

Dec. 5, 1944.

F. E. MYERS

2,364,465

CIRCUIT BREAKER COMPARTMENT LOCK OPERATED TRIPPING DEVICE

Filed Nov. 6, 1942

8 Sheets-Sheet 1.

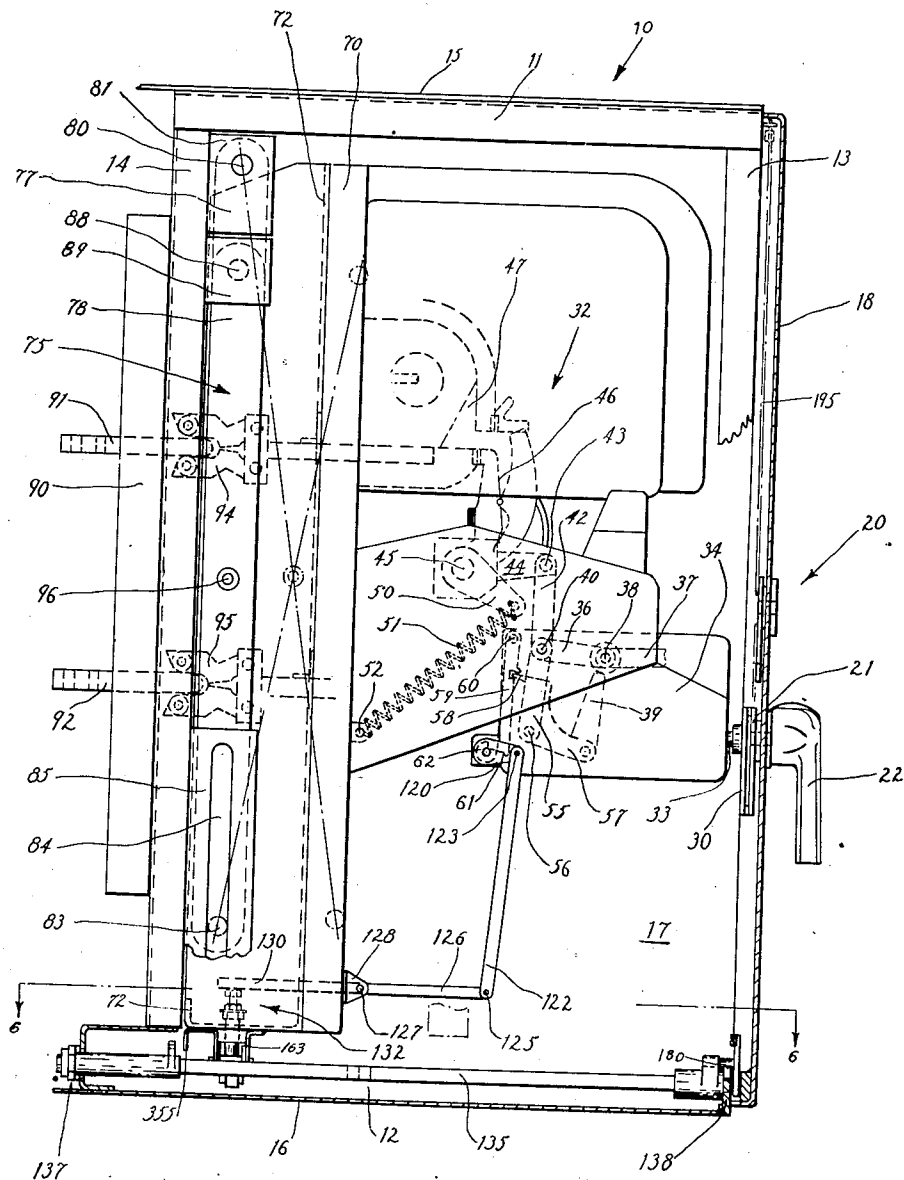


Fig. 1

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8 Sheets-Sheet 2

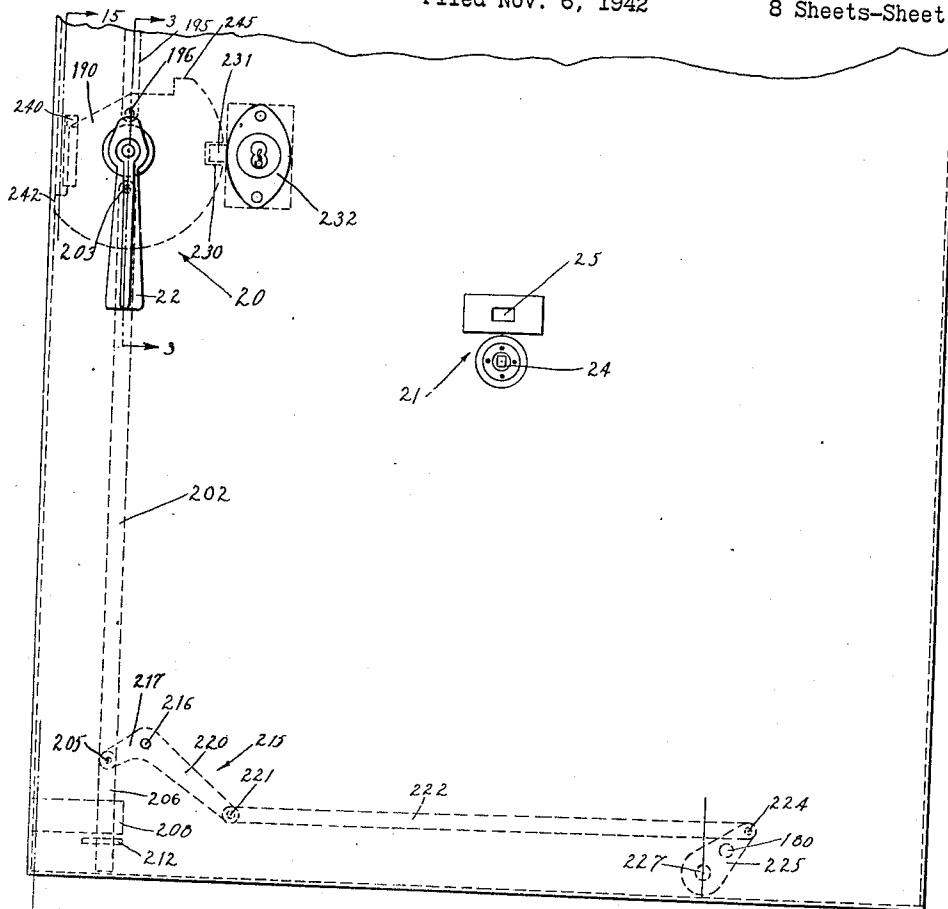


Fig. 2

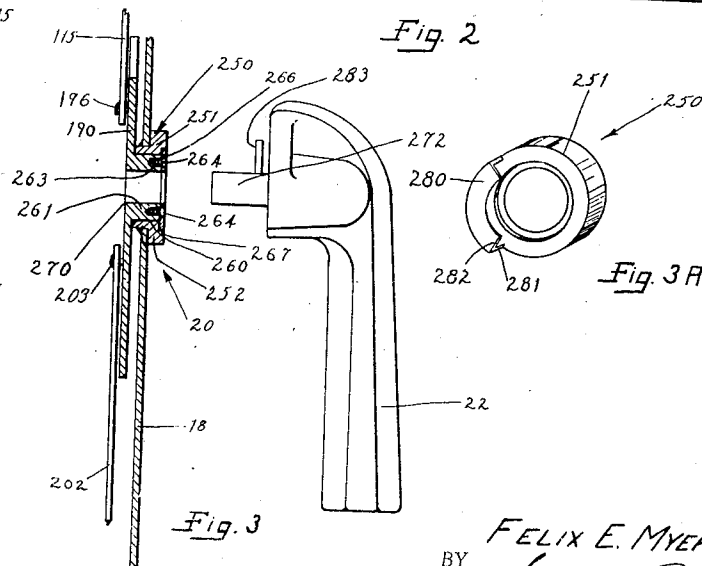


Fig. 3A

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CIRCUIT BREAKER COMPARTMENT LOCK OPERATED TRIPPING DEVICE

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8 Sheets-Sheet 3

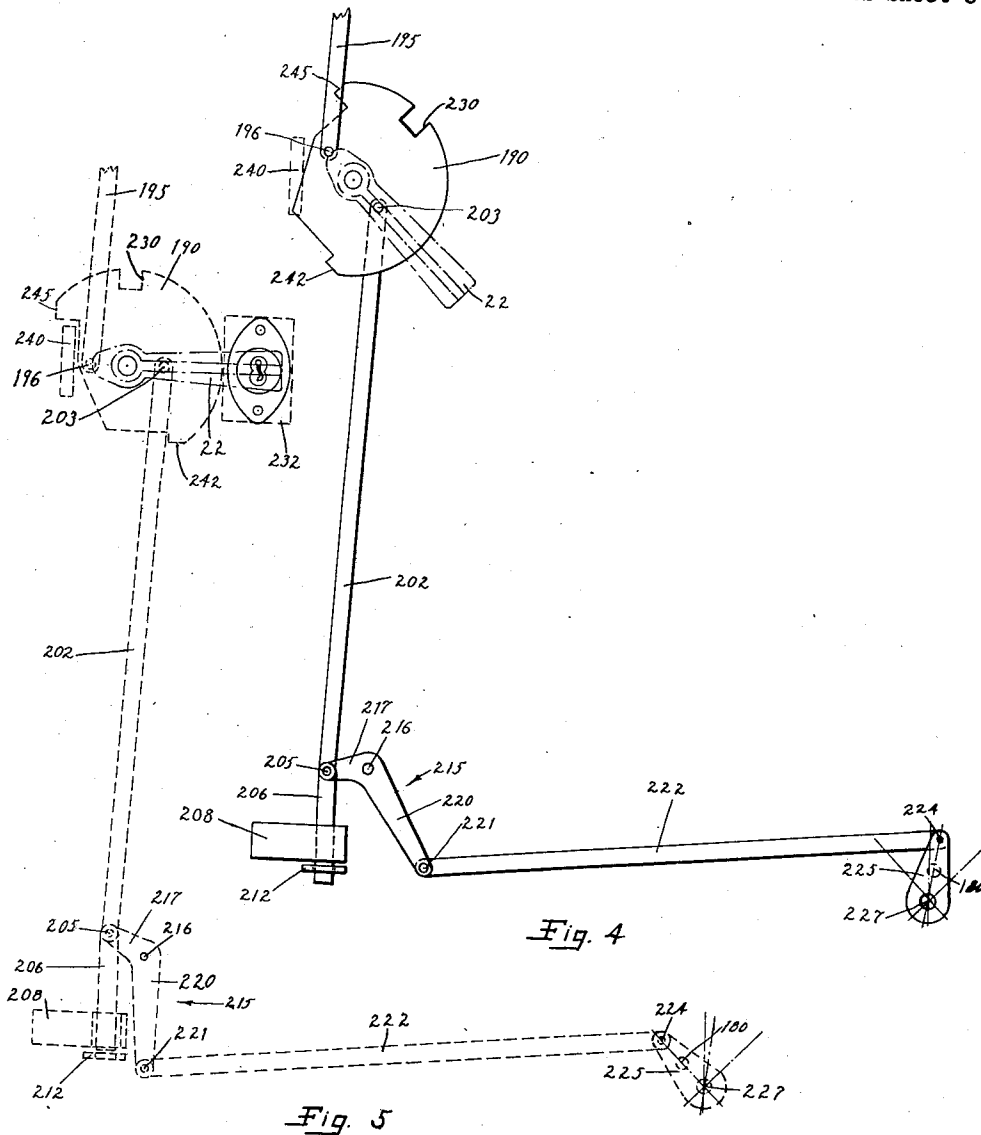


Fig. 4

Fig. 5

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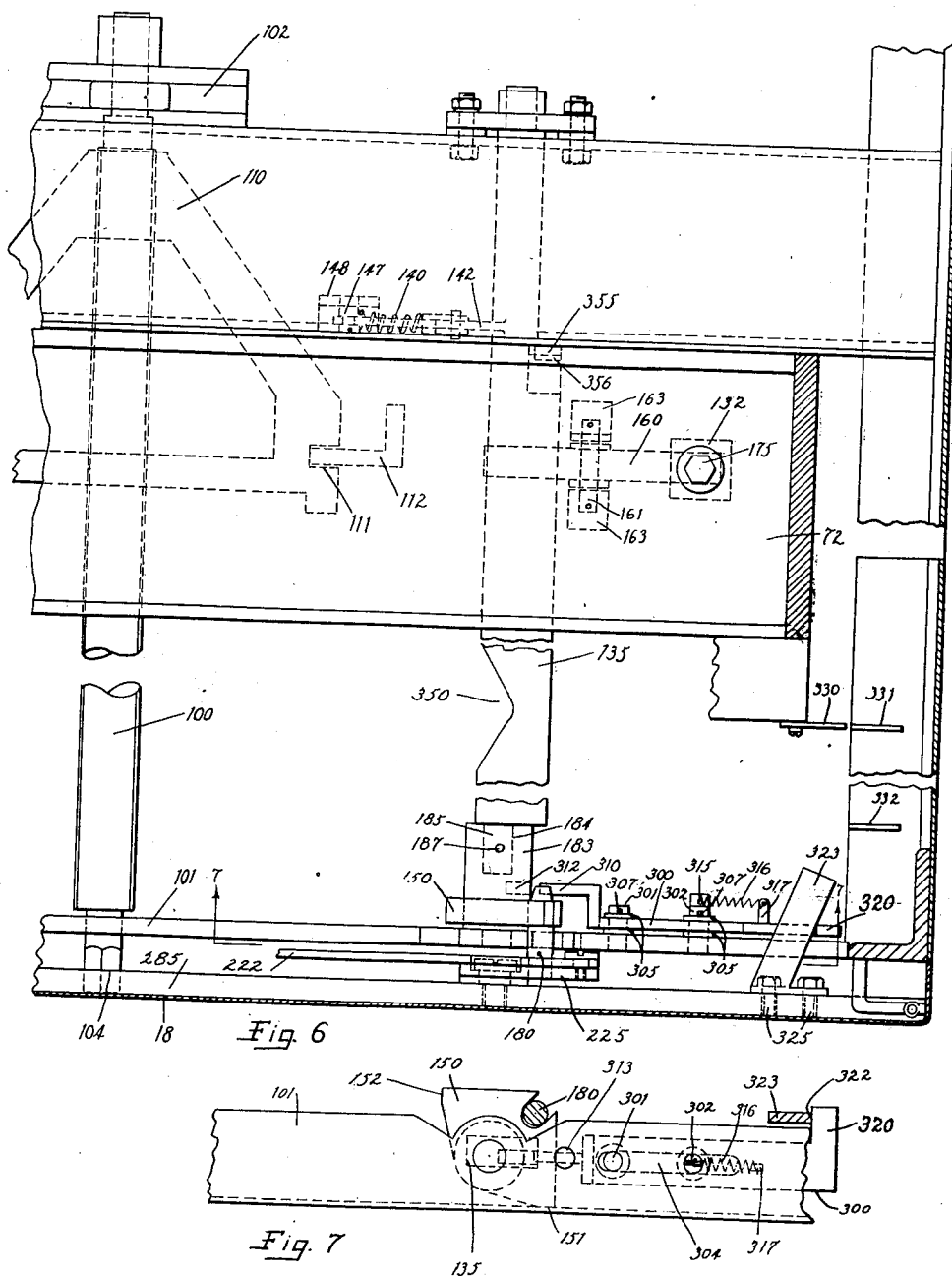
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CIRCUIT BREAKER COMPARTMENT LOCK OPERATED TRIPPING DEVICE

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8 Sheets-Sheet 4



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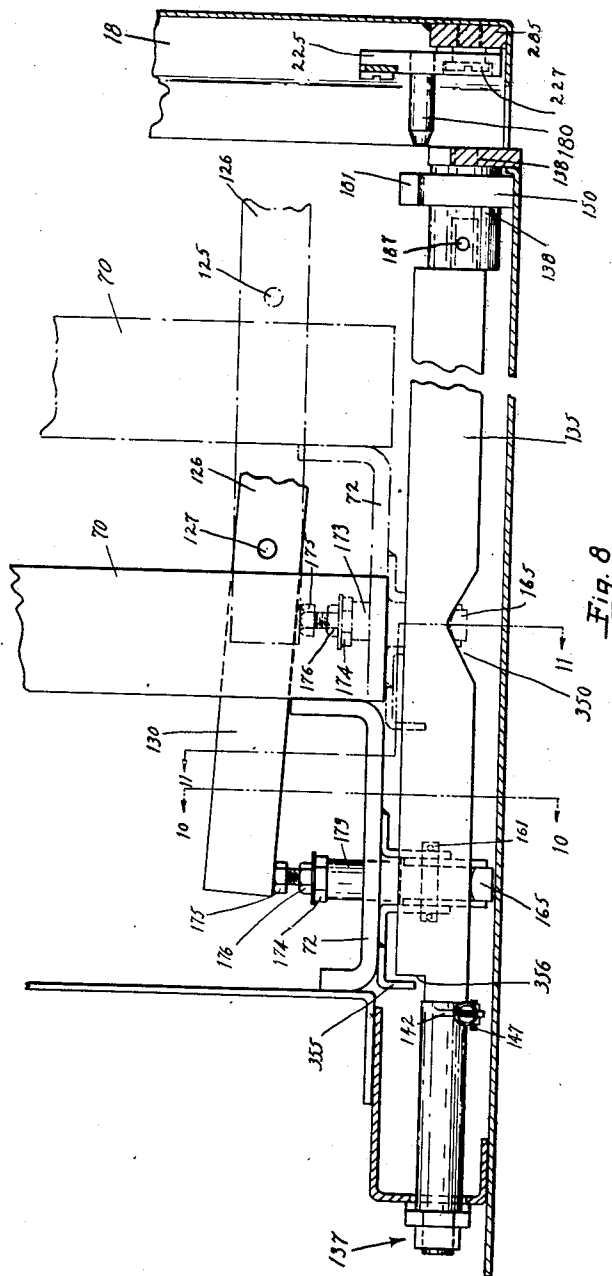
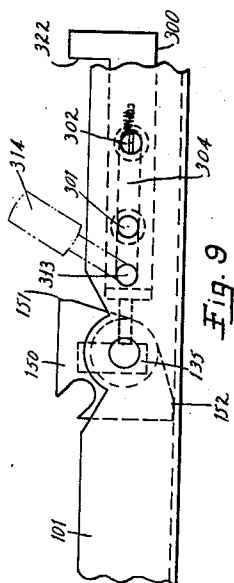
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CIRCUIT BREAKER COMPARTMENT LOCK OPERATED TRIPPING DEVICE

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8 Sheets-Sheet 5



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CIRCUIT BREAKER COMPARTMENT LOCK OPERATED TRIPPING DEVICE

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8 Sheets-Sheet 6

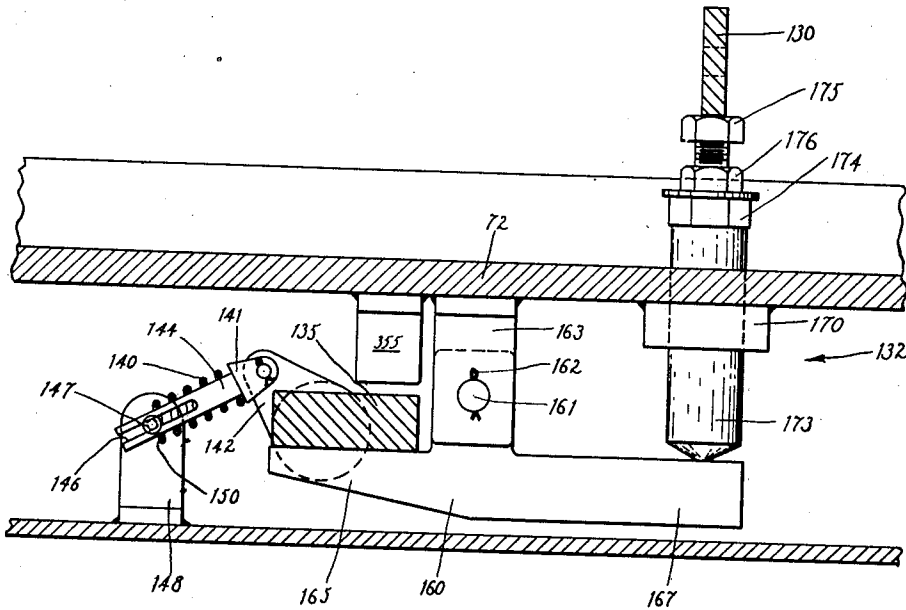


Fig. 10

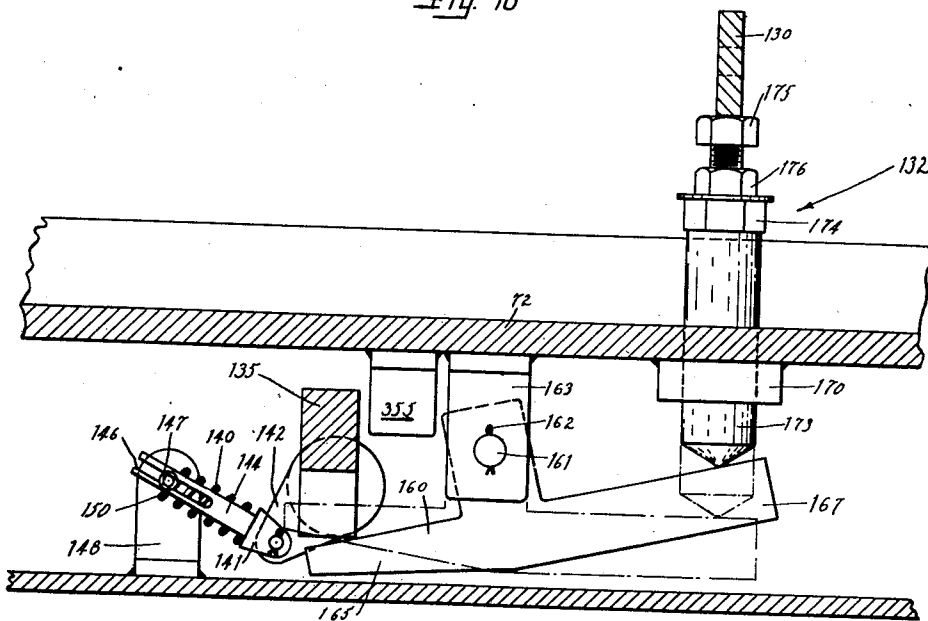


Fig. 11

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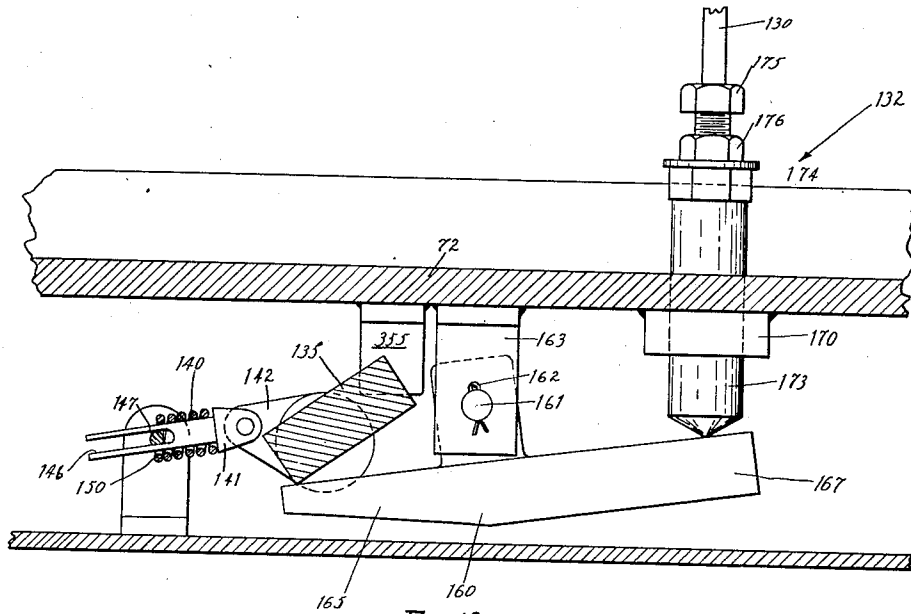


Fig. 12

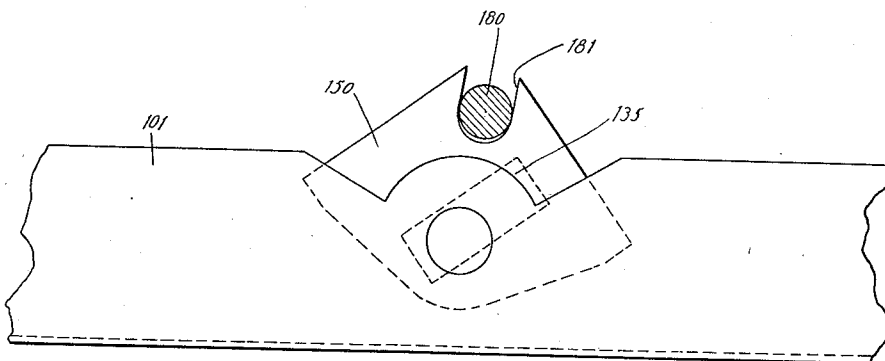


Fig. 13

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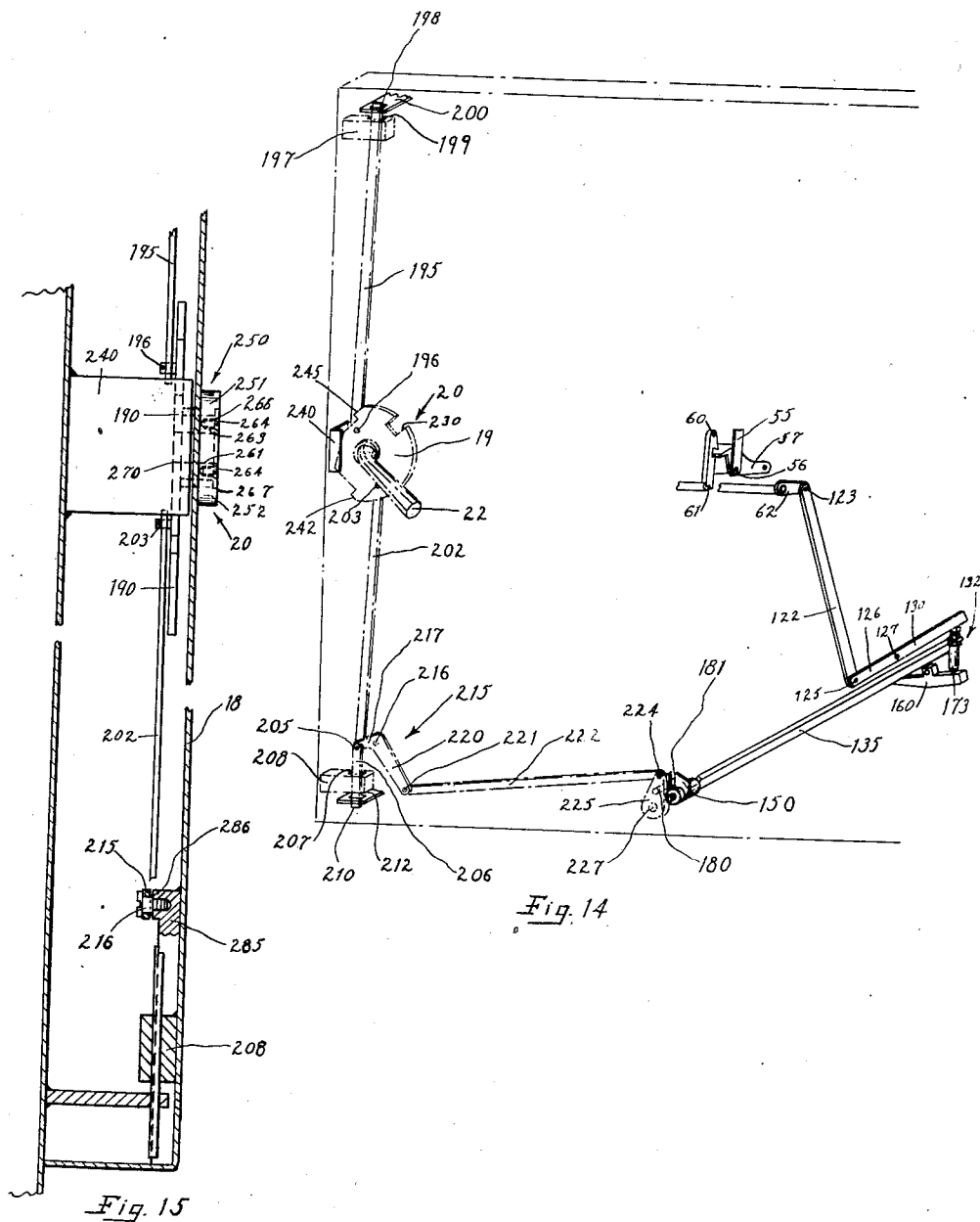
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CIRCUIT BREAKER COMPARTMENT LOCK OPERATED TRIPPING DEVICE

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8 Sheets-Sheet 8



UNITED STATES PATENT OFFICE

2,364,465

CIRCUIT BREAKER COMPARTMENT LOCK
OPERATED TRIPPING DEVICEFelix Edward Myers, Burlington, N. J., assignor
to I-T-E Circuit Breaker Company, Philadel-
phia, Pa., a corporation of Pennsylvania

Application November 6, 1942, Serial No. 464,734

8 Claims. (Cl. 200—50)

This invention relates to circuit breakers and switch gear, and more particularly to protective devices for fully enclosed switch gear having a swinging front panel or door wherein it is impossible to open the door before the circuit breaker has been tripped and wherein further means are provided to prevent energization of the circuit breaker elements until the door is closed.

In the maintenance and operation of enclosed circuit breakers, it has sometimes been found that a careless operator will open the enclosing structure before the circuit breaker has been tripped. The tripping of the circuit breaker after the door has been opened and the consequent flash has at times caused injury. Also, when the enclosing structure has been opened after the circuit breaker has been properly tripped, then it has also been possible for a careless operator to close the circuit breaker while the door is open and place the same in service position, thus jeopardizing his own safety as well as others.

The primary object of the present invention therefore is the provision of an enclosing structure for a circuit breaker or other switch gear wherein the door or front panel cannot be opened until after the circuit breaker has been tripped open.

Another object of my invention is the arrangement of an enclosing structure for a circuit breaker in such a manner that the circuit breaker contacts can not be closed and the circuit breaker itself cannot be moved into engagement with energized contacts while the door or front panel is open.

A further object of my invention is the provision of locking means for the front door or panel of a circuit breaker enclosing structure, the said locking means being so arranged that the movement thereof to unlocked position before the door can be opened simultaneously trips the circuit breaker open.

Another object of my invention is for the arrangement of the said locking means in such a manner that when the front door or panel is opened, the tripping mechanism of the circuit breaker is so arranged as to prevent closing thereof.

These and many other objects of my invention will be apparent, and where not apparent will be pointed out in the following description and drawings in which:

Figure 1 is a side view in elevation of a circuit

breaker compartment with the near wall or enclosing sheet of the compartment removed.

Figure 2 is a front view in elevation of the lower portion of the compartment door with the handle operated linkage shown in dotted lines.

Figure 3 is a cross sectional view partly in elevation taken on line 3—3 of Figure 2 and looking in the direction of the arrows.

Figure 3a is a view in perspective of one of the bearing members of Figure 3.

Figure 4 is a schematic view showing the position of the door handle and linkages when the circuit breaker is tripped.

Figure 5 is a schematic view showing the door handle and linkages when the members have been moved to a position permitting the door to be opened.

Figure 6 is a top plan view partly in section taken from line 6—6 of Figure 1, looking in the direction of the arrows and showing the operating structure in the lower part of the compartment.

Figure 7 is a fragmentary view partly in section taken on line 7—7 of Figure 6 looking in the direction of the arrows.

Figure 8 is an enlarged view of the lower section of the internal compartment structure shown in Figure 1.

Figure 9 is a view corresponding to that of Figure 7 but showing the tripped position of the elements of Figure 7.

Figure 10 is a cross sectional view taken on line 10—10 of Figure 8 and looking in the direction of the arrows.

Figure 11 is a cross sectional view taken on line 11—11 of Figure 8 looking in the direction of the arrows and showing the position of the elements when the circuit breaker has been tripped and the door is ready to be opened.

Figure 12 is a view corresponding to that of Figure 10 showing, however, the movement of the elements to the position where the circuit breaker is tripped while the door cannot yet be opened.

Figure 13 is a fragmentary enlarged view of a portion of Figure 7 showing the arrangement of the parts thereof when the circuit breaker is in tripped position while the door is still locked in.

Figure 14 is a schematic view in perspective of the various tripping elements and linkages showing the position thereof for tripping the circuit breaker without permitting an opening of the door.

Figure 15 is a cross sectional view taken on

line 15—15 of Figure 2 looking in the direction of the arrows.

Referring now to Figure 1, I have here shown a circuit breaker enclosing structure consisting of a compartment or cell in a switch board structure. The compartment 10 comprises upper and lower frame members 11 and 12 and vertical frame members 13 and 14 which serve as a supporting structure for the upper and lower enclosing sheets 15 and 16 and the side wall members 17.

The front of the cell or compartment 10 is closed by a hinged door or panel 18 which is suitably swingingly supported on one of the side frame members 13 and is provided with door actuating and opening mechanism 20 and circuit breaker operating mechanism 21. A common handle 22 may be utilized for each of the operating mechanisms carried by the door. The operation of the handles is hereinafter more specifically set forth.

The circuit breaker operating mechanism 21 is a cam which is rotatably supported in suitable bearings in the front panel or door structure 18 and is provided with a central squared opening adapted to receive the squared end of the handle 22. The squared opening 24 for receiving the handle end is more clearly shown in Figure 2 immediately beneath a suitable indicating device 25 which is provided with means for indicating the position of the circuit breaker, whether tripped or closed.

Cam 21 on the interior of door 18 engages the operating cam 30 of the circuit breaker 32, the said operating cam 30 being rotatably supported on the shaft 33 extending from the operating mechanism 34 of the circuit breaker. Cam 21 is mounted on the door 18 and swings outwardly therewith when the door is opened but is so arranged that it will interengage with the operating cam 30 of the circuit breaker when the door is closed.

The two cams may have any form suitable for interengagement in order to permit the operation of the circuit breaker to open or closed position while the door is closed or may have a form such as that shown in Graves Patent No. 1,955,287 or in Application Serial No. 377,605 both of which are assigned to the assignee of the present invention.

The operating mechanism contained in the housing 34 may be actuated by the cams to open and close the circuit breaker contacts. The circuit breaker in Figure 1 is shown in closed position. The links 36 and 37 have been extended so that the roller 38 on the pivot therebetween is supported by the abutment 39. This serves to provide a partial support for the pin 40 to which one end of the link 42 is secured.

The upper end of the link 42 is pivotally secured by pin 43 to the arm 44 which in turn is secured to and operates the contact carrying shaft 45. The movable contact structure 46 carried by the shaft 45 may thus be actuated into and out of engagement with the stationary contact structure 47 when the shaft 45 is rotated in appropriate directions.

A lever 50 is also secured to the contact carrying shaft 45, the outer end of the said lever having secured thereto one end of the tension spring 51, the opposite end of which is secured to the bracket 52 carried by the panel 70 of the circuit breaker. The pin 40 which as pointed out above is partially supported through the abutment 39, the roller 38 and links 36 and 37 is further sup-

ported by the link 55 which at its opposite end is pivotally secured at 56 to the latch lever 57.

The latching tip 58 of the latch lever 57 is held by the primary latch 59 which is supported at its upper end on the pivot 60. The lower end 61 of the primary latch 59 is engaged by the secondary latch 62. The said secondary latch 62 may be a milled shaft rotation of which in a clockwise direction will result in tripping of the circuit breaker.

The type of operating mechanism herein described is quite similar in its various functions to the operating mechanism shown in application Serial No. 377,605, assigned to the assignee of this invention and forms no part of the present invention except insofar as the trip elements of this type of structure may be integrated with the door actuating elements to result in a tripping open of the circuit breaker preliminary to the opening of the door.

The entire circuit breaker 32 is supported on a panel 70 which in turn is secured to a vertical frame member 72 which is slidable, in its vertical position, to selected positions in the compartment 10. The slidable supporting frame 72 is carried by a suitable extensible supporting structure 75 which comprises a pair of pantograph links 77 and 78 on each side. Link 77 is pivotally supported on the pin 80 which in turn is carried by the bracket 81 welded to the compartment structure.

The opposite end of link 77 is provided with a pin 83 slidable in a slot 84 in a bracket member 85 carried by the vertical frame supporting structure 72. Link 78 is pivotally carried by pin 88 on bracket 89 which in turn is carried by the frame 72. The opposite end of link 78 is provided with a pin and is supported in a slotted bracket similar to bracket 85 which however is secured to the compartment frame.

The mid-point of the two links 77 and 78 are joined by the pin 96 so that as the frame 72 and the circuit breaker panel 70 are moved towards the right, the links 77 and 78 assume an X form as their lower pivot pins move upward in their respective slots. This mechanism will maintain the circuit breaker panel 70 in a vertical position during its horizontal movement.

This type of pantograph circuit breaker supporting structure is more clearly shown and described in Graves Patent No. 1,955,287, as well as in application Serial No. 377,605 both of which are assigned to the assignee of this application. The particular type of slidable supporting structure forms no part of the present invention. Although various operations of the present invention relate to the maintenance of the door in open position while the circuit breaker is in a test position within the compartment, any type of sliding structure which will support the circuit breaker panel in erect condition while it is moved to various positions in the compartment may, however, be used and this invention is not limited to the pantograph structure herein set forth.

The rear end of the compartment structure is provided with an insulating panel 90 which carries suitable stationary disconnect contacts 91 and 92 which in turn are at their left hand ends connected to any suitable source of current supply. The stationary disconnect contacts project through the front of the panel and engage suitable movable disconnect contacts 94 and 95 which in turn are carried by the circuit breaker

panel 70 and thus provide means for carrying current to the circuit breaker structure 32.

The specific disconnect contacts herein described form no part of the present invention and may have any suitable form such as the form shown in application Serial No. 421,734 assigned to the assignee of this application. It is obvious, however, that when the circuit breaker structure is moved to the right, the movable disconnect contacts 94 and 95 disengage from the stationary disconnect contacts 91 and 92 thus making it possible to test the operation of the circuit breaker while no current flows therethrough.

The circuit breaker may be moved horizontally within the compartment structure in any suitable manner. At the left hand side of Figure 6 I have shown a simplified means for effecting this operation consisting of a threaded member 100 rotatable in a suitable bearing in a front bracket 101 supported at the lower end of the compartment structure and at the opposite end rotatable in a suitable thrust bearing 102. The front end of the threaded member is squared at 104 to receive the end of a socket wrench or similar member to effect rotation of the threaded member 100. A nut 110 is mounted on the threaded member and is provided with slots 111 on each side which receive flanges 112 secured to the lower end of the movable frame supporting structure 72.

Accordingly, when the threaded member 100 is rotated in an appropriate direction, the nut 110 is moved outwardly towards the front of the compartment thus moving the flange 112 and thus the frame member 72, thereby moving the circuit breaker panel horizontally and extending the pantograph supporting mechanism. When the threaded member is rotated in the opposite direction, then the circuit breaker panel and its supporting frame are moved inwardly and the pantograph supporting structure is correspondingly collapsed.

The door structure is so arranged that before the same can be opened various linkage mechanisms hereinafter described must be actuated in such a manner as to trip the circuit breaker. The tripping action will of course be obtained by rotation of the milled shaft 62 (Figure 1) in a clockwise direction to release the primary latch member 59 which in turn will permit a collapse of the movable contact supporting links.

It is obvious of course that the milled shaft 62 is operated by any suitable automatic tripping mechanism which will cause a rotation of the same under predetermined overload conditions. The milled shaft 62 also carries an arm 120, the rotation of which downwardly will also effect the necessary clockwise rotation of the shaft and hence a tripping of the circuit breaker.

A link 122 is pivotally secured at 123 to the outer end of the arm 120 and the opposite end of the said link 122 is pivotally secured by the pin 125 to the lever 126. Lever 126 is rotatably mounted on the fulcrum pin 127 which is carried by a bracket 128 secured to the panel 70 of the circuit breaker. The lever 126 projects through a suitable opening slot or notch in the lower end of the panel 70 and comprises an arm 130 projecting beyond the rear end of the panel. This arm rests upon the upper end of a suitable tappet 132.

It will now be obvious that raising the tappet 132 will cause the arm 130 of the lever 126 to rise thus depressing the pin 125 at the opposite

end of the lever, thus pulling the link 122 down and hence rotating the arm 120 and the milled shaft 62 in a clockwise direction, thus tripping the circuit breaker open.

The door opening structure 20 which is to be operated by the handle 22 is so arranged that when the handle is moved to unlock the door, the tappet 132 is caused to rise. A tripping bar 135 is provided in the lower part of the compartment (Figures 1 and 8). The said tripping bar is rotatably supported in the back bearing 137 and in the front bearing 138. This bar may more clearly be seen in Figures 6, 8, 10, 11, 12 and 13 and is over substantially all of its length of rectangular or substantially rectangular cross section.

The bar is maintained in its various operating positions as seen in Figures 10 and 11 (see also Figure 6), by means of a compression spring 140. One end of the compression spring 140 bears against the pivoted bearing 141 on the arm 142 extending from the back end of the tripping bar 135. The pivoted bearing carries a plunger 144 which is surrounded by the spring 140, the said plunger being slotted at 146 to engage the circumferentially slotted pin 147 carried by the stationary bracket 148 secured to the bottom of the compartment. The outer end 150 of the compression spring 140 is held in fixed position with respect to the pin 147 in any suitable manner, or it may simply bear against said pin.

In Figure 10 is shown the position of the tripping bar when the circuit breaker is in closed position or when it is so arranged that the circuit breaker may readily be moved to closed position. In Figure 11, the tripping bar is shown in a position which is rotated 90° counterclockwise from the position of Figure 10 where it has actuated the tripping elements.

As will readily be seen from Figures 10 and 11, the spring 140 has an over-center action. Thus in rotating the tripping bar 135 from the position shown in Figure 10 to the position shown in Figure 11, the spring 140 is first compressed for approximately 45° of the rotation where it reaches its maximum compression. Then, as the tripping bar 135 is further rotated to the position shown in Figure 11, the spring 140 may now expand again on the opposite side of center and thus bias the tripping bar 135 into the position shown in Figure 11.

Suitable stops must however be provided to fix the two positions of Figures 10 and 11. In the absence of such stops, the spring 140 by further expansion, say, in the position of Figure 10, would cause the tripping bar 135 to rotate clockwise to an alternate tripping position. Likewise, in the absence of such stops further expansion of the spring when the tripping bar is in the position of Figure 11 may cause a counterclockwise rotation of the tripping bar 135 to a non-tripping position.

As seen, however, in Figures 7 and 9, the tripping bar is provided with a suitable stop element which fixes the maximum rotation in either direction. The forward end of the tripping bar is provided with a fan-shaped cam 150, the additional functions and operations of which are hereinafter further described.

The cam 150, however, for purposes of this description, is provided with stop elements 151 and 152. When the tripping bar is in the position shown in Figure 10, the cam 150 has been rotated to the position shown in Figure 7 where the stop

element 151 bears against the bottom sheet of the compartment and limits further rotation in a clockwise direction. When the tripping bar 135 has been rotated counterclockwise to the trip position as shown in Figure 11, then the cam 150 which is rigidly secured to the tripping bar 135 is likewise rotated counterclockwise to the position shown in Figure 9 where the stop element 152 bears against the bottom sheet of the compartment and thus prevents further rotation in that direction.

Thus the position of the tripping bar 135 in either the trip position thereof or in the position where it permits operation of the circuit breaker is fixed first by the action of the over center spring 140 which urges the tripping bar to the selected position and secondly by the stop elements 151 or 152 on the fan-shaped cam 150 which oppose the compressive action of the spring 140 when the tripping bar has reached the selected position.

The manner in which the various positions of the tripping bar 135 affect the operation of the tappet 132 to effect a tripping of the circuit breaker through the links 126 and 122 is more clearly shown in Figures 10, 11 and 12. A tripping lever 160 is pivotally supported on a pin 161 and is secured thereon by means of the cotter pin 162. The pin 161 is carried by a bracket 163 secured to the under side of the frame 72. One arm 165 of the tripping lever 160 is engaged beneath the tripping bar 135. The opposite arm 167 bears against the lower end of the tappet 132.

Tappet 132 is slidably positioned by the reinforcing bracket 170, an opening being provided through bracket 170 and in the lower end of the frame 72. The tappet consists of a cylindrical rod 173 the upper end of the said rod being at 174 hexagonal in shape and is tapped to receive the adjusting screw 175 which is locked in position by the lock nut 176. The head 175 of the adjusting screw bears against the under surface of the arm 130 of the lever 126 as above described. The adjusting screw 175 provides for simplified means of adjustment for any variation in the dimension of the parts so that these variations may be compensated for.

In Figure 10, the tripping bar 135 is shown in horizontal position corresponding to that of Figures 1 and 6 which is the normal operating position in which current can be sent through the circuit breaker and in which the tappet 132 is permitted to remain in its lowered position to avoid a tripping of the latch 62.

In Figure 11 the tripping bar 135 has been rotated 90° counterclockwise. In this position, the circuit breaker has been fully tripped and the compartment door may be opened. This counterclockwise rotation of the tripping bar 135 has depressed the end 165 of the tripping lever 160 and has thus raised the end 167 thereby raising the tappet 132, and also raising the end 130 of the lever 126; in this way the milled shaft 62 of the circuit breaker tripping mechanism has been rotated clockwise thus tripping the circuit breaker open.

The tripping bar 135 as may readily be seen is now maintained in the tripping position of Figure 11 by means of the compression spring 140 in the manner previously described. The apparatus is so designed however that it is not essential to rotate the tripping bar 135 for a full 90° turn in order merely to effect a tripping of the circuit breaker. The link members 125 and 122 and the milled shaft 62 are so arranged that a mini-

mum of lift by the tappet 132 will result in a tripping of the breaker. This minimum motion of the tappet 132 may be accomplished by a rotation of the tripping bar in a counterclockwise direction of not more than 35°.

This condition is more clearly shown in Figures 12 and 13 wherein it will be seen that the tripping bar has been rotated roughly 35° counterclockwise corresponding to a similar rotation of the fan-shaped cam 150. The end 165 of the tripping lever 160 has been forced downwardly causing a consequent lifting of the end 167 and of the tappet 132 to trip the circuit breaker.

In Figure 13 it will be seen that the fan-shaped cam 150 has likewise been rotated to the same degree as has the tripping bar 135. The spring 140 (Figure 12) has been compressed but has not passed through center so that when the rotative force is removed from the tripping bar 135, the spring 140 may expand once more to reset the tripping bar in the position of Figure 10.

The tripping bar itself is caused to rotate by the operation of the handle 22 when it is inserted in the operating mechanism 20 (Figure 1). The operating mechanism for the tripping bar terminates in a pin 180 which engages a slot 181 in the fan-shaped cam 150 (Figs. 7 and 9). The fan-shaped cam 150 is rigidly secured to a sleeve 133 (Figure 6) having a squared hole 184 adapted to receive a similar squared extension 185 of the tripping bar 135.

A tapped hole 187 is provided for a set screw in order to integrate the cam 150 with the tripping bar 135. Any other suitable means of securing of the fan-shaped cam 150 to the tripping bar 135 may of course be utilized, the essential element being that any rotative force being imparted to the cam 150 by the pin 180 should be transmitted to the tripping bar 135.

The manner in which the pin 180 is operated to rotate the fan-shaped cam 150 and hence to rotate the tripping bar 135 is shown schematically in Figure 14.

A cam member 190 is rotatably mounted on the door 18 in a manner hereinafter more specifically described and is so arranged as to be operable by the handle member 22. An upper link 195 is pivotally secured at 196 in any suitable manner to the cam member 190. The upper end of the link passes through a slot 199 in the bracket 197 mounted on the door. In the closed and locked position of the circuit breaker, the outermost end 198 of the link 195 passes through a slot in a bracket 200 secured to the upper portion of the compartment structure.

Similarly, a lower link 202 is pivotally secured in any suitable manner at the pivot 203 to the cam member 190. The pivots 196 and 203 are 180° apart on opposite sides of the center of rotation of the cam member 190 so that the link 195 will be raised when the link 202 is lowered and vice versa. The lower end of the link 202 is provided with the pivot pin 205.

An additional link 206 is secured to the pivot 205 and extends downwardly through the slot 207 in the bracket 208, likewise mounted on the door 18. The lowest portion 210 of the additional link 206 passes through a slot in the bracket 212 which is secured to the cell structure.

When now the cam 190 is rotated so that the outer ends of the links 195 and 206 pass through the slots in the brackets 200 and 210, the door is locked in position to close the compartment. The door cannot be opened until the cam 190 is rotated to a position where the ends of links 195

and 206 are removed from the slots in brackets 200 and 212.

A bell crank lever 215 is rotatably secured on the door panel 18 by means of the pivot 216 and has an arm 217 the end of which is secured to the pivot 205 between links 202 and 206. The opposite arm 220 of the bell crank lever 215 is pivotally secured at 221 to the end of link 222. The opposite end of the link 222 is pivotally secured at 224 to the end of the crank 225, the said crank being pivoted at 227 on the door.

The crank 224 is provided with the pin 180 which projects into the slot 181 of the fan-shaped cam 150 which in turn is mounted on the end of the trip bar 135 and operates in the manner previously described.

In Figure 2 I have shown the position of the various operating elements of Figure 14 when the compartment door is closed and locked in position. Here it will be seen that the links 195 and 202—206 have been extended so that they pass through the respective brackets 200 and 212 to lock the door in position. In addition, the cam member itself has been locked in position so that it cannot be rotated by an unauthorized person.

To accomplish this purpose, the cam member is provided with a slot 230, to receive the bar 231 of a key operated lock 232. The slot 230 is opposite the extensible bar 231 in the fully closed and locked position of the door panel so that a key may be utilized in lock 232 to effect the engagement shown in Figure 2.

The rotation of the cam towards the locking position is limited so that when the door is fully locked in position, the cam can rotate no further in the locking direction and the said limit of rotation also predetermining the point at which the slot 230 will come to rest so that it may be engaged by the bar 231.

This limitation of rotation may be obtained in any suitable manner. Thus the cam 190 may be provided with projections 242 and 243 adapted to engage the angle clip 240 which is secured to the cell wall adjacent the door panel.

The angle clip itself serves as an additional point of securement for the door since the cam 190 carried by the door rotates behind the angle clip and is released therefrom only when it is rotated from the position shown in Figure 2 to the position shown in Figure 5; this thereby provides a three point locking system for the free edge of the door, at the top and bottom and at the angle clip 240.

When the cam has been rotated to the fully locked position shown in Figure 2, the projection 242 thereof engages the angle clip 240 and prevents further rotation.

In Figure 5 I have shown the position of the cams and linkages when the door has been fully unlocked. The cam has here been rotated 90° from the position shown in Figure 2 so that the ends of links 195 and 202—206 have been disengaged from the locking brackets 200 and 212 and the opposite stop member 245 on the cam 190 has engaged the upper surface of the angle clip 240 to limit further movement.

It will be obvious that before such rotation could take place, the key operated lock 232 must be turned so that the bar 231 is withdrawn from the slot 230. The position of the operating linkages shown in Figure 2 corresponds to the position of the trip bar shown in Figure 10. The position of the operating linkages shown in Figure 5 corresponds to the position of the trip bar shown in Figure 11.

In Figure 4 I have shown the arrangement of the operating linkages which corresponds to the arrangements of the trip bar shown in Figures 12 and 13. Here the cam 190 has been rotated sufficiently to cause through the linkages 202, 215 and 222, an effective rotation of the trip bar 135 to effect the trip of the circuit breaker.

However, it will be seen in Figure 4 that the link 195 and the link 202—206 have not been fully withdrawn from their respective locking brackets 200 and 212 so that the door cannot be opened. It will thus be obvious that the locking mechanism shown in Figures 2, 4 and 5 may under special circumstances be used to trip the circuit breaker open without unnecessarily unlocking the door.

It will also be clear from an inspection of Figures 2, 4 and 5 and their corresponding Figures 10, 11 and 12 that the tripping of the circuit breaker is effected during the unlocking operation and takes place before the door is unlocked and hence takes place before the door can even begin to open.

The cam member 190 may be mounted on the door in any suitable manner to permit rotation thereof by the handle 22. A preferred way is shown in Figures 3 and 15. In Figure 3 I have shown a bearing 250 in the front door panel 18 for the cam member 190.

The bearing itself consists of a cylindrical member welded to the panel 18, the said cylindrical member having a flange 251. The panel 18 has been drilled to receive the smaller cylindrical diameter 252 of the cylindrical bearing 250 and to provide a suitable support therefor. The bearing member 250 has a bore 260 to receive the cylindrical extension 261 of the operating cam 190.

The extension 261 of cam 190 is tapped at 263 to receive screws 264, 264 which secure the holding washer 266 in place in the counterbore 267 of the outer flange 251 of the bearing 250.

The back surface of the cam 190 bears against the inner surface of the bearing 250 and the cam is thus rotatably secured within the bearing 250 but, however, cannot escape longitudinally therefrom.

The extension 261 is provided with a squared hole 270 to receive the corresponding squared shaft 272 on the handle 22. The holding washer 266 also has preferably a squared hole although it may have a cylindrical hole to receive the shaft 272 of the handle 22. The bearing member which supports the cam 21 which operates to open or close the circuit breaker may be made in substantially the same manner.

In Figure 3a it will be seen that the outer face 251 of the bearing member 250 is equipped with an L-shaped extension 280 the said extension comprising an angular leg 281 and a reentrant ledge 282. The handle shaft 272 is provided with a protruding fin 283 which when inserted in the bearing member and rotated in a counterclockwise direction to fully unlock the door will slide under the reentrant ledge 282 of the extension 280. In this position when the circuit breaker has been tripped and the door fully unlocked force may be applied to handle 22 to pull the panel door open. Without such an extension 280, a pull on the handle when the door has been fully opened will result in the retraction of the handle.

The bearing member 24 which is used for merely opening or closing the circuit breaker need not of course be provided with a similar ex-

tension 280 since no pull is to be exerted on the handle to result in any operative function when the handle is inserted in said bearing member.

In order to provide for rigid securement of the lever 215 and the crank 225 on the door panel, a reinforcing bar 285 is secured to the door panel having an extension 286 within which the shouldered screw 216 may be mounted. (See Figure 15.)

Similarly (see Figure 8), the actuating crank 225 is pivotally secured to the reinforcement 285 by the shouldered screw 227. Inspection of Figure 8 will also clearly show the manner in which the pin 180 carried by the crank 285 may be moved to engage the slot 181 in the fan-shaped cam 150 to operate the mechanism.

By the means herein set forth, it will now be clear that the door cannot be opened until the circuit breaker has been tripped so that it will be impossible for the operator to be injured by the tripping open of an energized circuit breaker when the door is opened. When the panel door 18 has been fully opened and the inside operating mechanism has been exposed, there is a possibility that a careless or thoughtless operator may tamper with the tripping bar 135. A locking mechanism may then be provided to prevent any unauthorized revolving of the tripping bar 135, especially while the door is opened.

This locking mechanism may more clearly be seen in Figures 6, 7 and 9 and consists of a plunger shaped bar 300 secured to the front structural member 101 by means of pins 301, 302 which extend through the slot 304 in the bar 300. Holding washers 305, 305 are mounted on the pins on either side of the plunger bar 300 and maintained in place by cotter pins 307, 307, thus securing the plunger bar 300 in sliding position upon the pins 301—302.

The end 310 of bar 300 is narrowed to be received by the locking slot 312 in the supporting sleeve 183 of the cam 150. The end of the pin 302 is machined at 315 to receive and hold one end of the tension spring 316, the opposite end of which is supported by bracket 317 on the right hand end of the plunger bar 300. The bar 300 is thus continuously biased towards the slot 312.

The bar 300 has at its outermost right hand end a vertical shoulder 320 which will receive the surface 322 of the angle bracket 323 which is secured to the door panel 18 in any suitable manner as for instance by the screws 325. When the door 18 is swung open, the bracket 323 will move outwardly and will slip away from the shoulder 320 of the plunger bar 300. The spring 316 will thus urge the plunger bar towards the supporting cylinder member 183 of the cam 150 and thus urge the end 310 of the bar against the surface thereof.

When a full 90° rotation has been reached as shown in Figure 9, the end 310 of the plunger bar will enter into the slot 312 of the sleeve 183 and thus lock the sleeve 183 and hence the trip bar 135 against any rotation whatever. When the door is closed again, the angle bracket 323 will engage the shoulder 320 and draw the bar 300 to the right against the bias of spring 316 thus drawing the end 310 thereof out of the locking slot 312 and thereby unlock the tripping bar 135 so that it may be rotated.

Thus it will be seen that the door cannot be opened until the tripping bar has been rotated to the position shown in Figures 11 and 9. When the door is open, the locking element 310 engages the slot 312 and prevents any opera-

tion whatever of the tripping bar 135 until the door is closed whereupon the locking element 310 is withdrawn. The end 104 of the threaded element 100, the operation of which will move the circuit breaker to various positions within the compartment is uncovered when the door is opened so that a socket wrench may be used to draw the circuit breaker out to its test position in which case the disconnect contacts are separated at a safe distance.

A pointer 330 is secured to the movable frame 72 in any suitable manner as shown in Figure 6. This pointer may register with two marks 331 and 332, indicating respectively the service and the test position of the circuit breaker, the latter position being that wherein the circuit breaker has been safely deenergized.

When the circuit breaker has reached the test position wherein the pointer 330 registers with the mark 332, the tripping lever 160 moves opposite the notch 350 in the tripping bar 135. As seen particularly by the dotted line positions of Figures 8 and 11, the notch 350 thus permits the tripping lever 150 to rise to normal position, thus also permitting the tappet 132 to drop to its lowered position so that the circuit breaker may be manually closed to permit observation of its functioning by an inspector. This is necessary since the tripping bar 135 is so arranged that when the circuit breaker has been moved away from the service position, the tripping bar can under no circumstances return to its horizontal position of Figure 10 but remains in the position of Figure 11. This is accomplished by the provision of an angle clip 355 welded to the bottom of the frame 72 and extending immediately behind the shoulder 356 of the tripping bar 135 when the circuit breaker is in service position.

By reason of this position of the angle clip 355, the tripping bar 135 may in the service position of the circuit breaker be readily rotated to any desired position. When the circuit breaker is withdrawn from the service position as shown in Figures 8 and 11, then on the initial movement of the panel, the lower end of the angle clip 355 moves alongside of the upper part of the tripping bar 135 (see particularly Figure 11) and thus prevents the bar from being moved clockwise to its normal position of Figure 10. This arrangement assures the maintenance of the tripping lever 160 in tappet raising position during movement of the circuit breaker between the test and service positions. The notch 350 is provided with sloping sides so that if in the test position the circuit breaker has been closed and the operator starts to move it either towards the front of the compartment or towards the service position, the end 165 of the lever 160 will be depressed and the circuit breaker latch will be released.

From the foregoing it will be obvious that the compartment operating mechanism has been so arranged that the circuit breaker will be tripped before the door of the compartment is free to open and is maintained in that position under all conditions except when the circuit breaker is in predetermined test position. On movement in either direction away from test position, if the circuit breaker has been left closed, it will be automatically tripped when such movement is initiated.

Since it is desired that the circuit breaker which is to be used in connection with the mechanism herein described be of the trip free type, it will be impossible to make the contacts touch

upon an attempted closure of the circuit breaker while the tripping mechanism is in the actuated position of Figure 11. In closing the compartment door, it is necessary to hold the handle 22 in its extreme raised or counterclockwise position so that the actuating pin 180 may correctly engage the slot 181 of the tripping cam 150. It will be impossible to close the door if this condition is not satisfied since the design of the fan-shaped cam 150 is such that it will not permit the pin to enter into the compartment in a misaligned position.

Upon closure and locking of the door, removal of the operating handle leaves a surface which is neat and free from any protruding mechanism.

The operation of this device is both simple and safe. Should the inspector or operator attempt to open the door before the circuit breaker has been tripped, then in the process of unlocking the door and before the door is fully unlocked, the circuit breaker is tripped open so that thereafter the door may be opened with safety.

It is necessary merely for the operator to insert the handle 22 in position, holding the same aligned vertically into the opening 270 in the member 261 which is carried by the bearing 250. He then rotates the handle counterclockwise with respect to Figure 2 until the position of Figure 5 is reached, whereupon the door may be swung open.

This operation, as above described, trips the circuit breaker open as the handle moves through the position shown in Figure 4 and before the position of Figure 5 is reached. When the door is then pulled open by the handle after the position of Figure 5 is reached, the circuit breaker may be racked in and out but the trip bar 135 cannot be rotated since it is held locked in position in the manner shown in Figure 9.

The circuit breaker may be operated while the door is open only when it has been racked into a test position where it is completely disconnected from the back contact assembly so that it is safely deenergized.

Should the circuit breaker be racked in closed position from the test to the service position then on initiation of this movement, the circuit breaker will be tripped so that at no time can the circuit breaker contacts be energized or closed while the door is open. On closing the door and locking the same, the locking device of Figure 9 is released so that the trip bar may be operated to its non-tripping position and the circuit breaker placed into service once more by actuation of the cams 21-30.

An opening 313 may be placed in member 101 in line with slot 304 in plunger 300 when the plunger is in locking position. A pad-lock 314 may then be passed through this hole and the slot to prevent unauthorized tampering with the mechanism.

In the foregoing, I have set forth my invention in connection only with a preferred embodiment thereof and in connection with a type of circuit breaker which I have found readily adaptable to cooperation with the elements of my invention. Many variations both in the type of circuit breaker and in the manner of connection with the tripping elements thereof should now be obvious to those skilled in the art, and also many variations in the elements of my protective interlocking system which functions to increase the safety of the operator or the inspector should now be obvious to those skilled in the

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

I claim:

1. A circuit interrupter, an enclosure therefor comprising a movable panel, means outside of said enclosure effective when the panel is in enclosing position for opening and closing the contacts of said interrupter, means independent of said first means for opening said contacts, means for locking said panel in closed position, said independent means for opening said contacts being operable upon an unlocking movement of said locking means and comprising a rotatable shaft in said enclosure operative between a tripping and non-tripping position, and actuating means on said panel cooperating with an element of said shaft effective during unlocking movement of the locking means of said panel to rotate said shaft to the tripping position and operative during locking movement of said locking means to rotate said shaft to the non-tripping position and hold said shaft in said last-mentioned position while said panel is closed.

2. A circuit interrupter, an enclosure therefor comprising a movable panel, means outside of said enclosure effective when the panel is in enclosing position for opening and closing the contacts of said interrupter, means independent of said first means for opening said contacts, means for locking said panel in closed position, said independent means for opening said contacts being operable upon an unlocking movement of said locking means and comprising a rotatable shaft in said enclosure operable between a tripping and non-tripping position; a cam on said shaft; and a crank member on said panel, said crank member carrying a pin cooperating with the cam on said shaft and effective during unlocking movement of the locking means of said panel to rotate said shaft to a tripping position and operative during locking movement of said locking means to rotate said shaft to a non-tripping position and hold said shaft in said last-mentioned position while said panel is closed.

3. A circuit interrupter, an enclosure therefor comprising a movable panel, means outside of said enclosure effective when the panel is in enclosing position for opening and closing the contacts of said interrupter, means independent of said first means for opening said contacts, means for locking said panel in closed position, said independent means for opening said contacts being operable upon an unlocking movement of said locking means and comprising a rotatable shaft in said enclosure operable between a tripping and non-tripping position; a cam on said shaft; and a crank member on said panel, said crank member carrying a pin cooperating with the cam on said shaft and effective during unlocking movement of the locking means of said panel to rotate said shaft to a tripping position and operative during locking movement of said locking means to rotate said shaft to a non-tripping position and hold said shaft in said last-mentioned position while said panel is closed; said locking means comprising a rotatable member, links extending from said rotatable member and engageable with lock elements on said panel and said enclosure; and an additional link connected to one of said links at one end thereof and connected to said crank on said panel at the other end thereof, movement of said locking means to unlocked position actuating said crank in one direction and movement of said locking means to

locking position actuating said crank in said other direction.

4. A circuit interrupter, an enclosure therefor comprising a movable panel, means outside of said enclosure effective when the panel is in enclosing position for opening and closing the contacts of said interrupter, means independent of said first means for opening said contacts, means for locking said panel in closed position, said independent means for opening said contacts being operable upon an unlocking movement of said locking means and comprising a rotatable shaft in said enclosure operable between a tripping and nontripping position; a cam on said shaft; and a crank member on said panel, said crank member carrying a pin cooperating with the cam on said shaft and effective during unlocking movement of the locking means of said panel to rotate said shaft to a tripping position and operative during locking movement of said locking means to rotate said shaft to a non-tripping position and hold said shaft in said last-mentioned position while said panel is closed; and means carried by said door panel for locking said shaft in tripping position when said door is opened.

5. A circuit interrupter, an enclosure therefor comprising a movable panel, means outside of said enclosure effective when the panel is in enclosing position for opening and closing the contacts of said interrupter, means independent of said first means for opening said contacts, means for locking said panel in closed position, said independent means for opening said contacts being operable upon an unlocking movement of said locking means and comprising a rotatable shaft in said enclosure operable between a tripping and non-tripping position; a cam on said shaft; and a crank member on said panel, said crank member carrying a pin cooperating with the cam on said shaft and effective during unlocking movement of the locking means of said panel to rotate said shaft to a tripping position and operative during locking movement of said locking means to rotate said shaft to a non-tripping position and hold said shaft in said last-mentioned position while said panel is closed; and means carried by said door panel for locking said shaft in tripping position when said door is opened; said last mentioned means comprising a lock bar, engageable with an opening in said shaft, means biasing said lock bar toward engagement with said opening, and a member carried by said panel engageable with said lock bar when said panel is closed for retracting said lock bar against the bias of said spring.

6. In combination with a circuit interrupter mounted on a vertical panel of insulating material, a stationary enclosure, contacts rigidly mounted in said enclosure, said panel movable horizontally in said enclosure and having contacts engageable with and disengageable from said rigidly mounted contacts, said enclosure having a door panel movable to permit inspection of said interrupter, means operable from the out-

side of said enclosure for tripping and closing the contacts of said interrupter, a tripping member within said enclosure independent of said first named tripping means; means for locking said door panel in closed position; and means operable on movement of said locking means to unlocked position and before said door panel is opened to move said member to a tripping position, and means effective on closing and locking of said door panel to move said member to a non-tripping position and to hold said member in said last named position while said door panel is in locked position.

7. In combination with a circuit interrupter mounted on a vertical panel of insulating material, a stationary enclosure, contacts rigidly mounted in said enclosure, said panel movable horizontally in said enclosure and having contacts engageable with and disengageable from said rigidly mounted contacts, said enclosure having a door panel movable to permit inspection of said interrupter, means operable from the outside of said enclosure for tripping and closing the contacts of said interrupter, a tripping member within said enclosure independent of said first named tripping means; means for locking said door panel in closed position; and means operable on movement of said locking means to unlocked position and before said door panel is opened to move said member to a tripping position; and means effective on closing and locking of said door panel to move said member to a non-tripping position and to hold said member in said last named position while said door panel is in locked position, the initial unlocking movement of said locking means for said door panel moving said member to said tripping position.

8. A circuit interrupter, an enclosure therefor comprising a movable panel, means outside of said enclosure effective when the panel is in enclosing position for opening and closing the contacts of said interrupter, means independent of said first means for opening said contacts, means for locking said panel in closed position, said independent means for opening said contacts being operable upon an unlocking movement of said locking means and comprising a rotatable shaft in said enclosure operative between a tripping and non-tripping position, and actuating means on said panel cooperating with an element of said shaft effective during unlocking movement of the locking means of said panel to rotate said shaft to the tripping position and operative during locking movement of said locking means to rotate said shaft to the non-tripping position and hold said shaft in said last-mentioned position while said panel is closed; said locking means comprising a rotatable member, a link extending from said rotatable member and engageable with lock elements on said panel and said enclosure; and an additional link connection from said rotatable member to said actuating means.

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