Nov. 19, 1957 I. W. COX 2,813,946

CIRCUIT BREAKERS

Filed March 1, 1954 2 Sheets-Sheet 1

Fig. 1

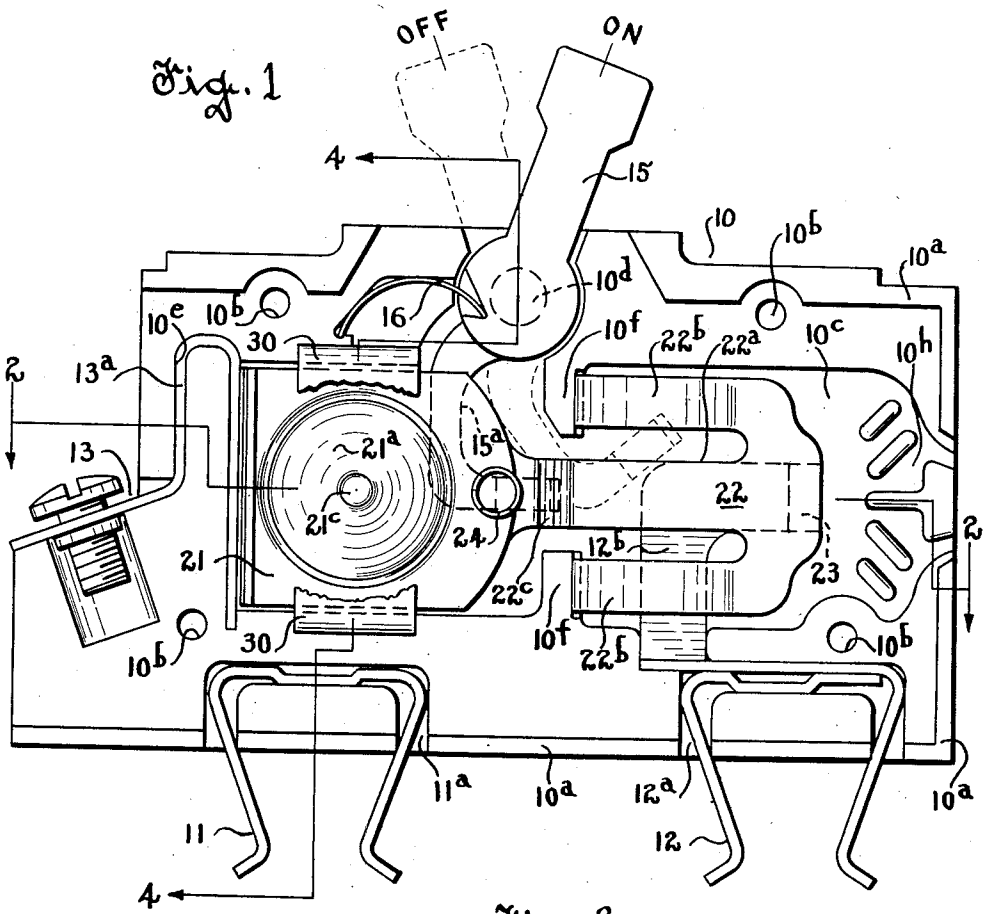
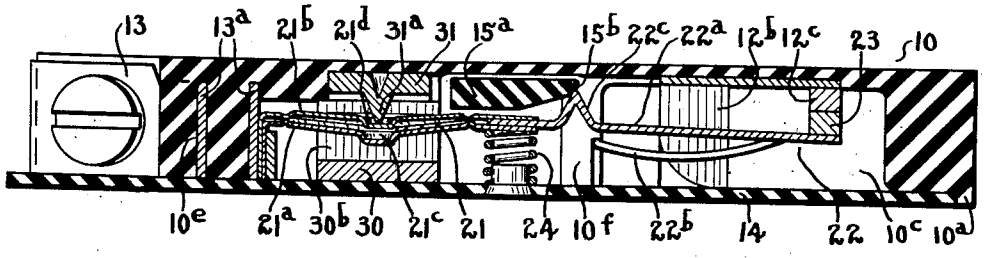


Fig. 2



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Filed March 1, 1954 2 Sheets-Sheet 2

Fig. 3

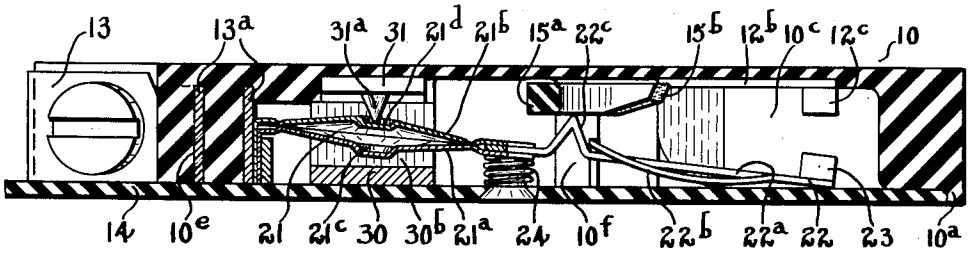


Fig. 4

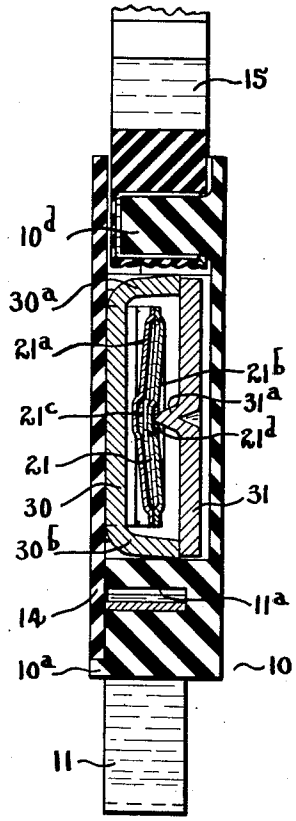
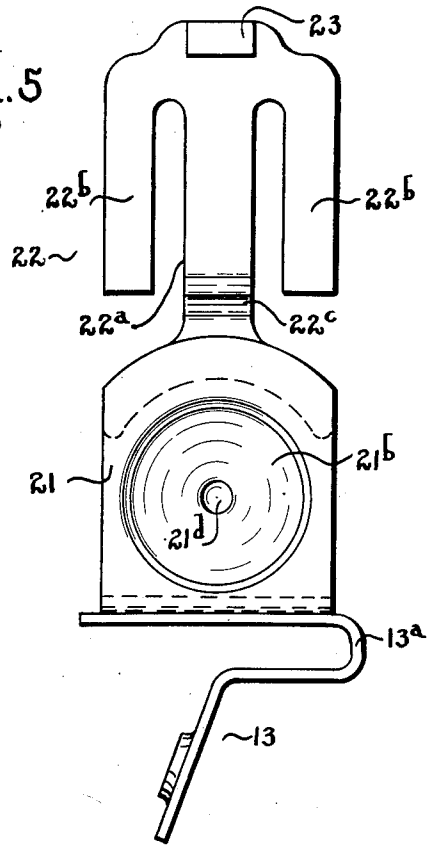


Fig. 5



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CIRCUIT BREAKERS

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Application March 1, 1954, Serial No. 413,363

13 Claims. (Cl. 200—88)

This invention relates to improvements in manually operable circuit breakers, and more particularly to such circuit breakers which are subject to automatic control by electro-thermally operable means, or electromagnetically operable means, or by both such means under predetermined conditions.

An object of the invention is to provide a fully snap-acting circuit breaker which uses a vapor pressure power element to effect circuit opening on overload.

Another object of the invention is to provide a circuit breaker which is extremely compact in relation to its current carrying and interrupting ability.

It is also an object of the invention to produce a circuit breaker construction which does not require calibration to obtain proper overload tripping, but rather is inherently calibrated.

Another important object of the invention is to provide a circuit breaker mechanism which is absolutely reliable in operation.

It is also an important object of the invention to reduce the number of parts required in a fully snap-acting circuit breaker without impairing its reliability or operating characteristics.

Another and more specific object of the invention is to provide a novel circuit breaker having a one-piece vapor pressure overload trip element and over-center contact carrying mechanism.

The above and other objects and advantages of the invention will be readily apparent from the following detailed description and the accompanying drawings wherein there is shown a preferred embodiment of one form of the present invention.

In the drawings:

Fig. 1 is a side elevational view of a circuit breaker made according to the present invention, the cover plate being removed to expose certain of the operating parts which are shown in the "on" position;

Fig. 2 is a sectional view taken along the lines 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 with some of the circuit breaker parts being shown in elevation and the circuit breaker being shown in the "overload tripped position";

Fig. 4 is a vertical sectional view taken along the lines 4—4 of Fig. 1, but showing the circuit breaker in the "short circuit tripped position"; and

Fig. 5 is a plan view of the one-pieice load terminal, overload trip element and movable contact carrier.

The invention contemplates the provision in a circuit breaker of a unitary, i. e., one-piece snap-acting contact carrying mechanism and vapor pressure overload trip mechanism. The invention further contemplates that the one-piece structure above-mentioned will readily lend itself to use with an electromagnetic trip mechanism.

Referring to Fig. 1 of the drawings, the circuit breaker therein shown comprises a molded insulating base or housing **10** having a plurality of cavities and projections for accommodating the bus clips **11**, **12**, the load terminal **13**, and the several parts of the operating mechanism. A flat cover plate **14** (shown in Figs. 2, 3 and 4) cooperates with the base **10** to complete the circuit breaker enclosure as well as to hold the several circuit breaker members in position. The cover fits within a projecting lip **10a** which extends substantially around three sides of the base **10** and is securely retained in place by rivets (not shown) which are inserted through openings **10b** formed in said base and in said cover plate **14**.

The bus clips **11** and **12** are retained in U-shaped recesses **11a** and **12a**. The bus clip **11** is not current-carrying and functions only as a clamping or support member. The bus clip **12**, used for making line connection, is formed of two parts, the right-hand part or leg having an integral conductor strip **12b** which leads into the contact chamber **10c** wherein it supports the stationary contact **12c** (Figs. 2 and 3). By leading the strip **12b** into the arc chamber at the left of the contacts as shown and having it extend at a right angle to run parallel to the movable contact arm **22** for a limited distance, a flux is provided which on circuit opening will tend to force any arc toward the right where it will be cooled by the labyrinth **10h** molded into the housing **10**.

The circuit breaker actuating handle **15** is pivotally mounted on a boss **10d** which also is formed integrally with the housing **10**. It is biased to "off" position by means of a spring **16** and includes a depending finger-like extension **15a** for engaging and actuating the movable contact arm **22**. In Figs. 1 and 2 the operating handle is shown iin the "on" position in which position it is latched by engagement with the detent **22c** formed in the contact arm **22**. However upon slight movement of the contact arm **22** toward open circuit position the operating handle **15** will be freed by the detent **22c** and moved to the "off" position under the bias of spring **16**.

The load terminal **13** comprises a relatively heavy current-carrying strip **13a** which is bent back upon itself as shown in Fig. 1. To anchor the power element and contact carrier securely in place the bent portion of said strip is snugly fitted into a similarly shaped groove **10e** formed in the housing **10**. Supporting the power element and contact carrier in this manner permits full pivotal movement thereof.

The overload trip power element **21** is of the vapor pressure type having a thermometric fill which boils when the current passing through it exceeds the desired limit. Power elements of this general type are shown and described in my earlier issued Patents No. 2,484,932, dated October 18, 1949, and No. 2,663,777, dated December 22, 1953.

In the embodiment herein illustrated the power element is formed of two substantially rectangular thin sheet metal portions **21a** and **21b** which are shaped and seam welded to form a diaphragm-like enclosure. The side **21a** does not undergo any substantial change in shape upon expansion of the thermometric fill and thus remains substantially stationary. However, the side **21b** is polarized so as to snap outwardly when the pressure inside the diaphragm exceeds the restoring force of said side (see Fig. 3). In the latter respect it has been found that the snap movement of the wall **21b** occurs very suddenly and with very little initial creep if bosses **21c**, **21d** are formed in the diaphragm walls as shown in the drawings. It is very desirable that the power element operate in such a manner, so as to insure accurate calibration of the circuit breaker and to avoid contact arcing which might occur if the contact carrier **22** were moved over-center with only a creeping force.

Support for the combined power element and contact carrier is provided by welding or brazing the left-hand end of the power element **21** to the load terminal strip **13a**, as best shown in Figs. 2 and 3. The right-hand end

of the power element is cut in arcuate form so as to avoid localized heating of the sheet metal of which it is composed. This end in turn supports the contact carrier 22, a portion of said carrier being inserted between the ends of the power element walls and welded or brazed thereto.

The snap mechanism 22 comprises a central tension or flipper arm 22^a and two compression spring strips 22^b. The length of said arm and said strips is so proportioned that when the breaker mechanism is inserted into the housing 10 with the free ends of the strips 22^b in abutting engagement with the grooved projections 10^f, the power element 21 and tension arm 22^a will be placed in tension and the strips 22^b will be placed in compression. The line of action of the snap mechanism thus provided is such that when the free ends of the strips 22^b are on that side of the tension arm 22^a opposite the movable contact 23 the latter will be in engagement with stationary contact 12^c. However, when the tension arm 22^a is moved to a point just on the other side of the ends of strips 22^b, the line of action will shift to effect opening of the contacts with a snap movement (Fig. 3). Additional restoring force for the movable contact carrier is provided by means of a coiled spring 24 held in compression between the flipper arm 22^a and the housing cover 14 so as to insure that the contacts will close with a snap action when the operating handle 15 is moved to "on" position. The same spring helps to insure snap-opening of the movable contact 23 by resisting movement of the tension arm 22^a when the abruptly sloping cam face 15^b is urged against the detent 22^c formed in said tension arm. In similar fashion the spring 24 helps to prevent premature opening of the circuit breaker by the power element 21 on moderate overloads.

For short circuit currents the circuit breaker is tripped electromagnetically. The magnetic trip means comprises a U-shaped electromagnetic core 30 having pole pieces 30^a, 30^b for attracting a movable armature member 31. Energization for the core is provided by the contact carrier 22 which is led between the core and its associated armature and is effective for moving the armature only upon the occurrence of very high currents. The armature 31 is permitted only limited movement, being confined on one side by the wall of housing 10 and on the other side by the pole faces of the magnet core 30. Normally the armature is held against the housing wall by the power element 21 which abuts against a projecting nib 31^a formed on the armature. It will remain in such position, during engagement of contact 23 with contact 12^c, unless the magnetic attraction of the core 30 becomes sufficient to overcome the bias afforded by the resiliency of the contact carrier 22.

It thus will be seen that the circuit breaker described is essentially a cantilever mounted snap-acting movable contact arm having intermediate the ends thereof a snap-acting power element for automatically effecting contact movement upon the passage of abnormal currents through said contact arm. The simplicity of its construction is readily apparent, there being relatively few parts and only a very few moving parts. It nevertheless has been found to be completely reliable in its operation and readily lends itself to applications where space and initial cost are at a premium; as, for example, in household and panelboard installations.

Its mode of operation will now be described. In Figs. 1 and 2 the circuit breaker is shown in its circuit closed or "on" position. In this position the line of action of the contactor tension arm 22^a lies between the fulcrum 10^f, 10^f and the stationary contact 12^c whereby the contacts are biased closed. From this position the contacts may be moved to open circuit position in any one of three ways.

For normal circuit opening the contact arm 22 is forced over-center by moving the operating handle 15 to the position shown in dotted lines in Fig. 1. In moving the handle to said latter position the cam face 15^b of the operating arm 15^a is forced against the detent 22^c on contact arm 22 which lifts against its own restoring force and the force of spring 24 to move the line of action past the fulcrum 10^f whereby the contact arm will be moved to its "off" position. Because the biasing spring 16 will hold the operating handle 15 in the "off" position the contact arm 22 will be prevented from returning to its "on" position by the flat face of the operating arm 15^a. To effect circuit reclosing it is only necessary to move the handle 15 to the "on" position against the bias of spring 16. The contact arm 22 will then reverse its position under its bias and that of spring 24 and the detent 22^c on said contact arm will latch the operating handle 15 in the "on" position against the bias of spring 16 by engaging the abruptly sloping cam face 15^b.

On overload tripping, however, the sequence of operation will be somewhat different. When the vapor pressure power element 21 has been heated sufficiently by an excessive current to make the thermometric fill boil, the diaphragm wall 21^b will snap outwardly, as shown in Fig. 3. Because said wall abuts the projection 31a of armature 31, the opposite wall of the power element will be moved in the other direction, the effect of which is to move the contact arm 22 over-center to the open circuit position. In so doing the switch arm detent 22^c will be moved out of engagement with the cam face 15^b of switch operating arm 15^a which will then move to the "off" position under the bias of spring 16. Because the operating handle 15 will remain in the latter position until manually moved back to the "on" position the contact arm 22 will be prevented by the flat face of the arm extension 15^a from returning to the "on" position when the power element 21 cools.

For short-circuit tripping the mechanism will operate in much the same manner as for moderate overload tripping as described above, except that a more rapid tripping will be effected by means of the electromagnet 31. It will be observed that the U-shaped electromagnetic core 30 is a fractional-turn magnet. The energization afforded by the current passing through the power element positioned therein is normally insufficient to move the armature 31 against the bias of the contact arm assembly. However, for currents greatly in excess of normal the magnetic attraction for the armature will be sufficient to overcome the bias of the contact arm and force it to the open circuit position as shown in Fig. 4. This arrangement provides an exceptionally fast trip and is highly desirable for effecting circuit interruption where interruption by expansion of the power element alone might not be fast enough to prevent damage to the equipment protected by the circuit breaker.

While only one embodiment of the invention has been disclosed, it should be understood that the invention is not limited thereto since other variations may occur to those skilled in the art. Thus it is intended that the invention be given the broadest possible interpretation within the terms of the following claims.

I claim:

1. A circuit breaker comprising, in combination, an electrically conductive expansible vapor type power element to be included in a circuit to be controlled; an over-center snap mechanism having a movable tension member for actuating said mechanism, said tension member including as a part thereof said expansible vapor type power element; movable means directly engageable with said tension member for effecting manual actuation of said snap mechanism; and normally stationary electromagnetically responsive means engaging one side of said expansible vapor type power element and cooperating with the latter under overload conditions to effect actuation of said snap mechanism upon a predetermined degree of expansion of said power element.

2. A circuit breaker comprising, in combination, a

base; a spring toggle snap mechanism for carrying a movable contact into and out of engagement with a stationary contact mounted on said base, said snap mechanism including a tension member which is movable to effect snap movements of said movable contact; means for biasing said snap mechanism and said tension member to contact engaging position; a vapor pressure type power element having a wall which is movable outwardly, said power element being rigidly attached to and forming a part of said tension member and having its movable wall extending in the direction of said bias; and means on said base for continuously abutting said movable wall whereby a predetermined degree of outward movement of said wall in said one direction will effect bodily movement of said power element and tension member in the opposite direction to effect contact disengagement with a snap action.

3. In combination with a circuit breaker movable contact carrying mechanism having an electrically conductive vapor pressure type power element which is bodily movable for effecting circuit opening on overload, an electromagnetic core positioned on one side of said power element for magnetization by the current passing through the latter; a movable armature member positioned on the opposite side of said power element in engagement therewith; and means for limiting movement of said armature in a direction away form said power element whereby expansion in the direction of said armature of the power element wall adjacent said armature will effect bodily movement of the major portion of said power element in the opposite direction, said power element being additionally movable under predetermined relatively high overload conditions as an incident to attraction of said armature member to said electromagnetic core in said last mentioned direction.

4. As an article of manufacture, a movable contact carrier for a circuit breaker comprising, a contact portion, a pair of compression members formed integrally with said contact portion; a tension member also formed integrally with said contact portion and movable to actuate said carrier; and a vapor pressure type expansible power element rigidly and permanently attached to said tension member for effecting movement thereof to actuate said carrier.

5. A circuit breaker comprising, in combination, a base; and over-center snap mechanism mounted on said base for carrying a movable contact between circuit controlling positions, said snap mechanism including a tension member which is movable relatively to said base to effect reverse movements of said contact; spring means normally biasing said snap mechanism toward circuit closing position; a manually operable lever directly engageable with said tension member for effecting circuit opening against the bias of said mechanism; and a vapor pressure type expansible power element rigidly attached directly to and forming a part of said tension member, said power element being expansible on circuit overload to move said tension member to the open circuit position regardless of the position of said manually operable lever.

6. A circuit breaker comprising, in combination, a base; a movable contact carrier mounted on said base, said carrier including a tension member which is movable to effect movement of said carrier between circuit controlling positions; a vapor pressure type expansible power element rigidly connected to and forming a part of said tension member, the arrangement being such that a predetermined degree of expansion of said power element on overload will forcibly and directly move said tension member to effect snap movement of said carrier to open circuit position, said power element being adapted to expand when the current through said circuit breaker exceeds a preselected value; and manually movable means mounted on said base for normally effecting snap movement of said contact carrier to open circuit position by engaging said tension member.

7. A circuit breaker comprising, in combination, a base; a movable contact carrier mounted on said base, said carrier including a tension member which is movable to effect movement of said carrier between circuit controlling positions; a vapor pressure type expansible power element rigidly connected to and forming a part of said tension member, the arrangement being such that a predetermined degree of expansion of said power element on overload will forcibly move said tension member to effect snap movement of said carrier to open circuit position, said power element being adapted to expand when the current through said circuit breaker exceeds a preselected value; manually movable means mounted on said base for normally effecting snap movement of said contact carrier to open circuit position by engaging said tension member; and electromagnetic means for accelerating the circuit opening movement of said power element under conditions of short circuit or relatively high overload.

8. A circuit breaker comprising, in combination, a base; a movable contact carrier mounted on said base, said carrier including a tension member which is movable to effect movement of said carrier between circuit controlling positions; a vapor pressure type expansible power element rigidly connected to and forming part of said tension member, the arrangement being such that a predetermined degree of expansion of said power element on overload will forcibly move said tension member to effect snap movement of said carrier to open circuit position, said power element being adapted to expand when the current through said circuit breaker exceeds a preselected value; manually movable means mounted on said base for normally effecting snap movement of said contact carrier to open circuit position by engaging said tension member; and electromagnetic means for accelerating the circuit opening movement of said power element under conditions of short circuit or relatively high overload, said electromagnetic means comprising a magnetizable core member through which said power element passes and a cooperating movable armature member supported by said base on the opposite side of said power element and directly engaging the latter.

9. A spring snap mechanism for carrying the movable contact of a circuit breaker, said mechanism comprising, a tension member; a contact portion connected to one end of said tension member, a compression member formed integrally with said one end of said tension member for cooperation therewith; combined terminal and mounting means rigidly and permanently attached to the other end of said tension member; and said terminal and mounting means having formed integrally therewith a vapor pressure type power element for effecting automatic operation of said snap mechanism upon expansion of a wall of said element as an incident to predetermined overload conditions in the controlled circuit.

10. A snap acting contact carrying mechanism for a circuit breaker, said mechanism comprising a spring snap mechanism including a tension member and a compression member; a vapor pressure type power element rigidly attached to and forming a part of said tension member between the ends of the latter for effecting movement thereof from each extreme position thereof to the other; and said power element having at least one wall which will be snapped outwardly upon the passage of a predetermined excessive value of current therethrough; and relatively immovable means for abutting said last mentioned wall whereby movement of said wall outwardly in said one direction will effect bodily movement of said power element and said tension member in the opposite direction.

11. A snap acting movable contact carrier for a circuit breaker operable automatically to "off" position

under predetermined overload conditions, said contact carrier comprising a terminal strip for connection to an electric circuit; an over-center electrically conductive snap mechanism comprising a tension member and a compression member; and an electrically conductive expansible fluid type power element having one end fixedly attached to said terminal strip and the opposite end rigidly and permanently connected to said tension member whereby automatic movement of said tension member may be effected by expansion of said power element upon occurrence of said overload conditions.

12. A circuit breaker comprising, in combination, a snap acting movable contact mechanism biased for movement to closed circuit position, said mechanism including a movable tension member for effecting actuation thereof; manually operable means movable between a first and a second position for operating said mechanism to open circuit position, said means being biased to said second position; detent means on said tension member for holding said manually operable means in said first position against its bias when said contact mechanism is in closed circuit position; a vapor pressure expansible power element responsive to a predetermined value of current flow in the circuit controlled by said breaker, said power element being attached to said tension member and having a wall which is expansible on circuit overload; and a member against which said wall may expand to actuate said tension member and effect automatic movement of said contact mechanism against its bias to open circuit position, said manually operable means then being movable under its bias to said second position wherein it will prevent reclosing of said contact mechanism upon contraction of said power element.

13. In a circuit breaker, an insulating base; a circuit controlling mechanism having a current carrying vapor pressure type expansible power element for effecting circuit opening on overload; an electro-magnetic core member mounted on said base adjacent one side of said power element for magnetization by current flowing through said element; and a movable armature member mounted on said base on the opposite side of said element for attraction by said core member, said armature member being biased against a stop on said base by said power element whereby expansion of the adjacent wall of said power element will effect bodily movement of said element in the opposite direction, said power element also being movable in said opposite direction by said armature member when the magnetization of said core member is sufficient to overcome the bias of said power element.

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