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CIRCUIT BREAKER

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Fig. 1.

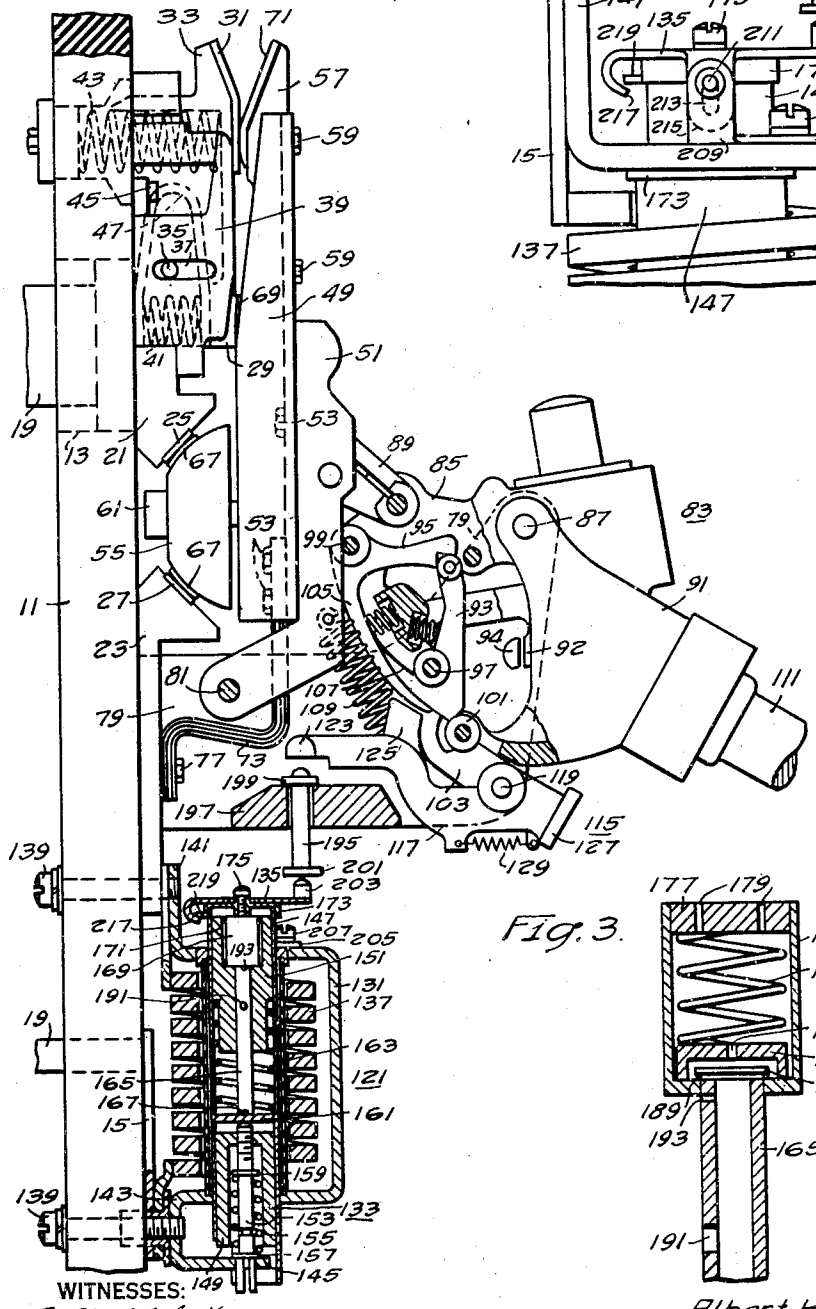


Fig. 2.

Fig. 3.

WITNESSES:
E. A. McCloskey.
Paul D. Harlow.

INVENTORS
Albert H. Baylis and
Herbert L. Rawlins.
BY
Ralph L. Swingle
ATTORNEY

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CIRCUIT BREAKER

Albert H. Baylis, Ypsilanti, Mich., and Herbert L. Rawlins, Pittsburgh, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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14 Claims. (Cl. 200—108)

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This invention relates to circuit breakers and, more particularly, to trip devices for controlling the automatic operation of circuit breakers.

An object of the invention is to provide a circuit breaker embodying an improved trip device which is of simple construction, reliable in operation, and inexpensive to manufacture.

Another object of the invention is to provide a circuit breaker with a novel electromagnetic trip device having a movable core structure movable in two directions to trip the breaker in which the armature is biased against operation in one direction and is movable in both directions relative to said core structure without changing the biasing force to vary the magnetic air gap of the trip device.

Another object of the invention is to provide a circuit breaker with a novel electromagnetic trip device having a movable core structure which is movable in two different directions to trip the breaker and embodying a novel calibrating means for varying the tripping characteristics of the device.

Another object of the invention is to provide a circuit breaker having a novel trip device including a core structure movable in two directions to trip the breaker and embodying a novel calibrating means for varying the tripping characteristics of said trip device in one direction.

Another object of the invention is to provide circuit breakers with an improved trip device including a sealed casing movable in two directions under different circuit conditions to trip the breaker embodying support means for supporting said casing in an initial position but permitting movement of said casing in both directions, the support means being manually adjustable to vary the tripping point in one direction while maintaining the initial position of said casing.

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 best be understood from the following detailed description of one embodiment thereof, when read in connection with the accompanying drawing, in which:

Figure 1 is a side elevational view, partly in section, of a circuit breaker embodying the invention;

Fig. 2 is an enlarged fragmentary view showing the device for tripping the breaker irrespective of the direction of movement of the core structure; and

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Fig. 3 is an enlarged fragmentary sectional view of the valve means for controlling the flow of fluid past the core member in the tube.

Referring to Figure 1 of the drawings, the reference numeral 11 designates a base of strong insulating material which supports the various parts of the circuit breaker. A pair of terminals 13 and 15 are suitably secured to the base and each terminal has one or more connecting studs 19 which extend through the back of the base 11 and serve to electrically connect the breaker to the circuit which it controls.

The upper terminal 13 has a contact block 21 of rigid conducting material secured thereto; and a rigid contact block 23 secured to the base is electrically connected to the lower terminal 15 through the energizing winding of the trip device of the breaker, which will be hereinafter described.

The contact means and mechanism of the circuit breaker illustrated are similar to the circuit breaker fully disclosed in Patent No. 2,214,471 issued September 10, 1940, to Leon R. Ludwig and Merle E. Horn, and assigned to the assignee of the present invention. Hence only a brief description of these parts will be given in this application.

The main stationary contacts 25 and 27 are rigidly secured to the contact blocks 21 and 23, respectively; and the auxiliary stationary contacts 29 and 31 are secured to a triangularly-shaped contact platform 33 of conducting material which is mounted on the upper portion of the block 21 for limited tilting and rocking movement by means of pins 35 projecting from the opposite sides of the platform which engage in slots 37 provided in a pair of side walls 39 secured to the block 21. The platform 33 is biased outwardly from the base 11 by a plurality of springs 41 and 43, and outward movement of the platform is limited by the engagement of the pins 35 with the outer ends of the slots 37 and by stop projections 45 carried by the platform adjacent its upper end. The platform 33 and, consequently, the auxiliary contacts 29 and 31 are electrically connected to the terminal 13 by means of a flexible shunt conductor 47.

The movable contact means of the circuit breaker comprises a channel-shaped contact arm 49 of conducting material which is rigidly secured to a pivoted switch member 51 by means of a plurality of screws 53. The contact arm 49 carries a main contact bridging member 55 for

bridging the main contacts 25 and 27, and an auxiliary contact member 57 for engaging the stationary auxiliary contacts 29 and 31, the auxiliary contact members 57 being secured to the upper end of the channel-shaped contact arm 49 by a plurality of screws 59.

The main contact bridging member 55 is formed of rigid conducting material, and is loosely mounted on the contact arm 49 for limited movement relative to the contact arm toward and away from the main contacts 25 and 27 by means of a pair of studs 61 secured to the contact carrying arm 49, only one stud being shown. A pair of coil springs (not shown) encircle the studs 61, and are disposed between the contact carrying arm 49 and the bridging member 55 for biasing the bridging member toward the stationary main contacts 25 and 27 with a predetermined force. The ends of the bridging member 55 are beveled to lie parallel with the beveled edges of the contact blocks 21 and 23, and have a pair of contacts 67 secured thereto for engaging the main stationary contacts 25 and 27.

The auxiliary contact member 57 is formed of rigid conducting material, and has an intermediate contact 69 and an arcing contact 71 secured thereto for engaging the intermediate and arcing contacts 29 and 31 of the stationary contact means.

A flexible shunt conductor 73 electrically connects the auxiliary contact arm 49 to the main stationary contact block 23. The flexible conductor 73 has its upper end secured to the contact arm 49 by the lower bolts 53. The lower end of the flexible shunt conductor 73 is secured to the lower contact block 23 by means of a bolt 77.

The switch member 51 has a yoke-shaped lower end which is pivotally mounted between the side walls of a main frame 79 by means of the pivot pin 81. The switch member 51 is movable about its pivot axis to open and closed circuit positions to open and close the contact means of the breaker by means of an operating mechanism indicated generally at 83.

The operating mechanism 83 is supported by the main frame 79 and comprises an actuating lever 85 pivoted on a pin 87 carried by the frame, and is connected to the switch member 51 by a link 89. An operating member 91 is also pivoted on the pin 87 for movement about the same axis as the actuating lever 85. The actuating lever 85 is normally and releasably connected to the operating member 91 for movement thereby by means of a pair of latches 93 and 95, which are pivotally mounted on the lever 85 at 97 and 99, respectively. The latch 93 engages a roller 101 carried by the operating member 91, and this latch is, in turn, held in latching position by the auxiliary latch 95. The operating member 91 is adapted to be releasably held in closed circuit position by means of a main holding latch 103 pivoted at 119, which releasably engages the roller 101. The auxiliary latch 95 is provided with a curved tailpiece 105 by means of which it is released to cause release of the latch 93 and consequent tripping of the circuit breaker by the release of the actuating lever 85 from its connection with the operating member 91. When released, the actuating member 85 moves in a counterclockwise direction about the pivot axis 87, causing opening of the movable contact means. During this movement, a cam surface 107 of the lever 85 engages the rounded nose of the main holding latch 103, moving the holding latch to released position to effect release of the operating

member 91. The switch member 51 and the actuating lever 85 are biased to open position by means of a pair of accelerating springs 109 (only one being shown), which are connected at their upper ends to the switch member 51 and at their lower ends to the sides of the main frame 79.

To close the circuit breaker after it has been tripped open, the operating member 91 is first moved in a counterclockwise direction about the pivot axis 87 to the open position to effect resetting of the latches and reestablishment of the releasable rigid connection between the actuating lever 85 and the operating member 91. After the rigid connection is thus established, the operating member 91 is moved in a clockwise direction to closed position by means of a handle 111 to effect closing of the contact means of the breaker. The clockwise or closing movement of the operating member 91 is limited by a portion 92 thereof striking a fixed stop 94 on the frame 79. When the parts have been moved to closed position, the main holding latch 103 reengages the roller 101 to hold the operating member in closed position. The stop 94 is located to permit a slight overtravel of the member 91 to insure proper engagement of the latch 103 with the roller 101. It will be noted that the construction of the operating mechanism is such that the movable contact means is trip-free of the operating member 91; that is, when the breaker is tripped, the contact means move to open position irrespective of the position of the operating member 91.

The mounting arrangement of the contact means is such that during opening of the breaker the main bridging member 55 is first separated from the stationary contacts 25 and 27, while the auxiliary contacts remain in engagement by reason of the outward movement of the contact platform 33 under the influence of the biasing springs 41 and 43. After the bridging member 55 has separated a predetermined distance from the main stationary contacts, the intermediate contacts 29 and 69 begin to separate. This takes place as soon as the pins 35 engage the ends of the slots 37. During this time, the arcing contacts 31 and 71 remain in engagement due to the rocking movement of the contact platform 33. After the intermediate contacts have separated a predetermined distance, the arcing contacts 31 and 71 begin to separate. During closing, the contacts engage in the reverse order, as will readily be understood. It will thus be seen that the arc formed during separation of the contacts is drawn only between the arcing contacts 31 and 71.

The circuit breaker is adapted to be tripped open either manually, or automatically, in response to predetermined overload conditions in the circuit, by means of a trip mechanism indicated generally at 115.

The trip mechanism comprises a trip lever 117 which is pivotally mounted intermediate its ends on the frame 79 by means of a pivot pin 119, and an electromagnetic trip means, indicated generally at 121, which is operable in response to the predetermined overload conditions to move the trip lever 117 to tripping position to cause automatic opening of the circuit breaker.

One arm 123 of the trip lever 117 is offset and extends inwardly toward the base 11 of the circuit breaker, and has its inner end disposed immediately above the trip means 121 to be engaged and moved by a plunger of the electromagnet to effect automatic tripping of the breaker. The arm 123 of the trip lever is provided with a pro-

jection 125 which is adapted to engage the curved tailpiece 105 of the auxiliary latch 95 to move this latch to released position upon movement of the trip lever to tripping position. The other arm of the trip lever 117 forms a handle 127 whereby the trip lever may be manually moved to tripping position to effect manual opening of the circuit breaker. A spring 129 connects the arm 123 of the trip lever 117 to an extension of the main holding latch 103 so that the spring thus serves to bias the main holding latch to latching position and the trip lever to its normal inoperative position, as shown in Fig. 1.

The electromagnet 121 comprises a stationary core member 131, a movable core structure indicated generally at 133 having a trip member 135 related thereto, and an energizing winding 137 having one end connected to the contact block 23 and the other end connected to the terminal 15.

The stationary core member 131 is secured to the base 11 by means of screws 139 which pass through openings in the base and engage threaded openings in formed over projections 141 and 143 of the core member 131. The lower projection 143 of the fixed core member is again formed outwardly as at 145 to serve as a support means for the movable core structure 133.

The movable core structure 133 comprises a sealed casing 147 containing a body of oil or other liquid of suitable viscosity, a main core member 149 and a secondary core member 151. The main core member 149 is tubular and has its upper end closed by an integral part which is tapped to receive the threaded upper end of an adjusting rod 153 which extends downwardly through an opening in the projection 145. A spring 155 is disposed between a washer 157 surrounding the rod 153 and a collar 159 integral with or suitably secured to the rod 153. The bottom 161 of the sealed casing 147 rests on the upper end of the rod 153. The spring 155, therefore, by supporting the rod 153, resiliently supports the entire movable core structure to permit the core structure to move downwardly for a purpose to be fully described later.

The secondary core member 151 is normally maintained in the upper end of the sealed casing by means of a spring 163 compressed between the bottom 161 of the sealed casing and a shoulder on the core member 151. The secondary core member 151 is provided with an opening extending axially therethrough, through which extends a control tube 165 of non-magnetic material. At its lower end the tube 165 rests on the bottom portion 161 of the sealed casing and is provided with an opening 167 for the passage of fluid. The upper end of the control tube 165 is provided with a valve chamber 169 rigidly secured thereto and disposed in nested relation in an enlarged opening 171 in the upper end of the core member 151, the opening 171 being somewhat larger in diameter than the valve chamber 169 to provide an oil passage bypassing the valve chamber.

The upper end of the sealed casing 147 is closed by a cap 173 suitably secured as by brazing to the body of the casing so as to hermetically seal the casing. The cap 173 is provided with a centrally located tapped opening and a filler casing for the purpose of filling the casing to the required level with fluid. After the casing 147 is filled with fluid to the required level, the opening is sealed by inserting a screw 175 therein and brazing or soldering the screw in place. The casing 147 is not completely filled with fluid, space being provided to permit expansion of the fluid.

The upper end of the valve chamber 169 is closed by means of a disc 177 (Fig. 3) suitably secured thereto as by brazing, the disc being provided with a plurality of orifices 179. The disc 177 rests against the inner end of the filler tube on the cap 173 to prevent movement of the control casing 165 relative to the sealed tube 147. Disposed in the valve chamber 169 is an inverted cup-shaped valve 181 biased by means of a spring 183 to a closed position against the bottom of the valve chamber 169. The valve 181 is provided with an orifice 185 but the rim of the valve biased against the bottom of the chamber 169 forms a seal. The valve 181 forms a seal for the upper end of the tube 165 except for the orifice 185. A valve disc 187 disposed within the space below the valve 181 is biased downwardly by the force of gravity and crimped at several points about its edge as at 189 to permit fluid to flow thereunder and through the orifice 185 in the valve 181. In addition to the opening 167 at the lower end of the tube 165, the tube is provided with a large opening 191 (Fig. 3) spaced a predetermined distance below the chamber 169 and a small orifice 193 located just below the bottom of the valve chamber for controlling the flow of fluid as will be more fully brought out later in the description of the operation of the device.

The sealed casing 147 is adapted to be moved upwardly under one set of conditions and downwardly under another set of conditions to effect tripping of the breaker. To accomplish this, the trip member 135 must operate to actuate a trip rod 195 upwardly to actuate the trip lever 117 when the casing 147 moves in either direction. The trip rod 195 extends vertically through an opening in a cross member 197 of the main breaker frame 79 and is provided with a collar 199 integral therewith for normally retaining the trip rod in the position shown. The lower end of the trip rod 195 is provided with a head 201 which is adapted to be engaged by a projection 203 on the righthand end (Figs. 1 and 2) of the trip member 135. The trip member 135 is supported in a bracket 205 secured by means of screws 207 to the top of the fixed core member 131 (see Fig. 2). The bracket 205 is provided with upwardly extending ears 209 each having an inwardly extending pin 211 secured therein. These pins extend through elongated slots 213 (Fig. 2) in ears 215 formed downwardly from the trip member 135. The lefthand end (Figs. 1 and 2) of the trip member has a downward reverse bend 217 which extends underneath a projection 219 of the cap 173 on the upper end of the sealed casing 147.

The trip member 135 is provided with a clearance opening for the screw 175 and normally rests on the flat top surface of the cap 173 so that upon upward movement of the casing 147 carries the trip member bodily therewith to actuate the trip rod 195. During this movement, the slots 213 in the ears 215 move freely over the pins 211. When the sealed casing 147 moves downwardly, as will be hereinafter described, the projection 219 on the cap 173 engages the bent portion 217 of the trip member 135 and rotates the trip member counterclockwise about the pins 211 to engage the projection 203 with the trip rod 195 to effect tripping of the breaker.

The trip device functions to trip the breaker after a comparative long time delay in response to overload currents in the lower range of overload current values, with a short time delay in the intermediate range of overload currents up

to a predetermined value and instantaneously in response to overload currents above said predetermined value or on short circuits. These ranges of overload current values may be arbitrarily defined as follows: The low range between 100% and 700% of normal rated current; the intermediate range from 700% to 1000% of normal rated current and instantaneous 1000% or more of normal rated current or short circuits.

Upon the occurrence of an overload current in the lower range of overloads, that is, up to 700% of normal current, the secondary core member 151 starts to move downwardly forcing oil through the control tube 165 out of the orifice 193 and between the valve chamber 169 and the wall of the opening 171 into the upper portion of the sealed casing above the core member. The upward pressure of the oil in the tube 165 raises the disc 187 against the bottom face of the valve 181 closing the orifice 185 but this pressure in insufficient to compress the spring 183 and open the valve 181. The downward movement of the core member 151 compresses the spring 163 and biases the entire core structure downward against the spring 155 but the force is not great enough to compress the spring 155.

As the secondary core member 151 continues its downward movement, it slowly reduces the magnetic air gap between itself and the main core member 149. After moving downwardly a predetermined distance the core member 151 uncovers the opening 191 in the tube 165 permitting a free flow of oil past the core member which now increases its downward speed to rapidly close the air gap between the two core members 149 and 151 and at the same time open an air gap between the core member 151 and the upper leg of the fixed core member 131. The entire core structure now acts as in a solenoid and is moved upwardly to trip the breaker.

When the circuit is interrupted, by opening of the breaker contacts, the winding 137 is deenergized permitting the entire core structure to drop to its original position. The spring 163 now moves the secondary core member 151 upwardly in the sealed casing 147 forcing oil to flow downwardly through the control tube. The downward pressure of the oil through the orifices 179 and 185 (Fig. 4) causes the valve disc 187 to move downward opening the orifice 185 and permitting free flow of oil to thereby permit the spring 163 to quickly restore the core member 151 to its uppermost position in the sealed casing.

An important feature of the invention is the provision of means for calibrating the time delay tripping time of the trip device. This means comprises the rod 153 which threadedly engages and adjustably supports the armature 149 and also supports the sealed casing 147 in a normal position. The rod 153 is resiliently supported by the spring 155 to permit downward tripping movement of the sealed casing in response to overload currents above the aforesaid predetermined value. By rotating the rod 153, the armature 149 is moved upwardly or downwardly relative to the casing 147 and the secondary core 151 depending on the direction of rotation of the rod. It will be obvious that this movement of the armature will vary the initial air gap between the main armature 149 and the secondary core member 151 and thereby vary the tripping point of the breaker in the low range of overload currents.

The rod 153 does not move axially when it is rotated; consequently, the sealed casing 147 and the secondary core 151 remain in their position when the armature 149 is adjusted. The adjustment of the armature is, therefore, independent of the position of the sealed casing.

When an overload occurs in the intermediate range of overloads between 700% and 1000% of normal rated current the force with which the secondary core member 151 is attracted downward is much greater due to increased energization of the winding 137. This forces the oil upwardly through the tube 165 with sufficient pressure to cause opening of the valve 181 and permits a greater flow of oil to the upper part of the sealed casing. The rate of movement of the secondary core member 151 is thus increased and tripping is effected with a much shorter time delay than it would be if the valve 181 were not provided. Under this condition, the oil flows around the valve 181 and out the orifices 179 in addition to the flow of oil through the orifice 193 and between the valve chamber 169 and the wall of the recess 171. After the core member 151 uncovers the opening 191 in the control tube 165, the tripping action is the same as that described previously in connection with low range of overload currents.

When the winding 137 is energized in response to an overload current of 1000% or over of normal rated value, or a short circuit, the secondary core member 151 is attracted downwardly with such force and speed that the oil below the core member is unable to flow through the control tube 165 and, therefore, moves the entire core structure including the sealed casing 147 downwardly to trip the breaker. The downward movement of the sealed casing engages the projection 219 of the cap 173 with the bent portion 217 of the trip member 135 and rocks the trip member counterclockwise to actuate the trip rod 195 and instantaneously trip the breaker. The downward tripping movement of the core structure compresses the spring 155 which, upon deenergization of the winding 137, reacts to restore the core structure to its normal position as shown in Fig. 1.

Certain features are disclosed but not claimed in the instant application which are fully disclosed and claimed in copending application Serial No. 622,469, filed October 15, 1945, by H. J. Madden and assigned to the assignee of the instant invention.

From the foregoing description, it will be apparent that there is provided a novel trip device for a circuit breaker wherein a solenoid is operated in one direction to trip the breaker after a time delay and in the opposite direction to instantaneously trip the breaker. The time delay feature is hermetically sealed in a casing so that its operation will remain unaffected by corrosion or foreign substances. An important feature of the invention is the provision of the calibrating means for varying the tripping characteristics of the trip device in the low overload range without disturbing the instantaneous tripping characteristics.

The limits of the intermediate range of overloads set forth (approximately 700% to 1000% of rated current) are to be considered merely by way of example and these may be varied considerably in the manner described to suit particular requirements for instance by varying the diameter of the orifices 193 and 195 and also by varying the strength of the springs.

Having described the invention in accordance

with the patent statutes, it is to be understood that various changes and modifications may be made in the structural details and combination of elements disclosed without departing from some of the essential features of the invention. It is, therefore, desired that the language of the appended claims be given as reasonably broad interpretation as the prior art permits.

We claim as our invention:

1. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of a trip device operable to cause automatic operation of said operating mechanism comprising an energizing winding, a magnetic circuit energized by said winding, a movable core structure disposed in said magnetic circuit comprising a sealed casing movable to trip said operating mechanism, an armature for moving said casing, a core member within said casing for delaying tripping movement of said casing, said core member cooperating with said armature to provide a magnetic air gap in said magnetic circuit, and manually operable adjustable means for adjustably varying the air gap without disturbing the position of said casing.

2. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of an electromagnetic trip device operable to cause automatic operation of said operating mechanism, a movable core structure operable in either of two directions to trip said operating mechanism comprising a sealed casing, an armature operable to move said casing, a core member within said casing cooperating with said armature to provide a magnetic air gap, means resiliently supporting said movable core structure, and manual means for varying the air gap independently of said resilient means and without changing the stress of said resilient means.

3. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of an electromagnetic trip device operable to cause automatic operation of said operating mechanism comprising an energizing winding, a magnetic circuit energized by said winding, a movable structure movable in two directions to trip said operating mechanism, an armature for moving said movable structure, said armature providing an air gap in said magnetic circuit, spring means supporting said armature and said movable structure, said spring permitting movement of said movable structure in one direction, and adjusting means for manually moving said armature relative to said movable structure and said spring without changing the stress of said spring or the position of said movable structure to vary the magnetic air gap.

4. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of an electromagnetic trip device operable to cause automatic operation of said operating mechanism, said trip device comprising an energizing winding, a magnetic circuit energized by said winding, a movable core structure movable in two directions to trip said operating mechanism, an armature for operating said movable core structure, said armature disposed to provide an air gap in said magnetic circuit, a spring biasing said armature and said core structure against movement in one direction, and adjustable means between said spring and said armature and said movable core structure supporting said armature and said movable core structure, said adjustable means being manually operable to move said armature relative to said movable core structure to vary the magnetic air gap without varying the tension of said spring and without changing the position of said movable core structure.

5. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of a trip device for causing automatic operation of said operating mechanism comprising an energizing winding, a sealed casing movable to trip said operating mechanism, an armature for moving said casing in one direction to trip said operating mechanism, a core member in said casing operable to delay movement of said casing by said armature, said core member being at times operable to move said casing in another direction to trip said operating mechanism, spring means supporting said sealed casing and biasing said casing against movement in said other direction, and adjustable means supported by said spring and supporting said armature and said casing, said means being manually adjustable to vary the position of said armature relative to said casing.

6. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of a trip device operable to cause automatic operation of said operating mechanism comprising a fixed core member, a sealed casing movable in two directions, an armature operable to move said casing in one direction, a movable core member in said casing operable in response to overload currents below a predetermined value to delay movement of said casing in said one direction, said movable core member being operable in response to overload currents above said predetermined value to operate said casing in another direction to instantaneously trip said operating mechanism, means biasing said casing against movement in said other direction, and manual means for adjusting said armature relative to said casing to vary the time delay tripping characteristic.

7. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of an electromagnetic trip device operable to cause automatic operation of said operating mechanism comprising an energizing winding, a sealed casing movable in one direction to trip said operating mechanism after a time delay and in another direction to instantaneously trip operating mechanism, an armature operable under certain circuit conditions to move said casing in said one direction, a core member disposed in said casing and operable to delay movement of said casing in said one direction, said core member being operable under certain other circuit conditions to move said casing in said other direction, means biasing said armature and said casing against movement in said other direction, and manual means supported by said biasing means and operable to move said armature relative to said casing and said core member.

8. In a circuit breaker comprising relatively movable contacts and operating means therefor, the combination of a trip device operable to cause automatic operation of said operating means comprising a magnetic circuit, an energizing winding, a movable core member, a sealed casing movable by said movable core member to trip said operating means, a secondary core member disposed in said casing to delay tripping movement of said movable core member, and

means for manually adjusting said movable core member relative to said casing to vary the tripping characteristic of said trip device.

9. In a circuit breaker comprising relatively movable contacts and operating means therefor, the combination of an electromagnetic trip device operable to cause automatic operation of said operating means, said trip device comprising a fixed magnetizable member, an energizing winding, a movable core member operable upon energization of said winding, a sealed casing movable by said movable core member to effect tripping of said operating means, time delay means disposed in said casing operable upon energization of said winding to delay movement of said casing, and means for manually adjusting said movable core relative to said casing to vary the tripping characteristic of said trip device.

10. In a circuit breaker comprising relatively movable contacts and operating means therefor, the combination of an electromagnetic trip device comprising a fixed magnetizable member, an energizing winding, a sealed casing movable to trip said operating means, a movable core member operable upon energization of said winding to move said casing, time delay means disposed within said casing and operable upon energization of said winding to delay tripping movement of said casing, means supporting said movable core member and said casing, said supporting means being manually adjustable to move said movable core member relative to said casing to vary the tripping characteristic of said trip device.

11. In a circuit breaker comprising relatively movable contacts and operating means therefor, the combination of an electromagnetic trip device comprising a fixed magnetizable member, an energizing winding, a sealed casing movable to trip said operating means, a movable core member operable upon energization of said winding to move said casing, time delay means disposed within said casing and operable upon energization of said winding to delay tripping movement of said casing, means supporting said movable core member and said casing, said supporting means being manually adjustable to move said movable core member relative to said casing while maintaining said casing in fixed position to vary the tripping characteristic of said trip device.

12. In a circuit breaker comprising relatively movable contacts and operating mechanism therefor, the combination of an electromagnetic trip device comprising a fixed magnetizable member, an energizing winding, a sealed casing movable to trip said operating mechanism, a movable core member operable upon energization of said winding to move said casing, a member supporting said casing in fixed initial position relatively to said winding and adjustably supporting said movable core member relative to said winding, means disposed in said casing operable upon energization of said winding to delay movement of said casing, and said support means being manually adjustable to vary the position of said movable core member relative to said winding while maintaining said casing in its fixed initial position relative to said winding.

13. In a circuit breaker comprising relatively movable contacts and operating means therefor, the combination of a trip device operable to cause automatic operation of said breaker comprising an energizing winding, a movable core structure movable in two directions to trip said operating means, said movable core structure comprising a sealed casing, an armature operable to move said casing in one direction to trip said operating means after a time delay, time delay means comprising a core member disposed within said casing and operable in response to overload currents below a predetermined value to delay operation of said movable core structure in said one direction, said core member being operable in response to overload current above said predetermined value to move said movable core structure in the other direction to instantaneously trip said operating means, means supporting said movable core structure in an initial position relative to said winding, and said supporting means being manually operable to adjust said armature relative to said movable core structure and said winding without disturbing the initial position of said core structure to thereby vary the minimum overload required to move said core structure in said one direction.

14. In a circuit breaker comprising relatively movable contact means, the combination of a trip device operable to effect automatic opening of said contact means, said trip device comprising a magnetic circuit, an energizing winding, a movable core member, a sealed casing containing a body of fluid movable in one direction by said movable core member to effect automatic opening of said contact means, a secondary core member disposed in said casing, means restricting displacement of fluid to retard tripping movement of said movable core member with a relatively long time delay, valve means operable to increase displacement of fluid to thereby retard tripping movement of said movable core member with a relatively short time delay, said secondary core member being at times operable to move said casing in another direction to effect instantaneous opening of said contact means, and manual adjustable means for adjusting said movable core member relative to said casing to vary the time delay and instantaneous tripping characteristics.

ALBERT H. BAYLIS.
HERBERT L. RAWLINS.

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