in the closed position a low portion 192 (Figs. 2 and 3) of the cam face is opposite the lower end of the breaker lever 57. When the latch member 58 releases the lever 57, the lower end thereof is free to move in a counter-clockwise direction about its pivot 59 on the switch member 15. The springs 51 therefore, expand and rock the switch members 15 clockwise to open the contacts with a snap action. During this movement the lever 57 pivots about the pivot pin 59 and the upper end of the lever pivots about its point of contact with the cam face 55. The parts are shown in their tripped open position in Fig. 4.

In order to reset the trip device the handle 27 is rotated in a counterclockwise direction (as viewed from the front of the breaker) from its "on" position (Fig. 2) to its "off" position (Fig. 3). During this movement of the handle, the cylindrical cam 53 is correspondingly rotated and an inclined portion 194 of the cam face engages the lower end of the breaker lever and rocks the lever in a clockwise direction about the pivot 59, at the same time the low portion 192 (Fig. 3) is presented to the upper end of the lever 57 which permits clockwise movement thereof without displacing the switch arm 15 from its open position.

When the breaker lever 57 is moved from its Fig. 4 position to its Fig. 3 position the lower end thereof wipes by the upper end of the latch member 58 causing the latch member to slide downwardly and toward the left over the pin 185 (Fig. 2) until it escapes the end of the lever whereupon the spring 193 restores the latch member to the position in which it appears in Figs. 2 and 3.

The contacts can now be closed by rotation of the handle 27 and the cam member 53 clockwise to the "on" position as viewed from the front of the breaker. During this movement of the cam 53, the inclined surface 197 (Fig. 3) engages the upper end portion of the lever 57 and rocks the lever counterclockwise about the pivot 59 until the lower end of the cradle engages the end of the latch member 58. The point of contact of the lever 57 with the latch member 58 now becomes the fulcrum and continued movement of the cam 53 in closing direction rotates the lever 57 counterclockwise about this fulcrum actuating the switch members 15 toward closed position to close the contacts. As the handle 27 approaches the "on" position, the low portion 192 (Figs. 4 and 6) is brought into position in the path of movement of the lower end of the lever 57 so that the breaker is in condition to be tripped open again.

With the breaker mechanism in the closed position as shown in Fig. 2, the contacts may be opened manually by rotating the handle 27 and thereby the cam 53 counterclockwise to the "off" position. During this movement the lever 57, pivoting about the point of contact with the latch member 58 as a fulcrum, is rocked clockwise by the springs 51, following the inclined surface 197 until the upper end of the lever rests against the low portion 192 of the cam 53 (Fig. 3).

As the handle 27 is rotated towards the "off" position, the disc 63 is rotated therewith and, through the pin and slot connection 65—67 (Fig. 6), rotates the cam member 53 in the same direction until the line of action of the overcenter spring 73 passes the center axis of the cam. When this occurs, the force of the spring causes the cam to rotate relative to the disc due to the connection 65—67 and toward the "off" position with a snap action. This quickly positions the low portion 192 of the cam in the path of travel of the upper end of the breaker lever 57 which is thus free to move to open the contacts with a snap action under the influence of the springs 51. A similar snap acting movement in a closing direction is imparted to the cam by the spring 73 during a closing operation so that the contacts are closed with a snap action.

It was mentioned previously that in order to open the door of the casing enclosing the circuit breaker for inspection of the breaker mechanism or for other purposes, it is first necessary to rotate

the handle 27 to the "off" position to effect opening of the contacts. There are occasions however when it is desirable to open the door without causing opening of the contacts. For this purpose provision may be made to render the cover interlock ineffective at will to permit opening the door without first displacing the handle from the "on" position.

Referring to Fig. 10 which shows a modification of the cover interlock, a latch member 199 pivotally supported on a pivot 201 on the inside of the side wall of the casing 23 has its free end 203 formed at substantially right angles and is normally biased to a position in the path of opening movement of the end 74 of the link 75, by means of a spring 205 connected between a spring stud 207 on the member 199 and a spring stud 209 on the wall of the casing 23. A manual operating handle 211 mounted on the latch member 199 projects through an arcuate slot (not shown) in the casing 23. The spring 205 normally biases the handle 211 to one end of the slot in which position the angular portion 203 of the latch member lies in the path of and over the link end 74. The handle 211 provides a convenient means whereby the latch 199 may be moved out of the way of the link 75 so that the door 25 may be opened without moving the breaker operating handle to the "off" position.

After the latch 199 has been disengaged from the link 75 the door may be opened and restraining means comprising a pivoted member 213 (Figs. 7, 8 and 9) is provided to maintain the breaker lever 57 and the switch arm 15 in closed position while the door is open. The member 213 is pivotally mounted on a pivot pin 215 supported in a pair of brackets 217. The brackets 217 are mounted on barriers 219 of insulating material disposed one on each side of the center pole of the breaker and suitably secured to the base 11. With the door 25 closed and the breaker handle and the cam 53 in the "on" position, the switch arm 15 is maintained in the closed contact position by engagement of the breaker lever 57 with the cam face 55 at one end and with the latch member 58 at the other end. When the breaker is in this condition, the member 213 is disposed substantially perpendicular to the lever 57 and there is a slight clearance between the free end of the member 213 and the outer or arcuate surface of the lever 57. If the door 25 is now opened without first having operated the cam 53 to effect opening of the contacts, this slight clearance will be taken up and the member 213 together with the latch member 58 will hold the switch arm 15 in the closed contact position against the force of the springs 51 which tend to actuate the switch arm to open position.

The previously described interlock comprising the member 135 (Figs. 2 and 6) which operates upon opening the door to prevent movement of the handle 27 from the "off" position to the "on" position is also made effective when the door is opened with the contacts closed to prevent displacement of the handle from the "on" position to the "off" position. This insures that the cam 53 will be in the correct position with relation to the lever 57 when the door is closed.

Referring to Fig. 6 it may be seen that a notch 225, similar to the notch 147, is provided in the periphery of the disc 63, and is in alignment with the lower end of the interlocking member 135 when the disc and the handle are in the "on" position. When the door of the casing is opened with the breaker closed the spring 141 (Figs. 2 and 6) acts to introduce the lower end of the member 135 into the notch 225 and thus prevent accidental displacement of the handle 27 from the "on" position while the door is open. When the door is closed the member 135 is withdrawn from the notch in the previously described manner.

The door may be closed with the handle 27 and the cam 53 in the "on" position and latched in the closed position by manipulation of the latch 199 (Fig. 10). The cam face 55 again comes into engagement with the lever 57 and acts to restrain the switch member 15 in closed position.

In order to effect opening of the contacts manually, it is necessary that the member 213 be moved to an ineffective position. This is accomplished by means of a cam 221 on the cylindrical surface of the cam 53 disposed to cooperate with a projection 223 on the member 213. The configuration of the cam 221 and its location on the cylindrical cam 53 are such that upon rotation of the latter from the "on" position to the "off" position, the cam 221 rocks the member 213 clockwise about the pivot 215 out of perpendicular relation to the breaker lever 57 so that, when the low portion 192 of the cam 53 is positioned adjacent the breaker lever 57 and the springs 51 act to move the switch members 15 to open position, the lever 57 engages the free end of the member 213 and rocks it further clockwise to the position shown in Fig. 8. When the cam 53 is operated to the closed position, actuating the lever 57 to close the contacts, the member 213 returns to its Fig. 7 position due to the force of gravity. Movement of the member 213 in a counterclockwise direction past the perpendicular position is prevented by engagement of the projection 223 with the low part of the cam 221.

The breaker is trip free of the handle when the contacts are closed with an overload condition on the circuit of any pole of the breaker since the low portion 192 of the cam 53 is in line with the lower end of the breaker lever 57 shortly before the contacts engage on a closing movement. The breaker is also trip free of the restraining member 213 when the door 25 is opened with the breaker in closed position since in this condition the trip device 21 is operative to release the latch member 58 to effect opening of the contacts irrespective of the position of the restraining member.

It will be obvious from the foregoing description, that the invention provides a simplified enclosed circuit breaker in which the operating handle is mounted on and movable with the movable part or door of the closure. Interlocks have been provided which normally compel operation of the breaker to open circuit position before the door can be opened and which prevent movement of the operating handle to closed position until the cover or door is closed.

Another advantage of the invention is the provision of a unitary arc extinguishing structure which is readily removable from the circuit breaker for inspection or repairs, and an interlock which compels replacement of the arc extinguisher in the breaker before the operating handle may be moved to the closed position to close the contacts.

Having described the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made in the structural details disclosed without departing from some of the essential features of the invention. It is, therefore, desired that the language of the appended claims be given as

reasonably broad interpretation as the prior art permits.

I claim as my invention:

1. A circuit breaker comprising a switch member movable to open and close the circuit, a casing including an openable cover for enclosing said breaker, operating mechanism for the switch member including a cam member mounted on and movable with said cover, said cam member cooperating with a part movable with the switch member to cause opening and closing movements of said switch member, a first locking means mounted on the cover and actuated with said cam member to prevent opening of said cover until the cam member is actuated to cause opening of the switch member, and a second locking means mounted on the cover and operable independently of said first locking means upon opening movement of said cover to lock the cam member in open position until the cover is closed.

2. A circuit breaker comprising relatively movable contacts, a switch member operable to cause opening and closing of said contacts, a casing including an openable cover for enclosing said breaker, operating mechanism for said switch member including a manually operable member mounted on the cover and movable therewith, a cam member separably engageable with said switch member, said cam member being movable with the cover and operable by said manual member to cause opening and closing of the contacts, and means mounted on said cover and cooperating with the cam member for moving said cam member relatively to the manual member with a snap action to cause opening and closing of the contacts with a snap action.

3. A circuit breaker comprising a switch member movable to an open and to a closed position for opening and closing the circuit, a casing including an openable cover for enclosing said breaker, operating mechanism for said switch member mounted on said cover and movable therewith, said operating mechanism including an operating member having an open and a closed position for engaging a part movable with the switch member for releasably restraining said switch member in closed position and operable to cause movement of the switch member to open position, means for at times restraining the switch member in closed position when the cover is opened, said means being incapable of operating the switch member and electroresponsive means operable in response to overload circuit conditions to cause opening movement of the switch member irrespective of the position of the operating member and irrespective of the position of the restraining means.

4. A circuit breaker comprising a switch member movable to an open and to a closed position for causing opening and closing of the circuit, a casing for enclosing the breaker including an openable cover, operating means mounted on said cover and movable from one position to a second position relative to said cover to cause opening movement of the switch member, a part removable from said breaker, and locking means on the cover cooperating with the removable part and operable upon opening movement of said cover to prevent movement of the operating means when the cover is opened, said locking means being engageable with the removable part upon closing of the cover to permit movement of the operating means.

5. A circuit breaker comprising a contact member movable to an open and to a closed position for opening and closing the circuit, a casing for enclosing the breaker including an openable cover, a member mounted on and movable with said contact member, operating mechanism mounted on the cover and movable therewith, said operating mechanism including an operating member engaging the movable member when the cover is in closed position to restrain the contact member in closed position and also operable to cause movement of the contact member to open position, and electroresponsive means cooperating with said movable member and operable in response to predetermined circuit conditions to release said movable member and permit opening movement of the contact member irrespective of the position of the operating member.

6. A circuit breaker comprising a pivoted contact member biased to open position, a casing for enclosing said breaker including an openable cover, a lever pivotally connected to the contact member, operating mechanism mounted on the cover and including a movable cam member cooperating with a portion of the lever when said cover is closed to restrain the contact member in closed position and operable to release said lever and permit movement of said contact member to open position, and an electroresponsive trip device for releasably restraining one end of the lever and operable in response to predetermined circuit conditions to release said lever and permit movement of the contact member to open position irrespective of the position of the cam member.

7. A circuit breaker comprising relatively movable contacts, a casing for enclosing the breaker including an openable cover, operating mechanism mounted on said cover and movable with said cover, said operating mechanism being movable relative to said cover for causing opening and closing of said contacts, an arc extinguisher removably mounted in the casing, and a locking member mounted on said openable cover and engageable with the operating mechanism to prevent movement thereof, said locking member being maintained in unlocking position when the arc extinguisher is in position and the cover is closed.

8. A circuit breaker comprising relatively movable contacts, a closure for enclosing said breaker including an openable cover, operating mechanism including an operating handle mounted on said cover and movable therewith, said handle being movable relatively to the cover to cause opening and closing of the contacts, an arc extinguisher removably mounted in the casing, a locking member, and said locking member being restrained in an unlocking position by engagement with the arc extinguisher when the cover is closed and operable upon opening of the cover to prevent movement of the operating handle.

9. In a circuit breaker relatively movable contacts, a casing for enclosing said breaker including an openable cover, an operating handle mounted on said cover for movement therewith and movable relatively to said cover to cause opening and closing of the contacts, an arc extinguisher removably mounted in said casing, a locking member biased to a locking position and normally restrained in an unlocking position by engagement with said arc extinguisher when the cover is closed, said locking member being operable upon opening of the cover to prevent movement of the operating handle to effect closing of the contacts and also being effective when the cover is closed with the arc extinguisher removed

from the breaker to prevent movement of the operating handle to effect closing of the contacts.

10. A circuit breaker comprising relatively movable contacts, a casing for enclosing the breaker including an openable cover, operating mechanism for said contacts including a manually operable member rotatably mounted on said cover, a cam member mounted on said cover and separably engageable with a part connected to the movable contacts, said cam member being operable in an opening direction and in a closing direction by said manual member to cause opening and closing of the contacts, said cam member being rotatable relative to said manual member, and means comprising an overcenter spring for rotating the cam member relative to said manual member in opening and closing directions with a snap action to cause opening and closing of the contacts with a snap action.

11. A multipole circuit breaker comprising a plurality of pairs of relatively movable contacts, a common operating mechanism movable to an open and to a closed position for causing simultaneous operation of all of said pairs of contacts to open and closed positions, an arc extinguisher of single unitary construction common to all of the poles of the breaker, said arc extinguisher being removably mounted in said breaker, a housing for enclosing the breaker, said housing having an openable cover, and means on said cover effective when said arc extinguisher is removed from its position in the breaker to prevent operation of the operating mechanism to the closed position.

12. A circuit breaker comprising relatively movable contacts, a casing including an openable cover for enclosing said breaker, operating mechanism for said contacts including an operating handle mounted on said cover and movable therewith, a cam member rotatably mounted on said cover having a cam surface separably engageable with a cam follower connected to the movable contact, said cam member being operable by said handle to cause opening and closing of said contacts, a pin and slot connection between the handle and said cam member, and means including an overcenter spring for moving the cam member relative to the handle with a snap action.

13. A circuit breaker comprising a switch member movable to open and close the circuit, a casing including an openable cover for enclosing the breaker, operating mechanism for the switch member including an operating member mounted on the cover and movable therewith, said operating member being rotatable to an open and to a closed position to cause opening and closing movement of the switch member, means operable to permit movement of said cover to open position irrespective of the position of the operating member, and means engageable with said operating member in the open and also in the closed position of said operating member upon opening movement of the cover to prevent rotation of the operating member from whichever position it occupied when the cover was opened.

14. A circuit breaker comprising relatively movable contacts, a casing for enclosing the breaker including an openable cover, operating mechanism for said contacts including an operating handle mounted on the cover, a cam member mounted on said cover and separably engageable with a part connected to the movable contact, said cam member being operable by said operating handle and movable relatively to said handle for causing opening and closing of the contacts, means including an overcenter spring for moving said cam member relatively to the handle with a snap action, and means engageable with a part movable with the handle to prevent movement of the handle when the cover is opened.

15. A circuit breaker comprising a contact member movable to an open position and to a closed position, means biasing said contact member to open position, a casing including an openable cover for enclosing the breaker, operating mechanism movable to "on" and "off" position for causing opening and closing of the contact member, said mechanism restraining the contact member in closed position when the cover is closed and the mechanism is in the "on" position, said operating mechanism being mounted on the cover and movable with said cover away from restraining position when the cover is moved to open position, and separate means at times effective when the cover is moved to open position to restrain the contact member in closed position.

16. A circuit breaker comprising a switch member movable to an open and to a closed position, means biasing said switch member to open position, a casing including an openable cover for enclosing the breaker, an operating mechanism mounted on the cover and operable to an open and to a closed position for causing movement of the switch member to open and closed positions, said operating mechanism being effective when the cover is closed and the mechanism is in closed position to restrain the switch member in closed position and movable with the cover away from restraining position when the cover is moved to open position, separate restraining means at times effective during opening movement of the cover and also when the cover is in open position to restrain the switch member in closed position, and means operable by the operating mechanism when said mechanism is operated to open position to render said separate restraining means ineffective.

17. A circuit breaker comprising a switch member movable to an open and to a closed position, means biasing said switch member to open position, a casing including an openable cover for enclosing said breaker, operating mechanism mounted on the cover and operable to an open position and to a closed position for causing opening and closing movement of the switch member, said operating mechanism being effective when the cover is closed and the mechanism is in closed position to restrain the switch member in closed position, and movable with the cover away from restraining position when the cover is opened, separate restraining means at times effective during opening movement of the cover and also when the cover is in the open position to restrain the switch member in closed position, and electroresponsive means operable in response to predetermined circuit conditions to cause opening movement of the switch member irrespective of the position of the operating mechanism and irrespective of the position of said saparate restraining means.

18. A circuit breaker comprising a pivoted switch member biased to open position, a casing for enclosing said breaker including an openable cover, a lever pivotally connected to the switch member, operating mechanism mounted on the cover and including a movable cam member cooperating with a portion of the lever to restrain the switch member in closed position, means comprising an overcenter spring for operating said

cam to cause movement of the switch member to open position with a snap action, an electroresponsive trip device for releasably restraining one end of the lever and operable in response to predetermined circuit conditions to cause movement of the switch member to open position irrespective of the position of the cam member.

19. A multipole circuit breaker comprising a pivoted switch member for each pole, said switch members being biased to open position, a casing for enclosing said breaker including an openable cover, a lever pivotally connected to one of the switch members, a common operating mechanism mounted on the cover and including a movable cam member cooperating with a portion of the lever to restrain the switch members in closed position and operable to cause simultaneous movement of all of said switch members to open position, and a trip device comprising means releasably restraining one end of the lever, and electroresponsive means associated with each of at least two of the poles of the breaker operable in response to predetermined circuit conditions to cause said restraining means to release said lever and thereby cause movement of all of the switch members to open position irrespective of the position of the cam member.

20. A multipole circuit breaker comprising a casing including an openable cover for enclosing said breaker, a flat base mounted within said casing for supporting the breaker, a plurality of mechanically connected switch arms pivotally suported on said base, a lever pivotally connected to one of said switch arms, a common operating mechanism for all of said poles, said operating mechanism being mounted on the cover and including a movable cam engageable with a portion of the lever and movable to a closed position to close and hold closed said switch arms said cam being movable to an open position to permit movement of all of the switch arms to open position, an electroresponsive trip device mounted on said flat base for releasably restraining one end of the lever and operable in response to predetermined conditions in the circuit of any of at least two of the poles of the breaker to release said lever and thereby cause simultaneous movement of all of the switch arms to open position, and a single arc extinguisher removably mounted on said flat base, said arc-extinguisher having a separate extinguishing chamber associated with each pole of the breaker.

21. A circuit breaker comprising a switch member movable to open and close the circuit, a casing including an openable cover for enclosing the breaker, operating mechanism for the switch member including an operating member mounted on the cover and movable therewith, said operating member being rotatable to open and closed positions to cause opening and closing movements of the switch member, means cooperating with said operating mechanism to prevent opening the cover until the operating mechanism is operated to cause movement of the switch member to open position, manual means operable to permit opening the cover irrespective of the position of the operating means, said switch member being biased to open position and held closed by said operating member when the cover is closed and the operating member is in the "on" position, means effective upon opening the cover with the operating mechanism in closed position to restrain the switch member in closed position, and an electroresponsive trip device operable in response to predetermined circuit conditions to cause opening movement of the switch member irrespective of the position of the operating mechanism and irrespective of the position of the restraining means.

22. A circuit breaker comprising a pivoted switch member movable to open and close the circuit, a casing including an openable cover for enclosing the breaker, operating mechanism for the switch member including a cam member mounted on the cover and movable therewith, said cam member being separably engageable with said switch member and rotatable to an open and to a closed position to cause opening and closing movement of the switch member, means operable to permit opening of said cover irrespective of the position of the cam member, and means engageable with a part movable with said cam member upon opening movement of the cover to prevent rotation of the cam member from whichever position it occupied when the cover was opened.

23. A circuit breaker comprising a contact means biased to open position and movable to a closed position, a casing having an openable cover for enclosing the breaker, operating mechanism for said contact means mounted on said openable cover and movable to an open position and to a closed position to effect opening and closing movements of the contact means, said operating mechanism constituting the sole means for moving said contact means to closed position and being incapable of closing said contact means when the cover is open, means mounted on the openable cover to prevent opening of said cover until the operating mechanism is moved to open position, and means mounted on said openable cover and operable upon opening of said cover to lock the operating mechanism in open position until the cover is closed.

24. A circuit breaker comprising a contact means movable too pen and close the circuit of the breaker, a casing having an openable cover, said casing constituting the sole means for enclosing said contact means, operating mechanism for said contact means mounted on said openable cover and separably engageable with said contact means, said operating mechanism being movable to an open position and to a closed position to effect opening and closing movements of said contact means, means mounted on the openable cover to prevent opening of said cover until the operating mechanism is moved to open position, and means operable upon opening of the cover to lock the operating mechanism in open position until the cover is closed, said operating mechanism being incapable of closing said contact means until the cover is closed.

HILLER D. DORFMAN.