

Aug. 24, 1948.

O. S. JENNINGS

2,447,652

CIRCUIT BREAKER

Filed Oct. 30, 1942

2 Sheets-Sheet 1

Fig. 1.

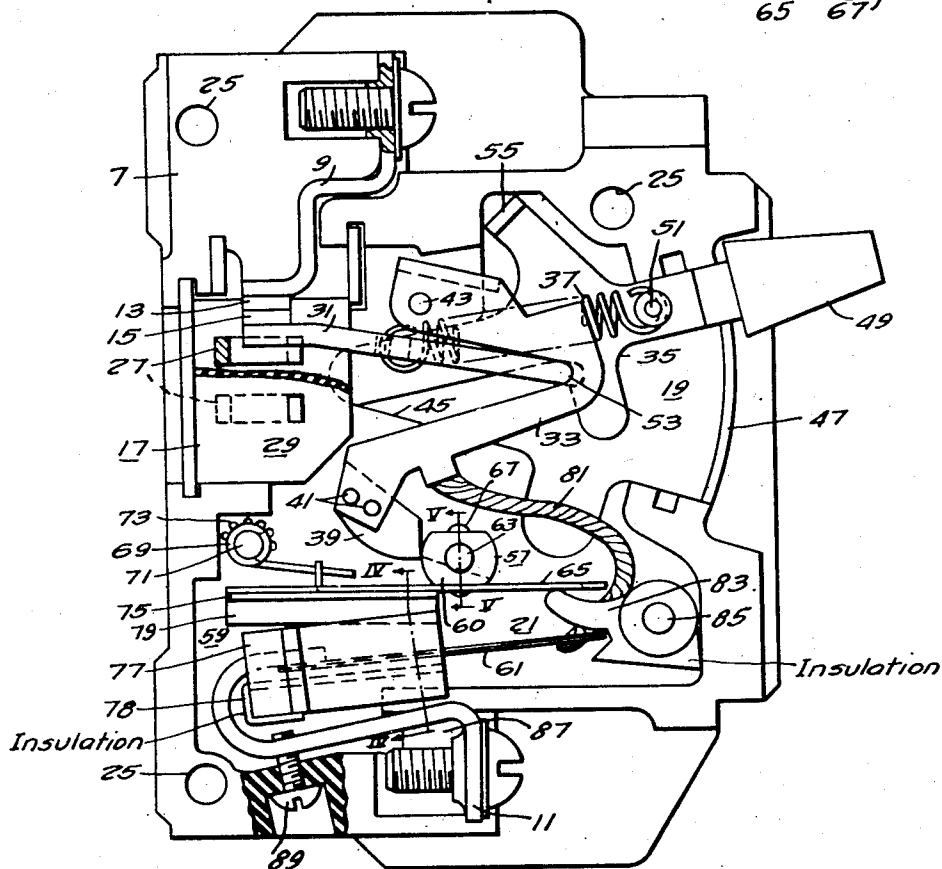


Fig. 5.

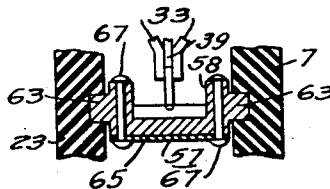
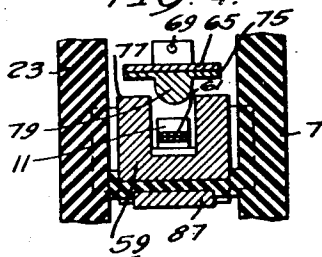


Fig. 4.



WITNESSES:

E. A. W. C. Lasky
E. S. Parker

INVENTOR

Oliver S. Jennings

BY

Ralph W. Swingle
ATTORNEY

Aug. 24, 1948.

O. S. JENNINGS

2,447,652

CIRCUIT BREAKER

Filed Oct. 30, 1942

2 Sheets-Sheet 2

Fig. 2.

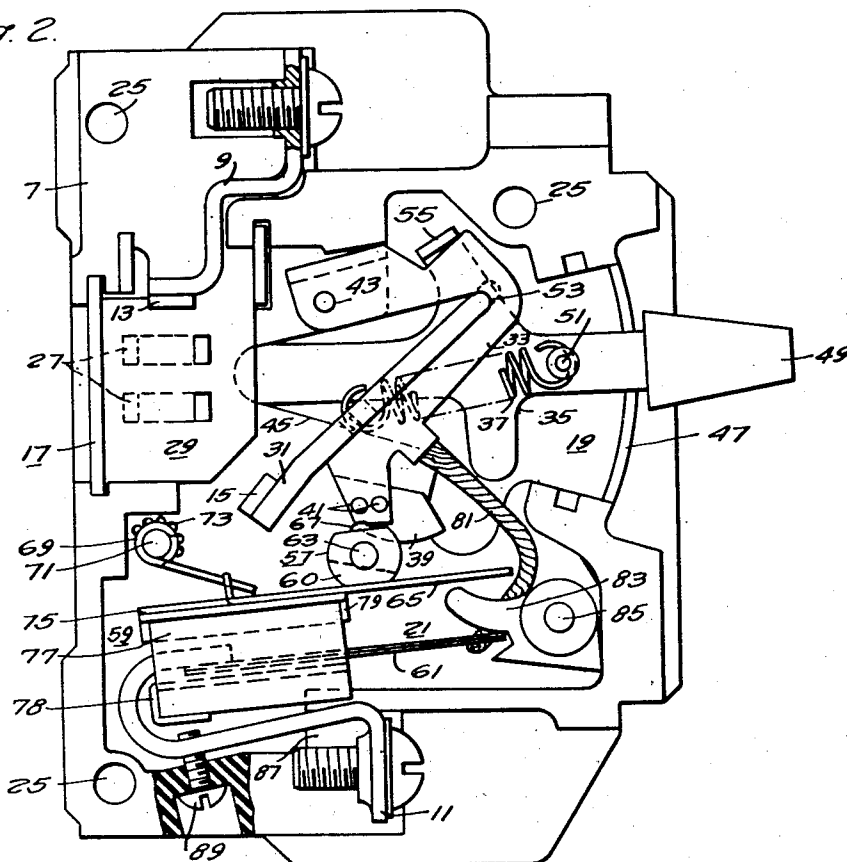
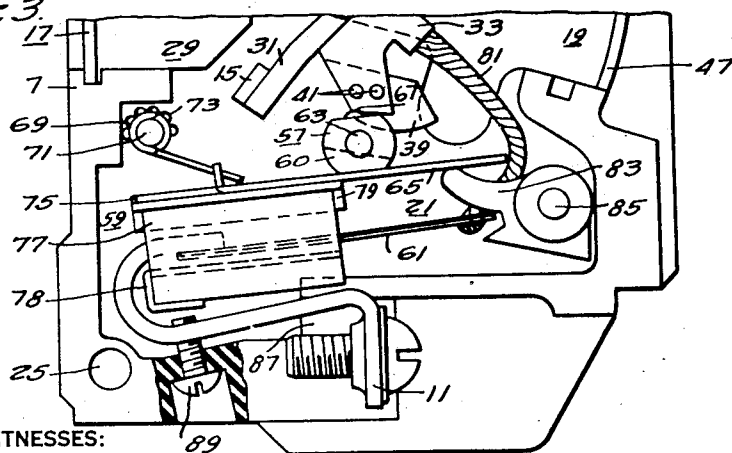


Fig. 3.



WITNESSES:

E. A. McLoskey
G. S. Parker

INVENTOR

Oliver S. Jennings

BY

Ralph H. Swingle
ATTORNEY

UNITED STATES PATENT OFFICE

2,447,652

CIRCUIT BREAKER

Oliver S. Jennings, Pittsburgh, Pa., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Application October 30, 1942, Serial No. 463,933

6 Claims. (Cl. 200—88)

1

The invention relates to circuit breakers and more particularly to automatic circuit breakers having current responsive tripping means for automatically tripping the breaker in response to predetermined overload current conditions.

An object of the invention is the provision of a circuit breaker with an improved trip device of simple construction which is operable to trip the breaker instantaneously upon the occurrence of heavy overloads above a predetermined magnitude or on short circuits, and which is operable to trip the breaker after a time delay in response to overloads of lesser magnitude.

Another object of the invention is the provision of a circuit breaker with a trip device having a current responsive bimetallic trip element and a current responsive magnetic tripping means operable independently under some conditions to trip the breaker, the two being arranged in a novel manner to at times mutually assist in effecting tripping of the breaker.

Another object of the invention is the provision of a circuit breaker as described in the preceding objects, wherein the parts are so arranged that substantially no undesirable stresses are applied to the bimetal trip element by the magnetic means.

Another object of the invention is the provision of a circuit breaker with an improved thermal-magnetic trip device wherein the flow of current through the bimetal element energizes the magnetic tripping means so that no separate energizing coil is required for the magnetic means.

Another object of the invention is the provision of a circuit breaker with an improved trip device having parts novelly arranged so that only a relatively light tripping force by the electro-responsive tripping means is required to trip the breaker mechanism.

Another object of the invention is the provision of a circuit breaker with an improved tripping mechanism comprising a rotatable latch member having a segmental or arcuate latch portion disposed very close to the axis of rotation of the latch and wherein the tripping forces produced by the bimetal element and the magnetic means are applied to the latch member at points relatively distant from the axis of rotation of the latch and on opposite sides of the axis.

Another object of the invention is the provision of a circuit breaker having a rotatable latch with the latch point close to the axis of rotation of the latch, and wherein a motion amplifier is interposed between the latch and the bimetal trip element to amplify the movement of the

2

bimetal element, the parts being arranged to obtain a large mechanical advantage in a small space.

Another object of the invention is the provision of a circuit breaker with an improved current energized magnetic tripping means wherein the magnetic means acts directly on the circuit breaker latch with a large mechanical advantage and yet the air gap of the magnetic means is maintained small.

Another object of the invention is the provision of an improved circuit breaker construction that is very simple and compact, reliable in operation and economical to manufacture.

The above and other objects and advantages of the invention, together with the construction and mode of operation thereof, will be best understood from the following detailed description of a preferred embodiment of the invention when read in conjunction with the accompanying drawings in which—

Figure 1 is a side view, partly in section, of a circuit breaker embodying the invention, with the side plate of the casing removed to show the mechanism and other part, the circuit breaker mechanism being shown in the closed circuit position,

Fig. 2 is a view similar to Fig. 1 but showing the circuit breaker the instant it has been tripped by operation of the magnetic tripping means,

Fig. 3 is a fragmentary view illustrating the tripping of the breaker in response to operation of the bimetallic trip element,

Fig. 4 is a detail sectional view of the magnetic means taken substantially along the section IV—IV of Fig. 1, and

Fig. 5 is a detail sectional view of the latching means taken substantially on the line V—V of Fig. 1.

Referring to the drawings, the circuit breaker comprises in general a casing 7 of molded insulating material, a pair of terminal conductors 9 and 11 mounted on the casing adjacent the opposite ends thereof, a stationary contact 13, a cooperating movable contact 15, an arc extinguisher 17, operating mechanism indicated generally at 19 for opening and closing the contacts, and a trip device indicated generally at 21 cooperating with the operating mechanism for causing automatic opening operation of the contacts in response to predetermined overload conditions.

The casing 7 is open at one side and is provided with various recesses and surfaces for removably receiving and supporting the parts of

the circuit breaker so that no metal mounting frame or brackets are required, all of the parts being directly supported by the molded material of the casing. A side cover plate 23, not shown in Figs. 1, 2 and 3 but a part of which is shown in Figs. 4 and 5, is adapted to be removably mounted on the open side of the casing section 7 to complete the casing and retain the parts in mounted position. The side plate is secured on the casing by bolts (not shown) which extend through openings 25 in the casing and side plate. The side plate is also provided with recesses and surfaces for supporting the parts of the circuit breaker.

The construction of the upper terminal conductor 9, contacts 13-15, arc extinguisher 17, operating mechanism 19 (except for the trip device), and the mounting arrangement of these parts in the casing are substantially similar to the corresponding parts of the circuit breaker disclosed in my Patent No. 2,429,722, dated October 28, 1947, and assigned to the assignee of the present invention.

The upper terminal conductor 9 is mounted in a slot provided therefor in the casing section 7 and the upper end of the conductor extends outwardly into a niche formed in this end of the casing. A terminal screw is threadably mounted in the outer end of the terminal conductor for making connection to an external circuit. The stationary contact 13 is secured to the inner end of the terminal conductor 9 within the casing. The arc extinguishing device 17 comprises a pair of U-shaped magnetic elements 27 disposed in a fiber arc chute 29 partially surrounding the path of the arc drawn by the movable contact upon interruption of the circuit.

The operating mechanism for operating the movable contact to open and closed circuit position comprises a bifurcated switch arm 31 to the inner end of which the movable contact 15 is secured, a yoke-shaped releasable carrier lever 33 for pivotally supporting the switch arm 31, a manually operable operating lever 35, and an overcenter operating spring 37 which is connected in tension between the switch arm 31 and a part of the operating lever 35.

The releasable carrier lever 33 which is of conducting material has spaced legs rigidly connected by an integral cross member and joined at their lower ends by a latch element 39 which cooperates with a movable latch of the trip device. The latch element is secured between the lower ends of the legs of the carrier member by means of rivets 41. The legs of the carrier lever are generally V-shaped in side elevation, and the switch arm 31 is pivotally supported in the apex of the carrier lever for movement back and forth to open and closed circuit positions in the V-shaped notches formed by the legs of the carrier. The switch arm 31 is bifurcated to form spaced legs which are notched at their outer ends for pivotally engaging the legs of the carrier lever 33 at the apex thereof. The carrier lever 33 is mounted for pivotal movement by a pivot pin 43, the ends of which are supported in cylindrical bearing recesses provided therefor in the casing 7 and side plate 23. The overcenter operating spring 37 always biases the carrier lever 33 in a counterclockwise direction about the pivot 43 as viewed in Fig. 1, and the carrier lever is adapted to be restrained in the normal position shown in Fig. 1 by the latch of the trip device which engages the tip of the latch element 39.

The manually operable operating lever 35 con-

sists of a generally flat lever and is pivotally mounted within the casing 7 adjacent the side wall thereof in a V-shaped recess 45 formed in the side wall. The operating lever is rounded at its inner end and this end is pivotally supported in the rounded bottom of the shallow V-shaped recess 45. The outer end of the operating lever 35 is slightly offset and extends out through a notch or slot 47 of the casing 7. An operating handle 49 of insulating material is secured to the outer end of the operating lever to provide for manual operation thereof. A stud 51 is rigidly secured to the operating lever adjacent the outer end thereof and projects laterally from the lever. The projecting end of the stud 51 carries a roller (not shown) which is adapted to bear against and roll on the inner surface of the side plate 23 of the casing. The operating lever thus has two spaced bearings for its pivotal movement.

The overcenter spring 37 is disposed between the legs of the bifurcated portion of the switch arm 31 and is movable in the space between the spaced legs of the carrier lever 33. One end of the spring is connected to an intermediate point of the switch arm 31 and the other end of the spring is hooked over a circular slot in the central portion of the stud 51 on the operating lever 35. The spring 37 serves to retain the switch arm in pivotal engagement with the carrier lever 33 and the operating lever in pivotal engagement with its bearings. The spring also functions to actuate the switch arm to open and closed position with a snap action upon movement of the operating lever to "off" and "on" positions, and provides the required contact pressure in the closed circuit position of the breaker.

The operating lever 35 is moved upwardly to the "on" position shown in Fig. 1 to effect closing of the circuit breaker. As soon as the line of action of the spring 37 is moved above the pivot axis 53 of the switch arm 31 the spring acts to move the switch arm to closed circuit position with a snap action. To manually open the contacts of the circuit breaker the operating lever is moved downwardly to the "off" position, and as soon as the line of action of the spring 37 passes below the pivot axis 53, the spring acts to move the switch arm to open circuit position with a snap action. In the manually opened position of the switch arm 31 the switch arm bears against the lower edges of the V-shaped notches formed in the legs of the carrier lever 33, these edges acting as open position stops upon manually opening the circuit breaker.

The circuit breaker is adapted to be automatically opened in response to predetermined overload conditions by operation of the trip device 21 which will be hereinafter described. The operation of the trip device effects release of the releasable carrier lever 33 whereupon the overcenter spring 37 moves the carrier lever in a counterclockwise or upward direction about its pivot 43, thereby shifting the pivot axis 53 of the switch arm above the line of action of the spring 37, thus causing snap acting movement of the switch arm to the open circuit position shown in Fig. 2. This circuit opening movement of the switch arm will take place irrespective of the position of the operating handle even though the operating handle were held in closed position. Thus the switch arm is trip-free of the operating lever. During automatic opening operation of the circuit breaker, the operating spring 37 also acts to move the operating lever 35 to an intermediate indicating position as shown

5

in Fig. 2, the lever being stopped in this intermediate indicating position by the engagement of a resetting projection 55 on the operating lever with an upper edge of a releasable carrier lever 33.

Before the breaker can be manually reclosed following a tripping operation, it is necessary to reset the releasable carrier lever 33 back to its normal latched position. This is accomplished by moving the operating lever downwardly to the "off" position. During this movement the resetting projection 55 moves the carrier lever in a clockwise direction about the pivot 43 back to its normal latched position where it is reengaged by the latch of the trip device. The circuit breaker may be manually closed following resetting thereof by moving the handle upwardly to the "on" position in the previously described manner.

The trip device 21 is removably mounted in the lower part of the circuit breaker casing and comprises a rotatably mounted latch member 57 controlled by an electromagnet 59 and by a current responsive bimetal element 61, each of which is operable to move the latch member to released position.

The latch member comprises a generally cylindrical member 57 having flattened portions on opposite sides thereof. A notch or slot 58 (Fig. 5) is cut out of the central portion of the latch member for a distance slightly past the axis of rotation of the latch member, leaving an arcuate or segmental latch portion 60, the arcuate edge of which is adapted to engage and latch the releasable carrier lever 33 in the normal position shown in Fig. 1. The latch member 57 is rotatably mounted by pivot studs 63 which project from the opposite ends of the latch member and engage in circular bearing recesses provided in the casing 7 and side plate 23 of the casing. The axis of rotation or turning movement of the latch member 57 passes substantially through the center thereof. By this construction the arcuate latch surface of the latch is concentric with and located very close to the axis of rotation of the latch member. A lever 65 is secured intermediate its ends by rivets 67 to one of the flattened sides of the latch member 57, the lever 65 providing oppositely projecting lever arms on either side of the axis of rotation of the latch member. The latch member is biased to the latching position shown in Fig. 1 by means of a spring 69 which is mounted on a stud 71 secured in the side wall of the casing 7. One end of the spring engages in an opening of an ear formed in one arm of the latch lever 65. The spring is coiled about the stud 71 and the other end of the spring is settable in any one of a plurality of openings 73 formed in the side wall of the casing 7. These openings 73 provide means for adjusting the force of the spring to adjust the instantaneous trip setting of the circuit breaker.

The magnetic tripping means 59 comprises a magnetic armature 75 secured to one arm of the latch lever 65, and a cooperating U-shaped magnet or magnetic member 77 which is fixedly mounted in supporting recesses in the casing adjacent the armature 75 in a position to provide an air gap between the armature and the U-shaped magnet. The armature 75 is provided with a projecting rib 79 (Fig. 4) which projects partly into the space between the legs of the magnet 77. This rib 79 provides for a relatively small air gap despite the relatively long travel movement of the armature between its unattracted and attracted position, the relatively long movement being necessary due to the fact that the

6

latch surface of the latch is located very close to the axis of rotation of the latch member 57. The stationary magnet 77 is set at a slight angle to permit the armature to move squarely against the pole faces of the magnet as the armature turns about the rotatable axis 63. The magnetic means is energized in response to the current of the circuit controlled by the breaker and the construction is such that the armature will be moved to attracted position to release the latch and trip the circuit breaker instantly upon the occurrence of an overload above a predetermined magnitude, for example, in excess of eight or ten times the rated current of the breaker, and on short circuits.

The current responsive bimetal element 61 comprises a strip of bimetallic material which is secured at its inner end to the inner end of the terminal conductor 11. A portion of the bimetallic strip 61 passes through the space between the legs of the U-shaped magnet 77 so that the flow of current through the bimetal element serves to energize and produce the magnetic flux in the magnet 77 and armature 75. This portion of the bimetal strip and a portion of the conductor are insulated from the magnet 77 by a layer of insulation 78. The bimetallic strip 61 extends generally parallel to the latch lever 65 and the outer end of the bimetallic strip is disposed opposite the end of one lever arm of the latch lever 65. A flexible conductor 81 electrically connects the free outer end of the bimetallic strip 61 to the releasable carrier lever 33 which is, in turn, electrically connected to the movable contact 15 of the circuit breaker.

The electrical circuit through the breaker extends from the upper terminal conductor 9, through the stationary and movable contacts 13 and 15, switch arm 31 which is of conducting material, through a portion of the releasable carrier lever 33, flexible conductor 81 and through the bimetallic strip 61 to the lower terminal conductor 11. The bimetallic strip 61 is thus heated in response to the current of the circuit and is arranged to deflect upwardly when heated a predetermined amount to operate the latch member 57 to unlatched position to effect tripping of the circuit breaker.

A motion amplifying means in the form of a cam lever 83 is provided for amplifying and transmitting the upward deflecting movement of the free end of the bimetallic strip 61 to the outwardly extending lever arm of the latch lever 65. The cam lever 83 is of insulating material and is pivotally mounted by means of a pivot 85 supported in pivot recesses provided in the casing 7 and side plate 23. The specific cam lever shown in the drawings is designed to amplify or multiply the deflecting movement of the bimetallic strip 61 by two at the point where the movement is transmitted to the lever arm of the latch member 57. It will be understood, of course, that more or less amplification of the deflecting movement may be obtained by changing the shape and design of the cam lever 83. Deflecting movement of the bimetallic strip 61 is thus made sufficient to move the latch portion 60 of the latch to released position despite the fact that the latch surface is located close to the axis of rotation of the latch, and yet the tripping force transmitted to the latch is applied through a relatively long lever arm. Both the magnetic means 59 and the bimetallic trip element 61 act on the latch member through relatively long lever arms so that

a large mechanical advantage is obtained and yet the entire trip mechanism occupies only a small amount of space due to the novel arrangement of the parts. With this construction only a relatively light tripping force is required to operate the latch to released position to effect tripping of the breaker. The current, in flowing through the bimetallic element, energizes and produces the magnetic flux for the magnetic tripping means so that no separate energizing coil or winding is required for the magnetic means.

The terminal conductor 11 is supported in a slot 87 provided therefor in the casing 7, and one end of this terminal conductor extends outwardly into a niche in the lower end of the casing and receives a terminal screw for connecting this terminal of the breaker to the external circuit. An adjusting screw 89 extends through the lower end of the casing 7 and is threadedly engaged in an opening provided therefor in the inner portion of the terminal conductor 11 at a point remote from the supporting slot. The screw 89 thus serves as a means for adjusting the position of the bimetallic element 61 to thereby adjust the thermal trip characteristic of the circuit breaker. Turning the screw 89 in one direction or the other changes the amount of deflection of the bimetallic strip 61 that is necessary to effect tripping of the circuit breaker mechanism.

The operation of the trip device is as follows: When an overload below the instantaneous trip value occurs in the circuit controlled by the breaker, the bimetallic element 61 is heated by the overload current and when the element is heated a predetermined amount it deflects in an upward direction. The deflecting movement of the bimetallic element 61 is amplified and transmitted by the cam lever 33 to one arm of the lever 65 causing counterclockwise movement of the latch member 57 about its axis 63 to released position, thereby disengaging the latch portion 60 from the latch on the lower end of the releasable carrier lever 33. The carrier lever 33, when thus released, is actuated by the spring 37 to cause automatic opening of the circuit breaker contacts in the manner previously described. During the movement of the latch member 57 to its released position the armature 75 is moved toward the pole faces of the U-shaped magnet 77, and, as the armature approaches the attracted position, the pull of the magnet becomes stronger and assists in moving the latch member 57 to released position. The electromagnet thus aids the bimetal in tripping the circuit breaker, and it will be apparent that the aiding force of the magnetic means becomes stronger as the magnitude of the overload increases. This means that the circuit breaker will be tripped more quickly as the magnitude of the overload increases so that a faster tripping characteristic is obtained in the range of moderate to heavy overloads than would be provided by a bimetallic trip element acting alone.

Upon the occurrence of a heavy overload above the predetermined magnitude, for example, above eight to ten times normal rated current, and upon short circuits, the electromagnet is sufficiently energized to instantaneously move the latch member 57 to released position before the bimetallic element 61 becomes substantially heated. In this instance the armature 75 is quickly moved to attracted position, rotating the latch to released position independently of the bimetal element 61. The carrier lever 33 is thus instantaneously re-

leased and causes automatic opening of the circuit breaker contacts.

With the construction shown, the magnetic tripping means does not exert any force on the bimetallic trip element at any time so that there is no danger of overstressing the bimetallic trip element and damaging its calibration.

It will be understood of course that the lever 65 of the latch may itself be made of magnetic material and a magnetic rib corresponding to the rib 79 secured to the inner lever arm of the magnetic lever 65 which cooperates with the fixed magnet 77, or the whole lever and rib may be formed from a single piece of magnetic material.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details and arrangement of parts may be made without departing from some of the essential features of the invention. It is desired therefore that the language of the appended claims be given the broadest reasonable interpretation permissible with the prior art.

I claim as my invention:

1. In a circuit breaker having relatively movable contacts, operating mechanism therefor including a spring biased member releasable to cause automatic opening operation of said contacts, a rotatably mounted latch member for normally engaging and releasably restraining said releasable member, said latch having a lever arm projecting therefrom, an electromagnet for moving said latch to released position in response to predetermined overload conditions comprising a magnetic armature member carried by the lever arm of the latch, a cooperating magnetic member mounted adjacent the armature member, and an energizing conductor passing between said magnetic members, one of said magnetic members being U-shaped and the other having a projecting portion which at least partially extends into the space between the legs of the U-shaped member in the normal unattracted position of the armature member.

2. In a circuit breaker having relatively movable contacts, operating mechanism therefor including a spring biased member releasable to cause automatic opening operation of said contacts, a latch for releasably engaging and restraining said releasable member, electromagnetic means energized in response to the current of the circuit for moving said latch to released position in response to predetermined overload current conditions comprising a U-shaped member of magnetic material having substantially square ends on the legs of the U forming magnetic pole surfaces, and an armature having spaced surfaces for attraction toward said pole surfaces and having a portion between said spaced surfaces projecting at least partially into the space between the ends of the U and providing a shorter air gap than between the square ends of the U and said spaced surfaces when the armature is in its normal unattracted position.

3. In a circuit breaker having relatively movable contacts, operating mechanism therefor including a member releasable to cause automatic opening operation of said contacts, a rotatably mounted latch member having a latch surface relatively close to the axis of rotation of said latch member for releasably engaging and restraining said releasable member, a pair of lever arms projecting from said latch member, electromagnetic means energized in response to over-

load current in the circuit for moving said latch member to released position in response to predetermined overload conditions comprising a magnetizable armature member on one of said lever arms and a cooperative magnetizable member mounted adjacent said armature for attracting said armature, a bimetal element heated in response to overload currents in the circuit operative to deflect when heated a predetermined amount to move the other lever arm of said latch and thereby move said latch to released position, said bimetal element having its free end disposed opposite said last mentioned lever arm, and a pivoted motion amplifying member having an end extending between the free ends of said bimetal element and of said last-mentioned lever arm, said motion amplifying member engaging said last-mentioned lever arm at a point remote from the pivot of the motion amplifying member and being engaged by said bimetal element nearer to said pivot for amplifying and transmitting the deflecting movement of the free end of said bimetal element to said lever arm for actuating said latch member.

4. In a circuit breaker having relatively movable contacts, operating mechanism therefor including a member releasable to cause automatic opening operation of said contacts, a rotatably mounted latch member for releasably engaging and normally restraining the releasable member, a lever arm projecting from said latch member, a bimetal element heated in response to the current of the circuit and operative to deflect when heated a predetermined amount by overload current to move said latch member to released position and thereby release said releasable member, said bimetal element having its free end disposed opposite the free end of said lever arm, and a member pivoted adjacent one end at a fixed point and having its other end extending between said free ends of the bimetal element and the lever arm and engaged by the bimetal element near the pivot of the member and having its end remote from its pivot engaging said lever arm for amplifying and transmitting the deflecting movement of the free end of said bimetal element to said lever arm.

5. A circuit breaker having relatively movable contacts, operating mechanism therefor including a member releasable to cause automatic opening operation of said contacts, a rotatably mounted latch member having a latch surface relatively close to the axis of rotation of the latch member for releasably engaging and normally restraining said releasable member, a lever arm projecting beyond said latch, a bimetal element connected in circuit with said contacts and operative to deflect when heated a predetermined amount by overload currents to move said latch member toward released position, said bimetal element having its free end disposed adjacent the free end of the lever arm, and a lever of insulating material having a fixed pivot for amplifying and transmitting the deflecting movement of the free

end of said bimetal element to said lever arm of the latch, said lever of insulating material having an end which separably engages the projecting latch lever arm, and the free end of said bimetal element separably engaging said lever of insulating material at a point closer to the pivot axis of the lever of insulating material than the end thereof.

6. In a circuit breaker having relatively movable contacts, operating mechanism therefor including a member releasable to cause automatic opening operation of said contacts, a rotatably mounted latch member having a latch surface close to the axis of rotation of said latch member for releasably engaging and restraining said releasable member, a pair of lever arms projecting from said latch member, electromagnetic means energized in response to overload current in the circuit for moving said latch member to released position in response to predetermined overload conditions comprising a magnetizable armature member mounted on one of said lever arms and a cooperating magnetizable member mounted adjacent said armature for attracting said armature, one of said magnetizable members being U-shaped and the other having a projection which at least partially extends into the space between the legs of the U-shaped member, a bimetal element heated in response to the overload currents in the circuit and operative to deflect and move the other lever arm of said latch and thereby move said latch toward released position and at the same time shorten the air gap between said armature member and said magnetizable member, and a pivoted lever of insulating material for amplifying and transmitting the heat deflecting movement of said bimetal element to said other lever arm of the latch, said latch being movable to released position by said electromagnetic means independently of said bimetal element and without moving said bimetal element.

OLIVER S. JENNINGS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
535,069	McElroy et al.	Mar. 5, 1895
570,419	Wurts	Oct. 27, 1896
677,353	Hewlett	July 2, 1901
689,836	Wheeler	Dec. 24, 1901
2,027,238	Lindstrom	Jan. 7, 1936
2,035,743	Frank et al.	Mar. 31, 1936
2,043,306	Sandin	June 9, 1936
2,046,701	Sanden	July 7, 1936
2,048,114	Gano et al.	July 21, 1936
2,353,756	Price	July 18, 1944

FOREIGN PATENTS

Number	Country	Date
95,895	Sweden	June 6, 1939