

- [54] **CIRCUIT INTERRUPTING APPARATUS**
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- [73] Assignee: **Westinghouse Electric Corporation, Pittsburgh, Pa.**
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- [52] U.S. Cl. **335/142, 335/175, 335/190**
- [51] Int. Cl. **H01h 73/48**
- [58] Field of Search. **335/142, 27, 174, 335/175, 190, 169, 170**

3,510,811 5/1970 Pokorny et al. 335/142
 3,544,931 12/1970 Patel 335/174
 3,611,215 10/1971 Patel 335/174
 3,629,747 12/1971 Findley, Jr. 335/174

Primary Examiner—Harold Broome
Attorney—A. T. Stratton, L. P. Johns et al.

[57] ABSTRACT

A circuit breaker comprising separable or relatively movable contact means, operating means releasable to open said contact means, and a fuse responsive to a predetermined current level to actuate the release of said operating means to open said contact means upon a current flow greater than the predetermined current level.

- [56] **References Cited**
UNITED STATES PATENTS
 3,031,601 4/1962 Rudolph 335/27

11 Claims, 10 Drawing Figures

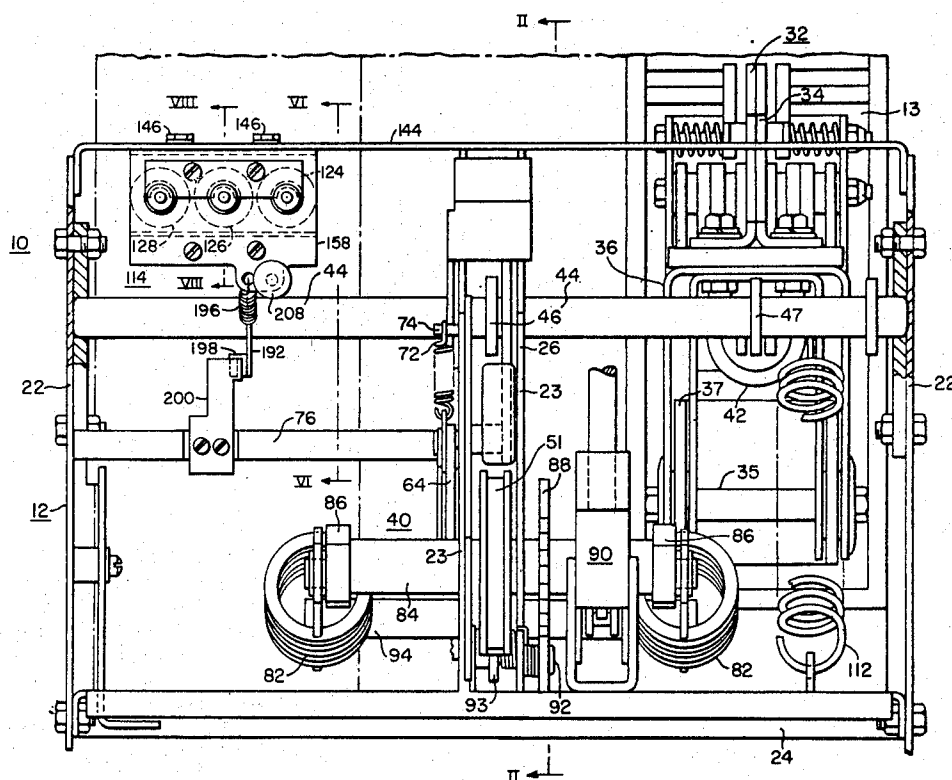
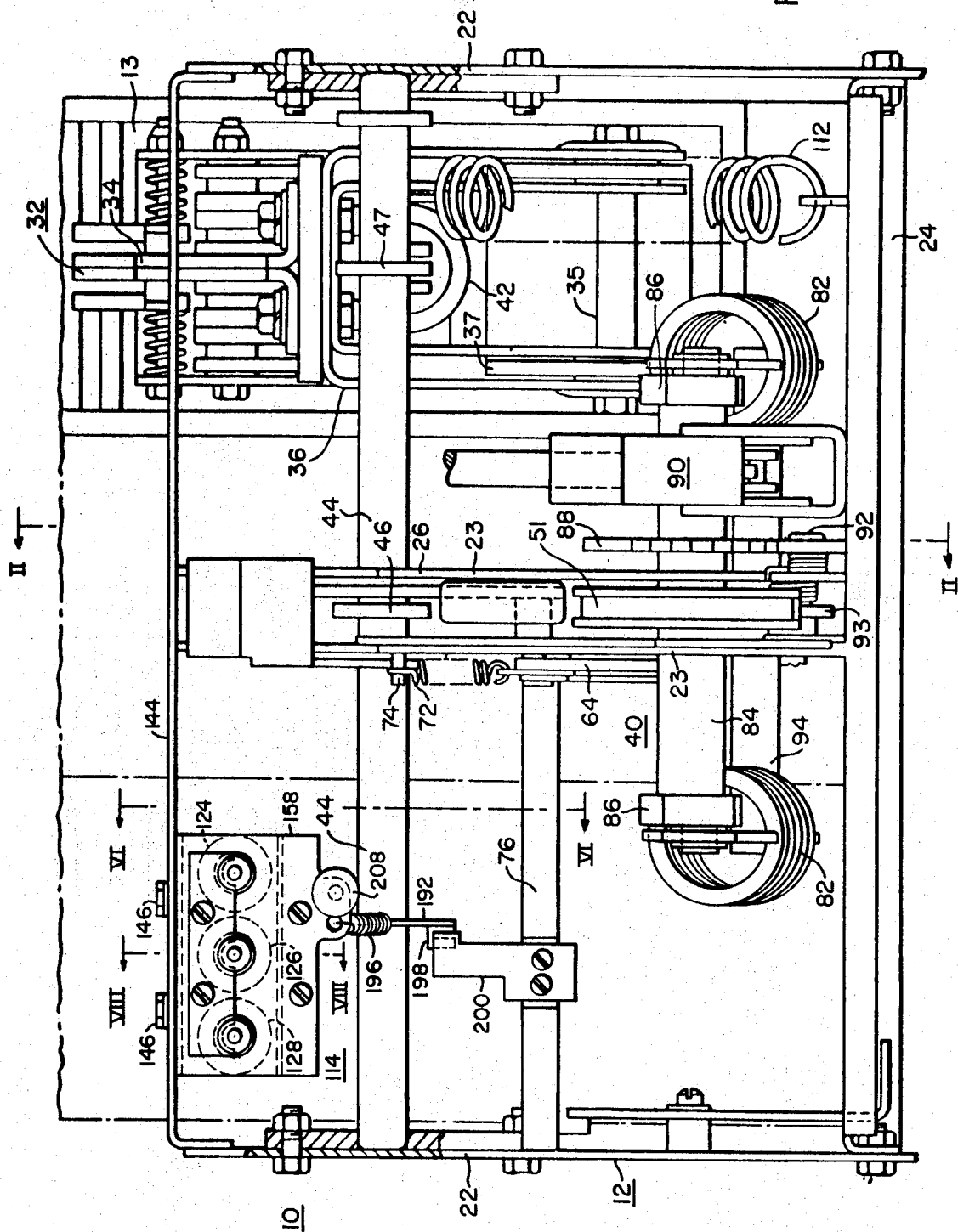


FIG. 1



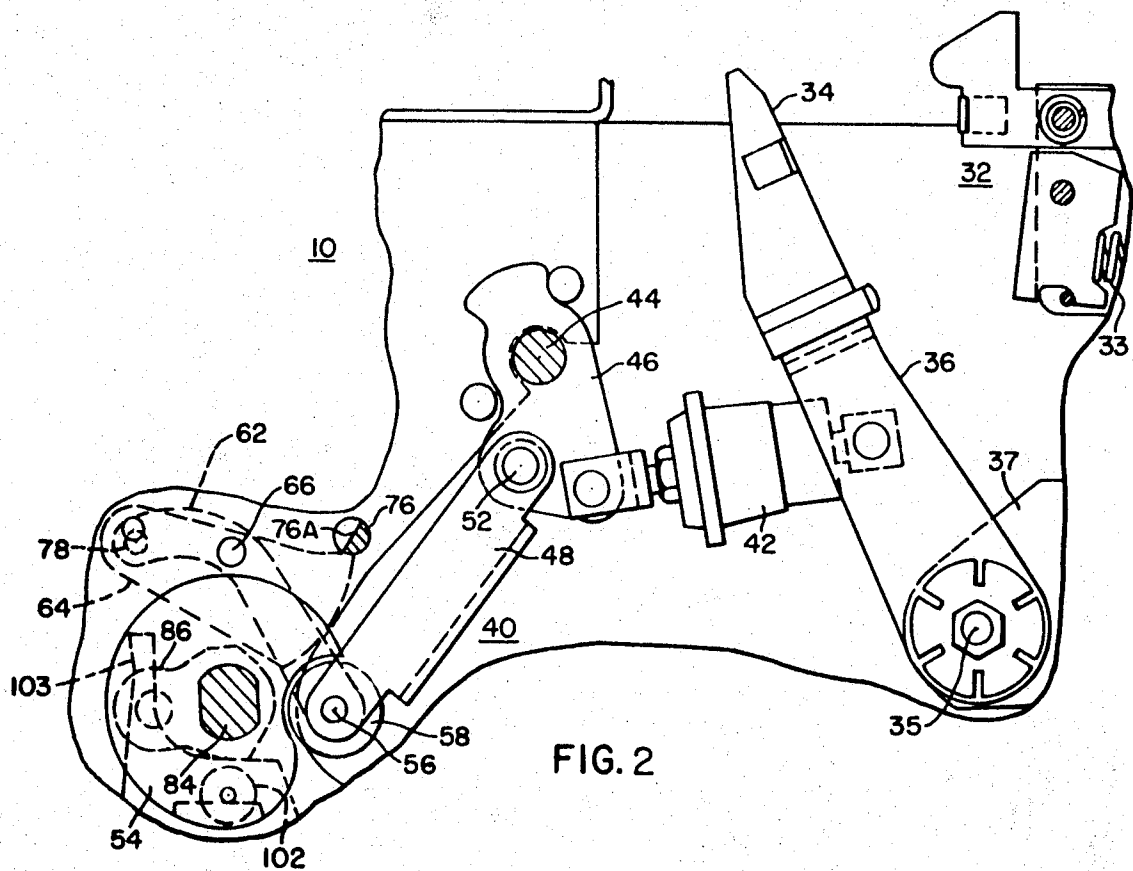


FIG. 2

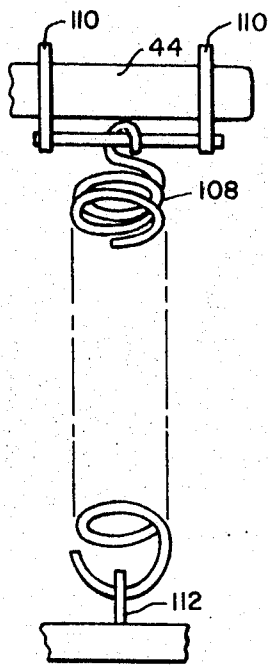


FIG. 5

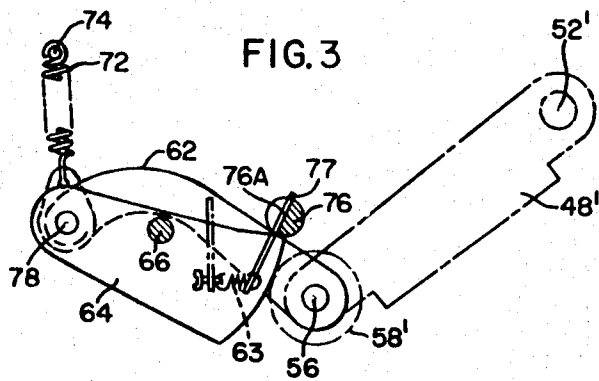
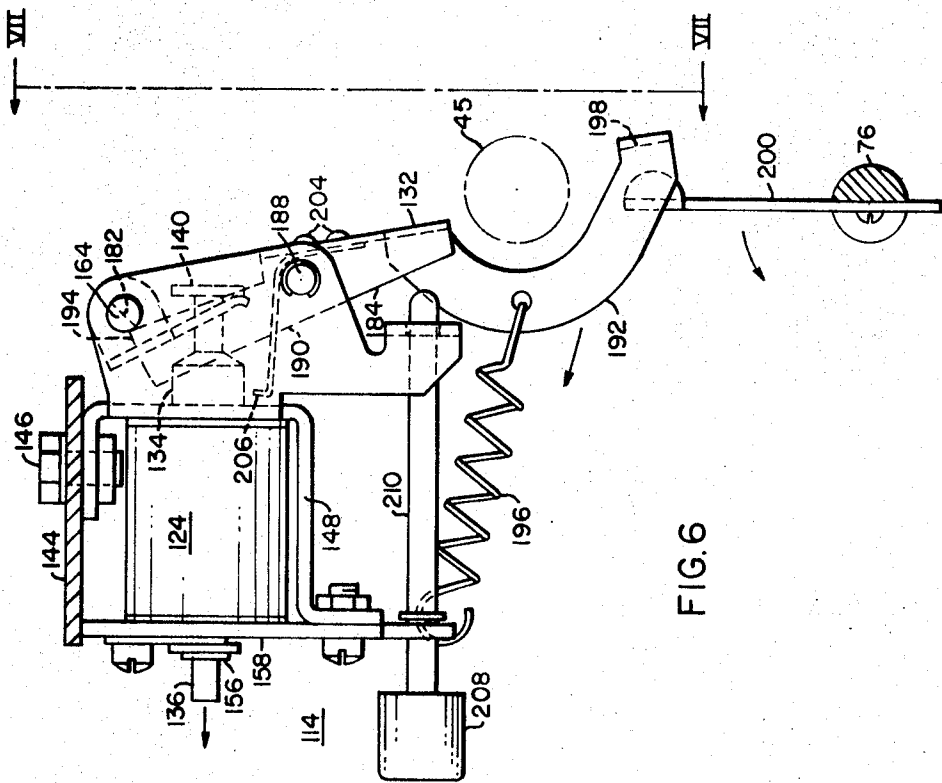
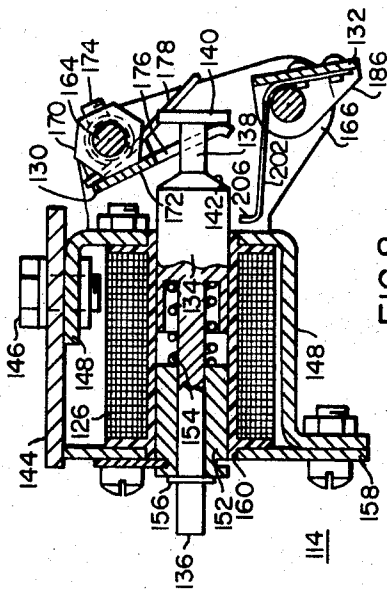
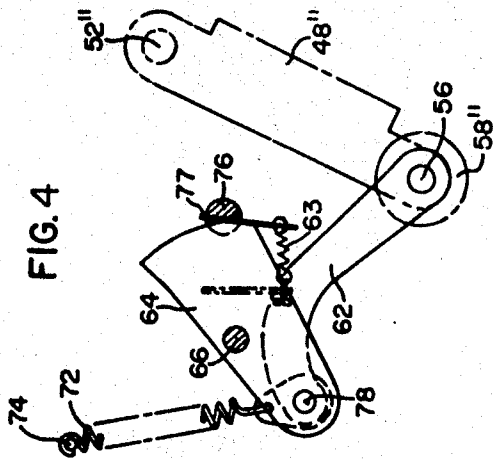


FIG. 3



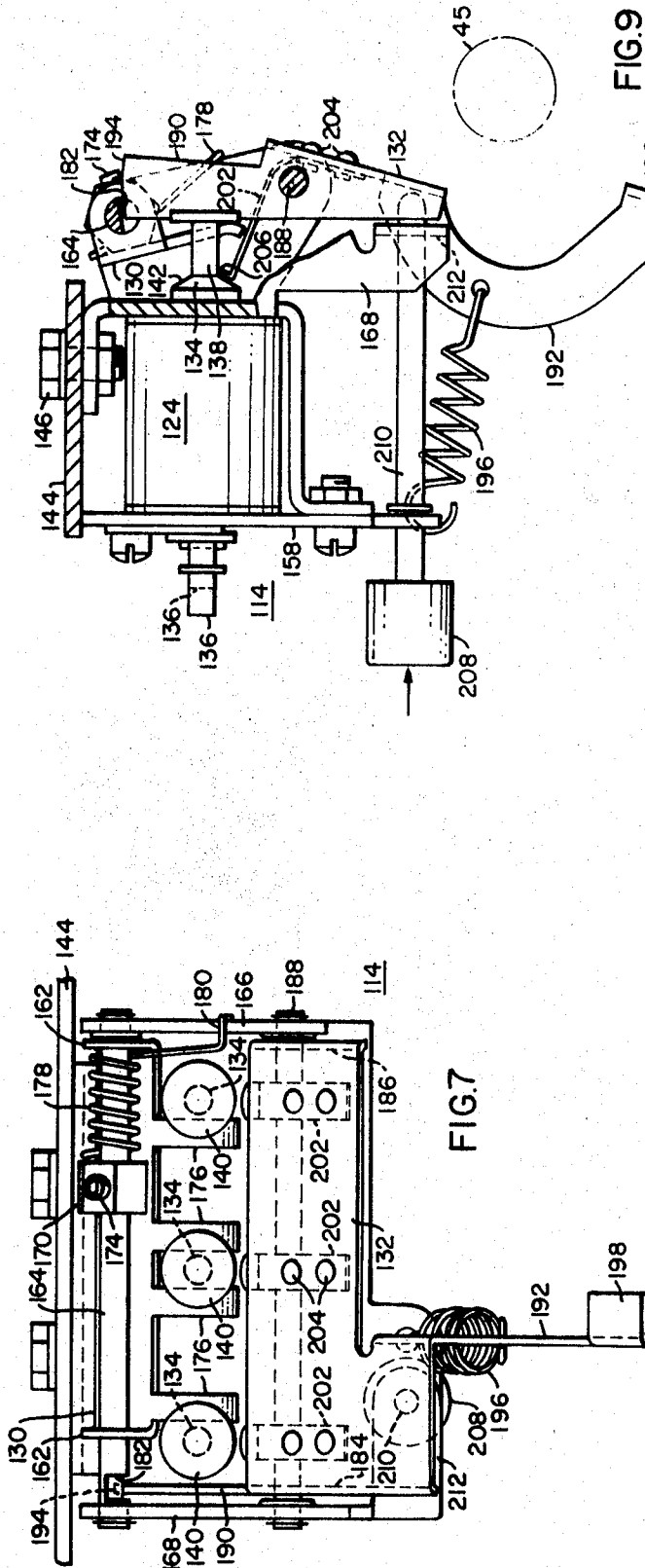


FIG. 9

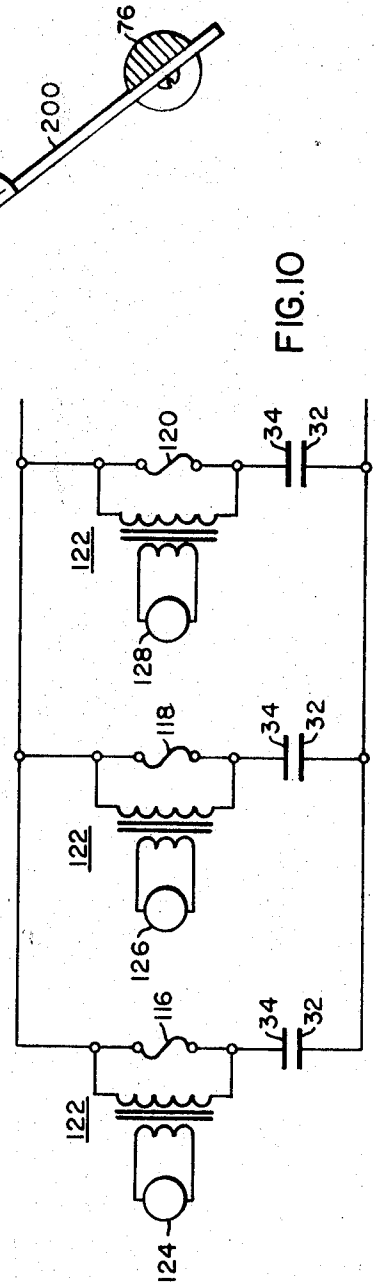


FIG. 10

CIRCUIT INTERRUPTING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

Certain parts of the circuit breaker disclosed herein are disclosed in the copending application to Nagar J. Patel, entitled "Circuit Breaker Including Improved Under-voltage Trip Means", Ser. No. 65,984, filed Aug. 21, 1970 now U.S. Pat. No. 3,611,215.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to circuit breakers and more particularly to fused circuit breakers including trip devices of the electromagnetic type for actuating the operation of the circuit breaker upon an overcurrent condition.

Description of the Prior Art:

It has been known in the art that a fuse of the current-limiting type connected in series with a circuit breaker and having interrupting characteristics coordinated with the circuit breaker will operate more effectively to protect an electric circuit against overload and short circuit currents than is possible with either of the devices separately. Moreover, to prevent signal phasing in the event that only one of three fuses in a typical three-phase circuit is ruptured, it is desirable for safety purposes to provide for tripping of the circuit breaker and thus interrupt all phases of the circuit in response to the rupturing of any one or more of series-connected fuses.

A typical arrangement is that shown in Rudolph Pat. No. 3,031,601 in which the tripping mechanism of a circuit breaker is actuated directly by the armature of an electromagnetic coil. One disadvantage of that construction is that the coil provides a force that is dependent upon circuit conditions which are variable rather than constant. Another disadvantage of that construction is that the coil is directly connected to the line conductor and provides an unsafe condition, because extra high voltages due to a fault in the line conductor may be conducted to the front portion of the breaker where the coil is located.

Associated with the foregoing has been a problem of availability of space within a circuit breaker in which to have access to the trip shaft of the circuit breaker. A circuit breaker is frequently provided with a variety of tripping mechanisms such as an undervoltage trip device, a shunt trip device, an overcurrent trip device, and a manual trip device, all of which require access to a portion of the trip shaft. Tripping apparatus of the type shown in above-mentioned U.S. Pat. No. 3,031,601 has the disadvantage of requiring an inordinate amount of space on the trip shaft due to the presence of three tripping coil armatures, each of which functions with a separate actuating arm on the tripping shaft. Another disadvantage of most series-connected fuse and circuit breaker types of apparatus is that available space within the circuit breaker is occupied by unreasonably large actuating coils, primarily due to the fact that each coil must have sufficient force to separately actuate the tripping shaft.

SUMMARY OF THE INVENTION

It has been found in accordance with this invention that the foregoing disadvantages may be overcome by providing circuit interrupting apparatus comprising a

circuit breaker and a fusible element, the circuit breaker having a pair of relatively movable cooperating contacts connected in series with the fusible element, which element is responsive to a predetermined current value, an operating mechanism for opening and closing the contacts including means biasing the contacts to open circuit position and latching means for retaining the contacts in closed circuit position in opposition to said biasing means, tripping means for releasing the latching means and comprising a movable trip member, an electromagnetic coil having an armature movable to an attracted position to actuate the trip member to a releasing position, the tripping means also including a reset lever and a trip lever, the reset lever being operatively connected to the movement between the attracted and unattracted positions of the armature and being biased in the unattracted position, the trip lever being operatively connected between the reset lever and the latching means and being biased in an unlatching position with respect to the latching means, the trip lever being normally in the latching position in opposition to the biased position when the reset lever is in the unattracted position, resetting means for moving the tripping means to the unattracted position, and means responsive to circuit interruption by the fusible element for energizing the electromagnetic coil.

The advantages of the device of this invention include the use of smaller electromagnetic coils, one point of access to the tripping system, a single reset button, and use of a coil to unlatch the operating mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be had to the preferred embodiment, exemplary of the invention, shown in the accompanying drawings, in which:

FIG. 1 is an end elevational view, with certain parts broken away, of a circuit breaker embodying the invention;

FIG. 2 is a sectional view, with certain parts omitted for clarity, taken generally the lines II—II of FIG. 1 illustrating the positions of certain parts when the separable contact means of the circuit breaker are open and the closing springs of the circuit breaker are charged;

FIG. 3 is a partial view similar to FIG. 2, illustrating the positions of certain parts when the separable contact means of the circuit breaker are closed;

FIG. 4 is a view similar to FIG. 3, illustrating the instantaneous positions of the parts just after the separable contact means of the circuit breaker are tripped or opened and prior to the resetting of the parts which occurs during a complete opening operation of the circuit breaker if the closing springs of the circuit are charged or after the circuit breaker is opened and the closing springs of the circuit breaker are then charged;

FIG. 5 is a fragmentary view, illustrating an opening spring which forms part of the circuit breaker shown in FIG. 1;

FIG. 6 is a vertical sectional view, taken on the line VI—VI of FIG. 1;

FIG. 7 is a rear elevational view, taken on the line VII—VII of FIG. 6;

FIG. 8 is a vertical sectional view, taken on the line VIII—VIII of FIG. 1;

FIG. 9 is a view similar to FIG. 6, with parts broken away, and showing the trip lever and reset levers in alternate positions; and

FIG. 10 is a circuit diagram showing the manner in which a fuse is connected with contacts of a circuit breaker, and showing the manner in which a transformer is connected to the line leading through the fuse and the circuit breaker contacts.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A circuit interrupter such as a three-phase or three-pole circuit breaker 10 embodying the principles of the invention is shown in FIGS. 1 and 2. The circuit breaker 10 may be of the type which is described in greater detail in U.S. Pat. No. 3,590,192 issued to Fred Bould and assigned to the same assignee as the present invention. The circuit breaker 10 may be mounted on a rigid housing or framework 12 which supports the elements or parts of the circuit breaker 10 and which, as illustrated, comprises a metallic base plate 24, a pair of spaced metallic side plates 22 which are secured to the flanges provided on the base plate 24, a pair of metallic, spaced, intermediate or center plates 23 which are also secured to the base plate 24 and a rear wall structure which may include a plurality of electrically insulating support members 13 which are rigidly secured to the side plates 22 and the base plates 24, such as described in greater detail in U.S. Pat. No. 3,584,170 issued to Fred Bould and assigned to the same assignee as the present invention.

Each pole unit of the three-pole circuit breaker 10 includes a stationary contact assembly 32 and a movable contact assembly 34 which are shown only for the right hand pole unit of the circuit breaker 10 in FIG. 1 for the sake of clarity and which may be of the type described in greater detail in U.S. Pat. No. 3,562,459 issued to Fred Bould and assigned to the same assignee as the present invention. As illustrated, the movable contact assembly 34 of each pole unit of the circuit breaker 10 is supported on an electrically conducting contact or switch arm 36 which is rotatably supported on an electrically conducting support member 37 by a suitable pivot support member 35. Each of the stationary contact assemblies 32, as shown in FIG. 1, include one or more compression springs 33 which assist during an opening operation of the circuit breaker 10, as is explained hereinafter.

In order to simultaneously actuate the contact arms 36 of the respective pole units of the circuit breaker 10 between open and closed positions, the operating means or mechanism of the circuit breaker 10 includes an electrically insulating connecting member 42 for each of the pole units of the circuit breaker 10. One end of each connecting member 42 is pivotally connected to the associated contact arm 36, while the other end of each connecting member 42 is pivotally connected to one of the pole unit levers 45, 46, and 47 which are welded or otherwise secured to a common jack shaft or tie bar 46 and spaced from one another along the length of said jack shaft, as shown in FIG. 1. The jack shaft 44 extends transversely across all three pole units of the circuit breaker 10 and is pivotally supported for rotation about its own axis by the side plates 22 and the intermediate plates 23 of the framework 12. The stationary contact assembly of the left hand and middle pole units of the circuit breaker 10 are similar

to those of the right hand pole unit of the circuit breaker 10 which is shown in detail in FIGS. 1 and 2.

In order to simultaneously close the separable contact means 32 and 34 of all three pole units of the circuit breaker 10, the operating means or mechanism of the circuit breaker 10 includes a stored energy spring closing mechanism 40 which is actuable to close said contact means and which may be of the type which is described in greater detail in said U.S. Pat. No.

3,590,192. As shown in FIGS. 1 and 2, the closing mechanism 40 includes a link member 48 which is pivotally connected at one end thereof to the lever 46 of the center or middle pole unit of the circuit breaker 10 by means of a pivot pin 52. The other end of the link 48 is pivotally connected to a link 62 by means of a knee pivot pin 56 to form a collapsible toggle means. A roller 58 is rotatably supported on the pivot pin 56 to cooperate with a closing cam 54 and functions as a cam follower. The other end of the link 62 is pivotally connected by means of a pivot pin 78 to a latch member 64 which is mounted for pivotal movement about a fixed pivot pin 66 which, in turn, is mounted on the left hand center plate 23 of the framework 12, as viewed in FIG. 1. In order to assist in resetting the closing mechanism 40 following a tripping operation of the circuit breaker 10, a tension spring 72 is connected at one end to the pivot pin 78 which connects the latch member 64 and the link 62 and at the other end to a stationary pin 74 which is also mounted on the left hand center plate 23 of the framework 12, as viewed in FIG. 1. As shown in FIG. 3, the latch member 64 normally engages a trip shaft 76 which includes a cut-out or notch portion 76A adjacent to the point where the latch member 64 normally engages the periphery of the trip shaft 76. The trip shaft 76 is supported for pivotal movement about its own axis between one of the center plates 23 and one of the side plates 22, as shown in FIG. 1. When the trip shaft 76 is rotated in a counterclockwise direction from the position shown in FIG. 3 to the position shown in FIG. 4, the latch member 64 will be free to rotate to the tripped position shown in FIG. 4.

More specifically, the closing cam 54 of the closing mechanism 40 is fixedly secured to a crank shaft 84 which is rotatably supported on suitable bearings which are secured, in turn, to the center plates 23 of the framework 12. A pair of crank arms 86 are fixedly mounted on the crank shaft 84 adjacent to the opposite ends of said crank shaft, as shown in FIG. 1. In addition, the closing mechanism 40 includes, as illustrated, a ratchet member 88 which is fixedly mounted on the crank shaft 84 and a pawl 92 which is supported on one of the center plates 23 to cooperate with the ratchet member 88. In order to provide the stored energy which is required during a closing operation of the circuit breaker 10, a separate tension spring 82 is operatively connected at one end thereof to each of the crank arms 86 with the other ends of said springs being connected to a rod 94 which is supported on the center plates 23.

In order to manually charge the closing springs 82 where desired, a handle operating mechanism 90 may be provided, as described in greater detail in said U.S. Pat. No. 3,590,192. To retain the closing cam 54 in the predetermined operating position which is shown in FIG. 2, a roller latch member 102 may be rotatably supported on the closing cam 54. As described in the last-mentioned application, a latch member 93 (FIG.

1) may be pivotally mounted on a fixed pivot pin (not shown) and biased to a latching position wherein the latch member 93 engages the member 102 on the closing cam 54 to latch the closing cam 54 and the crank shaft 84 to thereby prevent counterclockwise movement of said cam and said crank shaft under the influence of the closing springs 82.

The contact assemblies 32 and 34 of the respective pole units of the circuit breaker 10 are shown in the open circuit operating positions in FIG. 2 and the closing cam 54 is shown in the operating position which corresponds to a charged condition of each of the stored energy closing springs 82. As explained in detail in said U.S. Pat. No. 3,590,192, when the closing springs 82 are charged and the closing cam 54 is in the operating position shown in FIG. 2, the closing springs 82 operate to bias the crank shaft 84 and the closing cam 54 in a counterclockwise direction with respect to the axis of the shaft 84. Counterclockwise movement of the crank shaft 84 under the influence of the closing springs 82 is prevented by the engagement of the latch member 93 with the latch roller 102 which is mounted on the closing cam 54. The latch member 93 may be manually operated to the unlatching positions by the operation of a closing means indicated generally at 103, as described in greater detail in the last-mentioned copending application. As shown in FIG. 2, the roller 58 on the knee pivot pin 56 of the toggle links 48 and 62 is positioned in a depression which is provided on the closing cam 54 when the contact means of the circuit breaker 10 are opened and the closing springs 82 are charged.

During a closing operation of the circuit breaker 10, the closing means 103 may be manually operated to actuate the latch 93 in such a direction as to release the roller 102 on the closing cam 54. When the roller 102 is released, the closing cam 54 and the crank shaft 84 are free to rotate in a counterclockwise direction, as viewed in FIG. 2, and, under the influence of the closing springs 82, the closing cam 54 will actuate the roller 58 along with the toggle links 48 and 62 to the positions shown in FIG. 3 which correspond to the overall closed circuit operating condition of the circuit breaker 10 assuming that the latch member 64 engages the trip shaft 76, as shown in FIGS. 2 and 3, to prevent counterclockwise movement of the latch member 64.

During a closing movement of the link 48, the lever 46 of the center pole unit of the circuit breaker 10 is actuated in a counterclockwise direction to rotate the jack shaft 44 to a position which corresponds to the closed position of the circuit breaker 10. As the jack shaft 44 rotates to a closed position, all three of the levers 45, 46 and 47 of the respective pole units are simultaneously moved with the jack shaft 44 to thereby actuate the contact arms 36 of the respective pole units to the closed operating positions whereby each of the movable contact assemblies 34 engages the associated stationary contact assemblies 32. The closing movements of the movable contact assemblies 34 serve to compress the associated springs 33 where provided in the corresponding stationary contact assemblies 32 in their respective pole units. As explained in detail in said U.S. Pat. No. 3,590,192, the engagement of the closing cam 54 with the roller 58 serves to prop the link member 48 in the closed operating position to thereby maintain the jack shaft 44 and the associated contact means

32 and 34 of the circuit breaker 10 in the closed operating positions.

Assuming that the contact assemblies 32 and 34 of the circuit breaker 10 are in the closed positions as just indicated and that the closing springs 82 of the circuit breaker 10 are discharged, the circuit breaker 10 may be automatically tripped or actuated open in response to an overload current above a predetermined value in any of the pole units of the circuit breaker 10 by the operation of the trip means indicated generally at 106 in FIGS. 1 and 2 which may be of the type described in detail in U.S. Pat. Nos. 3,544,931 and 3,544,932. When actuated, the trip means 106 operates to rotate the trip shaft 76 in a counterclockwise direction from the latching position shown in FIG. 3 to the unlatched or tripped position shown in FIG. 4. When the trip shaft 76 is rotated to the trip position shown in FIG. 4, the latch member 64 is no longer retained in the position shown in FIG. 3 and is free to move in the notch 76A of the trip shaft 76 about the pivot pin 66 to the tripped position shown in FIG. 4.

When the latch member 64 is released as shown in FIG. 4, the compressed contact springs 33 and an opening spring 108 which is operatively connected between a pair of levers 110 on the jack shaft 44 and a fixed supporting member 112, as shown in FIG. 5, are then effective to then actuate the contact arms 36 toward the open positions indicated in FIG. 2 since the knee pivot pin 56 is free to move from the position shown in FIG. 3 to the position shown in FIG. 4 with the toggle links 48 and 62 collapsing to permit the pole unit lever 46 to move in a clockwise direction to the tripped open position shown in FIG. 2. In summary, the movement or rotation of the trip shaft 76 to the trip position shown in FIG. 4 permits the toggle links 48 and 62, as well as the latch member 64, to move to the tripped positions in which the roller 58 and the link 48 no longer retain the pole unit lever 46 in the closed position and the springs 33 operate to move the jack shaft 44 and the contact arms 36 to the tripped open positions illustrated in FIG. 2 for the right hand pole unit shown in FIG. 1.

It is to be noted that the circuit breaker 10 is trip free since the operator cannot manually restrain the circuit breaker 10 to remain in a closed operating position when an overload occurs in any of the pole units of the circuit breaker 10 and the latch member 64 is released. In summary, the first trip means 106 is energizable to actuate an opening operation of the circuit breaker 10 in response to predetermined overload conditions in the electrical circuit which is being protected by the circuit breaker 10, as explained in detail in said U.S. Pat. No. 3,544,931, previously mentioned.

When the circuit breaker 10 is in the open operating condition indicated in FIG. 4, and the closing springs 82 are discharged, the circuit breaker 10 is reset and the closing springs 82 are charged by the operation of the manual operating means 90. In order to reset the circuit breaker 10 and to charge the closing springs 82, an operator cranks the manually operable means 90 to rotate the crank shaft 84 from a position which is angularly disposed from that shown in FIG. 2 to the spring charged position shown in FIG. 2. As the crank shaft 84 moves to the position shown in FIG. 2, the roller 58 rides or moves off the peak portion of the closing cam 54 into the depression shown in FIG. 2. When the roller 58 moves into the depression of the closing cam 54, the spring 72 shown in FIG. 4 actuates or biases the latch

member 64 in a clockwise direction, as viewed in FIG. 4, to move the latch member 64 to the reset position shown in FIG. 3 and also actuates the toggle links 48 and 62 as well as the roller 58 to their reset positions shown in FIGS. 2 and 3 wherein the roller 58 is positioned in the depression of the closing cam 54. When the latch member 64 moves out of the notch portion 76A of the trip shaft 76 to the position shown in FIG. 3, a biasing spring 63 actuates the trip shaft 76 through an extending arm 77 which is mounted on the trip shaft 76 to rotate the trip shaft 76 clockwise from the position shown in FIG. 4 to the position shown in FIG. 3 in which the periphery of the trip shaft 76 once again latches the latch member 64 to thereby latch the associated parts of the circuit breaker 10 in the reset positions shown in FIGS. 2 and 3. As the crank shaft 84 moves to the position shown in FIG. 2, the closing springs 82 are moved to overcenter positions to thereby bias the crank shaft 84 in a counterclockwise direction, as viewed in FIG. 2, and the member 102 engages the latch 93 to latch the crank shaft 84 in the charged position shown in FIG. 2 wherein the circuit breaker 10 is ready for another closing operation.

When the circuit breaker 10 is in a closed circuit operating condition with the separable contact means 32 and 34 closed and with the closing springs 82 discharged, the closing mechanism 40 can be manually actuated to the spring charged operating condition by the operation of the manually operable means 90. During the manual charging operation, the crank shaft 84 is rotated through an angle of approximately 184° to charge the closing springs 82, as explained in detail in said U.S. Pat. No. 3,590,192. During this movement of the crank shaft 84, the roller 58 rides on a fixed radius portion of the closing cam 54 to an operating position just short of the peak portion of the cam surface of the closing cam 54. When the separable contact means 32 and 34 of the circuit breaker 10 are closed and the closing springs 82 of the circuit breaker 10 are in charged operating conditions, the circuit breaker 10 is capable of a sequence of operations in which the circuit breaker 10 is first tripped open, then closed and then tripped open again as described in said U.S. Pat. No. 3,590,192.

In accordance with this invention, where the circuit breaker 10 is used in conjunction with fuses to protect an electric circuit against heavy short circuit currents more effectively than can be done with either of the devices separately, tripping means are provided to trip the circuit breaker when a fuse is ruptured or blown. In FIG. 10, the manner in which fuses 116, 118, and 120 are connected in series with contact assemblies 32 and 34 is shown. In accordance with the invention, three isolating transformers 122 are provided, one transformer for each of the fuses 116-120. The primary side of each transformer is connected in parallel with the corresponding fuse 116-120; the secondary side of each transformer 122 is connected to a coil 124, 126, or 128.

As shown more particularly in FIGS. 7 and 8, the device 114 comprises the coils 124, 126, 128, a latch member 130 and a trip lever 132. Each coil 124, 126, and 128 is part of an electromagnet which also comprises a movable magnetic member or core 134 which is similar for each coil and which includes an elongated stem portion 136 (FIG. 8), a reduced neck portion 138, and an enlarged head or flange 140, and an inturned

inclined surface or shoulder 142 extending between the outer peripheral surface of the core 134 and the neck portion 138. As shown in FIG. 1, the device 114 is mounted within the confines of the circuit breaker 10 and on a frame member 144 in a suitable manner such as by spaced mounting screws 146 provided in a U-shaped mounting member 148 within which the coil 126 and a stationary core 152 is provided and a compression spring 154 holds the core 134 in the rightmost position, as shown in FIG. 8 when the coil 126 is inactive or deenergized. A retaining ring 156 is mounted on the stem portion 136 for retaining the core 134 within the coil 126. A mounting plate 158 supports the left end of the coil 126 (FIG. 8), and the stationary core 152 as well as the stem portion 136 extends through an opening 160 in the plate.

The latch member 130 includes a pair of apertured flanges 162 at opposite ends by which the lever is mounted on a shaft 164, the opposite ends of which are mounted in out-turned flange portions 166 and 168 of the U-shaped mounting member 148 (FIG. 7). The member 130 is also provided with a block 170 which is fixedly mounted at 172 on the member. The block 170, in turn, is mounted on the shaft 164 where it is secured by a set screw 174. Moreover, the latch member 130 includes a plurality of downwardly extending prongs 176 (FIG. 7) which extend into the path of travel of the flanges 140 of the movable cores 134. Accordingly, when one or more of the cores 134 is actuated to the left, as viewed in FIG. 8, the shaft 164 is rotated clockwise against a reset spring 178 which is mounted on the shaft and includes an end portion 180. Finally, the shaft 164 includes a cutout portion or notch 182, similar to the notch 76A in the trip shaft 76 for a purpose to be set forth hereinbelow.

The trip lever 132 (FIG. 7) includes opposite end flanges 184 and 186 by which the lever is mounted on a mounting shaft 188. Opposite ends of the shaft 188 are mounted in suitable apertures in the flange portions 166 and 168. The trip lever 132 also includes an arm 190 and an arm 192. The arm 190 extends upwardly from the mounting shaft 188 and has an upper end portion 194 which contacts the surface of the shaft 164 when the notch 182 is in the position shown in FIG. 6. However, upon clockwise rotation (FIG. 9) of the shaft 164 the trip lever 132 is free to rotate clockwise with the upper end portion 194 moving through the notch 182 due to pressure applied by a trip spring 196. As shown in FIGS. 6 and 9, one end of the spring 196 is attached to the arm 192 of the lever 132 and the other end of the spring is attached to a lower portion of the mounting flange 158. In FIG. 6, the arm 192 of the lever 132 is generally arcuate in order to extend around a levering in shaft 45 of the circuit breaker.

As shown in FIGS. 6, 7, and 9 the lower end of the arm 192 is provided with an out-turned flange 198 which is adapted to engage the upper end of a trip arm 200 on the trip shaft 76. Upon rotation of the trip lever 132 from the position shown in FIG. 6 to that of FIG. 9, the trip shaft 76 is rotated to the tripped position for opening the circuit through the contact assemblies 32 and 34 as set forth above.

In addition to the foregoing, the trip lever 132 is provided with three leaf springs 202 (FIG. 9), which springs are mounted on the lever 132 by suitable means such as rivets 204. The other end of the leaf springs 202

include end portions 206 which are normally disposed adjacent to the peripheral surfaces of the cores 134.

As one or more of the fuses 116, 118, or 120 blow, the corresponding coils 124, 126, or 128 are energized and the associated core 134 moves to the left to the position shown in FIG. 9. The end portion 206 of the leaf spring 202 moves counterclockwise toward the axis of the core 134 where it remains in abutment with the inclined surface 142 of the core and prevents the core 134 from moving to the right under pressure from the compression spring 154 when the coil 126 is deenergized. Accordingly, the stem portion 136 of the particular core 134 extends further to the left (as viewed in FIG. 9) than the stem portions of the adjacent cores, thereby providing a visual indication to the operator as to which of the fuses 116, 118, 120 requires replacement.

Upon tripping of the breaker the coil 126 is deenergized, but the core 134 is prevented by the leaf spring 202 from moving to the right under the force of the compression spring 154 until the unit 114 is reset.

After replacement of a blown fuse, a reset button 208 on the end of a rod 210 is pushed to the right. The rod is mounted on appropriate portions of the frame which include the mounting plate 158 and a flange 212 of the flange portion 168. Movement of the rod 210 to the right rotates the trip lever 132 counterclockwise against the force of the trip spring 196 until the upper end portion 194 of the arm 190 passes completely through the notch 182 of the shaft 164. Simultaneously, the leaf spring 202 is rotated counterclockwise until the curved end portion 206 clears the inclined surface 142 of the core 134, whereupon the reset spring 178 (FIG. 7) rotates the latch member 130 clockwise as the core 134 moves to the right under pressure of the compression spring 154. Likewise, the arm 192 of the trip lever 132 rotates counterclockwise from the position of FIG. 9 to that of FIG. 6, whereupon the trip shaft 76 is returned to the non-trip position. That completes the reset action.

In summary, the device 114 comprises three coils 124, 126, and 128 which are connected across each of the isolating transformers 122 which, in turn, are connected in parallel with corresponding fuses 116, 118, and 120. When a fuse blows, a voltage is developed across the fuse and therefore across the corresponding coil 124, 126, and 128. As a result, one of the cores 134 moves to the left against the source of the compression spring 154 and turns the member 130 which is connected to the shaft 164 in a clockwise direction. The trip lever 132 is then free to move clockwise under the influence or force of the trip spring 196 and as the trip lever 132 turns, it rotates the trip shaft 76 of the circuit breaker 10 through a trip arm 200, thus tripping the breaker. As the breaker trips, the voltage across the fuse and thus across the coil disappears. However, the core 134 remains in the left hand position because of the leaf spring 202, thus indicating a blown fuse. The compression springs 154 prevent the other cores from moving to the left due to any vibration developed. Accordingly, the breaker is held in the trip free position until the fuse is replaced and the unit is reset.

The device of the present invention satisfies the problems of the prior art as used with fuse circuit breakers for tripping the breaker when one or more fuses are blown, indicates which fuse or fuses that are blown, and holds the breaker in the trip free position until the fuse

is replaced and the device reset. If the device is reset without replacing the fuse, the breaker is tripped immediately. The device makes use of the voltage developed across the blown fuse to permit the breaker to be tripped. Finally, the device employs a "half moon" or notched trip bar as latching means as well as a reliable, independent extension spring for tripping the circuit breaker.

What is claimed is:

1. A circuit interrupting apparatus comprising a circuit breaker and a fusible element, the circuit breaker having a pair of relatively movable cooperating contacts connected in series with the fusible element which element is responsive to a predetermined current value, an operating mechanism for opening and closing the contacts including biasing means biasing the contacts to open circuit position and latching means for retaining the contacts in closed circuit position in opposition to said biasing means, tripping means for releasing the latching means and comprising a movable trip member, a trip lever, a latch member in a latching position latching said trip lever in an inoperative position, a trip spring biasing said trip lever toward a tripping position, an electromagnet comprising a movable armature and a coil energizable to move said armature to an attracted position, upon energization of said coil said armature moving to the attracted position to move said latch member to a releasing position to release said trip lever, whereupon said trip spring moves said trip lever to a tripping position during which movement said trip lever moves said trip member to release said latch means.

2. The circuit interrupting apparatus of claim 1 in which maintaining means are provided on the trip lever for maintaining said armature in the attracted position when the trip lever is in the tripping position.

3. The circuit interrupting apparatus of claim 2 in which the maintaining means comprises a latch part movable to an unlatching position when the trip lever is in the inoperative position.

4. The circuit interrupting apparatus of claim 1 in which the trip lever comprises a latch part movable to a latching position latching the armature in the attracted position when the trip lever is in the tripping position, and the latch part being movable to an unlatching position when the trip lever is in the inoperative position.

5. The circuit interrupting apparatus of claim 1 in which the latch member comprises a rotatable shaft and a shaft-rotating lever, biasing means biasing the rotatable shaft in the latched position, the rotatable shaft having a notch, the rotatable shaft maintaining the trip lever in the inoperative position when the armature is unenergized, the shaft-rotating lever being connected to the rotatable shaft and being movable by the armature to rotate the shaft, and the trip lever being movable through the notch to the tripping position upon rotation of the shaft.

6. The circuit interrupting apparatus of claim 3 in which the latch part comprises a resilient leaf spring, the armature having a surface engagable by the leaf spring when the armature is in the attracted position, whereby the armature is retained in the attracted position when the trip lever is in the tripping position.

7. The circuit interrupting apparatus of claim 1 in which the circuit breaker is a multi-pole breaker, an armature and coil for each pole, the latch member, and

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the trip lever being operable by each of the armature.

8. The circuit interrupting apparatus of claim 7 in which resetting means are provided for moving the trip lever to the unattracted position.

9. The circuit interrupting apparatus of claim 8 in which the resetting means comprises a reset rod for moving the trip lever to the inoperative position.

10. The circuit interrupting apparatus of claim 1 in which there are means responsive to circuit interrup-

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tion by the fusible element for energizing the electromagnetic coil.

11. The circuit interrupting apparatus of claim 10 in which said means includes a transformer the primary coil of which is connected in parallel with the fusible element and the secondary coil is connected to the electromagnetic coil.

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