Jan. 24, 1956 E. A. ERICSON ET AL 2,732,455

OVERLOAD RELEASING MECHANISM FOR AUTOMATIC CIRCUIT BREAKER

Filed March 3, 1953

Fig. 1.

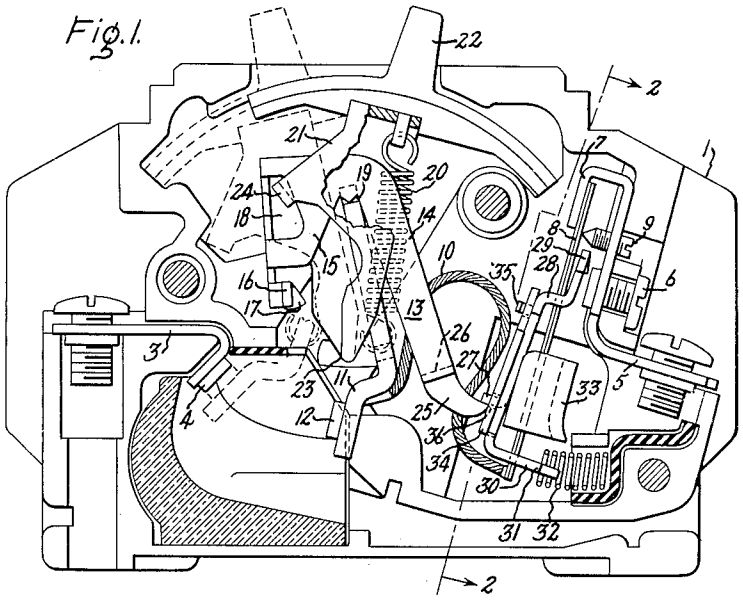


Fig. 2.

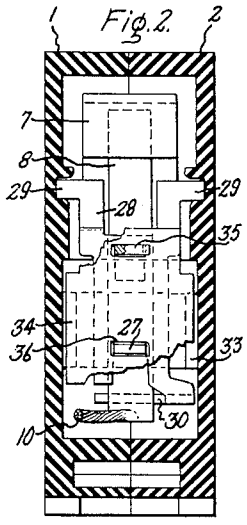


Fig. 3.

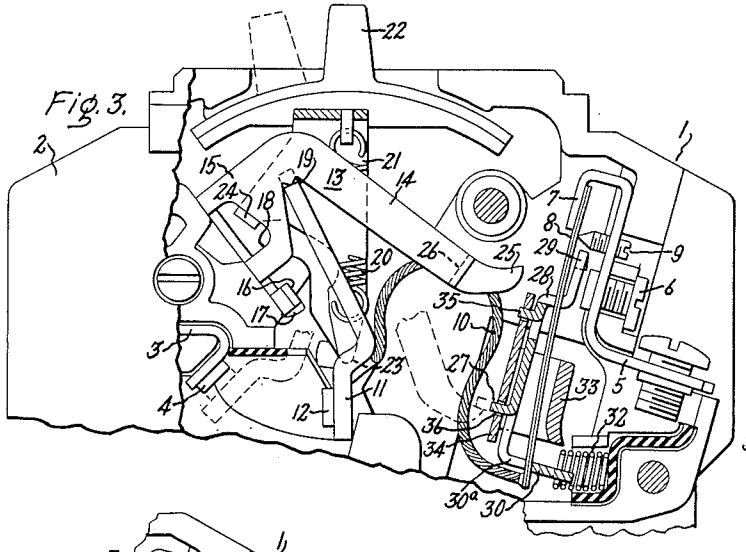


Fig. 4

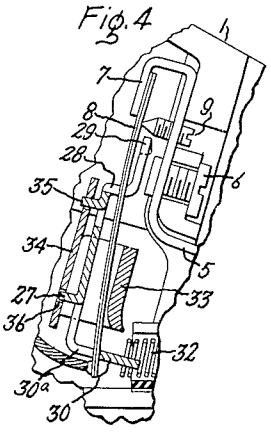


Fig. 5

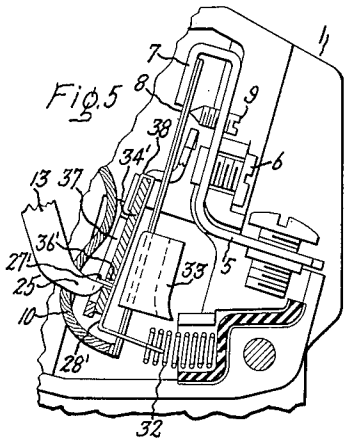
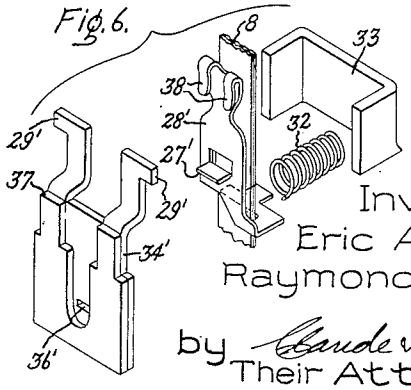


Fig. 6.



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OVERLOAD RELEASING MECHANISM FOR AUTOMATIC CIRCUIT BREAKER

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6 Claims. (Cl. 200—88)

Our invention relates to current overload releasing mechanisms for automatic electric circuit breakers, and more particularly to combined thermal and magnetic trip or latch releasing means responsive to current.

In manually operable current responsively tripped electric circuit breakers it is common practice to provide in the breaker operating mechanism a releasable member normally restrained by a latch member under the control of a thermally deformable current responsive member such as a bimetallic strip. It is well-known that such a bimetallic member, whether directly heated by current passing through it or indirectly heated by proximity to a heating coil, has an inverse-time response in relation to the magnitude of actuating current. Such inverse-time response means that a small overload current will take longer to deform the bimetal and trip the breaker than will a large overload current. This time delay is desirable at low and medium values of overload current, but at large overload current values of the order of ten times rated current and above, time delay in tripping is undesirable, and indeed often cannot be tolerated.

Therefore, to provide substantially instantaneous trip upon high values of overload current, it has heretofore been known to combine with the inverse-time responsive thermal tripping mechanism a current responsive magnetic tripping mechanism. Such combined arrangements are known wherein a magnetizable core member of U-shape is mounted to embrace a current-carrying bimetallic element for magnetization by the current passing through the element, and provided with magnetic poles disposed to attract the movable latch member or a magnetizable armature mounted upon such latch member.

Difficulties have been experienced with the foregoing combined thermal and magnetic trip for several reasons. When the U-shaped magnet is fixedly mounted, it serves to limit movement of the latch or armature and thus to inhibit overtravel movement of the bimetallic member connected thereto. It frequently occurs that, upon high values of overload current, such as short circuit current and the like, the amount of heat stored in the bimetallic member is such as to cause appreciable overtravel of the bimetal beyond the point at which the magnet is engaged by the latch or armature. When such overtravel is inhibited by a fixedly mounted magnet, the bimetallic member becomes permanently bent or set, thereby altering the calibration of the breaker and destroying its accuracy in subsequent tripping operations. It has been attempted to overcome these difficulties by welding the magnet directly on and movable with the bimetal, so that when the bimetal deflects the magnet is carried with it. This latter arrangement, however, definitely decreases the sensitivity and the useful deflection of the

bimetal by placing in contact therewith the comparatively large mass of metal of the magnet, this metal mass bleeding heat away from the bimetal and rendering its response undesirably slow in the operating low overload current range. Moreover, the mounting means utilized, whether riveting or welding, interferes with the normal functioning of the bimetal by removing or rendering ineffective a sizable area of the bimetal.

Accordingly, therefore, it is a principal object of our invention to provide a new and novel combined thermal and magnetic tripping mechanism for electric circuit breakers, in which overtravel of the bimetallic member is permitted without impairing operation of the bimetal in the thermal tripping range of overload current values.

In carrying out our invention in one form, we provide, in conjunction with an automatic electric circuit breaker having separable switch contacts and a movable member releasable automatically to separate the contacts, a movable latch member normally biased to engage and restrain movement of the releasable member. An elongated current-carrying, or directly heated, bimetallic strip is fixedly mounted at one end and has its free end connected to move the latch member to disengaging position when the bimetallic strip is sufficiently heated by the current passing through it. A U-shaped magnet core is fixedly mounted to embrace the bimetallic strip for magnetization by the current through the strip, and the bimetal and the latch member are movable in tripping operation between the poles of the magnet and toward its bight. To provide for magnetic tripping operation upon high overload current values, there is loosely connected to the latch member on its trailing side in tripping movement a magnetizable armature member engageable with the poles of the U-shaped magnet. The armature member is limited in its movement by the magnet poles, but the loose connection between the latch member and the armature member permits overtravel of the bimetal strip and the latch after the armature is in its attracted position against the magnet poles.

Our invention itself will be more fully understood and its various objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawing, in which Fig. 1 is a side elevational view, partly in section, of an electric circuit breaker embodying our invention, one of the cooperating halves of the housing being removed and the mechanism being shown in its manual "on" and "off" positions; Fig. 2 is a transverse cross-sectional view taken along the line 2—2 of Fig. 1; Fig. 3 is a side elevational view similar to that of Fig. 1 but showing the operating mechanism in its tripped position; Fig. 4 is a fragmentary side elevational view of the thermal and magnetic tripping mechanism of Figs. 1, 2 and 3 shown in its thermal overtravel position; Fig. 5 is a fragmentary side elevational view of a circuit breaker similar to that of Figs. 1 and 3 and including a tripping mechanism embodying our invention in modified form; and Fig. 6 is an exploded perspective view of the principal parts of the tripping mechanism shown at Fig. 5.

Referring now to the drawing, we have shown our invention as embodied in a manually operable current responsively tripped electric circuit breaker comprising a casing of molded plastic insulating material made up of two cooperating casing halves 1 and 2 (Fig. 2) having recesses and bosses formed therein to support, guide and insulate the terminals, contacts and other parts of the

operating mechanism. A line terminal 3 is supported in a recess at one end of the casing and carries at its inner end a stationary contact 4. An L-shaped load terminal 5 is mounted at the other end of the casing by means of a bolt 6, and is provided at its upper end with a return-bent portion 7 upon which a bimetallic strip 8 is fixedly mounted at one end in cantilever fashion by any suitable means, such as welding. A calibrating screw 9 is carried by the terminal 5 and engages the fixed end of the bimetallic strip 8 to spread the return-bent end of the terminal 5 and thus determine the initial or unheated position of the free end of the bimetal. The bimetal 8 has a flexible conductive braid 10 welded to it at its free end, the other end of the braid being welded to a movable switch member 11 carrying a movable contact 12.

Mechanism is provided for manually moving the movable switch member 11 and contact 12 between open and closed circuit positions with respect to the fixed contact 4, and for automatically moving the member 11 and contact 12 to open circuit position upon the occurrence of a current overload through the breaker. This mechanism comprises a generally U-shaped cradle or tripping member 13 having two bifurcated side arms 14 and 15 and mounted for pivotal movement in the casing by means of a pair of outwardly extending lugs at the outer end of the bifurcated side arm 15, the lugs 16 projecting loosely into recesses 17 in the casing halves 1 and 2. Aligned openings 18 are provided in the bifurcated side arm 15 of the member 13 for a purpose to be described more fully hereinafter.

The switch member 11 is also bifurcated and is pivotally mounted in the bight of the U-shaped tripping member 13, the bifurcated ends of the switch member 11 resting in notches 19 in the bight of the member 13. A tension spring 20 is connected between the bight portion of the switch member 11 and the movable end of a pivotally mounted operating lever 21, the spring moving between the bifurcations of the cradle arm 14 and of the switch member 11. The operating lever 21 is pivotally mounted at one end in V-shaped notches 23 in the sidewalls of the casing, and carries at its movable end a handle 22. The lever 21 has two inturned lugs 24 projecting into the apertures 18 in the member 13 for use in resetting the mechanism in a manner to be described hereinafter. The upward bias of the spring 20 on the switch member 11 causes it in turn to bias the tripping member 13 for rotation counterclockwise about its pivot 16.

For the purpose of normally preventing such movement of the tripping member 13, such member is provided at the end of its bifurcated arm 14 with a latching tip 25 which is mounted midway between the bifurcations of the arm 14 on a bridging piece 26. The latching tip 25 normally engages and is releasably held in position by a projecting tongue 27 on a movable latch lever 28. The latch lever 28 is pivotally mounted at one end in the casing halves 1, 2 by means of laterally projecting lugs 29. The latch lever 28 is L-shaped, and the bent-over portion 30 of its free end is reduced or cut away to form shoulders 31 engaging a compression spring 32. The spring 32 biases the latch member 28 into holding or latching engagement with the releasable cradle or tripping member 13. The portion 30 of the latch lever 28 is apertured at 30*a* to receive the free end of the bimetallic strip 8 in interlocking engagement.

The switch member 11 is manually operable between open and closed circuit positions with a snap action by moving the operating lever 21 so as to carry the center line of the spring 20 back and forth across the pivot point 19 of the switch member 11. The manual open or "off" and closed or "on" circuit positions of the switch member 11 with the tripping member 13 in its latched position, are shown in full and broken lines respectively at Fig. 1. Upon the occurrence of an overload in the circuit through the breaker, the bimetallic strip 8 becomes heated and deflects its free end toward the right, as shown in the

drawing, its free end moving the free end of the latch member 28 to the right, compressing the spring 32 and withdrawing the latching tongue 27 from engagement with the tip 25 of the tripping member 13.

Upon release of the latching tip 25 by the latch tongue 27, as shown at Fig. 3 in full lines, the tripping member 13 is rotated by the spring 20 in a counterclockwise direction about its pivots 16, thereby carrying the pivot points 19 at its bight across the line of action of the spring 20. The spring 20 then moves the switch member 11 to its tripped open circuit position, as shown in full lines at Fig. 3. As the switch member 11 moves to its tripped position, it carries the lower end of the spring 20 to the right, whereby its line of action is moved across the pivot points 23 of the operating lever 21. The spring 20, after such movement, biases the lever 21 for clockwise movement, so that if the lever 21 is not manually restrained it moves from the manual "on" position, shown in dotted lines at Fig. 3, clockwise until the lugs 24 engage the edges of the openings 18 in the tripping member 13. The lever 21 and handle 22 are there stopped by the member 13 in a mid or tripped position, as shown in full lines at Fig. 3, for the purpose of indicating that the breaker has tripped.

Following the foregoing tripping operation, the breaker may be relatched by moving the operating lever 21 from the mid or tripped position to the full "off" or right-hand position, as shown at Fig. 1. During this movement the cradle 13 is rotated in a clockwise direction by the engagement of lugs 24 with the edges of openings 18 until the latching tip 25 is below the latch tongue 27. If the bimetallic strip 18 has then cooled sufficiently, compression spring 32 will move the latch lever 28 to the latching position, as shown at Fig. 1, and the contacts may be reclosed by movement of the handle to the "on" position.

It will now be evident that the mechanism described above constitutes a manually operable snap acting electric switch having a releasable trip member which, when released, causes automatic separation of the contacts, the trip member being normally restrained by an overcurrent responsive spring biased latch member 28. As described above, the current carrying bimetallic strip 8 provides means for withdrawing the latch and releasing the cradle 13 upon the occurrence of moderate overload current.

To withdraw the latch lever 28 and release the member 13 substantially instantaneously upon the occurrence of high overload current, we provide, in conjunction with the latch lever and the bimetallic strip 8, a magnetic tripping mechanism comprising a U-shaped magnetizable member 33 fixedly mounted in the casing and a magnetizable armature member 34 loosely connected to the latch member 28. The U-shaped magnetizable core or magnet 33 is fixedly mounted in positioning recesses in the casing halves 1 and 2, as indicated at Fig. 2, and is positioned to embrace the bimetallic strip 8 and the latch member 28, so that in latch releasing movement the bimetallic strip and the latch lever freely move between the polar ends of the magnet 33 and toward its bight. The magnetizable armature member 34 is formed as a flat plate wider than the latch member 28, so that it may engage the poles of the magnet 33 but not pass between the poles. The armature plate is pivotally mounted upon the latch lever 28 by loosely hanging the armature upon a headed lug 35 bent outwardly from the latch lever on that side of the latch lever which is trailing in latch releasing movement. The lower portion of the armature plate 34 is apertured at 36 to permit passage therethrough of the latching tongue 27 of the latch lever.

In operation it will now be observed that the armature plate 34 normally lies loosely in flatwise engagement with the trailing side of the latch lever 28. In thermal operation the latch lever is moved by deformation of the bimetallic strip 8 from the latching position

shown at Fig. 1 to a latch releasing position, as shown in full lines at Fig. 3. In this movement the armature 34 lies idly on the following side of the latch lever 28 and has no effect upon the operation. When the latch releasing movement of the lever 28 has proceeded very slightly beyond the point at which the tongue 27 releases member 13, the armature plate 34 engages the poles of the magnet 33 and the magnet acts to stop further movement of the armature plate. If, however, the bimetallic strip 8 has sufficient thermal energy stored therein to continue its deformation beyond this point, it is free to do so without further movement of the armature plate 34, as indicated at Fig. 4. In this overtravel movement, the bimetallic strip 8 and its connected latch lever 28 freely move between the poles of the magnet 33 and take up the lost motion in the loose connection between the latch lever 28 and the armature 34. In taking up this lost motion the armature plate 34 swings about its pivot 35 away from the latch lever 28. Such free overtravel of the bimetallic strip prevents permanent set or deformation of the strip which would take place if its overtravel were inhibited.

It will be evident that this same overtravel action is permissible upon magnetic tripping operation wherein the armature 34 is attracted instantaneously to the poles of the magnet 33, moving the latch lever 28 to the position shown at Fig. 3 by magnetic action. In such case, stored thermal energy in the bimetallic strip is free to produce the same overtravel action described above.

Referring now to Figs. 5 and 6, we have shown a combined magnetic and thermal tripping mechanism embodying our invention in modified form. In the embodiment of the invention shown at Figs. 5 and 6, the bimetallic strip 8 and the U-shaped magnet 33 are mounted and arranged in the same manner as at Figs. 1–4 inclusive, and these and other corresponding parts have been assigned the same or like reference numerals. At Fig. 5, however, the magnetizable armature member 34', rather than being mounted upon a pivoted latch lever, is itself pivotally mounted, and a resilient latch lever 28' is mounted upon the armature near its pivoted end and on the leading side of the armature in latch releasing movement. More particularly, the armature 34', at Figs. 5 and 6, is formed as a flat plate having offset bifurcations at the upper end terminating in oppositely extending lugs 29' seated in suitable recesses in the casing halves, thereby pivotally to mount the armature 34' for swinging movement into and out of engagement with the poles of the magnet 33. To provide greater magnetic permeability, the magnet armature 34' is provided on one face with an additional plate 37 of magnetic material. Between the offset bifurcations at the upper end of the pivotally mounted armature 34', there is suspended by means of a pair of turned over mounting hooks 38 a resilient latch member 28' disposed in normal flatwise engagement with the leading face of the armature 34' and having an outturned latching tongue 27' projecting through an aperture 36' in the armature plate. The resilient latch member 28' is formed of any suitable spring metal and is bent outwardly at its lower end into an L-shape to engage the biasing spring 32. An aperture in the outturned lower end of the latch member 28' provides for interlocking engagement of the bimetallic strip 8. As clearly indicated at Fig. 6, the bimetallic strip 8 and the resilient latch member 28' are narrower than the armature 34', so that they may freely pass between the poles of the U-shaped magnet 33.

It will now be evident to those skilled in the art that, in operation of the device shown at Figs. 5 and 6, whenever the armature plate 34' comes into engagement with the poles of the magnet 33, either by reason of thermal deformation of the bimetallic strip 8 or by reason of magnetic attraction, further movement of the bimetallic strip toward the bight of the U-shaped magnet 33 is permitted by bending of the resilient latch member 28' away from the lower end of the armature 34' while leaving the armature in engagement with the magnet poles.

While we have described certain preferred embodiments of our invention by way of illustration, many modifications will occur to those skilled in the art, and we therefore wish to have it understood that we intend in the appended claims to cover all such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In an electric circuit breaker having separable switch contacts and a releasable tripping member movable to separate said contacts automatically, a latch member and a magnetizable armature member loosely connected together and movably mounted, said latch member having a portion operable to release said releasable tripping member, an elongated bimetallic member connected in circuit with said contacts and having a movable end coupled to move said latch member to releasing position, and a U-shaped magnetizable core member fixedly mounted to embrace said bimetallic member for magnetization by the current conducted therethrough and providing spaced-apart pole pieces to attract said armature, said bimetallic member and said latch member each including a portion movable within said core member in a tripping direction, said armature being wider than the space between said pole pieces and being movable into engagement with said pole pieces upon a predetermined amount of movement of said portion of said bimetallic member and said latch member within said core member, the loose connection of said latch and armature members permitting thermal responsive overtravel of said bimetallic member due to heat stored therein after release of said releasable tripping member and following said engagement of said armature member with said pole pieces.

2. An electric circuit breaker as set forth in claim 1 wherein the latch member and the armature member are each pivotally mounted at one end for swinging movement and in which the bimetallic member is fixedly mounted at one end adjacent the said pivotally mounted ends of said latch and armature members and extends in substantially parallel spaced relation to said latch member.

3. A circuit breaker as set forth in claim 1 wherein the latch member and the armature member are each pivotally mounted at one end for swinging movement and in which the bimetallic member is fixedly mounted at one end adjacent the pivotally mounted ends of said latch and armature members and extends in substantially parallel spaced relation to said latch member, and wherein the said armature member is pivotally mounted on said latch member between the magnetic core member and the pivot of the latch member.

4. A circuit breaker as set forth in claim 1 wherein the armature member is pivotally mounted and the latch member comprises a flexible resilient strip carried by said armature member.

5. A circuit breaker as set forth in claim 1 wherein the armature member and the latch member comprise a pair of plates in flatwise engaging relation, the latch plate being between the armature plate and the core member and having a tongue extending beyond said armature plate normally to engage the releasable tripping member.

6. An electric circuit breaker having separable switch contacts and a releasable tripping member movable to separate said contacts automatically, a latch member and a magnetizable armature member resiliently connected together and movably mounted, said latch member having a portion operable to release said releasable tripping member, an elongated bimetallic member connected in circuit with said contacts and having a movable end coupled to move said latch member to releasing position, and a U-shaped magnetizable core member fixedly mounted to embrace said bimetallic member for magnetization by the current conducted therethrough and providing spaced-apart pole pieces to attract said arma-

ture, said trip member and said bimetallic member including portions movable within said core member in a tripping direction, said armature being wider than the space between said pole pieces and being movable into engagement with said pole pieces upon a predetermined amount of movement of said portion of said bimetal within said core member, the said resilient connection of said latch and armature members permitting thermal responsive overtravel of said bimetallic member due to heat stored therein after release of said releasable tripping member and following said engagement of said armature member with the said pole pieces.

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