May 4, 1943. T. LINDSTROM 2,318,086

FIELD DISCHARGE CIRCUIT BREAKER

Filed Dec. 24, 1941 3 Sheets-Sheet 1

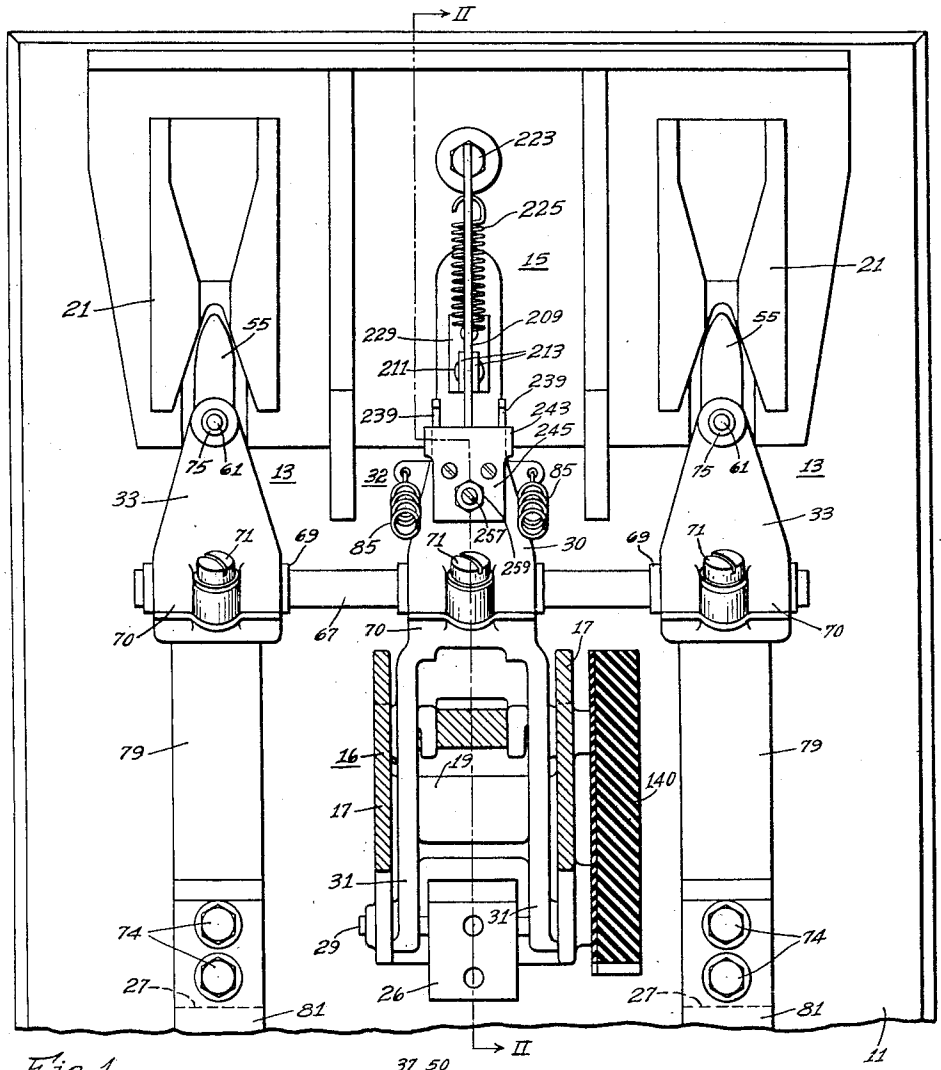


Fig. 1.

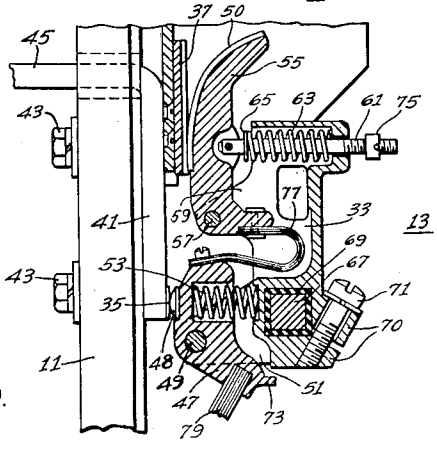


Fig. 3.

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Filed Dec. 24, 1941 3 Sheets-Sheet 2

Fig. 7.

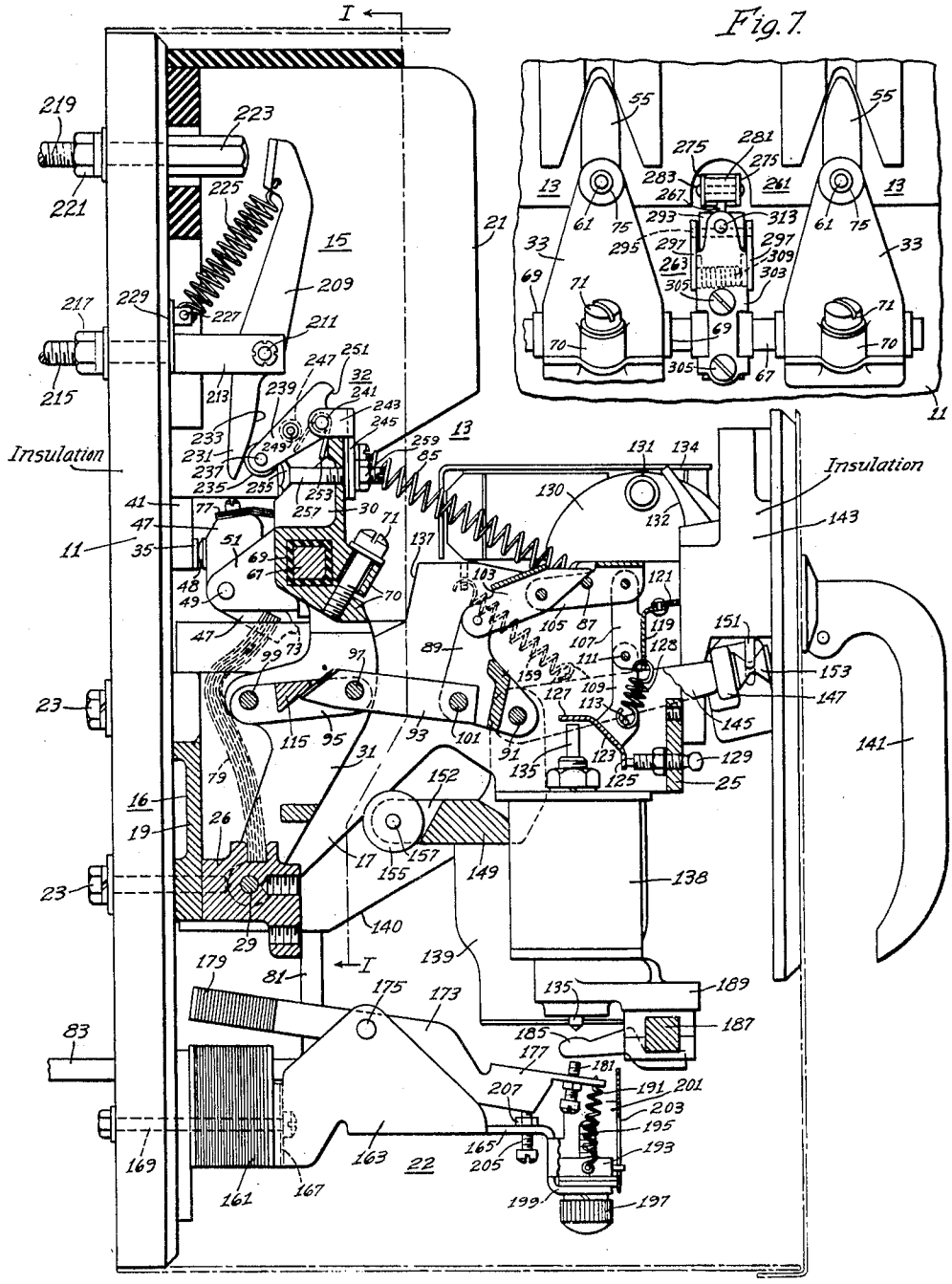


Fig. 2.

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Filed Dec. 24, 1941 3 Sheets-Sheet 3

Fig. 4.

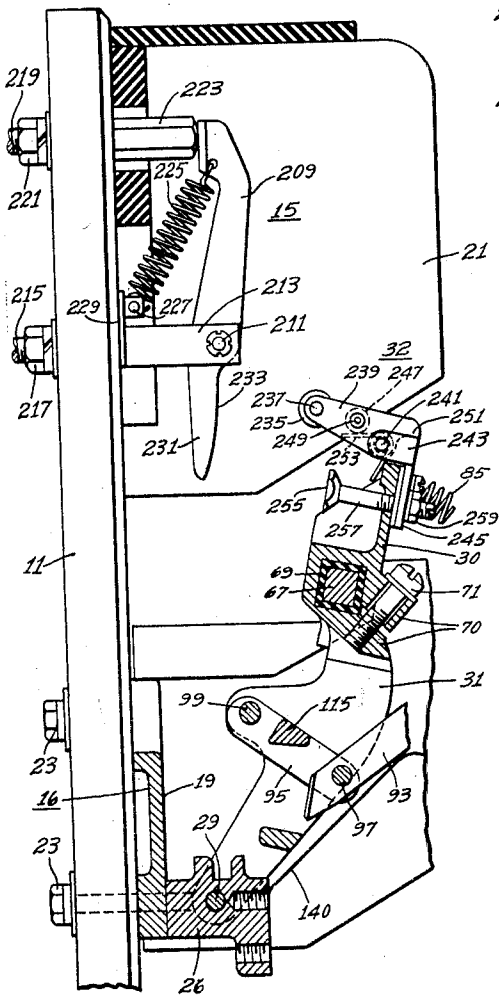


Fig. 5.

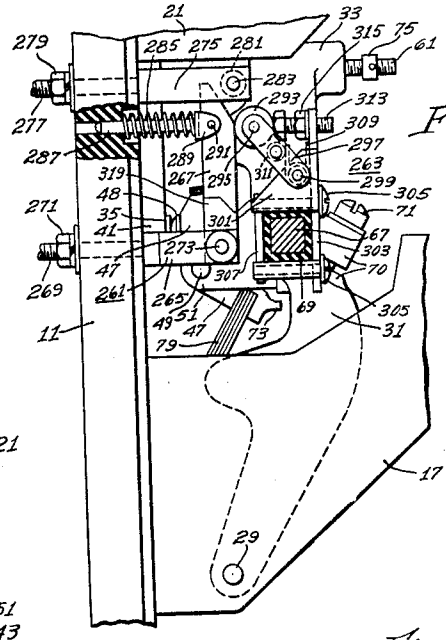
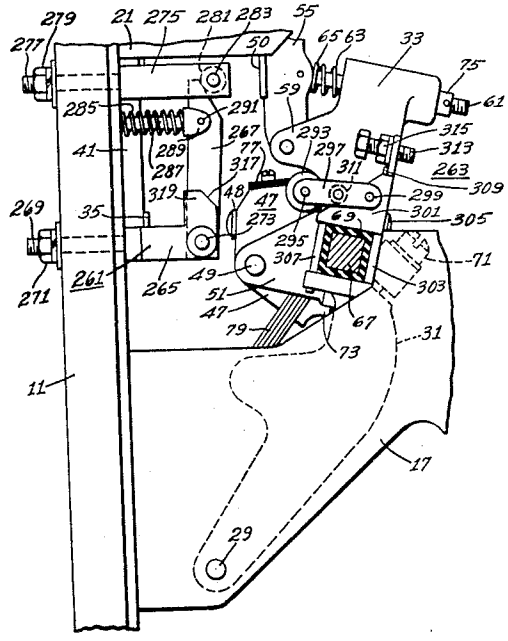


Fig. 6.



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2,318,086

FIELD DISCHARGE CIRCUIT BREAKER

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Application December 24, 1941, Serial No. 424,301

15 Claims. (Cl. 200—5)

This invention relates to circuit breakers and more particularly to field discharge circuit breakers.

The shunt field windings of large separately excited generators are protected against excessive induced voltages by means of field discharge circuit breakers. An excessive voltage may be induced in the winding of a separately excited generator when the generator is disconnected from its normal voltage supply. Such induced voltage may be of sufficient magnitude to rupture the insulation of the winding. For this reason, it is desirable to protect the winding by providing the circuit breaker in such applications with a field discharge switch which closes when the breaker opens and connects a resistance across the shunt field winding for the purpose of discharging the induced voltage. A circuit breaker equipped with such a switch is usually referred to as a field discharge circuit breaker.

One object of the invention is the provision of a circuit breaker embodying an improved field discharge switch which is simple, more reliable and efficient in operation and which is more economical to manufacture and install than field discharge switches heretofore known in the art.

Another object of the invention is the provision of an improved field discharge circuit breaker embodying a field discharge switch wherein the actuating mechanism for the switch is mounted independently of said switch and is separable therefrom, the actuating mechanism being operable during an operation of the breaker to close and open the switch at the proper instants.

Another object of the invention is the provision of an improved field discharge circuit breaker embodying a field discharge switch wherein the actuating mechanism for the switch is mounted separately therefrom and which is provided with adjusting means for adjusting the airgap of the switch and for adjustably determining the time, during an operation of the breaker, at which the switch will close.

Another object of the invention is the provision of an improved field discharge circuit breaker embodying a field discharge switch biased to closed position and normally restrained in open position by an actuating mechanism which is mounted on a part movable with the main breaker contacts and which is operable during an operation of the breaker to release the switch at the proper time and permit the biasing means to close it.

Another object of the invention is the provision of an improved field discharge circuit breaker embodying a field discharge switch which is mounted separately from the circuit breaker mechanism, and an actuating mechanism mounted for movement with the breaker mechanism, said actuating mechanism having a part for cooperating with the switch to cause closing and opening thereof at the proper time during an operation of the breaker.

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 description of several embodiments thereof when read in conjunction with the accompanying drawings, in which:

Fig. 1 is an elevational sectional view taken substantially on line I—I, of Fig. 2 showing the contact structure of a circuit breaker embodying the principles of the invention.

Fig. 2 is a vertical sectional view taken substantially on line II—II of Fig. 1 showing the circuit breaker operating mechanism and the field discharge switch.

Fig. 3 is a fragmentary sectional view of the contact structure for the two poles of the breaker.

Fig. 4 is a fragmentary sectional view of the field discharge switch and the operating mechanism therefor in the position assumed when the breaker contacts are open and the field discharge switch is closed.

Fig. 5 is a fragmentary elevational view showing a modification of the field discharge switch and its operating mechanism in the open position.

Fig. 6 is a view of the mechanism shown in Fig. 5 but in the closed position of the field discharge switch.

Fig. 7 is a fragmentary front elevational view of the modification of the invention shown in Figs. 5 and 6.

Referring to Figs. 1 and 2 of the drawings, the field discharge circuit breaker comprises, generally, a base 11 of insulating material, circuit breaker contact structure 13 (Figs. 2 and 3) for each of the two poles of the breaker, a field discharge switch indicated generally at 15, a main frame 16 having spaced sides 17 rigidly connected at their inner ends by a cross member 19 and at their outer ends by a cross member 25, an arm extinguisher 21 for the contact means of each of the two poles, and a trip device indicated generally at 22.

The main frame 16 is mounted on the central portion of the base 11 and is secured thereto by means of bolts 23. The lower bolt 23 extends through an opening in the cross member 19 and serves to rigidly secure a member 26 to the cross member and to the base 11. The member 26 is provided with an opening through which extends a shaft 29. The shaft 29 also extends through openings in the sides of the main frame 16 and pivotally supports a pair of parallel arms 31 disposed between the sides of the frame 16. At their free ends, the arms 31 are formed integral with a support member 30 upon which is mounted a field discharge switch actuating device indicated generally at 32 (Fig. 2).

Rigidly clamped to the member 30 by means of a split clamp 70 and a screw 71 is a tie bar 67 extending transversely across the poles of the breaker. Identical contact arms 33 (Figs. 1 and 3) are rigidly secured to the bar 67 by means of split clamps 70 and screws 71. The support member 30 and the contact arms 33 are insulated from the tie bar 67 by means of sheaths 69 of insulating material (Figs. 2 and 3).

The contact arms 33 are disposed on opposite sides of the main frame 16, and each arm 33 carries movable contact means illustrated in Fig. 3 which serve to open and close the main circuits of the breaker. The stationary contacts and the movable contact assemblages for the two poles are alike consequently only the contacts for one of the poles will be described.

Each contact arm 33 carries a main movable contact member 47 and a movable arcing contact member 55. The main contact member 47 is pivotally mounted on a pivot pin 49 supported in projections 51 (only one being shown) of the contact arm 33, and the movable arcing contact member 55 is pivoted on a pivot pin 57 supported in projections 59 (only one being shown) of the arm 33. The main movable contact member 47 carries a contact 48, and a contact 50 is secured to the arcing contact member 55. The contacts 48 and 50 are adapted to cooperate respectively with fixed stationary contacts 35 and 37 secured on a conductor 41 which is in turn secured to the base 11 by means of bolts 43. The conductor 41 extends upwardly and is bent at right angles, the bent portion extending through an opening in the base 11 to form a terminal connector 45.

A spring 53 (Fig. 3) compressed between a spring seat on the contact arm 33 and a spring seat on the main contact member 47 provides contact pressure for the main contacts 35—48 when the contact arm is in the closed position. Contact pressure for the arcing contacts 37—50 is provided by a spring 63 surrounding a rod 61 which is pivotally connected to the arcing contact member 55 and which is slidable through an opening in a spring seat on the contact arm 33. The spring 63 is compressed between a washer 65 seated on a shoulder on the rod 61 and the spring seat on the contact arm 33. The rod 61 has a nut 75 on the outer end thereof which cooperates with the contact arm 33 to limit counterclockwise rotation of the arcing contact member 55 about its pivot when the contact arm 33 is moved to open the contacts. Counterclockwise movement of the main contact member 47 (Fig. 3) is limited by a projection 73 thereon striking the body of the contact arm 33. The adjustment of the nut 75 on the rod 61 is such that the arcing contacts 37—50 open after the main contacts 35—48 have opened during an opening operation of the breaker.

When the contact arms 33 are operated to open the contacts, the arcs across the arcing contacts resulting from the rupture of the current are drawn into arc-extinguishers 21 (Figs. 1 and 2) where they are cooled and quickly extinguished. Any suitable arc extinguisher may be employed, those illustrated comprising, generally, stacks of slotted plates of magnetic material disposed adjacent the paths of travel of each of the arcing contact members 55. The plates serve to draw the arcs toward the apices of the slots where they are broken up into a plurality of short arcs which are quickly cooled and extinguished.

The movable arcing contact member 55 is connected by a flexible shunt conductor 77 (Fig. 3) to the main contact member 47 which in turn is connected by means of a flexible shunt conductor 79 to a corresponding connector 27 (Fig. 1). The connectors 27 for the two poles are bolted to the base 11 with spacers (not shown) between the base and each of the connectors. To each of the connectors 27 for the two poles is secured by means of bolts 74, the upper end of a conductor 81 (Figs. 1 and 2) which extends downwardly from the connectors 27. The conductors 81 are bent at right angles and the horizontally disposed portions thereof extend between the legs of U-shaped magnet cores 161 (Fig. 2) forming part of the trip device 22. The conductors extend through openings in the base 11 and form terminal connections 83 (only one being shown) which, together with the terminal connectors 45, serve to connect the poles of the breaker in electrical circuits.

The electrical circuits for the two poles of the breaker are essentially the same, therefore, only the circuit for one of the poles will be traced. This circuit extends from the terminal connector 45 (Fig. 3) through the conductor 41, the main contacts 35—48, the main contact member 47, the flexible shunt conductor 79, the connector 27 (Fig. 1), the conductor 81 to the terminal connector 83 (Fig. 2). The circuit for the arcing contacts 37—50 (Fig. 3) extends from the terminal connector 45, through the conductor 41, the arcing contacts 37—50, the arcing contact member 55, the flexible shunt conductor 77, the main contact member 47 and through the previously described circuit to the terminal connector 83.

The support member 30 (Fig. 2) for the field discharge switch mechanism and the contact arms 33 are biased in a clockwise or opening direction by means of a pair of springs 85 (Figs. 1 and 2). These springs are tensioned between the support member 30 and a fixed pivot 87 supported in the main frame 16. In the closed position of the main circuit breaker, the support member 30 and consequently the main contact arms 33 are releasably restrained in closed contact position in which the main contacts 35—48 and the arcing contacts 37—50 (Fig. 3) are closed and the field discharge switch 15 is open. The movable contact assemblage is releasably restrained in the closed position by means of a toggle and linkage mechanism which is collapisble to cause opening of the main circuit breaker contacts and closure of the field discharge switch. The toggle and linkage forms a part of the common operating mechanism.

This collapsible linkage includes a lever 89 (Fig. 2) pivotally mounted on a fixed pivot 91 supported on the main frame 16. The lever 89 comprises a pair of levers rigidly connected by an

integral cross bar 117, and is operatively connected to the support arms 31 of the field discharge switch operating mechanism 32 by a main operating toggle comprising toggle links 93 and 95. The toggle link 93 has one end pivoted on a pin 101 supported on the lever 89, and the link 95 is pivoted on a pivot pin 99 on the arms 31. The links 93 and 95 are pivotally connected by a knee pivot pin 97. The toggle link 95 comprises a pair of links rigidly connected by means of an integral cross member 115.

The free end of the lever 89 is connected by means of a link 103 to one arm of a lever 105 pivoted on the fixed pivot 87. The other arm of the lever 105 is pivotally connected to a toggle link 107 of a tripping toggle comprising the link 107 and a toggle link 109. The link 109 is pivoted on a fixed pivot 113 supported on the frame 16 and comprises a pair of links joined near the pivot 113 by a yoke 123 provided with projections 125 and 127. The toggle link 107 comprises a pair of links connected by a yoke 119 having a bent portion to which is secured an extension 121 of insulating material. The toggle links 107 and 109 are pivotally connected by a knee pivot pin 111. The purpose of the extension 121 is to cooperate with a part connected to a manually operable handle 141 to manually trip the breaker in a manner to be more fully described later. The lever 105 and the link 103 each comprise a pair of members rigidly connected by yokes substantially as illustrated.

The linkage just described serves to releasably hold the contact assemblage including the movable contacts for the two poles of the breaker in closed contact position. In the closed position, the main operating toggle 93—95 is overcenter above a line through the center of the pins 99—101 and a second toggle, one link of which comprises the overcenter links 93—95 and the other link of which comprises the lever 89, is overcenter above a line through the center of the pins 99 and 91. The overcenter movement of the main operating toggle 93—95 is limited by the projecting end of the link 93 engaging the cross member 115 of the link 95.

With the main operating toggle 93—95 and the toggle comprising the links 93—95 and the lever 89 in the overcenter position, as shown in Fig. 2, the springs 85 bias the lever 89 in a clockwise direction. Movement of the lever 89, however, is normally prevented by the tripping toggle 107—109 which is overcenter to the left of a line through the center of the fixed pivot 113 and the point of connection of the toggle link 107 with the lever 105. The toggle 107—109 is biased to its overcenter position by a spring 128 tensioned between the yoke 119 and the fixed pivot 113. The overcenter position of the tripping toggle 107—109 is adjustably determined by the projection 125 of the yoke 123 engaging an adjusting screw 129 in the cross member 25 of the frame. The tripping toggle 107—109 in its overcenter position, acting through the lever 105 and the link 103, prevents clockwise movement of the lever 89 and consequently holds the movable contact assemblage in the closed contact position against the biasing influence of the springs 85, and holds the field discharge switch open.

The tripping toggle 107—109 is adapted to be moved overcenter outwardly in a direction to cause its collapse to effect opening of the breaker contacts by means of the trip device 22 (Fig. 2). The trip device is operable in response to overload currents in the circuits of the breaker to actuate a trip rod 135 and cause collapse of the tripping toggle 107—109. The trip rod 135 is slidable vertically through a shunt trip coil (not shown) enclosed in a casing 138 attached to the main frame 16. The shunt coil is adapted to be energized from a suitable source and in a manner well known in the art, to operate the trip rod and trip the breaker from a remote point.

When operated either by the shunt coil or by the trip device 22, the trip rod 135 is thrust upwardly and strikes the projection 127 of the yoke 123 and rocks the toggle link 109 clockwise about the fixed pivot 113. This movement of the link 109 causes collapse of the tripping toggle 107—109 permitting clockwise movement of the lever 89 which permits the springs 85 to rock the movable contact assemblage clockwise to open the contacts. Movement of the contact assemblage to open position effects closing of the field discharge switch 13 as will be fully described later.

The main operating toggle 93—95 does not immediately collapse but the force of the springs 85 applied through the arms 31 and the main operating toggle causes collapse of the toggle comprising the links 93—95 and the lever 89 which results in clockwise movement of the lever 89. This movement is transmitted through the link 103 and the lever 105 to complete the collapse of the tripping toggle 107—109.

The clockwise or opening movement of the support member 30 is arrested by projections (not shown) thereon striking portions 137 of the main frame 16. At this time the rebound of the inertia of the main operating toggle 93—95 and the parts of the linkage 89, 103 and 105 starts the main operating toggle overcenter in a direction to cause its collapse. By the time the knee pin 97 of the toggle has passed overcenter below the line 99—101 the weight of the parts act to complete the collapse of the toggle 93—95 and causes the linkage 89, 103, 105 and the tripping toggle 107—109 to be automatically reset to their normal position. The main operating toggle 93—95 remains in collapsed condition until the contacts are reclosed.

The contacts are closed manually by operation of the previously mentioned handle 141. The handle is rotatably mounted in a bracket 143 of insulating material secured to the outer end of the main frame 16. Operatively connected to the mechanism (not shown) operated by the handle is a link 151. The lower end of the link 151 is recessed and straddles a pulley-shaped roller 153 rotatably mounted on a cross member 147 rigidly connecting the outer ends of a pair of spaced contact closing levers 145. These levers are disposed on the outside of the frame 16 and are pivotally supported on the ends of the fixed pivot 91 which project beyond the sides of the frame 16. The inner ends of the lever 145 are rigidly connected by a cross member 149. Spaced projections 152 extending from the center portion of the cross member 149 support a pivot pin 157 upon which is rotatably mounted a roller 155.

The contacts are closed manually by clockwise rotation of the handle 141. This movement of the handle, through connections (not shown) thrusts the link 151 downwardly and due to its engagement with the roller 153, rotates the closing lever 145 in a clockwise direction. During this movement of the lever 145, the roller 155 engages the link 93 of the now collapsed main operating toggle 93—95 and moves this toggle to its overcenter position. Since at this time the tripping toggle 107—109 has been restored to its overcenter position, rotation of the lever 89 is

prevented and consequently the force applied by the roller 155 to straighten the toggle 93—95 rotates the arms 31 counterclockwise to close the contacts for the two poles and to tension the springs 85. Counterclockwise movement of the arms 31 and of the support member 30 effects opening of the field discharge switch 15. The clockwise movement of the closing lever 145 moves the toggle 93—95 overcenter above the line 99—101 so that the contacts are held in the closed position until the breaker is again tripped.

Upon release of the handle 141 following a contact closing operation, a spring 159 (Fig. 2) tensioned between the closing lever 145 and a point on the frame 16 restores the lever 145 in a counterclockwise direction. This movement of the lever 145 and the roller 153 thrusts the link 151 upwardly to restore the handle 141 to its neutral position.

The closing lever 145 may be operated to automatically close the contacts through the agency of a motor 139 (Fig. 2) mounted on a plate 149 (Fig. 1) attached to the side of the frame 16. The motor 139 may be energized from any suitable source. When energized, the motor is adapted, through a suitable driving connection, to rotate a crank disc 130. This disc carries an antifriction roller 131 which engages a cam face 132 on an arm 134 secured to one side of the closing lever and rotates the arm and the closing lever 145 clockwise to effect closing of the contacts in the previously described manner. As soon as the roller 131 passes out of engagement with the arm 134, the spring 159 acts to restore the lever 145 to its normal position. The motor 139 is deenergized by a suitable limit switch (not shown).

The circuit breaker may be tripped manually by rotation of the handle 141 through a small angle in a counterclockwise direction from its neutral position. When the handle is rotated in tripping direction, a projection (not shown) on the link 151 engages the extension 121 on the yoke 119 of the toggle link 107 and rocks the link counterclockwise about its point of connection with the lever 105. This moves the tripping toggle 107—109 overcenter in a direction to cause its collapse and effects opening of the contacts in the previously described manner.

As previously stated, the trip rod 135 is operated to effect tripping of the breaker by means of a current responsive trip device 22. There is a trip device 22 provided for each of the two poles of the breaker but since the trip devices are alike only one will be described.

The trip device includes the U-shaped magnet core 161 and a frame comprising substantially parallel side members 163 rigidly connected at their outer ends by a yoke 165. The members 163 are provided with mounting feet 167, and bolts 169 (only one being shown Fig. 2) extend through openings in the feet 167 and in the magnet core 161 and in the base 11 to rigidly secure the core and frame to the base. A trip lever 173 is pivotally supported on a pivot 175 mounted in the frame 163. The trip lever 173 comprises a pair of spaced levers having an armature 179 secured to one end and being rigidly connected by a yoke 177 at the other end. The trip lever 173 is biased against operation by the magnet 161 by means of a pair of springs 191 (Fig. 2, only one being shown) having one end secured to the yoke 177 and the other end attached to a vertically movable plate 193. The plate 193 cooperates with an adjusting screw 195 which is provided with a knurled head 197 bearing against the bottom side of a formed projection 199 of the yoke 165. Rotation of the screw 195 moves the plate 193 and thereby adjusts the tension of the spring 191 to vary the tripping characteristic of the breaker. A scale plate 203, supported on spaced projections 201 of the yoke 165, bears indicia indicating the adjustment of the spring 191 or the tripping point of the breaker. An adjustable stop screw 205 provided with a lock nut 207 determines the open air gap of the magnet.

A trip bar 187 is rotatably supported in a bracket 189 secured to the casing 138 for the shunt coil. The trip bar extends transversely across the poles of the breaker and is provided with an arm 185 for each of the poles, and a center arm 185 on the trip bar is in alignment with the lower end of the trip rod 135. An adjusting screw 181 is mounted in each of the yokes 177 in alignment with the corresponding arm 185.

Normal rated current flowing through the circuit of the breaker, including the conductor 81, causes slight energization of the magnet 161 but not sufficient to overcome the tension of the springs 191. Upon the occurrence of an overload current above a predetermined value in the circuit of either of the poles, the flow of current through the conductor 81 causes energization of the magnet sufficient to overcome the springs 191 and attract the armature 179 rocking the trip lever 173 counterclockwise. At this movement of the trip lever 173, the screw 181 rotates the arm 185 and the trip bar 187 in a clockwise direction and thrusts the trip rod 135 upwardly to trip the breaker in the previously described manner.

The construction of the circuit breaker as thus far described with the exception of the field discharge switch and the trip device 22 is essentially the same as that fully disclosed in the copending application of John W. May and Ture Lindstrom, Serial No. 391,625, filed May 3, 1941, and assigned to the assignee of this invention.

In the illustrative embodiment of the invention, the field discharge switch 15 (Figs. 1, 2 and 4) is located in the position which would ordinarily be occupied by the contact assemblage of the center pole of a three pole breaker. The field discharge switch 15 comprises a switch member 209 pivotally supported on a pivot pin 211 mounted in the two arms of a bifurcated member 213 of conducting material. The member 213 is secured to the base 11 by means of a shouldered bolt 215 integral with the member 213, and a nut 217. Similarly secured to the base 11 by a shouldered bolt 219 and a nut 221 is a contact member 223 with which the free end of the switch member 209 is adapted to cooperate to close a circuit for connecting the shunt winding of a generator (not shown) to a resistance (not shown). The bolts 215 and 219 project beyond the nuts 217 and 221 and form terminal connectors for connecting the field discharge switch to the circuit.

The switch member 209 is biased in a counterclockwise (Fig. 2) or closing direction by means of a spring 225 having one end hooked through an opening near the free end of the switch member and the other end anchored to a pin 227 supported by a bracket 229 integral with the members 213 and which is secured to the base 11 by the shouldered bolt 215 and member 213. The pin 227 projects into the base 11 to prevent rotation of the bracket 229 and the member 213.

The switch member 209 is provided with a downwardly extending tail 231 having an arcuate surface 233 with which the field discharge switch

operating mechanism 32 cooperates to restrain the switch member 209 in open position when the main circuit breaker is in the closed position. The switch operating mechanism 32 comprises a roller 235 rotatably mounted on a pin 237 supported in an arm 239. The arm 239 is pivotally supported on a pivot pin 241 mounted in a pair of ears 243 formed on the upper end of a bracket 245 which is rigidly secured to the support member 30. The arm 239 comprises a pair of identical arms (Fig. 1) spaced apart by means of the roller 235 and a spacer 247 mounted on a pin 249 supported on the arms 239. The arms 239 are provided with shouldered projections 251 which ade adapted to engage the body of the bracket 245 to limit clockwise travel of the arms. The arm 239 is biased in a clockwise direction by means of a spring 253 coiled around the pivot pin 241 and having one end bearing against the member 30 and the other end bearing against the spacer 247. A headed bolt 257 threaded into the support member 30 passes through an opening in the bracket 245 and is adjustably secured thereto by means of a lock nut 259. The head 255 of the bolt engages the roller 235 when the main breaker is in cosed position to restrain the switch member in open position.

When the main circuit breaker is operated to the open position, as previously described, and the arms 31 and the member 30 move clockwise, the spring 225 rotates the switch member 209 in a counterclockwise direction maintaining the tail 231 in contact with the roller 235 and the roller in contact with the head 255 of the bolt 257 until the movement of the switch member 209 is arrested by engagement of its free end with the contact member 223. The closing of the switch 15 is arranged to occur just an instant before the arcing contacts 37 and 59 disengage during opening of the breaker. Upon continued movement of the main contact assemblage in opening direction, the spring 253 expands and rotates the arm 239 in a clockwise direction until the movement thereof is arrested by engagement of the projections 251 with the bracket 245. In Fig. 4, the parts are shown with the main breaker contact assemblage in the open position and the field discharge switch 15 in the closed position.

In this position, it may be observed that the center line 237—241 of the arm 239 is above a line tangent to the radius 29—241. When the arms 31 and the support member 30 are rotated in a counterclockwise or closing direction in the previously described manner, the roller 235 will engage the arcuate surface 233 just prior to engagement of the breaker contacts and start the switch member in a clockwise direction toward open position. At the time of engagement of the roller 235 with the tail 231 of the switch member 209, the angle subtended by a line drawn tangent to the surface 233 at the point of contact of the roller 235, and a line drawn through said point of contact and center of the pivot 241 is greater than 90°. Continued movement of the member 30 toward closed position of the main circuit breaker rotates the switch member 209 in a clockwise or opening direction, thus reducing this angle and separating the contacts 209—223. As soon as the angle becomes less than 90°, the force of the spring 225 overcomes the relatively light force of the spring 253 and causes collapse of the arm 239. During the collapsing movement of the arm 239, the roller 235 travels downwardly along the surface 233 until it strikes the head 255 of the bolt 257. The parts are shown in Fig. 2 in the fully closed position of the main breaker contacts.

Referring to Fig. 2, it can be seen that the bolt 257 and the roller 235 determine the amount of separation of the contacts 209 and 223 when the circuit breaker contacts are in fully closed position and also determines the time of engagement of said contacts during the opening movement of the main breaker contacts. Adjustment of the bolt 257 relative to the support member 30, therefore, varies these two conditions. The arrangement and adjustment of the parts is such that the field discharge switch closes just an instant before the arcing contacts of the breaker disengage and the switch opens just before the arcing contacts of the breaker engage during closing of the breaker.

While the field discharge switch 15 (Fig. 1) is illustrated in the position ordinarily occupied by the center pole of a three pole breaker, it is to be understood that the switch 15 may be mounted in place of either of the outer poles without affecting the operation of the switch or of the main circuit breaker. The field discharge switch has been illustrated for convenience in connection with a two pole circuit breaker. It is not desired to limit the use of the switch to a two pole circuit breaker as it can be as readily applied to any circuit breaker of the general type illustrated having one or more poles.

According to the modified form of the invention illustrated in Figs. 5, 6 and 7, the field discharge switch may be mounted in the space between any two poles of the breaker without reducing the number of effective poles in the main circuit breaker and without affecting the operation of the breaker.

The modified form of the invention shown in Figs. 5 to 7 is illustrated in connection with the circuit breaker mechanism shown in Figs. 1, 2 and 3 and like parts have been given the same reference characters. The circuit breaker in this case is of the three pole type, only two poles being shown (Fig. 7). The main contact structure is identical with that shown in Fig. 3, and the operating mechanism is the same as that illustrated in Fig. 2 for which reason a description of these mechanisms is not repeated in conjunction with the following description of the modification of the invention.

Referring to Fig. 5 of the drawings, the modification of the invention comprises a field discharge switch 261 mounted on the base 11 of the circuit breaker, and an actuating means 263 for the switch mounted on the tie bar 67 of the circuit breaker. The switch 261 includes a bifurcated support member 265 for pivotally supporting a switch member 267. The member 265 is secured to the base 11 by means of a bolt 269 and a nut 271. The bifurcated end of the member 265 pivotally supports the switch member 267 on a pivot pin 273, and a contact support member 275 disposed adjacent the free end of the switch member 267 is secured to the base 11 by means of a bolt 277 and a nut 279. The contact support member 275 is bifurcated and a cylindrical contact 281 is supported on a stud 283 secured in the forks of the member 275. The free end of the switch member 267 is disposed between the forks of the contact support member 275 and has a beveled portion which is adapted, upon opening of the contacts of the breaker, to engage the cylindrical contact 281 to close the circuit for connecting the shunt field

winding of a generator to a field discharge resistance.

The switch member 267 is actuated to closed position by means of a coil spring 285 but is restrained in open position by the operating mechanism 263 when the main breaker is in closed position. The spring 285 surrounds a pilot rod 287 and is compressed between a yoke 289 secured to one end of the rod and a spring seat in the base 11. The arms of the yoke 289 embrace the switch member 267 and are pivotally connected thereto by means of a pivot pin 291. The left hand end of the rod 287 (Fig. 5) is slidable in an opening in the base 11.

The actuating mechanism 263 for the field discharge switch member 267 includes a roller 293 rotatably mounted on a pin 295 mounted on the free ends of a pair of spaced arms 297. The arms 297 are pivotally mounted on a pin 299 supported in ears 301 formed inwardly from a bracket 303 which is mounted on the tie bar 67 for movement therewith. The bracket 303 is rigidly secured to the tie bar 67 by means of screws 305 which pass through openings in the bracket and are threaded into a plate 307 disposed on the opposite side of the tie bar from the bracket 303. A rectangular sheath 69 of insulating material disposed between the tie bar 67 and bracket 303, plate 307 and screws 305 insulates the operating mechanism 263 from the tie bar and from the poles of the breaker.

The arm 297 is biased in a counterclockwise direction by means of a coil spring 309 surrounding the pivot pin 299 and having one end bearing against the bracket 303 and the other end bearing against a spacer 311 rigidly connecting the arms 297. When the main contact assemblage is in the closed position (Fig. 5) an adjustable stop bolt 313 secured in the upper end of the bracket 303 by means of a lock nut 315, cooperates with the roller 293 to hold the switch member 267 in its open position against the biasing force of the spring 285.

When the main circuit breaker is operated to open position, the tie bar 67 and the actuating mechanism 263 are moved clockwise from the Fig. 5 position to the Fig. 6 position, moving the contact assemblages for the several poles of the breaker to open circuit position. During this movement, the spring 285 expands causing the switch member 267 to maintain contact with the roller 293 and to maintain the roller in contact with the head of the stop bolt 313 until the beveled portion of the switch member engages the cylindrical contact 281 and arrests the movement of the switch member. This occurs just before the arcing contacts 37—50 of the circuit breaker separate. As the actuating mechanism continues its clockwise travel, the spring 309 rocks the arm 297 counterclockwise about the pivot 299 until the counterclockwise movement of the arm 297 is arrested by the spacer 311 striking the ears 301 of the bracket 303. The parts are shown in Fig. 6 with the main breaker contact assemblage in the fully open position and with the field discharge switch in closed position.

When the circuit breaker contacts are closed, in the previously described manner, the tie bar 67 together with the actuating mechanism 263 is moved counterclockwise from the Fig. 6 position to the Fig. 5 position. Just before the arcing contacts touch, the roller 293 engages the switch member 267 and rocks it counterclockwise against the tension of the spring 285 in the opening direction. At the time of engagement of the roller with the switch member, the arm 297 is overcenter below a line drawn through the center of the pivot 299 and perpendicular to the right hand edge of the switch member 267. Continued movement of the actuating mechanism, therefore, causes the roller 293 to engage beveled corners 317 of angular portions 319 integral with forks of the support member 265. This cams the arm 297 clockwise about the pivot 299. As soon as the arm moves overcenter above the line through 299 perpendicular to the edge of 267, the spring 285 overcomes the force of the relatively weaker spring 309 and rocks the arm 297 sharply clockwise until it strikes the head of the adjusting screw 313.

By adjusting the screw 313 relatively to the bracket 303, the open air gap of the field discharge switch may be varied and the time of closing the field discharge switch in relation to the opening movement of the circuit breaker contacts may be adjusted.

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, intended that the invention as set forth in the following claims be interpreted as broadly as the prior art permits.

I claim as my invention:

1. A circuit breaker comprising relatively movable contacts, a switch member movable to an open and to a closed position to open and close said contacts, operating mechanism for moving the switch member to open and to closed position, a field discharge switch including a stationary contact, a pivoted switch arm biased to a closed position, means for pivotally supporting said switch arm independently of the breaker operating mechanism, and means including a roller mounted on a part movable with the switch member for cooperating with the switch arm during operation of the breaker to cause closing and opening of the field discharge switch.

2. A circuit breaker comprising relatively movable contacts, a switch member movable to an open and to a closed position to open and close said contacts, operating mechanism for moving said switch member to open and to closed position, a field discharge switch including a stationary contact, a switch arm mounted on a fixed pivot independently of the switch member, means biasing the switch arm to closed position, and actuating means movable with the switch member for cooperating with the switch arm to permit said biasing means to close the field discharge switch when the circuit breaker switch member is moved to open position and to actuate said field discharge switch to open position when the circuit breaker switch member is moved to closed position.

3. A circuit breaker comprising relatively movable contacts, a switch member movable to an open and to a closed position to open and close said contacts, operating mechanism for moving said switch member to open and to closed position, a field discharge switch including a stationary contact, a switch arm pivotally mounted on a fixed pivot, and actuating means for the field discharge switch comprising a member pivotally mounted on the switch member and separable from said switch arm, said member being operable when the switch member is moved to closed position to actuate the switch arm to open position and being operable when the switch

member is moved to open position to cause closing of the switch arm.

4. A circuit breaker comprising a switch member movable to an open and to a closed position for opening and closing the circuit, operating mechanism for moving said switch member to open and closed position, a field discharge switch comprising relatively movable contacts, and actuating means for said contacts comprising a member mounted on the switch member and movable relatively thereto, said member being biased to one position to effect opening of said contacts during closing of the circuit breaker and movable to another position to restrain said contacts in open position when the switch member is in closed position.

5. A circuit breaker comprising a switch member movable to an open and to a closed position for opening and closing the circuit, operating mechanism for said switch member, a field discharge switch comprising a stationary contact and a movable contact biased in closing direction, actuating mechanism for said field discharge switch comprising a member pivotally mounted on said switch member and biased to one position to effect opening of the contacts at a predetermined time during the movement of the switch member to closed position, said pivoted member being movable to another position to restrain the contacts in open position when the switch member is moved to closed position.

6. A circuit breaker comprising a switch member movable to an open and to a closed position, operating mechanism for said switch member, a field discharge switch comprising a stationary contact and a pivoted switch arm cooperating therewith to close and open said switch, actuating mechanism for said field discharge switch comprising an arm pivotally supported on the switch member, said arm being biased to an operating position and movable to a holding position, and means on said arm engageable with the switch arm at a predetermined time during movement of the switch member to closed position to effect opening of said field discharge switch and to cause movement of said arm to holding position.

7. A circuit breaker comprising relatively movable contacts, a switch member movable to an open and to a closed position to open and close said contacts, operating mechanism for moving said switch member to open and closed position, a field discharge switch comprising a stationary contact and a movable switch arm, a support member for pivotally supporting said switch arm, an actuating member for said switch arm pivotally mounted on a part movable with the switch member, said actuating member being biased to an operating position and operable during closing movement of said switch member to engage and actuate the switch arm to an open position, and means on the support member engageable by the actuating member to move said member to another position in which it restrains the switch arm in open position when the breaker is in closed position.

8. A circuit breaker comprising relatively movable contacts, a switch member movable to an open and to a closed position, operating mechanism for moving the switch member to open and to closed position to open and close the contacts, a field discharge switch comprising a stationary contact and a movable switch arm, a support member for pivotally supporting said switch arm, actuating means for said switch arm comprising an arm mounted on the switch member and movable relatively thereto, means biasing the actuating arm to operative position, a roller on said actuating arm engageable with the switch arm when the switch member is moved to closed position to move the switch arm to open position, said actuating arm being moved to a restraining position by engagement with said support member, and means on the switch member engageable with said roller to restrain the switch arm in open position when the switch member is in closed position.

9. A circuit breaker comprising a switch member movable to open and closed positions, operating mechanism for moving said switch member to open and to closed position, a field discharge switch comprising a stationary contact and a cooperating switch arm, a support member for pivotally supporting said switch arm, an actuating arm for said switch arm pivotally mounted on the switch member, means biasing said actuating arm to an operative position, a roller on said actuating arm engageable with the switch arm to move said switch arm to an open position when the switch member is moved to closed position, means on said support member engageable by the roller to move the actuating arm to a restraining position, and means on the switch member for cooperating with the roller to restrain the switch arm in open position when the circuit breaker is in closed position.

10. A circuit breaker comprising a switch member movable to open and closed positions, operating mechanism for moving said switch member to open and to closed position, a field discharge switch comprising a stationary contact and a cooperating switch arm, an actuating member for said field discharge switch pivotally mounted on a part movable with the switch member, means on said part for cooperating with the actuating member to releasably restrain the switch arm in open position when the switch member is in closed position, means biasing the switch arm in a closing direction and operable during opening movement of the switch member to close the field discharge switch, said actuating member being biased to an operative position and operable during closing movement of the switch member to actuate the switch arm to open position.

11. A circuit breaker comprising a switch member movable to an open and to a closed position, operating mechanism for moving said switch member to open and to closed position, a field discharge switch comprising a stationary contact and a switch arm biased in a closing direction and movable to an open position, an actuating arm mounted on a part movable with the switch member, said actuating arm being engageable with the switch arm to actuate said switch arm to open position when the switch member is moved to closed position, said actuating arm being movable to a restraining position, and restraining means on a part movable with the switch member for cooperating with the actuating arm to releasably restrain the switch arm in open position, said restraining means being adjustable to vary the time at which the field discharge switch will close during an opening movement of the switch member.

12. A circuit breaker comprising a switch member, operating mechanism for moving said switch member to an open and to a closed position, a field discharge switch mounted in de-

tached relation with the circuit breaker mechanism and comprising a stationary contact and a movable contact member, actuating means for said contact member comprising an arm pivotally mounted on the switch member, said actuating means being operable to move the contact member to open position when the switch member is moved to closed position, means engageable with said actuating means to move said actuating means to a restraining position, and a stop member on the switch member for cooperating with the actuating means to restrain the contact member in open position when the switch member is in closed position, said stop member being adjustable to adjustably determine the open air gap of the field discharge switch.

13. A circuit breaker comprising a switch member movable to an open and to a closed position, operating mechanism for moving said switch member to open and to closed position, a field discharge switch comprising a stationary contact and a pivoted switch arm, a cam member on said switch arm, an actuating arm pivotally mounted on the switch member and engageable with said cam member to move the pivoted switch arm to open position when the switch member is moved to closed position, said cam member acting to move the actuating arm to a restraining position near the end of the closing movement of the switch member, and adjustable means on the switch member for cooperating with the actuating arm when said arm is in restraining position to restrain the switch arm in open position, and resilient means for moving said switch arm to closed position when the switch member is moved to open position.

14. A circuit breaker comprising a switch member movable to an open and to a closed position, operating mechanism for said switch member, a field discharge switch comprising a stationary contact and a movable switch arm, support means for pivotally supporting said switch arm, an actuating arm mounted on the switch member and engageable with said switch arm to move said switch arm to open position when the switch member moves to closed position, a cam member on said support means engageable by the actuating arm to move said actuating arm to a restraining position near the end of the movement of the switch member to closed position, a stop member on the switch member for cooperating with the actuating member to restrain the switch arm in open position, and means comprising a spring for moving said switch arm to closed position when the switch member is moved to open position.

15. A circuit breaker comprising relatively movable contacts, a switch member movable to an open and a closed position to open and close said contacts, operating mechanism for moving said switch member to open and to closed position, a field discharge switch including a stationary contact, a switch arm mounted on a fixed pivot, means biasing said switch arm to closed position, and actuating means for the switch arm movable with the switch member, said actuating means being operable during closing of the breaker to engage and effect opening of the field discharge switch prior to closing of the contacts of the breaker and said actuating means being separable from the switch arm during opening of the breaker to cause closing of said field discharge switch prior to opening of the breaker contacts.

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