June 8, 1937. T. LINDSTROM 2,083,304

CIRCUIT BREAKER

Original Filed April 24, 1933 4 Sheets-Sheet 1

Fig. 1.

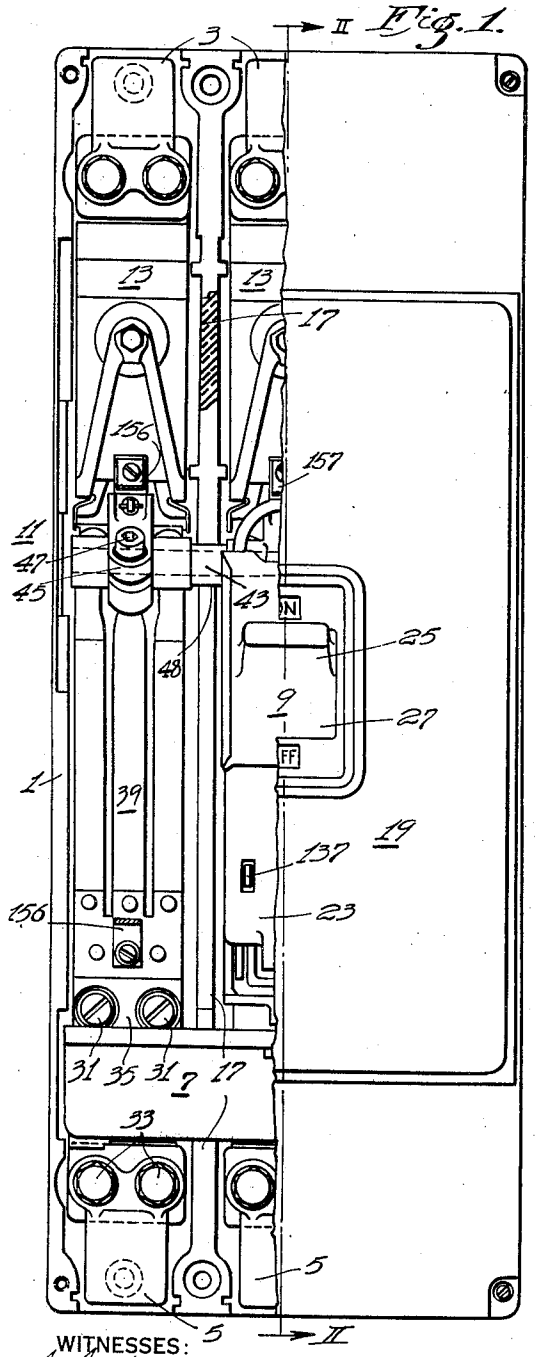
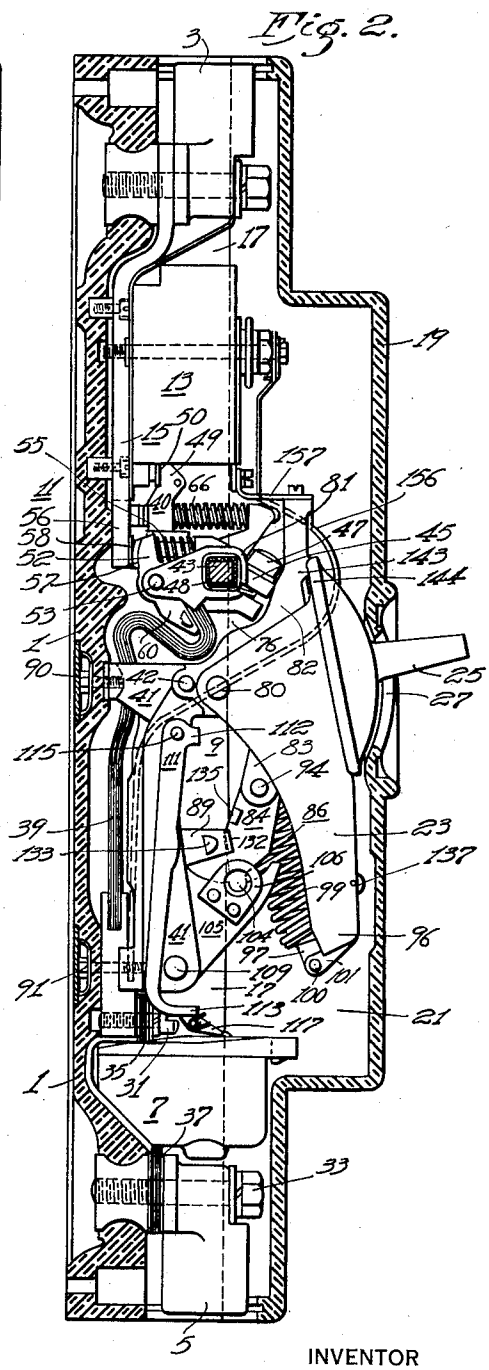


Fig. 2.



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CIRCUIT BREAKER

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Fig. 3.

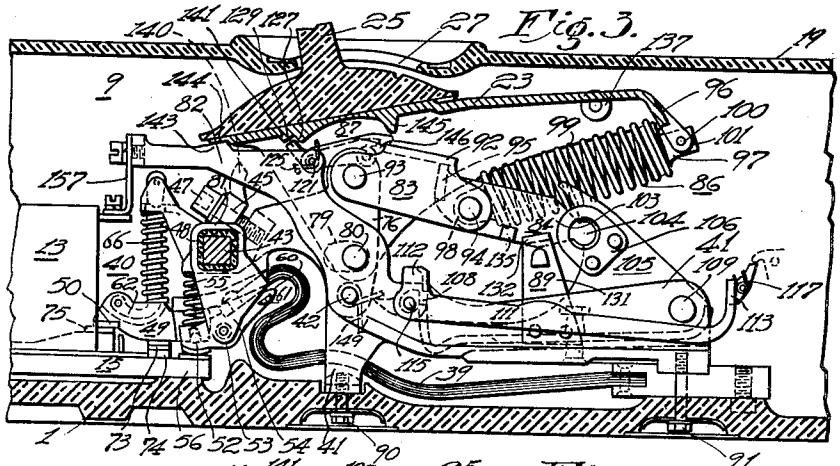


Fig. 4.

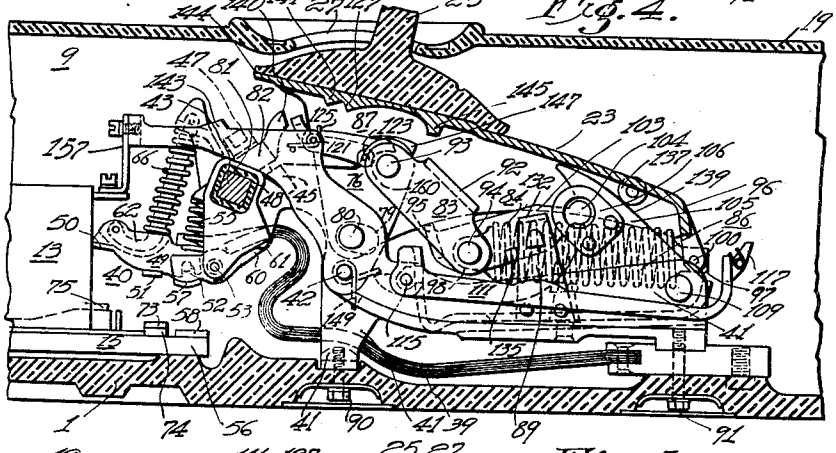
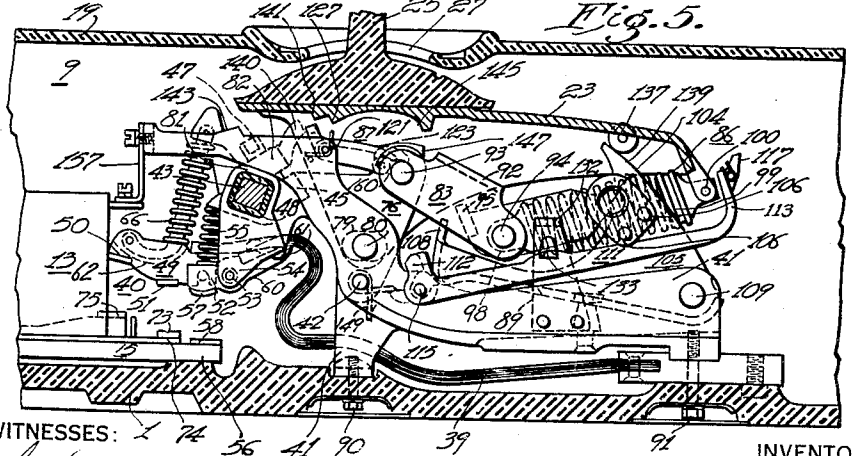


Fig. 5.



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CIRCUIT BREAKER

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Fig. 6.

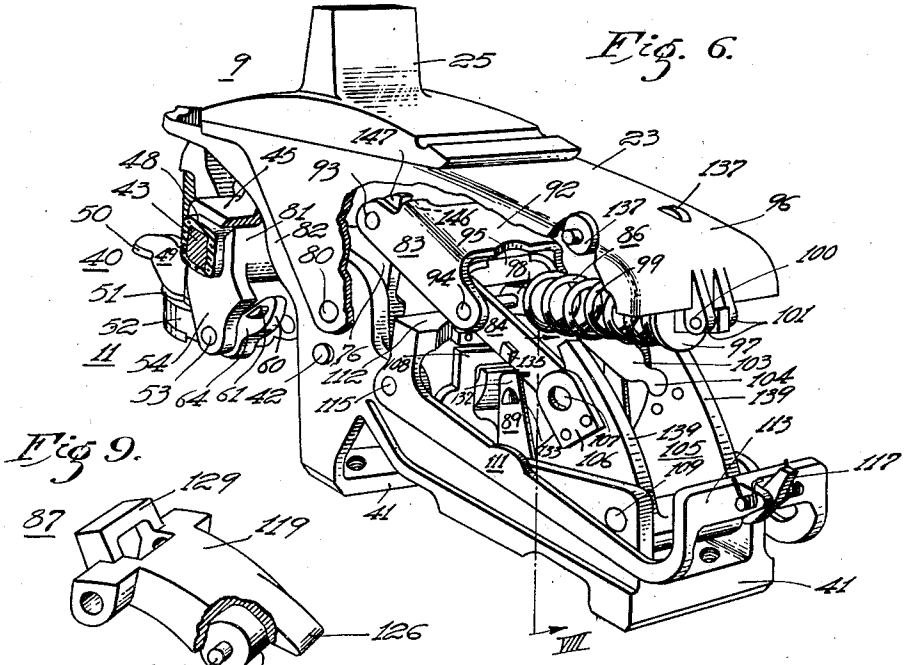

Fig. 9.

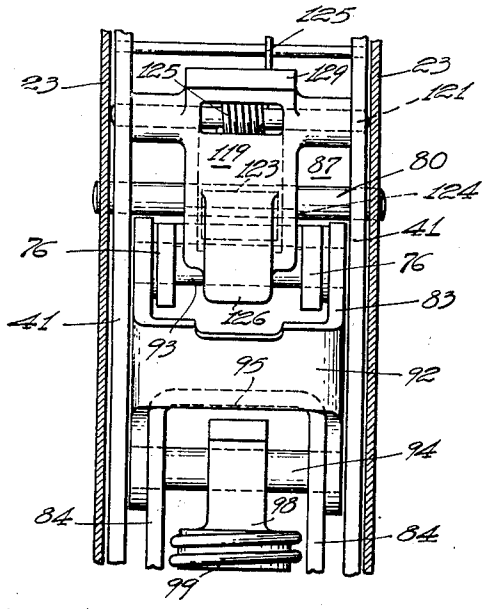

Fig. 8.

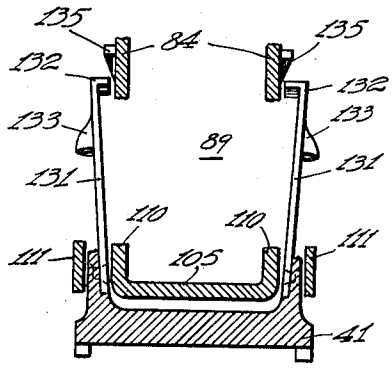

Fig. 7.

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CIRCUIT BREAKER

Original Filed April 24, 1933 4 Sheets-Sheet 4

Fig. 10.

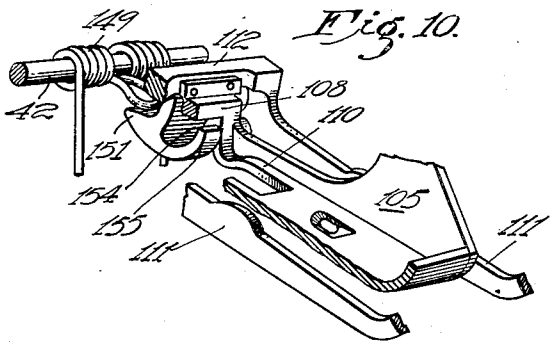


Fig. 14.

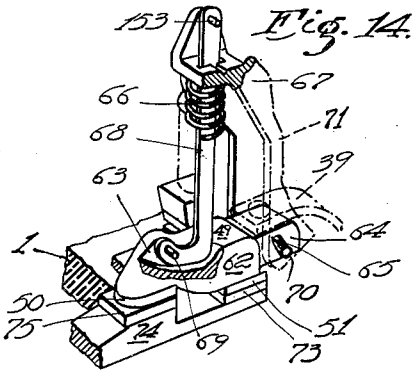


Fig. 11.

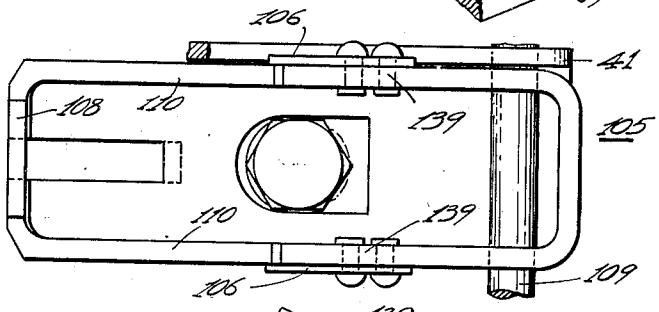


Fig. 12.

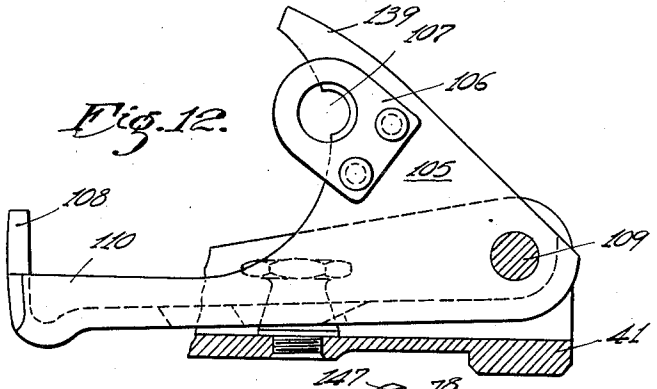
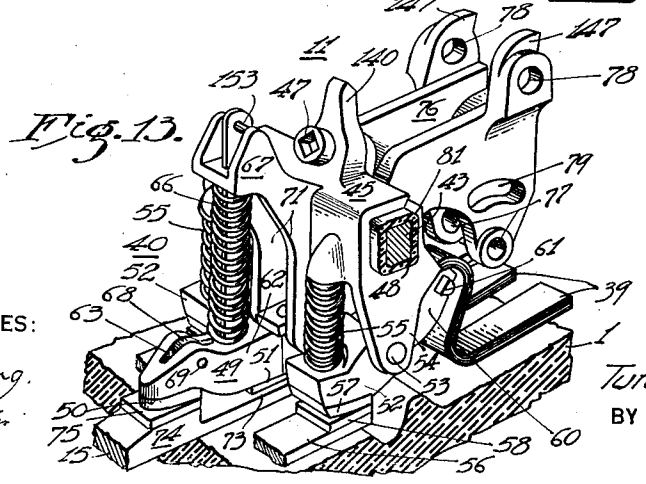


Fig. 13.



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Patented June 8, 1937 2,083,304

UNITED STATES PATENT OFFICE

2,083,304

CIRCUIT BREAKER

Ture Lindstrom, Edgewood, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 24, 1933, Serial No. 667,624
Renewed November 4, 1936

20 Claims. (Cl. 200—89)

My invention relates particularly to circuit breakers for use in controlling lighting and distribution systems. Circuit breakers of this type are often subjected to very severe operating conditions, especially in industrial service, and at the same time the physical dimensions of the circuit breaker and its enclosure must be kept as small as possible.

My application Serial No. 109,111, filed November 4, 1936 is a division of this application.

One object of my invention, therefore, is to provide an improved circuit breaker of this type that shall be capable of interrupting large amounts of power and that shall occupy a minimum of space.

Another object of my invention is to provide an improved circuit breaker that is manually actuable to open or close the circuit, and is automatically actuable to open the circuit and to prevent the holding of the circuit closed during the occurrence of short circuit or overload conditions.

A further object of my invention is to provide an improved mechanism for opening and closing circuit breaker contacts that shall positively set the moving contact into motion when the operating member reaches a predetermined position during the opening and during the closing operation.

A further object of my invention is to provide an improved latching arrangement particularly suitable for use with circuit breakers which utilize very powerful operating springs, large capacity shunts, and heavy contact parts, my improved latch to hold the circuit breaker in the open position until the operating member reaches a predetermined position during the closing operation and to then release the mechanism so as to cause the contacts to close with a snap action.

A further object of my invention is to provide a circuit breaker having an electro-responsive trip device with a latch mechanism operable to releasably latch the circuit breaker in the open position following each opening of the circuit by the trip device, my latch mechanism to be inoperable except when the breaker has been opened by the trip device and to be releasable by suitable means adapted to be engaged by the circuit breaker operating member.

A still further object of my invention is to provide an improved contact structure for use with circuit interrupters wherein the contacts open and close with a snap action, my improved structure to include main, intermediate, and arcing contacts which open in the above-mentioned order and which maintain the normal contact pressure between the engaging surfaces substantially unchanged during the opening operation.

As mentioned before, the principal field for immediate application of my invention is in connection with multi-pole circuit breakers for controlling lighting and distribution feeder circuits, and I shall hereinafter describe an embodiment of my invention as applied to such circuit breakers, without, however, in any way intending to restrict the scope of my invention except as indicated in the appended claims.

In this embodiment of my invention, which includes many of the features disclosed in the application for Letters Patent of Harry J. Lingal, Serial No. 637,749, filed October 14, 1932, and assigned to the assignee of this invention, I provide a plurality of switch members and a plurality of cooperating stationary contact members for opening a plurality of poles. In addition, I provide a manually operable mechanism for opening and closing the circuit breaker contacts with a snap action, an insulating base upon which the structure is assembled, an arc extinguishing device for each pole, springs for biasing each of the switch members to the open position, a plurality of latch and switch member engaging devices which will be described in some detail later, a releasable restraining means for holding all of the switch members closed, and a unitary trip device for releasing the restraining means in response to a predetermined electrical condition in any one pole and thereby opening all of the poles of the breaker, the releasing means being operable to open the breaker regardless of the position of the operating handle.

The features of my invention which are believed to be new are particularly pointed out in the appended claims. For a fuller understanding of the principles of the invention, reference may be had to the accompanying drawings in which:

Figure 1 is a plan view of a three-pole circuit breaker embodying the principal elements of my invention; the cover has been partially cut away to more completely show the various parts of the breaker structure.

Fig. 2 is a sectional view taken on the line II—II of Fig. 1.

Fig. 3 is an enlarged fragmentary view, partly in section and partly in side elevation, showing the circuit breaker mechanism and the contact structure in the fully closed position.

Fig. 4 is an enlarged fragmentary view, similar to Fig. 3, showing the circuit breaker mechanism and the contact structure in the open position.

Fig. 5 is an enlarged fragmentary view, similar to Fig. 3, showing the circuit breaker mechanism and the contact structure in the tripped position; certain of the parts have been cut away in Figs. 3, 4 and 5 in order to more clearly illustrate the arrangement of the various elements of the mechanism and the contact structure.

Fig. 6 is a perspective view showing the circuit breaker operating mechanism and part of the contact structure.

Fig. 7 is a fragmentary view, partly in section, showing one of the latch devices and the associated parts of the operating mechanism.

Fig. 8 is a fragmentary sectional view, taken on the line VIII—VIII of Fig. 6, showing another of the latch devices.

Fig. 9 is a perspective view of the latching member shown in Fig. 7.

Fig. 10 is a fragmentary perspective view showing the portion of the circuit breaker operating mechanism which is intermediate the trip device and the toggle carrier.

Fig. 11 is a fragmentary plan view showing the carrier lever and a portion of the frame of the circuit breaker operating mechanism.

Fig. 12 is a fragmentary elevational view, partly in section, of the structure shown in Fig. 11.

Fig. 13 is a fragmentary perspective view showing the central pole contact assemblage and a portion of the tie-bar used for interconnecting the contact structures of the several poles, and,

Fig. 14 is a fragmentary perspective view showing the central unit of the contact assemblage shown in Fig. 13.

Referring to the drawings, the base 1 is of molded insulated material and has mounted thereon six terminal contacts 3 and 5, the unitary trip device 7, the circuit breaker operating mechanism 9 which has associated therewith the assemblage of switch members 11, the arc extinguishers 13, and three stationary contact assemblages 15. The assemblage of switch members 11 and the stationary contact assemblages 15 combine to form the plurality of poles. Each of the poles is insulated from the adjacent pole by means of insulating barriers 17 (Figs. 1 and 2), which are molded into the base 1. These insulating barriers 17 aline with similarly shaped barriers 21 (Fig. 2) in the cover 19 which is likewise of molded insulating material. The operating member 23 has a handle 25 and is rigidly pivoted onto the frame 41 of the operating mechanism 9. An opening 27 is provided in the cover 19 to accommodate the operating handle. The unitary trip device 7 is retained in position by the screw fastenings 31 and 33, which also serve to electrically connect the terminals 35 and 37 of the trip device with the shunts 39 and the terminal contacts 5, respectively.

The electrical circuit for each of the poles is substantially the same. Beginning with the terminal contact 3, the current passes successively along the arc extinguishing structure 13 thence through the main stationary contact assemblage 15, the cooperating moving contact assemblage 40, the flexible conducting shunt 39 which is associated with each of the switch members, the terminal 35 of the unitary trip structure 7, and finally through the trip structure to the other terminal contact 5.

The assemblage of the switch members 11 is pivoted to the frame 41 of the operating mechanism 9 by means of a pin 42. A tie-bar 43, preferably of steel, serves to rigidly interconnect the three switch members 11—the bearing for the center pole serving for all three poles. As shown particularly in Fig. 13 each of the switch members 11 includes a clamp member 45 for engaging the tie-bar 43, a stud bolt 47 being provided as a fastening means. A square tube 48 of insulating material is positioned between the tie-bar 43 and the clamp members 45 to prevent the short circuiting of the several poles.

As shown particularly in Fig. 13, each of the moving contact assemblages 40 is supported upon suitable projections extending downwardly from the body of the clamp member 45. Due to the large area of the contact surfaces and the mass of the contact parts, the shunt 39 has been split into three sections and the moving contact assemblage 40 is likewise made up of three differing contact members. The centrally disposed contact member 49 includes the arcing contact 50 and the auxiliary main contact 51. The two outer contact members 52 are utilized to form the main contacts. The stationary contact assemblage 15 is provided with suitable surfaces for engaging the contact members which go to make up the moving contact assemblage 40.

The two outer contact members 52 are pivotally supported by means of pins 53 which extend through suitable openings in the projections 54 which extend downwardly from the body of the clamping member 45. Suitable springs 55 bias the contact members 52 into engagement with the cooperating sections 56 of the stationary contact assemblage 15. The engaging surfaces 57 and 58 are faced with silver in order to improve the current carrying characteristics. Each of the outer contact members 52 has a rearwardly extending portion 60 (Fig. 13), which is adapted to engage the shunt 39. This portion 60 has projections 61 extending outwardly therefrom. These projections are adapted to engage the downwardly extending portions 54 of the clamping member 45 in order to limit the motion of the contact member 52 about the pins 53.

The centrally disposed contact member 49 is shown particularly in Fig. 14. It includes the arcing contact 50, a body portion 62 having a slot 63 therein, the auxiliary main contact 51, and a rearwardly extending portion 64 which is brazed or otherwise conductively joined to the central portion of the shunt 39 and which includes a slot 65. The contact pressure for the arcing and auxiliary main contacts is provided by a spring 66 which is adapted to abut against the top of the body portion 62 of the central contact 49 and the projection 67 extending outwardly from the clamp member 45. An L-shaped spring guide 68 passes through a suitable opening in the projection 67 and engages the centrally disposed contact member through the agency of a pin 69 positioned within the slot 63. This L-shaped spring guide makes it possible to concentrate practically all of the force of the spring 66 at a point near the arcing contact 50.

When the circuit breaker is in the fully closed position, the centrally disposed contact member 49 is entirely free of the clamp member 45 except for the resilient connection provided by the spring 66. During the opening operation a lost motion connection between the central contact member 49 and the assemblage of switch members 11 is made possible by the slot 65 and its cooperating pin 70. This, as will be described in detail later, is a very desirable arrangement in that it assures the proper sequence of contact separation. The pin 70 is supported by the

downwardly extending projections 71 of the clamp member 45.

The contact pressure securing spring 66 for the central contact member is made considerably longer than the similar springs 55 for the two outer contact members. This is done in order that the initial movement of the clamp member 45 which causes the separation of the main contacts during the first stages of the opening operation shall not result in any appreciable lessening of the normal contact pressure between the auxiliary main contacts and the arcing contacts, the initial movement being taken up by the lost motion connection so as to delay the separation of the arcing and auxiliary main contacts.

The auxiliary main contact 51 and the engaging face 73 of the cooperating portion 74 of the stationary contact assemblage 15 are made of silver in order to secure a minimum contact resistance. The arcing contact 50 and its cooperating portion 75 are made of arc resisting material, preferably a silver-tungsten alloy consisting of 40% of the former and 60% of the latter. Any conducting material capable of resisting the high temperature of the arc would be equally suitable, however.

The clamp member 45 of the central switch member 11 has a bifurcated section 76 formed integral therewith. This section 76 has openings 77 (Fig. 13) for engaging the contact assemblage pivot pin 42, openings 78 for engaging the breaker operating mechanism, and slotted openings 79 for clearing the pivot pin 80 of the operating member 23.

The limit of upward motion of the assemblage of switch members 11 as they rotate about pin 42 is defined by the engagement of the portion 81 of the central clamping member 45 with the portions 82 of the U-shaped frame 41 (see Figs. 2 to 5).

The arc extinguishers 13 which I prefer to use with my invention are of the spaced-plate type. The extinguishers are disposed adjacent to the arc path, the plates being provided with slots of substantially the same outline as the moving contacts. The arc is moved into the spaces between the plates where it is rotated by suitable means associated with the extinguisher until it is cooled and extinguished. Patent No. 1,896,764, issued to M. W. Brainard on February 7, 1933, and assigned to the assignee of this invention, fully discloses the structural features and fully describes the operation of an arc extinguisher of this type.

Each of the extinguishers 13 is separated from the adjacent extinguisher by a portion of the insulating barriers 17 and 21. This construction gives an increased margin of safety while interrupting heavy current arcs by reducing the possibility of flashover between adjacent poles.

The operating mechanism 9 comprises, in general, a U-shaped base or frame 41, a pair of toggle links 83 and 84 having one end connected to the assemblage of switch members 11 through the bifurcated section 76, a carrier lever 105 for releasably restraining the other end of the toggle links 83 and 84 in operative position, a channel shaped operating member 23, an over-center spring unit 86 for connecting the operating member 23 to the knee of the toggle link, the operating handle 25, and the releasable latch mechanisms 87 and 89. The U-shaped base 41 is positioned above the conducting shunt 39 of the central pole and is rigidly affixed to the base 1 by means of screw fastenings 90 and 91. The screw fastenings 91 extend through one end of the shunt 39 which is positioned between the frame 41 and the base 1, and, since no insulation is placed between the frame 41 and the shunt 39, the entire operating mechanism is at the same electrical potential as the central pole, the reason for this will be discussed in a subsequent paragraph. As previously pointed out, the assemblage of the switch members 11 is pivoted to the base 41 by means of the pivot pin 42, and the channel shaped operating member 23 is pivoted to the base 41 by means of the pivot pin 80.

The toggle link 83 comprises a pair of substantially parallel links which are joined by a bridge portion 92. One end of the toggle link 83 engages the bifurcated section 76 of the central clamping member 45 through the agency of the pin 93 which is journalled in the holes 78. The other end of the double toggle link 83 is pivoted to one end of the toggle link 84 by means of the knee pivot pin 94.

The toggle link 84 comprises a pair of link sections joined by a bridge portion 95 similar to the bridge portion 92 joining the link sections of the toggle 83, but disposed at the extreme end of the links beyond the pin 94. The bridge section 95 is adapted to engage the bridge portion 92 of the link 83 when the breaker is in the fully closed position (Figs. 3 and 7) and provides a stop for defining the limit of upward motion of the knee of the toggle.

The overcenter spring unit 86 operatively connects the end 96 of the operating member 23 with the knee pivot pin 94 of the toggle links and exerts a tension force therebetween. The spring unit 86 comprises a pair of end portions 97 and 98 which are threaded to engage the spring 99. The end portion 98 (Fig. 6) of the overcenter spring nut 86 pivotally engages the knee pivot pin 94 of the toggle links, and the end portion 97 pivotally engages the end 96 of the operating member 23 through the agency of a pivot pin 100 and a pair of supporting ears 101.

The end 103 of each of the parallel sections of the toggle link 84 is provided with a circular bearing portion 104 (Fig. 6). Each of the bearing portions 104 engages a suitable recess in the end of one of the parallel sections of the bell crank carrier lever 105. Two retaining plates 106 having openings 107 for the admission of a lubricant are disposed on the outer sides of the carrier lever 105 to prevent the bearing portion 104 from moving sidewise and disengaging the recesses.

The carrier lever 105 comprises a pair of parallel bell crank levers which are joined by a bridging section 108 (Figs. 10, 11 and 12). The carrier is pivoted to the base 41 at the apex of the bell crank levers by means of the pin 109. The portions 110 of the carrier lever 105 which do not engage the toggle link 84 extend along the base 41 to form what might be called a tail portion. The perpendicular distance from the center of the carrier pin 109 to the line of action of the toggle link 84 is considerably less than the distance from the center point of the carrier pivot pin 109 to the bridging portion 108 which joins the tail portions 110. This gives the carrier lever a very appreciable mechanical advantage over the toggle. The over-center spring unit 86 at all times exerts a force on the carrier lever 105—transmitted through the toggle link 84—biasing that lever in a clockwise direction (Figs. 3, 4 and 5), and it is to restrain the carrier lever 105 in an operative position that the latching lever 111 is provided.

Similar to the other parts of the operating mechanism 9, the latching lever 111 comprises a pair of parallel sections which are joined by bridging portions (112 and 113). One end of the latching lever 111 is pivoted to the base 41 by the pivot pin 115 adjacent the point of engagement with the tail piece 108 of the carrier 105. The bridge portion 112 normally overhangs the bridge portion 108 (Fig. 10) which connects the tail portions 110 of the carrier lever 105 and thus holds the carrier lever in an operative position by preventing it from moving upward under the bias of the operating spring unit 86. The free end of the latching lever 111 is releasably restrained by a pivoted latch engaging mechanism 117 which is supported on the bridging portion 113 (Fig. 6).

It should be noted at this point that the mechanical advantage of the latching lever 111 is very great with respect to the carrier lever 105, the distance from the center of the latching lever pivot pin 115 to the point of engagement of the bridging members 112 and 108, that is, the point of engagement of the latching lever and the carrier lever being very small as compared with the distance from the center of the pin 115 to the point of engagement of the trip device 7 and the latch engaging mechanism 117 which forms a part of the latching lever 111. Furthermore, it should be noted that the various parts of the frame 41, the toggle links 83 and 84, the carrier lever 105, and the latching lever 111 are all disposed to occupy a minimum of space upward from the base; they are all arranged substantially parallel to each other and all extend along the base, both of these characteristics being of great value in securing a mechanism which occupies a minimum of space but which is capable of satisfactory operation with mechanical parts of high inertia and heavy operating springs.

My invention is not particularly concerned with the trip device 7, and any releasable restraining means capable of disengaging the latch mechanism 117 and thereby releasing the unpivoted end of the latching lever 111 in response to a predetermined electrical condition may be used. I prefer to use a trip device similar to that disclosed in the copending application of Jerome Sandin, filed October 29, 1932, Serial No. 640,214, which became Patent No. 2,043,306 on June 9, 1936 and which is assigned to the assignee of this invention. This trip device has a thermally responsive and a magnetically responsive element electrically connected in each pole of the breaker. A common trip bar which is actuable by any one of the thermally responsive or magnetically responsive trip elements, engages the circuit breaker latch mechanism through suitable linkages. Upon the occurrence of an overload in any one of the poles of the breaker, the thermally responsive element acts to trip all of the poles of the breaker after a predetermined interval. Upon the occurrence of a short circuit condition in any one of the poles of the breaker, the magnetically responsive element in that pole is energized and immediately opens all the poles of the breaker. Suitable means are provided for restoring all the parts of the trip device to an operative condition following each operation—the trip device is thus completely automatically resettable.

The releasable latch mechanism 87 is shown particularly in Figs. 3, 7, and 9 and comprises a body portion 119 which is pivotally mounted on the frame 41 by means of a pin 121. A roller 123 is rotatably supported within the body portion 119 through the agency of a pin 124. A spring 125 biases the latch clockwise (Fig. 3) about the pivot pin 121, and a stop 126 is provided for limiting the clockwise motion of the body portion 119 and for positioning the latch with respect to the toggle links. The latch 87, as will be described in some detail later, is adapted to engage the pivot pin 93 when the circuit breaker is in the open position (Fig. 4) and thereby prevent the over-center spring unit 86 from moving the assemblage of switch members 11 to the closed position until the operating handle has reached a predetermined point during the closing operation. The release of the latch 87 is accomplished by the engagement of the projection 127 (Figs. 3, 4, and 5) on the operating member 23 with the projection 129 on the latch 87.

The latch 89 is utilized for preventing any movement of the switch members 11 after the circuit breaker has been opened by the trip device. This latch, as shown particularly in Fig. 8, comprises a pair of spring members 131 having bent over top portions 132 and outwardly extending projections 133. The spring members 131 are rigidly supported on the base 41. The top portions 132 coact with suitable wedge shaped projections 135 on the parallel sides of the toggle link 84, the projections 133 define the upward limit of motion of the latching lever 111.

The operation of this embodiment of my invention may best be described in conjunction with Figs. 3, 4, and 5 which show the disposition of the various parts of the mechanism for the three static positions of the moving parts. Fig. 4 shows the circuit breaker contacts in the fully opened position with the mechanism in the operative or set condition; that is, the tail portion of carrier lever 105 is held in position along the base by the overhanging bridge portion 112 of the latching lever 111, and the latching lever 111, in turn is releasably restrained in position along the base 1 by the latch engaging mechanism 117 which operatively connects the circuit breaker operating mechanism 9 and the trip device 7. It will be noted that the knee pivot pin 94 is positioned adjacent the base 41 of the operating mechanism, and the operating spring unit 86 extends along, and is substantially parallel to, the base 1. The operating spring unit 86 has drawn the operating member 23 clockwise about its pivot pin 80 until the two rollers 137, disposed on opposite sides of a channel shaped operating member 23, have engaged the surfaces 139 on the two parallel bell crank lever units of the carrier lever 81. This engagement of the rollers 137 with carrier member 105 provides a convenient and satisfactory means for defining the limit of motion of the operating member 23 in a clockwise direction; the rollers 137 also provide a means for resetting the carrier and latching levers following the opening of the breaker by the trip device, as will be explained in some detail later.

To close the breaker, the operating handle 25 is moved in a counter-clockwise direction (Fig. 4) about its pivot point 80; the pivot pin 100 which connects the operating member 23 with the spring unit 86 is likewise moved in a counter-clockwise direction about the pivot pin 80, and as soon as the line of action of the spring unit has moved over the central line of the link 84 the operating spring unit 86 exerts a force having a component biasing the knee pivot pin 94 upwardly from the base. This component increases in

magnitude as the operating handle is moved toward the closed position, and during normal operation of such a mechanism it reaches a magnitude sufficient to cause the knee pivot pin **94** to move upwardly some time before the operating handle **25** has reached the fully closed position. This upward movement of the knee pivot pin **94** and the resulting closing of the breaker—which might be undesirable due to insufficient spring tension to cause rapid, positive closing of the contacts—is prevented, however, by the engagement of the roller **123** of the latch **87** with the pivot pin **93**. As a result, the only effect of the counter-clockwise movement of the operating handle **25** is to change the line of action and tension the spring **99**. When the projection **127** engages the projection **129** on the latch **87**, the latch is moved to release the pivot pin **93** and the entire force of the spring **99** is made immediately available for causing upward movement of the knee pivot pin **94**. The breaker contacts are thus positively closed with a snap action. The circuit is established first between the arcing contacts, next the auxiliary main contacts engage, and finally the main contacts themselves are closed.

In order to be positively sure that the assemblage of switch members shall begin to move toward the closed position immediately following the release of the latch, a projection or kicker **140** (Fig. 13) is provided on the clamp member **45** of the central pole. This kicker **140** is adapted to be engaged by the projection **141** on the operating member **23** immediately following the release of the latch **87**, and just before the operating handle reaches the fully closed position.

The action of the kicker **140** is practically automatic. Considerable force must be exerted on the operating handle **25** in order to tension the operating spring and to release the latch **87**, and since the opposition to that force is suddenly released by the release of the latch the result is that the low inner handle moves more rapidly than the assemblage of switch members, thereby permitting the engagement of the projection **141** and the kicker **140**. Should the mechanism stick, it is not necessary to depend upon the suddenly released handle overtaking the assemblage of switch members in order to further accelerate its movement, the starting blow is then delivered substantially at the instant the latch is released. In either case, positive closing of the breaker is assured without making it necessary to supply an excessively large operating spring capable of starting the mechanism under any possible adverse condition. Once the mechanism is set in motion, the closing operation proceeds rapidly and more or less automatically, because any upward movement of the knee pivot point **94** progressively increases the effect of force component of the operating spring unit **86**, and the knee pivot pin **94** is, therefore, continuously accelerated upward, which acceleration is mechanically transferred to the contacts themselves.

With the contacts in the closed position (Fig. 3), it will be noted that the center line of the toggle links is generally parallel to the base **1** and the frame **41**. In addition, the line of action of the force exerted by the operating spring unit **86** on the operating member **23** is such as to bias that member counter-clockwise about its pivot **80**. The limit of this counter-clockwise movement of the operating member **23** is defined by the offset projections **143** on the frame **41**, which engage suitable protuberances **144** on the operating member **23**.

To open the circuit breaker contacts manually, the operating handle **25** (Fig. 3) is moved in a clockwise direction about the pivot pin **80** of the operating member **23**. When the operating handle **25** has been moved a short distance, the projection **145** on the operating member **23** engages the bridge portion **92** of the toggle link **83** and upon continued movement of the operating handle positively sets the knee of the toggle in motion toward the base **1**. At the time of engagement of the projection **145** with the toggle link **83**, the operating spring unit **86** has been moved across the center line of the link **84** where it exerts a component of force tending to move the knee pivot pin **94** toward the base. The movement of the various parts of the operating mechanism is now automatic and the contacts are opened with a snap action, the various parts returning to the position shown in Fig. 4. The latch **87** immediately moves under the effect of its bias spring **125** to latch the mechanism in the open position.

The operating mechanism, when in the fully closed position (Fig. 3) is substantially locked in. This results from the fact that the operating member **23** is biased counter-clockwise by the operating spring unit **86** into engagement with the frame **41**, the line of action of the spring unit being above (Fig. 3) the pin **80**. Furthermore, there is a slight clearance **146** between the bridging member **92** on the toggle link **83** and the projections **147** on the bifurcated section **76** of the central clamping member **45**, which permits the bridge member **95** of the toggle link **84** to abut against the bridge member **92**. Thus, since the carrier member **105** is rigidly restrained in position by the engagement of its bridging portion **108** with the bridging portion **112** of the latching lever **111**, the entire assemblage of movable parts is rigidly interconnected to lock the contacts in the closed position. This locking or holding of the contacts is of considerable assistance in maintaining uniform contact pressure and in preventing any burning of the engaging contact surfaces because, to be effective, the contact springs **55** and **66** must exert a substantially constant force biasing the engaging contact surfaces toward each other.

The spring **149** which is disposed about the pivot pin **42** engages the projection **151** (Fig. 10) on the rear portion of the latching lever **111** and biases that lever in a counter-clockwise direction about its pivot pin **115**; the transmitted force of the operating spring unit **86** likewise biases the latching lever **111** in a counter-clockwise direction. Both of these forces must be balanced by the trip device **7** but due to the large mechanical advantage of the latching lever, the actual restraining force which must be exerted by the trip structure is sufficiently small to permit the use of a very sensitive trip device.

When the breaker contacts are in the fully closed position (Fig. 3) and an overload or short circuit occurs in the circuit controlled by any one of the poles of the breaker, the latch engaging mechanism **117** is released by the trip device **7**, the latching lever **111** then moves counter-clockwise about its pivot **115** under the biasing influence of the spring **149** and the operating spring unit **86**, and the bridging portion **112** uncovers the cooperating bridging portion **108** of the carrier lever **105**. The carrier lever **105** is then

free to move about the pivot pin 109, under the biasing action of the force exerted by over-center spring unit 86 and the force of the contact springs 55 and 66 which is transmitted through the central switch member frame 45 and the links 83 and 84. It should be noted at this point, that although the knee pivot pin 94 is beneath the center line of the toggle links when in the fully closed position, it is sufficiently near the center line to reduce the downward component of the force exerted on the knee pivot pin 94 by the contact springs 55 and 66 to a value considerably less than the opposing upward component exerted by the over-center spring unit 86. Thus the breaker is biased to the closed position.

With the carrier lever 105 free to move, however, a simultaneous movement of the carrier lever 105 and the assemblage of switch members begins. Almost immediately the clearance 146 between the projections 147 and the bridging portion 92 of the toggle link 83 is taken up, this changes the line of action of the resultant force exerted by the contact springs 55 and 66 from along the center line of the link 83 to a line normal to the line connecting the pivot point of the assemblage of switch members (the pin 42) and the knee pivot pin 94. A very great increase in the downward component of force tending to move the knee of the toggle downward to the collapsed position results. Then, since the various links and springs are so proportioned that the downward component of force exerted by the springs 55 and 66 at the instant the link 83 engages the frame 45 of the central switch member and is caused to move clockwise about the pin 42, due to the taking up of the clearance 146, always exceeds the upward component exerted by the operating spring unit 86, the opening of the breaker contacts proceeds positively and automatically and is not affected by the position of the operating member 23.

Upon the completion of the automatic opening operation, the various parts of the mechanism are in the position shown in Fig. 5. It will be noted that the wedge projections 135 on the toggle link 84 have moved beneath the top portions 132 of the latch 89, thus effectively latching the contacts in the open position and preventing any bouncing of the contacts which might follow the opening of a heavy power circuit. Similarly, the side portions of the latching lever 111 have moved upwardly into contact with the projections 133 thus effectively limiting the upward movement of the latching lever 111 and at the same time acting to prevent any possible separation of the spring members 131.

As in the case of manual operation, the contacts are opened with a snap action due to the progressive acceleration of the moving parts as the toggle collapses. During the opening operation, the line of action of the operating spring unit 86 moves from a position above the center of the pivot pin 80 for the operating member 23 to a position below the center of the pin 80. The operating member 23 is then biased clockwise about the pin 80 and moved to a position substantially midway between the open and closed positions, the clockwise movement of the operating member being limited by the engagement of the rollers 137 with the surfaces 139 on the carrier member 105. This positioning of the operating handle provides a ready indicating means for showing when the breaker has been opened by the action of the trip device rather than manually.

As mentioned previously, the main moving contacts 52 and the cooperating stationary contact members 58 are the first to separate. This results from the engagement of the projections 61 with the edges of the downwardly extending portions 54 of the clamp member 45. The springs 66 are considerably longer than the springs 55, and a movement of the switch members sufficient to cause separation of the main contacts does not result in an appreciable decrease in the contact pressure exerted by the springs 66. Thus, at the time of the separation of the main contacts, the auxiliary main contact pressure and the arcing contact pressure are substantially undiminished. As the opening operation progresses, the pin 70 (Fig. 14) moves upwardly in the slot 65 and lifts the rear end of the body portion 62 of the central contact member, thereby causing the auxiliary main contacts 51 and 73 to separate. The body portion of each of the central contact members thus begin to rotate about the arcing portion 50, the entire force of the spring 66 being still exerted substantially undiminished on the engaging surfaces of the arcing contacts. This force is further intensified due to the fact that the rotation of the body portion 62 brings its line of action almost over the engaging arcing surfaces. When the pin 153 which is affixed to the upper end of the spring guide 68 reaches the projection 67 on the central clamping member 45, further rotary movement of the central contact member is prevented. The arcing contacts then separate, and the arc is established between the surfaces 50 and 75.

Following each opening of the circuit breaker in response to an overload or short circuit condition, it is necessary to restore the operating mechanism and the trip device to an operative condition. This is done by moving the operating handle 25 to the normal open position for manual operation. As the operating handle 25 and the connected operating member 23 are moved clockwise from the position shown in Fig. 5, the rollers 137 engage the surfaces 139 of the carrier member 105 and move that member counter-clockwise about the pivot 109. As shown particularly in Fig. 10, the bridging portion 108 which connects the two tail portions 110 of the carrier member 105 has a recess 154 therein. This recess is adapted to engage a projection 155 forming a part of the bridging portion 112 which connects the two side portions of the latching lever 111. The engagement of the bridging portion 108 and the projection 155 causes the counter-clockwise movement of the carrier lever 105 to be transmitted to the latching lever 111. As a result, the latching lever 111 is moved clockwise against its biasing spring 149, and when the operating member 23 has nearly reached its limit of travel in a clockwise direction, the carrier lever 105 and the latching lever 111 have been restored to the position shown in Fig. 4. The latch engaging mechanism 117 has meanwhile reengaged the trip device 7 and is retained in position thereby. The counter-clockwise movement of the carrier lever 105 causes a lateral displacement of the toggle link 84 with the result that the projections 135 are no longer over the latch 89. The latch 87 moves to the position shown in Figs. 4 and 5 immediately following the tripping of the breaker, a slight clearance 160 exists between the roller 123 of the latch 87 and the pin 93.

Should an attempt be made to close the breaker against an overload or a short circuit condition,

the latching lever 111 will be released after a predetermined time delay, or instantaneously depending upon the magnitude of the overload, exactly as described before. The carrier lever will likewise be released and will cause the mechanism to break toggle so as to open the circuit breaker contacts and to latch the structure in the open position independently of the operating handle. It is not possible, therefore, to hold the breaker closed against a short circuit or against a continued overload condition.

For the most satisfactory operation of the arc extinguishers 13, it is necessary that the top plate of each of the arc extinguishers be connected to the moving contact members at all times. This is accomplished in the two outer poles of the breaker by means of a copper strip 156 (Figs. 1 and 2) which is fastened at one end to the top plate of the arc extinguisher 13 and at the other end to the shunt 39. The top plate of the central arc extinguisher is electrically connected to the frame 41 of the operating mechanism 9 through a strip 157; the frame being electrically connected to the central shunt 39, as mentioned before.

It will be seen that I have disclosed a new improved circuit interrupter which possesses a number of novel and advantageous features. By the improved arrangement of the mechanism, I have made possible a considerable saving of space. In addition, I have provided means for positively setting the assemblage of switch members in motion during both the opening and the closing operation of the breaker, I have provided latch means for rendering the over-center spring inoperative to close the breaker except when a predetermined position has been reached by the operating member during the closing operation, I have provided latching means for positively latching the operating mechanism in the open position following each opening of the breaker in response to an overload or short circuit condition, and I have provided means for causing all of the latches to return to the operative position or to be resettable by means actuated by the operating member. Besides the novel features relating particularly to the operating mechanism, I have disclosed a new contact structure which is particularly suitable for use in this type of breaker and which is capable of maintaining the contact pressure at the arcing and auxiliary contacts of a circuit breaker employing a plurality of contacts which open at different times substantially constant up to the point of circuit interruption.

While in accordance with the patent statutes, I have given the foregoing details of a practical embodiment of my invention, it is to be understood that many of these are merely illustrative and that variations in their precise form will be desirable in many applications. I desire, therefore, that the language of the accompanying claims be accorded the broadest reasonable construction and that my invention be limited only by what is specifically stated in the claims and by the prior art.

I claim as my invention:

1. In a circuit interrupter, a movable switch member for opening and closing the circuit, and an operating mechanism for said switch member including a pair of toggle links, an operating member, and a spring means for operatively connecting the knee of said toggle links with said operating members, said operating mechanism having releasable latch means associated therewith for holding said switch member in one position, said operating member having means for engaging and releasing said releasable latch means when said operating member is moved to a predetermined position.

2. In a circuit interrupter, a movable switch member for opening and closing the circuit, and an operating mechanism for said switch member including a pair of toggle links, an operating member, a spring means for operatively connecting the knee of said toggle links with said operating member, a releasable latch means for holding said switch member in the open position, and latch releasing means actuable to release said latch means to permit said switch member to move to the closed position when said operating member is moved to a predetermined position during the closing operation.

3. In a circuit interrupter, a movable switch member for opening and closing the circuit, means biasing said switch member to the open position, electro-responsive means for holding said switch member in the closed position against said biasing means, and an operating mechanism for said switch member including a toggle linkage, an operating member, a spring for operatively connecting the knee of said toggle linkage with said operating member, releasable latch means for holding said switch member in the open position, and latch releasing means actuable to permit said switch member to move to the closed position when said operating member is moved to a predetermined position.

4. In a circuit interrupter, a movable switch member for opening and closing the circuit, an electro-responsive trip device, and an operating mechanism for said switch member including a pair of toggle links, an operating member, a spring for operatively connecting the knee of said toggle links with said operating member, a carrier member for releasably restraining the toggle links in an operative position, and means for positively setting said switch member in motion during the closing operation of the circuit interrupter, said trip device releasably engaging said carrier member to restrain said toggle links in the operative position.

5. In a circuit interrupter, a movable switch member, and an operating mechanism for moving said switch member to the open and to the closed position, said mechanism including an operating member, a unitary spring means which simultaneously holds said switch member in the closed position and biases said switch member to the open position when said operating member is in the closed position, releasable means for holding said switch member closed against said bias, means for positively setting said switch member in motion during the closing operation of the circuit interrupter, and means for positively setting said switch member in motion during the opening operation of the circuit interrupter.

6. In a circuit interrupter, a movable switch member for opening and closing the circuit, and an operating mechanism for moving said switch member to the open and to the closed position with a snap action, said mechanism including a toggle linkage, an operating member, an over-center spring unit for operatively connecting the knee of said toggle with said operating member, a movable carrier for supporting said toggle linkage, electro-responsive means for engaging said carrier to cause said spring unit to open the circuit in response to a predetermined electrical condition, independent of the position of said operating member, means associated with said operating member for positively setting said

switch member in motion during the closing operation of the circuit interrupter, and other means likewise associated with said operating member for positively setting said switch member in motion during the opening operation of the circuit interrupter.

7. In a circuit interrupter, a movable switch member for opening and closing the circuit, manually operable means for actuating said switch member, means biasing said switch member to the open position, an electro-responsive trip device for causing said biasing means to open the circuit upon the occurrence of predetermined electrical conditions, latching means for restraining said switch member in the open position following each operation of said trip device, and means engageable by said manually operable means for releasing said latch means to permit the closing of the interrupter.

8. In a circuit interrupter, a movable switch member for opening and closing the circuit, an operating mechanism including an operating member and an overcenter spring for moving said switch member to the open and to the closed position with a snap action, a trip device cooperating with said mechanism to cause the opening of the circuit, independent of the position of said operating member, upon the occurrence of a predetermined electrical condition, and latching means associated with said operating mechanism for restraining said switch member in the open position only when said switch member has been moved to the open position by an operation of the trip device.

9. In a circuit interrupter, a movable switch member for opening and closing the circuit, and an operating mechanism for moving said switch member to the open and to the closed position, said operating mechanism including a toggle linkage, an operating member, an overcenter spring unit for operatively connecting the knee of said toggle with said operating member, a carrier for supporting said toggle linkage, electro-responsive means for engaging said carrier to cause said spring unit to open the circuit in response to a predetermined electrical condition, independent of the position of said operating member, and means for latching said mechanism in the open position immediately following each opening operation resulting from a movement of said carrier.

10. In a circuit interrupter, a movable switch member for opening and closing the circuit, and an operating mechanism for said switch member including a pair of toggle links, an operating member, an overcenter spring for operatively connecting the knee of said toggle with said operating member, and a carrier supporting said toggle links and movable to open the circuit, in response to a predetermined electrical condition, independent of the position of said operating member, said operating member having means associated therewith for engaging a part of said operating mechanism and positively setting the knee of said toggle in motion during the opening operation of the circuit interrupter.

11. In a circuit interrupter, means movable to open and close the circuit, a releasable, pivotally mounted carrier, a pair of toggle links having one end of one link pivoted to said means to open and close the circuit and one end of the other link pivoted on said carrier, releasable restraining means for engaging one end of said carrier to hold it in the operative position, and operating means for moving said toggle links to actuate said means to open and close the circuit when said carrier is restrained in the operative position, said operating means including a means for engaging said toggle links and positively setting the knee thereof in motion during the opening of the circuit by said operating means.

12. In a circuit interrupter, a switch member movable to open and to closed positions, a bell-crank lever pivoted at a point intermediate its ends, a pair of toggle links pivoted to each other to form the knee of the toggle and having one end pivoted to said switch member and the other end pivoted to one end of said bell-crank lever, a handle member, a spring connected between said handle member and the knee of said toggle links for transmitting movement of said handle member to move said toggle links and thereby move said switch member from one position to the other, a releasable latch for holding the other end of said bell-crank lever in a set position, said latch being releasable in response to the current flow through the circuit interrupter, said toggle links being collapsible upon the release of said bell-crank lever to move the switch member to the open position, said handle member having means associated therewith for positively setting the knee of the toggle links in motion during the opening of the circuit by a movement of said handle.

13. In a circuit interrupter, separable contact means for opening and closing the electrical circuit through said interrupter, and an actuating means for said separable contact means, said actuating means including an operating member movable between two extreme positions to actuate said switch, a toggle linkage, one end of which is operatively connected to said separable contact means, an overcenter spring intermediate said linkage and said operating member for moving said separable contacts to the open and to the closed-circuit position with a snap action, and means forming a part of said operating member for engaging said toggle linkage, intermediate its ends, during the circuit opening operation, in order that said separable contacts may be positively moved to the open-circuit position in response to movement of said operating member in the event that said spring should become damaged or broken.

14. In a circuit interrupter, separable contact means for opening and for closing the electrical circuit therethrough, and actuating means for said contact means including an operating member movable between two extreme positions, means operable in response to movement of said operating member to open and to close said separable contact means, a member movable from a normal inoperative to an operative position to cause said mechanism to move said contact means automatically to the open circuit position, means biasing said member to said operative position, electro-responsive means normally retaining said member in said inoperative position, and means associated with said operating member for positively setting said actuating means in motion when said operating member is moved from one of said two positions to the other.

15. In a circuit interrupter, separable contact means movable to an open and to a closed circuit position, and actuating means for said contact means including an operating member movable between two extreme positions, means operable in response to movement of said operating member to move said separable contact means to said open and to said closed circuit position with a

snap action, a trigger member movable from a normal inoperative to an operative position to cause said mechanism to move said contact means automatically to the open circuit position with a snap action, means biasing said trigger member to said operative position, electro-responsive means normally retaining said trigger member in said inoperative position, and means associated with said operating member which engages said contact actuating means and positively sets that means in motion when said operating member is moved from one of said two positions to the other.

16. In a circuit interrupter, separable contact means movable to an open and to a closed circuit position, and actuating means for said contact means including an operating member movable between an open circuit and a closed circuit position, means, including an overcenter spring, one end of which is mechanically movable by movement of said operating member, operable in response to said movement of the operating member to move said separable contact means to said open and to said closed circuit position with a snap action, a trigger member movable from a normal inoperative to an operative position to cause said actuating means to move said contact means automatically to the open circuit position, irrespective of the position of said operating member, means biasing said trigger member to said operative position, electro-responsive means normally retaining said trigger member in said inoperative position, and means associated with said operating member which engages said contact actuating means and positively sets that means in motion when said operating member is moved from said closed circuit to said open circuit position.

17. In a circuit interrupter, separable contact means movable to an open and to a closed circuit position, and actuating means for said contact means including an operating member movable between an open circuit and a closed circuit position, means, including an overcenter spring, one end of which is mechanically connected to said operating member, operable in response to movement of said operating member to move said separable contact means to said open and to said closed circuit position with a snap action, a trigger member movable from a normal inoperative to an operative position to cause said actuating means to move said contact means automatically to the open circuit position with a snap action, irrespective of the position of said operating member, means whereby said trigger member is biased to said operative position by the reaction force of said overcenter spring, electro-responsive means normally retaining said trigger member in said inoperative position, and means forming a part of said operating member which engages said contact actuating means and positively sets that means in motion toward the open circuit position thereof when said operating member is moved from the closed to the open circuit position thereof.

18. In a circuit interrupter, separable contact means for opening and for closing the electrical circuit therethrough, and actuating means for said contact means including a toggle linkage formed by a pair of pivotally joined links, an operating member, and a spring for operatively connecting the knee of said toggle linkage with said operating member, at least one of said toggle links comprising a pair of flat, similarly proportioned link members disposed in substantially parallel planes which are spaced some distance from each other and mechanically interconnected by suitable tie means, the other of said toggle links being arranged for movement in the space between said spaced link members and being adapted to engage said tie means during the operation of said actuating means, said tie means thereby serving as a stop for defining the limits of motion of said toggle linkage in at least one direction, and means forming a part of said operating member for engaging said toggle linkage, intermediate its ends, during the circuit opening operation, in order that said separable contacts may be positively moved to the open circuit position in response to a movement of said operating member in the event that said spring should become damaged or broken.

19. In a circuit interrupter, separable contact means for opening and for closing the electrical circuit therethrough, operating means for said contact means including a part movable between two extreme positions and a manually engageable portion associated therewith, means operable in response to movement of said operating means to open and close said separable contact means, a tripping member movable from a normal inoperative to an operative position to cause movement of said contact means automatically to the open circuit position, said tripping member being biased to said operative position, electro-responsive means normally retaining said tripping member in said inoperative position, means associated with said operating means for positively setting said contact means in motion when said operating means is moved from closed position to open position, and the movement of said tripping member to operative position causing movement of said manually engageable portion of said operating means to an indicating position where further movement of said operating means is stopped by engagement with a portion of said tripping member.

20. In a circuit interrupter, separable contact means for opening and closing the electrical circuit therethrough, operating means for said contact means including a part movable between two extreme positions and a manually engageable portion associated therewith, an overcenter spring operable in response to movement of said operating means to normally both open and close said separable contact means with a snap action, a tripping member movable from a normal inoperative to an operative position to cause movement of said contact means automatically to the open circuit position, said tripping member being biased to said operative position, electro-responsive means normally retaining said tripping member in said inoperative position, means in addition to said overcenter spring for positively setting said contact means in motion when said operating means is moved from closed position to open position, and said tripping member when released by said electro-responsive means causing said overcenter spring to move and to bias said contact means toward open position and to bias said operating means to move to an intermediate indicating position where it is stopped by engagement with a portion of said tripping member.

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