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(54) **Electromagnet for automatic circuit breaker having a flat core with twisted portion**

Elektromagnet für einen Leitungsschutzschalter mit einem flachen Kern mit einem verdrehten Teil

Electro-aimant pour un interrupteur automatique avec un noyau plat avec une partie torsadée

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IT

• **Re, Marcello**
21040 Venegono Superiore (Varese) (IT)

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(74) Representative: **Pezzoli, Ennio et al**
Jacobacci & Perani S.p.A.
Via Senato, 8
20121 Milano (IT)

(73) Proprietor: **BTICINO S.P.A.**
20154 Milano (IT)

(72) Inventors:
• **Fabrizi, Fabrizio**
24100 Bergamo (IT)

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Description

[0001] The present invention relates to an electromagnet for an automatic circuit breaker, and in particular to an electromagnet for an automatic circuit breaker according to the preamble of the first claim.

[0002] A circuit breaker is an electrical apparatus capable of interrupting or establishing a flow of current in a circuit by means of suitable separable contacts; in particular, the contacts are pressed together with a suitable force in a closed circuit breaker condition, while they are separated by an insulation space in an open circuit breaker condition. Circuit breakers are commonly provided with a quick-release mechanism which increases the speed of a circuit breaker opening operation, so as to prevent the striking, between the contacts which are at the point of detachment from each other, of an electrical arc which is subsequently maintained by a violent phenomenon of ionization of the medium (air, for example) lying between the detached contacts.

[0003] Circuit breakers of the automatic type include a protective device which automatically activates the release mechanism, causing the circuit breaker to open, when an excess current is present as a result of a short circuit. The short-circuit protection device basically consists of an electromagnetic relay; the electromagnet has a fixed core on which there is a winding through which the electrical current of the circuit breaker passes and a moving element (the keeper or keeper) which moves under the action of a magnetic field produced by the current in the winding.

[0004] Known electromagnets used in automatic circuit breakers have a cylindrical structure. The electromagnet includes a fixed cylindrical core enclosed by an external shell and a cylindrical keeper, coaxial with the fixed core, which moves with a translational motion. The fixed core is covered by an insulating guide around which the winding is disposed. Document EP 0 226 907 discloses a device according to the preamble of claim 1.

[0005] A disadvantage of known electromagnets is that they have rather large overall dimensions, equal to the sum of the overall dimensions of the fixed cylindrical core, the insulating guide and the winding. This is because the fixed cylindrical core (and the moving keeper) must have a minimum diameter to ensure correct operation of the electromagnet, and the insulating guide must have a minimum thickness to ensure sufficient mechanical strength; and, in any case, the winding must have a rather large minimum cross-section to reduce the heating action produced by the Joule effect by the current in the circuit breaker.

[0006] Typically, known electromagnets have an overall dimension equal to the width of a DIN module circuit breaker, namely 17.5 mm. These electromagnets cannot, therefore, be used in circuit breakers of smaller sizes, for example with a width of half a DIN module.

[0007] The object of the present invention is to overcome the aforesaid disadvantages. To achieve this ob-

ject, an electromagnet for an automatic circuit breaker as described in the first claim is proposed.

[0008] Briefly, the present invention provides an electromagnet for an automatic circuit breaker comprising a substantially flat open core and a winding disposed around the core to create a magnetic field, in which the core has a first portion which is twisted with respect to a remaining second portion about a center line of the core, such that the first portion is disposed in a plane intersecting the second portion, the winding being disposed around the first portion.

[0009] The present invention also provides an automatic circuit breaker comprising this electromagnet.

[0010] Further characteristics and the advantages of the electromagnet for an automatic circuit breaker according to the present invention will become evident from the following description of a preferred embodiment of the invention, provided for guidance and without restriction, with reference to the attached figures, in which:

Fig. 1 is a sectional view of an automatic circuit breaker in which the electromagnet according to the present invention can be used;

Fig. 2 shows schematically, in a perspective view, an embodiment of the electromagnet according to the present invention.

[0011] With reference to Fig. 1 in particular, an automatic circuit breaker 100 of the magnetothermal type comprising an insulating casing 105 is illustrated; on a left-hand side wall and on a right-hand side wall of the insulating casing 105 there are provided, respectively, an input terminal 110a and an output terminal 110b for connecting of the circuit breaker 100 to corresponding electrical cables of an external circuit (not shown in the figure).

[0012] The circuit breaker 100 includes a fixed contact 115a and a moving contact 115b; the moving contact 115b is pressed against the fixed contact 115a in a closed condition of the circuit breaker 100, while the moving contact 115b is separated from the fixed contact 115a in an open condition of the circuit breaker 100. An external control lever 120 enables the circuit breaker 100 to be opened and closed manually (or by means of a suitable actuator).

[0013] A quick-release mechanism 125 is housed inside the insulating casing 105. When the circuit breaker 100 is closed manually by moving the control lever 120, the release mechanism 125 is set (cocked), thus putting a spring 130 under pressure; when the circuit breaker 100 is opened, the release mechanism 125 is made to trip (releasing the spring 130) such that the moving contact 115b is quickly separated from the fixed contact 115a. The opening of the circuit breaker establishes an electrical arc between the contacts 115a, 115b, which is guided, by a switching electrode 135, towards a group of extinction strips 140.

[0014] The circuit breaker 100 also includes a protective device consisting of a bimetallic strip 145 and an electromagnet 150. The bimetallic strip 145 (consisting of two materials whose coefficients of thermal expansion are very different from each other) is connected electrically to the input terminal 110a and, through a flexible conducting braid 155, to the moving contact 115b. The electromagnet 150 consists of a fixed core 160, around which there is an insulated winding 165, and a moving keeper 170, kept separate from the fixed core 160 by means of a return spring 175, as described in detail below. The winding 165 is connected electrically at one end to the fixed contact 115a and at the other end to the output terminal 110b.

[0015] When the circuit breaker is closed (with the moving contact 115b pressed against the fixed contact 115a), the current flowing through the circuit breaker 100 passes through the bimetallic strip 145 and the winding 165 of the electromagnet 150. If the circuit breaker 100 is subjected to a prolonged overload, the circuit breaker current heats the bimetallic strip 145 and deforms it in such a way that it acts on the release mechanism 125, causing the opening of the circuit breaker 100 (thermal protection). In the case of a short circuit, however, the circuit breaker current (which is very high) passing through the winding 165 magnetizes the fixed core 160, which attracts the moving keeper 170 which acts, by means of a suitable mechanism (not shown in the figure), on the release mechanism 125, causing the instantaneous opening of the circuit breaker 100 (magnetic protection).

[0016] The electromagnet according to the present invention can, however, also be used in automatic circuit breakers having a different structure, for example those with two or more pairs of terminals (and a corresponding number of electromagnets), without any thermal protective device, with a different release mechanism, and the like.

[0017] With reference now to Fig. 2 (the elements previously represented in Fig. 1 are identified by the same reference numbers), the fixed core 160 of the electromagnet 150 consists of a flat strip of ferromagnetic material with a weak coercive field, typically soft iron. The fixed core strip 160 is developed along a line 205 having a generally U-shaped configuration, with a smaller side 210 from whose ends a left-hand larger side 215a and a right-hand larger side 215b extend perpendicularly.

[0018] The left-hand larger side 215a is twisted with respect to a remaining part of the strip 160 (the smaller side 210 and the right-hand larger side 215b) about the line of development 205. The winding 165 is disposed on the left-hand larger side 215a (or at least on part of it).

[0019] The present invention can, however, also be produced with the strip having a different configuration, for example a semi-circle or, ultimately, even rectilinear; alternatively, a flat core, cut in a U-shape for example, with one larger side twisted and the winding disposed around the other larger side, is used. More generally, a

substantially flat open core is provided, having a first portion which is twisted with respect to a remaining second portion about a center line of the core, such that the first portion is disposed in a plane intersecting the second portion, the winding being disposed around the first portion.

[0020] The electromagnet according to the present invention occupies less space, approximately as much as the height of the second portion, since the overall dimension of the winding is contained (at least partially) within this portion. This solution enables an electromagnet of small dimensions to be produced, while retaining the operational characteristics required for its operation. In particular, the electromagnet according to the present invention may easily be housed in a small automatic circuit breaker, in particular one with a small width. This result is obtained in an extremely simple way, with a structure which can easily be mass-produced at low cost.

[0021] Advantageously, as in the example shown in the figure, the portion 215a around which the winding 165 is disposed is an end portion of the core 160; this enables the core 160 to be made by a single bending operation (although the use of a non-end portion, requiring a further bending operation, is not excluded). Preferably, the left-hand larger side 215a is rotated through 90° about the center line 205, such that it becomes perpendicular to the right-hand larger side 215b. This ensures that the overall dimension of the winding is contained completely within the right-hand larger side 215b, as a result of which the dimensions of the electromagnet are reduced to a minimum.

[0022] The moving keeper 170 consists of a plate (of soft iron), whose width is preferably equal to the width of the right-hand larger side 215b, which pivots about a free end of the right-hand larger side 215b, in such a way as to form a gap 220 between itself and the free end of the left-hand larger side 215a. In particular, the right-hand end of the moving keeper 170 has a fork 225 having an upper branch 230a and a lower branch 230b. The branches 230a, 230b terminate in projections 235a, 235b that project towards the interior of the fork 225 to retain the moving keeper 170. In particular, the fork 225 is snap-fitted on the free end of the right-hand larger side 215b, in which an upper saddle 240a and a lower seating 240b are provided. The inner portion of the projections 235a, 235b is shaped in the form of a knife-edge, so that it acts as a fulcrum for the rotation of the moving keeper 170 about the right-hand larger side 215b. The left-hand end of the moving keeper 170 is fixed to the return spring 175 and is typically provided with an anti-locking pin (not shown in the figure) of nonmagnetic material, projecting from an inner surface of the moving keeper 170 in such a way that, even when the moving keeper 170 is attracted by the fixed core 160, the gap 220 is not eliminated (to prevent the residual magnetism present in the fixed core 160 from keeping the moving keeper 170 attracted even in the absence of current in

the winding 165, without requiring a return spring 175 of excessive size).

[0023] The moving keeper described above is particularly simple and effective, and enables the available space to be used in the best way. The present invention is, however, also suitable for use with a different moving keeper, for example one hinged to the magnetic core, and the like.

[0024] Obviously, a person skilled in the art may make numerous modifications and changes to the electromagnet for an automatic circuit breaker described above, in order to meet contingent and specific requirements, all such modifications and changes being contained within the scope of protection of the invention, as defined by the following claims.

Claims

1. Electromagnet (150) for an automatic circuit breaker (100), comprising a substantially flat open core (160) and a winding (165) disposed around the core (160) to create a magnetic field,
characterized in that
the core (160) has a first portion (215a) which is twisted with respect to a remaining second portion (210, 215b) about a center line (205) of the core (160), such that the first portion (215a) is disposed in a plane intersecting the second portion (210, 215b), the winding (165) being disposed around the first portion (215a).
2. Electromagnet (150) according to Claim 1, in which the first portion (215a) is an end portion of the core (160).
3. Electromagnet (150) according to Claim 1 or 2, in which the first portion (215a) is substantially perpendicular to the second portion (210, 215b).
4. Electromagnet (150) according to any one of Claims 1 to 3, further comprising a moving element (170) operated by the magnetic field, the moving element (170) pivoting about a first free end of the core (160) to form a gap (220) between itself and a second free end of the core (160).
5. Electromagnet (150) according to Claim 4, in which the core (160) has a generally U-shaped configuration with a first (215a) and a second (215b) larger side, the first portion consisting of the first larger side (215a) and the moving element (170) pivoting about a free end of the second larger side (215b).
6. Electromagnet (150) according to Claim 5, in which the moving element (170) consists of a plate whose width is substantially equal to the width of the second larger side (215b).

7. Electromagnet (150) according to Claim 5 or 6, in which the moving element (170) terminates at one end in a fork (225) which is snap-fitted on the free end of the second larger side (215b).
8. Electromagnet (150) according to Claim 7, in which the fork (220) has a first and a second branch (235a, 235b), each terminating in a projection (235a, 235b) that projects towards the interior of the fork (220) and interacting with a corresponding seating (240a, 240b) formed on the second larger side (215b) to retain the moving element (170).
9. Electromagnet (150) according to Claim 8, in which each projection (235a, 235b) has an inner portion shaped in the form of a knife-edge which acts as a fulcrum for the moving element (170).
10. Automatic circuit breaker (100) comprising a quick-release mechanism (125) to open the circuit breaker (100), and the electromagnet (150) according to any one of Claims 1 to 9 to operate the release mechanism (125) in a short-circuit situation.

Patentansprüche

1. Elektromagnet (150) für einen automatischen Schaltungsunterbrecher (100), der einen im Wesentlichen flachen offenen Kern (160) und eine Wicklung (165) aufweist, die um den Kern (160) herum angeordnet ist, um ein Magnetfeld zu erzeugen,
dadurch gekennzeichnet, dass
der Kern (160) einen ersten Abschnitt (215a) aufweist, der mit Bezug auf einen verbleibenden zweiten Abschnitt (210, 215b) um eine Mittellinie (205) des Kerns (160) verdreht ist, derart, dass der erste Abschnitt (215) in einer Ebene angeordnet ist, die den zweiten Abschnitt (210, 215b) schneidet, wobei die Wicklung (165) um den ersten Abschnitt (215a) herum angeordnet ist.
2. Elektromagnet (150) gemäß Anspruch 1, bei dem der erste Abschnitt (215a) ein Endabschnitt des Kerns (160) ist.
3. Elektromagnet (150) gemäß Anspruch 1 oder 2, bei dem der erste Abschnitt (215a) im Wesentlichen senkrecht zu dem zweiten Abschnitt (210, 215b) ist.
4. Elektromagnet (150) gemäß einem der Ansprüche 1 bis 3, der ferner ein sich bewegendes Element (170) aufweist, das durch das Magnetfeld betrieben wird, wobei das sich bewegendes Element (170) sich um ein erstes freies Ende des Kerns (160) schwenkt, um einen Zwischenraum (220) zwischen demselben und einem zweiten freien Ende des

Kerns (160) zu bilden.

5. Elektromagnet (150) gemäß Anspruch 4, bei dem der Kern (160) eine im Wesentlichen U-förmige Konfiguration mit einer ersten (215a) und einer zweiten (215b) größeren Seite aufweist, wobei der erste Abschnitt aus der ersten größeren Seite (215a) besteht und das sich bewegende Element (170) um ein freies Ende der zweiten größeren Seite (215b) schwenkt. 5 10
6. Elektromagnet (150) gemäß Anspruch 5, bei dem das sich bewegende Element (170) aus einer Platte besteht, deren Breite im Wesentlichen gleich der Breite der zweiten größeren Seite (215b) ist. 15
7. Elektromagnet (150) gemäß Anspruch 5 oder 6, bei dem das sich bewegende Element (170) an einem Ende in einer Gabel (225) endet, die einschnappt auf das freie Ende der zweiten größeren Seite (215b) gepasst ist. 20
8. Elektromagnet (150) gemäß Anspruch 7, bei dem die Gabel (220) eine erste und eine zweite Verzweigung (235a, 235b) aufweist, die jeweils in einem Vorsprung (235a, 235b) enden, der zu dem Inneren der Gabel (220) vorsteht und mit einem entsprechenden Sitz (240a, 240b), der an der zweiten größeren Seite (215b) gebildet ist, in Wechselwirkung steht, um das sich bewegende Element (170) zu halten. 25 30
9. Elektromagnet (150) gemäß Anspruch 8, bei dem jeder Vorsprung (235a, 235b) einen inneren Abschnitt aufweist, der in der Form einer Messerschneide gebildet ist, die als ein Drehpunkt für das sich bewegende Element (170) wirkt. 35
10. Automatischer Schaltungsunterbrecher (100), der einen Schnelllösemechanismus (125), um den Schaltungsunterbrecher (100) zu öffnen, und den Elektromagneten (150) gemäß einem der Ansprüche 1 bis 9 aufweist, um bei einer Kurzschlussituation den Lösemechanismus (125) zu betreiben. 40 45

Revendications

1. Electroaimant (150) pour un disjoncteur automatique (100), comportant un noyau ouvert sensiblement plat (160) et un bobinage (165) disposé autour du noyau (160) pour créer un champ magnétique, **caractérisé en ce que**
le noyau (160) a une première partie (215a) qui est torsadée par rapport à une seconde partie restante (210, 215b) autour d'un axe central (205) du noyau (160), de façon que la première partie (215a) soit disposée dans un plan intersectant la 50 55

seconde partie (210, 215b), le bobinage (165) étant disposé autour de la première partie (215a).

2. Electroaimant (150) selon la revendication 1, dans lequel la première partie (215a) est une partie extrême du noyau (160).
3. Electroaimant (150) selon la revendication 1 ou 2, dans lequel la première partie (215a) est sensiblement perpendiculaire à la seconde partie (210, 215b).
4. Electroaimant (150) selon l'une quelconque des revendications 1 à 3, comportant en outre un élément mobile (170) actionné par le champ magnétique, l'élément mobile (170) pivotant autour d'une première extrémité libre du noyau (160) pour former un entrefer (120) entre lui-même et une seconde extrémité libre du noyau (160).
5. Electroaimant (150) selon la revendication 4, dans lequel le noyau (160) a une configuration de forme générale en U avec un premier côté (215a) et un second côté (215b) qui est plus grand, la première partie étant constituée du premier côté (215a) plus grand et l'élément mobile (170) pivotant autour d'une extrémité libre du second côté (215b) plus grand.
6. Electroaimant (150) selon la revendication 5, dans lequel l'élément mobile (170) est constitué d'une plaque dont la largeur est sensiblement égale à la largeur du second côté (215b) plus grand.
7. Electroaimant (150) selon la revendication 5 ou 6, dans lequel l'élément mobile (170) se termine à une extrémité par une fourchette (225) qui est encliquetée sur l'extrémité libre du second côté (215b) plus grand.
8. Electroaimant (150) selon la revendication 7, dans lequel la fourchette (220) comporte des première et seconde branches (235a, 235b) se terminant chacune par une saillie (235a, 235b) qui fait saillie vers l'intérieur de la fourchette (220) et qui interagit avec un siège correspondant (240a, 240b) formé sur le second côté (215b) plus grand pour retenir l'élément mobile (170).
9. Electroaimant (150) selon la revendication 8, dans lequel chaque saillie (235a, 235b) comporte une partie intérieure configurée sous la forme d'un tranchant de couteau qui agit en tant que point d'appui pour l'élément mobile (170).
10. Disjoncteur automatique (100) comportant un mécanisme (125) à libération rapide pour ouvrir le disjoncteur (100), et l'électroaimant (150) selon l'une

quelconque des revendications 1 à 9 pour actionner le mécanisme de libération (125) dans une situation de court-circuit.

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