

March 14, 1939.

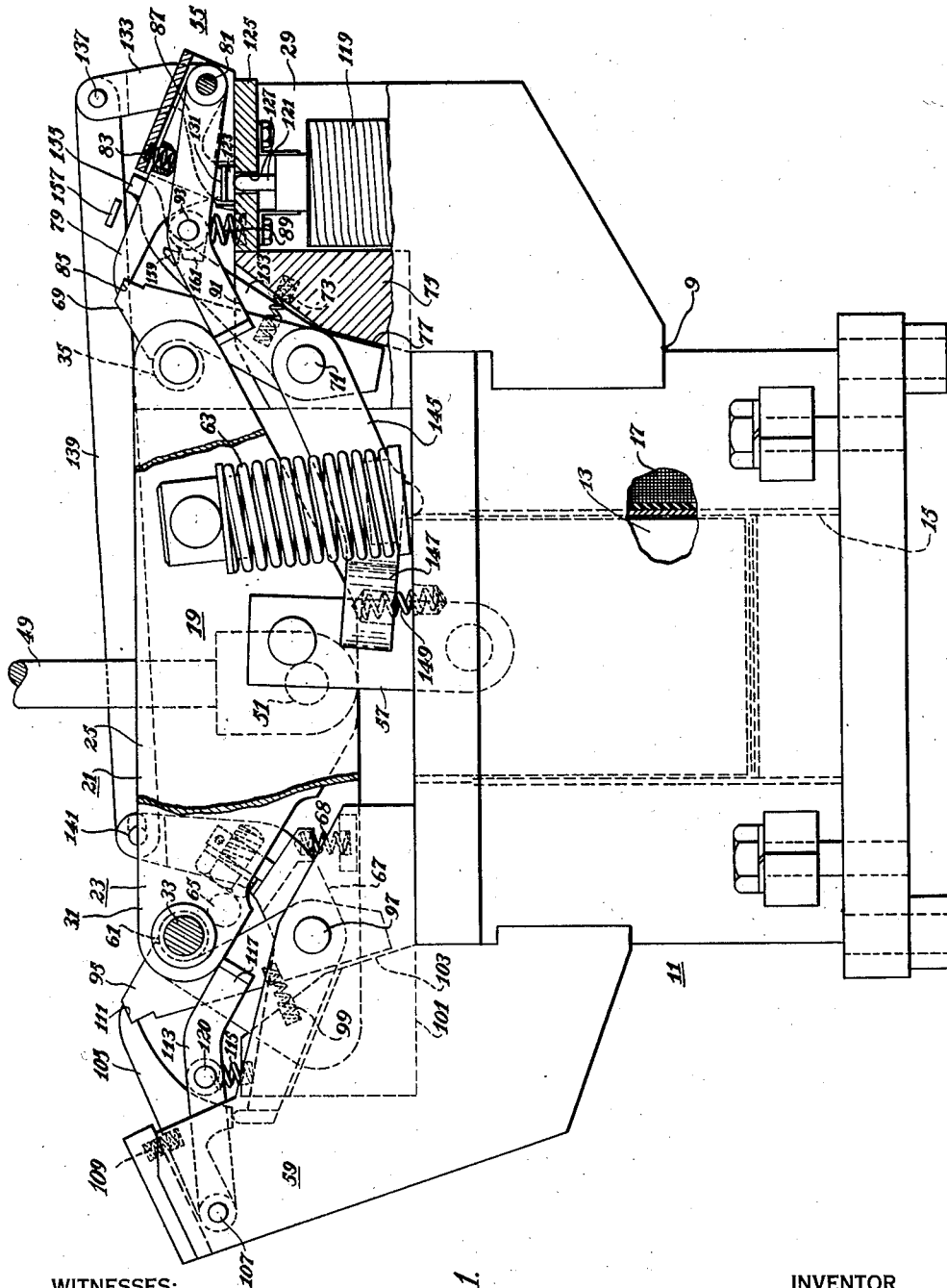
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2,150,587

CIRCUIT BREAKER

Filed May 27, 1938

4 Sheets-Sheet 1



WITNESSES:
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Fig. 1.

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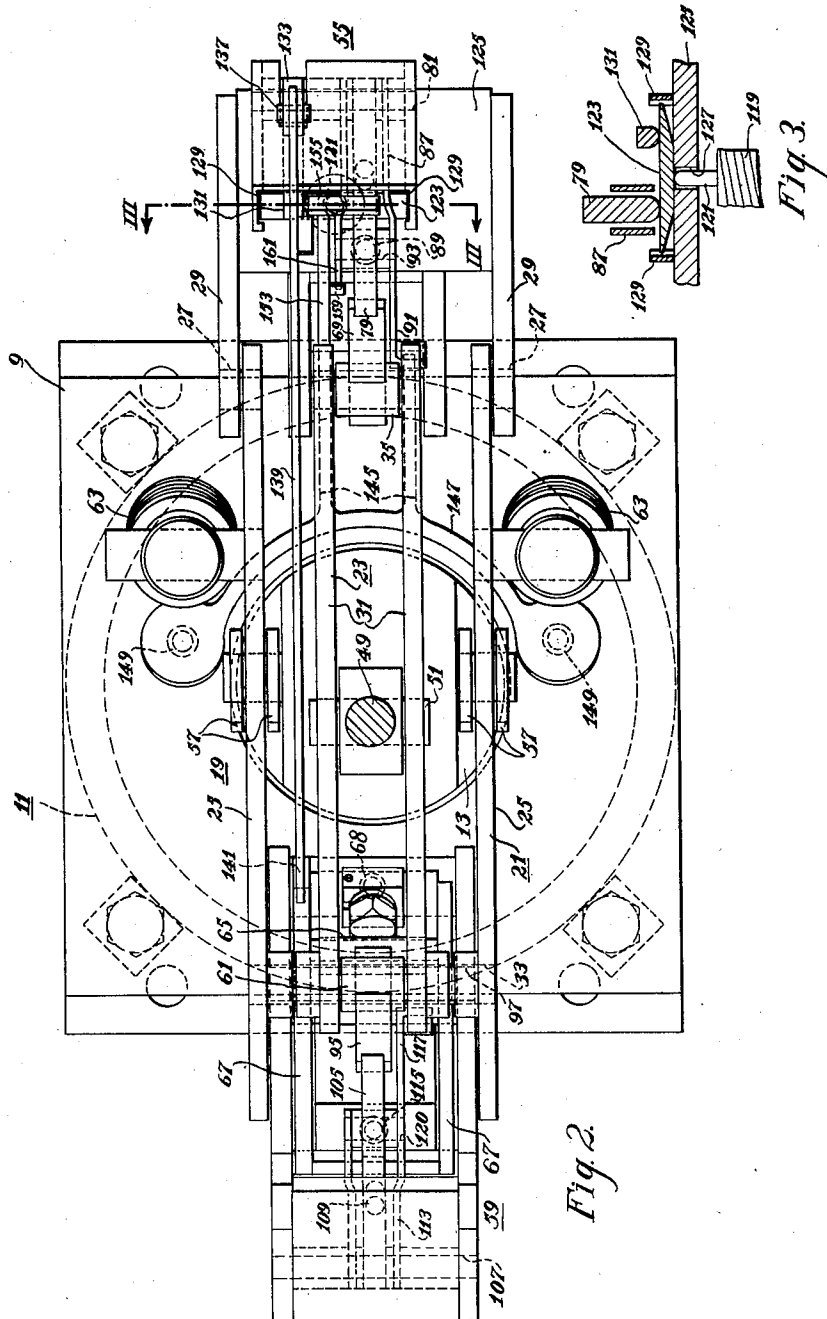
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CIRCUIT BREAKER

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4 Sheets-Sheet 2



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CIRCUIT BREAKER

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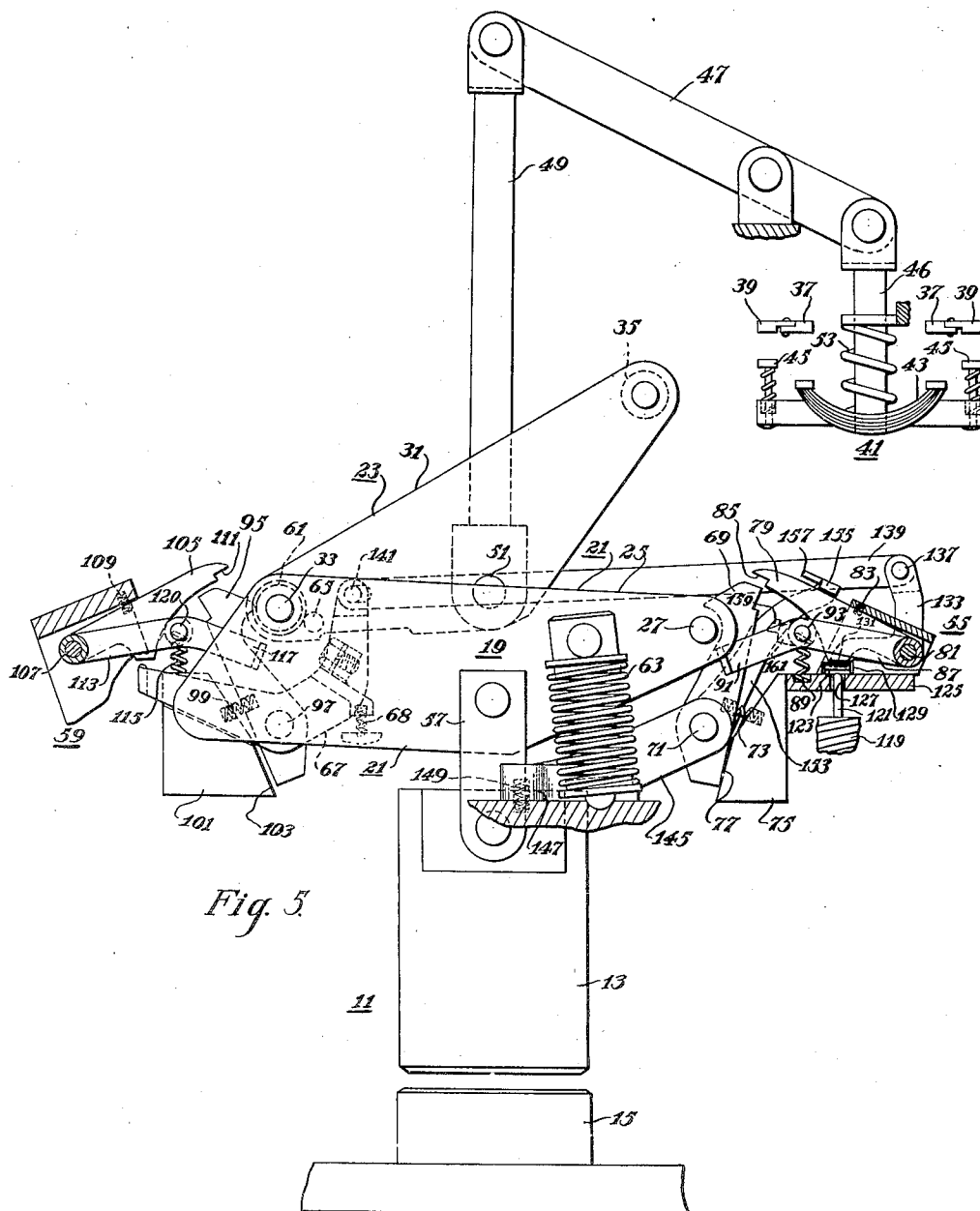


Fig. 5

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UNITED STATES PATENT OFFICE

2,150,587

CIRCUIT BREAKER

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of Pennsylvania

Application May 27, 1938, Serial No. 210,309

19 Claims. (Cl. 200—98)

The invention relates to circuit breakers in general and more particularly to solenoid operating mechanisms for circuit breakers.

To secure high speed reclosing of a circuit breaker it is desirable to provide for tripping the breaker by a non-trip free tripping means which maintains an operative connection between the breaker and the closing core so that the breaker is under the immediate control of the closing means. This is permissible, however, only when the breaker has been standing closed with the closing coil deenergized for some time. Under such conditions it is a relatively simple matter to provide for additional opening acceleration to compensate for the weight of the closing core so that the circuit interrupting time can be kept within prescribed limits. If the breaker is reclosed against a fault condition, it is desirable to trip the breaker by a trip free tripping means, i. e., free of the closing core so that the breaker opening will not be retarded by the weight of the core plus the magnetic drag caused by the flux which is still present in the core and magnet frame. The magnetic drag is quite appreciable and may delay the opening time by several cycles.

An object of the invention is the provision of an improved circuit breaker operating mechanism for securing high speed opening and closing of a circuit breaker.

Another object of the invention is the provision of a circuit breaker operating mechanism which is automatically operable to provide for non-trip free tripping of the breaker if a fault condition occurs when there is substantially no magnetic flux present in the closing means, and trip free tripping of the breaker if the fault condition occurs when there is any appreciable magnetic flux present in the closing means.

Another object of the invention is the provision of a circuit breaker operating mechanism embodying a trip free tripping means for effecting opening of the breaker free of any restraint by the closing means and a non-trip free tripping means for effecting opening of the breaker only when the closing means is deenergized but without releasing the operative connection of the breaker to the closing means, and a means responsive directly to the magnetic flux of the closing means for automatically selecting which of the tripping means will be effective to trip the breaker.

Another object of the invention is the provision of a circuit breaker operating mechanism as previously described in which the means re-

sponsive to the magnetic flux of the closing means comprises a magnetic selector lever which prevents operation of the trip free tripping means only when there is substantially no magnetic flux present in the closing means, and permits operation of the trip free tripping means whenever any appreciable magnetic flux is present in the closing means.

Another object of the invention is the provision of a circuit breaker operating mechanism as previously described, which is simple, reliable in operation, and inexpensive to manufacture.

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

Figure 1 is an elevational view, partly in section, of a circuit breaker operating mechanism constructed in accordance with the invention, the mechanism being shown in the closed latched position with the closing solenoid deenergized;

Fig. 2 is a plan view of the operating mechanism shown in Fig. 1;

Fig. 3 is a fragmentary sectional view taken substantially along the line III—III of Fig. 2 showing the trip coil plunger and the rocking trip bar for operating either of the two tripping latches of the mechanism;

Fig. 4 is a partly schematic view of the operating mechanism and circuit breaker showing the relative positions of the parts immediately following a tripping operation effected by the non-trip free latch; and

Fig. 5 is a partly schematic view similar to Fig. 4 showing the relative positions of the parts immediately following a tripping operation effected by the trip free latch.

The present invention constitutes an improvement and further development of the circuit breaker mechanism disclosed and claimed in the copending application of J. B. MacNeill, Serial No. 209,970, filed May 25, 1938, and assigned to the assignee of this invention.

Referring to the drawings, the reference numeral 9 indicates generally a fabricated steel frame which may be constructed in any suitable manner to support the various parts of the circuit breaker operating mechanism.

A closing solenoid 11 is mounted on the lower portion of the frame 9 and comprises a mov-

able core 13, a cooperating stationary core 15 and an operating winding 17 which, when energized, pulls the movable core 13 downwardly to effect a closing operation of the circuit breaker.

A lever mechanism of the trip-free type indicated generally at 19 is mounted on the upper portion of the frame and this mechanism serves to normally connect the circuit breaker with the closing solenoid. The lever mechanism comprises a closing lever 21 which is pivoted at its right-hand end on the upper portion of the frame 9, and a breaker lever 23 which is pivoted at its left-hand end to the free end of the closing lever 21. The closing lever 21 consists of a pair of spaced parallel outer levers 25 (Fig. 2) which have their right-hand ends pivoted about a common axis by means of a pair of aligned pivot studs 27 carried by two spaced vertical plates 29 which form a part of the frame 9. The breaker lever 23 consists of a pair of spaced parallel inner levers 31 which have their left-hand ends pivoted on a pivot pin 33 carried by and connecting the free ends of the outer levers 25. The inner levers 31 which form the breaker lever are spaced so as to be movable into the space between the outer levers 25 which form the closing lever. The right-hand end of the breaker lever 23 carries a trip free roller 35 which is mounted on a pin carried by and connecting the free ends of the inner lever 31.

The circuit breaker which may be of any suitable construction is shown schematically in Figs. 4 and 5 as comprising stationary main and arcing contacts 37 and 39 and a movable bridging contact assemblage 41 which consists of a main bridging contact 43 for bridging the main stationary contacts 37, and a pair of spring biased movable arcing contacts 45 for engaging the stationary arcing contacts 39. The arcing contacts are arranged to engage prior to engagement of the main contacts during closing of the circuit breaker, and to separate following separation of the main contacts during opening of the circuit breaker. The movable contact assemblage is carried by a rod 46 which is connected to the mid-portion of the breaker lever 23 through the agency of a pivoted lever 47 and an operating rod 49, the lower end of the operating rod 49 being pivotally connected to the breaker lever 23 by means of a pivot pin 51 which extends between the inner levers 31. The circuit breaker is biased to open circuit position by an opening spring 53.

The breaker lever 23 is biased upwardly by the opening bias of the circuit breaker, and the trip free roller 35 carried by the free end of the lever 23 is normally engaged and releasably held in a position of alignment with the pivot axis 27 of the closing lever 21 by a trip free latching mechanism indicated generally at 55. When the trip free roller 35 is held in latched position, the breaker lever 23 is operatively connected to the closing lever 21 for movement thereby. The closing lever 21 is connected to the movable core 13 of the closing solenoid 11 by means of a pair of connecting links 57, and the free end of the closing lever is adapted to be releasably held in closed position as shown in Fig. 1 by means of a non-trip free latch mechanism indicated generally at 59 which engages a non-trip free roller 61 carried by the pivot pin 33.

The closing lever 21 is biased in a clockwise direction about its fixed pivot axis 27 by means of a pair of retrieving compression springs 63 which are disposed between each of the outer

levers 25 and an upper supporting plate of the frame 9.

When the trip free roller 35 carried by the free end of the breaker lever 23 is released by a releasing operation of the trip free latch mechanism 55, the operative connection between the circuit breaker and the closing lever 21 is released and the breaker is moved to open circuit position under the influence of its opening spring free of any restraint by the closing means. The opening movement of the circuit breaker causes the breaker lever 23 to rotate in a counter-clockwise direction toward the open position shown in Fig. 5 about the pivot pin 33 which is held down by the non-trip free latch mechanism 59. The breaker lever 23 during a portion of its opening movement, effects an automatic releasing operation of the non-trip free latching mechanism 59 to cause release of the free end of the closing lever 21. For this purpose the breaker lever 23 is provided with a projecting pin 65 adjacent its pivoted end which, during a portion of the opening movement of the lever 23, engages and rotates a pivoted bell crank releasing lever 67 to effect release of the non-trip free latching mechanism 59 and consequently the free end of the closing lever 21. The bell crank releasing lever 67 is pivoted on a pivot pin 97 and is biased in counter-clockwise direction by means of a coil spring 68 interposed between the upper supporting plate of the frame and a projection on the lever 67.

When the free end of the closing lever 21 is thus released by the releasing lever, the retrieving springs 63 rotate the closing lever in a clockwise direction about its fixed pivot axis 27, and since the pivot pin 51 which connects the breaker operating rod 49 with the breaker lever 23 becomes stationary when the breaker reaches open position, the clockwise rotation of the closing lever 21 by the retrieving springs effects a clockwise rotation of the breaker lever 23 about the pivot pin 51 as a center to return the trip free roller 35 into latching engagement with the trip free latch mechanism 55. At this point the two levers 21 and 23 are in the position shown in Fig. 4 and since the trip free roller is relatched by the trip free latch mechanism 55, the breaker lever 23 is again operatively connected to the closing lever 21 and through the same to the movable core 13 of the closing solenoid.

When the closing solenoid 11 is energized, the two levers 21 and 23 are rotated in a counter-clockwise direction about the common axis of the pivot studs 27 and the trip free roller 35 to the closed position shown in Fig. 1 to effect closing of the circuit breaker. When the two levers reach the closed position the non-trip free roller 61 carried by the pin 33 is reengaged and latched by the non-trip free latch mechanism 59.

The circuit breaker may also be tripped open by a releasing operation of the non-trip free latching mechanism 59. A releasing operation of the non-trip free latch mechanism allows the circuit breaker to be moved to open position by its opening spring and this movement causes the two levers 21 and 23 to rotate in a clockwise direction about the common axis of the pivot studs 27 and the trip free roller 35 to the open position shown in Fig. 4. In this instance, however, the circuit breaker remains operatively connected to the closing lever 21 and through the same to the movable core of the closing solenoid 11 so that the breaker can be immediately reclosed by energization of the closing solenoid 11.

The trip free latch mechanism 55 (Fig. 1) comprises a main latch member 69 pivoted on a pivot pin 71 carried by a part of the frame and is biased by means of a spring 73 to a latching position in which it engages and restrains the trip free roller 35 in the position shown in Fig. 1. A block 75 carried by the frame serves as a seat for one end of the latch spring 73, and this block is provided with a surface 77 which forms a stop to prevent movement of the latch 69 beyond its latching position. In order to hold the latch 69 in latching position against the upward bias exerted on the breaker lever 23, a secondary auxiliary latch 79 is provided. The latch 79 is pivoted by means of a pin 81 carried by a portion of the frame and is biased to latching position by means of a light spring 83. The nose of the latch 79 is provided with a substantially right angled notch 85 for engaging the upper corner of the main latch 69. The auxiliary latch 79 in latching position effectively locks the main latch 69 in its latching position. The auxiliary latch 79 is adapted to be moved in a clockwise direction about its pivot axis 81 to effect a releasing operation of the latch mechanism by a tripping means which will be hereinafter described.

When the auxiliary latch 79 is released, the trip free roller 35 moves upwardly under the opening bias of the breaker forcing the main latch 69 in a clockwise direction until the roller 35 clears the nose of the latch. The spring 73 then returns the main latch 69 to latching position. The main latch 69 is provided with a rounded nose to allow the roller 35 to force the latch back and clear the same during resetting or retrieving of the breaker lever 23 and the roller 35. As soon as the trip free roller 35 has cleared the nose of the latch 69 during a retrieving operation, the spring 73 returns the latch 69 to latching position and the auxiliary latch 79 returns to its latching position to engage and hold the main latch 69.

In order to ensure complete retrieving of the breaker lever 23 and the trip free roller 35 to latching position, it is necessary that the auxiliary latch 79 be held in its released position free of the main latch 69 until the trip free roller has been returned to its latching position. Otherwise the trip free roller would jam against the rounded nose of the main latch 69 during a retrieving operation. For holding the auxiliary latch 79 in its released position during the release and retrieving of the breaker lever 23, there is provided a holding lever 87 pivoted on the pivot pin 81 and biased in a clockwise direction by a spring 89 which is slightly stronger than the latch spring 83. The lever 87 is provided with one extending arm 91 which lies in the path of the final retrieving movement of the free end of the breaker lever 23. When the trip free roller 35 is in latching position, the free end of the breaker lever 23 holds the lever 87 down in an inoperative position to allow the auxiliary latch 79 to assume its latching position. However, when the trip free roller moves upwardly following a tripping operation by the latch mechanism 55, the holding lever 87 rotates in a clockwise direction, and a cross pin 93 carried thereby engages and holds the auxiliary latch 79 in its released position until the trip free roller has been retrieved to its latching position.

The non-trip free latch mechanism 59 is substantially similar to the trip free latch mechanism previously described. The latch mechanism 59 comprises a main latch 95 pivoted on the

pin 97 carried by part of the frame, and the latch is biased by means of a spring 99 to latching position in which it engages and restrains the non-trip free roller 61 carried by the closing lever 21. A block 101 carried by the frame serves as a support for one end of the spring 99, and this block is provided with a stop surface 103 for preventing movement of the latch 95 beyond its latching position. The main latch 95 is held in latching position by means of an auxiliary latch 105. The auxiliary latch 105 is pivoted on a pin 107 carried by a portion of the frame, and the latch 105 is biased to latching position by means of a light spring 109. The nose of the latch 105 is provided with a substantially rectangular notch 111 for engaging the upper corner of the main latch 95 to lock the main latch in latching position. The main latch 95 is provided with a rounded nose to permit it to be forced back and cleared by the non-trip free roller 61 during closing movement of the closing lever 21. In order to permit the closing lever 21 to be moved to its completely closed position and to be relatched by the latch mechanism 59, there is provided a holding lever 113 which is similar to the holding lever 87 of the trip free latch mechanism 55. The holding lever 113 is pivoted on the pin 107 and is biased in a counter-clockwise direction by a spring 115 which is slightly stronger than the latch spring 109. The lever 113 is provided with an arm 117 which extends into the path of the final closing movement of the free end of the closing lever 21. When the closing lever 21 is in the closed position shown in Fig. 1, the lever 113 is held down in an inoperative position to permit return of the auxiliary latch 105 to latching position. However, when the free end of the closing lever 21 moves upwardly following a tripping operation of the latch member 105, the holding lever 113 rotates in a counter-clockwise direction and a cross pin 120 carried thereby engages and holds the auxiliary latch 105 in released position clear of the main latch 95 until the closing lever 21 has been returned to the fully closed and latched position by the closing solenoid 11.

Both of the latching mechanisms 55 and 59 are adapted to be operated by a single trip coil 119 (Fig. 1). The trip coil 119 is mounted on a portion of the frame beneath the trip-free latch mechanism 55 and is provided with a trip plunger 121. The operating winding of the trip coil is adapted to be energized in response to predetermined overload conditions in the circuit controlled by the breaker or in response to any other conditions under which tripping of the breaker is desired. Energization of the trip coil causes upward movement of the trip plunger 121. A rocking trip bar 123 (Fig. 3) rests freely on a plate 125 carried by the frame above the trip coil 119. The plate 125 is provided with an opening 127 for receiving the upper end of the trip plunger 121 and with suitable guides 129 for guiding the trip bar 123 and for preventing longitudinal and lateral displacement thereof. The trip plunger 121, when moved upwardly, engages the under side of the trip bar 123 to cause rocking movement of the bar about whichever end is held against movement. The auxiliary latch 79 of the trip free latch mechanism 55 is disposed over one end of the trip bar 123 and the free end 131 of a pivoted bell crank lever 133 is disposed over the opposite end of the trip bar 123. The bell crank lever 133 is pivoted intermediate its ends on the pivot pin 81 carried by the frame 9, and the upper 75

end of the bell crank lever is pivotally connected by means of a pivot pin 137 to the right-hand end of a horizontal connecting link 139. The left-hand end of the connecting link 139 engages the upper end of the releasing lever 67 through the agency of a pin and slot connection 141.

If the trip plunger 121 is moved upwardly at a time when the bell crank lever 133 is prevented from moving in a clockwise direction, the upward movement of the trip plunger 121 will cause the rocking trip bar 123 to rock about its end which engages the free end 131 of the bell crank lever 133 to effect upward movement of the auxiliary latch 79 to cause release of the trip free latch mechanism 55. On the other hand, if the trip plunger 121 is moved upwardly at a time when the auxiliary latch 79 is prevented from moving in a clockwise direction, the upward movement of the plunger 121 causes the rocking trip bar 123 to rock about its end which engages the auxiliary latch 79 to effect clockwise rotation of the bell crank lever 133. The clockwise rotation of the bell crank lever 133 moves the horizontal connecting link 139 towards the right and rotates the releasing lever 67 in a clockwise direction to effect release of the latch 105 and the non-trip free latch mechanism 59. If neither the bell crank lever 133 or the auxiliary latch 79 are held against movement, the upward movement of the plunger 121 effects release of both the trip free and the non-trip free latch mechanisms.

If an overload condition occurs in the circuit controlled by the breaker when the breaker has been standing closed and the solenoid 11 deenergized for a sufficient length of time for the residual flux to have died down to a point where there is substantially no flux present in the solenoid, it is desirable that the circuit breaker be tripped only by means of the non-trip free latch mechanism 59 because when the breaker is tripped by the non-trip free latch mechanism 59, it is moved to open circuit position without releasing the operative connection between the breaker and the closing lever or solenoid. This permits the circuit breaker to be reclosed in the shortest possible time. The closing solenoid may be arranged to be energized substantially simultaneously with the trip coil so that it will have developed sufficient flux to halt opening movement of the breaker and begin to reclose the breaker as soon as the arcs drawn between the contacts of the breaker have been extinguished, without allowing the breaker to continue to the full open circuit position, as disclosed in the copending application of J. B. MacNeill, Serial No. 209,970, filed May 25, 1938. However, if the overload condition occurs at a time when the solenoid is in an energized condition or when there is still an appreciable quantity of residual magnetic flux present in the solenoid, it is important that the breaker be tripped open by means of the trip free latch mechanism 55 in order to permit high speed opening of the breaker unretarded by any opposing force or magnetic drag of the closing solenoid 11.

In order to provide for tripping of the breaker by the proper latch mechanism in accordance with the condition of the closing solenoid there is provided a means responsive directly to the magnetic flux of the closing solenoid for automatically selecting the proper latch mechanism 55 or 59 for operation by the trip coil 119. The automatic selecting means comprises a magnetic

selector lever 145 which is pivoted intermediate its ends on the pivot pin 71. The lever 145 has a yoke-shape portion 147 of magnetic material at the end of one of its arms, which is disposed directly over the winding 17 and the magnetic frame of the closing solenoid 11 so as to be traversed and influenced by a portion of the magnetic flux of the solenoid. The selector lever 145 is biased in a clockwise direction to a normal unattracted position by means of a pair of springs 149 which are interposed between the yoke portion 147 of the lever and the upper end plate of the solenoid 11. The right-hand arm 153 of the selector lever 145 is provided with a laterally offset end or projection 155 which is disposed directly above the auxiliary latch member 79 of the trip free latch mechanism 55.

When the solenoid 11 is deenergized and when there is substantially no magnetic flux present in the solenoid which would retard opening movement of the closing lever 21, the springs 149 maintain the selector lever 145 in the unattracted position shown in Figs. 1 and 4, in which position the projection 155 thereof engages and holds the auxiliary latch 79 of the trip free latch mechanism 55 in latching position. The springs 149 are of sufficient strength to overcome the force of the trip plunger 121 and hold the auxiliary latch 79 in latching position to prevent operation of the trip free latch mechanism 55 by the operation of the trip coil 119. If an overload condition occurs under these conditions, that is, with the magnetic selector lever in the unattracted position, the upward movement of the trip plunger 121 causes the trip bar 123 to be rocked about the end thereof engaged by the latch 79, to rotate the bell crank lever 133 in a clockwise direction. The clockwise rotation of the bell crank lever 133 moves the horizontal link 139 toward the right to cause clockwise rotation of the releasing lever 67 and consequently release of the non-trip free latch mechanism 59. It will thus be seen that the occurrence of an overload when the selector lever 145 is in the unattracted position prevents operation of the trip free latch mechanism 55 and allows the operation of the trip coil to effect tripping of the breaker by means of the non-trip free latch mechanism 59.

When the solenoid is in energized condition or whenever there is any appreciable magnetic flux present in the solenoid which would retard opening movement of the closing lever 21, the magnetic flux maintains the selector lever 145 in the attracted position shown in Fig. 5. In the attracted position of the magnetic selector lever 145, the projection 155 thereof is maintained in the raised position clear of the auxiliary latch 79 so as to permit operation of the trip free latch mechanism 55. In its raised position the projection 155 engages a lug 157 carried by the horizontal link 139 to prevent right-hand movement of the link 139 and consequently clockwise movement of the bell crank lever 133. If an overload condition occurs under these conditions, that is, when the magnetic selector lever is in the attracted position due to the presence of magnetic flux in the solenoid 11, the upward movement of the trip plunger 121 will cause the trip bar 123 to rock about the end thereof which engages the arm 131 of the bell crank lever 133, to cause the trip bar to move the auxiliary latch 79 to released position since the bell crank lever 133 is prevented from being moved in a clockwise direction. Thus, the upward movement of the plunger

121 under these conditions effects a tripping operation of the breaker by means of the trip free latch mechanism 55.

The pin and slot connection 141 between the left-hand end of the horizontal link 139 and the releasing lever 67 serves to allow the releasing lever 67 to be automatically moved to the released position during the upward movement of the breaker lever 23 to effect release of the closing lever and retrieving of the trip free roller 35, even though the link 139 is prevented from being moved towards the right by the engagement of the projection 155 with the lug 157.

In order to prevent the magnetic selector lever 145 from forcing the auxiliary latch 79 down to latching position in engagement with the main latch 69 at times when the trip free roller 35 is away from latching position, the arm 153 of the lever 145 is provided with an interlock projection 159, which is adapted to be engaged by a short arm 161 of the holding lever 87 when the holding lever 87 is in the raised position, as shown in Fig. 5.

The circuit breaker and mechanism of the present invention may be controlled by any suitable circuit breaker reclosing control system as, for example, the system disclosed in the copending application of J. E. MacNeill, Serial No. 209,970, filed May 25, 1938.

The operation of the circuit breaker and mechanism is briefly as follows. If an overload condition occurs when the mechanism is in the position shown in Fig. 1, that is, with the closing solenoid 11 deenergized and having no appreciable magnetic flux present therein, the upward movement of the trip plunger 121 by the operation of the trip coil 119 effects release of the non-trip free latch mechanism 59 and the free end of the closing lever 21. Under these conditions the magnetic selector lever 145 is maintained in unattracted position by the springs 149 to prevent release of the trip free latch mechanism 55. The breaker moves to open circuit position under the influence of its opening spring and the two levers 21 and 23 are rotated to the position shown in Fig. 4, the breaker remaining operatively connected to the movable core 42 of the closing solenoid. When the closing solenoid is energized to reclose the breaker, the two levers 21 and 23 are rotated in a counter-clockwise direction about the common pivot axis of the studs 27 and the trip free roller 35 which is held latched, to the closed position shown in Fig. 1 to effect closing of the circuit breaker.

The energization of the closing solenoid to reclose the breaker also causes the magnetic selector lever 145 to be rotated to attracted position to free the trip free latch mechanism 55 for operation by the trip coil 119, and to prevent clockwise movement of the bell crank lever 123 by the trip coil 119. The magnetic selector lever 145 is maintained in attracted position by the magnetic flux after the solenoid 11 is deenergized until the residual magnetic flux has been reduced to substantially zero value. If the fault condition causing the overload is still present during reclosing of the breaker, when the arcing contacts engage, the trip coil 119 will again be energized and the trip plunger 121 moved upwardly; this time to effect release of the trip free latch mechanism 55 and the trip free roller 35 at about the moment the closing lever 21 reaches closed latched position. The release of the trip free roller 35 immediately releases the operative connection between the breaker and

the closing lever 21 and the circuit breaker moves to open circuit position under the influence of its opening spring free of any restraint by the closing means. The breaker lever is moved in a counterclockwise direction about the pivot pin 33 and during a portion of its opening movement the projecting pin 65 engages and rotates the releasing lever 67 to effect release of the non-trip free latch mechanism 59 and the free end of the closing lever 21 which has been brought to the closed and latched position by the closing operation. When the non-trip free latch mechanism 59 and the closing lever 21 are released, the retrieving springs 63 rotate the closing lever in a clockwise direction about the fixed pivot axis 27 to return the trip free roller 35 to latching position, where it is reengaged by the trip free latch mechanism 55. The energization of the closing solenoid to reclose the circuit breaker after the trip free roller has been relatched rotates both levers 21 and 23, together in a counterclockwise direction about the pivot axis 27 to the closed position to effect closing of the circuit breaker. If the fault condition causing the overload has in the meantime been cleared, the free end of the closing lever is moved to the fully closed position and is relatched by the non-trip free latch mechanism 59 and the breaker remains closed.

It will thus be seen that the invention provides an improved circuit breaker operating mechanism which is operable to trip the breaker by a non-trip free tripping means which maintains the breaker operatively connected to the closing solenoid if the fault condition or overload occurs when there is no appreciable magnetic flux in the closing solenoid, and which is operable to trip the breaker free of any restraint by the closing means if the fault condition occurs when there is an appreciable quantity of magnetic flux present in the closing solenoid. The invention thus provides a mechanism which permits the circuit breaker to be reclosed in the shortest possible time if the overload condition which causes tripping of the breaker occurs when there is no appreciable magnetic flux present in the closing solenoid which would retard opening of the breaker, and yet which secures a high speed opening of the breaker unretarded by any opposing force or magnetic drag of the closing means if the overload occurs when there is any appreciable magnetic flux present in the closing means.

While the invention has been disclosed in accordance with the patent statutes it is to be understood that various changes in the structural details thereof may be made without departing from the spirit of the invention. It is desired, therefore, that the appended claims be given the broadest reasonable interpretation permissible in the light of the prior art.

I claim as my invention:

1. In combination, a circuit breaker, electromagnetic closing means for said breaker, tripping means for effecting opening of said breaker independently of the energized condition of said closing means, additional tripping means for effecting opening of said breaker only when said closing means is deenergized, and means responsive directly to the magnetic flux of said closing means for automatically selecting which of said tripping means shall be effective to trip said breaker.

2. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free

tripping means operable in response to predetermined conditions for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means operable in response to predetermined conditions for effecting opening of said breaker only when said closing means is deenergized, and means responsive directly to the magnetic flux of said closing means for preventing operation of said trip free tripping means only when there is no appreciable magnetic flux in said closing means.

3. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means operable in response to predetermined conditions for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means operable in response to predetermined conditions for effecting opening of said breaker only when said closing means is deenergized, and means responsive directly to the magnetic flux in said closing means for causing tripping of said breaker in response to said predetermined conditions to be effected only by said non-trip free tripping means when there is no appreciable magnetic flux in said closing means, and by said trip free tripping means where there is any appreciable magnetic flux in said closing means.

4. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means normally effecting an operative connection between said breaker and said closing means, said tripping means being operable in response to predetermined conditions to effect opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means releasably holding said breaker closed while it is operatively connected to said closing means, said non-trip free tripping means being operable in response to predetermined conditions to effect opening of said breaker only when said closing means is deenergized, and means responsive directly to the magnetic flux in said closing means for causing tripping of said breaker in response to said predetermined conditions to be effected only by said non-trip free tripping means when there is no appreciable magnetic flux in said closing means, and by said trip free tripping means when there is any appreciable magnetic flux in said closing means.

5. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means normally effecting an operative connection between said breaker and said closing means, said tripping means being operable to effect opening of said breaker free of any restraint by said closing means irrespective of the presence of any amount of magnetic flux in said closing means, additional non-trip free tripping means for releasably holding said breaker closed while it is operatively connected to said closing means, said non-trip free tripping means being operable to effect opening of said breaker while it remains operatively connected to said closing means but only when said closing means is deenergized, and means responsive directly to the magnetic flux in said closing means for causing a tripping operation of said breaker to be effected only by said trip free tripping means when there is no appreciable magnetic flux present in said closing means, and by said trip free

tripping means whenever there is any appreciable magnetic flux present in said closing means.

6. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means for effecting opening of said breaker only when said closing means is deenergized and means including a magnetic selector lever responsive directly to the magnetic flux of said closing means for automatically selecting which of said tripping means shall be effective to trip said breaker.

7. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means for effecting opening of said breaker only when said closing means is deenergized, and means including a member having at least a portion of magnetic material responsive directly to the magnetic flux of said closing means for causing a tripping operation of said breaker to be effected only by said non-trip free tripping means when there is no appreciable magnetic flux present in said closing means, and by said trip free tripping means whenever there is any appreciable magnetic flux present in said closing means.

8. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means for effecting opening of said breaker only when said closing means is deenergized, and means independent of said closing means responsive to the magnetic flux of said closing means for automatically selecting which of said tripping means shall be effective to trip said breaker.

9. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means for effecting opening of said breaker only when said closing means is deenergized, and means independent of said closing means responsive to the magnetic flux of said closing means for causing a tripping operation of said breaker to be effected only by said non-trip free tripping means when there is no appreciable magnetic flux present in said closing means, and by said trip free tripping means when there is any appreciable magnetic flux present in said closing means.

10. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means operable in response to predetermined conditions for effecting opening of said breaker independently of the energized condition of said closing means, additional non-trip free tripping means operable in response to predetermined conditions for effecting opening of said breaker only when said closing means is deenergized, and means including a movable member having at least a portion of magnetic material responsive to the magnetic flux of said closing means for causing the tripping of said breaker in response to said predetermined conditions to be effected only by said non-trip free tripping means when there is no appreciable magnetic flux in

said closing means, and by said trip free tripping means when there is any appreciable magnetic flux in said closing means.

11. In combination, a circuit breaker, electromagnetic closing means for said breaker, trip free tripping means normally effecting an operative connection between said breaker and said closing means, said tripping means being operable to effect opening of said breaker free of any restraint by said closing means irrespective of the presence of any amount of magnetic flux in said closing means, additional non-trip free tripping means for releasably holding said breaker closed while it is operatively connected to said closing means, said non-trip free tripping means being operable to effect opening of said breaker while it remains operatively connected to said closing means but only when said closing means is deenergized, and means including a movable member having at least a portion of magnetic material responsive to the magnetic flux of said closing means for causing the tripping of said breaker to be effected only by said non-trip free tripping means when there is no appreciable magnetic flux in said closing means, and by said trip free tripping means when there is appreciable magnetic flux in said closing means.

12. In combination, a circuit breaker, electromagnetic closing means for said breaker, a first latch releasable to cause opening of said breaker free of any restraint by said closing means and irrespective of the presence of any amount of magnetic flux therein, a second latch releasable to effect opening of said breaker while it is operatively connected to said closing means but only when said closing means is deenergized, trip means operable in response to predetermined conditions for releasing said latches, and means including a movable member having a portion of magnetic material responsive to the magnetic flux of said closing means for automatically selecting which of said latches will be released in response to said predetermined conditions.

13. In combination, a circuit breaker, electromagnetic closing means for said breaker, a first latch releasable to cause opening of said breaker free of any restraint by said closing means and irrespective of the presence of any amount of magnetic flux therein, a second latch releasable to effect opening of said breaker while it is operatively connected to said closing means but only when said closing means is deenergized, trip means operable in response to predetermined conditions for releasing said latches, and means including a movable member having at least a portion of magnetic material responsive to the flux of said closing means for preventing the release of said first latch only when there is no appreciable magnetic flux in said closing means.

14. In combination, a circuit breaker, electromagnetic closing means for said breaker, a first latch normally and releasably connecting said breaker to said closing means, said latch being releasable to effect opening of said breaker free of said closing means, a second latch for releasably holding said breaker closed while it is operatively connected to said closing means, said second latch being releasable to effect opening of said breaker while it remains connected to said closing means but only when said closing means is deenergized, trip means operable in response to predetermined conditions for releasing said latches, and means including a movable member having at least a portion of magnetic material responsive to the magnetic flux of said closing means for

causing tripping of said breaker in response to said predetermined conditions to be effected only by said second latch if said predetermined conditions occur when there is less than a predetermined amount of magnetic flux in said closing means, and by said first latch if said predetermined conditions occur when there is more than said predetermined amount of magnetic flux in said closing means.

15. In combination, a circuit breaker, electromagnetic closing means for said breaker, a first latch normally and releasably connecting said breaker to said closing means, said latch being releasable to effect opening of said breaker free of said closing means, a second latch for releasably holding said breaker closed while it is operatively connected to said closing means, said second latch being releasable to effect opening of said breaker while it remains connected to said closing means but only when said closing means is deenergized, a single trip coil operable in response to predetermined conditions to release said latches, and interlocking means including a movable member having at least a portion of magnetic material responsive to the magnetic flux of said closing means for preventing release of said first latch by said trip coil when there is less than a predetermined amount of magnetic flux in said closing means and for permitting release of said first latch when there is more than said predetermined amount of flux in said closing means.

16. In combination, a circuit breaker biased to open position, closing means for said breaker comprising a closing lever and a solenoid for moving said lever to close said breaker, a first latch normally and releasably connecting said breaker to said closing lever, said latch being releasable to cause opening of said breaker free of said closing means, a second latch for releasably holding said closing lever in breaker closed position, trip means operable in response to predetermined conditions to release said latches, and means including a movable member having at least a portion of magnetic material responsive to the magnetic flux of said solenoid for causing the operation of said trip means to effect release of said second latch only if said predetermined conditions occur when there is less than a predetermined amount of magnetic flux present in said solenoid.

17. In combination, a circuit breaker, electromagnetic closing means for said breaker, two tripping means operable in response to predetermined conditions to effect opening of said breaker, one of said tripping means being operable to effect opening of said breaker free of any restraint by said closing means irrespective of the presence of any amount of magnetic flux in said closing means, and the other of said tripping means being operable to effect opening of said breaker while it remains connected to said closing means but only when said closing means is deenergized, and means including a selector lever having at least a portion of magnetic material responsive to the magnetic flux of said closing means for causing tripping of said breaker in response to said predetermined conditions to be effected only by said last mentioned tripping means when there is no appreciable magnetic flux present in said closing means, and by said first mentioned tripping means when there is any appreciable magnetic flux present in said closing means.

18. In a circuit breaker, electromagnetic closing means for said breaker, tripping means including a latch movable from a latching position

to a released position to effect opening of said breaker independently of the condition of said closing means, additional tripping means for effecting opening of said breaker only when said closing means is deenergized, means including a movable member responsive to the magnetic flux of said closing means for automatically selecting which of said tripping means will be effective to trip said breaker, said member being movable to a holding position when there is no appreciable flux in said closing means in which position it engages and holds said latch in latching position, and movable to a second position when there is any appreciable flux in said closing means to permit movement of said latch to released position, and interlocking means carried in part by said movable member for preventing movement of said member to holding position when said latch is in released position.

19. In a circuit breaker, electromagnetic closing means for said breaker, tripping means including a latch movable from a latching position to a released position to effect opening of said breaker, a movable member responsive to the flux in said closing means, said member normally engaging and holding said latch in its latching position when there is no appreciable magnetic flux in said closing means, and being movable away from said latch to permit movement of said latch to released position when there is any appreciable flux in said closing means, and interlocking means carried in part by said movable member for preventing movement of said movable member to holding position when said latch is in released position.

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