

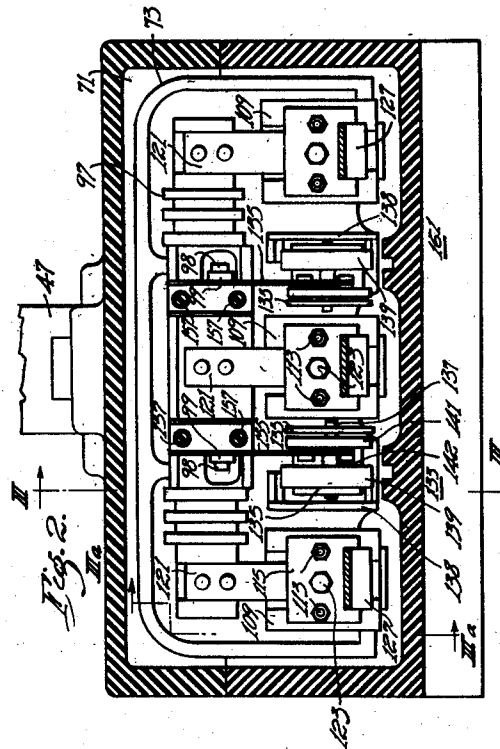
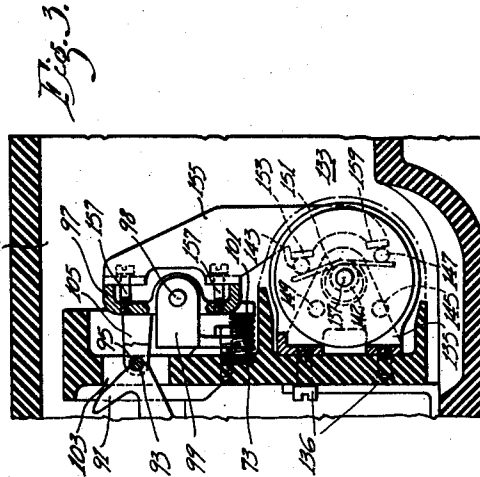
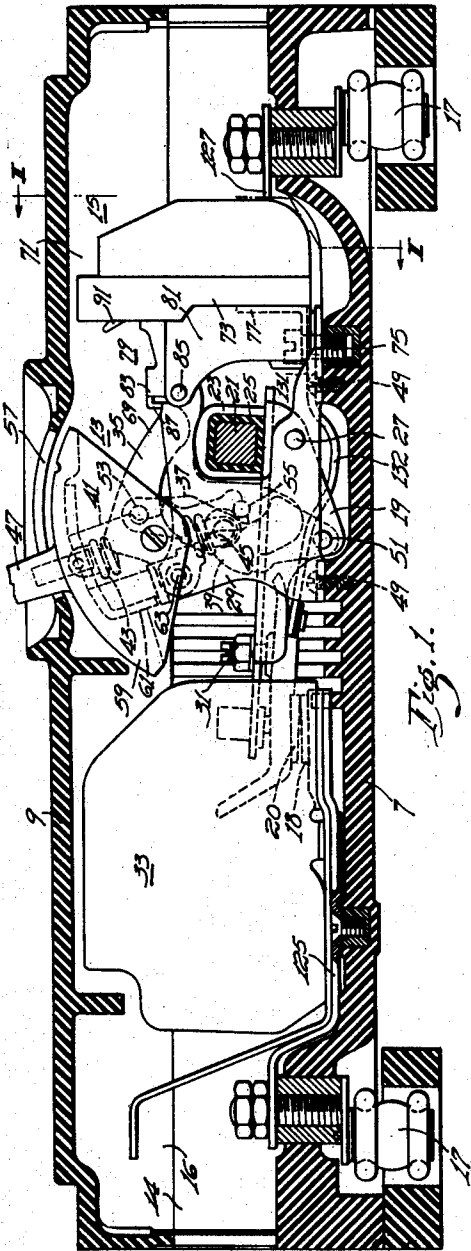
Dec. 19, 1950

G. G. GRISSINGER ET AL
SHOCKPROOF CIRCUIT INTERRUPTER

2,534,906

Filed Dec. 11, 1943

3 Sheets-Sheet 1



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Fig. 3a.

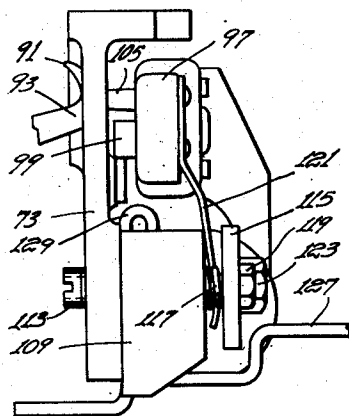


Fig. 9.

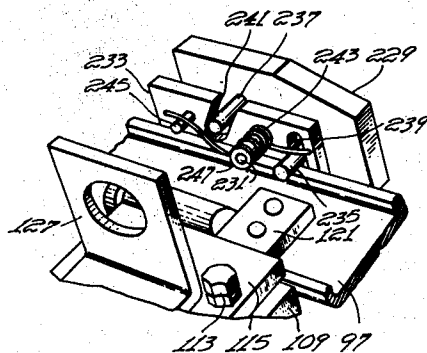


Fig. 4.

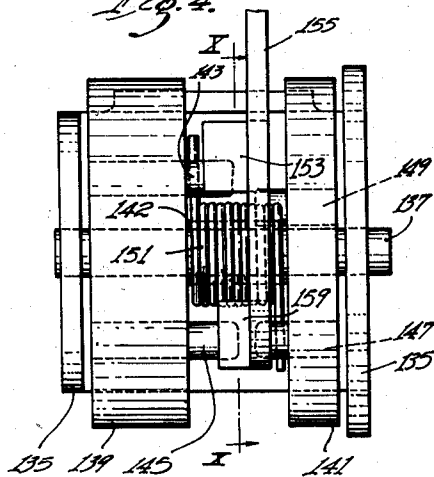
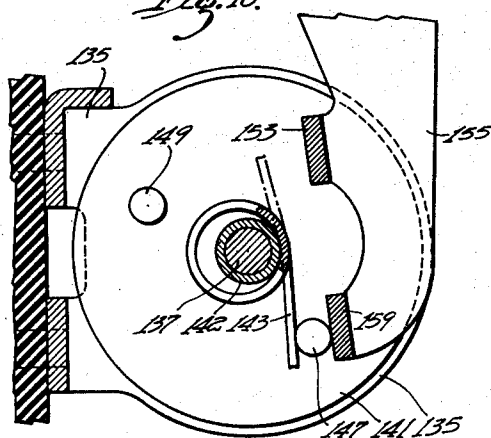


Fig. 10.



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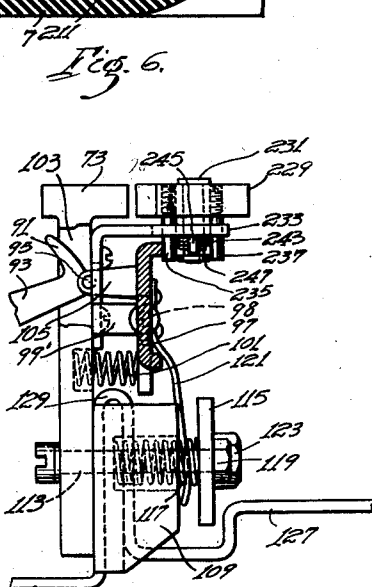
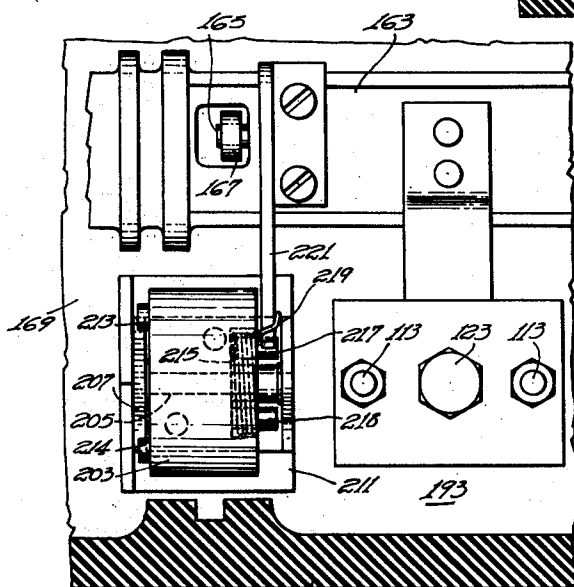
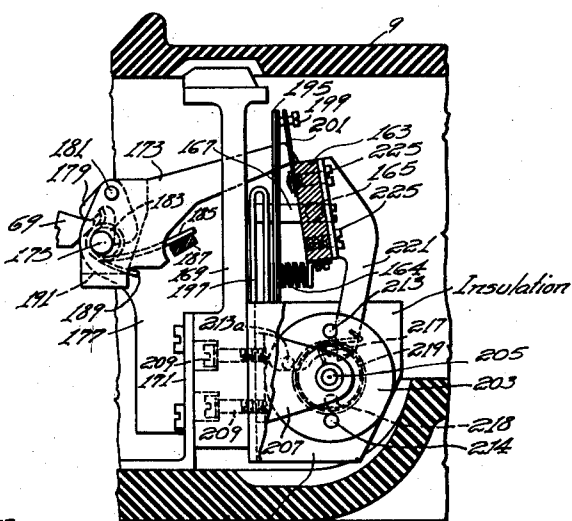
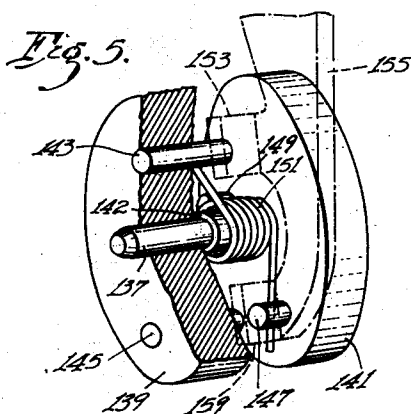
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2,534,906

SHOCKPROOF CIRCUIT INTERRUPTER

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Application December 11, 1943, Serial No. 513,868

20 Claims. (Cl. 200—109)

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This invention relates to circuit interrupters, and more particularly to air circuit breakers of the trip free type provided with a trip device automatically operable in response to predetermined overload conditions to trip the circuit breaker open irrespective of the position of the closing means.

In certain installations of circuit breakers, the breakers and the trip devices are often subjected to shocks of such magnitude as to cause movement of the trip mechanism and undesirable opening of the breaker. In such cases the circuits controlled by the breakers are opened and remain open until an authorized person recloses the affected breakers. Under such conditions serious consequences may result from such unwanted interruption of the circuits controlled by the breakers so affected.

An object of the invention is the provision of a circuit breaker having an improved shockproof structure which will prevent tripping of the breaker by jars or shocks even of very large magnitude but which will allow automatic tripping operation in response to abnormal conditions in the circuit.

Another object of the invention is to provide a circuit interrupter with a device for preventing operative movement of a movable element of the interrupter in response to jars or shocks.

Another object of the invention is the provision of a circuit interrupter having a shockproof structure which automatically prevents operative movement of a movable element of the circuit interrupter and which utilizes the energy of the shock force to prevent movement of said movable element.

Another object of the invention is the provision of a circuit breaker with a device which automatically prevents opening of the circuit breaker in response to shocks or jarring forces.

Another object of the invention is the provision of a circuit breaker with a device which automatically prevents opening of a circuit breaker in response to shocks or jarring forces, but which will allow automatic opening of the breaker in response to predetermined abnormal circuit conditions.

Another object of the invention is the provision of a circuit breaker with a device for preventing automatic opening of a circuit breaker in response to shocks or sudden jarring forces and only during the existence of such forces.

Another object of the invention is the provision of a circuit breaker with an automatic shockproof

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device, which has a minimum number of parts and which is of simple and sturdy construction.

Another object of the invention is the provision of a circuit breaker with a shockproof mechanism which will react to one, or a plurality of sudden shocks or jarring forces occurring in quick succession, to prevent automatic opening of the breaker by the jars or shocks.

Another object of the invention is the provision of a circuit breaker with a shockproof device comprising a plurality of inertia members which will react for a period of time following the occurrence of a sudden shock to prevent tripping the breaker in response to said shock and to prevent tripping of the breaker in response to a shock or shocks occurring immediately after the first shock.

Another object of the invention is the provision of a circuit breaker having an improved shockproof means which comprises a plurality of shock reactors each having a different period of reaction to prevent operation of the breaker in response to a series of shocks occurring in quick succession.

Another object of the invention is the provision of a circuit breaker having a shockproof structure which automatically prevents tripping of the circuit breaker by jars or shocks and which utilizes the energy of the shock force to prevent tripping of the breaker.

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

Figure 1 is a vertical longitudinal sectional view of a multipole circuit breaker embodying the invention;

Fig. 2 is a transverse sectional view taken substantially on the line II—II of Fig. 1 and showing the trip device of the circuit breaker;

Fig. 3 is an enlarged sectional view of the circuit breaker trip device, taken substantially on the line III—III of Fig. 2, showing the shockproof device thereon;

Fig. 3a is an enlarged sectional view of the circuit breaker trip device, taken substantially along the line IIIa—IIIa of Fig. 2, showing one of the magnetic tripping means;

Fig. 4 is an end elevational view of one of the shockproof devices shown in Fig. 2;

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Fig. 5 is a perspective view of the inertia device forming a part of the shockproof device shown in Figs. 2, 3 and 4;

Fig. 6 is a side elevational view, partly in section, of the trip device showing a modification of the invention;

Fig. 7 is an enlarged end elevational view of a part of the mechanism shown in Fig. 6.

Fig. 8 is a side elevational view, partly in section, of the trip device showing another modification of the invention;

Fig. 9 is a perspective view of the modification shown in Fig. 8; and

Fig. 10 is a sectional view taken substantially on line X—X of Fig. 4.

Referring to Fig. 1, the circuit breaker structure shown therein is of the same general type as is disclosed in Patent No. 2,025,697, issued on December 24, 1935, to Benjamin P. Baker, and assigned to the assignee of the present invention; the contact means and operating mechanism shown, however, are of the same construction as disclosed in the copending application of J. Sandin and Ture Lindstrom, Serial No. 513,869, filed December 11, 1943, now Patent No. 2,492,009, December 20, 1949, also assigned to the same assignee. This type of breaker has been shown for illustrative purposes only in order to illustrate the application of the improved shockproof device to a circuit breaker structure. It will be understood that the shockproof device is capable of application to various other forms of current-responsive circuit breakers.

The three-pole circuit breaker illustrated in Fig. 1 comprises, in general, a base 7 of molded insulating material, a cover 9 of similar material secured to the base by means of bolts (not shown), contact actuating means indicated generally at 13, and a trip unit indicated generally at 15. The casing formed by the base and cover is divided into three longitudinal compartments at the forward end thereof by partitions 14 (only one being shown) formed integral with the base. Each compartment is adapted to receive a stationary contact 18 and a cooperating movable contact 20 which with their corresponding terminals 17 collectively form the three poles of the breaker.

The partitions form insulating barriers between the contact means of each pole of the breaker and align with similar partitions 16 formed in the cover 9.

Each pole of the circuit breaker has end terminals 17 secured in openings formed in the base at each end thereof. The respective movable contacts 20, one for each pole of the breaker, are each carried by a pivoted channel-shaped frame 19, only one of these being shown. The three channel-shaped frames are rigidly fastened for movement together by means of a steel tie bar 21 which extends across all of the poles of the breaker. The tie bar is affixed to the frames 19 adjacent the pivoted ends thereof by means of iron straps 23 which loop about the bar and have projecting ends extending through openings in the frames and which are clinched thereagainst. An insulating tube 25 is disposed about the tie bar 21 in order to prevent the short circuiting of the poles of the breaker. The bar serves to mechanically interconnect all of the channel-shaped contact supporting frames 19 and thereby makes it possible to operate all three of the frames from a single actuating mechanism to be hereinafter described. The channel-shaped frame 19 of the center pole of the breaker is pivotally supported

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on a pin 27 carried by a main frame 29 of the common actuating mechanism. The pivot pin 27 forms the common pivot for the three mechanically contacted switch arms or frames 19.

The movable contacts 20 are each carried by an arm attached to its corresponding channel-shaped frame 19 by means of an adjustable screw 31. The particular contact means do not form an important part of the invention and hence will not be described in detail. The contact structure is fully disclosed and claimed in the copending application Serial No. 513,869, filed December 11, 1943, now Patent No. 2,492,009, December 20, 1949, by J. Sandin and Ture Lindstrom, and assigned to the assignee of this application. Suitable arc extinguishing means 33 of the spaced plate type may be provided for the contact means of each pole of the breaker.

The single actuating means 13 comprises in general a U-shaped main frame 29, a carrier or support member 35 pivoted to said frame, a pair of toggle links 37 and 39 interconnecting the carrier member and the channel-shaped contact supporting frame 19 of the center pole of the breaker, a U-shaped operating lever 41, over-center springs 43 for connecting the operating lever to the knee pivot pin 45 of the toggle links, and an insulating operating handle 47 for the lever.

The U-shaped main frame 29 is secured to the base 7 by means of screws 49 which extend through the frame and engage in suitable inserts provided in the base. The toggle links 39 are pivoted to the center pole channel-shaped frame 19 by means of a pin 51, while the toggle links 37 are pivotally connected to the carrier by means of a pin 53. The legs of the operating lever are pivoted to the sides of the main frame 29 at 55. The operating handle projects through a slot 57 provided in the cover 9 and has a curved protective portion 59. The operating lever 41 is provided with a hook 61 for resetting the carrier member 35 to its latched position by movement of the operating handle as far as it will go in opening direction, to reset the mechanism following a tripping operation of the breaker. The carrier member is pivoted to the main frame by a pin 63 and is normally held in latched position as shown by a latch of the trip unit to be hereinafter described which engages the latch portion 69 of the carrier.

The operation of the circuit breaker actuating means is as follows. With the parts in the position shown in Fig. 1 in which all of the contact means are closed and in which the carrier member is held in the latched position; if the operating handle 47 is moved from the position shown to the opposite edge of the slot 57 to rotate the lever 41 in a clockwise direction, the over-center springs 43 will snap over and cause the toggle links 37—39 to collapse, causing simultaneous movement of all of the channel-shaped frames 19 and movable contacts 20 to the open circuit position with a snap action. To reclose the breaker the operating handle is moved in the opposite direction back to the position shown in Fig. 1. This movement of the handle will cause the overcenter springs to snap over in the opposite direction and move the toggle to in-toggle position to simultaneously close all of the contact means with a snap action.

The mechanism of the current responsive trip unit is mounted in a compartment 71 in the casing and is supported by a panel 73 which extends across all the poles of the breaker. The panel

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is removably mounted in position in the compartment 71 by means of bolts 75, which pass through openings provided in angle brackets 77 secured to the panel and which are threadedly engaged in inserts formed in the base of the breaker. Referring to Fig. 1, a common latch mechanism 79 is mounted on the panel by means of a frame 81. The latch mechanism comprises a pivoted latch member 83 pivotally mounted on a pin 85 carried by the frame 81. The latch member has a latch portion 87 for engaging and holding the latch engaging portion 69 of the carrier member 35. The latch member is biased in a counterclockwise direction by means of a spring (not shown) coiled about the pin 85 and which engages under the latch portion at one end thereof and which has its other end secured against the face of the panel. The latch member has a hook-shaped extension 91 which is provided at its end with a detent 93 (Fig. 3) adapted to be engaged by a roller 95 which is carried by a trip bar 97. The trip bar is pivotally mounted by means of pins 98 (Figs. 2 and 3) supported by brackets 99 carried by the panel 73, and extends across all of the poles of the breaker. The trip bar is biased in a counterclockwise direction by means of a coiled spring 101 which has one end engaged in a spring seat provided in the panel 73 and the other end engaging a similar seat provided in the trip bar 97. An opening 103 is cut in the panel to accommodate the end of the hook-shaped portion 91 of the latch member 83 and a projection 105 formed on the trip bar which carries the roller 95. The trip bar is biased by the spring 101 to engage the roller 95 in the detent 93 in the end of the latch member. The trip bar thus holds the latch member in latching position by the means described above.

A plurality of electromagnetic trip elements are provided, one for each pole of the breaker. Each trip element consists of a U-shaped stator 109 (Figs. 2 and 3a) of magnetic material suitably secured to the panel 73 by means of bolts (not shown). The ends of the legs of the U-shaped stators 109 form pole faces. Each pole face has a bolt 113 extending therefrom for supporting an armature 115. The armature consists of a flat plate of magnetic material having two openings provided therein for slidably receiving the bolts 113. A coiled spring 117 (Fig. 3a) surrounds each of the bolts 113 and engages the armature. These springs are for the purpose of biasing the armature away from the pole face. Lock nuts 119 (Fig. 3a) are threaded on the outer end of the bolts in order to adjustably position the armature and to limit movement of the same away from the pole faces. The trip bar 97 carries a plurality of strips 121 (Figs. 2 and 3a), one for each pole of the breaker. The strips 121 extend at right angles to the trip bar and are adapted to be engaged by an adjustable projecting bolt 123 (Fig. 3a) carried by each of the armatures of the trip elements, and engageable by the armatures to move the trip bar to tripping position when any armature is attracted. The electrical connections for each pole of the breaker are the same and are as follows: One terminal 17 of each pole of the breaker is connected to the stationary contact by a conductor 125. The other terminal 17 of each pole is connected by a conductor bar 127 which has a looped portion 129 (Fig. 3a) extending around the bight of the U-shaped stator of its trip element, to a second conductor 131 which is connected, in turn, to the movable contact 20 through a

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flexible shunt conductor 132. The looped shaped portion 129 of the conductor 127 forms a one-turn coil for the stator of the magnetic tripping means. Current passes from one terminal 17 of the breaker through the conductor member 127, around the loop 129 to the conductor 131, thence through the flexible shunt conductor 132 to the movable contact 20, the stationary contact 18 and the conductor 125 to the other terminal 17. The connections for each pole of the breaker are the same, hence each magnetic tripping means is responsive to the current flowing through its corresponding pole and is operative when an overload of predetermined magnitude occurs therethrough to move the trip bar 97 to its tripped position.

The operation of the circuit breaker by the trip unit is as follows: With the parts of the circuit breaker in the position shown in Fig. 1, i. e., with the contact means in the closed circuit position and the carrier member 35 in its latched position; if an overload occurs in any of the circuits extending through the poles of the breaker, the corresponding electromagnet formed by the U-shaped stator and looped conductor is energized, its armature is attracted and the projection 123 thereon engages the strip 121 and rotates the trip bar 97 in the clockwise direction. Rotation of the trip bar 97 in the clockwise direction moves the roller 95 out of engagement with the detent 93 in the latch member 83, thus releasing the same. The carrier member 35 being biased in a counterclockwise direction by the overcenter springs 43 partially rotates the latch member 83 in a clockwise direction, thus freeing its latch engaging portion 87 from engagement with the latch portion 69 of the carrier member. When the carrier member is thus released, the toggle links 37-39 are collapsed by means of the overcenter springs 43 and cause the channel-shaped frames 19 to move the movable contacts to an open circuit position. The breaker cannot be reclosed until the operating handle has been moved to full open position in order to reset and latch the carrier member. After the carrier member has been latched, the operating handle may then be moved to its closed circuit position to effect closing of the contact means.

In order to prevent accidental movement of the tripping bar to its tripping position in response to jarring forces, there is provided a shockproof device indicated generally at 133. One form of the shockproof device is illustrated in Figs. 2, 3, 4, and 5 and consists of a U-shaped bracket 135 which supports a pin 137 between the legs thereof. The bracket 135 is secured to the panel 73 by means of screws 136 (Fig. 3) and is disposed between the magnet stator 109 for the center pole and an insulating projection 138 integral with the panel 73. The center pole stator 109 and the projection 138 serve to hold the pin 137 in place. Rotatably mounted on the pin 137 are a pair of cylindrical masses or members 139 and 141 of different weights. Each mass 139 and 141 is preferably substantially balanced about its center axis or pin 137. The members 139 and 141 are spaced apart by a spacer 142 on the pin 137. The member 139 carries two pins 143 and 145, and the member 141 carries two pins 147 and 149 (Fig. 10). These pins project from the facing sides of their respective members 139 and 141. One end of a double-acting coil spring 151 (Figs. 3 and 4) coiled about the pin 137 between the members 139 and 141 bears against the pin 143 and biases the member 139 in a clockwise direc-

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tion about the pin 137. The clockwise movement of the member 139 is limited by engagement of the pin 143 with an ear 153 on an arm 155 secured by means of screws 157 to the trip bar 97. The other end of the spring 151 bears against the pin 147 in the inertia member 141 biasing this member and the pin in a counterclockwise direction so that the pin 147 rests against the left-hand side of an ear 159 on the free end of the arm 155. It will be seen that under normal conditions the members 139 and 141 are biased against the lever 155 by the relatively light force of the spring 151.

Movement of the trip bar 97 and the lever 155 in a clockwise or tripping direction, for instance, by operation of the trip device 15, will rotate the members 139 and 141 respectively counterclockwise and clockwise until the pins 145 and 149 respectively engage the ears 159 and 153. In this condition all four of the pins will be touching the ears on arm 155 thereby acting as a limit stop for the clockwise or tripping movement of the trip bar. In this position of the trip bar, the latching roller 95 (Fig. 3) is clear of the latch 93 which is then free to operate to release the operating mechanism.

The trip bar 97 with the arm 155 and the strips 121 attached thereto is unbalanced, and therefore is susceptible to displacement in response to shocks or jarring forces which may be transmitted thereto through the base or the breaker mechanism. For example, a blow may be transmitted to the trip bar through the base and the pivot 96 or the latch mechanism 79. Also the armatures 115 of the trip magnets may be moved in tripping direction in reaction to a shock or jar an extent sufficient to cause displacement of the trip bar in tripping direction. When a jarring force is applied to the base of the breaker of such magnitude as to cause the trip bar to move in tripping direction, the blow on the trip bar is transmitted through the lever 155 (Fig. 3) to the pins 143 and 147 respectively on the larger inertia member 139 and the smaller member 141, causing the member 139 to rotate in a counterclockwise direction and causing the member 141 to rotate in a clockwise direction about the pin 137. The movement of the members 139 and 141 will cause the pins 145 and 149 to deliver secondary blows to the lever 155 to prevent the lever and the trip bar from moving to tripping position. Due to the difference in mass or capacity of the members 139 and 141, and also to the difference in the lever arms to the point of contact of the arm 155 with the pins 143 and 147, the pin 147 on the lighter mass 141 will separate from the arm 155 ahead of the pin 143 on the heavier mass, and the secondary blow of the pin 149 will be delivered to the arm 155 ahead of the secondary blow of the pin 145. Both members, after separating from the arm 155, continue their respective rotary motions in opposite direction, and in quick sequence deliver a series of secondary blows to the arm 155 to restore the arm and the trip bar to fully latched position before it has moved far enough to trip the breaker. The members 139 and 141 reverse the direction of their respective motions after each secondary blow, and after spending all of their inertia they finally stop in their original positions with the pins 143 and 147 biased against the arm 155 by the spring 151.

It will be noted that the distance between the pivot 98 (Fig. 3) for the trip bar and the pivot 137 for the inertia member is greater than the distance between the pivot 137 and the pins

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147—149, hence, the blows struck by any of the pins on the arm 155 upon rotation of the inertia member in either direction are always in a direction opposing tripping movement of the trip bar.

The reaction of a single inertia member 139 or 141 is sufficient to prevent tripping the breaker in response to a single shock delivered to the base of the breaker, however, a second or third shock delivered to the breaker immediately after the first shock may fall between the secondary blows of the single oscillating inertia members and effect tripping of the breaker. By the provision of two or more inertia members 139—141, each having a different frequency of oscillation, the time between the secondary blows is reduced and the trip bar is prevented from moving to tripping position in response to a second or third shock following the first shock in quick sequence.

While only two cooperating inertia members 139 and 141 have been described, it will be obvious that in certain applications a single inertia member may be sufficient, or any suitable number, each having a different mass or frequency response, may be provided. Illustrated generally at 161 (Fig. 2) is a second shockproof device similar to the device 133 except that the two inertia members of the device 161 are of different masses than the members 139 and 141. Also the disposition of the members is reversed from that of the members 139 and 141. By the provision of the shockproof device 161, in addition to the device 133, the time between the secondary blows is further reduced.

Figs. 6 and 7 illustrate a modified form of the invention in which a single inertia member is provided. In the Fig. 6 embodiment, the inertia member rebounds from its support bracket to deliver the secondary blows to the trip bar. Referring to Fig. 6, the trip bar 163 is pivotally mounted at 165 on brackets 167 (only one being shown) supported on a panel 169 of insulating material. The panel 169 is secured to the base 7 by means of an angle bracket 171. The trip bar 163 is biased to latching position by a spring 164 and is engaged by a latch member 173 pivotally supported on a pin 175 mounted in the sides of a U-shaped bracket 177 secured to the panel 169. A by-pass pawl 179 is pivoted on a pin 181 mounted on the latch member 173. The by-pass pawl 179 is biased in latching direction by a spring 183 and is limited in its movement in latching direction by one arm thereof engaging a portion of the pin 175. The spring 183 is coiled double about the pin 175 and has one end 185 bearing against a fixed part 187 of the breaker and the other end 189 bearing against a yoke portion 191 of the latch 173 thus biasing the latch in unlatching direction. The bight of the spring 183 engages the by-pass pawl 179. The latching end 69 of the carrier 35 (Fig. 1) engages the pawl 179 and, with the latch 173 restrained by the trip bar, is held in latched position.

When the trip bar 163 is operated in response to overload currents, it releases the latch member 173 which is then rotated in a clockwise direction to release the carrier 35 and thus effect opening of the contacts in the previously described manner. The trip bar 163 may be operated by an electromagnet 193 (Fig. 7) similar to the previously described trip magnet, or it may be operated by a thermal element 195 (Fig. 6). The thermal element 195 is mounted on and heated by a loop 197 of a conductor which is traversed by the current in the circuit through

the particular pole of the breaker. When the thermal element 195 is heated a predetermined amount by overload currents it deflects toward the right, engages an adjusting screw 199 in the upper end of an extension 201 secured to the trip bar, and rocks the trip bar clockwise to release the latch 173. Upon the occurrence of an overload current above the predetermined value for example above ten times normal rated current, or a short circuit, the electromagnet 193 (Fig. 7) operates the trip bar 163 to effect release of the latch 173 instantaneously tripping the breaker.

The breaker cannot be reclosed until the operating handle has been moved to full open position in order to reset the latch and the carrier member. After the carrier has been relatched, the operating handle may be moved to its closed position to effect closing of the contact means.

In the Fig. 6 embodiment the shockproof device, a cylindrical inertia member 203 is rotatably mounted on a pin 205 which is supported in a U-shaped bracket 207. The bracket 207 is secured to the panel 169 by means of screws 209 which also serve to secure an angular member 211 to the panel. The member 211 is made of insulating material and a portion thereof extends at right angles to the panel adjacent the bracket 207 to insulate the shockproof device from the conductor 197.

The inertia member 203 has two diametrically opposed pins 213 and 214 mounted in one face thereof. The other face of the member 203 is counterbored as at 215 (Fig. 7) and two pins 217 and 218 are rigidly mounted in the bottom of the counterbore and project to the right (Fig. 7) beyond the face of the member 203. Disposed in the counterbore 215 is a coil spring 219 having one end hooked over one of the pins 217, as shown in Fig. 7, and the other end hooked around an arm 221 mounted on the trip bar 163. The spring biases the inertia member 203 in a clockwise direction (Fig. 6) so that the pin 217 rests against the left-hand side of the arm 221 near its free end. The pins 214 and 218 are provided to counterbalance the pins 213 and 217 and in this modification serve no other purpose. The arm 221 is secured to the trip bar 163 by means of a pair of screws 225.

When the trip bar 163 is operated by the thermal element 195 (Fig. 6) or by the electromagnet 193 (Fig. 7), the arm 221 is also actuated with a sustained pull and rotates the inertia member 203 in a counterclockwise direction and since the spring 219 is tensioned between the arm 221 and the member 203 it offers no resistance to the tripping movement of the trip bar. The trip device, therefore, has only to overcome the inertia of the member 203.

As previously set forth, a shock may be applied to the base of the breaker of sufficient magnitude to cause the trip bar to move in tripping direction. Such shocks or jarring forces are transmitted through the arm 221 to the pin 217 causing the inertia member 203 to react sharply in a counterclockwise direction. During this movement the pin 213 strikes the bracket 207 as at 213a and reverses the direction of movement of the member 203 causing the pin 217 to deliver a secondary blow to the arm 221 in a direction to maintain the trip bar 163 in a latching position. The member 203 reverses the direction of its motion after each blow, and after expending all of its inertia will finally stop in the original position as shown. While the inertia member 203

is set in oscillation by the relatively sharp blow of a shock to exert one or more impacts on the arm 121 of trip bar 163 in a direction to oppose tripping movement thereof before the trip bar has moved sufficiently to cause tripping of the breaker, the inertia member 203 cannot prevent ultimate tripping movement of the trip bar by an overload, since it will exert a sustained force on the trip bar lasting longer than any oscillation of the inertia member which may be caused by the overload tripping force.

According to the embodiment of the invention illustrated in Figs. 8 and 9, the inertia device is mounted above the trip bar and is engageable directly by the bar. The trip device of the Fig. 8 modification is the same as that shown in Figs. 1, 2 and 3 and like parts have been given the same reference numerals. The inertia device comprises a member 229 (Figs. 8 and 9) pivotally mounted on a pin 231 supported in an extension 233 of the bracket 99' which pivotally supports the trip bar 97. The member 229 carries two pins 235 and 237 which respectively extend downwardly through arcuate slots 239 and 241 (Fig. 9) in the bracket extension 233. The pin 235 is biased by means of a spring 243 in a clockwise direction (Fig. 9) into contact with the upper edge of the trip bar 97. The spring 243 is coiled about the pin 231 and has one end bearing against the pin 235 and the other end is anchored to a pin 245 projecting downwardly from the bracket extension 233. A head 247 on the lower end of the pin 231 retains the spring in place.

When a shock or jarring force is delivered to the base of the breaker of sufficient magnitude to cause the trip bar to move toward its tripping position, the blow on the trip bar is transmitted to the pin 235 causing the inertia member 229 to rotate in a counterclockwise direction. The movement of the member 229 causes the pin 237 to deliver a secondary blow to the trip bar in a direction to prevent movement thereof to tripping position. The inertia member 229 reverses its direction of movement after each blow and, after spending all of its inertia, will come to rest in the position shown in Figs. 8 and 9.

If a jarring force has occurred and caused actuation of the inertia device of any of the modifications to prevent movement of the trip bar in tripping direction, and an overload or short-circuit occurs in any of the poles of the breaker, the sustained pull exerted on the trip bar will overcome the action of the inertia devices and move the trip bar to trip the breaker.

In the absence of shocks or jars, the shockproof device offers very little resistance to the normal operation of the trip device or to the manually resetting of the breaker mechanism.

By making at least one of the inertia masses of the proper weight the device, in addition to serving as a shockproof device will also function as a transient time delay for slightly delaying tripping of the breaker in response to a sudden increase in load.

It will thus be seen that there is provided a shockproof circuit breaker construction which prevents accidental movement of the trip bar in response to jarring forces but only during the existence of such jarring forces and which permits normal operation of the trip bar in response to overload conditions.

Certain features disclosed but not claimed in this application are fully disclosed and claimed in copending application Serial No. 513,869, filed December 11, 1943, now Patent No. 2,492,009, De-

ember 20, 1949, by T. Lindstrom and J. Sandin, and assigned to the assignee of this application.

Having described several embodiments of the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made therein without departing from some of the essential features of the invention.

We claim as our invention:

1. In a shockproof circuit interrupting device, means for preventing operative movement of a movable element of the circuit interrupter in response to jarring forces, comprising a pair of movable masses biased in opposite directions into engagement with said movable element and each disposed to be set in motion by said movable element when said movable element is set in motion by jarring forces, and said masses being arranged so that when set in motion each mass applies one or more impacts to said movable element opposing movement of said element.

2. In a circuit breaker, a trip device comprising a trip member movable to cause opening of the breaker, electroresponsive means operable in response to predetermined conditions to operate said trip member, and means comprising a plurality of movable masses biased in opposite directions into engagement with a part movable with said trip member, each of said masses being adapted to be set in motion by said trip member in response to jarring forces, and each of said masses being operable when set in motion to impinge a series of successive blows on said part movable with the trip member in a direction to oppose tripping movement of the trip member.

3. A trip device for a circuit breaker comprising a trip member operable to cause opening of the breaker, means comprising a plurality of movable balanced masses of different weights, each of said masses being biased into engagement with said trip member, said trip member being set in motion in response to a jarring force and arranged when set in motion to successively set said masses in oscillatory motion in opposite directions to thereby impart a series of successive impacts to the trip member opposing operation of said member, each of said masses having a different period of oscillation.

4. In a shockproof circuit interrupting device, means for preventing operative movement of a movable element of the circuit interrupter in response to jarring forces, comprising a plurality of pivoted masses, each of said masses being balanced in all positions about its pivot and disposed to be set in motion by said movable element in response to jarring forces, means biasing said masses in opposite directions into engagement with said movable element, each of said masses being arranged to reflect by impact with said movable element to impart one or more impacts to said movable element opposing operative movement of said element.

5. The invention according to claim 4, characterized by the fact that the balanced masses are of different weights.

6. A circuit breaker comprising a fixed support, a member mounted on said fixed support and movable to cause opening of the breaker, a shockproof device for preventing false movement of said member in response to jarring forces including a balanced mass pivotally mounted on said fixed support, a projection on said mass disposed in the path of movement of said movable member, means normally biasing said projection into engagement with said movable member

whereby said mass will be set in motion by said member when said member is set in motion by jarring forces transmitted thereto by said fixed support, a second projection on said mass disposed in alinement with said fixed member, and said mass being disposed relative to said fixed support and said member so that said mass when set in motion by said member causes said second projection to react by impact with said fixed support to cause said first projection to impart one or more impacts to said member in a direction to oppose false movement thereof.

7. A circuit breaker comprising a pivoted trip member movable to effect opening of said circuit breaker, electroresponsive means operable in response to abnormal circuit conditions to move said trip member, a substantially balanced pivoted oscillatable member engageable with said trip member upon rotation of the balanced member about its pivot in either direction, the pivot of said trip member being so positioned relative to the pivot of said balanced member that the engagement of the balanced member with the trip member moves the trip member in the same direction irrespective of the direction of movement of the balanced member, means normally biasing said balanced member into engagement with said trip member whereby movement of said trip member in response to physical shocks will impart oscillatory movement to said balanced member, and said balanced member being free to oscillate in either direction a distance sufficient to cause it to deliver one or more blows to said trip member opposing tripping movement thereof.

8. A circuit breaker comprising a trip member movable to effect opening of the breaker, electroresponsive means operable in response to predetermined abnormal circuit conditions to move said trip member, a pair of substantially balanced members of different weights each provided with a pair of projections engageable with said trip members upon rotation of the balanced members in either direction, means normally biasing said balanced members in opposite directions into engagement with said trip member so that false tripping movement of said trip member in response to physical shocks will impart oscillatory movement to each of said balanced members in opposite directions whereby the projections on each of said balanced members will alternately deliver one or more blows to said trip member opposing tripping movement thereof.

9. In a circuit breaker having relatively movable contacts, a trip device comprising a trip member operable to cause opening of the breaker, electroresponsive means operable in response to predetermined abnormal circuit conditions to operate said trip member, a pair of balanced oscillatable members each balanced in all positions about its axis of oscillation and each having a different mass and a different frequency of oscillation, each of said balanced members being constructed and arranged to be set in motion by said trip member when said trip member is moved in response to jarring forces, and each of said balanced members being disposed when set in motion by said trip member to deliver a series of successive blows on said trip member opposing tripping movement thereof in response to shocks occurring in quick succession.

10. In a shock-proof circuit interrupting device, means for preventing operative movement of a pivoted movable element of a circuit interrupter in response to jarring forces comprising

a substantially balanced pivoted mass, separate pivots for said movable element and said mass, spaced projections on said mass extending across the plane of movement of said movable element, the pivot of said balanced mass being spaced from the pivot of movable element a distance greater than the distance between the pivot of said mass and said projections, biasing means normally biasing one of said projections against said movable element whereby movement of said movable element in response to jarring forces will impart oscillatory movement to said mass, and the pivot of said mass being disposed relative to said movable element so that when set in motion said mass will cause each of said projections to deliver one or more blows to said movable element opposing operative movement of said element.

11. A circuit breaker comprising an unbalanced member movable to effect opening of said breaker, a pivoted mass balanced in all positions about its pivot, a pair of projections on said mass disposed on opposite sides of said pivot engageable with said member upon rotation of said mass about its pivot in either direction, biasing means normally biasing one of said projections against said movable member whereby false movement of said member in response to physical shocks imparts oscillatory movement to said mass, and said mass being disposed relative to said movable member so that when in oscillatory motion in either direction said mass is free to cause said projections to alternately deliver one or more blows to said unbalanced member opposing opening movement thereof.

12. A circuit breaker comprising an unbalanced member movable to effect opening of said breaker, a pair of balanced oscillatable members each having a different period of oscillation, a pair of projections extending from the facing sides of each of said masses and across the path of movement of said movable member, biasing means normally biasing one projection on each of said masses in opposite directions about said pivot into engagement with said movable member whereby false movement of said member in response to physical shocks sets said masses in oscillatory movement in opposite directions, each of said masses when in motion being free to move in either direction an extent sufficient to cause its projections to alternately deliver a series of blows to said unbalanced member opposing opening movement thereof.

13. A circuit breaker comprising a pivoted member movable to effect opening of said breaker, a substantially balanced pivoted mass having a pair of projections thereon engageable with said movable member upon rotation of said mass, said mass being so positioned relative to said movable member that engagement of said projections with said movable member moves said movable member in the same direction irrespective of the direction of movement of said mass, biasing means normally biasing one of said projections into engagement with said movable member whereby false movement of said movable member in response to physical shocks imparts rotary motion to said mass, and said mass being disposed relative to said movable member so that when set in motion said mass is free to cause said projections to alternately impact said movable member and said mass reflecting by said impacts to deliver a plurality of secondary blows to said movable member opposing movement thereof.

14. A circuit breaker comprising an unbalanced trip member movable to effect opening of the breaker, electroresponsive means operable in response to abnormal circuit conditions to move said member, an extension on said unbalanced trip member, a substantially balanced oscillatable member disposed adjacent one side of said extension so as to strike said one side of said extension upon rotation of said balanced member in either direction, means normally biasing said balanced member into engagement with said one side of said extension so that movement of said unbalanced trip member in response to physical shocks will impart oscillatory movement to said balanced member, the oscillating movement of said balanced member in either direction causing said member to deliver a plurality of secondary blows to said one side of said extension in a direction opposing tripping movement of said trip member.

15. A circuit breaker comprising a pivoted trip member movable to effect opening of said breaker, electro-responsive means operable in response to abnormal circuit conditions to move said member, an extension on said trip member, a balanced mass having a pivot disposed adjacent the free end of said extension, a plurality of means actuated by said balanced member and disposed on opposite sides of said pivot, said means being engageable with said extension upon rotation of said mass in either direction, means normally biasing one of said means into engagement with said extension whereby movement of said trip member in response to physical shocks will impart oscillatory movement to said balanced member, and said balanced member when in motion causing said means to deliver a plurality of blows to said extension opposing tripping movement of said trip member.

16. A circuit breaker comprising a pivoted trip member movable to effect opening of said breaker, means operable in response to overload currents in the circuit of said breaker for moving said trip member, an extension on said trip member, a balanced oscillatable member disposed relative to said extension so as to engage said extension upon rotation of said balanced member in either direction, means biasing said balanced member into engagement with said extension so that said member will be set in oscillatory movement by said trip member upon movement of said trip member in response to physical shocks, the oscillatory movement of said balanced member causing said member to deliver a series of secondary blows to said extension opposing tripping movement of said trip member.

17. A circuit breaker comprising a pivoted trip member movable to effect opening of said breaker, electro-responsive means operable in response to abnormal circuit conditions to move said trip member, a substantially balanced pivoted oscillatable member having one or more portions engageable with one side of said trip member upon rotation of said balanced member in either direction, the pivot of said balanced member being disposed adjacent said one side of said trip member and spaced from the pivot of said trip member a distance greater than the distance between the pivot of said balanced member and said one or more portions engageable with said trip member, biasing means normally biasing said portion into engagement with said trip member so that movement of said trip member in response to physical shocks will impart oscillatory movement to said balanced member, and said balanced mem-

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ber being free to oscillate in either direction a distance sufficient to cause said one or more portions to deliver a series of secondary blows to said one side of said trip member opposing tripping movement thereof.

18. A circuit breaker comprising a trip member movable to effect opening of said breaker, electroresponsive means operable in response to abnormal circuit conditions to move said trip member, a substantially balanced oscillatable member engageable with said trip member upon rotation of said balanced member, said balanced member being so disposed relative to said trip member that engagement of said balanced member with said trip member moves said trip member in the same direction irrespective of the direction of rotation of said balanced member, means normally biasing said balanced member into engagement with said trip member so that movement of said trip member in response to physical shock will impart oscillatory movement to said balanced member, and said balanced member being free to oscillate in either direction a distance sufficient to cause it to deliver one or more blows to said trip member opposing tripping movement thereof.

19. In a shock proof circuit interrupter, means for preventing operative movement of a movable element of said interrupter in response to jarring forces comprising a substantially balanced oscillatable member engageable with said movable element upon rotation of said oscillatable member in either direction, said oscillatable member being so positioned relative to said movable element that the engagement of said oscillatable member with said movable element moves said movable element in the same direction irrespective of the direction of movement of said oscillatable member, means biasing said oscillatable member to a position whereby movement of said movable element in response to sudden shock will impart os-

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cillatory movement to said oscillatable member, and said oscillatable member being free to oscillate in either direction a distance sufficient to cause it to deliver one or more blows to said movable element opposing operative movement of said element.

20. A trip device for a circuit breaker comprising a trip member movable to cause opening of the breaker, means comprising a balanced mass having a plurality of projections, said projections being disposed in the path of tripping movement of said trip member, means normally biasing one of said projections into engagement with said trip member whereby said mass is set in motion by said trip member in response to jarring forces, and said mass being arranged relative to said trip member so that when in motion it causes said plurality of projections to alternately impinge on said trip member to prevent movement of said trip member in opening direction an extent sufficient to cause opening of the breaker.

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