Oct. 31, 1939. J. SANDIN 2,178,083

CIRCUIT CONTROLLING DEVICE

Filed Jan. 30, 1937 2 Sheets-Sheet 1

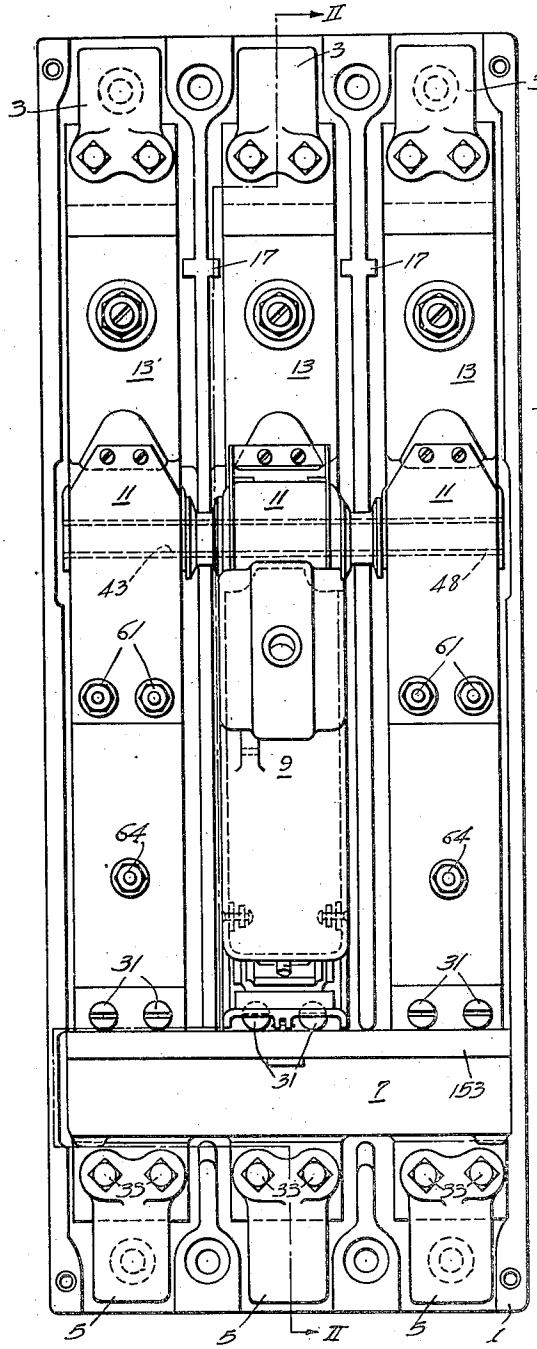

Fig. 1.

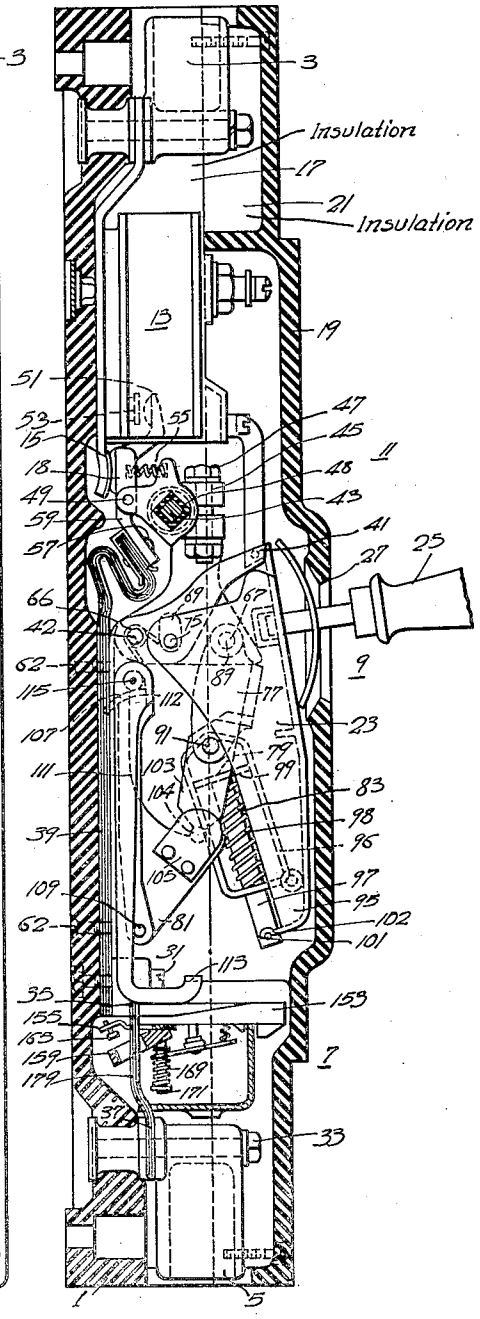

Fig. 2.

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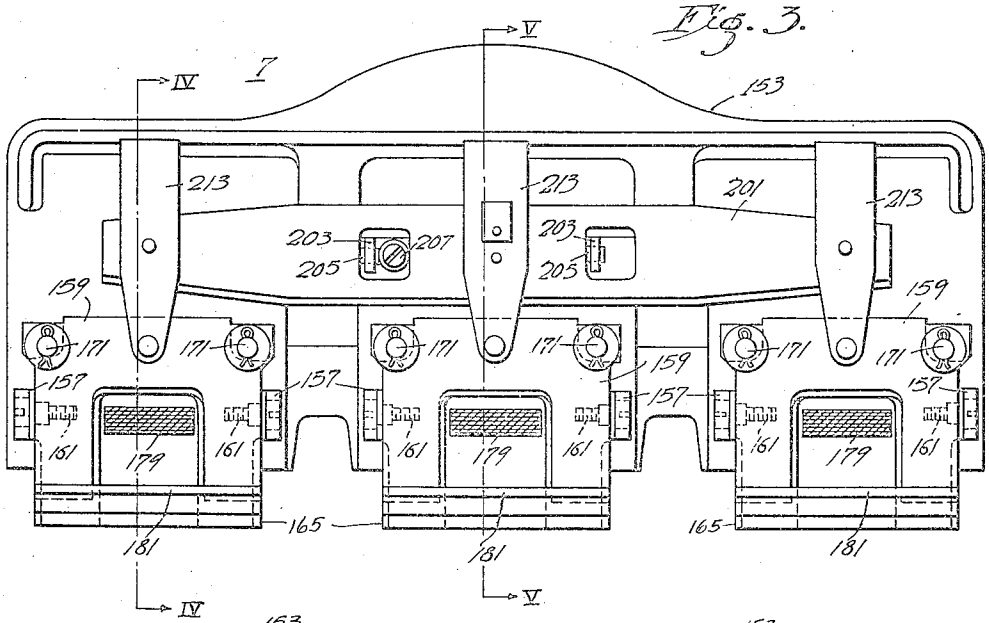
Fig. 3.



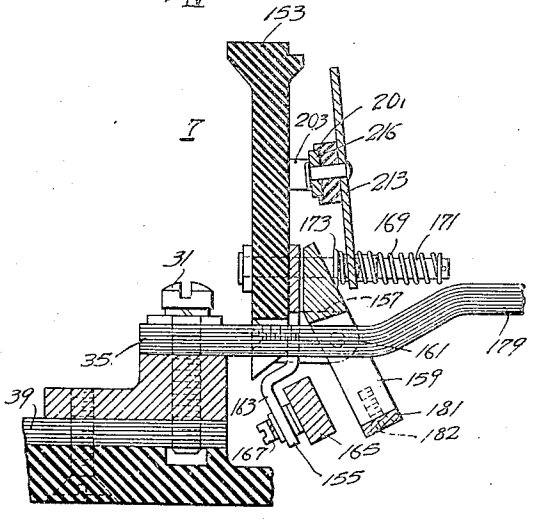


Fig. 4.

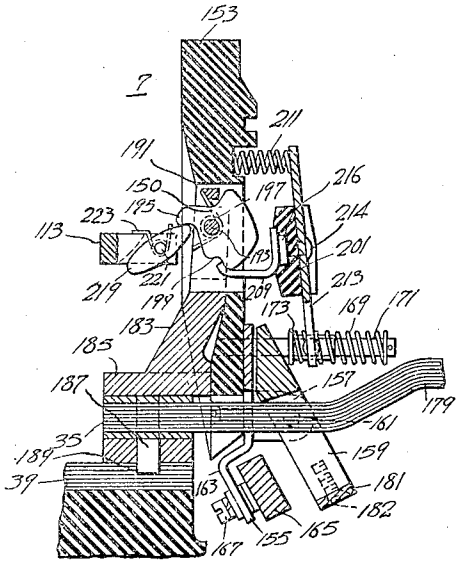


Fig. 5.

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Patented Oct. 31, 1939

2,178,083

UNITED STATES PATENT OFFICE

2,178,083

CIRCUIT CONTROLLING DEVICE

Jerome Sandin, Forest Hills, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 30, 1937, Serial No. 123,236

18 Claims. (Cl. 200—107)

My invention relates to circuit controlling devices in general and more particularly to trip devices for circuit breakers.

In certain applications of circuit breakers principally in installations aboard war craft such as battleships and the like, the circuit breakers are often subjected to severe shocks and heavy vibrations of sufficient magnitude to move the sensitive trip elements of the breaker to cause tripping of the breakers resulting in interruptions of the electric circuits. The interruptions are likely to occur when continuity of service is most needed, as for example during the heat of battle, or upon an impact or collision.

Many efforts have been made to design circuit breaker structures which would be insensitive to shock. Few, if any, of the breakers thus developed have proved entirely satisfactory principally because in making the structure shock proof, other desirable features had to be sacrificed.

It is accordingly an object of my invention to provide an improved shock proof circuit breaker having a trip device that is simpler, more efficient and reliable in operation, and less expensive to manufacture and service, than trip devices heretofore known or used.

Another object of my invention is to provide a trip device embodying an improved trip bar structure and manner of mounting the same.

Another object of my invention is to provide a trip device embodying an improved electromagnetic trip element structure and manner of mounting the same.

Another object of my invention is to provide a shock proof trip device embodying an improved trip bar structure and a cooperating improved electromagnetic trip element structure both of which will be substantially unaffected by shocks or vibrations.

The features that I consider characteristic of my 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 best be understood from the following detailed description of a specific embodiment thereof when read in connection with the accompanying drawings, in which

Figure 1 is a plan view of a circuit breaker embodying the features of my invention, the cover having been removed to illustrate certain details.

Fig. 2 is a sectional view of the circuit breaker with the cover in mounted position, taken on the line II—II of Fig. 1.

Fig. 3 is an elevational view of the improved trip device.

Fig. 4 is a sectional view of the trip device taken on the line IV—IV of Fig. 3.

Fig. 5 is a sectional view of the trip device taken on the line V—V of Fig. 3.

The invention has been shown in connection with a particular form of multi-pole circuit breaker for illustrative purposes only. It will be understood, however, from the following description that the invention is capable of more or less general application to various other forms of circuit controlling devices and electrical devices.

Since the invention is particularly concerned with the electro-responsive trip device and since the circuit breaker wherein my invention has been embodied is completely described in the copending application of Harry J. Lingal, Serial No. 637,749, filed October 14, 1932, and assigned to the assignee of this invention, the description will be limited to setting forth the various elements. Application Serial No. 637,749 became Patent No. 2,083,305 on June 8, 1937.

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

The electrical circuit for each of the poles is substantially the same. Beginning with the terminal 3, the current passes successively along the arc extinguishing structure 13, thence through the main stationary contact 15, the cooperating

main moving contact 18 and the flexible shunt 39 which is associated with each of the switch members, the terminals 35 of the trip structure 7, and finally through the trip structure to the other terminal 5.

The assemblage of the switch members 11 is pivoted to the main frame 41 of the operating mechanism 9 by means of a pin 42. A steel tie bar 43 serves to rigidly mechanically interconnect the three switch members 11, there being only one pivot point. Each of the switch members 11 includes a clamp member 45 for engaging the tie bar 43. The clamp members are secured to the tie bar by means of bolts 47 or any other suitable form of securing means. A square tube 48 of insulating material is disposed between the tie bar 43 and the clamping members 45 to insulate the several poles of the breaker from each other. The main moving contacts 18 are pivoted to the clamp members 45 through the agency of pivot pins 49. A projecting auxiliary contact member 51 is provided for engaging the stationary arcing contact 53. Springs 55 are provided for biasing each of the main moving contact members 18 toward the cooperating main stationary contact member 15 with a predetermined normal force.

The end of each of the shunts 39 adjacent the switch members 11 is secured to the pivotally mounted contact members 18 through the agency of rivets 57. Each of the main moving contact members 18 has a rearwardly extending portion 59 for engaging the end of the shunt 39 and for defining the limit of movement of each of the contact members 18 under the biasing action of the contact springs 55. The shunts 39 for the two outer poles are rigidly affixed to the base 1 by means of screw fastenings 61 and 64 which pass through suitable openings in the shunts. The shunt 39 for the central pole is held in place by four screws 62 which engage threaded openings in the base of the main frame 41. The shunts 39 are of laminated construction being built up of a plurality of thin sheets of copper. The clamp member 45 of the central switch member has openings 66 for engaging the contact assemblage pivot pin 42, openings 67 for engaging the breaker operating mechanism, and slotted openings 69 for clearing the pivot pin 75 of the main operating member 23.

Any suitable type of arc extinguishing means may be used. The form illustrated is similar to that shown in Patent No. 1,896,764 of M. W. Brainard, issued February 7, 1933, and assigned to the assignee of this invention.

The operating mechanism 9 comprises in general a base or main frame 41, a pair of toggle links 77 and 79, one end of which is connected to the assemblage of switch members 11 through the central clamp member 45, a carrier lever 81 for releasably restraining the other end of the toggle links 77 and 79 in operative position, an operating member 23, an overcenter spring unit 83 for connecting the operating member 23 to the knee of the toggle links, and the operating handle 25.

The base 41 is positioned above the conducting shunt 39 of the central pole and is rigidly affixed to the base by means of the screw 62. One end of the toggle link 77 operatively engages the openings 67 in the central clamping member 45 through the agency of a pivot pin 89. The other end of the toggle link 77 is pivoted to one end of the toggle link 79 by means of a knee pivot pin 91, the toggle links 77 and 79 are provided with portions which engage when the breaker is in the closed position to define the limit of upward movement of the knee of the toggle.

The overcenter spring unit 83 operatively connects the end 95 of the operating member 23 with the knee pivot pin 91 of the toggle links and exerts a tension force therebetween. The overcenter spring unit 83 comprises a frame 96 one end of which is adapted to engage the knee pivot pin 91 and the other end of which has a circular opening to accommodate the plunger member 97. The overcenter spring 98 which is itself in compression is positioned between the end of the frame 96 and the enlarged portion 99 of the plunger 97. The other end of the plunger 97 pivotally engages the end 95 of the operating member 23 by means of a pin 101 which fits in a suitable recess 102.

The end 103 of the toggle link 79 is provided with a circular bearing portion 104 which engages a suitable recess in the end of the bell crank carrier lever 81. Two retaining plates 105 are disposed on the outer sides of the carrier 81 to prevent the bearing portion 104 from moving sideways and disengaging the recess.

The bell crank carrier lever 81 has a projecting portion 107 for engaging the latching lever 111 and is pivoted to the base 41 at its apex by means of a pivot pin 109. The portion 107 of the carrier 81 extends along the base 41 to form what might be termed a tail portion. The perpendicular distance from the center of the carrier pivot pin 109 to the line of action of the toggle lever 79 is considerably less than the distance from the center point of the carrier pivot pin 109 to the end of the projecting portion 107 of the carrier 81. This gives the carrier lever 81 an appreciable mechanical advantage over the toggle.

The overcenter spring unit 83 at all times exerts a force on the carrier lever 81 biasing the lever in a clockwise direction and it is to restrain the carrier lever in the operative position that the latching lever 111 is provided.

The latching lever 111 includes a projecting portion 112 for engaging the end of the section 107 of the carrier lever 81, and a portion 113 for engaging the trip latch 150 (see Fig. 4). One end of the latching lever 111 is pivoted to the base 41 by the pivot pin 115 adjacent the point of engagement with the tail piece 107 of the carrier member 81. The projecting portion 112 of the latching lever normally overhangs the end of the portion 107 of the carrier lever 81 and thus holds the carrier in an operative position by preventing it from moving upward. The free end of the latching lever 111 is releasably restrained in the position shown in Fig. 2 by reason of the engagement of the portion 113 with the trip latch 150, which latter forms a part of the trip device 7.

The improved trip structure 7 is a unitary device entirely assembled upon its own base 153 of molded insulating material and is completely removable from the circuit breaker; the screw fastenings 31 and 33 being utilized to mount the trip structure on the base 1 of the circuit breaker and also to make the necessary electrical connections. The trip device 7 includes a magnetically responsive element for each of the poles of the breaker and the mechanism of the device is so arranged that a heavy magnitude overload in the circuit controlled by any one of the poles will actuate the trip mechanism substantially instantaneously to effect simultaneous opening of all of the contacts

of the breaker to interrupt the circuit of each of the poles.

Each of the magnetically responsive trip elements of the trip device is mounted on the trip base 153 through the agency of a metallic yoke 155 of non-magnetic material. The yoke 155 is substantially U-shaped and has a pair of outstanding lugs 157 for pivotally supporting a U-shaped armature 159 of magnetic material. The armature 159 is pivotally mounted on the lugs 157 by means of pivot pins 161. Each of the legs of the yoke 155 is provided with an offset angular end portion 163 for supporting a transverse stationary core member 165 of magnetic material. The stationary core member 165 is secured to the offset ends 163 of the yoke 155 by means of screw fastenings 167. Each of the armatures 159 is adapted to be biased towards its normal position away from its stationary core, as shown in Figs. 4 and 5, by means of a pair of biasing springs 169. The springs 169 are disposed upon studs 171 which are secured to the base 153 of the trip device. One end of each of the springs 169 engages a slidable bushing 173 which is slidably mounted on the stud 171, and the other end of each spring is held in stressed condition by means of a washer fitted on the stud and a cotter pin passing through the end of the stud. The force exerted by the compression springs 169 causes the slidable bushings 173 to engage and bias the armatures 159 to their normal position. An energizing conductor 179 is provided for each of the magnetically responsive trip elements. The ends of each conductor form the terminals 35 and 37 of each of the magnetically responsive trip elements and the body portion passes between the legs of the armature 159 and the yoke 155, and over the stationary core 165. The current flowing in the conductor when the circuit breaker is closed sets up a circular magnetic field about the conductor which produces a magnetic flux in the armature 159 and the core 165. This flux passes through the armature, across the air gaps, and through the stationary core 165 and produces an attracting force between the legs of the armature 159 and the core 165 which tends to move the armature to attracted position with its legs against the stationary core 165. Under normal current conditions, the biasing force produced by the springs 169 prevents the armature from being moved from its normal position. Under abnormal current conditions, such as occur on short circuit or heavy magnitude overloads, the attracting force produced by the flux becomes sufficient to overcome the biasing action of the springs 169 and move the armature to its attracted position to effect a tripping operation of the breaker, as will be hereinafter described.

The pivot pins 161 of each of the armatures 159 are disposed as close as is possible to the center of mass of the armature, and each armature is provided with a balanced weight means or cross piece 181 of non-magnetic material in order to statically and dynamically balance the armature. The feature of statically and dynamically balancing the armature is particularly important in that it prevents the armature from being moved toward its attracted position in response to jarring forces or heavy vibrations so that by this arrangement each of the armatures is rendered substantially shock proof. The cross piece or balance member 181 is secured transversely across the ends of the legs of the armature by means of the screws 182.

The length of the air gaps between the armature 159 and the stationary core 165 in the case of each of the electromagnetic tripping means is made sufficiently large so that any small movement of the armature toward the core, which may be caused by shock, will be ineffective to increase the attractive pull a sufficient amount to move the armature to attracted position, even in the case of overload currents which are only slightly below the tripping value.

In order to provide for accurate positioning of the trip device with respect to the path of movement of the latching lever 111, there is provided a metallic bracket 183 (Fig. 5) which is rigidly secured to the center portion of the trip base 153 by means of screw fastenings (not shown). The bracket 183 has a portion 185 which is of substantially the same outline as the center terminal 35 of the trip device and is thus adapted to be fastened to the base 1 of the circuit breaker by means of the screw fastenings 31 of the central pole. The center screw fastenings 31 would probably be sufficient to accurately position the trip device but in order to insure that the position is correct, there is provided an additional positioning means which consists of a male member 187 which extends downwardly through a suitable opening in the center terminal 35 and engages in a cooperating female portion 189 provided in the center shunt 39, this shunt being securely fastened to the base 1 and accurately positioned with respect to the operating mechanism by means of the screw fastenings 62 previously mentioned.

The bracket 183 has an opening 191 in the upper portion, the trip lever 150 being pivotally mounted therein through the agency of a pivot pin 193.

The trip lever 150 is preferably constructed of metal and has a projecting portion 195 for engaging the latch engaging means associated with the latching lever 111. A spring 197 is provided for biasing the trip lever 150 to its latched position and a notch 199 is provided in the trip lever for engaging a bracket carried by the trip bar 201.

The trip bar 201 is constructed of molded insulating material and extends across all three poles of the breaker. It is pivotally supported at two points adjacent and on either side of the trip lever 150 by means of a pair of lugs 203 (Fig. 3) which project from the bracket 183 of the trip device. The lugs 203 are provided with openings for the reception of pivot pins 205 carried by the trip bar 201. A filler screw 207 is screwed into a portion of one of the lugs 203 in order to maintain the trip bar in pivotally mounted position. The body of the screw 207 substantially fills the space between the pivot pin 205 and the opposite edge of the recess into which projects the pivot pin 205. This particular form of pivotal mounting means for the trip bar permits the trip bar to be easily mounted or dismounted from the lugs 203.

The trip bar 201 engages the trip lever 150 through the agency of an angular bracket 209 (Fig. 5), one end of which engages in the notch 199 of the trip lever 150 and the other end of which is rigidly secured to the trip bar by a pair of rivets. A compression spring 211 biases the trip bar clockwise (Fig. 5) about its pivot axis to its latching position. Three plates 213 are secured in spaced relation on the trip bar by means of rivets 214. Each of the plates 213 extends downwardly to a position adjacent its corresponding armature 159 and is adapted to be engaged and moved by the armature when the same is moved to its attracted position upon the occurrence of an overload.

Counterweight members 216 (Figs. 4 and 5) are secured to the trip bar adjacent and on the opposite side of each of the plates 213 in order to balance for the weight of these plates. The trip bar itself and all of the members carried thereby are so constructed and disposed that the trip bar is both statically and dynamically balanced in order to prevent the same from being moved in response to jarring forces and heavy vibrations. Thus the pivoted trip bar as well as each of the pivoted armatures is rendered substantially shock proof.

This position of the pivot points of the trip bar on either side of and adjacent the latch load prevents any flexing or bending of the trip bar which would tend to throw the same out of balance.

The end 113 of the latching lever 111 is provided with a bifurcated portion in which is pivotally mounted a latch 219. The latch 219 is pivotally mounted by means of a pivot pin 221 and is biased to latching position by means of a spring 223. Clockwise rotation of the latch 219 under the biasing influence of the spring 223 is limited by the engagement of a tail portion of the latch with the end 113 of the latching lever 111. The latch 219 is adapted to be engaged and held by the latch lever 150 to restrain the latching lever 111 in its normal position as shown in Figs. 1 and 5.

The exact details of operation of the circuit breaker mechanism 9 are set forth in the previously mentioned application of Harry J. Lingal and the disposition of the various mechanism in the open, closed, and tripped positions are shown in the drawings accompanying that application. Generally, however, the operation is as follows. To manually move the contacts from the closed position shown in Fig. 2 to the open position, the handle 25 is moved downwardly. This downward movement causes the toggle links 77 and 79 to collapse toward the base 1 under the influence of overcenter spring unit 83. The collapse of the toggle causes the entire assemblage of the switch members 11 to pivot about the pin 42 and move to the open position with a snap action. To close the contacts manually, the operation is substantially reversed: the handle 25 is moved upwardly and the toggle is restored to the position shown in Fig. 2 by the force exerted by the overcenter spring unit 83. The contacts close as well as open with a snap action due to the progressive acceleration given by the toggle.

When a circuit breaker is in the closed circuit position and an overload of sufficient magnitude to actuate the trip device occurs in the circuit controlled by any one of the poles of the breaker; the latching lever 150 is released to free the end 113 of the latching lever 111 by the movement of the trip bar 201 to trip position. The latching lever 111 is biased counter-clockwise (Fig. 2) about its pivot pin 115 and as soon as it is released, it moves so that the portion 112 thereof disengages the cooperating end portion 107 of the carrier lever 81. The entire mechanism is now free to move under the biasing action of the contact springs 55. These springs cause the assemblage of the switch members to move clockwise about the pivot pin 42 and at the same time cause the toggle link 77 and 79 to be moved toward the base of the circuit breaker. The combined result of these movements is to cause a clockwise movement of the carrier lever 81 and a collapse of the toggle links toward the base 1 due to the bringing of a center line of the overcenter spring unit 83 below the center line of the toggle unit 79. The circuit breaker operating mechanism is completely resettable by means associated with the operating member 23.

The operation of the trip device is substantially as follows: Upon the occurrence of an overload in the circuit controlled by any one of the poles of a breaker, the flux set up in the armature 159 and the stationary core 165 of the particular pole of the breaker on which the overload occurs reaches a sufficient magnitude to produce an attracting force between the armature 159 and the core 165; which is sufficient to move the armature 159 to its attracted position against the biasing action of the springs 169. Movement of the armature from its normal to its attracted position causes the same to engage and move the plate member 213 to effect a counter-clockwise rotation of the trip bar 201. The counter-clockwise rotation of the trip bar 201 causes the bracket 209 carried thereby to release the latch lever 150 thus permitting the latch 219 affixed to the free end 113 of the latching lever 111 to disengage the projection 195 of the latch lever 150. The free end of the latching lever 111 is biased away from the base by the operating spring means and it, therefore, immediately moves to the tripped position thereby causing the contacts of the breaker to open. As soon as the latch 219 has disengaged the projection 195 on the latch 150, the biasing spring 223 restores the latch 219 to latched position, shown in Fig. 5. After the contacts of the breaker have been opened by the tripping operation described above, the armature is returned to its normal position by the biasing springs 169. This permits the trip bar to return to its latching or normal position under the influence of its biasing spring 211 so that the trip device is reset. The return of the trip bar to its normal or latching position causes the bracket 209 to reengage the notch 198 of the trip lever 150 which has in the meantime been reset to normal position by its spring 197, so that the trip device is thus automatically reset. Before the breaker can be reclosed it is necessary that the latching lever 111 be returned to its original or latched position. This is accomplished by moving the operating handle 25 of the breaker to the full open circuit position. The breaker may then be manually closed in the manner described previously in connection with the manual operation.

The feature of both statically and dynamically balancing the pivoted trip bar and each of the pivoted armatures renders the trip device and the breaker substantially shock proof. The location of the pivot points of the trip bar on either side of and close to the latch load prevents the trip bar from being bent or flexed and thus thrown out of balance.

By my invention, I have provided an improved shock proof trip device that is simpler, more efficient and reliable in operation and less expensive to manufacture than any trip devices heretofore known or used.

While I have shown and described the invention in accordance with the provisions of the patent statutes, it is to be understood that various changes in the details of the structure may be made without departing from the spirit of the invention. I desire, therefore, that the invention be limited only by the reasonable construction of the appended claims and by the prior art.

I claim as my invention:

1. In a circuit breaker having a spring biased

actuating member releasable to effect a circuit opening operation, the combination of a trip device comprising releasable latch means for restraining said actuating member in an inoperative position, a pivoted trip member of non-symmetrical shape movable from a normal position to tripping position to release said latch means to free said actuating member, electro-responsive means operable in response to predetermined conditions to move said trip member to tripping position said trip member being both statically and dynamically balanced to render the same substantially shock proof.

2. In a multi-pole circuit breaker having a spring biased actuating member releasable to effect opening of the breaker, the combination of a trip device comprising releasable latch means for restraining said actuating member in an inoperative position, a rotatably mounted trip bar extending across at least two poles of the breaker movable from a normal position to tripping position to release said latch means to free said actuating member, a plurality of electro-responsive means each operable in response to predetermined conditions to move said trip bar to tripping position, said trip bar having a plurality of projections along its length and a balancing mass opposite each projection for statically and dynamically balancing said trip bar to render the same shock proof.

3. In a multi-pole circuit breaker having a spring biased actuating member releasable to effect opening of the breaker, the combination of a trip device comprising a latch member for restraining said actuating member in an inoperative position, a rotatably mounted trip bar extending across at least two poles of the breaker, said bar being biased to a normal position in which it holds said latch member in latching position to restrain said actuating member, a plurality of projections on said bar along its length, a plurality of electroresponsive trip elements each operable in response to predetermined conditions to engage one of said projections and move said trip bar to a tripping position to release said latch member and free said actuating member, said trip bar having a balancing mass opposite each projection for statically and dynamically balancing said bar to render the same substantially shock proof.

4. In a multi-pole circuit breaker, a plurality of pairs of relatively movable contacts forming a plurality of poles, a common operating mechanism for opening and for closing said contacts, a spring biased actuating member releasable to effect opening of said contacts, the combination of a trip device comprising a latch for restraining said actuating member, a rotatably mounted trip bar extending across at least two poles of said breaker biased to a normal position and having an element thereon for engaging and restraining said latch in latching position to hold said actuating member, a plurality of projections on said bar along its length, a plurality of electro-responsive means each operable in response to predetermined conditions to engage one of said projections and move said trip member to tripping position to release said latch and free said actuating member, said trip bar having a balancing mass oposite said latch engaging element and opposite each projection for statically and dynamically balancing said bar to render the bar substantially shock proof.

5. In a circuit breaker provided with a spring biased actuating member releasable to effect a circuit opening operation of the breaker, in combination, a trip device comprising releasable latch means for restraining said actuating member in a predetermined position, electro-magnetic means including a pivoted armature of non-symmetrical shape biased to a normal position and movable to an attracted position in response to predetermined conditions to effect release of said latch means to free said actuating member, said armature being statically and dynamically balanced to prevent the same from being moved by jarring forces.

6. In a circuit breaker relatively movable contacts, operating mechanism for opening and for closing said contacts, a spring biased actuating member releasable to effect opening of said contacts, the combination of a trip device comprising releasable latch means for restraining said actuating member in a predetermined position, a pivoted U shaped armature biased to a normal position and movable to an attracted position to effect release of said latch means to free said actuating member, a core member mounted adjacent the legs of said armature and an energizing conductor connected in circuit with said contacts and extending between the legs of said armature, said core and conductor being operable in response to predetermined conditions to move said armature to attracted position, said armature being statically and dynamically balanced to render the same substantially shock proof.

7. In a circuit breaker provided with a spring biased actuating member releasable to effect a circuit opening operation, the combination of a trip device comprising releasable latch means for restraining said actuating member in a predetermined position, a pivoted trip member biased to a normal position and movable from said normal position to a tripping position to effect release of said latch means to free said actuating member, electro-magnetic means including a pivoted armature biased to a normal position and movable from said normal position to an attracted position in response to predetermined conditions to move said trip member to tripping position, said trip member being statically and dynamically balanced and said armature being at least statically balanced to prevent movement of the said elements in response to jarring forces.

8. In a circuit breaker, relatively movable contacts, operating mechanism for opening and for closing said contacts, a spring biased actuating member releasable to effect opening of said contacts, a trip device comprising a latch for restraining said actuating member in a predetermined position, a pivoted trip member biased to a normal position for restraining said latch to hold said actuating member, electromagnetic means including a pivoted armature biased to a normal position and movable from said normal position to an attracted position to move said trip member to a tripping position to release said latch and free said actuating member in response to predetermined conditions, said trip member and said armature being statically and dynamically balanced to prevent their being moved in response to jarring forces.

9. In a multi-pole circuit breaker, a plurality of pairs of relatively movable contacts forming a plurality of poles, operating mechanism for opening and for closing all of said pairs of contacts, a spring biased actuating member releasable to effect simultaneous opening of all of said pairs of contacts, in combination, a trip device

comprising a releasable latch for restraining said actuating member, a pivoted trip bar extending across two or more of said poles biased to a normal position to restrain said latch in latching position and movable to a tripping position to release said latch to free said actuating member, said trip bar being pivoted on both sides of and adjacent said latch, a plurality of electro-responsive trip elements one for each pole each operable in response to predetermined overload conditions in the circuit of its pole for moving said trip bar to tripping position, said trip bar being statically and dynamically balanced to prevent the same from being moved in response to jarring forces.

10. In a multi-pole circuit breaker, a plurality of pairs of relatively movable contacts forming a plurality of poles, operating mechanism for opening and for closing all of said pairs of contacts, a spring biased actuating member releasable to effect simultaneous opening of all of said pairs of contacts, in combination, a trip device comprising a releasable latch for restraining said actuating member, a pivoted trip bar extending across two or more of said poles biased to a normal position to restrain said latch in latching position and movable to a tripping position to release said latch to free said actuating member and a plurality of electro-responsive trip elements, one for each pole each operable in response to predetermined overload conditions in the circuit of its pole for moving said trip bar to tripping position, said trip bar being statically and dynamically balanced to prevent the same from being moved in response to jarring forces.

11. In a multi-pole circuit breaker having a plurality of pairs of relatively movable contacts forming a plurality of poles, a common operating mechanism for simultaneously opening or closing said pairs of contacts, and a spring biased actuating member releasable to effect simultaneous opening of said pairs of contacts, the combination of a trip device comprising a releasable latch means for normally restraining said actuating member, a pivotally mounted trip bar extending across two or more poles of said breaker biased to a normal position, and movable to a tripping position to effect release of said latch means to free said actuating member, a plurality of electromagnetic trip means one for each pole each including a pivoted armature biased to a normal position and movable to an attracted position in response to abnormal conditions in the circuit of its pole to move said trip bar to tripping position, said trip bar being statically and dynamically balanced to prevent the same from being moved by jarring forces or vibrations.

12. In a multi-pole circuit breaker having a plurality of pairs of relatively movable contacts forming a plurality of poles, a common operating mechanism for simultaneously opening or closing said pairs of contacts, and a spring biased actuating member releasable to effect simultaneous opening of said pairs of contacts, the combination of a trip device comprising a releasable latch means for normally restraining said actuating member, a pivotally mounted trip bar extending across two or more poles of said breaker biased to a normal position, and movable to a tripping position to effect release of said latch means to free said actuating member, a plurality of electromagnetic trip means one for each pole each including a pivoted armature biased to a normal position and movable to an attracted position in response to abnormal conditions in the circuit of its pole to move said trip bar to tripping position, said trip bar and each of said armatures being statically and dynamically balanced to prevent their being moved to trip the breaker in response to jarring forces or vibrations.

13. A trip device for a multi-pole circuit breaker provided with a spring biased actuating member releasable to effect opening of the circuits of all the poles of the breaker, said trip device comprising a releasable latch means for restraining said actuating member, a pivoted trip bar extending across two or more poles of the breaker biased to a normal position for restraining said latch means in latching position and movable to a tripping position to release said latch means and free said actuating member, and a plurality of electro-responsive means, one for each pole, each operable in response to predetermined abnormal conditions in the circuit of its pole to move the trip bar to tripping position; said trip bar being statically and dynamically balanced to prevent its being moved in response to jarring forces.

14. A trip device for a multi-pole circuit breaker provided with a spring biased actuating member releasable to effect opening of the circuits of all the poles of the breaker, said trip device comprising a releasable latch means for restraining said actuating member, a pivoted trip bar extending across two or more poles of the breaker biased to a normal position for restraining said latch means in latching position and movable to a tripping position to release said latch means and free said actuating member, and a plurality of electro-responsive means, one for each pole, each operable in response to predetermined abnormal conditions in the circuit of its pole to move the trip bar to tripping position; said trip bar being statically and dynamically balanced to prevent its being moved in response to jarring forces, and said bar being pivotally supported adjacent said latch means on both sides thereof to prevent distortion of said bar when subjected to latch load and jarring forces to preserve its balance.

15. A trip device for a circuit breaker provided with a spring biased actuating member releasable to effect a circuit opening operation, said device comprising releasable latch means for restraining said actuating member in a predetermined position, electro-magnetic means including a U shaped pivot armature biased to a normal position and movable to an attracted position to effect release of said latch means to free said actuating member, a stationary core mounted adjacent said armature, an energizing conductor for said core and armature connected in the circuit controlled by the breaker, said core and conductor being operable in response to predetermined conditions to cause movement of said armature to its attracted position, said armature being statically and dynamically balanced to prevent the same from being moved by jarring forces or vibration.

16. A trip device for a multi-pole circuit breaker provided with a spring biased actuating member releasable to effect opening of the circuits of all of the poles of the breaker, said device comprising a releasable latch means for restraining said actuating member, a trip bar pivotally supported close to and on both sides of said latch means and extending across two or more poles of the breaker, said bar being biased to normal position to restrain said latch means in latching position and movable to a tripping position to release said latch means to free said actu-

ating member, a plurality of electromagnetic trip means, one for each pole, each including a pivoted U-shaped armature biased to a normal inoperative position and movable to an attracted position in response to a predetermined overload on the circuit of its pole to move said trip bar to tripping position; said trip bar and each of said armatures being statically and dynamically balanced to prevent their being moved by jarring forces or vibrations to trip the breaker.

17. In a multi-pole circuit breaker having a plurality of pairs of relatively movable contacts and an actuating member releasable to effect simultaneous opening of said pairs of contacts, the combination of a trip device comprising a pivotally mounted trip bar extending transversely across at least two poles of the breaker and rotatable from a normal position to a tripping position to effect release of said actuating member, the weight distribution of said bar being such that the forces acting on said bar are substantially balanced at each and every point of its length so as to prevent the bar from being subjected to torsional stress and to prevent its being moved in response to jarring forces.

18. In a multi-pole circuit breaker having a plurality of pairs of separable contacts and an actuating member releasable to effect simultaneous opening of said pairs of contacts, the combination of a trip device comprising a pivoted trip bar extending across two or more poles of said breaker and movable from a normal position to a tripping position to effect release of said actuating member, said bar having spaced openings extending transversely therethrough, a plurality of pivot studs carried by the bar, one for each opening, said studs projecting into said openings and being disposed in alignment with their axis coinciding with the longitudinal axis of said bar, stationary bearing means extending into said openings and engaging said studs for pivotally mounting the bar and a removable spacer means disposed in at least one of said openings between the pivot stud and the opposite transverse wall of the opening for maintaining said bar in mounted position on said bearing means and for preventing longitudinal movement of said trip bar.

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