(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 006 737**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **79301199.0**

(51) Int. Cl.³: **H 01 H 71/40**

(22) Date of filing: **21.06.79**

(30) Priority: **22.06.78 US 910786**

(43) Date of publication of application: **09.01.80 Bulletin 80/1**

(84) Designated Contracting States: **BE DE IT NL**

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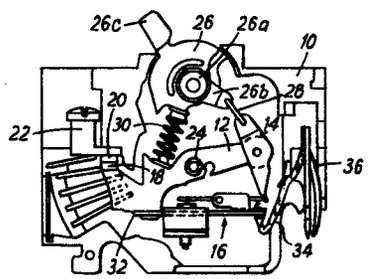
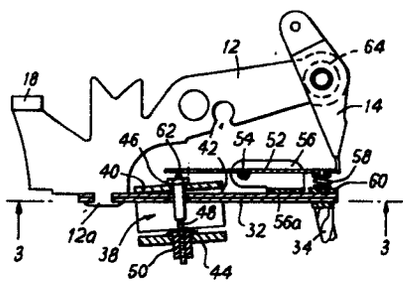
(54) Thermal-magnetic circuit breaker.

(57) A circuit breaker of the type in which a toggle is manually erected to drive a "heart" as a unit for closing the circuit breaker. The "heart" includes a contact arm (12), an actuator (14), and overcurrent releasable latch means (16) which collectively form a normally latched unit. Under excess-current conditions, the latch means (16) releases the actuator (14), and the contact arm (12) then opens the circuit. The latch means (16) includes a conventional bimetal strip (32) fixed at one end to the contact arm (12). The bimetal strip (32) carries a pivoted latch lever (52), and is surrounded by a core-and-armature unit (38, 44) adjacent its secured end, for operating the latch lever (52) in response to high overcurrents. High magnetic trip sensitivity is achieved in a construction wherein the whole electromagnet (38, 44) moves bodily with the contact arm (12), without resort to a current-carrying coil for the electromagnet.





EP 0 006 737 A1

Thermal-Magnetic Circuit Breaker

The present invention relates to thermal-magnetic circuit breakers of the type involving a manually operated toggle that drives a pivoted "heart" in closing the circuit breaker. The toggle becomes erect and slightly over-set to lock the "heart" in closed condition, but the heart itself incorporates overcurrent releasable latch means that allows the breaker to open despite the locked condition of the toggle. The "heart" includes three main parts: an elongated contact arm, an actuator, and an overcurrent latch device. The heart is operable as a unit about a pivot roughly midway between the ends of the contact arm. The actuator is pivoted to one end of the contact arm. The opposite end of the contact arm carries the movable contact of the circuit breaker. An elongate bimetal member forming part of the overcurrent release device has one end secured to the contact arm near the movable contact. The bimetal member carries a pivoted latch that normally obstructs the actuator, the heart constituting a latched unit in this condition. Deflection of the bimetal member due to heating by circuit breaker current carried by the bimetal member shifts the latch in the release direction. Associated with the bimetal is an electromagnet that also can operate the latch in the release direction.

Various forms of the toggle-and-"heart" type of circuit breaker are known in the prior art, conforming to all of the above description. In the past, it has always seemed necessary to

incorporate a coil with the core or yoke and the armature whenever a sensitive magnetic trip was desired. Notably, in many cases, most if not all of the structure forming the thermal and magnetic trip elements move bodily with the contact arm when the circuit breaker closes and when it is opened either manually or automatically. That basic requirement of a bodily movable thermal-magnetic trip device inherently has constraints in the way of achieving practical and economical circuit breakers of the type.

An object of the invention is to provide a novel toggle-and-heart circuit breaker having a practical and economical over-current release device including thermal and sensitive magnetic release means.

According to the present invention there is provided a circuit breaker having a case of molded insulation and a mechanism including

a pivoted unit comprising an elongate contact arm having a pivotal support between the ends thereof and having a movable contact at one end thereof, an actuator pivoted to the other end of the contact arm, and an overcurrent release device constituting latching means for the pivoted actuator and including a short-circuit responsive electromagnet and an elongate overcurrent responsive bimetal fixed at one end thereof to the contact arm, the mechanism also including

a handle pivoted in the said case and link means articulated to the actuator and acting with the handle to form an operating toggle for the pivoted unit,

an opening spring which biases the contact arm towards the opening direction, and

a companion contact engageable by the movable contact when the handle is operated to close the circuit breaker, characterised in that the electromagnet comprises a core and an armature together encircling the bimetal, the core being fixed to the pivoted unit adjacent the said fixed end of the bimetal, means supporting the armature at the side of the bimetal remote from the contact arm and the supporting means limiting the gap between the core and the armature and a medially pivoted latch lever carried by the bimetal and disposed between the bimetal and the contact arm, one end of the latch lever acting as a latch normally obstructing the actuator and the other end of the latch lever being

operated by the armature, the arrangement being such that the overcurrent in the bimetal causes displacement of the pivot and the latch end of the latch lever to release the actuator and that short-circuit current in the bimetal causes pivoting of the latch lever to release the actuator.

In a preferred embodiment, the circuit breaker has a release device that utilizes the usual elongate bimetal member secured at one of its ends to the movable contact arm. Fixed to the heart near the secured end of the bimetal is the core of an electromagnet, the core extending across the bimetal between the bimetal and the contact arm. The armature extends across the opposite side of the bimetal. A latch lever extends along the bimetal and has a medial pivot carried by the bimetal at a position relatively remote from the secured end of the bimetal. When the bimetal is heated, its deflection causes shift of the latch-lever pivot in the tripping direction. The armature of the electromagnet, when shifted magnetically toward its core, drives the latch lever in the tripping direction. The construction has proved highly effective for its intended purpose, and it avoids complexity and is economical to produce.

An illustrative embodiment of the invention will now be described, solely by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a lateral view of an illustrative circuit breaker embodying the present invention, the front cover of the molded-case enclosure being removed to reveal the internal mechanism;

Fig. 2 is an enlarged view of portions of Fig. 1, shown partly in cross-section; and

Fig. 3 is a cross-section of portions of Fig. 2 as viewed from the plane 3--3, Fig. 2.

In Fig. 1, the illustrative circuit breaker has a case 10 of molded insulation whose cover (not shown) has been removed to reveal the internal parts. The illustrative mechanism includes a "heart" consisting of three principal parts and a toggle. The "heart" includes an elongated contact arm 12 as of copper, a pivoted actuator 14, and an over-current release device 16 that forms a latch for the actuator 14 when the circuit breaker is closed (and while it is being closed) and which releases the actuator 14 in response to an overcurrent or a short-circuit

for enabling the circuit breaker to open. The mechanism is shown in the closed condition of the circuit breaker. A movable contact 18, for example of silver-tungsten, is united to the end of the contact arm 12 that is remote from the actuator 14. The movable contact 18 is in engagement with a companion contact 20, also of silver-tungsten in this example, fixed to a terminal 22. In other embodiments, the companion contact 20 is capable of limited motion, and is spring-biased toward the movable contact. Approximately at its mid-point, contact arm 12 is supported on a transverse pivot 24 whose ends are supported in the cover (not shown) and the case 10. Where the contact 20 is fixed, as in the present example, this pivot 24 takes the form of a tightly wound coil spring that resembles a rod, with its ends supported in the cover (not shown) and the case 10, and with the contact arm 12 carried at the mid-point along the length of this coil spring. In circuit breakers where contact 20 is spring-biased, the pivot 24 is normally a rigid pin.

A manual operating mechanism is provided for actuating the three-part unit or "heart" 12, 14, 16 into the closed configuration illustrated in Fig. 1. This includes a handle 26, for example of molded insulation, having aligned oppositely extending pivot portions 26a received in bearings of the molded case 10 and cover (not shown). A link 28 is articulated to arm 26b of the handle 26 and to the actuator 14. In the present example, the link 28 is a U-shaped piece of wire whose legs are received in bearings formed in the actuator 14 and the arm 26b respectively. In other circuit breakers embodying the invention, (2-pole and 3-pole) the link 28 is more complex, being made of a number of parts. In any case, the arm 26b of the handle and the link 28 constitute a toggle which is slightly over-set (as shown in Fig. 1). when the circuit breaker is closed. A finger-piece 26c of the handle 26 engages the case 10 and cannot move counterclockwise beyond the position illustrated in Fig. 1; and for this reason the toggle 26b-28 cannot become overset beyond the degree illustrated. In this condition, the handle 26 and the link 28 drive the three-part device 12, 14, 16 counterclockwise to force the movable contact 18 against the companion contact 20. The middle of the spring pivot 24 is forced downward whil its ends are restrained in the case 10 and the cover (not shown), the pivot 24 thus becoming stressed.

When the latch 16 releases the actuator 14, the toggle 26b-28 is no longer effective to hold the contact arm 12 in its contacts-closed position. Upon release of the latch, the spring pivot 24 becomes freed to drive the contact arm 12 counterclockwise about the contacts 18 and 20 as a fulcrum, providing initial impetus for the counterclockwise movement of the contact arm 12. A contact-opening spring 30 then pushes the contact arm 12 counterclockwise about the pivot 24 in the direction to open the contacts 18 and 20.

The overcurrent release device 16 includes an elongate bimetal member in the form of a bimetal strip 32. In the closed condition of the circuit breaker, a current path can be traced through the circuit breaker from the terminal 22, through the closed contacts 20 and 18, through a portion of the contact arm 12 and along the bimetal strip 32, to a flexible conductor 34 of fine-wire copper braid which is welded to the extremity of the bimetal strip 32 and to an external plug-in terminal 36. The bimetal strip 32 is arranged so that, upon heating, the right-hand extremity of the bimetal strip 32 moves downward in relation to the rest of the mechanism, this being the latch-releasing direction.

In its most widely used commercial form hitherto, the "heart" of this class of circuit breaker involves direct engagement of an actuator corresponding to the actuator 14 with the free end of a bimetal strip (to which end a conductor corresponding to the conductor 34 is connected). In other known forms of this type of circuit breaker mechanism, the bimetal strip is arranged to operate a latch separate from the bimetal strip, and some form of magnetic operator is also provided for deflecting that separate latch for releasing the circuit breaker under short-circuit conditions. However, in those instances in the past when so-called "sensitive" magnetic tripping was desired, it always seemed to be necessary to incorporate a coil as part of an electro-magnet in series with the conductive path through the circuit breaker. Such a coil adds considerably to the expense and complexity of circuit breakers. However, in accordance

with the present invention, it has proved feasible to achieve high magnetic tripping sensitivity in this class of circuit breaker of the order of as little as five times the rated thermal tripping current, without using a trip coil. For example, a circuit breaker constructed to embody the present invention (as illustrated in the drawing) having a nominal current rating of 51 amperes, may be required to trip after a time delay in response to 30 amperes, and such a breaker can be made to trip at 75 amperes instantaneously using the construction described with reference to the accompanying drawings.

Referring to Figs. 2 and 3, the details of the overcurrent release 16 may now be considered. As seen in Fig. 2, the contact arm 12 is united to one end of the bimetal strip 32 by means of an integral rivet 12a, providing a low-resistance electrical connection and a secure mechanical connection between the contact arm 12 and the bimetal strip 32. At its opposite end, the bimetal strip 32 is united to the braid conductor 34 by welding. The sidewalls 38a of a channel-shaped core 38 straddle the bimetal 32. The "bottom" or web of the core 38 is disposed closely adjacent to the wide surface of the bimetal strip 32. The core 38 is resistance-welded to the bimetal strip 32 at a region 40 (represented by the small crosses). There is a slight space 42 between the bimetal strip and that portion of the core 38 that is remote from the welded region 40. (The space 42 is exaggerated in Fig. 2).

A flat armature 44 is separated by small gaps from the edges of the side walls 38a. A composite rod maintains assembly of the armature 44 to the core 38. This rod includes a hexagonal head portion 46 which rests on the web of the core 38, and an end portion 48 that is threaded along part of its length. This threaded portion 48 extends through an internatally threaded bushing 50 that is united to the armature 44. The gaps between the armature 44 and the side walls 38a of the core 38 are adjusted by rotating the hexagonal head 46 of the rod, and thereafter the bushing 50 is crimped against the rod to resist any change of adjustment such as might otherwise result from vibration.

The channel-shaped core 38 is made of an electrical grade steel such as Losil 630 which is produced by the British

Steel Corporation and has a high permeability and a low resistivity but differs from transformer steel in establishing a high flux density at relatively low values of the inducing field. The armature 44 is a suitable steel, and the composite rod including the head portion 46 and the threaded rod 48 is made of brass.

As can be seen from Fig. 2, the composite rod passes through apertures in the bimetal strip 32 and the web of the core 38 which provide considerable clearance. Consequently, in the condition shown in Figs. 1 and 2, the armature 44 is held in position simply by the pressing of one end of a latch lever 52 on the upper end, as viewed in Figs. 1 and 2, of the composite rod and the resting of the hexagonal head portion 46 on the web of the core 38.

The latch lever 52 is pivoted roughly midway between its ends on a shaft 54 which is, in turn, supported by a bracket 56. The bracket 56 includes two side walls that carry the ends of shaft 54. The side walls of the bracket 56 are connected by a web 56a that is welded to the bimetal strip 32. A coil spring 58 biases the right-hand arm of latch lever 52 upward. The coil spring 58 bears downward against a piece of insulation 60 that is adhered to the bimetal strip 32. The left-hand arm of the latch lever 52 is engaged by a slight projection 62 of the composite rod 46-48. The spring 58 biases the latch lever 52 counterclockwise and accordingly biases the composite rod 46-48 downward so as to bias the armature 44 away from the core 38.

During periods of moderate overcurrent flowing through the bimetal strip 32, the bimetal strip 32 deflects downward, and carries the bracket 56 and the pivot 54 downward. Since projection 62 constituting the upper end of the composite rod 46-48 supports the left-hand extremity of the latch lever 52, the right-end extremity of the latch lever 52 moves downward and unlatches the actuator 14. When this occurs, the spring 30 pushes the contact arm 12 counterclockwise, the actuator 14 moves clockwise about its pivot, and the contacts 18 and 20 are opened.

When there is a short-circuit or a current of sufficient magnitude to magnetise the core 38 sufficiently to cause the armature 44 to move inwards against the core 38, the composite rod 46-48 shifts upward and drives the latch lever 52 clockwise

about its pivot 54. This clockwise movement of the latch lever 52 releases the actuator 14 from the latch lever 52 and the contact arm 12 is driven counterclockwise as before to open the contacts 18 and 20.

The only current path through the overcurrent release 16 is that which includes the length of the bimetal strip 32. The insulator 60 prevents current from flowing through the coil spring 58 and the latch lever 52. Moreover, there is an insulating bushing 64 in the pivot of the actuator 14 on the contact arm 12, and this insulation prevents flow of any current from the bimetal strip 32 through the rod portion 46 and the latch lever 52 to the actuator 14.

The combined thermal and magnetic tripping device 16 is of remarkable magnetic sensitivity, considering the fact that no coil is needed. The cost of such a coil and the inherent complexity of a coil are eliminated. The entire tripping device 16 is compatible with the requirement in this class of circuit breaker that the "heart" comprising parts 12-14-16 must be operated clockwise as a unit when the circuit breaker is manually closed. The unit 16 and the movable contact arm 12 have a very small moment of inertia and move at high speed to interrupt an overcurrent or a short-circuit when the contacts open. This circuit breaker can have a current-interrupting rating of 3,000 amperes at 415 volts, and it can trip at 5 times its rated current, with rated currents as low as 15 amperes. This breaker can be made as an "L" characteristic unit to VDE 0664 (German Standard).

As will be apparent to those skilled in the art, this circuit breaker is trip-free, so that the contact-opening operation of the contact arm 12 when the actuator 14 is unlatched is not in any way impeded if the handle 26 is pressed to remain in the "on" position illustrated. However, if the handle 26 is not restrained, the handle 26 is moved by the spring 30 to the "off" position when the contact 12 arm is driven to its "off" position. Additionally, even though the actuator 14 is momentarily driven clockwise when it is unlatched, the actuator 14 quickly moves counterclockwisee when the handle 26 moves to the "off" position. The actuator 14 is then in condition to become relatched against the latch lever 52 at the start of a subsequent circuit-breaker closing operation of the handle 26.

CLAIMS

1. A circuit breaker having a case (10) of molded insulation and a mechanism including

a pivoted unit comprising an elongate contact arm (12) having a pivotal support (24) between the ends thereof and having a movable contact (18) at one end thereof, an actuator (14) pivoted to the other end of the contact arm (12), and an overcurrent release device (16) constituting latching means for the pivoted actuator (14) and including a short-circuit responsive electromagnet (38,44) and an elongate overcurrent responsive bimetal (32) fixed at one end thereof to the contact arm (12), the mechanism also including

a handle (26) pivoted in the said case (10) and link means (28) aritculated to the actuator (14) and acting with the handle (26) to form an operating toggle for the pivoted unit,

an opening spring (30) which biases the contact arm (12) towards the opening direction, and

a companion contact (20) engageable by the movable contact (18) when the handle (26) is operated to close the circuit breaker, characterised in that the electromagnet comprises a core (38) and an armature (44) together encircling the bimetal (32), the core (38) being fixed to the pivoted unit (12, 14, 16) adjacent the said fixed end of the bimetal (32), means (46,48) supporting the armature (44) at the side of the bimetal (32) remote from the contact arm (12) and the supporting means (46,48) limiting the gap between the core (38) and the armature (44), and a medially pivoted latch lever (52) carried by the bimetal (32) and disposed between the bimetal and the contact arm (12), one end of the latch lever (52) acting as a latch normally obstructing the actuator (14) and the other end of the latch lever (52) being operated by the armature (44), the arrangement being such that overcurrent in the bimetal (32) causes displacement of the pivot (54) and the latch end of the latch lever (52) to release the actuator (14) and that the short-circuit current in the bimetal (32) causes pivoting of the latch lever (52) to release the actuator (14).

2. A circuit breaker according to claim 1, characterised by a spring (58) biasing the latch lever (52) into its actuator-latching position and biasing the armature (44) away from the core (38).

FIG. 1

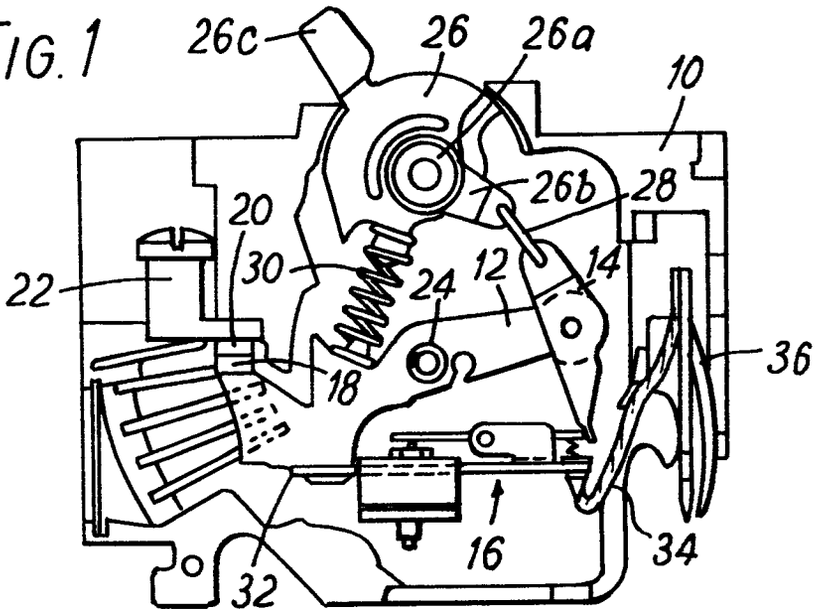


FIG. 2

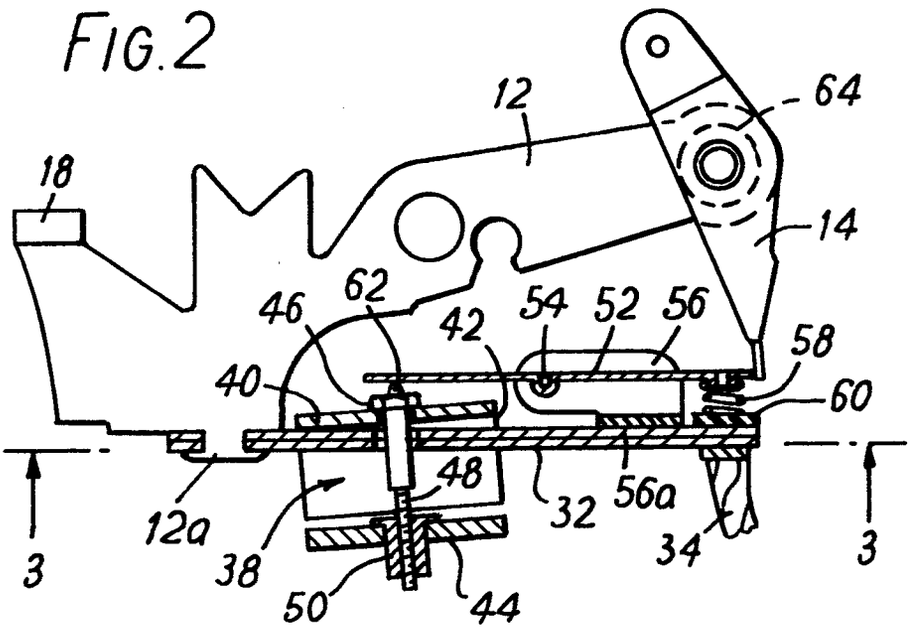
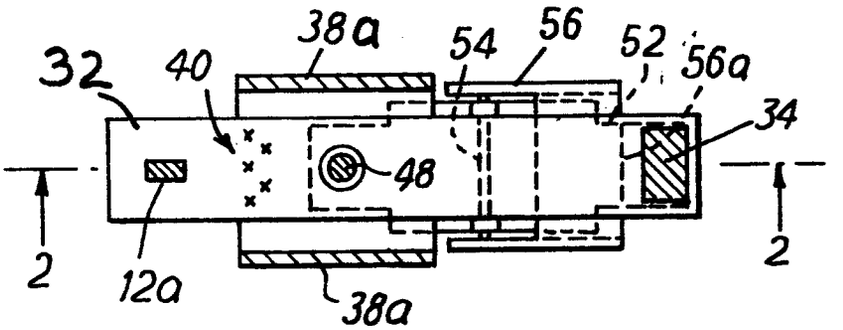


FIG. 3



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EUROPEAN SEARCH REPORT

0006737
Application number
EP 79 30 1199

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 2 854 546 (COLE) * column 2, lines 18-72; column 3, lines 1-75; column 4, lines 1-25 and 68-75; columns 5 and 6; column 7, lines 1-18 * --	1,2
	US - A - 3 599 136 (DE TORRE) * whole document * --	1,2
	US - A - 2 876 309 (WIKTOR) * column 2, lines 38-72; columns 3 and 4; column 5, lines 1-9 * --	1,2
	US - A - 2 631 208 (PAGE) * column 2, lines 14-55 * ------	1,2

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
H 01 H 71/40

TECHNICAL FIELDS SEARCHED (Int.Cl.³)
H 01 H 71/40

CATEGORY OF CITED DOCUMENTS
X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29-08-1979	DESMET

EPO Form 1503.1 06.78