June 13, 1939. H. S. GANO 2,162,577

CIRCUIT BREAKER

Filed Aug. 31, 1936 3 Sheets-Sheet 1

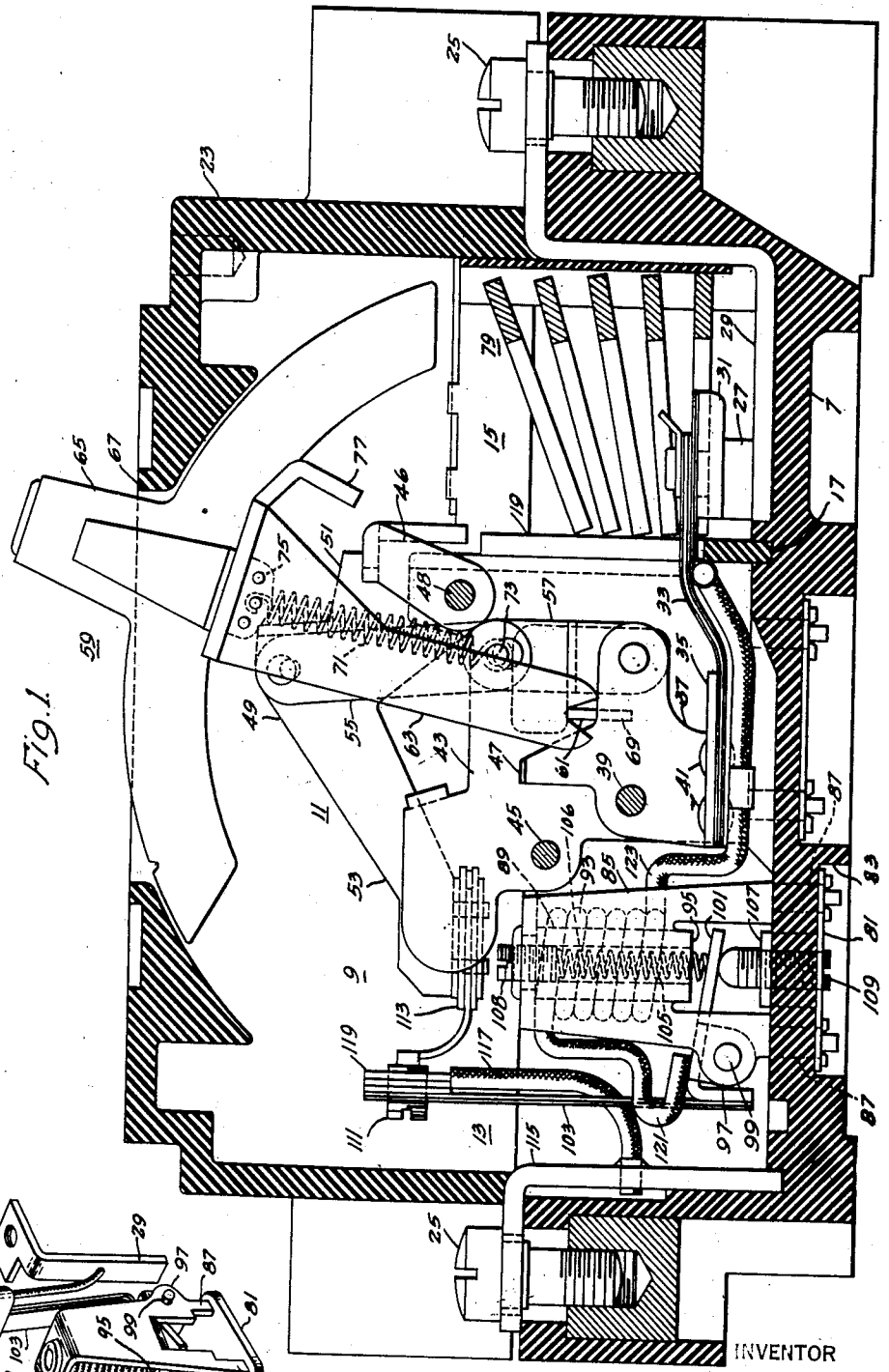


Fig. 1.

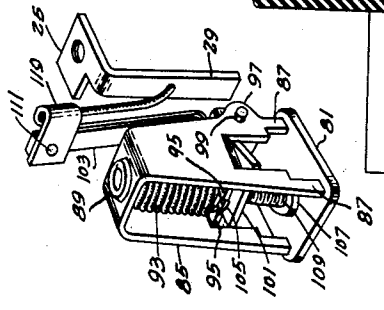


Fig. 4.

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CIRCUIT BREAKER

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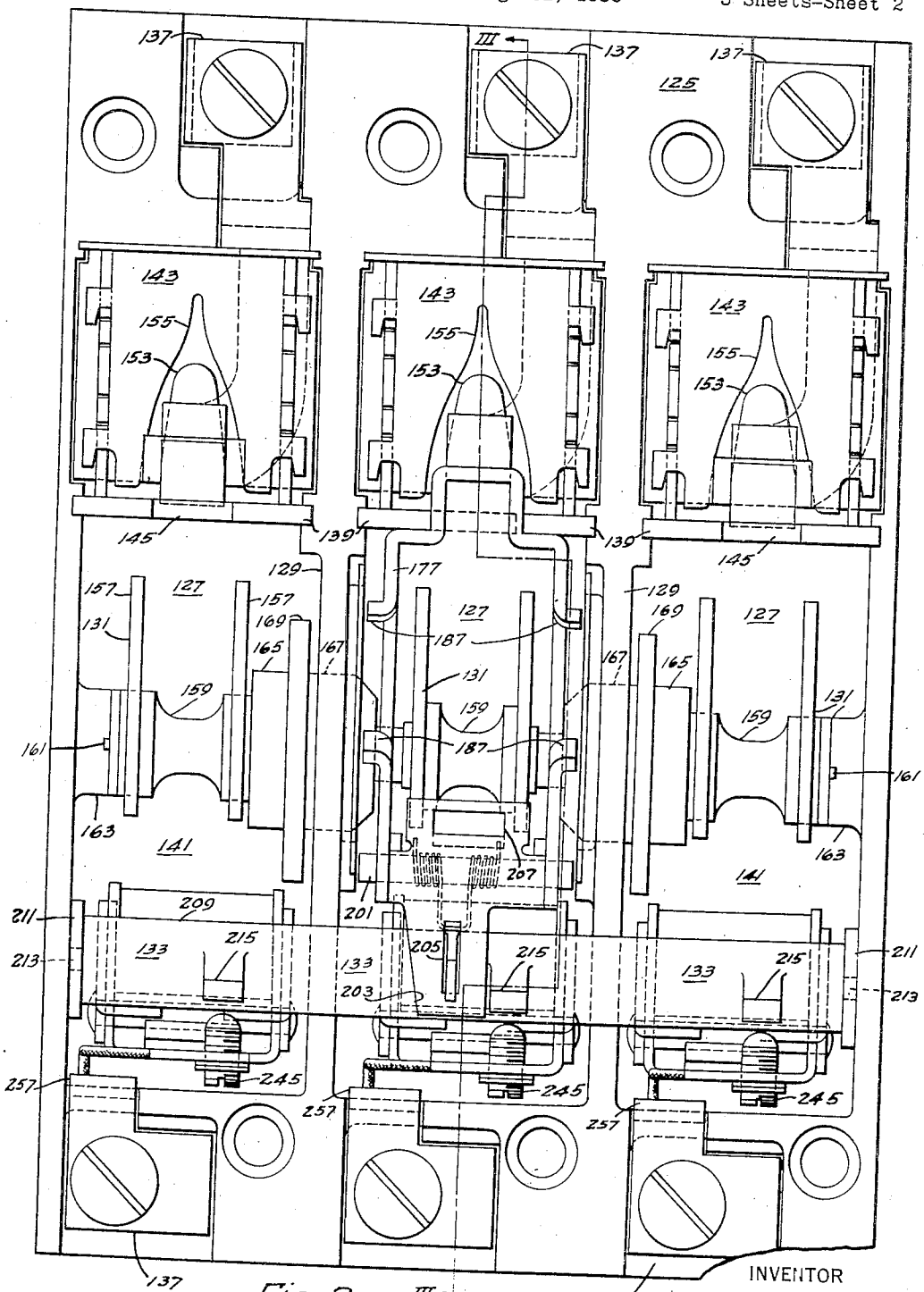


Fig. 2.

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CIRCUIT BREAKER

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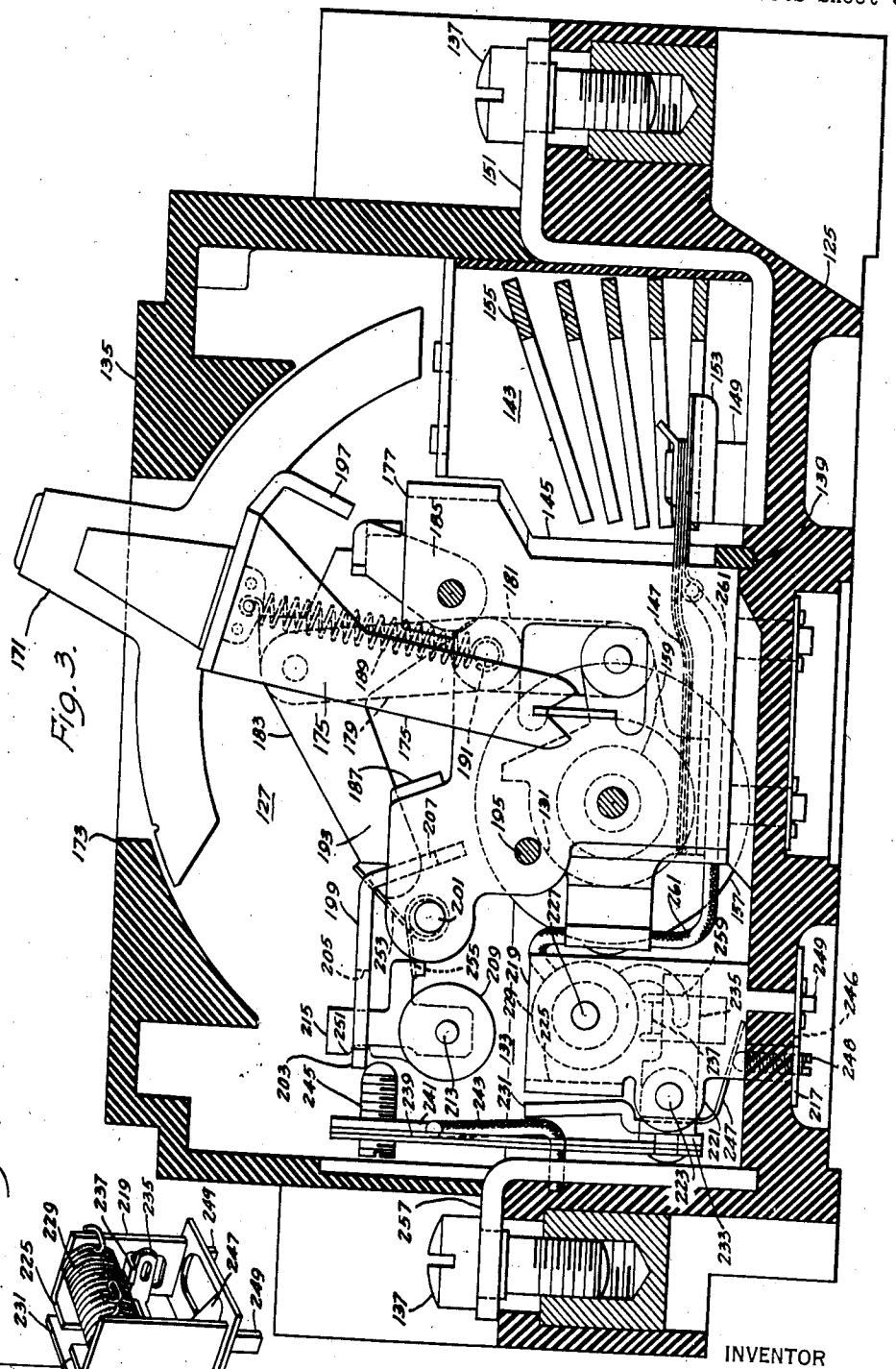


Fig. 3.

Fig. 5.

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Patented June 13, 1939 2,162,577

UNITED STATES PATENT OFFICE

2,162,577

CIRCUIT BREAKER

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Application August 31, 1936, Serial No. 98,747

20 Claims. (Cl. 200—88)

My invention relates to electrical apparatus, and more particularly, to electrical responsive devices of the type used for controlling the operation of the protective circuit breakers for power distribution or feeder network systems or other electrical systems.

In services of this type, the circuit breakers must compete directly with fuse devices, hence, to be commercially successful they must be relatively inexpensive. At the same time, however, since the breakers may be operated by inexperienced persons, they must be absolutely safe as well as simple and reliable in operation.

The very nature of the service to which the breakers may be put imposes a serious problem upon the circuit breaker designer. The magnitude of the normal line current of the system may be comparatively small, yet, due to the interconnection of a large number of circuits, overloads of varying amounts are apt to occur. Thus, to give satisfactory protection to the associated equipment, the circuit breaker must be capable of automatic opening either upon low magnitude overloads or upon extremely heavy overloads or short circuit conditions.

The most satisfactory method of meeting these requirements has been in the provision of circuit breakers of large arc extinguishing capacity and in which a trip device is operable after a predetermined time to effect the opening of the associated breaker upon the occurrence of predetermined small overload currents, and is also operable, substantially instantaneously, to effect opening of the controlled breaker upon the occurrence of large overloads or short circuit conditions.

For selectively distinguishing between overloads of different magnitudes, it has been customary to provide a current carrying bimetallic element, which is so calibrated that it will cause operation of a trip device, which opens the breaker after a predetermined time delay following the occurrence of a lower magnitude overload. When a large magnitude overload occurs, it is imperative that the breaker open quickly, and to accomplish this, an electromagnetic trip element is usually provided, which element is made responsive to the current through the breaker to cause operation of the trip device in response to such conditions.

In multi-pole switch structures, a magnetically responsive and a thermally responsive trip element were usually provided for each separate pole.

The principal object of the present invention is the improving of trip devices of this general form.

Heretofore, it has been the practice to provide separate mountings for the bimetallic trip element and for the magnetically responsive trip element. This arrangement has necessitated a relatively large number of parts, together with increased cost of manufacture.

In the present invention, I provide a trip device in which the bimetallic trip element and the magnetic trip element or armature are secured together and pivoted about a common axis. Through this means the structure of the trip device is considerably simplified, the number of parts necessary to achieve the desired result materially reduced, and the expense of manufacturing the circuit breaker as a whole or the trip device as a unit is greatly reduced.

Another object of the invention is to provide an improved electro-responsive trip device which utilizes a plurality of thermally responsive trip elements and a plurality of magnetically responsive trip elements, the various structural features being arranged in a novel manner in order to effect a reduction in the space occupied by the device, and to effect a material reduction in the number of parts necessary to produce the desired result.

Another object of my invention is in the provision of a trip device having the parts thereof arranged in a novel manner to cooperate with certain features of the circuit breaker operating mechanism.

Another object of my invention is to provide an improved trip device for a circuit breaker embodying a bimetallic trip element and a magnetic trip element secured together and pivoted about a common axis, in which the trip characteristics of each element may be separately adjusted.

These and other objects, as well as the preferred method of carrying out the invention, will be made more apparent by reference to the accompanying drawings, wherein are shown views of the structural details of devices utilizing the principles of my invention. Referring to the drawings:

Figure 1 is a vertical sectional view of a single-pole circuit breaker and trip device wherein are embodied the features of one form of my invention;

Fig. 2 is a top plan view of a three-pole circuit breaker and trip device with the cover removed, in which a slightly modified form of trip device embodying the features of my invention is shown;

Fig. 3 is a vertical sectional view of the circuit breaker and trip device shown in Fig. 2, taken along the line III—III thereof;

Fig. 4 is a perspective view of the trip device embodied in the single-pole circuit breaker structure shown in Fig. 1; and

Fig. 5 is a perspective view of the modified trip device embodied in the multi-pole circuit breaker structure shown in Figs. 2 and 3.

The circuit breaker illustrated in Fig. 1 includes a base 7 of molded insulating material, which is provided with a main compartment 9 for receiving the switch actuating mechanism 11 and the trip device 13, and a second compartment 15 for receiving the contact means. The second compartment is separated from the main compartment by a partition 17 provided with a longitudinally extending slot 19 therein, through which a resilient contact supporting arm extends. A cover 23 also of molded insulating material, is provided for enclosing the conducting portions of the breaker and protecting the elements and mechanisms thereof. The cover is secured in place on the base by suitable fastening means, such as bolts (not shown), at each end thereof. These bolts pass through the cover and base and clamp the two members tightly together. A pair of terminals 25 are mounted in recesses provided therefor in each end of the base.

The contact means of the breaker includes a stationary contact 27, disposed in the second-mentioned compartment 15 referred to above, which is connected by a conductor 29 to one of the terminals 25 of the breaker. The movable contact 31 is mounted upon a resilient contact carrying arm 33 which passes through the partition and is secured to the base 35 of a U-shaped contact supporting member 37 pivoted to a main frame member by means of a pin 39. The resilient contact carrying arm 33 is secured to the base of the U-shaped contact support by any suitable fastening means, such as the rivets 41 shown in Fig. 1.

The contact actuating mechanism 11 is mounted within the main compartment 9 of the base and is supported by a main frame member 43 having side walls, only one of which is shown. A stop pin 45 extends through the side walls for engaging a projection 47 on the pivoted movable contact supporting member 37 to limit its movement in the open position of the contacts 27—31. Pivotally secured to the upper and forward corners of the side walls of the main frame 43 means of the U-shaped member 46 and pin 48, is a cradle member 49 having a cut-away portion 51 and an extension 53. A pair of toggle links 55 and 57 pivotally connect the movable contact supporting member 37 with the pivoted cradle member, as shown in Fig. 1. The operating member 59 for the breaker is pivotally mounted on the main frame, as indicated at 61, and consists of a U-shaped member 63 having a manual control member 65 secured to the bight of the U thereof. A portion of the control member projects through a slot 67 provided in the cover 23 for the circuit breaker. The lower ends of the legs of the U-shaped operating member are bifurcated and rest upon lugs 69 struck out from the sides of the main supporting frame 43. Over-center springs 71 connect the knee pivot 73 of the toggle links 55 and 57 with projecting ears 75 carried on the under side of the bight of the U-shaped operating member 63. The bight of the U-shaped operating member is provided with a downwardly bent hook 77 for engaging an edge of the notch 51 provided in the pivoted cradle member 49 for engaging and moving the same to its latched position when the operating handle is moved to its open position.

From the above description of the breaker actuating structure, it will be apparent that when the operating member is moved to the left, or downwardly, as shown in Fig. 1, the movable contact supporting member is moved to an open circuit position with a snap action, due to the construction and mounting of the toggle links and overcenter springs. Likewise, after being moved to the open position, if the operating handle is now moved to the position shown in Fig. 1, the movable contact member will be moved with a snap action to its closed position.

For aiding in the extinction of the arcs which are formed incident to the opening of the circuit controlled by the breaker, an arc extinguishing device 79 of the spaced plate type, is provided. The features of this extinguisher are not an important part of my invention, and any suitable structure may be utilized.

The novel electro-responsive trip device 13, shown associated with the circuit breaker structure of Fig. 1, which breaker has been described above, is shown more clearly in Fig. 4. The trip device is supported by a base plate 81, which fits in a recess 83 provided on the underside of the circuit breaker base 7. A U-shaped supporting member 85 is supported on the base plate 81 by means of projections 87 provided on the legs of the U-shaped member which extends through the base of the breaker and the base plate, and have portions thereof clinched over to engage the base plate to hold the U-shaped member rigidly against the breaker base, as shown in Fig. 1. A core member 89 is secured between the legs of the U-shaped member by any suitable fastening means, such as shown in Fig. 1. The core member 89 extends in a direction parallel to the legs of the U-shaped supporting member 85, and has wound thereon an insulated conductor wire 93. Each leg of the U-shaped supporting member has a lug 95 struck therefrom and bent inwardly adjacent the end of the core member 89 to form a pole face for the electromagnet formed by the coil and the core. The rear edges of each of the legs of the U-shaped member are provided with ears 97, each having an opening therein to receive a pivot pin 99. An armature 101 is pivotally mounted on the pivot pin and extends to a position adjacent the pole faces 95 and the end of the core member 89. A bimetallic trip element 103 is secured to the armature at one end, and extends in a direction substantially parallel with the edges of the U-shaped supporting member.

Means are provided for biasing the armature 101 away from the pole faces and for adjusting the trip characteristic of the magnetic trip device. This means comprises a tension spring 105 of non-magnetic material positioned in an opening 106 in the core member 89. One end of the spring engages the armature 101 and the other end engages an adjusting screw 108 which is threaded into the upper end of the opening in the core member. The adjustment of the trip characteristic is obtained by changing the position of the adjusting screw to change the tension of the spring 105. It will be noted that this adjustment is independent of the adjusting means for the bimetallic trip element, and has no effect on the trip characteristic of the bimetallic element.

An internally threaded bushing 107 extends

through the base plate 81 and the bottom wall of the breaker base, and is held against turning movement by serrations provided on its outer face. An adjusting screw 109 is threaded through the bushing for limiting the movement of the armature away from the pole faces and for further adjusting the trip characteristics of the electromagnetic trip element, and also the position of the bimetallic member. The bimetallic trip element may be of any conventional form, and usually consists of a pair of metallic strips having different linear coefficients of expansion secured together and calibrated so that when a predetermined overload current passes therethrough, the heat produced will cause the trip element to bend in a direction away from the bight of the U-shaped supporting member 85, its lower end being held relatively fixed by reason of the adjusting screw 109 and spring 105. The free end of the bimetallic trip element has an adjusting screw 111 threaded therethrough, which is adapted to engage and hold a latch device 113 secured to the free end of the cradle member.

The adjusting screw 111 provides a means for changing the trip characteristic for the bimetallic trip element and for compensating for any change in the normal position of the armature effected by the adjusting screw 109. The screws 111 and 109 permit a very fine adjustment of the trip characteristic of the bimetallic trip element, so that it may be arranged to release the cradle in response to varied magnitudes of overload after varied time intervals. It will be noted that the means for adjusting the trip characteristic of the bimetallic trip element is independent of the adjustment for the magnetic trip characteristic introduced by the adjusting screw 108 and spring 105.

The trip device is connected in circuit with the contact means in the following manner. A conductor 115 extending from the terminal 25 has secured thereto a conductor wire 117, which is connected to an extension 119 formed on the free end of the bimetallic member. A second conductor wire 121 connects the other end of said bimetallic member, which is secured to the armature, to one end of the electromagnet coil 93. The other end of the electromagnet coil 93 is connected by a relatively flexible wire 123 to the resilient movable contact carrying arm 33. This form of connection in which the electromagnet coil is connected in series with the contact members, results in an instantaneous tripping of the cradle member on a heavy overload. If an instantaneous trip is not desired, a connection may be provided in which the electromagnet coil is connected in a shunt connection.

The operation of the circuit breaker described above in connection with the trip device is as follows. With the elements arranged in the position shown in Fig. 1, i. e., with the contact means thereof in closed position and the cradle member held in latched position by the bimetallic trip element, if an overload of predetermined low magnitude occurs in the circuit for a predetermined length of time, the current in passing through the bimetallic trip element heats the same and causes it to bend in a direction away from the cradle latch member, thus releasing the cradle member and allowing the overcenter springs which are under tension to move the contacts to open position. Likewise, if an overload of high magnitude or a short circuit occurs on the circuit in which the interrupter is connected, the armature is instantaneously attracted to the pole faces and moves the bimetallic trip element in such a direction as to release the cradle member and thus cause the overcenter springs to move the switch contacts to their intermediate open circuit position. After the contacts have been moved to their open circuit or tripped position, the contacts thereof cannot again be closed without first moving the operating member to the full open position, by reason of the fact that the cradle member is no longer held in latched position. In moving the operating handle of the breaker to the full open position, the hook carried by the U-shaped operating member engages the edge of the notch provided on the cradle member and moves the same in a counter-clockwise direction about its pivot toward its latched position. Just prior to arriving at its latched position, the latch portion of the cradle engages the adjusting screw and moves the bimetallic trip element slightly in a counter-clockwise direction so as to allow the end of the latch on the cradle member to re-engage under the adjusting screw. It will thus be seen that the trip unit is automatically re-set and the breaker is in a condition to again be closed by the manual operation of the control handle toward the closed position. It will be noted at this point that a part of the force of the biasing overcenter springs is transmitted through the cradle member, the latch thereon and the bimetallic trip element to bias the armature against its adjustable stop, thus aiding the spring 105 in maintaining the armature in this position, and holding the trip element in latching position.

It will also be noted that the deflection or bending of the bimetallic trip element, when the same is heated in response to lower and moderate magnitude overloads, is entirely independent of and uninfluenced by the electromagnetic trip means including the armature 101. This feature is of considerable importance because it permits the bimetallic trip element to control the breaker over a wider range of overloads and permits a more accurate and reliable adjustment of the trip characteristic of the bimetallic trip element to be made in the range of overloads above normal and below the critical value of current above which the electromagnetic trip means is designed to respond.

The three-pole structure illustrated in Figs. 2 and 3 includes many features which are common to the single pole structure. The three-pole circuit interrupter includes a base 125 of molded insulating material having a plurality of longitudinal compartments 127 formed therein by means of the partitions 129 formed integral with the base. Each compartment accommodates a movable contact supporting structure 131 and a trip device 133 for one pole of the breaker. A cover 135 is provided also of molded insulating material for enclosing the conducting portions of the breaker. Six terminals 137 are mounted in recesses formed in the ends of the base for receiving the conductors which connect the poles of the breaker in their electrical circuits. Transverse partitions 139 are provided for each of the compartments 127 to divide it into a main compartment 141 and a contact receiving compartment 143. These partitions are formed with longitudinal slots 145 through which pass the resilient contact carrying arms 147 of the breaker. A stationary contact 149 is mounted at the bottom of each of the contact receiving compartments 143 and is connected by a conductor 151 to its corresponding terminal 137. The movable con-

tacts 153 are each carried by a resilient contact carrying arm 147 which passes through the slot 145 in the partition 139.

For aiding in the extinction of the arcs which are formed incident to the opening of the circuits controlled by the poles of the breaker, three arc extinguishing devices 155 of the spaced plate type are provided. The features of these extinguishers are not an important part of my invention, and any suitable structures may be utilized.

Each of the contact carrying arms 147 is mounted for movement with its rotatable support member 131. The support members are preferably of U-shape and have opposed substantially parallel side walls 157 and a transverse section 159 to which the flexible contact arms 147 are secured. A hub member 159 is disposed transversely between the side walls of the member 131 and is rigidly secured to the side walls in any suitable manner, as for instance, by providing the hubs with reduced end portions of elongated cross section and the side walls with correspondingly shaped apertures through which the end portions extend. The protruding portions of the hubs may be spun over so as to firmly hold the hubs in position. The outer ends of the hub members for the outside poles of the breaker are secured in coaxial relation each through a bearing pin 161 which is pivotally mounted on a support 163 extending upwardly from the base. The inner ends of the hub members are each provided with a coaxial coupling pin (not shown). The coupling pins are serrated on their outer surfaces and are adapted to be rigidly coupled with similar coupling pins extending from the hub 159 for the center contact carrying arm by means of cylindrical coupling members 165 of insulating material. It will thus be seen that the coupling members unite the movable contact supporting members to each other so as to form a rotatable support structure whereby the movement of the movable contact members into and out of engagement with the fixed contacts will be simultaneously effected.

In order to accommodate the coupling members an aperture 167 is provided in each of the partitions. Provision is also made to prevent flashover from one pole to the other at the points between the apertures 167 and the coupling members by providing annular flanges 169 upon the coupling members.

A single actuating mechanism is provided for simultaneously moving all of the contact means of the breaker to open and to closed positions. This actuating means is actuated by the movement of the handle member 171 which has a portion extending through an opening 173 formed in the cover. The single operating means for moving the contacts of each pole of the breaker is substantially the same as that disclosed for the single pole breaker described in preceding paragraphs. It consists, as has been mentioned before, of a U-shaped operating member 175 pivoted to a main supporting frame 177, toggle links 179 and 181 which are pivoted at one end to the rotatable support member for the center contact arm and also pivotally connected at their upper ends to a common cradle member 183 which is, in turn, pivoted at its forward end to the frame 177 by means of the U-shaped pivot means 185 shown in Fig. 3. Lugs 187 are struck out from each side of the main frame member for limiting movement of the operating member 175. Overcenter springs 189 connect the bight of the U-shaped operating means 175 with the knee pivot 191 of the toggle link mechanism. The free end 193 of the cradle member 183 is provided with a notch as shown in Fig. 3 to engage a latch which will be described hereinafter. A stop pin 195 extends through the main frame for limiting movement of the rotatable contact supporting member 131 for the center pole of the breaker.

From the above description, it will be seen that all of the contact means are moved simultaneously to open or closed circuit position with a snap action upon movement of the control handle to corresponding positions. The cradle member is engaged and moved to its latched position by the hook 197 carried by the operating member 175.

The novel form of trip device 133 for the three-pole breaker structure described above cooperates with a latch device pivotally mounted on a pin 201 which extends transversely between the side walls of the main frame 177. The latch device consists of a U-shaped member 199 having the legs thereof pivoted about the pin 201 mentioned above. An extension 203 projects from the bight of the latch member 199 and is provided with a rectangular shaped aperture 205. A rectangular aperture 207 is also provided in the bight portion of the latch member 199. A common trip bar 209 extends across the three poles of the breaker and is pivotally mounted at its ends on supporting members 211 by pins 213. The trip bar constructed of molded insulating material is provided with spaced projecting lugs 215 one for each pole of the breaker. A plurality of individual trip devices 133 are provided, one for each pole of the breaker.

Referring to Fig. 5, each trip device comprises a base of non-magnetic material 217, a pair of spaced supporting members of magnetic material 219, each having an ear 221 formed thereon, provided with a hole for receiving a pivot pin 223. Extensions are provided on said support members above the ears and are bent inwardly as shown to form pole pieces 225. A core 227 of magnetic material is mounted transversely between the support members 219 adjacent the pole pieces, and an insulated conductor 229 is wound about said core. An armature 231 is pivotally mounted on the pin 223 by means of a U-shaped member 233 of non-magnetic material having a short leg, not shown, and a long leg 235, each provided with an opening to receive the pivot pin. The long leg 235 of the member extends adjacent the inner surface of one of the supporting members 219 and a lug 237 is struck inwardly from the leg 219 to limit movement of the armature away from the pole faces. A bimetallic trip element 239 is secured to the base of the armature 231 and to the U-shaped pivot member 233 by any suitable means such as by riveting or welding. The free end of the bimetallic trip element is provided with an extension 241, for connecting a conductor wire 243 thereto. The free end of the trip element has an adjusting screw 245 threaded therethrough. A spring means 247 is provided for engaging the armature 231 and biasing the same in a direction away from the pole faces 225.

An internally threaded bushing 246 is fitted in an opening in the breaker base and accommodates an adjusting screw 248 which engages the spring 247. The position of the adjusting screw 248 may be changed to adjust the tension of the spring 247 and hence the trip characteristic of the magnetic trip device. The adjusting screw 245 provides a means for adjusting the trip

characteristic of the bimetallic trip element. It will be noted that the two adjustments are independent and neither has any effect on the other. The lower ends of the supports **219** are each provided with a projection **249** which projects through the base member **217** of non-magnetic material and the base of the circuit breaker, and each projection **249** has its end clinched over to engage the base member of non-magnetic material to hold the trip unit in rigid engagement with the base **125** of the circuit breaker (see Fig. 3). The free ends of the bimetallic tripped elements having the adjusting screws threaded therethrough, are disposed adjacent and are adapted to engage their corresponding projections on the trip bar, when moved. A latch engaging member **251** of the configuration shown in Fig. 3 is provided on the trip bar for engaging the edge of the opening **205** in the latch member to hold the latch **199** in latched position. The latch member is biased to latched position by means of a spring **253** which has one end engaging a projecting surface **255** on the trip bar, its body coiled about the pivot pin **201** of the latch device, and its other end engaging an edge in the opening **207** in the bight of the latch device. The nose **193** of the cradle member **183** is adapted to engage under the edge of the opening **207** in the bight of the latch device **199** and is held in latched position thereby. The extension **203** of the latch is held in a horizontal position by the engagement of an edge thereof with the latch engaging projection **251** on the trip bar **209**. Thus the cradle member **183** of the breaker is held in latched position by means of the latch device **199** and the trip bar **209**.

The electrical connections for the three pole breaker are as follows: Each trip device is connected in circuit with its corresponding contact means and pole in the following manner: A conductor **257** extending from the terminal **137** of the breaker is connected by the flexible lead **243** with the extension piece **241** at the free end of the bimetallic trip element **239**. Another flexible lead wire **259** is connected to the long leg **235** of the armature supporting member **233** and extends to one end of the electromagnet coil **229**. The other end of the electromagnet coil is then connected to the conventional flexible lead **261** which is in turn connected at its other end to the movable resilient contact carrying arm **147**. The bimetallic strip and the electromagnet coil are thus connected in series circuit with the contact means. Each trip device is connected in circuit with its contact means in the manner described above. If desired, a shunt connection may be provided for the electromagnet as described in connection with the trip device for the single pole breaker.

The operation of the three-pole circuit breaker and trip device is as follows: With the parts of the breaker in the position shown in Fig. 3, if an overload of low magnitude occurs on the circuit through any of the poles of the breaker for a predetermined length of time, the current, in passing through the bimetallic trip element, heats the same and causes it to bend in a direction to engage the projection on the trip bar and to move the same in a clockwise direction. The movement of the trip bar in a clockwise direction causes the latch engaging projection of the trip bar to release the latch device. The latch device is now moved in a counter-clockwise direction by the force exerted on the cradle member by the overcenter springs, and after a partial rotation, releases the free end or nose of the cradle member and allows it to move in a clockwise direction, as viewed in Fig. 3. This movement of the cradle member allows the overcenter springs and toggle mechanism to move the contact means to open position. The breaker is now in its opened or tripped position and cannot again be closed by reason of the position of the cradle member. To reset the switch, it is necessary to move the handle to the full open circuit position. Movement of the handle to this position causes the hook of the operating member to engage and move the cradle member in a counterclockwise direction. As the cradle member approaches the latching position shown in Fig. 3, its nose engages the latch device and rotates the same partially in a clockwise direction, so that the latch engaging projection on the trip bar reengages and latches the latch device. The cradle member is now held in latched position and the operating handle can now be moved to its full closed position, during which movement it moves all of the contact means to their closed circuit position with a snap action.

When a heavy magnitude overload or short circuit condition occurs in any one of the circuits controlled by the breaker, the pull of the electromagnet of the trip device associated with the pole of the breaker on which the abnormal condition occurs becomes sufficient to move its armature **231** in a clockwise direction about the pivot pin **233** to attracted position against the pole pieces **225**. This movement of the armature **231** moves the bimetallic trip element supported thereby in a clockwise direction to move the trip bar to tripped position to effect opening of all of the contact means in the manner previously described.

It will be noted that in this form of the invention the flexing or bending movements of the bimetallic trip elements is independent of the electromagnetic trip means the same as in the single pole trip device.

From the foregoing it will be seen that I have disclosed the structural details of a new and improved form of trip device which is particularly suitable for use with circuit breakers and similar apparatus. The novel structure of my improved trip device, both in the form used in the single pole breaker and that used in connection with the multi-pole circuit breakers enables the same to be manufactured at an extremely low cost, reduces the number of parts necessary to achieve the desired results, and provides an extremely simple and rugged unit which can be manufactured either as a separate unit or for use with any particular form of circuit breaker. By reducing the number of necessary parts, required in the marketing of a line of circuit breakers, substantial manufacturing economies are effected.

Obviously many structural changes may be made in the devices without departing from the spirit of the invention. For example, the bimetallic strip may be mounted in various other positions on the armature to engage an adjustable stop when bent due to heat to cause movement of the armature. In such cases an additional trip member would be mounted on the armature for movement therewith to release the cradle in one modification and to move the trip bar in the other modification. The armature and electromagnet could also be mounted in various other positions and by various other forms of supporting means.

While in accordance with the patent statutes I have disclosed the foregoing details of two prin-

cipal embodiments of my invention, it is to be understood that the broad principles disclosed are capable of much wider application and that many of the details are merely illustrative. I desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction and that my invention will be limited by only what is expressly stated therein and by the prior art.

I claim as my invention:

1. In a multipole circuit breaker, contact means for each pole thereof, common actuating means for moving all of said contact means to an open circuit position and to a closed circuit position, said actuating means including a releasable member having a latched position and a released position which when released causes movement of all of said contact means to an open circuit position, a trip bar extending across all of the poles of said breaker and movable between a normal position and a tripped position, said trip bar having means associated therewith for holding said releasable member in the latched position when said trip bar is in its normal position, and for releasing said member when said trip bar is moved to its tripped position, a plurality of electro-responsive trip devices one for each pole of said breaker each operable in response to predetermined conditions to effect movement of the trip bar to its tripped position, each said trip device including an electromagnet, an armature pivoted adjacent said electromagnet, and a bimetallic trip element secured to said armature, said trip bar being provided with projections, one for each trip device, adapted to be engaged by said trip elements to move said trip bar to tripped position, and means for connecting each bimetallic trip element and its corresponding electromagnet in circuit with its corresponding contact means.

2. A trip device for electrical control apparatus comprising a base of non-magnetic material, a pair of spaced supports of magnetic material mounted on said base, each support having an ear extending from one edge adjacent the base and an extension above said ear bent inwardly at right angles to form a pole face, a core of magnetic material secured between said supports adjacent the pole faces, a coil wound upon said core, an armature pivotally mounted to said ears between the same and extending to a position adjacent said pole faces for cooperation therewith, and a bimetallic trip element secured at one end to said armature.

3. In a multipole circuit breaker, a plurality of pairs of relatively movable contacts forming the poles of the breaker, common operating mechanism operable to open and to close all of said pairs of contacts said operating mechanism including a member releasable to cause opening of all of said pairs of contacts, a trip device operable in response to predetermined conditions to effect release of said releasable member comprising a plurality of electroresponsive trip means one for each pole of the breaker, each trip means comprising an electromagnet, a movable armature therefor, a bimetallic thermally responsive trip element carried by said armature, said electromagnet and said thermally responsive element being energized in response to the current flowing in the circuit of their corresponding pole, an adjusting means for adjusting the trip characteristic of said thermal trip element and a separate adjusting means for adjusting the trip characteristic of said electromagnet.

4. In a multipole circuit breaker, a plurality of pairs of relatively movable contacts forming a plurality of poles, common actuating mechanism for said contacts operable to open and to close all of said pairs of contacts, said actuating mechanism including a member releasable to cause opening of all of said pairs of contacts, a separate trip device for each pole of the breaker each independently operable in response to predeterconditions to effect release of said releasable member, each trip device comprising an electromagnet connected in circuit with its corresponding pair of contacts, a movable armature for said electromagnet and a bimetallic trip element carried by said armature and heated in response to the current flowing through its corresponding pair of contacts.

5. A trip device for releasable electrical control apparatus comprising a pair of spaced parallel supporting members, an armature pivotally mounted on said supporting members, an electromagnet secured to said supporting members in cooperative relation to said armature, and a bimetallic trip element having one end secured to said armature adjacent the pivot thereof.

6. A trip device for electrical control apparatus comprising a support, an electromagnet mounted on said support, an armature pivotally mounted on said support in cooperative relation to said electromagnet, a bimetallic trip element having one end secured to said armature adjacent the pivot thereof, and spring means for biasing said armature away from said electromagnet.

7. A trip device for electrical control apparatus comprising a support, an electromagnet mounted on said support, an armature pivotally mounted on said support in cooperative relation to said electromagnet, a bimetallic trip element having one end secured to said armature adjacent the pivot thereof, spring means for biasing said armature away from said electromagnet, and an adjustable stop for limiting movement of said armature away from said electromagnet.

8. A trip device for electrical control apparatus comprising a base, a pair of supports extending from said base, an electromagnet mounted on said supports, an armature pivotally mounted on said supports in cooperative relation to said electromagnet, a bimetallic trip element having one end secured to said armature adjacent the pivot thereof, spring means for biasing said armature away from said electromagnet, each of said supports being provided with an extension bent over to form a pole face for said electromagnet.

9. A trip device for electrical control apparatus comprising a U-shaped base member, a core secured to the bight of said U-shaped member and extending parallel to the legs thereof, a coil conductor wound upon said core, a lug struck out from each leg of said U-shaped member to form a pole for the electromagnet formed by the coil and core, an armature pivoted to the legs of said U-shaped member adjacent said core and pole faces, and a bimetallic trip element secured to said armature adjacent the pivot thereof.

10. In a circuit breaker having relatively movable contacts and a member releasable to cause opening of said contacts, a trip device operable in response to predetermined conditions to effect release of said releasable member to cause opening of said contacts, said trip device comprising an electromagnet, a movable armature for said electromagnet and a bimetallic trip element carried by said armature for movement thereby and for movement relative thereto.

11. For use in a circuit breaker having a means releasable to cause opening of the contacts thereof, a trip device comprising a support, an electromagnet mounted on said support, an armature pivotally mounted on said support in operative relation to said electromagnet, adjustable means for biasing said armature away from said electromagnet, a bimetallic trip element secured to said armature for normally holding said release means when said armature is unattracted, means for adjusting the amount of movement of said trip element necessary to cause release of said release means.

12. In a circuit breaker having relatively movable contacts and a member releasable to cause opening of said contacts, a trip device operable in response to predetermined conditions to effect release of said releasable member to cause opening of said contacts, said trip device comprising an electromagnet, a movable armature therefor, and a bimetallic trip element carried by said armature for movement thereby and for movement relative thereto, said trip element being heated in response to the current flowing in the circuit and said electromagnet energized in response to the current flowing in the circuit, said trip element being movable relative to said armature when heated a predetermined amount to effect operation of the trip device and said trip element being movable by said armature when said electromagnet is energized a predetermined amount to effect operation of the trip device.

13. In combination with a circuit interrupter having relatively movable contacts and a member releasable to cause opening of said contacts, a trip device operable in response to predetermined conditions to effect release of said releasable member comprising an electromagnet, a movable armature and a thermally responsive trip element carried by said armature for bodily movement thereby and for flexing movement relative thereto, said trip element and said electromagnet being energized in response to the current flowing in the circuit controlled by the breaker, said trip element and said electromagnet having variable trip characteristics, and means for individually adjusting the trip characteristic of said trip element and of said electromagnet.

14. The combination with a circuit controlling device having contact means for opening and closing the circuit, of a trip device operable in response to predetermined conditions to cause said contact means to open the circuit comprising an electromagnet including a movable armature, and a thermally responsive trip element carried by said armature, and means for individually adjusting the trip characteristic of said electromagnet and of said thermally responsive element.

15. A trip device for electrical control apparatus comprising an electromagnetic trip means including a movable armature, a thermally responsive trip element carried by said armature, and means for individually adjusting the trip characteristic of said electromagnetic trip means and of said thermally responsive trip element.

16. A trip device for electrical control apparatus comprising an electromagnetic trip means including a movable armature, and a thermally responsive trip element carried by said armature.

17. The combination with a circuit controlling device having contact means for opening and closing the circuit, of a trip device operable in response to predetermined conditions to cause said contact means to open the circuit comprising an electromagnet including a movable armature, and a thermally responsive trip element carried by said armature.

18. A trip device for electrical control apparatus comprising an electromagnetic trip means including a movable armature, and a thermally responsive bimetallic trip element having one end secured to said armature so that its free end is movable independently of said armature when the element is heated.

19. In a circuit breaker, contact means, actuating means for said contact means including a spring biased member releasable to cause opening of said contact means, a trip device for normally restraining said member operable in response to predetermined conditions to release said member and cause opening of said contact means, said trip device comprising an electromagnet, a pivotally mounted armature movable from an unattracted to an attracted position by said electromagnet, and a bimetallic trip element carried by said armature having means for normally engaging and restraining said spring biased member, the point of engagement of said trip element with said spring biased member being so disposed relative to the pivot axis of said armature that a component of the force exerted by said spring biased member biases said armature to the unattracted position.

20. In a circuit breaker, contact means, actuating means for said contact means including a spring biased member releasable to cause opening of said contact means, a trip device for normally restraining said member operable in response to predetermined conditions to release said member and cause opening of said contact means, said trip device comprising an electromagnet, a pivotally mounted armature movable from an unattracted to an attracted position by said electromagnet, and a bimetallic trip element carried by said armature having means for normally engaging and restraining said spring biased member, the point of engagement of said trip element with said spring biased member being so disposed relative to the pivot axis of said armature that a component of the force exerted by said spring biased member biases said armature to the unattracted position and said trip element to latching position.

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