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CIRCUIT BREAKER WITH THERMAL AND MAGNETIC TRIP MEANS

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This invention relates generally to circuit breakers and 15 in particular to circuit breakers of the type which operate instantly on sudden heavy overloads and after a time delay on continued overloads of a lesser magnitude.

The primary object of the present invention is to provide a circut breaker constructed to be opened automatically under the control of thermal-current responsive means and also under the control of electro-magnetic means, wherein each of the controls is independently and separately adjustable to provide for the accurate calibration of the circuit breaker both for sudden heavy overloads as well as for continued overloads of a lesser magnitude.

In my prior application Serial No. 282,819, filed April 17, 1952, now Patent No. 2,673,264, dated March 23, 1954, there are illustrated and described such independ-30 ently and separately adjustable controls in connection with a circuit breaker mechanism having an actuator and a latch mounted independently of the movable switch element or contact member, therefore, another object is the 35 provision of said independently adjustable thermal and magnetic controls in a circuit breaker mechanism of the type wherein a movable switch element is provided both with a pivotally mounted actuator and a latch, said latch releasably restraining the actuator against movement relative to the switch element in the circuit making condition of the breaker.

A further object is the provision of generally improved tripping means of the thermal and magnetic type, which means are of generally simplified construction, economical to manufacture and reliably effective in operation.

The above and other objects, features and advantages of the present invention will be more fully understood from the following description considered in connection with the accompanying illustrative drawings.

In the drawings, which illustrate the best mode presently contemplated by me of carrying out my invention:

Fig. 1 illustrates a side view of a circuit breaker pursuant to the present invention, one part of the housing being removed and the movable contacts of the circuit 55 breaker mechanism being in circuit making condition; Fig. 2 is a fragmentary sectional view, on an enlarged scale, taken on the line 2-2 of Fig. 1;

scale, taken on the line 2-2 of Fig. 1; Fig. 3 is a fragmentary view, on an enlarged scale.

taken in the direction of the arrows 3-3 in Fig. 1; and Fig. 4 is a fragmentary view similar to Fig. 1, the cir-

cuit breaker mechanism being illustrated in circuit open condition thereof. Referring now to the drawings in detail, there is illus-

trated the automatic circuit breaker 10 which includes a housing 12 constituted by companion casing parts preferably molded of suitable insulation material, only one of the companion parts 14 being illustrated herein, and said parts being retained in housing defining relation by the securing elements 16. The housing 12 defines a chamber 18 in which is disposed a circuit breaker mechanism, generally indicated by the reference numeral 20. As here shown, said circuit breaker mechanism is of the 2

general type illustrated and described in Patent No. Re. 23,188, issued to H. A. Humpage on January 10, 1950, and assigned to the assignee hereof.

The circuit breaker mechanism 20 includes a movable $\mathbf{5}$ switch element or contact member 22 formed of conducting material. Said member is mounted for pivotal movement by the pivot 24 suitably carried by the casing parts 14. The switch element 22 is provided at one end thereof with a movable contact 26, which is adapted to 10 engage a companion stationary contact 28 provided on the terminal connector 30, the latter being suitably mounted in an open recess 32 defined in the casing 12. At the other end thereof, the switch element 22 is provided with an actuator 34 having portions 35-35 which straddle the switch element. The actuator is pivotally mounted thereon by means of the pivot 36. A manually operable member or handle 38 extends through an opening 40 defined in the upper wall of the housing 12 and is suitably pivotally mounted in the housing. A link 42 pivotally interconnects the handle 38 and the actuator 34 and forms a toggle with the handle which is overset in the closed or circuit making condition of the breaker. as illustrated in Fig. 1. A helical compression spring 44 is interposed between the handle 38 and the movable switch element 22 and biases both the switch element and the handle to the open position, respectively, thereof, as illustrated in Fig. 4.

Pursuant to the present invention, provision is made for the latching member 46 which is pivotally mounted on the movable switch element 22 by means of the pivot 48. More specifically, at one end thereof, the latch element 46 is bifurcated, as at 50, to provide the laterally spaced arms 52 and 53 thereof which straddle the movable switch element 22 as will be evident from Figs. 1 and 4. At its other end, the latching member 46 is Ushaped, being provided with the downwardly bent portion 54 which is provided with the reflexed free end portion 56. The portion 54 is provided with a cut out or notch 58, as best illustrated in Fig. 3 in which the free end 60 of the actuator 34 is adapted to engage. With the circuit breaker in the closed condition thereof, as illustrated in Fig. 1, it will be understood that the overset toggle, constituted by the handle 38 and the link 42, operating through the actuator 34, which is in latched engagement 45 with the latch member 46 at the notch 58 therein, serves to retain the movable switch element in circuit-closed position against the bias of the spring 44. Further, it will be understood that in order for the circuit breaker to trip automatically upon the occurrence of an overload, 50 or other abnormal current condition in the circuit controlled thereby, it is necessary for the latch member 45 to pivotally move in the direction of the arrow 62 to release the actuator 34 whereby to break the overset toggle and effect the immediate opening of the circuit breaker mechanism through the expansion of the compressed spring 44, as illustrated in Fig. 4. It will be noted that pivoted contact-carrying member 22, to which actuator 34 and latch member 46 are pivoted, forms a triangle with those elements when actuator portion 60 is arrested by latch member 46.

Pursuant to the present invention, provision is made for the electro-magnetic tripping means 64 for opening the circuit breaker instantly on sudden heavy overloads and the thermally responsive tripping means 66 which opens the breaker on continued overloads of a lesser magnitude. The thermally responsive tripping means 66is constituted by a bimetallic strip which is suitably secured at one end thereof, as at 68, to the movable switch element 22. At the other end thereof, the bimetallic strip is provided with an insulation element 70 which cooperates with the adjusting element 71 threadedly engaged in the free end portion 56 of the latch member 46, as hereinafter described in detail. A wire coil 72 has one end thereof secured to the bimetal 66, as at 74, and the other end thereof is secured to a flexible conductor 76, as at 78. The other end of the flexible conductor 76 is secured to a stab terminal element 80, 5 as at 82. Consequently, it will be noted that in the closed circuit condition of the circuit breaker, the circuit therethrough may be traced as follows: From the terminal 30, through the engaged contacts 28 and 26, through the switch element 22, through the bimetal 66 10 through the coil 72 and through the flexible conductor 76 to the stab terminal 80.

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In the event of a continued overload of predetermined magnitude in the circuit controlled by the circuit breaker 10, it will be apparent that the bimetal 66 will be heated 15and it will be understood that the bimetal will flex in the direction of the arrow 62, whereupon the insulating element 70, acting upon the adjusting element 71 will effect pivotal movement of the latch 46 in the direction 20of the arrow 62 to disengage the end 60 of the actuator 34 to collapse the toggle constituted by the handle 38 and the link 42 for automatic opening of the circuit breaker by the spring 44. In order to calibrate the circuit breaker for operation in response to the deflection 25of the bimetal 66, the adjusting element 71 is threaded in a direction to increase or to decrease the overlap of the end 60 of actuator 34 relative to the latch 46, in the notch 58 thereof, as may be required. In this connection, it will be noted that the bimetal is quite rigidly 30 secured to the switch element 22, at 68, whereas the latch 46 is pivotally carried by the switch element. Consequently, rotation of the screw 71, one end of which abuts the element 70 carried by the rigidly secured bimetal 66, will result in the pivotal movement of the latch 46 relative to the switch element 22 whereby to increase or decrease the overlap, depending upon the direction of rotation of the screw 71.

In order to provide for instantaneous tripping of the circuit breaker on heavy overloads, provision is made for the previously mentioned electro-magnetic means 64 which is constituted by the wire coil 72, the pole piece 84 and the latch 46 which is formed of magnetic material to constitute an armature. More specifically, it will be understood that the wire coil 72 is formed of insu- 45 lated wire, preferably wire which is enamel covered, said coil being disposed about a magnetic core 86 which is constituted by a threaded element. At the upper end thereof, the threaded element 86 is provided with an axially extending unthreaded portion 88, of reduced diam- 50 eter, which is preferably beveled, as at 90, and which is provided with a circumferential groove 92. The unthreaded portion 88 extends through an aperture 94 defined in the bimetal 66, being secured in position therein by a spring ring 96 which readily snaps into 55 position in the groove 92 over the bevelled end 90. A helically coiled spring 98 is interposed between the bimetal 66 and the latch or armature 46 at the portion of the bimetal in which the threaded element 86 is secured. The latch 46 is recessed, as at 100, and is pro- 60 vided in said recess with an insulation cap 102 which abuts the spring 98. The spring 98 is relatively weak and serves to retain the latch 46 in spaced disposition relative to the bimetal 66. In this respect, it will be understood that the spring pressure of the spring 98 is 65 insufficient to prevent the pivotal movement of the latch 46 in the direction of the arrow 62 upon the flexing of the bimetal, as previously described. The threaded element 86 is in threaded engagement with the U-shaped pole piece 34. In view of the fact that the unthreaded 70 portion 88 of the threaded element 86 is fixed against longitudinal movement relative to the bimetal 66 by the spring ring 96 and the shoulder 104 of said threaded element, it will be apparent that rotation of the mem-75 ber 26 will result in movement of pole piece 84 axially

of the member 86. In this manner, the air gap between the ends 106 of the pole piece 84 and the confronting portions of the pivotally mounted magnetic armature 46 may be adjusted, as illustrated in broken line in Fig. 2. Therefore, it will be readily apparent that the action of the circuit breaker in response to sudden heavy overloads may be calibrated by adjustment of the threaded element 86.

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Upon occurrence of a sudden heavy overload, the electro-magnetic means 64 is energized, substantially instantaneously, sufficiently to attract the movable armature 46 so that the latter moves in the direction of the arrow 62 for releasing the actuator 34 to trip the circuit breaker mechanism. This action occurs before the bimetal 66 is sufficiently heated to the point where it flexes. However, it will be understood that upon the occurrence of intermediate overloads, the tripping action results from the combined action of the thermal means 66, and the electro-magnetic means 64. If it is desired to increase the current rating of the circuit breaker, the insulation element 70 carried by the bimetal 66 may be omitted whereby to provide parallel current paths in the circuit breaker through the latch 46 and the bimetal 66.

While I have shown and described the preferred embodiment of my invention, it will be understood that various changes may be made in the present invention without departing from the underlying idea or principles of the invention within the scope of the appended claims. Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a circuit breaker having stationary and movable contact members, mechanism for actuating said movable contact member to open and close the circuit breaker. said mechanism including an actuator mounted on said 35 contact member, and a trip device including a movable latching member provided on said movable contact member and releasably engageable with said actuator for releasably holding said mechanism in contact-closing condition; electro-magnetic means energized by the cur-40 rent in the circuit, said latching member being formed of magnetic material and constituting a movable armature for said electro-magnetic means, and means for adjustably varying the air gap between said armature and said electro-magnetic means for adjusting the response of said latching member in relation to current value, said electro-magnetic means including a coil energized by the current in the circuit, a core for said coil, and said adjusting means being pole piece means adjustably mounted on said core, a bimetallic strip carried by said movable contact member, said strip flexing in response to predetermined current in the circuit to move said latching member for tripping the breaker, and adjustable means interposed between said strip and said latching member for adjusting the response of said latching member in relation to current value.

2. In a circuit breaker having stationary and movable contact members, mechanism for actuating said movable contact member to open and close the circuit breaker, said mechanism including an actuator mounted on said contact member, and a trip device including a movable latching member provided on said movable contact member and releasably engageable with said actuator for releasably holding said mechanism in contact-closing condition; electro-magnetic means energized by the current in the circuit, said latching member being formed of magnetic material and constituting a movable armature for said electro-magnetic means, and means for adjustably varying the air gap between said armature and said electro-magnetic means for adjusting the response of said latching member in relation to current value, said electro-magnetic means including a coil energized by the current in the circuit, a core for said coil. and said adjusting means being pole piece means adjustably mounted on said core, a bimetallic strip carried by said movable contact member, said strip flexing in re-

sponse to predetermined current in the circuit to move said latching member for tripping the breaker, and adjustable means interposed between said strip and said latching member for adjusting the response of said latching member in relation to current value, said core being 5 carried by said bimetallic strip.

3. A circuit breaker having a pair of separable contacts, a movable member bearing one of said contacts and a mechanism operable to open and close the contacts and further operable to open the contacts auto- 10 rable contacts, a pivoted contact-carrying member for matically in response to overload, said mechanism including an actuator pivoted to said contact-carrying member, a current-responsive bimetal carried by said movable contact-carrying member and a latch having a pivot to the movable contact-carrying member, said 15 actuator normally bearing against said latch lengthwise toward the pivot thereof and said latch having a mechanical coupling to said bimetal enabling the bimetal to shift the latch in the actuator-releasing direction, said latch and said actuator and said contact member forming a 20 triangle when the actuator is latched, and said latching assembly including electromagnetic means for tripping the latch independent of said mechanical coupling.

4. A circuit breaker including a pair of separable contacts, a movable contact-carrying arm, and a manually 25 operable mechanism for operating said arm to open and close said contacts, said mechanism including a spring and automatic release means enabling opening of the contacts in response to overload, said mechanism includ-30 ing a latching assembly carried by said contact-carrying arm and an actuator restrained by said latching assembly when the contacts are closed, said latching assembly including a latch pivoted to said contact-carrying arm and said actuator having a portion bearing endwise 35 against said latch toward the pivot thereof and said actuator portion being arranged to move along a lateral surface of the latch when the latch is deflected out of actuator-restraining position, and a combined thermal and magnetic tripping means for deflecting said latch and 40 releasing said actuator, said means including a currentresponsive bimetal carried by said contact-carrying arm closely adjacent to the side of said latch opposite that along which said actuator moves open release thereof by the latch, said latch being formed with a magnetic armature and said bimetal bearing an electromagnet.

5. A circuit breaker including a pair of separable contacts, a contact carrying arm for one of said contacts, and mechanism for automatically opening said contacts in response to an overload including an actuator pivotally carried by said arm and a latch having a fixed pivot 50 on said contact arm and having the opposite end thereof normally interposed in the path of a portion of said actuator and arranged to prevent opening of said contacts, said contact-carrying arms and said latch and said actuator constituting a triangular assembly when the actu- 55 ator is latched, a current-responsive bimetal extending generally parallel to said latch and having a mechanical connection thereto to operate the latch laterally only in the tripping direction, and electromagnetic means including an armature forming part of said latch and effective 60 to operate the latch in the tripping direction.

6. A circuit breaker including a pair of separable contacts, a contact carrying arm for one of said contacts, said arm having a pivotal support, mechanism for automatically opening said contacts in response to an over- 65 load including an actuator pivotally carried by said arm and a latch having a fixed pivot on said contact arm and having the opposite end thereof interposed in the path of a portion of said actuator and arranged to prevent opening of said contacts, means adjusting the extent 70 of overlap of said actuator across the latch end to adjust the tripping level, said contact-carrying arm and said latch and said actuator constituting a triangular assembly when the actuator is latched, a current-responsive bimetal extending generally parallel to said latch and 75

having a mechanical connection thereto to operate the latch laterally only in the tripping direction, and electromagnetic means movable with said contact arm and including an armature forming part of said latch and effective to operate the latch in the tripping direction, said means including an adjustment for the air gap of the electromagnetic means independent of said overlap adjusting means.

7. An automatic circuit breaker including a pair of sepaone of said contacts, mechanism effective when released to separate said contacts, said mechanism including an actuator pivoted to said contact-carrying member and having a portion effective when restrained to prevent automatic contact opening operation of said mechanism, a latching assembly carried by said contact-carrying member for restraining said actuator portion normally and for releasing said actuator in response to overload, said assembly including a spring-biased pivoted latch having the end thereof remote from its pivot normally in arresting engagement with said actuator portion and said actuator portion being arranged to move along one side of the latch toward the pivot thereof upon release, a bimetal having one end joined to said contact-carrying member and having the opposite end thereof mechanically coupled to drive said latch only in the actuator-releasing direction, said bimetal extending along the side of said latch opposite said one side thereof, an electromagnetic means also carried by said pivoted contact-carrying member for releasing said latch and including an armature forming part of said latch, said electromagnetic means operating said latch in the direction to release said actuator portion free of obstruction by said bimetal.

8. An automatic circuit breaker including a pair of separable contacts, a pivoted contact-carrying member for one of said contacts, mechanism effective when released to separate said contacts, said mechanism including an actuator pivoted to said contact-carrying member and having a portion effective when restrained to prevent automatic contact opening operation of said mechanism. a latching assembly carried by said contact-carrying member for restraining said actuator portion normally and for releasing said actuator in response to overload, said assembly including a spring-biased pivoted latch having 45 the end thereof remote from its pivot normally in arresting engagement with said actuator portion and said actuator portion being arranged to move along one side of the latch toward the pivot thereof upon release, a bimetal having one end joined to said contact-carrying member and having the opposite end thereof mechanically coupled to drive said latch only in the actuator-releasing direction, said bimetal extending along the side of said latch opposite said one side thereof, an electromagnetic means also carried by said pivoted contact-carrying member for releasing said latch and including an armature forming part of said latch, said electromagnetic means operating said latch in the direction to release said actuator portion free of obstruction by said bimetal, said electromagnetic means further including a coil carried by said movable contact-carrying member having one end thereof united to said bimetal and having a core opposite said armature, the other end of said coil having a flexible connection to a stationary terminal of the circuit breaker

9. An automatic circuit breaker including a pair of separable contacts, a pivoted contact-carrying member for one of said contacts, mechanism effective when released to separate said contacts, said mechanism including an actuator pivoted to said contact-carrying member and having a portion effective when restrained to prevent automatic contact opening operation of said mechanism, a latching assembly carried by said contact-carrying member for restraining said actuator portion normally and for releasing said actuator in response to overload, said assembly including a spring-biased pivoted latch having

the end thereof remote from its pivot normally in arresting engagement with said actuator portion and said actuator portion being arranged to move along one side of the latch toward the pivot thereof upon release, a bimetal having one end joined to said contact-carrying 5 member and having the opposite end thereof mechanically coupled to drive said latch only in the actuator-releasing direction, said bimetal extending along the side of said latch opposite said one side thereof, an electromagnetic means also carried by said pivoted contact-carrying mem- 10 ber for releasing said latch and including an armature forming part of said latch, said electromagnetic means operating said latch in the direction to release said actuator portion free of obstruction by said bimetal, said electromagnetic means including an iron-cored coil car- 15 ried by said bimetal and with one end of the coil joined to said bimetal at the end thereof remote from its connection to the contact-carrying arm, said iron-cored coil including a core extending through the bimetal and exposed to said armature, and an insulated spring between 20 said armature and said bimetal and providing bias normally maintaining said drive connection between said latch and said bimetal.

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