Dec. 17, 1957 A. C. GIBSON ET AL 2,816,974

ELECTRIC CIRCUIT BREAKERS

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Fig. 1.

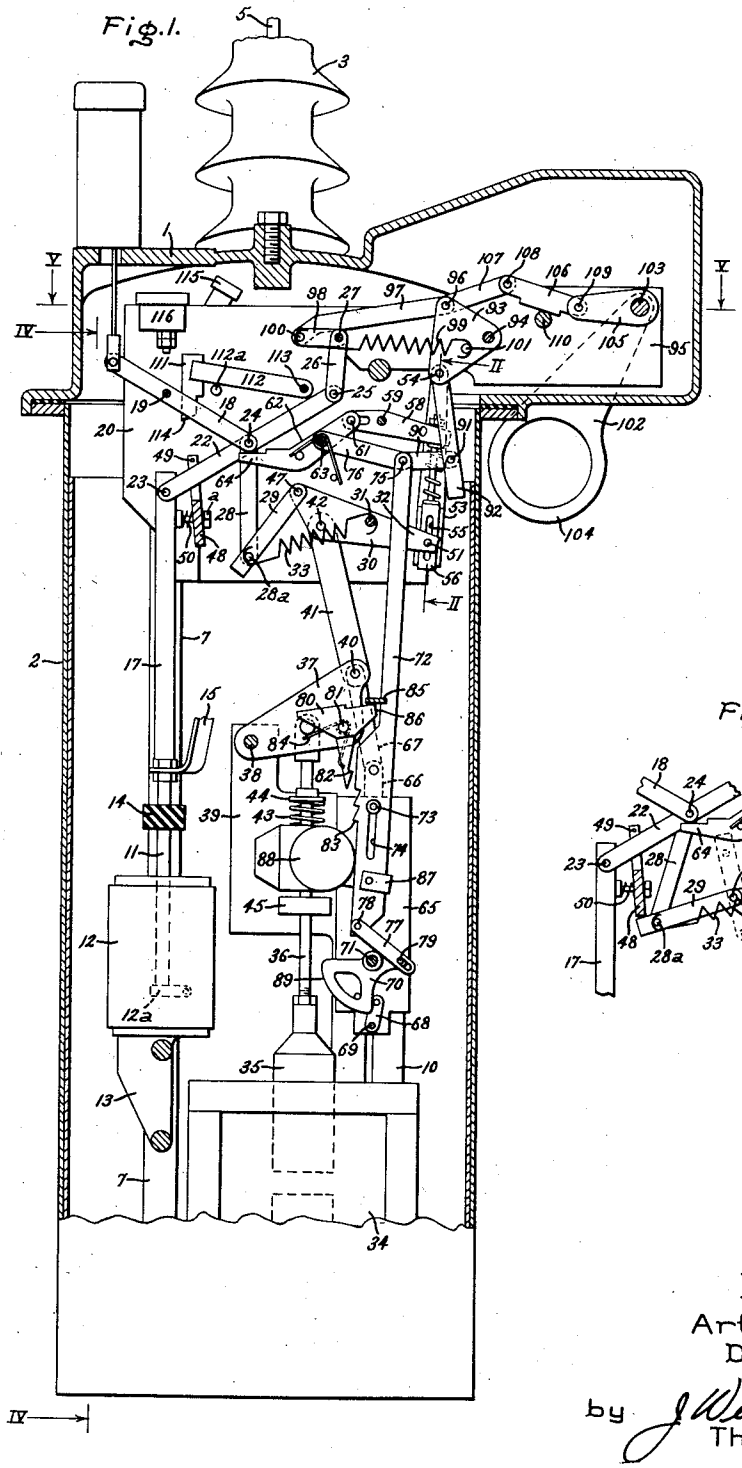


Fig. 2.

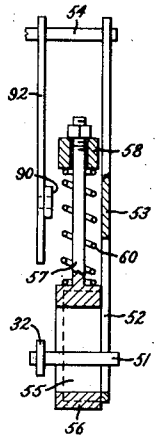
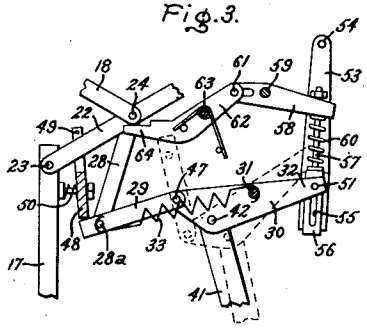


Fig. 3.



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ELECTRIC CIRCUIT BREAKERS

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Fig. 4.

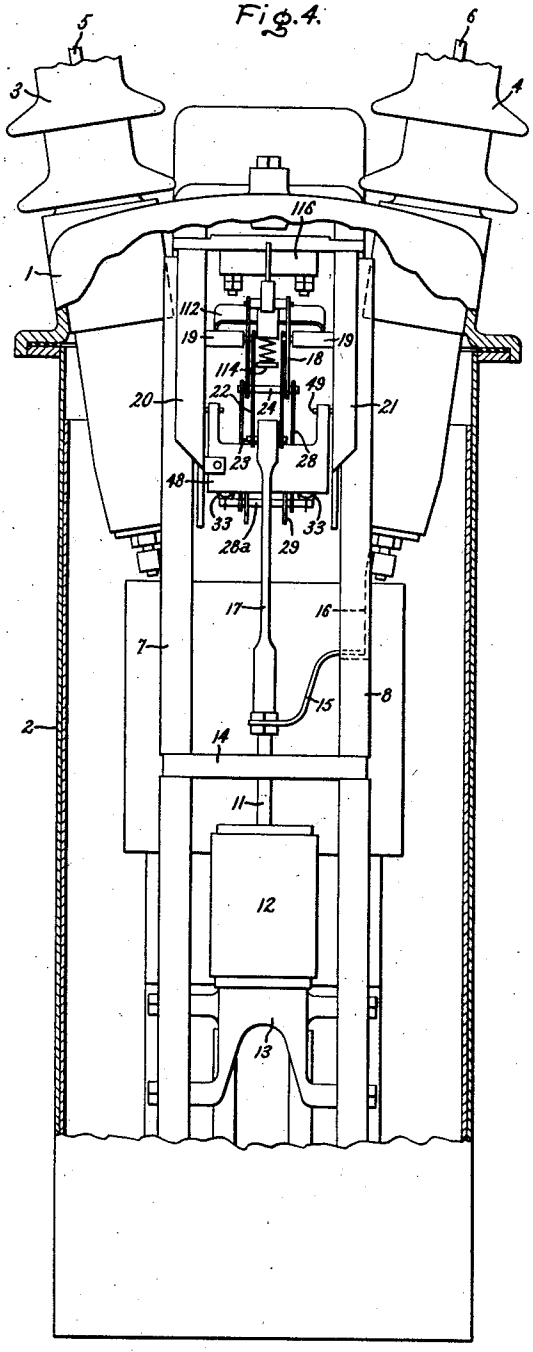
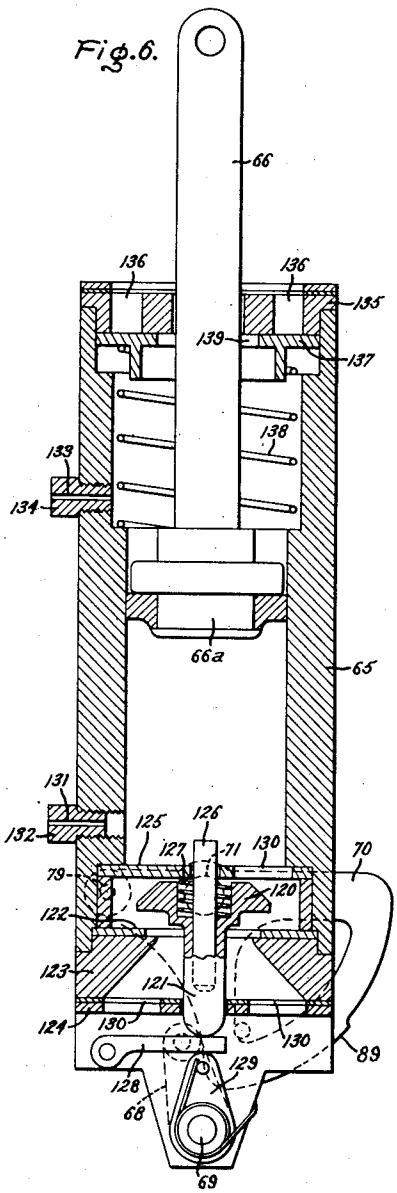


Fig. 6.



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ELECTRIC CIRCUIT BREAKERS

Filed May 17, 1955 3 Sheets-Sheet 3

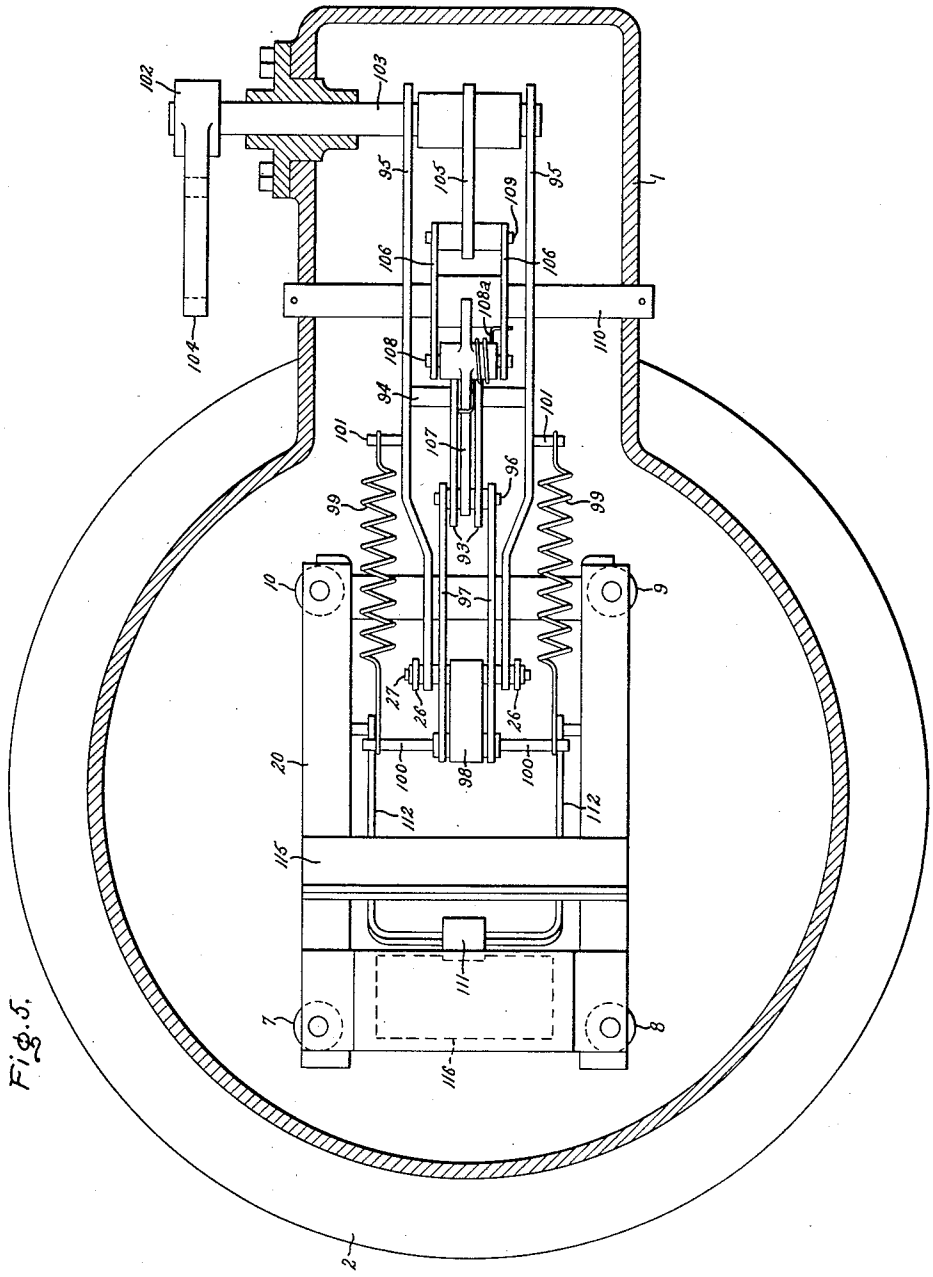


Fig. 5.

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2,816,974

ELECTRIC CIRCUIT BREAKERS

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Application May 17, 1955, Serial No. 509,046

Claims priority, application Great Britain May 21, 1954

14 Claims. (Cl. 200—89)

This invention relates to electrical circuit breakers of the kind wherein the contacts are biased to the closed position and are operable to the open position by a solenoid or other operating means energized by the circuit breaker current whereby in response to said current exceeding a predetermined value said operating means will open the contacts so as to interrupt the current, the contacts then reclosing and being again opened if the circuit conditions are still such that the current exceeds said value. Counting means are provided whereby after a predetermined number of opening and closing operations have been performed in response to such circuit conditions, the contacts are finally maintained in the open position. Timing mechanism may be arranged so that the successive time periods for which the contacts are open and closed before being finally locked open follow a predetermined schedule. Circuit breakers of the kind referred to are, for example, well adapted for use in rural electrification schemes and other remote locations wherein fault conditions may normally be cleared either in themselves or as a result of fuses included in the circuits.

The present invention has for its object to provide advantageous operating mechanism in circuit breakers of the kind referred to.

In circuit breakers of the kind referred to, the time periods for which the contacts remain closed, both after the initial occurrence of the predermined over-current conditions and during each subsequent period for which the contacts remain closed as a result of a sequence of opening and closing operations in response to a given occurrence of over-current conditions, is determined by means of a dashpot or other time delay device coupled with the mechanism by which the solenoid or other device operates the contacts. The movement of the mechanism is therefore comparatively slow and the invention has for its object to provide convenient and advantageous mechanism whereby the comparatively slow movement derived from the solenoid or other device will result in rapid contact movement at the desired time.

According to the present invention, in an electric circuit breaker of the kind referred to, the operating mechanism comprises a toggle and an operating spring connected with said toggle so as to tend to collapse the latter, one link of said toggle being connected with the solenoid or other device and the other link of said toggle being connected with the moving contact, or switch member, of the circuit breaker and being a floating link, that is to say, having its end remote from the connection with the first said link arranged for movement in the plane of action of the toggle. Said free end of the second toggle link co-operates with abutment means arranged so that said abutment lies in the path of movement of the free end of the toggle when the links of the latter are in line with one another. In the closed position of said moving contact, or switch member the toggle is over-centre with respect to said spring so that the connection between the two links of the toggle will, upon

operation of the solenoid or other device, be moved toward the line of action of the spring, a corresponding movement of the second-mentioned toggle link then being in the direction to maintain the contacts closed. The movement of the toggle by the solenoid or other device thus tends to straighten the links with respect to one another and brings the free end of the second link into engagement with said abutment. Continued movement of the solenoid moves the toggle over-center with respect to the spring, but said abutment prevents the spring causing collapse of the toggle until the latter has been moved so far over-center that the free end of the second link is withdrawn laterally from said abutment whereupon the operating spring is permitted rapidly to collapse the toggle and thereby open the contacts. It will be seen that at the time the toggle is withdrawn from the abutment, the contact pressure is suddenly released and the energy stored in the operating spring by extension of the toggle linkage by the solenoid is then released to cause rapid movement of the moving contact. An abutment will also normally be arranged in co-operation with the free end of the second-mentioned toggle link for providing corresponding operation in the closing direction of the circuit breaker.

The invention comprises further features, specific embodiments of which are included in one arrangement of circuit breaker now to be described by way of example with reference to the accompanying drawings.

In the drawings:

Fig. 1 is a vertical cross-sectional elevation of the circuit breaker;

Fig. 2 is an enlarged cross-sectional view taken along the line II—II of Fig. 1;

Fig. 3 is a detailed view of a portion of the mechanism shown in Fig. 1, the position of the parts being illustrated at different intervals during a breaker opening stroke;

Fig. 4 is a vertical cross-sectional elevation of the circuit breaker taken on the line IV—IV of Fig. 1;

Fig. 5 is a sectional plan view taken on the line V—V of Figs. 1 and 2; and

Fig. 6 is a vertical cross-sectional view of a preferred arrangement of dashpot employed in the circuit breaker of Figs. 1–5. This view is taken looking in a direction opposite to that shown in Fig. 1.

This circuit breaker comprises a fixed circuit breaker head casting **1** supporting a depending oil tank **2**, in which the circuit breaker parts and operating mechanism hereinafter to be described are located. A pair of insulating bushings **3** and **4** extend through the head **1** and support therein conductors **5** and **6** which form terminals for connection with the line conductors and at their lower ends are connected in a manner hereinafter to be described.

The contacts and operating mechanism are mainly supported from a main framework comprising four vertical rods **7**, **8**, **9**, and **10** which at their upper ends are secured to the head casting **1**, such as by means of frame plates **20** and **21**. The contact arrangement comprises a moving contact, or switch member, **11**, of elongated rodlike form which co-operates with a fixed contact (not shown) mounted within an explosion pot or other arc control structure of any suitable type indicated generally at **12**. In the example being described, the contacts are of butt type. The fixed contact and arc control device are mounted on a conductive casting **13** which is bolted to the frame rods **7** and **8**. The moving contact is guided by means of a cross bar **14** of insulating material, supported from the frame rods **7** and **8** and provided with a vertical bore through which the rod **11** freely extends. At its upper end the contact rod **11** is connected by means of a flexible strap conductor **15** and a conducting

member 16 with the terminal stem within the bushing 4. The flexible conductor 15 thus allows vertical movement of the rod 11 from the illustrated closed position upwardly to the open position.

The contact rod 11 is connected at its upper end with a vertical insulating lift rod 17, the upper end of which is connected with a straight-line operating linkage comprising a link 18 pivotally mounted on a fixed pivot 19 supported in frame plates 20 and 21 depending from the upper ends of the frame rods 7—10, and a switch lever 22 which at one end is pivotally connected, namely at 23, with the upper end of the insulating rod 17, and at an intermediate point, namely 24 is pivotally connected with the link 18. The right-hand end of the lever 22 in Fig. 1 is pivotally connected at 25 with a swinging link 26 pivotally mounted on a fixed pivot 27. The arrangement is thus such that angular motion imparted to the lever 22 by means of an operating link 28 will result in the lever 22 pivoting about the pin 25 but so that the pin 24 will be constrained to move in an arcuate path about the fixed pin 19 as a center, and the pin 23 therefore moves substantially in a vertical straight line.

The link 28 has pivotal connection at its lower end with a toggle linkage comprising links 29 and 30, the link 30 being mounted on a fixed pivot at 31 supported by the frame plates 20 and 21. The link 30 includes a tail portion 32 extending past the pin 31 for a purpose hereinafter to be described. A tension spring 33 extends between the pins 28*a* and 31 thereby tending to collapse the toggle.

The opening of the switch contacts is effected, in a manner which will hereinafter appear, by means of a solenoid 34 carried by the main framework, and having a plunger 35 connected by a connecting link 36 with a lever 37 pivoted at 38 in frame plates secured to the frame rods 8 and 9, one of said frame plates appearing at 39. At its free end the lever 37 has a pivotal connection at 40 with a link 41, the upper end of which has pivotal connection at 42 with the toggle link 30.

The solenoid plunger 35 and with it the lever 37 and toggle link 30 are biased upwardly to the illustrated position by means of a compression spring 43 acting between an abutment 44 on the link 36 and a fixed abutment 45 mounted between the frame plates of which one is shown at 39. The solenoid has its winding connected in series between the casting 13, carrying the fixed contact, and the terminal stem within the bushing 3.

A latch or detent member 48 is mounted on a fixed pivot 49 and biased by means of a compression spring 50 engaging the lower end of the latch and urging the latter toward the right-hand in Fig. 1. A suitable stop *a* is provided for limiting such movement of the latch or detent 48 to the illustrated position. As may be seen in Fig. 4, the latch 48 has a notch in its upper surface which functions in a manner soon to be described.

The arrangement includes means for accelerating the contact-opening action as will now be described by referring especially to Figs. 1 and 2. The tail end 32 of the toggle link 30 carries a pin 51 which works in a slot 52 in a link 53 which is pivoted at 54 in a manner hereinafter to be described. The pin 51 extends also through a slot 55 in a member 56 which comprises also a rod 57 extending at its upper end through an opening in the end of a lever 58 which is mounted on a fixed pivot 59. A compression spring 60 surrounding the rod 57 bears at its end on the upper surface of the member 56 and the under surface of the said end of the lever 58. The upper end of the rod 57 is screw-threaded and carries a nut or abutment member engaging with the upper surface of the lever 58 so as to limit the downward movement of the rod with respect to said lever. The lever 58 has pin and slot connection at 61 with a lever 62 mounted on a fixed pivot 63, said lever 62 including a heel part 64 which is adapted to engage beneath the pin 24 so that clockwise movement of the lever 62 in Fig. 1 will urge the lever 22 upwardly.

As seen in Fig. 1, a dashpot 65 is mounted on the main frame and the piston of this dashpot is connected by means of its piston rod 66 and a link 67 with the pin 40 whereby the dashpot piston is moved with the solenoid plunger 35. Preferably, the link 67 includes a spring whereby the vibration of the solenoid plunger at the supply frequency will not be transmitted to the dashpot piston. The lower part of the dashpot is provided with a discharge valve 120, 121 (Fig. 6) having an operating member 68 fixed to a shaft 69 and displaceable by a cam member 70 pivotally mounted on the fixed pivot 71. The dashpot and discharge valve referred to are preferably arranged as hereinafter described with reference to Fig. 4. The cam member 70 is operable by means of a member 72 hereinafter referred to as the monitoring rack which is adapted for substantially vertical movement, said rack being located toward its lower end by means of a pin 73 secured to the dashpot and extending through a slot 74 in the rack, and the upper end of the monitoring rack having a pin connection 75 with a link 76 loosely mounted on the pivot 63. The connection between the rack 72 and the cam member 70 comprises a link 77 having a pin connection at 78 with the lower end of the rack and a pin and slot connection 79 with said cam member.

As will be seen, the arrangement of the link 77 and pin and slot connection 79 is such that movement of the rack 72 upwardly will initially be without effect on the position of the member 70 but when the pin 73 has risen sufficiently to take up the lost motion in the connection 79 further movement of the rack will result in the link 77 displacing the member 70 in the counter-clockwise direction in Fig. 1.

The rack 72 is actuable by a pawl 80 pivotally mounted at 81 on the lever 37, this pawl having a catch portion 82 co-operating with teeth 83 formed on the edge of the rack. The pawl 80 is biased by means of a hairpin spring 84 towards engagement with the rack, but is normally held clear of the rack by means of an adjustable stop 85 which is mounted on the fixed framework and co-operates with a portion 86 of the pawl 80 so that in the illustrated position of the lever 37 said stop holds the catch 82 of the pawl out of engagement with the rack.

The rack 72 is also coupled by means of a lever 87 with a clockwork or other timing device 88 mounted on the framework and operative to delay the downward movement of the rack after the latter has been raised, this downward movement being due to the weight of the rack. Since this timing device 88 may be of any suitable conventional form, it has been shown schematically only.

The arrangement also includes lock-out controlling means in which the link 76, by which the upper end of the rack 72 is located, forms a toggle with a further link 90, said link 90 having a pin connection at 91 with a lever 92 which is pivotally mounted on the pin 54. The lower end of the lever 92 is normally clear of the tail 32 of the toggle link 30. The pin 54 is carried by a bell-crank lever 93 mounted on a fixed pivot 94 carried in lateral extensions, one of which appears at 95 in Fig. 1, of the frame-plates 20 and 21. The bell-crank 93 has a pin connection 96 with a re-entrant toggle comprising respective long and short links 97 and 98, the link 98 being loosely pivoted on the fixed pin 27, this pin serving also to limit the downward movement of the link 97 to the position in which it is illustrated. Tension springs 99 extend between the pin 100 connecting the links 97 and 98 and fixed pins 101. In the illustrated position of the parts the line of action of this spring, which tends to draw the pins 100 and 101 together, lies below the pin 27 so that the toggle and spring 99 are maintained in the illustrated "set" position, and the spring is without effect on the operation of the mechanism.

It will be convenient at this stage to describe the operation of the contacts by means of the solenoid. The contact being in the closed position, then upon the occurrence of a sufficient overload current the solenoid plunger **35** is drawn downwardly against the force of the spring **43** so as, by means of the lever **37** and link **41**, to actuate the toggle link **30** in the counter-clockwise direction in Fig. 1 about the pin **31**. This movement of the link **30** therefore causes outward movement of the pin 28_a at the end of the other toggle link **29**, by swinging of the lever **28** about the pin **24**. This movement extends the spring **33** but is without effect on the lever **22** until the toggle links move over-center, that is to say, until the pivotal connection at **47** moves below the line joining the pins 28_a and **31**. Thereafter the toggle, having thus been moved over-center is permitted to collapse so that the spring **33** will cause clockwise movement of link **29** about pin **47** so as to lift the link **28** and thereby rotate the lever **22** about the pin **25** and thereby lift the lift rod **17** and contact rod, or switch member, **11** out of engagement with the fixed contact.

As shown in Fig. 3, the collapsing of the links **29** and **30** in the manner above described is, however, positively controlled by means of the interfering abutment or latch **48**, which interferes with collapse of the toggle **29**, **30** until the solenoid has nearly completed its downward stroke. The position of the latch **48** is such that when the toggle links **29** and **30** are in line with one another, the outer end, left-hand in Fig. 3, of the link **29** will be located beneath the lower end of the latch **48**. The dimensions of the various parts are such that the said end of the link **29** will remain under the lower end of the latch **48** also during continued downward movement of the pin **47** past toggle center, being only released from said latch by movement toward the right-hand in Fig. 3 when the solenoid has nearly completed its downward stroke. The dotted lines of Fig. 3 illustrate the fully-open position of the toggle links **29** and **30** after release from the abutment or latch **48**. The latch, or abutment, thus renders the toggle collapsing action ineffective to produce contact-opening movement of the operating lever **22** until the solenoid has nearly completed its stroke.

The latch, or abutment, **48** furthermore prevents movement of the operating lever **22** by the accelerating spring **60** until the solenoid has nearly completed its opening stroke since although the spring **60** has been stressed by the upward movements of the tail **32** of the toggle link **30** so that the lever **62** is therefore in engagement with the pin **24** and urging the latter upwardly, said pin **24** is prevented by the restrained link **28** from moving until the toggle link **29** clears the latch or abutment **48**.

With this arrangement, the downward movement of the solenoid plunger, causing counter-clockwise movement in Fig. 1 of the toggle link **30** to lift the pin **51** will, after the lost motion provided by the slot **55** has been taken up, result in the member **56** being lifted by the pin **51**, as will be evident from Fig. 2. The spring **60** is thus compressed against the lever **58** with the result that an upward force is applied against the pin **24** by the heel **64** of the lever **62**. Accordingly, the spring **60** thus tends to open the contacts but is unable to move the pin **24** until the toggle link **29** is withdrawn from the latch or abutment **48** in the manner hereinbefore described. The link **29** is not so withdrawn from the latch or abutment until nearly the end of the downward stroke of the plunger **35**. It will thus be seen that during the major part of the opening stroke of the solenoid, energy is stored in the spring **60** by progressive compression thereof, and this energy is released at the end of the opening stroke of the solenoid so as to accelerate the opening movement of the contact rod **11**. The slot **52** in the member **53** then allows the member **53** to move upwardly independently of the pin **51**, as is required should the breaker be subsequently locked-open, as will soon appear.

In the open condition of the mechanism, the end of the toggle link **29** is positioned above the notched portion of the latch member **48**. During reclosure, when the link **41** is moved upwardly by spring **43**, the end of the link **29** moves into engagement with this notched portion and is thus retained against downward movement as the pin **47** moves above the line of action of the spring **33** until this upward movement of the pin **47** draws the end of link **28** (to the right hand in Fig. 1) clear of the member **48**, when the spring **33** is then permitted rapidly to collapse the toggle and by means of link **28** move the switch lever **22** rapidly downwardly. During reclosure the energy of the reclosing spring **43** in returning the plunger **35** to the normal position is thus stored in the toggle linkage until near the end of its reclosing stroke, by the initial extension of spring **33** as the toggle **29**, **30** is moved toward center. Said energy is then released near the end of the closing stroke of the solenoid plunger to effect rapid re-engagement of the contacts.

In the operation of this arrangement the dashpot is operative to control the speed of the downward and upward strokes of the solenoid plunger **35** to open and close the circuit breaker. As will appear from the description hereinafter given of the dashpot the latter in the embodiment being described provides a fixed rate of upward, or reclosing, movement of the plunger but the rate of downward, or opening, movement of the piston is controlled by the discharge valve **120**, **121** and therefore by the position of the valve operating lever **68**. In the illlustrated position of said valve operating lever **68** the control valve is fully open so that the solenoid can move rapidly and therefore will open the contacts promptly in response to an over current. The downward movement of the lever **37** during the opening movements of the circuit breaker results in the catch surface **82** of the pawl **80** engaging beneath the uppermost tooth **83** on the rack. The circuit breaker having been opened the solenoid is consequently de-energized and the plunger **35** therefore moves upwardly by spring **43** to its original position. During this movement the pawl **80** raises the monitoring rack but the latter in the embodiment being described is not effective during this part of its movement to displace the cam member **70**. The circuit breaker having been re-closed, the solenoid is again energized and if the over-current conditions have persisted the plunger **35** will again be drawn downwardly so as for a second time to open the circuit breaker promptly. The consequent termination of current will again result in the circuit breaker re-closing and during the re-closing movement the pawl **80** having engaged the second of the teeth **83** will have lifted the rack **72** a corresponding further amount. This movement of the rack will be sufficient to displace the cam member **70** so as to close the control valve referred to of the dashpot. Assuming that the over-current conditions still persist, then the solenoid will again draw the plunger **35** downwardly but the speed of movement will now be retarded by the closure of said control valve in the dashpot. A corresponding period will therefore elapse before the contacts open, it being remembered that the operating mechanism is such that the contacts do not open until the solenoid plunger has nearly completed its downward movement.

If the over-current conditions are not cleared during this longer closed period of the circuit breaker, then when the contacts re-close the plunger will once more be drawn downwardly to re-open the contacts. The member **70** includes an arcuate surface **89** so that during the previous upward movement of the monitoring rack **72** the arm **68** remains in its displaced position. The contacts therefore remain closed for a similar period to that for which they were last closed.

If the over current conditions have not been cleared during the first of the two longer periods of reclosure the

upward movement of the lever **37** results in the pawl **80**, which has now engaged with the lowest of the teeth **83**, lifting the rack to a position which by the means now to be described will result in locking out the circuit breaker.

The arrangement is such that when the rack 72 has been raised to its uppermost position, corresponding with the lever **37** being in its illustrated position with the pawl **80** just disengaged from the lowermost of the teeth **83**, then the toggle links **76, 90** will have drawn the lower end of the lever **92** to the left hand in Fig. 1 into the path of movement of said tail part **32**. The part 32 thus has engaged with the lower end of the lever **92** during the upward movement of said part **32** resulting from the downward movement of the solenoid plunger **35**. This engagement occurs when the toggle links **29** and **30** are approaching the straight-line condition, that is to say, prior to the opening of the contacts. Continued movement of the link **30** by the solenoid plunger and further upward movement of the part **32** will therefore lift the link 92 which, as will now be described, has the result of locking the circuit breaker in the open position.

The manual operating mechanism comprises an operating lever **102** made fast to a shaft **103** and conveniently provided with a ring-shaped end **104** adapted to receive a hook on an operating pole. A lever **105** made fast to the shaft **103** is connected with the bell-crank **93** by means of a toggle linkage comprising links **106** and **107** pivoted together at **108** and connected with the lever **105** by a pin **109** and with the bell-crank by the pin **96**. The pin **108** lies above the line joining the pins **96** and **109** so that the toggle linkage will collapse to allow the hereinafter described clockwise movement of the bell-crank lever **93**, the link **106** pivoting freely about the pin **109** during this movement with no ensuing movement of the manual handle **102**.

The upward movement of the lever **92** as hereinbefore described by the part **32** of the toggle link **30**, when the rack 72 is in its uppermost position, moves the bell-crank **93** in the clockwise direction in Fig. 1.

The line between the pivots **100** and **101** will now lie above the pivot **27** so that the movement of the bell-crank lever is enabled to cause movement of the links **97** and **98** tending to raise the pin **100**. At the same time the pin **100** is moving upwardly so that the line of action of the spring **99** moves above the pivot **27** and will then cause rapid movement of the pin **100** in the clockwise direction and of the pin **96** also in the clockwise direction thereby continuing the clockwise movement of the bell-crank **93** to lift the slotted link **53**. The engagement of the pin **51** with the bottom of the slot **52** in said link **53** then transmits the force of the spring **99** to the toggle link **30**. The spring **99** through the link **53** and the toggle lever **30** thus acts downwardly on the link **41** and is of such strength as to overcome the re-closing spring **43** so that the lever **30** is maintained in the position to which it is actuated in the open position of the circuit breaker. In other words, the toggle link **29** is maintained in the collapsed position wherein the spring **33** holds the switch lever **22** in its upper position and the contacts in the open position.

The cessation of current in the solenoid **34** therefore does not now result in re-closure of the circuit breaker. In order to re-close the circuit breaker a manual operating member has to be actuated mechanically as will now be described.

In order to reset the circuit breaker, the end **104** of the operating lever is moved upwardly so as to rotate the lever **105** in the clockwise direction and thereby to bring the toggle links **106** and **107** into the straight line position. A hairpin or other tension spring **108**$_a$ is provided on the pin **108** and the end of the spring abuts on the links **106** and **107** so as to tend to maintain said links just over the "set" position of the toggle. In other words the toggle linkage is now set so as to constitute an integral thrust-resistant structure. Return movement of the operating lever **102** and with it of the lever **105** will therefore transmit the counterclockwise movement of pin **109** to the bell-crank so as to return the latter to the illustrated position. The slotted link **53** then releases the toggle link **30** so that the spring **43** will now cause the solenoid plunger **35** to lift and so reclose the circuit breaker.

A fixed abutment **110** co-operates with the link **106** so as to "break" the toggle **106, 107** during the final part of the return movement of the lever **102**, whereby the lock-out mechanism is in condition for subsequent operation. Thus, the circuit breaker is trip-free since the collapse of the toggle **106, 107** effectively disconnects the operating handle **102** from the bell-crank **93**. If the breaker is manually closed on to a fault condition it will thus be free to trip and will again lock open.

The mechanism also includes an inertia device comprising in this embodiment an anvil member **111** carried by an arm **112** mounted on a fixed pivot **113**, and co-operating with a fixed stop **112**$_a$, an abutment surface **114** of the anvil being engaged by the switch lever **22** during the upward movement of the latter as the latter approaches the contact open position. The surface **114** may be provided by a plunger slidably mounted in the anvil with a compression spring **114**$_a$ (Fig. 2) interposed between said plunger and the anvil. The kinetic energy in the moving parts is thus transferred to the pivoted anvil **111** causing rapid retardation of said moving parts. The anvil moves upwardly into engagement with a suitable buffer **115** whereby to absorb said energy. An additional buffer **116**, of suitable construction, is mounted on the frame for finally arresting the upward movement of the contact rod by engagement with the upper end of the link 17.

It will be understood that certain of the links and springs described may be of duplicated construction for convenience in mounting and assembly, such duplicated construction being apparent in Figs. 2 and 3 in the case of some of the links.

A preferred construction of dashpot is illustrated by Fig. 4 wherein the control valve operated by the cam **70** and lever **69** is of the poppet or mushroom type comprising a head **120** carried by a stem **121** and co-operating with a seat formed by a diaphragm **122** held in place by an end member **123**. The valve is guided by means of a further diaphragm **124** through which the stem **121** extends, and a diaphragm **125** above the valve mounted at the base of the dashpot cylinder, and having a central perforation through which a spigot rod **126** mounted in the valve stem **121**, extends. The valve is urged downwardly from its illustrated position into engagement with its seat **122** by means of a compression spring **127**. The valve is maintained lifted by a pivoted rocker **128** engaged by a crankarm **129** made fast to the shaft **69** so that the movement of the cam **70** causing clockwise movement of the arm **68** in Fig. 1 (counterclockwise movement of said arm in Fig. 4) will allow the spring **127** to close the valve. Openings such as appearing at **130** are provided in the diaphragms **124** and **125** for allowing free passage of oil from the dashpot when the valve is opened.

When the valve is closed, only a slow discharge of oil from beneath the piston shown at **66**$_a$ is permitted by a bleed discharge port **131** which preferably comprises a removable perforated plug **132**. By this means various rates of movement may be obtained by selection of plugs **132** having different sizes of orifices therein.

The upper end of the dashpot cylinder **65** is in communication with the tank by means of a bleed discharge port **133** preferably comprising a removable bored metering plug **134** whereby again to provide ready control of the rate of movement of the piston **66**$_a$ upwardly during the re-closing stroke. In order that the downward or opening stroke of the dashpot shall be controlled independently of the port **133** the upper end of the dashpot cylinder is closed by a cylinder cover **135** having ports of which two appear at **136** and a disc valve **137** is urged into engagement with the underside of said cover by means of a compression spring **138**. This valve therefore closes

the ports **136** during upward movement of the piston **66a** but during downward movement of the latter the disc **137** will move downwardly to allow passage of oil through said ports and a central opening **139** in the disc valve **137**.

It will be understood that at all times when the rack is raised from the illustrated position it tends to return at a relatively low speed to the illustrated position under control of the clockwork device **88** so that after each occasion on which over-current conditions occur, except when the contacts are locked open, the mechanism returns automatically to the illustrated condition in readiness for a further cycle of operations above described in response to a subsequent occurrence of over-current conditions.

While we have shown and described a particular embodiment of our invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from our invention in its broader aspects and we, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of our invention.

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

1. In a circuit breaker having a switch member movable between a closed position and an open position, an overcenter toggle linkage operatively coupled to said movable switch member, an overcenter spring urging said toggle linkage into a first collapsed position wherein said switch member is in closed position, actuating means for driving said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said toggle toward a second collapsed position wherein said switch member is in open position, abutment means operable when interfering with said toggle to render collapsing movement thereof ineffective to produce opening movement of said switch member, said abutment means being disposed to interfere with said toggle during movement thereof through and initially past center whereby to preclude opening movement of said switch member during this interference interval, said toggle being movable out of interfering relationship with said abutment means upon continued movement of said toggle past center whereby then to permit said spring quickly to drive said toggle into said second collapsed position, thus driving said switch member into open position.

2. The combination of claim 1 wherein said toggle linkage is returnable from said second to said first collapsed position to return said switch member to closed position, said abutment means temporarily interfering with return movement of said toggle and permitting said overcenter spring to initiate closing movement of said switch member only after said toggle has been returned a substantial distance past toggle center.

3. The circuit breaker mechanism of claim 1 in combination with timing means for limiting the speed of said actuating means to a rate which is substantially less than the opening speed of said movable switch member.

4. The circuit breaker of claim 2 in combination with reclosing means operable following opening of said contact to return said toggle from said second to said first collapsed position, timing means for limiting the speed of operation of said reclosing means and of said actuating means to rates which are substantially lower than the closing and opening speeds, respectively, of said switch member.

5. In a circuit breaker having a switch member movable between a closed position and an open position, an overcenter toggle linkage operatively coupled to said movable switch member, an overcenter spring urging said toggle linkage into a first collapsed position wherein said switch member is in closed position, actuating means for driving said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said toggle toward a second collapsed position wherein said switch member is in open position, abutment means operable when engaging a predetermined portion of said toggle to render collapsing movement of said toggle ineffective to produce opening movement of said switch member, said predetermined toggle portion being engageable with said abutment means as the toggle is moved through center and for an initial distance past center whereby to preclude opening movement of said switch member during this interference interval, said predetermined toggle portion being disengageable from said abutment means upon continued movement of said toggle past center, whereby then to permit said spring quickly to drive said toggle into said second collapsed position, thus driving said switch member into open position.

6. In a circuit breaker having a contact movable between a closed position and an open position, an overcenter toggle linkage operatively coupled to said movable contact, an overcenter spring urging said toggle linkage into a first collapsed position on one side of toggle center, actuating means for driving said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said toggle toward a second collapsed position, means interconnecting said toggle and said contact for positioning said contact in a closed position when said toggle is in said first collapsed position and responsive to movement of said toggle into said second collapsed position to drive said contact into open position, abutment means operable when interfering with said toggle to render movement thereof past center ineffective to produce opening movement of said contact, said abutment means being disposed to interfere with said toggle during movement thereof through and initially past center whereby to preclude opening movement of said contact during this interference interval, said toggle being movable out of interfering relationship with said abutment means upon continued movement of said toggle past center whereby then to permit said spring quickly to drive said toggle into said second collapsed position, thus producing movement of said contact into open position.

7. In a circuit breaker having a contact movable between a closed position and an open position, an overcenter toggle linkage operatively coupled to said movable contact, an overcenter spring urging said toggle linkage into a first collapsed position wherein said contact is in closed position, actuating means for driving said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said togggle toward a second collapsed position wherein said contact is in open position, interference means operable during movement of said toggle through center and initially past center for precluding opening movement of said contact, and means for rendering said interference means inoperable to preclude said contact opening movement upon continued movement of said toggle past center whereby then to permit said overcenter spring quickly to drive said toggle into said second collapsed position, thus producing movement of said contact into open position.

8. The combination of claim 7 wherein said toggle linkage is returnable from said second to said first collapsed position to return said contact to closed position, said abutment means temporarily interfering with return movement of said toggle and permitting said overcenter spring to initiate closing movement of said contact only after said toggle has been returned a substantial distance past toggle center.

9. The circuit breaker mechanism of claim 7 in combination with accelerating means including a chargeable accelerating spring which upon discharge acts to drive said contact toward open position, charging means operated by said actuating means during movement of said toggle toward, through and initially past center for progressively charging said accelerating spring, means for applying the stored energy of said accelerating spring to

a portion of said mechanism which is under the control of said interference means, said interference means thereby preventing discharge of said accelerating spring until rendered inoperable whereupon said accelerating spring then discharges and aids said overcenter spring in driving said contact open.

10. In a circuit breaker having a contact movable between a pair of spaced-apart circuit-controlling positions, an overcenter toggle linkage operatively coupled to said movable contact, an overcenter spring urging said toggle linkage into a first collapsed position wherein said contact is in one of its circuit-controlling positions, actuating means for driving said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said toggle toward a second collapsed position wherein said contact is in the other of its circuit-controlling positions, abutment means operable when interfering with said toggle to render movement thereof past center ineffective to produce movement of said contact between said circuit-controlling positions, said abutment means being disposed to interfere with said toggle during movement thereof through and initially past center whereby to preclude circuit-controlling movement of said contact during this interval, said toggle being movable out of interfering relationship with said abutment means upon continued movement of said toggle past center whereby then to permit said spring quickly to drive said toggle into said second collapsed position, thus producing movement of said contact into said other circuit-controlling position.

11. The combination of claim 10 wherein said toggle linkage is returnable from said second to said first collapsed position to return said contact to said one circuit-controlling position, said abutment means temporarily interfering with return movement of said toggle and permitting said overcenter spring to initiate return motion of said contact only after said toggle has been returned a substantial distance past toggle center.

12. In a circuit breaker having a contact movable between a pair of spaced-apart circuit-controlling positions, an overcenter toggle linkage coupled to said movable contact, an overcenter spring urging said toggle linkage into a first collapsed position wherein said toggle is in one of said circuit-controlling positions, actuating means for driving said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said toggle toward a second collapsed position wherein said contact is in the other of said circuit-controlling positions, interference means operable during movement of said toggle through center and initially past center for precluding opening movement of said contact, and means for rendering said interference means inoperable to preclude said circuit-controlling movement upon continued movement of said toggle past center, whereby then to permit said spring quickly to drive said toggle into said second collapsed position, thus producing movement of said contact into said other circuit controlling positions.

13. In a circuit breaker having a contact movable between a pair of spaced-apart circuit-controlling positions, an overcenter toggle linkage comprising a pair of toggle links one of which is a floating link coupled to said movable contact, an overcenter spring urging said toggle linkage into a first collapsed position wherein said contact is in one of said circuit-controlling positions, actuating means coupled to the other of said toggle links and operable to drive said toggle toward center to charge said overcenter spring and for thereafter driving said toggle past center to permit said charged spring to urge said toggle toward a second collapsed position wherein said contact is in the other of said circuit-controlling positions, abutment means operable when interfering with said floating link to render collapsing movement of said toggle ineffective to produce circuit-controlling movement of said contact, said abutment means being disposed to interfere with said floating link during movement of said toggle through and initially past center whereby to preclude circuit-controlling movement of said contact during this interval, said floating link being movable out of interfering relationship with said abutment means in response to continued movement of said toggle past center whereby then to permit said spring quickly to drive said toggle into said second collapsed position, thus producing movement of said contact into said other circuit-controlling position.

14. The circuit breaker mechanism of claim 13 in combination with accelerating means including a chargeable accelerating spring which upon discharge acts to drive said contact toward said other circuit-controlling position, charging means operated by said actuating means during movement of said toggle through and initially past center for progressively charging said accelerating spring, means for applying the stored energy of said accelerating spring to a portion of said mechanism which is under the control of said interference means, said interference means thereby preventing discharge of said accelerating spring until rendered inoperable whereupon said accelerating spring then discharges and aids said overcenter spring in producing movement of said contact toward said other circuit-controlling position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,031,479	Smith	July 2, 1912
1,721,417	Schwennker	July 16, 1929
1,810,624	Rankin	June 16, 1931
1,848,902	Paxton et al.	Mar. 8, 1932
2,542,736	Viti et al.	Feb. 20, 1951