Dec. 6, 1949 J. A. FAVRE 2,490,514

THERMAL-MAGNETIC CIRCUIT BREAKER

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Fig. 1.

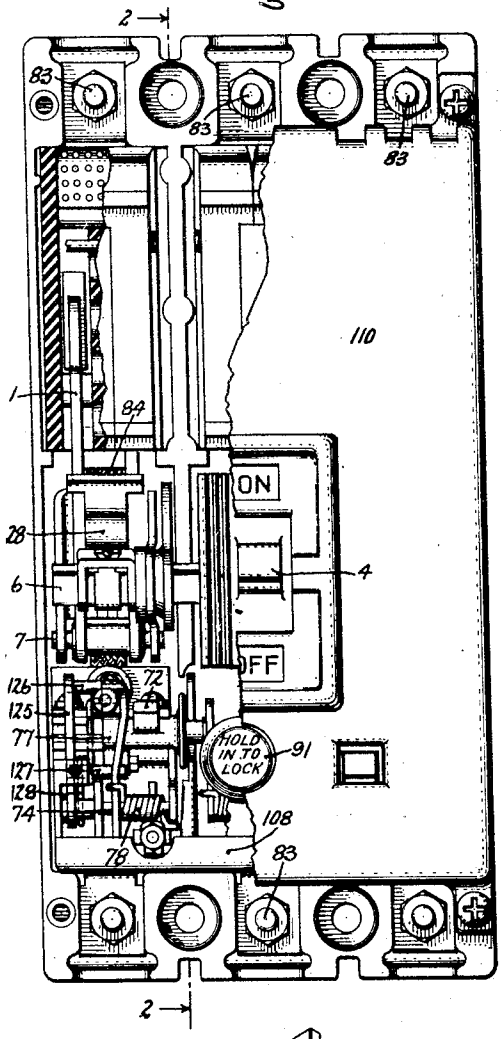


Fig. 2.

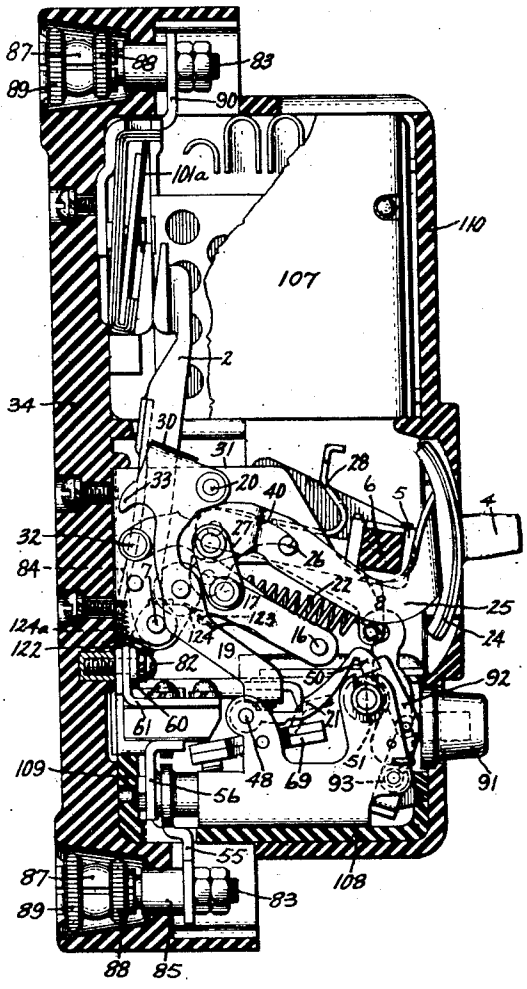
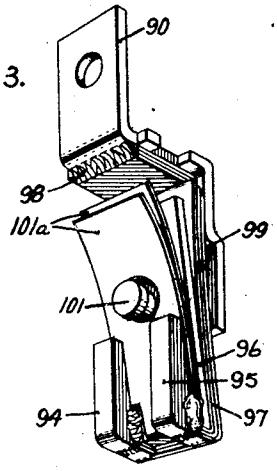


Fig. 3.



Inventor:
John A. Favre,
by Harry E. Dunham
His Attorney.

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Fig. 4.

TRIPPED OPEN
HANDLE IN CLOSED POSITION

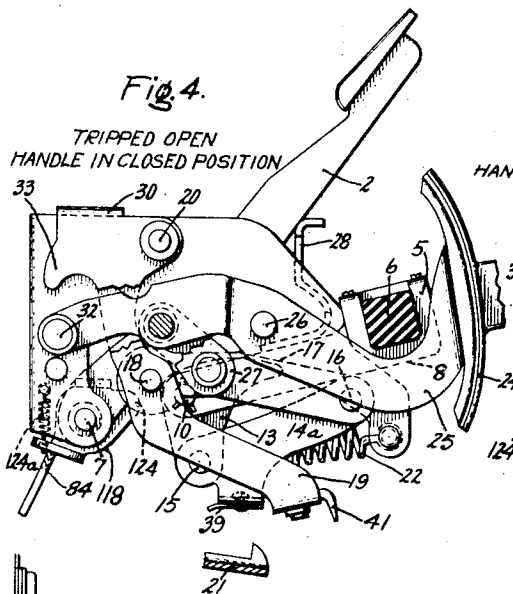


Fig. 5.

TRIPPED OPEN
HANDLE IN INDICATING POSITION

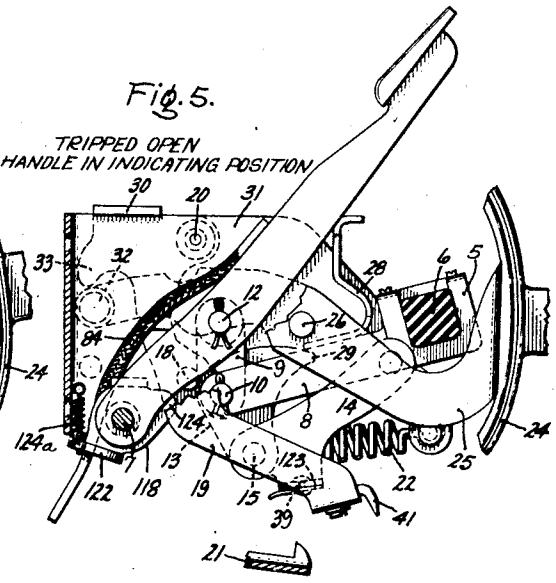


Fig. 6.

CLOSED POSITION

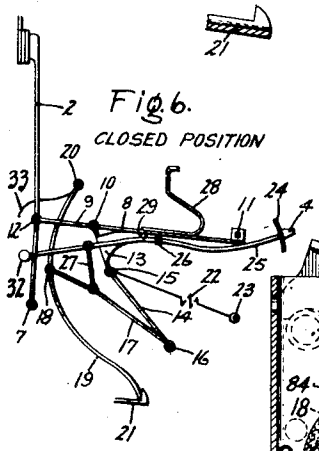


Fig. 7.

OPEN
RESET POSITION

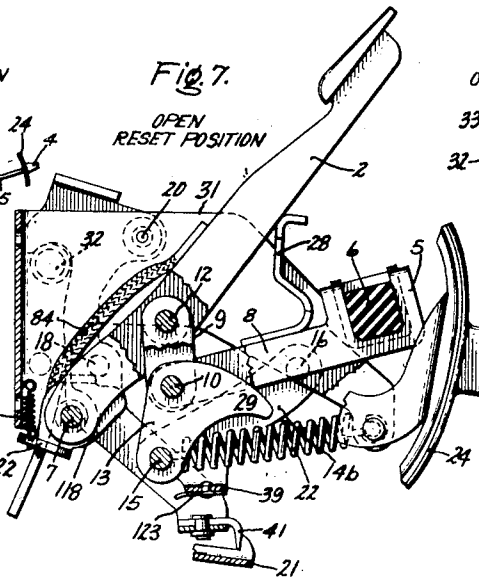


Fig. 8.

OPEN POSITION

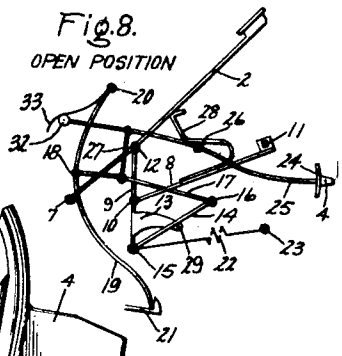


Fig. 9.

CLOSED POSITION

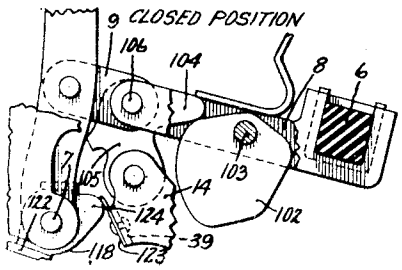
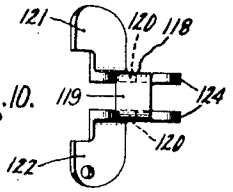


Fig. 10.



Inventor:
John A. Favre,
by Harry E. Dunham
His Attorney.

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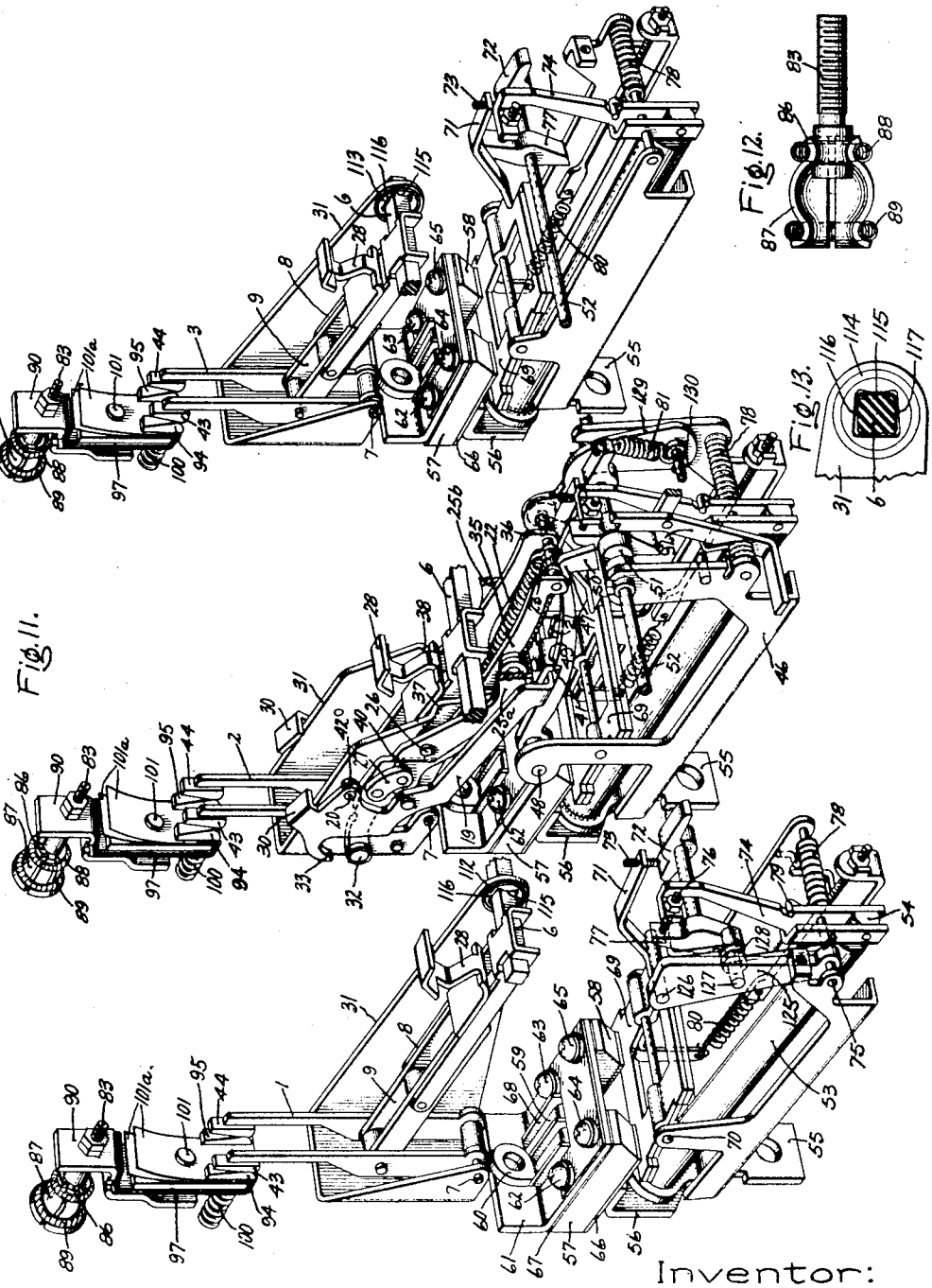


Fig. 11.

Fig. 12.

Fig. 13.

Inventor:
John A. Favre,
by Harry E. Dunham
His Attorney.

UNITED STATES PATENT OFFICE

2,490,514

THERMAL-MAGNETIC CIRCUIT BREAKER

John A. Favre, Drexel Hill, Pa., assignor to General Electric Company, a corporation of New York

Application September 25, 1944, Serial No. 555,630

12 Claims. (Cl. 200—88)

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My invention relates to switches or circuit breakers, more particularly to manually operated, thermal current responsive circuit breakers, and has for its object a compact, reliable and shock-proof circuit breaker of this type.

More particularly, my invention relates to circuit breakers of the branch circuit type which, while capable of opening currents of short circuit magnitude, up to 30,000 amperes, are adapted for continuous operation on relatively low currents and voltages, for example, currents up to 600 amperes and voltages up to 440.

In carrying out my invention in one form, I provide a toggle for operating the movable switch contact between its open and closed circuit positions, together with a second toggle having one end connected to the first toggle for operating the first toggle between its made and collapsed positions. I also provide an overcenter spring for effecting snap movement of the switch contact from one position to the other and to its open circuit position on overload. This spring has one end fixed and its other end connected to the floating pivot of the second toggle. The other end of the second toggle is movable through suitable mechanism by means of the operating handle thereby to move this end of the second toggle from one side to the other of the line of force of the spring and effect snap operation of the contact between its open and closed positions.

To effect opening movement in response to a predetermined overload current or a short circuit current, the movable end of the second toggle is released in response to the current to provide for snap operation of the first toggle by the spring to its collapsed position thereby to open the circuit breaker. An important feature of my invention is that all other movable operating parts are already moving at high speed when the first toggle is operated so that the movable contact is accelerated very quickly to a high speed. This facilitates the extinguishment of the arc between the contacts.

For a more complete understanding of my invention, reference should be had to the accompanying drawings, Fig. 1 of which is a view in elevation of a circuit breaker embodying my invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows; Fig. 3 is an enlarged view in perspective showing the mounting for one of the contacts; Figs. 4–8 inclusive are fragmentary views showing the operating mechanism in different positions, Figs. 6 and 8 being diagrammatic; Fig. 9 is a fragmentary view showing a modified form of my invention; Fig. 10 is a perspective view of a shock latching member; Fig. 11 is an exploded view of the circuit breaker shown in Figs. 1 and 2; while Figs. 12 and 13 are views showing details of construction.

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Referring to the drawing, I have shown my invention in one form as applied to a circuit breaker for three-phase circuits. As shown in Fig. 11, the circuit breaker comprises three pivoted switch arms 1, 2 and 3 arranged to be connected in the separate legs of a three-phase circuit and an operating mechanism by means of which the contact arms are moved between their open and closed circuit positions by a handle 4 (Fig. 2) mounted on a pivoted arm 25. This operating mechanism is associated with the middle contact arm 2, the two outer contact arms being operated through a common rotatably mounted cross bar 6.

The operating mechanism may perhaps be most clearly understood by first referring to the diagrammatic Figs. 6 and 8, showing the contact arm 2 respectively in its closed and open circuit positions. The contact arm 2 is mounted on a stationary pivot 7 and is operated on the pivot 7 by means of a multiple link toggle consisting of links 8 and 9 having a floating pivot 10. The link 8 is relatively long and has its outer end mounted on the bar 6 which is in effect a stationary pivot 11, while the relatively short link 9 has its outer end pivotally connected at 12 to the contact arm 2. Thus, by moving the toggle between its made position (shown in Fig. 6) and its collapsed or broken position (shown in Fig. 8), the contact arm is moved between its two positions.

A second mulitple link toggle is provided for operating the first toggle 8, 9. This toggle consists of links 13 and 14 having a floating pivot 15. The relatively short link 13 has its outer end connected to the pivot 10 while the relatively long link 14 has its outer end pivotally connected at 16 to an operating arm 17 whose other or left hand end is pivotally mounted at 18 on a pivoted release element such as a trip member 19, the pivot 18 being intermediate the length of the trip member 19. The upper end of the trip member 19 is mounted on a stationary pivot 20 while its lower end is normally held by a current responsive latch projection 21.

By means of a helical tension spring 22 having its left hand end connected to the pivot 15 and its other end connected to a stationary support 23, the various linkages are caused to assume the positions of Figs. 6 and 8 and are caused to move between these positions when the handle 4 is moved between the positions of Figs. 6 and 8.

The handle 4 is mounted on the right hand end of an operating lever 25 mounted on a stationary pivot 26 and connected by a link 27 to the operating arm 17, the ends of the link 27 being pivotally connected to the lever 25 and the arm 17.

In the operation of the mechanism, it will be observed that with the switch closed, as shown in Fig. 6, the spring 22 which pulls the pivot 15 toward the point of support 23 applies a force tending to straighten the toggle 13, 14 whereby an upward force is applied to the floating pivot 10 of the first toggle 8, 9 thereby to secure this toggle in its straightened position with the switch closed. This final position of the toggle 8, 9 is preferably not quite a fully made or straightened position whereby the rapid movement of the contact arm to its open circuit position on overload is facilitated. It is defined by the left hand end of a stop 28, as seen in Fig. 6, secured to the link 8 with which engages a projection 29 on the link 13. With the two outside contact arms 1 and 3 (Fig. 11) the links 9 are extended and engage the stops 28. The substantially made position of the toggle 13, 14 is a further assurance against breaking of the toggle 8, 9 in response to a severe shock. In this position it will be noted that the handle 4 and the operating lever 25 are in their extreme upper or counterclockwise positions whereby the operating arm 17 is moved to an extreme clockwise position about the pivot 18 and is held in that position through the link 27 by the lever 25, whereby the pivot 16 is fixed in the position shown.

In order to move the switch from the closed position of Fig. 6 to the open position of Fig. 8, the operating handle 4 is moved through a relatively small angle in a clockwise direction about the pivot 26 whereby the operating arm 17 is moved about its pivot 18 in a counterclockwise direction to bring its end to the upper side of the direction of the force applied by the spring 22. When the end of the arm 17 moves to the upper side of the spring 22, the direction of the force applied by the spring to the link 14 is reversed, the spring then tending to move the link 14 in a counterclockwise direction about the pivot 16 on the end of the arm 17. This counterclockwise movement of the link 14 immediately breaks or collapses the toggle 13, 14, which in turn breaks the toggle 8, 9 whereby the contact arm 2 is moved clockwise by the spring and finally comes to rest against the end of the stop arm 28 secured to the arm 8. It will be understood that this movement of the operating linkages and the switch arm takes place very quickly with a snap action. It begins as soon as the pivot 16 of the floating link 14 moves to the upper side of the direction of force of the spring 22.

The positions of the parts when the switch is opened in response to an overload or overcurrent will be understood from Figs. 4 and 5. It will be observed that the spring 22, when the switch is in its closed circuit position of Fig. 6, applies a force to the operating lever 17, which force is transmitted to the trip arm 19, tending to move the lower end of the trip arm toward the right hand. When the latch 21 is moved in response to overload or short circuit to release the trip arm, this lower end moves counterclockwise about the pivot 20 in response to the force applied by the spring. At the time the projection 29 on the link 13 is in engagement with the link 8 and as a result the two links 8 and 13 swing together about the point 11 whereby the switch

arm is moved to its open circuit position, the other parts including the arm 17 and the link 27 moving to the positions shown in Fig. 5.

For purposes of illustration, Fig. 4 shows the manual operating lever 25 as held in its fully closed circuit position during overcurrent opening, although the handle 4 will move from that position to the position of Fig. 5 if it is not held. In this position the handle lever 25 holds the arm 17 in such position that the projection 29 has disengaged the left hand end of the stop 28 (Fig. 4). In the movement from Fig. 4 to Fig. 5, when the handle is released, the link 13 turns through a slight additional angle counterclockwise about its pivot 10 until the projection 29 (Fig. 5) on the link 13 comes to rest against the lower end of the stop 28. In this final movement, the arm 17 is moved through a small angle counterclockwise about its pivot 18 (Fig. 4) and through the link 27 moves the lever 25 through a small angle in a clockwise direction to an intermediate position (shown in Fig. 5) between the closed and open positions. This intermediate position gives an indication to the operator, upon inspection of the position of the handle 4, that the circuit breaker has opened in response to an overload or short circuit. The trip arm 19 is brought to rest by the engagement of a laterally extending projection 30 on its upper end with an edge of the supporting frame 31 for the mechanism.

The mechanism is reset from Fig. 5 by moving the handle downward from the position shown in Fig. 5 to the fully open position of Fig. 7. During this movement a roller or projection 32 on the left-hand end of the lever 25 engages a projection 33 on the trip arm 19 whereby the trip arm is moved clockwise about its pivot 20 back to the position shown in Fig. 7 where it is secured by the latch 21. It is assumed that the current responsive means has cooled sufficiently to return the latch 21 to the holding position. The parts are then in the normal open circuit position shown in Figs. 7 and 8. The circuit breaker may thereafter be closed by moving the handle upward to the closed circuit poistion.

The arrangement of the operating linkages and other parts is shown in further detail in Fig. 11. The operating mechanism, as previously stated, is associated with the middle contact arm 2. The supporting frame 31 is a substantially U-shaped member having its base secured to the insulating support 34 (Fig. 2) for the circuit breaker and with two parallel arms extending outward from the support and terminating in two parallel projections 35 and 36 (Fig. 11). These projections are offset toward each other at the points 37 and 38 to provide space for the links 14 and 17. It should be noted that actually the link 14, for purposes of additional strength, consists of two duplicate parallel links 14*a* and 14*b* (Figs. 4 and 7) which are connected rigidly together by means of a cross member 39. Also, certain other links are provided in duplicate, as will now be pointed out. The operating lever 25 is constructed with duplicate parallel arms 25*a* and 25*b* joined together by a cross member at their right-hand ends, to which the handle 4 is secured.

These two parallel levers 25*a* and 25*b* (Fig. 11) are located on opposite sides of the two arms of the support 31, each being provided with its own pivot 26, only one of which is shown, on opposite sides of the support 31, and the pivots being in alignment with each other. The two levers are spaced apart between the handle and the pivots

26 a somewhat greater distance than the width of the support 31 to provide space for the duplicate links 14 and 17 on each side of the projections 35, 36. At its lower end each lever is bent toward the support 21 at the point 40 so that its lower end is in loose sliding relation with the adjacent sides of the support 31.

Likewise, the trip arm 19 is formed in two parallel identical lengths positioned on opposite sides of the support 31 and connected at their lower ends by a cross member to which is secured a latching projection 41 engaging the latch 21. Each parallel length of the trip arm 19 has its own pivot 20 (Fig. 11) on the frame 31, a washer 42 being provided between the trip arm and the support so as to space the two apart a distance providing for movement of the left-hand end of the operating lever 25 between them.

The two parallel rigidly connected portions 14*a* and 14*b* of the link 14 are connected at their right-hand ends to duplicate links 17 pivoted respectively on the two sides of the trip arm 19. The left-hand ends of the duplicate links 14*a* and 14*b* are joined together by a pin constituting the pivot 15, and this pin in turn is connected through a single link 13 (Figs. 4 and 7) to the floating pivot 10.

It will be noted that the toggle links 8, 9 (Fig. 11) are each formed in two parallel portions which extend between the two sides of the support 31, and likewise the contact arms are each formed in two parallel portions or arms mounted between the sides of the support 31 and provided with individual movable contacts 43 and 44.

Also, the links 27 are provided in duplicate to connect the two portions of the operating lever 25 to the duplicate links 17.

Likewise, the spring 22 is provided in duplicate parallel lengths having their right-hand ends connected to the cross pin 23 (Fig. 11) secured to the outer ends of the extensions 35 and 36. The left-hand ends of these springs are connected to the floating pivot 15.

As shown in Fig. 11, a metal support 46 is provided for the current responsive tripping mechanism which controls the trip lever 19. An arm 47 mounted on this support on a pivot 48 is provided with a projection 49 and also with the projection 21 (Figs. 4–8) with both of which normally the projection 41 on the trip arm 19 engages so that the trip arm is held. The right-hand end of the arm 47 has a downwardly projecting extension 50 which is adapted to move downward through a notch 51 in a rotatable latch member mounted on a trip shaft 52 when the cross shaft and latch member are turned in response to an overcurrent to bring the notch 51 in registering relation with the projection 50. Normally, the shaft 52 is turned in a clockwise direction slightly beyond the registering position so that the left-hand edge of the projection 50 engages the upper edge of the bottom wall of the notch whereby the arm 47 is held in a latching position.

As shown, the trip shaft 52 extends across the three poles or switch arms 1, 2 and 3. Thermal current responsive means 53 is provided in circuit with each switch arm for rotating the shaft 52 through the small angle necessary to trip the circuit breaker when the current in any one or more of the poles exceeds a predetermined minimum value. These three temperature responsive trip mechanisms are identical in construction and interchangeable and therefore one only, i. e., the one associated with the switch arm 1, will be described in detail.

The thermal current responsive device 53 comprises two concentric electric resistance heater tubes made of a metal having suitable electric resistance heating characteristics and heating a thermal expansion rod 54 (Fig. 11) extending through the inner tube and made of a suitable material having a high temperature coefficient of expansion. The two concentric tubes have their right-hand ends mechanically and electrically connected together and their left-hand ends mechanically and electrically connected respectively to an electric terminal member 55 and a supporting conductor member 56, the outer tube being connected to the terminal member 55. Thus current flows between the two members 55 and 56 and through the two tubes in series with each other whereby the rod 54 is heated in response to the current, and its right-hand end moves in accordance with changes in its length. If desired the rod 54 can be heated by current passing directly throught it.

The conductor member 56 also forms a support for two magnet pole members 57 and 58 (Fig. 11) made of magnet iron, the left-hand ends of which (not shown) extend laterally into two coil turns 59 electrically connected with the member 56. The magnet members 57 and 58 are additionally supported by a supporting plate 61 made of non-magnetic material such as copper or brass. The plate 61 and the magnet members are secured to the conductor member 56 by means of screws 62 and 63, while screws 64 and 65 additionally secure the plate 61 to the magnet members.

By means of layers of suitable fibrous electrically insulating material 66, 67 and 68, the magnet members 57 and 58 are electrically insulated from the members 56 and 61 and from the turns 59. Also, the lateral extensions (not shown) on the magnet members which extend into the turns 59 are suitably insulated from the turns by layers of electrically insulating material (not shown).

The right-hand ends of the magnetic members 57 and 58 form pole pieces of a magnet whose magnetic strength depends upon the current in the turns 59. Associated with the pole pieces is a pivoted armature 69 balanced about its pivot support 70 so as to be free from the effect of shocks. This armature carries an arm 71 which extends to a position adjacent an operating arm 72 on the trip shaft 52. An adjustment screw 73 is provided on the end of the arm 71 which engages with the arm 72 when the armature is attracted and turned clockwise as seen in Fig. 11 by the magnet poles in response to a current greater than a predetermined value whereby the shaft 52 is turned in a counterclockwise direction and the circuit breaker tripped open. This electromagnetic tripping of the breaker is responsive to very high currents of short circuit magnitude flowing through the turns 59 to trip the circuit breaker instantaneously before the thermal current responsive device 53 has time to heat and trip the breaker. The device 53 is heated by currents which are not strong enough to attract the armature 69, i. e., currents of overload magnitude, and the device 53 is heated by these currents to operate in inverse time relation with these currents.

The right-hand end of the rod 54 operates an

arm 74 mounted on a pivot 75 and the upper end of this arm carries an adjustment screw 76 cooperating with a second operating arm 77 secured to the trip shaft 52. Thus, in response to excessive currents, the end of the rod 54 moves toward the right hand thereby turning the arm 74 in a counterclockwise direction and turning the trip shaft 52 counterclockwise to trip the circuit breaker. A relatively strong helical spring 78 is provided for the arm 74, this spring surrounding the pivot pin 75 and having one end fixed and its other end 79 engaging the arm 74 and applying a counterclockwise bias to the arm. The spring 78 thus takes up all looseness in the parts and, by biasing the arm 74 in a tripping direction, assures that the arm 74 cannot be moved in a tripping direction by severe shocks.

A helical tension spring 80 is provided for biasing the armature 69 to its unattracted position, this armature being substantially free from shocks because of its balanced construction about its pivot. A helical tension biasing spring 81 is also provided for the shaft 52 whereby the shaft is biased in a clockwise direction to its latching position with the arm 77 against the arm 74. The operating arms 72 and 77 are made of electrically insulating material, preferably a molded electrically insulating material, firmly secured to the metal shaft 52 whereby the current responsive trip mechanism is electrically insulated from the shaft.

The terminals 55 and 60 not only provide for the connection of the current responsive mechanism in circuit with the switch arm 1, but also provide means for securing the mechanism on the insulating support 34, as shown in Fig. 2. A screw 82 extends through the terminal 60 and a hole provided for the screw in the support 61 into a tapped metal insert in the support 34. The terminal 55 is firmly secured to the support 34 by a bolt 83, which also forms a connecting terminal for the circuit breaker.

The screw 82 also clamps the support 61 against one end of a flexible conductor 84 whose other end is electrically connected to the two switch arms 1. This completes the electrical connections from the terminal 55 to the switch arms.

The bolt 83 (Fig. 2) is shown more in detail in Figs. 11 and 12. Its threaded portion fits into a threaded bore in a cylindrical conductor 85 secured in the base or support 34. This member 85 is suitably secured in place during the construction of the support 34 which preferably is made of a molded insulating material. At its left hand the bolt 83 is provided with an enlarged portion having a peripheral groove 86 in which fit the adjacent ends of four quickly detachable connector members 87 held in place on the bolt by a helical clamping spring 88 surrounding them. The four members 87 loosely surround the bolt, and obviously any suitable number may be used. The outer ends of the members 87 are wider and are shaped to form arcs of a larger circle so as to form an enlarged opening for a plug terminal member. The outer ends are held together by a second helical clamping spring 89.

Each of the terminals 55 for the three poles of the breaker and also each of the opposite terminals 90 is secured to the base 34 by a bolt with a quickly detachable plug connection on its end of the construction described in the preceding paragraph and shown in Fig. 12. It is contemplated that the circuit breaker will be mechanically supported as well as electrically connected in the desired circuits by means of these connections. Thus electrically conducting pins will be provided on the support for the circuit breaker, these pins forming terminals of the circuit breaker circuits and being spaced apart so that the circuit breaker may be both electrically connected and mechanically mounted by simply pushing it into place so that the pins are forced into the spring connection members.

A lock button 91 (Fig. 2) is provided which, when pushed in, moves a latch lever 92 against its biasing spring 93 in front of the member 50 so as to hold this member in a switch closed position as long as the button remains depressed. In this manner the current responsive means may be prevented from tripping the circuit breaker in emergencies even though abnormal currents may be passing through the circuit breaker whereby the current responsive means is caused to turn the trip shaft 52 to a tripping position.

Referring to Fig. 3, the two movable contacts 43 and 44 in each pole actuated by the switch arms of that pole respectively cooperate with two stationary contacts 94 and 95 which are mounted to give equalized contact pressure between the two pairs of contacts. The two stationary contacts are sutably secured to one end of a steel plate 96 and also to the ends of the flexible electric conductors 97. The opposite ends of the conductors 97 are suitably secured at 98 to the terminal member 90. These various connections may be made by welding or preferably by brazing. The terminal 90 is formed to fit the flexible members 97 up to the point 99 where it is bent away from the flexible members to form a fulcrum point about which the members 97 bent upon engagement of the movable contacts with the stationary contacts.

Pressure is applied to the stationary contacts by means of a helical compression spring 100 (Fig. 11) just below the flexible members 97 and positioned midway of the length and midway between the stationary contacts. This spring extends into a suitable cavity (not shown) provided for it in the insulating support 34. Movement of the stationary contacts by the spring 100 is limited by a headed pin 101 extending through holes in the members 96 and 97 and secured to the end of the terminal 90.

With this mounting of the stationary contacts, the two contacts may be depressed against the force applied by the spring 100 about the fulcrum 99 while at the same time the two stationary contacts are free to twist a sufficent amount to equalize the contact pressures between the two pairs of contacts. The steel plate 96 is provided between the stationary contacts and the flexible conductors 97 for the purpose of magnetically shielding the conductors.

Two thin sheets 101*a* (Fig. 3) of electrically insulating material, such as horn fibre, are provided over the iron member 96 to prevent the arc from striking to the iron member when the switch is opened, thereby to keep the magnetic flux of the conductor 97 from moving the arc away from the arc chute and toward the mechanism.

For the purpose of still further securing the mechanism against shocks, an inertia member 102 (Fig. 9) may be mounted between the two lengths of the middle link 8. This member 102 is balanced about its pivot support 103 to substantially the position shown in Fig. 9. In this position, its upper lefthand edge rests against a projection 104 on the link 105, which corresponds with the link 13 of Fig. 6. Thus, in the event of

a shock from the left toward the right, as seen in Fig. 9, the inertia member 102 tends to turn in a clockwise direction about its pivot 103 and thereby applies a force to the projection 104 tending to turn the link 105 about its pivot 106 in a counterclockwise direction. This force applied to the link 105 effectively overcomes any tendency of the link 105 to be moved by the shock in a clockwise direction whereby the toggle links 8 and 9 would be broken and the circuit breaker opened.

Each of the contact arms is provided with a suitable arc chute 107 (Fig. 2) which, as shown, is constructed as described and claimed in a copending application Serial No. 527,913, now Patent No. 2,429,846, October 28, 1947, filed by Joseph W. Seaman on March 24, 1944 and assigned to the same assignee as this invention.

The three current responsive devices 53 and the mechanism operated by them are preferably secured to a plate 108 (Figs. 1 and 2), made of a molded electrically insulating material, extending at right angles with the support 34 and having an upwardly extending base portion 109 to which the terminal member 56 is secured by suitable screws (not shown). Thus, by taking out all three screws 82 and taking the nuts off the three bolts 83, the three current responsive mechanisms are both mechanically and electrically disconnected from the other parts and may be removed as a unit while still mounted on the support 108.

As shown in Figs. 1 and 2, a cover 110 fits on the base 34 and encloses the mechanism, suitable apertures being provided in the cover for the handle 4 and the button 91 so that they may be operated from the exterior. Also, as shown in Fig. 2, the handle 4 is provided with a shield 24 which is shaped to correspond to the contour of the curved inner face of the cover 110 in the vicinity of the handle aperture.

For the purpose of speeding up the opening of the circuit breaker in response to an excessive current, special loose bearings are provided for mounting the square operating shaft 6 in the supporting framework 31, two of such bearings 112 and 113 being shown in Fig. 11. As shown in Fig. 13, each bearing comprises a bushing or sleeve 114 having an irregularly shaped aperture or bore through which the shaft 6 extends, these sleeves being in turn journaled in the framework 31 for the required amount of rotation. The aperture in the sleeve is provided with a raised portion or hump 115 on the normal bearing side to which pressure is applied when the switch arms are in their closed circuit positions, while the adjacent sides 116 and 117 of the aperture are slightly diverging thereby to allow for a slight amount of rocking movement of the shaft on the hump 115 independently of the sleeve 114. This freedom of rolling movement of the shaft on the hump 115 is preferably 10 or 15 degrees. This construction has the effect of eliminating, during this preliminary movement, the static friction of the bushings 114 in their bearings, whereby greater initial freedom of turning of the shaft is provided. Moreover, the shaft is moving when it engages the side of each of the bushings, and consequently more easily overcomes the static friction of the bushing.

I have also provided a shockproof latch or locking member for the operating mechanism for preventing opening of the circuit breaker in response to shocks. Referring to Figs. 9 and 10, this latch comprises a member 118 consisting of two portions joined together by a cross part 119, the

member being provided with an aperture 120 extending through both of these portions. This locking member is mounted on the pivot 7 between the two sides of the central switch arm 2 with the laterally extending portions 121 and 122 extending in opposite directions parallel with the pivot 7 and the cross portion 109 between the two links of the switch arm. On the cross member 39 of the link 14 is secured a latch element such as a plate 123 having its upper end, as shown in Fig. 9, when the switch is in its closed position, extending in front of and engaging the two projections 124 on the member 118. Thus any tendency for the link 8 to swing about the shaft 6 in a counterclockwise direction in response to a shock is prevented by the plate 123 in engagement with the projections 124. This force applied to the projections 124 tends to cause a clockwise movement of the member 118 about the pivot 7, but such movement is prevented by engagement of the lateral projections 121 and 122 with the base support 34 of the circuit breaker mechanism. The member 118 is biased clockwise about the pivot 7 by a spring 124*a* (Fig. 4) with the projections 121 and 122 in engagement with the base.

When the switch is opened manually the arm 14 is first moved counterclockwise about the pivot 15 whereby the plate 123 is moved away from the projections 124. On manual closing the member 118 is turned counterclockwise on the pivot 7 by the engagement therewith of the plate 123, after which the member 118 returns clockwise to the latching position in accordance with its spring bias.

Referring to Fig. 11, I have also provided a shock responsive latch mechanism for securing the trip shaft 52 against rotation. This mechanism comprises a bar 125 having one end mounted on the pivot 75 and provided with two spaced pins 126 and 127 extending laterally in parallel relation with the shaft 52 on opposite sides of the shaft and on opposite sides of the two ends of the operating arm 77 on the shaft 52. A helical spring 128 is mounted on the pin 127 and has one end bearing on the pivot 75. The other end of the spring 128 engages the upper end of the arm 77 and applies a force to the arm in a clockwise direction so as to hold its upper end against the stop pin 76, i. e., in its latching or non-released position, while at the same time holding the pin 127 against the lower end of the arm 77.

In response to a shock which tends to swing the arm 125 counterclockwise about the pivot 75 and which might cause counterclockwise rotation of the trip shaft 52 to trip the circuit breaker, the pin 127 engages the lower end of the arm 77 thereby to prevent such rotation of the trip shaft. Likewise, if the arm 125 is moved clockwise about the pivot 75 by the shock, the upper pin 126 engages the upper end of the arm 77 thereby to hold the shaft 52 against rotation in a circuit breaker tripping direction.

I have also provided a latch member 129 (Fig. 11) for securing the current responsive tripping means to the supporting framework 31 of the switch mechanism. This latch is an arm having one end pivoted on the rod 130 and its other end provided with a slot, the side walls of which embrace the pin 23 joining the ends of the arms 35 and 36.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any

such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A switch comprising a contact member, a link, a linkage connection between a first end of said link and said contact member for movement of the member each way between open and closed circuit positions upon reverse pivotal movement of said link about its other end, a support for said contact member, an overcenter spring having one end connected to said support and its other end connected to said first end of said link, and manually operable means on said support mounting the other end of said link for movement from each side to the other of said spring to effect the reverse pivotal movement of said link by the spring about said other end and movement of said contact member each way between said open and closed positions.

2. A switch comprising a contact member, a floating link, a linkage connection between a first end of said link and said contact member for movement of the member each way between open and closed circuit positions upon reverse pivotal movement of the link about its other end, a support for said contact member, a tension overcenter spring having one end connected to said support at a point adjacent said other end of said link and its other end connected to said first end of said link, said spring extending substantially lengthwise of said link, a second link having a first end normally pivotally secured and its other end pivotally mounting said other end of said floating link, manually operable means on said support for moving said second link about its said first end thereby to move said other end of said floating link from each side to the other of said spring to effect the reverse pivotal movement of the floating link by the spring about said other end and movement of said contact member each way between said open and closed circuit positions, and current responsive means for releasing said first end of said second link to effect the movement of said contact member to its open circuit position by said spring.

3. A circuit breaker comprising a contact operating member, a toggle, means interconnecting one end of said toggle and said contact operating member for movement of said member each way between closed and open circuit positions upon reverse movement of said toggle between made and collapsed positions, a support for said operating member, an overcenter spring having one end connected to said support and its other end connected to one of the links of said toggle, and manually operable means on said support mounting the other end of said toggle for movement from each side to the other of said spring to effect the reverse movement of said toggle by said spring and movement of said contact operating member each way between said open and closed positions.

4. A circuit breaker comprising a contact operating member having a pivotal mounting support, a toggle provided with an intermediate movable pivot, a connection between one end of said toggle and said contact operating member for movement of the member each way between closed and open circuit positions upon reverse movement of said pivot to make and collapse said toggle, an overcenter tension spring having one end fixed to said support and its other end connected to said intermediate pivot, means mounting the other end of said toggle for movement from each side to the other of said spring to effect the reverse movement of said toggle by the spring and movement of said contact operating member each way between said open and closed positions, and current responsive means for releasing said other end of said toggle for movement of said contact operating member to said open position by said spring.

5. A circuit breaker comprising a contact operating member, a first toggle, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said contact operating member for movement of the member between closed and open circuit positions upon movement of the toggle between made and collapsed positions, a second toggle, a pivotal connection between one end of said second toggle and one of the links of said first toggle, an overcenter spring having one end fixed to said support and its other end connected to one of the links of said second toggle, means mounting the other end of said second toggle for a predetermined movement relatively to said spring and manually operable means for effecting relative movement between said spring and said other end of said second toggle to effect the operation of said toggles by the spring thereby to move said contact operating member between said open and closed positions.

6. A circuit breaker comprising a contact operating member, a first toggle provided with an intermediate movable pivot, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said contact operating member for movement of the member between closed and open circuit positions upon movement of said movable pivot to make and collapse said toggle, a second toggle having an intermediate movable pivot, a pivotal connection between one end of said second toggle and the intermediate movable pivot of said first toggle, an overcenter tension spring having one end fixed to said support and its other end connected to the intermediate movable pivot of said second toggle, means mounting the other end of said second toggle for a predetermined movement relatively to said spring and manually operable means for effecting relative movement between said spring and said other end of said second toggle to effect the operation of said toggles by said spring and movement of said contact operating member between said open and closed positions.

7. A circuit breaker comprising a contact operating member, a first toggle provided with an intermediate movable pivot, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said contact operating member for movement of the member between closed and open circuit positions upon movement of said movable pivot to make and collapse said toggle, a second toggle having an intermediate movable pivot, a pivotal connection between one end of said second toggle and the intermediate movable pivot of said first toggle, an overcenter tension spring having one end fixed to said support and its other end connected to the intermediate movable pivot of said second toggle, releasable means mounting the other end of said second toggle for a predetermined movement relatively to said spring manually operable means for effecting relative movement between said spring and said other end of said second toggle to effect the operation of said toggles by said spring, and movement of said con-

tact operating member between said open and closed positions, and current responsive means for releasing said other end of said second toggle to provide for movement of said contact operating member to its open circuit position by said spring.

8. A circuit breaker comprising a pivoted contact operating member, a first toggle provided with an intermediate movable pivot, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said contact operating member for movement of the member between closed and open circuit positions upon movement of said pivot to make and collapse said toggle, a second toggle having an intermediate pivot, a pivotal connection between one end of said second toggle and the intermediate pivot of said first toggle, an overcenter tension spring having one end fixed to said support and its other end connected to the intermediate pivot of said second toggle, releasable means mounting the other end of said second toggle for a predetermined movement relatively to said spring and manually operable means for moving said other end of said second toggle from one side to the other of said spring to effect the operation of said toggles by said spring and movement of said contact operating member between said open and closed positions.

9. A circuit breaker comprising a pivoted contact member, a first toggle, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said contact member for operating the member between closed and open circuit positions upon movement of said toggle between collapsed and made position, a pivoted release element, current responsive means normally holding said release element in a predetermined position, an operating arm pivoted at one end on said release element, a second toggle, connections between the respective ends of said second toggle and said first toggle and the other end of said arm, a spring having one end connected to said second toggle and its other end fixed to said support, and a handle connected to move said arm about its pivot on said release element thereby to move the other end of said arm from one side to the other of the line of action of said spring whereby the spring is caused simultaneously to operate said toggles between made and collapsed positions thereby to move said contact member between closed and open circuit positions, said release element when released by said current responsive means being moved by said spring to effect the collapse of said toggles and movement of said contact member to its open circuit position.

10. A circuit breaker comprising a pivoted contact member, a first toggle, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said contact member for operating the contact member between closed and open circuit positions upon movement of the knee joint of said toggle to make and collapse the toggle, a pivoted release element, current responsive means normally holding said release element in a predetermined position, an arm pivoted at one end on said release element, a second toggle, connections between the respective ends of said second toggle and the knee joint of said first toggle and the other end of said arm, a helical tension spring having one end connected to the knee joint of said second toggle and its other end fixed to said support, and a handle connected to move said arm about its pivot on said release element thereby to move the free end of said arm from one side to the other of the line of action of said spring whereby the spring is caused simultaneously to operate said toggles between made and collapsed positions thereby to move said contact member between closed and open circuit positions, said release element when released by said current responsive means being moved by said spring to effect the collapse of said toggles and movement of said switch member to its open circuit position.

11. A switch comprising a switch arm having a stationary pivotal support, a first toggle having one end operatively connected to said switch arm, a second toggle having one end of one link connected to the central pivot of said first toggle, an overcenter spring having one end fixed to said support and the other end connected to the central pivot of said second toggle, manually operable means for moving the end of the other link of said second toggle with respect to said spring to move said switch arm between open and closed circuit positions, a latch member pivotally mounted on the pivot of said switch arm, and an element carried by said other link of said second toggle normally in position to engage said latch member when the switch arm is in its closed circuit position thereby to secure said second toggle against collapsing movement under the effect of a shock applied to said switch, said element being moved with said other link of said second toggle out of engagement with said latch member when the other link is moved to operate said switch arm to its open circuit position.

12. A switch comprising a pivoted switch arm, a first toggle, a stationary pivot support for one end of said toggle, a pivotal connection between the other end of said toggle and said switch arm for movement of said switch arm between open and closed circuit positions, a second toggle having one end connected to one of the links of said first toggle, an overcenter spring having one end connected to one of the links of said second toggle and its other end fixed to said support, means for moving the other end of the other link of said second toggle with respect to said spring to effect the operation of said toggles by said spring thereby to move said switch arm between open and closed circuit positions, a latch member pivotally mounted on the pivot of said switch arm, and an element carried by said other link of said second toggle normally in position to engage said pivoted latch member when the switch arm is in its closed circuit position thereby to secure said first toggle against opening movement by the effect of a shock applied to said switch, said element being moved with said other link of said second toggle out of engagement with said latch member when the other link is moved to operate said switch arm to its open circuit position.

JOHN A. FAVRE.

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