Aug. 21, 1945. S. H. BODEN ET AL 2,383,288

CIRCUIT BREAKER

Filed May 19, 1942 4 Sheets-Sheet 1

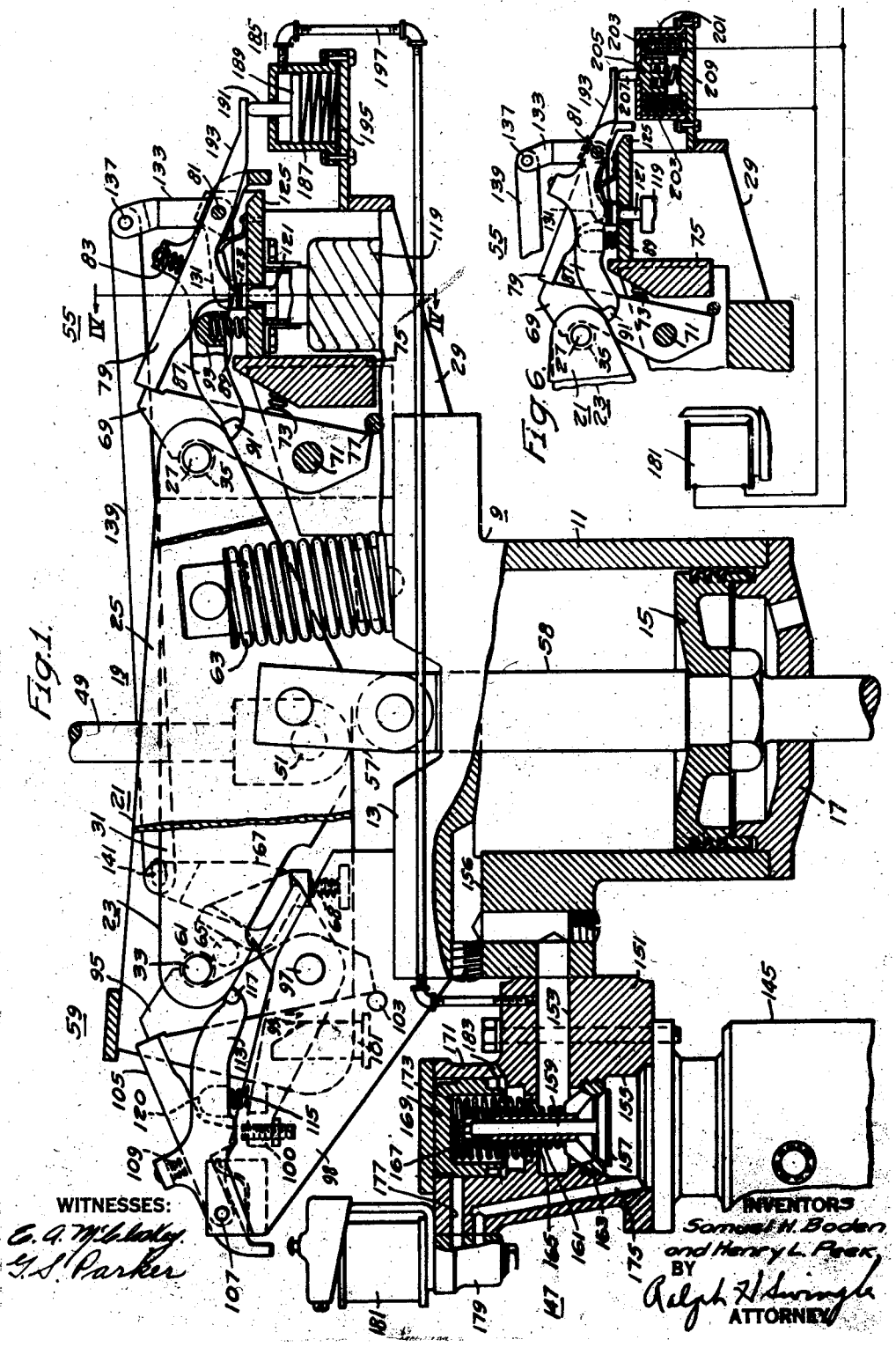

FIG. 1.

FIG. 6.

WITNESSES:
E. A. McAuley
G. S. Parker

INVENTORS
Samuel H. Boden
and Henry L. Peek,
BY
Ralph H. Strong
ATTORNEY

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CIRCUIT BREAKER

Filed May 19, 1942 4 Sheets-Sheet 2

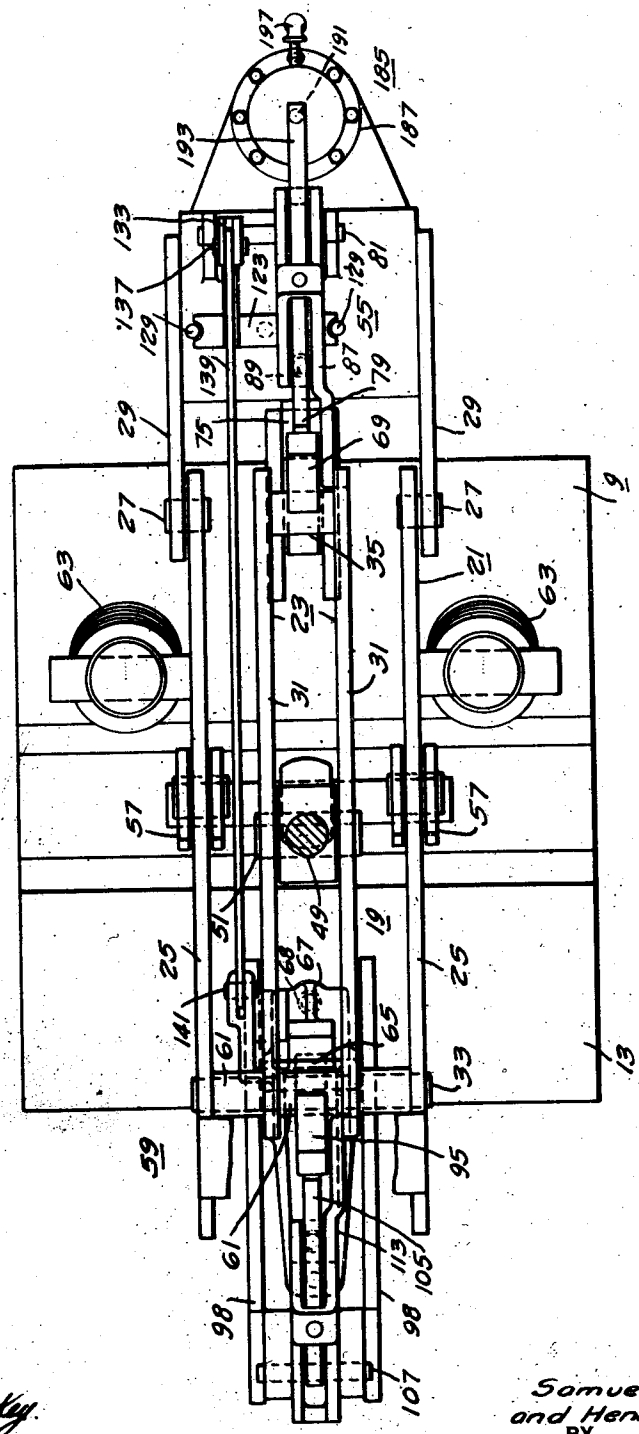

Fig. 2.

WITNESSES:
E. A. McCloskey.
G. S. Parker

INVENTORS
Samuel H. Boden
and Henry L. Peek.
BY
Ralph W. Swingle
ATTORNEY

Aug. 21, 1945. S. H. BODEN ET AL 2,383,288

CIRCUIT BREAKER

Filed May 19, 1942 4 Sheets-Sheet 3

Fig. 3.

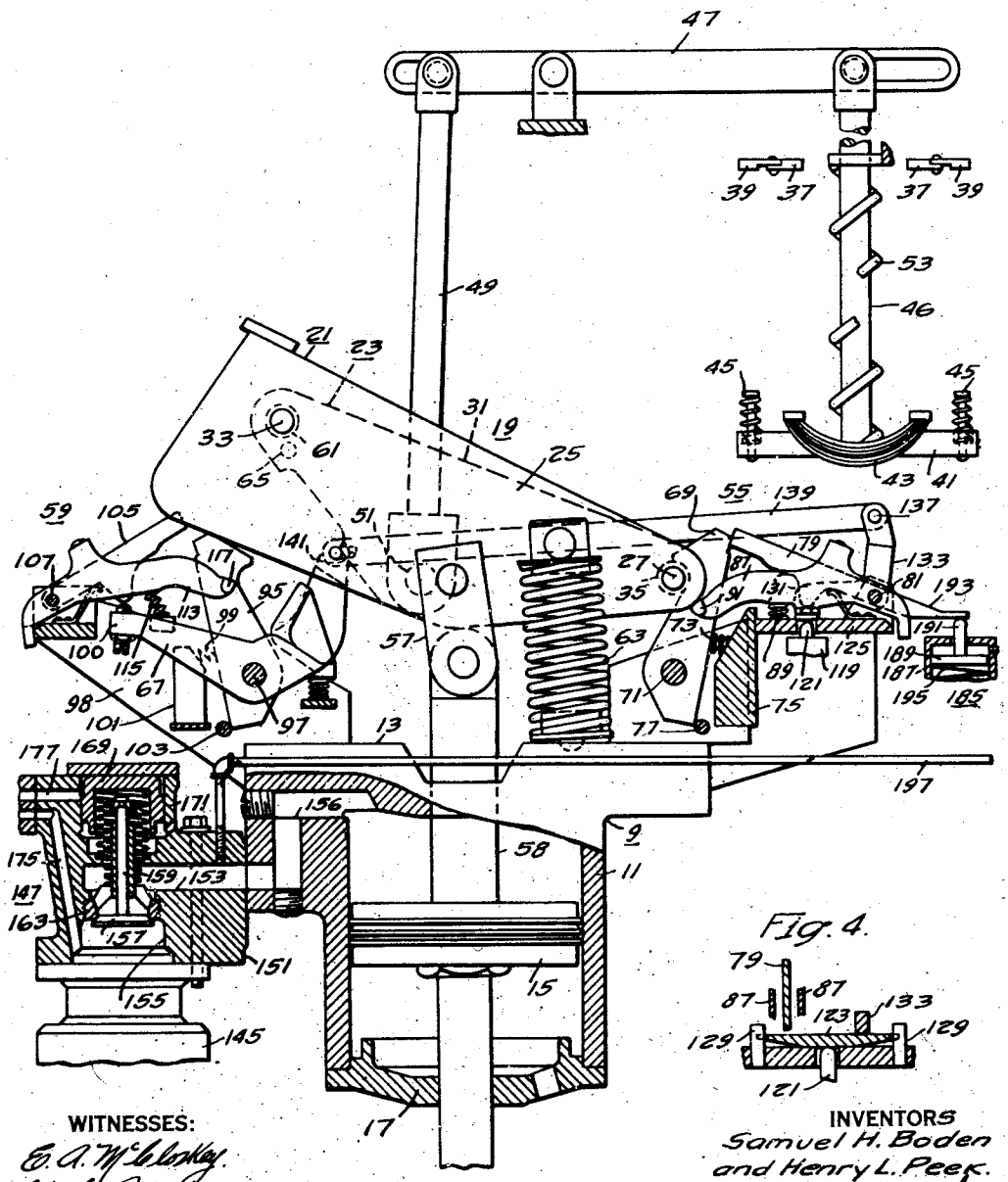

Fig. 4.

WITNESSES:
E. A. McCloskey.
G. S. Parker

INVENTORS
Samuel H. Boden
and Henry L. Peek.
BY
Ralph H. Swingle
ATTORNEY

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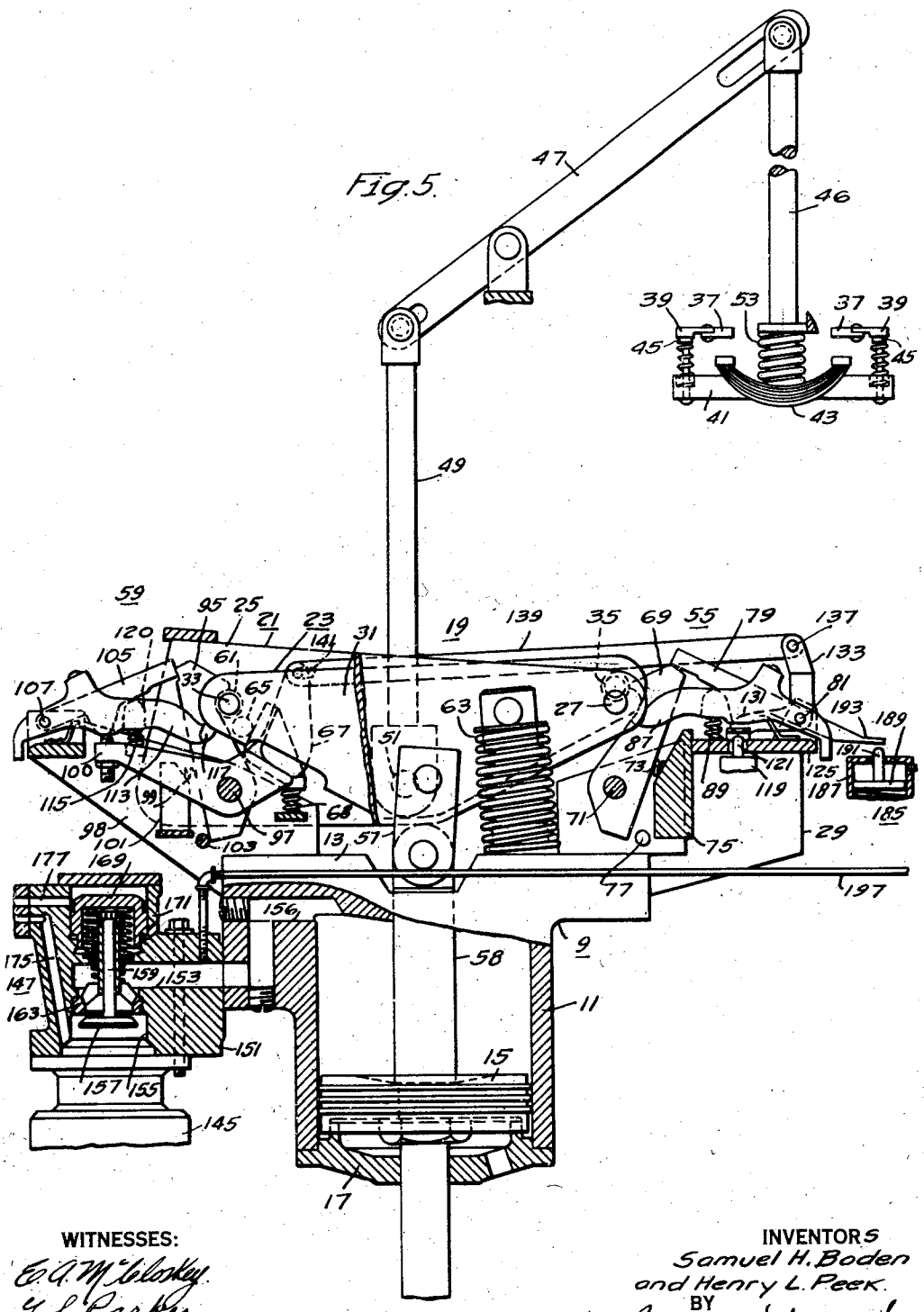
CIRCUIT BREAKER

Filed May 19, 1942 4 Sheets-Sheet 4

Fig. 5.



WITNESSES:

E. A. McCloskey

G. L. Parker

INVENTORS

Samuel H. Boden

and Henry L. Peek.

BY

Ralph W. Swingle

ATTORNEY

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UNITED STATES PATENT OFFICE

2,383,288

CIRCUIT BREAKER

Samuel H. Boden, Turtle Creek, and Henry L. Peek, Edgewood, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 19, 1942, Serial No. 443,550

15 Claims. (Cl. 200—82)

The invention relates to circuit breakers in general and, more particularly, to automatic reclosing circuit breakers of the type which are adapted to be reclosed substantially instantaneously upon the initial opening thereof in response to abnormal conditions.

In order to obtain quick reclosing of a circuit breaker, it is desirable to initially trip the breaker in response to a fault condition by a non-trip-free tripping means which leaves the breaker operatively connected to the closing means or under the immediate control of the closing means, so that reclosing movement can be initiated before the breaker reaches full open position or at least by the time the breaker reaches full open position. This is permissible, however, only when the closing means is in deenergized condition and will not retard opening of the breaker. If a fault condition is present when the breaker recloses the circuit, it is important that the breaker be tripped by trip-free tripping means free of the closing means, so that opening of the breaker will not be retarded or prevented by the closing means which is usually in energized condition at this time.

In Patent No. 2,150,587, issued to A. J. A. Peterson March 14, 1939, there is disclosed a solenoid circuit breaker mechanism which accomplishes the aforementioned selective tripping by means of a magnetic selector lever operated by the magnetic flux or force produced by the closing solenoid. The copending application of H. L. Peek, Serial No. 443,040, filed May 15, 1942, also discloses a quick reclosing circuit breaker mechanism which accomplishes the selective tripping by a selector switch for selecting the trip-free or non-trip-free trip coils provided on the mechanism.

The present invention has for an object the provision of a circuit breaker operating mechanism having a different automatic selecting arrangement from that disclosed in the above-mentioned patent and copending application, and a different type of mechanism from that of the aforementioned patent.

An object of the present invention is the provision of a circuit breaker having a trip-free tripping means, a non-trip-free tripping means, and an automatic trip selecting device energized simultaneously with the closing means, but independently of any force produced by the closing means, said device when deenergized preventing operation of the trip-free tripping means, even if a tripping force is applied to the trip-free tripping means, and said device when energized permitting operation of the trip-free tripping means.

Another object of the invention is the provision of a circuit breaker having a fluid or gas pressure operated closing means, a trip-free tripping means, a non-trip-free tripping means and an automatic trip selecting device energized and deenergized simultaneously with said closing means, said device being effective when deenergized to prevent operation of the trip-free tripping means, even though a tripping force is applied thereto, and said device being operative when energized to permit operation of the trip-free tripping means.

Another object of the invention is the provision of a circuit breaker mechanism as described in the preceding paragraph, wherein the trip selecting device is energized or operated by fluid or gas pressure whenever fluid or gas pressure in said closing means is above a predetermined value.

Another object of the invention, in accordance with a modification thereof, is the provision of a circuit breaker having a trip-free tripping means, a non-trip-free tripping means, and an automatic trip selecting device comprising an electromagnet separate from the closing means and energized and deenergized simultaneously with the closing means for selecting the proper tripping means.

Another object of the invention is the provision of a circuit breaker as described in the preceding objects, wherein each of the two tripping means comprises a releasable latch, and the two latches are both mechanically operated by a single tripping electromagnet, operation of the trip-free latch being prevented or permitted by the automatic trip selecting device.

Another object of the invention is the provision of an improved circuit breaker operating mechanism for obtaining high speed opening and reclosing of a circuit breaker.

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

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

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

Fig. 3 is a side elevational view, partly in section, of the circuit breaker operating mechanism showing a momentary intermediate open position of the parts after the mechanism has been tripped by the non-trip-free tripping means or latch, the circuit breaker being shown somewhat schematically in this figure;

Fig. 4 is a fragmentary sectional view taken

substantially along the line IV—IV of Fig. 1 showing the trip coil plunger and the rocking trip bar for operating either of the two latching means of the mechanism;

Fig. 5 is a view similar to Fig. 3, but showing another momentary position of the parts an instant after the breaker has been tripped by the trip-free tripping means or latch; and

Fig. 6 is a fragmentary view showing a modification of the trip selecting arrangement.

Referring to the drawings, the reference numeral 9 indicates generally a metal casting which is formed to provide an operating cylinder 11 and a plate 13 which closes the upper end of the operating cylinder and forms a support for the various parts of the mechanism. An operating piston 15 adapted to be operated by fluid pressure, such as compressed air, is reciprocably movable in the cylinder 11, and this piston together with the cylinder constitutes a fluid motor or closing means for closing the circuit breaker. The lower end of the operating cylinder is closed by a closure member 17 secured in any suitable manner to the cylinder.

A lever mechanism of the trip-free type, indicated generally at 19, is mounted on the support portion 13, and this mechanism serves to normally connect the circuit breaker with the closing means or fluid motor 11—15. The lever mechanism comprises a closing lever 21 which is pivoted at its right-hand end on the support 13 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 end pivoted about a common axis by means of a pair of aligned fixed pivot studs 27 carried by two spaced vertical plates 29 secured to the support portion 13. 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 23 are spaced so as to be movable into the space between the outer levers 25 which form the closing lever 21. 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 levers 31.

The circuit breaker may be of any suitable construction, either of the liquid or air break type, and is shown schematically in Figs. 3 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 and a pair of spring biased arcing contacts 45. The arcing contacts are arranged to engage prior to the main contacts during closing of the circuit breaker and to separate after separation of the main contacts during opening of the 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 by a pivot pin 51 which extends between the inner levers 31. The circuit breaker is biased to open position by an opening or accelerating spring 53. It will be understood that the circuit breaker may be of any conventional type and may have any suitable form of contact means.

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 fixed 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 operating piston 15 of the closing means by means of a pair of connecting links 57 and a connecting rod 58 which extends into the cylinder through a fluid-tight opening in the head of the cylinder. The free end of the closing lever 21 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 is biased in a clockwise direction about its fixed pivot axis 27 by means of a pair of strong helical retrieving springs 63 which are disposed in compression between each of the outer levers 25 and the support portion 13.

When the trip-free roller 35 on 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 piston 15 of the closing means is released, and the breaker moves to open circuit position under the influence of the accelerating spring 53 free of any restraint by the closing means. The opening movement of the circuit breaker causes the breaker lever 23 to rotate in a counterclockwise direction toward the open position 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 latch mechanism 59 to thereby cause the release of the free end of the closing lever 21. For this purpose, the breaker lever has 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 lever 67 to effect release of the non-trip-free latch 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 supported between a pair of spaced vertical plates 98 secured to the support portion 13, and this lever has a projection 100 for releasing the latch mechanism 59. The bell-crank releasing lever 67 is biased in a counterclockwise direction, as viewed in Fig. 1, by means of a compression spring 68 interposed between a projection on the bell-crank lever and a fixed support.

When the free end of the closing lever 21 is thus released, the retrieving springs 63 rotate the closing lever in a clockwise direction about its fixed pivot axis 27, and this clockwise rotation effects a clockwise rotation of the breaker lever 23 about the pivot pin 51 as a center to thereby return the trip-free roller 35 into latching engagement with the trip-free latch mechanism 55. At this point, the breaker is in full open position, and the two levers 21 and 23 are latched together to form, in effect, a single lever, the breaker lever thus being again operatively connected to the closing lever 21 and through the same to the operating piston 15 of the closing means. When the closing means is energized, that is, when compressed air is admitted to the upper end of the cylinder, the operating piston 15 is moved downwardly and rotates the two levers 21 and 23 in a counterclockwise

direction about the common axis of the pivot studs 27 to the closed position shown in Fig. 1, thereby effecting closing of the circuit breaker. When the two levers reach closed position, the non-trip-free roller 61 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 mechanism 59. This allows the circuit breaker to be moved to open position by its accelerating spring, thereby causing the two levers 21 and 23 to rotate in a clockwise direction about the common axis of the pivot studs 27 to the open position. In this instance, however, the circuit breaker remains operatively connected to the closing lever 21 and through the same to the operating piston of the closing means, so that the circuit breaker can be reclosed instantly, preferably from some intermediate open position after the arc is extinguished and before the contacts reach full open position. This quick reclosing operation is initiated by admitting compressed air to the cylinder 11 at an intermediate point in the opening movement of the breaker so as to initiate the reclosing movement before the breaker reaches full open position.

The trip-free latch mechanism 55 (Fig. 1) comprises a main latch 69 of the slip-off type pivoted on a pivot pin 71 carried by the support portion 13, and the latch 69 is biased by means of a compression spring 73 to 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 support portion 13 serves as a seat for one end of the latch spring 73. A stop pin 77 is positioned to prevent movement of the latch 69 beyond its latching position. In order to hold the latch 69 in latching position against the upward or opening bias exerted on the breaker lever 23, an auxiliary latch 79 is provided. The latch 79 is pivoted by means of a pin 81 carried by the framework on the support portion 13, and this auxiliary latch is biased to latching position by means of a light spring 83. 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 trip-free latch mechanism by means of a tripping solenoid 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 strong spring 89 which is 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-piece 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. A stop pin 103 prevents 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 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 counterclockwise direction by a spring 115 which is 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 counterclockwise direction and a cross-piece 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 lever 21 has been returned to the fully closed and latched position by the closing means.

Both of the latching mechanisms 55 and 59 are adapted to be operated by a single trip coil or trip solenoid 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 circuit fault conditions under which tripping of the breaker is desired. Energization of the trip coil causes upward movement of the trip plunger 121. A trip bar 123 (Fig. 4) rests freely on a plate 125 carried by the frame above the trip coil 119. The plate 125 is provided with an opening 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 center of the underside of the trip bar 123 to cause upward movement thereof to effect release of both latch mechanisms 55 and 59, if a trip selecting means, to be hereinafter described, does not prevent release of the trip-free latch mechanism 55. If release of the latch mechanism 55 is prevented by the trip selecting device, upward movement of the trip plunger 121 causes the trip bar to rock about the end which is held down so that only the non-trip-free latch mechanism 59 is released under these conditions. 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 (Fig. 1) is pivoted intermediate its ends on the pivot pin 81 carried by the frame, and the upper 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 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 (as viewed in Fig. 1) 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 nor 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 or fault condition occurs in the circuit controlled by the breaker when the breaker has been standing closed and the closing means is deenergized, that is, when the air pressure in the cylinder on the upper side of the operating piston is substantially at atmospheric pressure, 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 means. This permits the circuit breaker to be reclosed in the shortest possible time. The closing means is preferably energized at a predetermined intermediate point in the opening movement of the breaker, that is, compressed air is admitted to the cylinder at a predetermined intermediate point in the opening movement of the breaker so as to initiate the reclosing movement of the breaker before the breaker reaches full open position, preferably shortly after the arcs drawn by the contacts have been extinguished. This may be accomplished by energizing the inlet air valve controlling electromagnet by a control circuit similar to that disclosed in the copending application of J. M. Cumming and R. C. Cunningham, Serial No. 410,686, filed September 13, 1941, and assigned to the assignee of the present invention. However, if the overload condition occurs at a time when the closing means is in energized condition, that is, when the air pressure in the cylinder above the operating piston is above a predetermined value, 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 of the closing means.

Compressed air for moving the operating piston 15 downwardly to close or reclose the circuit breaker is supplied from an auxiliary air reservoir tank 145. The auxiliary tank 145 is connected to a main air storage tank (not shown) in which compressed air is stored and maintained by a suitable motor driven compressor unit (not shown). The supply of compressed air to the upper end of the operating cylinder 11 is controlled by an inlet valve mechanism indicated generally at 147. The inlet valve mechanism comprises a valve housing 151 which is secured to the side of the cylinder casting 9 by a plurality of bolts (not shown), and this valve housing is provided with inlet passages 153 and 155, the former communicating with an inlet port 156 in the upper end of the cylinder 11 and the latter communicating with the auxiliary air reservoir 145. The main inlet valve element 157 disposed in the valve housing has a stem 159 slidably mounted in a guide sleeve 161 carried by bushing 163. The bushing 163 is threaded in an opening and a wall of the valve housing between the passages 153 and 155, and this bushing serves as a valve seat for the valve element 157. The valve element 157 is biased to closed position, as shown in Fig. 1, by means of a helical compression spring 165 which surrounds the guide sleeve 161. The lower end of the valve spring bears against spider legs on the bushing 161, and the upper end bears against a spring support 167 secured to the upper end of the valve stem.

The main inlet valve element 157 is adapted to be opened by means of a valve piston 169 to admit compressed air into the upper end of the operating cylinder 11 to close or automatically reclose the circuit breaker. The valve piston 169 is movable in a valve cylinder 171 formed in the valve housing, and this valve piston is biased upwardly to an inoperative position against the head of the valve cylinder by means of a helical compression spring 173 surrounding a portion of the valve biasing spring and disposed between the underside of the valve piston and a shoulder formed in the valve housing. The valve operating piston 169 is adapted to be moved downwardly to open the main inlet valve element 157 by compressed air from the auxiliary air tank 145 through passages 175 and 177 formed in the valve housing. Communication between the auxiliary air tank and the upper end of the valve cylinder 171 is normally shut off, however, by a pilot valve 179 which is biased to closed position and which is adapted to be opened by means of an electromagnet 181 when the electromagnet is energized. The cylinder

portion 171 of the main inlet valve is provided with one or more atmosphere exhaust ports 183 which are closed by a skirt on the valve piston when the valve mechanism is in open position. When the valve mechanism is in closed position, as shown in Fig. 1, however, the atmosphere exhaust ports 183 communicate with the interior of the main operating cylinder 11, and thereby serve to exhaust the air pressure in the operating cylinder 11 to atmosphere after the valve mechanism returns to closed position following a circuit breaker closing operation.

In accordance with the present invention, automatic selection of the proper latch mechanism for tripping the breaker is accomplished by means of an automatic trip selecting device indicated generally at 185. The automatic trip selecting device 185 comprises a relatively small cylinder 187 mounted on the frame of the mechanism adjacent the trip-free latch mechanism 55. A trip selecting or interlock piston 189 is reciprocably movable in the cylinder 187, and this piston has a plunger 191 which extends in a fluid-tight manner through an opening provided therefor in the upper end of the cylinder 187. The plunger 191 is disposed directly beneath an extended tail portion 193 of the auxiliary latch or trigger 79 of the trip-free latching mechanism 55. The piston 189 is biased to and normally held in the upper position shown in Fig. 1 by means of a helical compression spring 195 disposed within the cylinder 187. The upper end of the cylinder 187 is connected by means of an air conduit or pipe 197 to the inlet passage 153 of the inlet valve mechanism, so that compressed air is admitted to the upper end of the cylinder 187 simultaneously with the admission of compressed air to the main operating cylinder 11. Since the inlet passage 153 is in direct communication with the operating cylinder 11, the interlock or trip selecting piston 189 is responsive to air pressure conditions within the main circuit breaker operating cylinder 11. If the air pressure in the main operating cylinder 11 above the breaker operating piston 15 is substantially at atmospheric pressure, the spring 195 holds the trip selecting or interlock piston 189 in its upper or locking position, as shown in Fig. 1, thereby preventing release of the auxiliary or trigger latch 79 of the trip-free latching means 55. The strength of the spring 195 is such that it will prevent release of the auxiliary latch 79 even though the trip coil 119 is energized and acts to move the auxiliary latch to released position. Thus if the trip coil 119 is energized at any time when the air pressure within the trigger operating cylinder 11 is substantially at atmospheric pressure, the trip selecting or interlock piston 189 prevents release of the auxiliary latch 79 of the trip-free latching mechanism. Under these conditions, the upward movement of the trip plunger 121 causes the trip bar to be rocked about the end thereof engaged by the latch 79 to rotate the bell crank lever 133 in a clockwise direction as viewed in Fig. 1. The clockwise rotation of the bell crank lever 133 moves the horizontal link 139 towards the right to cause clockwise rotation of the releasing lever 67, thereby effecting release of the non-trip-free latch mechanism 59. It will thus be seen that the occurrence of an overload when the closing means is in deenergized condition, that is, when there is no compressed air in the main breaker operating cylinder, results in the breaker being tripped only by the non-trip-free latching mechanism 59, the trip-free latch mechanism being locked in latching position by the automatic trip selecting device. Tripping of the breaker under these conditions is illustrated in Fig. 3. When compressed air is admitted to the breaker operating cylinder 11 by opening of the inlet valve 157 to effect a closing or reclosing operation of the circuit breaker, compressed air is also simultaneously admitted to the upper end of the cylinder 187 of the automatic trip selecting device through the pipe 197. Under these conditions, the trip selecting or interlock piston 189 is moved downwardly, compressing the spring 195, and is thus moved away from the tail portion of the auxiliary latch 79 so as to permit operation of the trip-free latching means 55. Since the compressed air is applied until the breaker operating piston reaches closed position, the trip selecting piston 189 will be maintained in its depressed or unlocking position throughout the entire closing stroke of the breaker operating piston, and thus will permit the operation of the trip-free latching means 55 if the trip coil 119 should be energized when the breaker recloses the main circuit. The upper end of the operating cylinder 187 is in direct communication with the breaker operating cylinder 11, and the strength of the spring 195 is so selected that the trip selecting interlock piston 189 will be maintained in its downward or unlocking position at any time when the air pressure within the main operating cylinder is above a predetermined value, that is, substantially above atmospheric pressure.

From the foregoing, it will be seen that if the trip coil 119 is energized at any time when compressed air or air above a predetermined pressure is in the breaker operating cylinder 11, the piston 189 and plunger 191 will be in the lower or unlocked position, as shown in Fig. 5, thereby permitting release of the auxiliary latch 79, allowing the mechanism to trip from the trip-free end and thus permitting the circuit breaker to be tripped free of the closing means. The mechanism is, therefore, trip-free at all times that sufficient air pressure is present above the main breaker operating piston 15 to retard opening movement of the breaker, and is non-trip-free at all other times.

A modification of the invention is illustrated in Fig. 6. In Fig. 6, the main parts of the operating mechanism have been omitted since they are of the same construction as shown in the original embodiment. In this modification of the invention, the automatic trip selecting device is in the form of a solenoid 201 having a winding 203 and a movable core 205. The core 205 carries a plunger 207 which is disposed directly beneath the extending tail portion 193 of the auxiliary latch 79 of the trip-free latch mechanism 55. The core 205 is biased to the upper position shown in Fig. 6 by means of a compression spring 209, so as to prevent release of the auxiliary latch 79 when the solenoid 201 is deenergized. The winding of the solenoid 201 is arranged to be energized simultaneously with the energization of the inlet valve controlling electromagnet 181 which controls the admission of compressed air to the breaker operating cylinder, as disclosed in the original embodiment. For this purpose, the winding of the solenoid 201 is connected in parallel with the winding of the inlet valve controlling electromagnet 181. Thus the device 201 will be energized simultaneously with the inlet valve controlling electromagnet 181, and conse-

quently simultaneously with the energization of the fluid motor for closing the breaker. When the solenoid 201 is energized, the moving core and plunger move downwardly to the unlocked position, thereby permitting release of the auxiliary latch 79 of the trip-free latch mechanism 55 whenever the closing means is energized. When the closing means is deenergized, the solenoid 201 is also deenergized and prevents operation of the trip-free tripping means, so that under these conditions tripping of the breaker is placed under the control of the non-trip-free tripping means only and quick reclosing can be obtained.

In both embodiments of the invention the biasing spring 89 of the holding lever 87 is stronger than the biasing spring of the trip selecting device so that the trip selecting device will not interfere with the retrieving operation of the breaker.

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 if the fault condition or overload occurs when the closing means is in deenergized condition, thereby permitting quick reclosing of the breaker, and which is operable to trip the breaker free of the closing means if the fault condition occurs when the closing means is in energized condition.

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 some of the essential features of the invention. It is desired, therefore, that the language of the appended claims be given the broadest reasonable interpretation permissible in the light of the prior art.

We claim as our invention:

1. In combination, a circuit breaker, a motor for closing the breaker, tripping means for effecting opening of the breaker irrespective of the energized condition of the motor, additional tripping means for effecting opening of the breaker only when said motor is deenergized, a single trip coil operable in response to predetermined conditions for operating either of said tripping means, a source of power for energizing said motor, a device effective when deenergized to prevent operation of said first mentioned tripping means and operable when energized to permit operation of said first mentioned tripping means, and stationary power transmitting means having parallel connections to said motor and to said device for energizing said device simultaneously with said motor.

2. In combination, a circuit breaker, a fluid pressure operated motor for closing said breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said closing motor, non-trip-free tripping means for effecting opening of the breaker only when said motor is deenergized, a single tripping electromagnet for operating both said tripping means, means including a source of fluid under pressure for energizing said motor, and a device effective when deenergized to prevent operation of said trip-free tripping means and operable when energized to permit operation of said trip-free tripping means, said device being energized by fluid pressure from said source simultaneously with the energization of said fluid motor.

3. In combination, a circuit breaker, a fluid pressure operated motor for closing the breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of said breaker only when said motor is deenergized, a single tripping electromagnet for operating both of said tripping means, means including a source of fluid under pressure for energizing said motor, and a device normally effective to prevent operation of said trip-free tripping means by said tripping electromagnet, said device being operable by fluid pressure when the fluid pressure in said motor exceeds a predetermined value to permit operation of said trip-free tripping means.

4. In combination, a circuit breaker, a fluid pressure operated motor for closing the breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of said breaker only when said motor is deenergized, a single tripping electromagnet for operating both of said tripping means, means including a source of fluid under pressure for energizing said motor, and a device effective to prevent operation of said trip-free tripping means by said tripping electromagnet when the fluid pressure in said motor is below a predetermined value and operable to permit operation of said trip-free tripping means when the fluid pressure in said motor is above said predetermined value.

5. In combination, a circuit breaker, a fluid pressure operated motor for closing said breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of the breaker only when said motor is deenergized, means including a source of fluid under pressure for energizing said motor, and a device effective to prevent operation of said trip-free tripping means when said motor is deenergized even though a tripping force is applied to said trip-free tripping means, said device being operated by fluid pressure whenever fluid pressure in said motor exceeds a predetermined valve to permit operation of said trip-free tripping means.

6. In combination, a circuit breaker, a fluid pressure operated motor for closing the breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of said breaker only when said motor is deenergized, a single tripping electromagnet for operating both of said tripping means, means including a source of fluid under pressure for energizing said motor, a fluid pressure operated device effective when deenergized to prevent operation of said trip-free tripping means by said tripping electromagnet and operable when energized to permit operation of said trip-free tripping means, and means for simultaneously admitting fluid pressure to said device and to said motor.

7. In combination, a circuit breaker, a fluid motor for closing said breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of the breaker only when said motor is substantially deenergized, means including a source of fluid under pressure for energizing said motor, a device effective when deenergized to prevent operation of said trip-free tripping means even though a tripping force acts on said trip-free tripping means, said device being operative when

energized to permit operation of said trip-free tripping means, and means for energizing said device when the fluid pressure in said motor is above a predetermined value.

8. In combination, a circuit breaker, closing means for closing the breaker, trip-free tripping means for effecting opening of said breaker irrespective of the energized condition of said closing means, non-trip-free tripping means for effecting opening of said breaker, means including a source of power and power transmitting means for energizing said closing means, a device effective when deenergized to prevent operation of said trip-free tripping means even though a tripping force acts on said trip-free tripping means, said device being operative when energized to permit operation of said trip-free tripping means, and stationary energy transmitting means having parallel connections to said device and to said closing means for energizing said device simultaneously with energization of said closing means.

9. In combination, a circuit breaker, a fluid motor for closing said breaker, a trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of the breaker only when said motor is substantially deenergized, means including a source of fluid under pressure for energizing said motor, a fluid pressure operated device effective when the fluid pressure in said motor is below a predetermined value to prevent operation of said trip-free tripping means even though a tripping force acts on said trip-free tripping means, said device being operative to permit operation of said trip-free tripping means when fluid pressure in said motor is above said predetermined value.

10. In combination, a circuit breaker, a fluid pressure operated motor for closing the breaker, a first latch releasable to cause opening of the breaker free of the closing motor and independently of the energized condition of the motor, a second latch releasable to cause opening of the breaker while the breaker remains operatively connected to the motor and under the immediate influence of the motor, tripping means for releasing said latches, means including a source of fluid under pressure for energizing said motor, a device effective when deenergized to prevent release of said first latch even though a tripping force is applied to said latch by said tripping means, said device being operative when energized to permit release of said first latch and being connected to said source for simultaneous energization with said motor.

11. In combination, a circuit breaker, a fluid pressure operated motor for closing said breaker, trip-free tripping means for effecting opening of said breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of said breaker, an inlet valve for controlling the flow of fluid under pressure from a source of fluid under pressure to said motor, an electromagnet for controlling said inlet valve, and a device normally effective to prevent operation of said trip-free tripping means even though a tripping force is applied to said tripping means, said device being operative to permit operation of said trip-free tripping means when said electromagnet is energized.

12. In combination, a circuit breaker, a fluid pressure operated motor for closing the breaker, trip-free tripping means for effecting opening of said breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of said breaker only when said motor is substantially deenergized, means including a source of fluid under pressure and an inlet valve for supplying fluid under pressure to said motor for closing the breaker, an electromagnet for controlling said inlet valve; and an electromagnetic means independent of said valve electromagnet effective when deenergized to prevent operation of said trip-free tripping means and operative when energized to permit operation of said trip-free tripping means, said electromagnetic means being energized simultaneously with said inlet valve controlling electromagnet.

13. In combination, a circuit breaker, a fluid pressure operated motor for closing the breaker, trip-free tripping means for effecting opening of the breaker irrespective of the energized condition of said motor, non-trip-free tripping means for effecting opening of the breaker while leaving the breaker subject to immediate control by the motor, means including a source of fluid under pressure and an inlet valve for supplying fluid under pressure to said motor to close the breaker, and a device effective at times when said inlet valve is in closed position to prevent operation of said trip-free tripping means even though a tripping force is applied to said trip-free tripping means, said device being operative to permit operation of said trip-free tripping means when said inlet valve is open.

14. In a compressed gas operated circuit breaker, an operating cylinder and a movable piston therein for closing the breaker, means including a source of gas under pressure and an inlet valve for supplying compressed gas to said cylinder, trip-free tripping means for effecting opening of the breaker free of said piston, non-trip-free tripping means for effecting opening of said breaker while leaving the breaker under the immediate control of said piston, a single tripping electromagnet for mechanically operating both said tripping means, a gas pressure operated device communicating with said cylinder and effective when the gas pressure in said cylinder is below a predetermined value to prevent operation of said trip-free tripping means by said tripping electromagnet, said device being operable by gas pressure to permit operation of said trip-free tripping means whenever the gas pressure in said cylinder is above said predetermined value.

15. In a compressed gas operated circuit breaker, an operating cylinder and a movable piston therein for closing the breaker, means including a source of gas under pressure and an electromagnetically controlled valve for supplying compressed gas to said cylinder to close the breaker, an electromagnet for controlling said valve, trip-free tripping means for effecting opening of said breaker free of said piston, non-trip-free tripping means for effecting opening of said breaker while leaving the breaker subject to the immediate control of said piston, a single tripping electromagnet for mechanically operating both of said tripping means, and an electromagnetic selector device electrically connected for simultaneous energization with said valve controlling electromagnet, said selector device being effective when deenergized to prevent operation of said trip-free tripping means by said tripping electromagnet and being operative when energized to permit operation of said trip-free tripping means.

SAMUEL H. BODEN.
HENRY L. PEEK.