May 10, 1938. J. G. JACKSON 2,116,791

CIRCUIT BREAKER

Filed Dec. 27, 1934 2 Sheets-Sheet 1

Fig. 1.

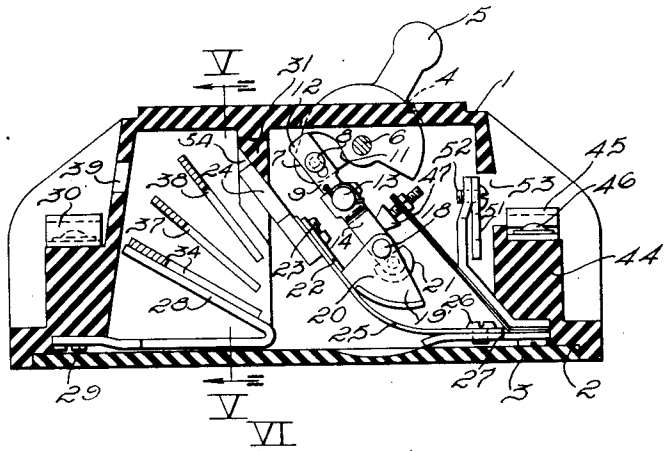
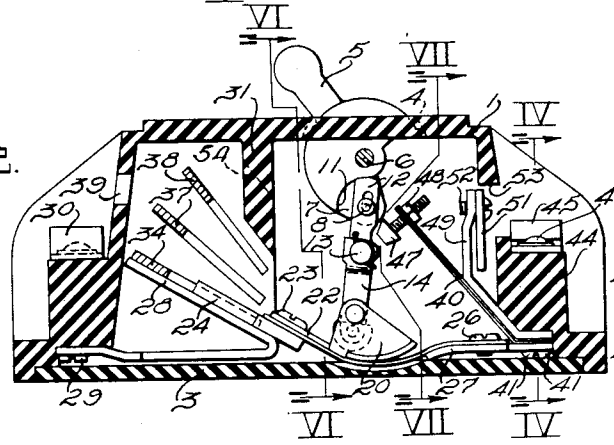


Fig. 2.



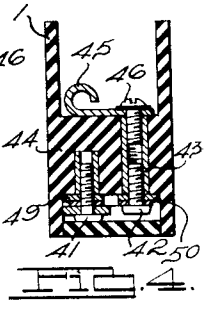


Fig. 4.

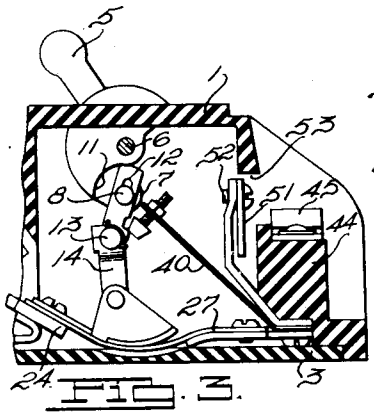


Fig. 3.

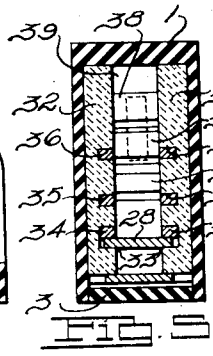


Fig. 5.

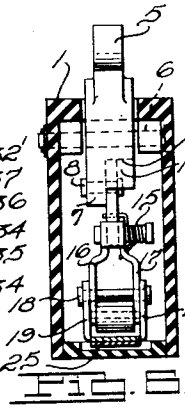


Fig. 6.

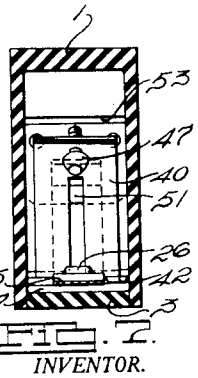


Fig. 7.

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CIRCUIT BREAKER

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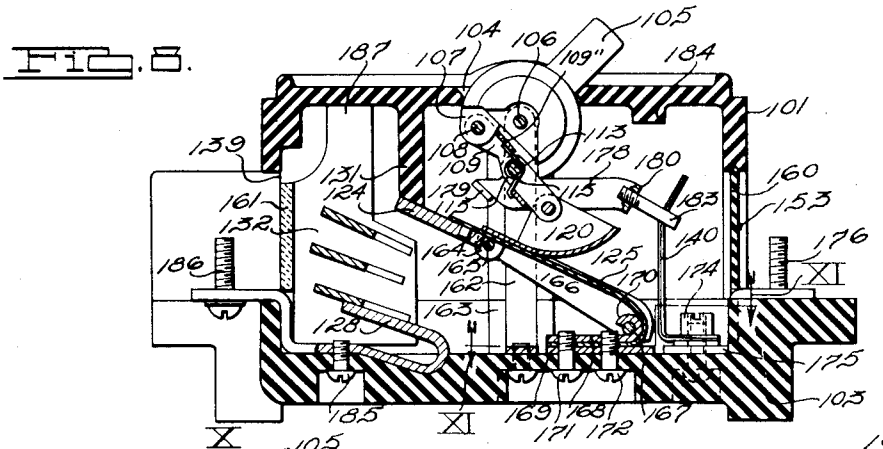
Fig. 8.



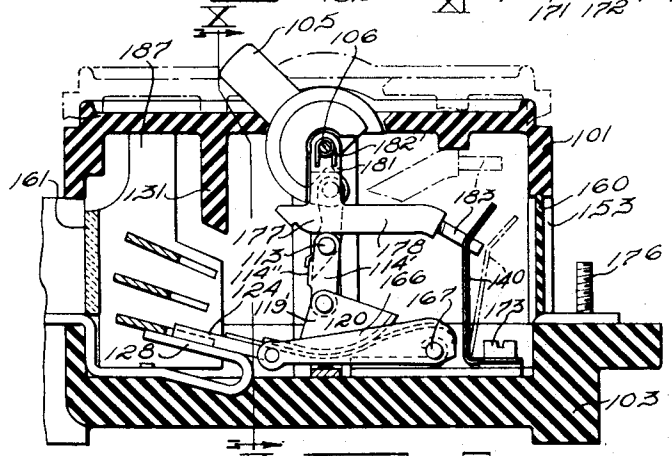


Fig. 9.

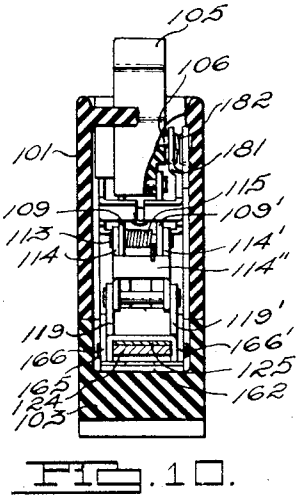


Fig. 10.

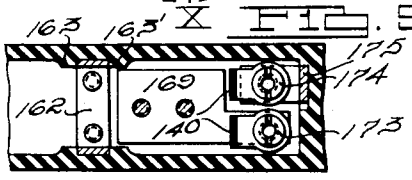


Fig. 11.

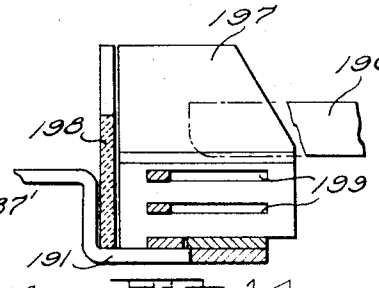


Fig. 14.

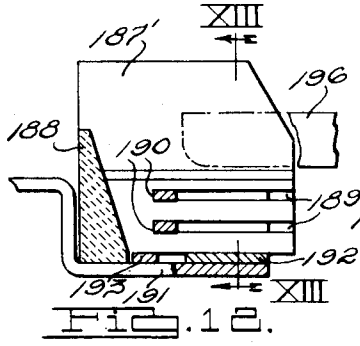


Fig. 12.

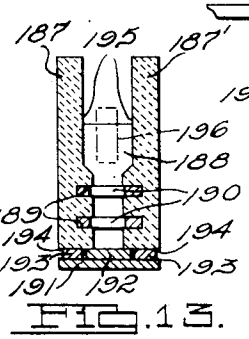


Fig. 13.

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Patented May 10, 1938

2,116,791

UNITED STATES PATENT OFFICE

2,116,791

CIRCUIT BREAKER

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Application December 27, 1934, Serial No. 759,353

21 Claims. (Cl. 200—116)

This invention relates generally to apparatus for making and breaking an electrical circuit and more particularly to circuit breakers having current responsive devices which operate to automatically break the circuit in response to predetermined current values.

One object of this invention is to provide a circuit breaker having an improved construction for producing both quick make and quick break contact operation.

Another object of this invention is to provide a circuit breaker which is to be automatically tripped by the action of a thermostatic member influenced by the current passing therethrough in which a shunt is provided for the thermostatic member to by-pass a portion of the current there-around.

Another object of this invention is to provide a circuit breaker which is to be automatically tripped by the action of a thermostatic member influenced by the current passing therethrough in which a shunt is provided for the thermostatic member to by-pass a portion of the current therearound, the resistance of the shunt being adjustable to permit the same thermostatic member to be utilized to interrupt the circuit at different predetermined values of circuit current.

Another object of this invention is to provide a circuit breaker which is to be automatically tripped by the action of a thermostatic member influenced by the current passing therethrough in which a shunt is provided for the thermostatic member to by-pass a portion of the current therearound, the resistance of the shunt being adjustable to permit the same thermostatic member to be utilized to interrupt the circuit at different predetermined values of circuit current and in which the shunt is arranged to limit the maximum value of current below which the circuit breaker will not respond to a safe value.

A further object of the invention is to provide an arc suppressor which will operate efficiently over a wide range of current values.

A still further object of the invention is to provide a sealable circuit breaker having an improved interlock between the cover and the operating handle to prevent removal of the cover while the circuit breaker is in the "on" position.

Another object of the invention is to provide a circuit breaker in which the contacts cannot be engaged by movement of the operating handle while the cover is removed.

A still further object of the invention is to provide a circuit breaker in which the initial force on the contact arm when the operating handle is moved toward "on" position is in a direction to further separate the contact members.

Further objects and features of the invention will be readily apparent to those skilled in the art from the following specification and the appended drawings illustrating certain preferred embodiments of the invention in which:

Figure 1 is a vertical longitudinal sectional view showing one form of the improved circuit breaker in "off" position.

Figure 2 is a view similar to Figure 1 with contacts engaged.

Figure 3 is a broken sectional view similar to Figure 1 showing the parts in initially tripped position.

Figure 4 is a sectional view taken on the lines IV—IV of Figure 2.

Figure 5 is a sectional view taken on the lines V—V of Figure 1.

Figure 6 is a sectional view taken on the line VI—VI of Figure 2.

Figure 7 is a sectional view taken on the line VII—VII of Figure 2.

Figure 8 is a vertical longitudinal sectional view of a circuit breaker illustrating another form of the invention with the parts in normal "off" position.

Figure 9 is a sectional view similar to Figure 8 showing the parts with the contacts in engaged position, the automatic trip position of certain of the parts, and a removal position of the cover, being shown in dotted lines.

Figure 10 is a sectional view taken on the line X—X of Figure 9.

Figure 11 is a sectional view taken on the line XI—XI of Figure 8.

Figure 12 is a vertical longitudinal sectional view through a modified form of arc suppressor.

Figure 13 is a sectional view taken on the line XIII—XIII of Figure 12, and

Figure 14 is a vertical longitudinal sectional view through a still further modification of the arc suppressor.

Referring now particularly to the device as illustrated in Figures 1 to 7 inclusive, the circuit breaker as shown comprises a box like body portion 1 having an open bottom 2 closed by plate 3. In the top of the body portion is provided a slot 4 through which extends operating handle 5, said operating handle being pivoted at 6 to the body portion. The operating handle is provided at its under side with a depending portion 7 carrying a pivot 8 on which is mounted a slotted member 9 forming one leg of a toggle. The operating member is cut away adjacent to the depending por-

tion 7, as shown at 10 in Figure 6, providing a curved abutment 11 against which the upper end 12 of the leg 9 is in sliding engagement when the handle is moved toward the "on" position. The member 9 is pivoted at 13 to the lower leg 14 of the toggle and a coil spring 15 is provided normally biasing the legs of the toggle toward "made" position. The lower leg 14 of the toggle comprises parallel arms 16 and 17 (Figure 6) rigidly joined together and pivoted intermediate their ends, as at 18, to the upstanding sides 19 and 19' of a member 20 and provided at the ends, removed from the knee of the toggle, with a pivoted counter-weight 21. The member 20 also comprises a base portion 22 rigidly connected as by a stud 23 to a contact 24 and one end of a flexible contact arm 25. The other end of the contact arm 25 is rigidly secured, as by a stud 26, to a conducting member 27.

A stationary contact member 28 is secured to the body portion of the circuit breaker as by a stud 29 which extends into a conducting sleeve to which is bolted a conductor lug 30 in a manner similar to that to be hereinafter described in Figure 4.

From the underside of the top of the body portion 1 extends a plate-like member 31 having a slot 54 therein into which the contact member 24 extends in its "off" position.

The base portion 22 of the member 20 at its end remote from the stud 23 is curved away from the contact arm on a wide radius so as to engage a relatively large area of said arm when the contacts are in engaged position, thus avoiding a localized point of strain on the contact arm.

Upon either side of the contact member 28 are closely disposed plates 32 and 32' of insulating material, one form of which may be composed of asbestos fibre bonded with magnesite cement. These plates are notched as at 33 to enclose the side edges of the contact 28 so as to lie closely adjacent to the path of movement of contact 24. Located within the slot 33 and resting on the contact surface of the contact 28 is a U-shaped magnetic member 34 the legs of which extend wholly within the slots 33 upon either side of the path of movement of the contact 24. At spaced intervals along the path of movement of contact 24 slots 35 and 36 are provided in each of the plates 32, 32' and in these slots are imbedded magnetic members 37 and 38 in a similar manner to that shown at 34. These magnetic members are in a plane substantially parallel to the plane of the contact member 24 when it is adjacent their position. The number of these magnetic members 34, 37 and 38 will vary with the size and rating of the device and any of them may be omitted although it is preferred that they appear in the general location as shown. In the end wall of the body portion 1 adjacent the arc suppressor vents 39 are provided.

To the conducting member 27 is attached one leg of a U-shaped bimetallic member 40 as by a stud 41. The other leg of member 40 is secured by a stud 42 to a conducting sleeve 43 extending through the portion 44 of the body portion 1 and to the upper end of which a conductor lug 45 is secured by a stud 46.

It is thus seen that current passes through the device from lug 45 through sleeve 43 to one leg of the bimetallic member through this leg and the other leg of the bimetallic member to the conducting element 27, thence through the flexible contact arm 25, contact 24, contact 28 and stud 29 to lug 30 by means of a conducting sleeve arrangement such as that shown at 43 in Figure 4.

To the free end of the bimetallic element 40 is attached a striker 47 having a threaded shaft cooperating with a threaded hole in the member 40 and maintained in adjusted position by the nut 48. The striker is mounted in such position that upon movement of the member 40 under the action of a predetermined current value it will engage against the knee of the toggle and break it to permit the contacts to be separated under the action of the energy stored in the spring contact arm 25.

The shunt for the bimetallic member comprises two arms 49 and 50 attached to the ends of the legs of the bimetallic member 40 by means of the studs 41 and 42 aforesaid. These arms are separated from each other and are adapted to be electrically connected at their free ends by the U-shaped link 51 having its legs secured to the arms 49 and 50 by means of studs 52. The side of the body portion 1 is provided with an opening 53 which permits access to the link 51 so that it may be changed for a different link having different resistance. The arms 49 and 50 of the shunt are formed with a predetermined resistance so that regardless of the low resistance of the bridging link 51 the breaker will still respond to a desired predetermined value of current. Thus if a large copper link were secured to the arms 49 and 50, the resistance of the shunt would still be such that the current flowing through the bimetallic member 40 would give the desired maximum rating for the breaker. With any greater resistance link across the arms it can readily be seen that a greater proportion of the current will pass through the bimetal 40 and hence the breaker will operate at lower current values. A selection of links 51 of predetermined resistivity affords a desirable variation in the rating of the breaker without changing the bimetal 40 and without breaking the seal in the breaker enclosure. It can readily be seen that a shunt arranged in this fashion has desirable safety features since under the worst possible conditions when a connecting link of practically no resistance connects the arms 49 and 50 the breaker will still operate at a safe current value due to the resistance of the arms 49 and 50.

When a shunt link is connected across the arms 49, 50 there will be heat generated in the shunt by the passage of current therethrough which will affect the member 40 through radiation. The movement of member 40 will then be due to a resultant of the heat generated therein by its own current and that radiated from the shunt.

From the position of the parts in Figure 1 it can readily be seen that the initial movement of the operating handle counter-clock-wise toward "on" position causes a force to be directed through the toggle legs 9 and 14 and member 20 upon the contact arm 25 above its effective center of rotation, thus tending to move the contact 24 upward away from the stationary contact 28. The contact 24 is, however, restrained from movement by the upper surface of the groove 54 whereupon the contact arm 25 is flexed until the line of force through the toggle comes below the effective center of rotation of said arm whereupon the energy stored in the spring arm 25 by its flexure is expended by snapping contact 24 into engagement with the contact 28 as shown in Figure 2, thus providing a quick "make".

When the contacts are to be manually tripped

to "off" position the operating handle 5 is moved in a clock-wise direction whereupon the link 9 through its frictional engagement at 12 with the curved surface 11 of the operating handle is rotated in a clock-wise direction about the pivot 8, thus breaking the knee of the toggle at the pivot 13 whereupon the contact 24 quickly moves to its "off" position under the action of the spring contact arm 25, thus providing a quick break. Under the action of the spring 15 the toggle arms 9 and 14 will thereafter be straightened out into "made" position as shown in Figure 1.

The action of the automatic trip on over-load is shown in Figure 3. Here the bimetallic thermostatic member 40 has become heated due to an over-load current and has moved in a counter-clock-wise direction so that the striker 47 has engaged the knee of the toggle and moved it past its center or "made" position so that it will then collapse under the force of the spring contact arm 25 and separate the contacts. It is noted that this trip is entirely independent of the operating handle, thus providing for trip free of the handle operation.

The theory of operation of the magnetic members 34, 37 and 38 is thought to be a drawing of the arc toward their closed ends and a forcing of it into an elongated path curving in and out around the closed ends of these members, thus greatly elongating the path of the arc between the contact members in their separated position. In conjunction with this elongation the suppressor plates 32 and 32' are mounted closely adjacent the path of movement of the movable contact 24 and hence operate to confine the arc and provide cooling surfaces to aid in quickly quenching the arc. It is noted that the magnetic member 34 rests directly on the contact member 28. It, therefore, exerts its effect on the arc at the very moment of inception of the arc. The suppressor of which one embodiment is shown in connection with the circuit breaker illustrated in Figures 1 to 7 inclusive, is highly efficient in operation for all current values and produces a result not obtainable for either the plates or the magnetic members alone. The stacked magnetic plates by themselves work fairly well with high or short-circuit current values, however, these currents are not the only ones which the breaker is required to interrupt, but in its ordinary functioning will also operate to interrupt normal and subnormal current values and it is at these values that the plates 32 and 32' are peculiarly effective since at these values the magnetic effect of the stacked plates has only a small effect upon the path of the arc and does not serve to appreciably elongate it. This is believed to be a disadvantageous feature of the stacked magnetic plate type of arc suppressor as while it functions fairly well with very high current values, it is not designed for and will not satisfactorily interrupt the normal and underload current values. The plates 32 and 32' will of themselves function with acceptable efficiency for the lower current values as they here confine the arc and act to cool the arc stream. However, at the very high or short-circuit current values the plates 32 and 32' alone will not function to quench the arc with sufficient rapidity due to the fact that they do not operate to elongate the path of the arc. The form of suppressor illustrated as a part of the breaker of Figures 1 to 7 inclusive operates with greater efficiency at shorter time intervals at every current value than either the stacked magnetic plates or the insulating suppressor plates taken alone and hence operates with a high efficiency over the entire range of currents to be interrupted from sub-normal to short-circuit currents.

While the arc suppressor as herein illustrated may be used with any type of circuit interrupting device it is peculiarly well suited for use with circuit breakers having thermostatic over-load tripping devices as it considerably lessens the danger of burning out the thermostatic current responsive element. Heretofore the period running from the inception of an over-load to the final interruption of the current has been divided into three roughly equal periods; the first being taken up in the self-heating of the thermostatic element by the over-load current; the second period being taken by the operating mechanism before the contact tips separate; and the third period being the duration of the arc before it is quenched. As the over-load current is flowing during all three of these periods, there has been considerable danger of burning out the thermostatic element and it has been necessary to use a relatively heavier element to guard against destruction. By using the suppressor herein illustrated the time of the third period is very greatly reduced, thus providing either a greater safety factor in the same sized current responsive thermostatic element or permitting the use of a lighter thermostatic element with the same safety factor.

In Figures 8 to 11 inclusive a modified form of circuit breaker is shown. Parts similar to those illustrated in the breaker of Figures 1 to 7 inclusive are here given the same numerals in the one hundred series. The breaker as herein shown embodies a base 103 having a cover 101 which is sealable thereto to prevent unauthorized access to the breaker mechanism. In the top of the cover 101 is a slot 104 through which extends an operating handle 105. At opposite ends of cover 101 are provided slots 139 and 153. Slot 153 is sealed off by means of a sliding cover 160 received in grooves in the sides of slot 153. Slot 139 is partially sealed by an insulating plate 161 forming a part of the arc suppressor structure. To the base 103 is bolted a U-shaped bracket 162. Between the arms of said bracket at its upper end the operating handle 105 is pivoted as at 106. The arms of the bracket 162 extend slightly beyond the sides of the operating handle 105 and are received within guides 163 and 163' forming between them guiding grooves on opposite sides of cover 101. This arrangement prevents removal of the cover except in a direction at right angles to the plane of the base 103. The handle 105 is provided with a depending lug 107 at one side thereto of a thickness less than that of the handle member. On opposite sides of lug 107 are pivoted at 108 parallel arms 109 and 109' rigidly connected by transverse web 109'' and forming an upper leg of a toggle. The arms 109 and 109' are pivoted at their lower ends at 113 to parallel arms 114 and 114' rigidly connected by transverse web 114'' and forming the lower leg of the toggle. A coil spring 115 wrapped around the pivot 113 has its ends engaging the transverse webs 109'' and 114'', thus biasing the legs of the toggle to their "made" position. At their lower ends arms 114 and 114' are pivoted to the upstanding sides 119 and 119' of member 120. Member 120 is provided below the sides 119 and 119' with a curved portion engaging a flexible contact arm 125 in the same manner as in the breaker disclosed in Figures 1 to 7 inclusive. The opposite end of

member 120 is provided with depending flanges 164 which are pivoted at 165 to the upper ends of parallel arms 166 and 166'. The lower ends of arms 166 and 166' are pivoted at 167 to a member 168. Mounted on the upper face of base 103 is a conducting member 169. An extension of contact arm 125 extends around the curved end portion 170 of member 168 and is secured between conductor 169 and member 168 by means of studs 171 and 172. The opposite end of contact arm 125 extends between the arms 166 and 166' and is restrained in position between pivot 165 and the lower face of member 120. To this end of the contact arm a contact 124 is attached by means of a rivet or other securing means.

One leg of a U-shaped bimetallic member 140 is attached to conductor 169 by a bolt and nut connection 173. The other leg of said U-shaped bimetallic member is attached by means of a bolt and nut arrangement 174 to a conductor 175 which extends through a double bend beneath the sliding cover 160 to the outside of the circuit breaker where it may be attached by means of bolt 176 to a lug or other conductor attaching means.

A member 177 formed generally in the shape of two spaced parallel inverted T-shaped portions 178 has webs 179 and 180 extending between the ends of the cross arm of the T. The web 179 is slanted at an acute angle to the arm of the T. This web 179 may be formed as a solid connection between the portions 178 but is illustrated as being separated, this being a form which may be constructed more easily than the solid web. The vertical legs 181 of the double T-shaped member are located within the arms of the bracket 162 and are rotatedly mounted upon the pivot 106. Two small coil springs 182 and 182' urge the member 177 to rotate in a counter-clock-wise direction. The member 177 is held against rotation by means of an adjustable extension 183 held within the slot in the bimetallic member 140. In its released position member 177 bears against lug 184 extending from the lower face of the top of the cover 101 as shown in dotted lines in Figure 9. A stationary contact member 128 is secured to base 103 by means of a stud 185 and extends beneath the back suppressor plate 161 to the outside of the circuit breaker where it may be attached by means of bolt 186 to a lug or other conductor securing means.

Clearance is provided between arms 166 and the arms of the bracket 162 and also between the member 178 and the legs of the toggle for insulating purposes to prevent a shunting of the current about one leg of the bimetal. The handle member is formed of insulating material and this arrangement secures the desired insulation of the operating part. However, if desired, thin insulating sheets may be secured between arms 166 and the upright legs of bracket 162 and also between the members 178 and the legs of the toggle to more surely insulate the operating parts and prevent a current path therethrough.

With the breaker in "on" position as shown in Figure 9, if the cover is removed in the manner shown in dotted lines at top of said figure the guides 163 and 163' permit movement only at right angles to the base, this causing sufficient movement of handle 105 against the edge of its slot to cause the knee of the toggle to engage the under surface of web 179, thus breaking the toggle and causing the operating mechanism to assume its "off" position as in Figure 8 and preventing removal of the cover while the circuit breaker is in "on" position. With the cover removed it is impossible to operate the breaker into "on" position by means of the operating handle since the initial movement thereto causes actual upward movement of the contact 124, this contact no longer being restrained from such movement by plate 131. This movement of the contact causes such a change in the effective center of rotation of the contact arm 125 that the line of force through the toggle always remains above such center of rotation and hence the contact will not snap into engaged position. The upward movement of the contact occurs about the pivot 165, the arms 166 being held from further upward movement by the positive engagement of their other ends with the contact plate 169 and the contact arm 125 being restrained from upward movement relative thereto by the under surface of member 120.

The suppressor shown in this circuit breaker is very similar to that disclosed in the circuit breaker illustrated in Figures 1 to 7 inclusive with the exception of the back plate 161 which extends across between the side plates 132. These side plates are, however, shown as being of a lesser height and having extensions 187 of a length conforming to the under face of the top of the cover member 101 for securing purposes.

The operation of the circuit breaker shown in Figures 8 to 10 inclusive is as follows:

With the parts in the position shown in Figure 8 the breaker is in normal "off" position. Rotation of handle member 105 in a counter-clock-wise direction causes a force to be exerted upon the flexible contact arm 125 in a line above its effective center of rotation. This tends to raise the contact 124 still further away from contact 128. A plate member 131 extending from the under side of the top of the cover 101 restrains the contact from further upward movement, hence the contact arm 125 is flexed until the line of force through the toggle comes below the effective center of rotation of arm 125 whereupon the contact 124 is snapped into engagement with contact 128, thus securing a quick make in the same manner as in the breaker of Figures 1 to 7 inclusive. In this movement due to the flexure of arm 125 the knee of the toggle slips past the web 179 without contacting therewith. The parts then assume the position shown in full lines in Figure 9. When it is desired to manually open the circuit breaker the handle 105 is rotated in clock-wise direction from the position shown in Figure 9 whereupon the toggle moves upwardly and to the left until the knee strikes the under surface of web 179 whereupon the toggle linkage is broken and contact 124 is quickly separated from contact 128 under the force of the energy stored in the spring contact arm 125.

The automatic operation of the circuit breaker is as follows:

When an over-load current flows through the bimetallic element 140, this element becomes heated and bends to the right as shown in dotted lines in Figure 9 releasing extension 183 and permitting member 177 to rotate in a counter-clock-wise direction under the action of the springs 182 and 182'. Due to this rotation the under surface of web 179 strikes the knee of the toggle and breaks the linkage so that contact 124 quickly separates from contact 128 regardless of the position of the operating handle. Extension 183 is adjustably carried on web 180 to permit adjustment of the amount of move-

ment of the bimetallic member 140 necessary to release the tripping member 177. When the device has been automatically tripped by an overload into position shown in dotted lines in Figure 9, it is re-set by turning the operating handle 105 to its extreme right-hand position whereupon the handle will positively engage the legs 181 of the member 177 and positively rotate it in a clock-wise direction as shown, whereupon the extension 183 will slide down the inclined plane of the upper end of the bimetallic member 140 and again engage with the under surface of the slot therein. It should, of course, be obvious that a shunt 49 similar to that disclosed in Figures 1 to 7 inclusive may also be used across the legs of the bimetallic member 140 to function in a similar manner.

In Figures 12 and 13 a slightly modified form of arc suppressor is shown. Herein the side walls 187 and 187' and end wall 188 are formed as a unitary molded piece. Slots 189 are provided extending from the front ends of the side walls 187 and 187' and within these slots are arranged the U-shaped magnetic members 190. A stationary contact arm 191 has mounted directly upon its upper face a contact 192. Surrounding this contact 192 on three sides is a U-shaped magnetic member 193. The suppressor structure in this form rests upon the contact arm 191, the side plates 187 and 187' of the suppressor being cut out as at 194 to provide clearance for the contact and magnetic member 193. The upper portions of side walls 187 and 187' are cut out on their inner faces as shown at 195 to provide additional clearance for contact blade 196 to guard against leakage of current through said side walls. The movable contact 196 in this form is shown as a straight bar having a reciprocatory movement.

In Figure 14 another modified form of arc suppressor is shown similar to that shown in Figures 12 and 13 except that the side walls 197 and back plate 198 are here separately formed and are joined together in position upon the stationary contact arm. The slots 199 in side walls 197 do not in this arrangement extend to the front edge of the side walls but are contiguous in length with the side faces of the magnetic members.

It is obvious that many other variations may be made in the form of the arc suppressor, it being only necessary to provide in some manner parallel insulating faces closely adjacent to the path of the movable contact and having U-shaped magnetic members with the inner faces of the legs thereof also closely adjacent to the path of the movable contact.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. In a circuit controlling device, a stationary contact, a movable contact, a flexible contact arm carrying said movable contact and normally biasing it to open circuit position, an operating handle, a toggle linkage inter-connecting said handle and said arm, the line of force through said toggle upon initial movement of said handle being directed above the effective center of rotation of said arm thus tending to further separate said contacts.

2. In a circuit controlling device, fixed and movable contacts, flexible means carrying said movable contact and normally urging it toward open position, fixed means limiting the open movement of said movable contact, and means for actuating said movable contact, operating by movement in a single direction to initially urge said contact toward further separated position and flex said first mentioned means, the flexure of said means then snapping said contact into closed circuit position.

3. In a circuit controlling device, relatively movable contacts, a flexible contact arm for one of said contacts stressed to urge it toward open position, an operating handle and a toggle linkage between said operating handle and said flexible arm for engaging the contacts, the line of force through said toggle moving from above to below the effective center of rotation of said arm upon movement of the operating handle to produce a quick make.

4. In a circuit controlling device, a stationary contact, a movable contact, a flexible contact arm carrying said movable contact and normally biasing it to open circuit position, an operating handle, a toggle linkage interconnecting said handle and said arm, the line of force through said toggle upon initial movement of said handle being directed above the effective center of rotation of said arm and tending to further separate said contacts, means restraining said movable contact from actual further movement and causing flexure of the contact arm until the line of force through the toggle passes below the effective center of rotation of said arm, whereupon the movable contact is snapped into closed circuit position.

5. In a circuit controlling device, a stationary contact, a flexible contact arm carrying a movable contact at one end, the opposite end of said arm being fixed, said arm normally biasing the movable contact toward separated position, means to actuate said arm to snap said contacts into engagement with quick make, said actuating means holding the contacts engaged, the release of said actuating means permitting quick separation of the contacts under the bias of said arm.

6. In a circuit breaker, a stationary contact, a flexible contact arm carrying a movable contact at one end, the opposite end of said arm being fixed, said arm normally biasing the movable contact toward separated position, means to actuate said arm to snap the contacts into engagement with a quick make, said actuating means holding the contacts engaged, the release of said actuating means permitting separation under the bias of said arm, means for manually releasing said actuating means and means for automatically releasing said actuating means in response to an over-load.

7. In a circuit breaker, a stationary contact, a contact arm carrying a movable contact at one end and means including a toggle for actuating said contact arm, a normally stationary pivoted member having a striker portion thereon, the knee of the toggle passing said portion without contact when moving toward "on" position, the knee of said toggle engaging said portion when the actuating mechanism is initially manually moved toward "off" position to break the toggle and insure a quick break, and means for automatically moving said member and striker portion in response to an overload to break the toggle.

8. In an automatic electric circuit breaker, a stationary contact, an operating unit comprising a movable contact, a contact supporting arm and

mechanism for moving said arm to open and close the circuit through the breaker and a cover for said breaker carrying a part adapted to engage a movable part in said unit to provide for closing of the circuit through the breaker, removal of said cover and the part carried thereby rendering said mechanism ineffective to move said arm to close the circuit.

9. In an automatic electric circuit breaker, a base, relatively movable contacts mounted on said base, manually operable mechanism for opening and closing said contacts carried by said base, current responsive means for automatically opening said contacts carried by said base, a cover mounted over said parts and secured to the base, and means preventing operation of said mechanism to close the contacts when the cover is removed.

10. In a circuit controlling device, a base, a stationary contact, a movable contact, operating mechanism for said movable contact, a removable cover cooperable with said base to seal the breaker, said operating mechanism being inoperable to close the contacts unless the opening movement of the movable contact be limited and means on said cover for limiting movement of said movable contact whereby the mechanism cannot be operated to close the contacts when the cover is removed.

11. In a circuit breaker, a base, a stationary contact mounted on said base, a movable contact, a flexible contact arm mounted on said base carrying said movable contact at one end, operating mechanism for said movable contact, a manually operable handle actuating said mechanism, spaced arms mounted on said base supporting said mechanism and handle, a removable cover cooperable with said base to seal the breaker, guides on said cover receiving said arms to provide for longitudinal movement of said cover, the handle being interlocked with the cover to prevent such movement of the cover while the contacts are engaged.

12. In a circuit breaker, automatic means for tripping said breaker including a series connected thermostatic member, and a shunt for said member comprising separated arms of predetermined resistance and an interchangeable link bridging said arms, the resistance of said arms being such that with a link of no appreciable resistance the shunt will not by-pass more than a predetermined portion of the circuit current.

13. In a circuit controlling device, stationary and movable contacts, a contact arm carrying said movable contact and biased to separated position, an operating handle, a toggle interconnecting said handle and arm, said toggle having a frictional engagement with said handle, whereby initial movement of the handle toward "off" position will break the toggle to cause snap actuation of the contact arm under the action of said bias.

14. In a circuit controlling device, stationary and movable contacts, a contact arm carrying said movable contact and biased to separated position, an operating handle, a toggle having one leg connected to the contact arm and its other leg having a pin and slot connection with the handle, and an abutment on the handle slidably engaging said other leg, whereby upon initial movement of the handle toward "off" position the friction of said slidable engagement will break the toggle to cause snap actuation of the contact arm under the action of said bias.

15. In an automatic electric circuit breaker, separable contacts, means for effecting automatic separation of said contacts including current responsive means, and a shunt for said current responsive means comprising fixed and variable portions, the resistance of the fixed portions being such that when the resistance of the variable portion is negligible the shunt will not by-pass more than a predetermined portion of the circuit current.

16. In an automatic electric circuit breaker, separable contacts, means for automatically separating said contacts including a series connected bimetallic member, and a shunt for said member comprising fixed and variable portions, the resistance of the fixed portion being such that when the resistance of the variable portion is negligible the shunt will not by-pass more than a predetermined portion of the circuit current.

17. In an automatic electric circuit breaker, a sealable enclosure, separable contacts and means for automatically separating said contacts within said enclosure, said means including a series connected bimetallic member, and an adjustable shunt for said member accessible from the exterior of the enclosure without disturbing said seal.

18. In an automatic electric circuit breaker, a sealable enclosure, separable contacts and means for automatically separating said contacts within said enclosure, said means including a series connected bimetallic member, shunt terminals for said member accessible from the exterior of the enclosure, and interchangeable links of predetermined resistance connectable across said terminals to by-pass a portion of the circuit current around said member.

19. In an automatic electric circuit breaker, separable contacts, means for automatically separating said contacts including a series connected thermostatic member, and a shunt for said member comprising an open circuit fixed portion having a predetermined resistance, and interchangeable elements of predetermined resistance connectable to close the shunt circuit and by-pass a portion of the circuit breaker current around said member, the resistance of the fixed portion being such that with an element of negligible resistance the shunt will not by-pass more than a predetermined portion of the circuit current.

20. In an automatic electric circuit breaker, a sealable enclosure, separable contacts and means for automatically separating said contacts within the enclosure, said means including a series connected bimetallic member, a partial shunt of predetermined resistance for said member within the enclosure and having terminals accessible from the exterior of the enclosure, and interchangeable links of predetermined resistance connectable across said terminals to complete the shunt circuit, the resistance of said partial shunt being such that a link of negligible resistance the shunt will not by-pass more than a predetermined portion of the circuit current.

21. In an automatic electric circuit breaker, separable contacts, automatic means for separating said contacts including a series connected U-shaped bimetallic member, spaced arms of predetermined resistance connected to the legs of said member, and interchangeable links of predetermined resistance connectable across said arms to complete a shunt circuit for said member, the resistance of said arms being such that with a link of negligible resistance the shunt will not by-pass more than a predetermined portion of the circuit current.

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