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(54) **DEVICE FOR PROTECTING AN ELECTRIC CIRCUIT**

SCHUTZVORRICHTUNG FÜR EINE ELEKTRISCHE SCHALTUNG

DISPOSITIF DE PROTECTION D'UN CIRCUIT ELECTRIQUE

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(73) Proprietor: **ABB Service S.r.l.**
20135 Milano (IT)

(72) Inventor: **ASCARI, Claudio**
I-20154 Milano (IT)

(74) Representative: **Giavarini, Francesco et al**
ZANOLI & GIAVARINI S.r.l.
Viale Bianca Maria, 35
20122 Milano (IT)

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DE-A- 2 832 386 **US-A- 5 027 093**

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EP 1 258 020 B1

Description

[0001] The present invention relates to a device for protecting an electric circuit against a condition of earth leakage current exceeding a preset limit.

[0002] It is known that in electric power distribution systems it is crucially important to adopt adequate protection against conditions of earth leakage current exceeding a preset limit. The main purpose of this kind of protection is in fact to protect people against direct contacts, i.e., accidental contacts with a phase conductor which is normally live, and against indirect contacts, i.e., for example, with a metallic mass which is normally insulated but is in contact with a phase due to a fault; it also allows to protect the system against the risk of fire entailed by deterioration of the system itself caused by the continuous leakage.

[0003] In order to provide this kind of protection, particularly for low-voltage applications, one of the most widely used configurations entails the use of an interruption unit, generally an automatic circuit breaker, with which components suitable to provide protection against residual currents are associated. Said components generally comprise a relay, for example a magnetic release polarized relay, which uses an electromagnetic element with which a release pin is associated, and a release unit which is operatively interposed between the relay and the circuit breaker.

[0004] In practice, during the normal operation of the electric circuit, a suitable sensor monitors the current that flows in the circuit; when an earth leakage current in excess of a preset limit occurs, the sensor causes the intervention of the electromagnetic element, which actuates the release pin. In turn, the pin impacts against an element which is part of the kinematic mechanism of the release unit, actuating said mechanism. The kinematic mechanism transmits to the associated circuit breaker the force received from the pin, amplifying it appropriately and causing the opening of the contacts of the circuit breaker and therefore the interruption of the flow of current in the circuit.

[0005] Although this solution adequately meets the necessary protection requirements, it has drawbacks as regards the assembly of the various components, particularly as regards the mutual positioning of the release pin with respect to the kinematic mechanism of the release unit.

[0006] When the relay and the release unit are coupled to the circuit breaker, the useful stroke that the pin must perform in order to impact against the corresponding element of the kinematic release mechanism must in fact be contained within a given range in order to ensure effective and correct execution of the various interventions of the circuit breaker. Otherwise, after assembly and in view of the inevitable manufacturing tolerances of the various elements, the useful stroke of the pin may for example be insufficient to produce impact, or the pin may be too close to the component which it must

impact, so as to render the stroke insufficient.

[0007] To avoid these drawbacks, systems for adjusting the position of the pin with respect to the kinematic mechanism of the release unit are used during the assembly of the relay. In particular, a first solution uses an adjustment screw which acts on the case of the relay and accordingly moves the pin until it reaches the useful distance from the kinematic mechanism; during adjustment, said distance and the corresponding stroke that the pin can perform are measured for example by means of a laser system. Although this solution allows adequate positioning of the pin, it is particularly complicated to use during assembly; furthermore, the correct positioning of the pin must be ensured throughout the useful life of the device, locking the adjustment screw in the position it has reached and making it for example insensitive to impacts and vibrations. For this purpose, it is necessary to use a varnish which covers and locks the screw, entailing further complication during assembly.

[0008] Another solution entails the use of various kinds of metallic lamina having mutually different thicknesses; in practice, during assembly a first lamina is used and is inserted between a wall of the case of the relay and an appropriate seat of the case of the circuit breaker; then the useful stroke of the pin is measured, for example by virtue of a laser system. If the useful stroke is not within the intended range, the first lamina is replaced with a second one having a different thickness and the measurements are made again; these operations can be repeated several times until the intended result is reached or until the relay is rejected.

[0009] This solution is clearly disadvantageous as regards both the complexity of the positioning procedure and, most of all, the production aspect. It is in fact necessary to manufacture various kinds of lamina having mutually different thicknesses and treated in different manners, with operations performed off-line; furthermore, the laminas must be appropriately kept in store, using different sort codes to avoid mixing them.

[0010] The aim of the present invention is to provide a device for protecting an electric circuit against a condition of earth leakage current in excess of a preset limit which, with respect to the known art, allows to significantly simplify the operations for adjusting the relative position of the pin with respect to the release mechanism.

[0011] Within the scope of this aim, an object of the present invention is to provide a device for protecting an electric circuit against a condition of earth leakage current in excess of a preset limit which allows to reduce both the number of components and the operations required to adjust the position of the release pin.

[0012] Another object of the present invention is to provide a device for protecting an electric circuit against a condition of earth leakage current in excess of a preset limit which allows to perform all the operations for adjusting the position of the release pin directly on the as-

sembly line.

[0013] Another object of the present invention is to provide a device for protecting an electric circuit against a condition of earth leakage current in excess of a preset limit which is highly reliable, relatively easy to manufacture and at competitive costs.

[0014] This aim, these objects and others which will become apparent hereinafter are achieved by a device for protecting an electric circuit against a condition of earth leakage current in excess of a preset limit, comprising:

- an interruption unit, which has at least one fixed contact and one moving contact which can be mutually coupled/uncoupled in order to close/open said circuit;
- a release unit, which is operatively associated with the interruption unit and comprises a kinematic mechanism which is suitable to open said contacts;
- a relay, which comprises a case, from which a release pin suitable to actuate said kinematic mechanism protrudes, and actuation means, arranged in the case, which are suitable to actuate the release pin when said condition of earth leakage current exceeding the preset limit occurs;
- means for adjusting the position of the release pin with respect to the kinematic mechanism;

characterized in that said adjustment means comprise a contoured pin which is operatively associated with said case and is suitable to adjust the position of the release pin with respect to said kinematic mechanism.

[0015] The device thus conceived, by virtue of the use of the contoured pin, allows to adjust the position of the release pin with respect to the kinematic release mechanism in a simplified manner with respect to the known art, with operations which are performed directly on the assembly line, and reducing the store codes to be used.

[0016] Further characteristics and advantages of the invention will become apparent from the description of preferred but not exclusive embodiments of the protection device according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figures 1 and 2 are perspective views of the contoured pin used in the protection device according to the invention;

Figure 3 is a perspective view of the contoured pin of Figures 1 and 2 during arrangement in a seat formed in the case of an interruption unit used in the device according to the invention;

Figure 4 is a plan view of the contoured pin of Figures 1 and 2, coupled to the relay used in the device according to the invention, in a first coupling position;

Figure 5 is a plan view of the contoured pin of Figures 1 and 2, coupled to the relay used in the device

according to the invention, in a second coupling position;

Figure 6 is a plan view of the contoured pin of Figures 1 and 2, coupled to the relay used in the device according to the invention, in a third coupling position.

[0017] The protection device according to the invention comprises an interruption unit, not shown, which has at least one fixed contact and one moving contact positioned inside a case and which can be mutually coupled/uncoupled to close/open an electric circuit in which the interruption unit is inserted; a typical example of an interruption unit that can be used in the protection device according to the invention is constituted by a magnetothermal circuit breaker, and this particular type of circuit breaker will be referenced hereinafter without intending to limit in any way the scope of application of the invention. The embodiment and the operation of a magnetothermal circuit breaker are widely known in the art and for this reason are not described in detail hereinafter.

[0018] The protection device furthermore comprises a release unit which is operatively associated with the magnetothermal circuit breaker and is also not shown; one possible embodiment of a release unit that can be used in the device according to the invention is shown in European patent application no. 00200582.5, whose description is to be understood as included herein by reference. In particular, the release unit comprises a kinematic mechanism which is actuated when an earth leakage current exceeding a preset limit occurs in the circuit in which it is inserted together with the circuit breaker. The form and the operation of the release unit also are widely known in the art and for this reason will not be described further hereinafter.

[0019] The actuation of the kinematic mechanism of the release unit occurs by using a relay, designated by the reference numeral 1 in Figure 3. In particular, the relay 1 comprises a case 2 from which a release pin 3 protrudes which is suitable to actuate the kinematic mechanism of the release unit. Inside the case there are actuation means which are suitable to actuate the release pin 3 when a condition of earth leakage current exceeding the preset limit occurs in the circuit. In particular, it is possible to use, as a relay, according to an extremely simple solution, a magnetic release polarized relay; in this case, the means for actuating the release pin 3 comprise a core, provided with a movable armature, on which a coil is wound. Said armature, in normal operating conditions, is retained in the inactive position by a permanent magnet which contrasts the force applied by a preloaded spring.

[0020] When an earth leakage current exceeding the preset limit occurs in the circuit, a current is injected into the coil and produces a magnetic flux which reduces the force applied by the permanent magnet to the movable armature. In this situation, the force applied by the preloaded spring prevails, causing the actuation of the

armature and accordingly the movement of the release pin.

[0021] Accordingly, the release pin impacts against a component of the kinematic mechanism of the release unit, typically an actuation lever, actuating it. In turn, the kinematic mechanism of the release unit transmits the movement to the kinematic system of the interruption unit, causing the contacts to open and therefore interrupting the flow of current in the circuit.

[0022] In the protection device according to the invention, in order to allow correct execution of the operations for the intervention of the interruption unit, means are used to adjust the position of the pin with respect to the kinematic mechanism of the release unit. In particular, said adjustment means comprise a contoured pin 10, shown in detail in Figures 1 and 2, which is suitable to operatively interact with a protrusion 5 which is formed on the case 2 of the relay 1 and to adjust the position of the release pin 3 between a first position of minimum distance and a second position of maximum distance with respect to the kinematic mechanism; the distance of the release pin 3 with respect to the kinematic mechanism of the release unit is to be understood as the distance, in a rest position, between the release pin 3 and the lever of the kinematic mechanism on which the pin impacts, i.e. its actuation lever, during operations.

[0023] According to an extremely advantageous embodiment, the protrusion 5 is constituted, in this case, by one of the two eyes of the case 2 that are required to fix the relay to the case of the interruption unit, schematically designated by the reference numeral 4 in Figure 3. As an alternative, it is possible to use another protrusion, for example by shaping the case 2 of said relay in a different manner. As shown in said figures, the contoured pin 10 has an elongated body which has a first end 11 which is suitable to be inserted in a seat 6 formed in the case 4 of the interruption unit. The end 11 has at least one portion which protrudes from the seat 6 and is suitable to operatively interact with the walls of the eye 5. In particular, the first end 11 has a transverse cross-section which has a first C-shaped portion whose walls are suitable to wrap around the eye 5 and to operatively interact with its walls, as shown in detail in Figures 4 to 6. Furthermore, the transverse cross-section of the first end 11 has a second portion 13 which is contiguous to the first portion 11 and is shaped so as to form at least three slots 14 which run along the length of a portion of the body of the contoured pin and can couple geometrically to a raised portion 7 formed along a wall of the seat 6. In this manner, depending on which slot 14 accommodates the raised portion 7, the contoured pin 10 allows to position the release pin 3 with respect to the kinematic mechanism in three different positions: a first position of minimum distance from the kinematic mechanism, a second position of maximum distance from the kinematic mechanism, and a third position which is intermediate between said first and second positions, as described hereinafter. As an alternative, the second por-

tion 13 could be contoured so as to have a larger number of slots 14 and thus allow a larger number of positions which are intermediate between the two end positions.

[0024] A protruding tooth 16 is furthermore formed on the body of the contoured pin 10, proximate to a second end 15 which lies opposite the first one and on the opposite side with respect to the slots 14, for abutment against a surface of the eye 5; said second end 15 is conveniently shaped so as to allow grip by a handling device, for example a robot.

[0025] In practice, during assembly the contoured pin 10 is inserted in the seat 6 so that the raised portion 7 couples geometrically with a slot 14, for example the slot that corresponds to the position of maximum distance from the release mechanism shown in Figure 4; in this step, the abutment of the tooth 16 on the eye 5 cooperates in keeping the relay in position. The useful stroke that the release pin 3 can perform is then measured; if it is within the acceptable range, assembly is to be considered as successfully completed. Otherwise, an appropriate device, for example a robot, grips the end 15 of the contoured pin, partially extracts it from the seat 6 until the slot 14 is disengaged from the raised portion 7, and turns said contoured pin, inserting it again in said seat 4, making the raised portion 7 couple with a second slot 14, as shown for example in Figure 5. Then the useful stroke of the pin 3 is measured, and if said stroke does not meet the necessary operating requirements, one proceeds as described above, moving the contoured pin to the position shown in Figure 6, so as to achieve the arrangement that is suitable for the correct operation of the device.

[0026] In practice it has been found that the protection device according to the invention fully achieves the intended aim and objects, since it allows to adjust the position of the release pin with respect to the kinematic mechanism in a very simple and effective manner, with operations which are performed directly on the assembly line. Furthermore, this adjustment is achieved by means of a single contoured pin, according to a solution which is advantageous from the point of view of production and of store sort code management.

[0027] The fact should not be ignored that all the innovative functions and the inventive aspects of the device can be obtained by using commonly commercially available elements and materials with extremely low costs; in particular, the contoured pin 10 is made of plastic, according to a solution which is extremely simple and cheap.

[0028] The protection device thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept as defined by the appended claims; all the details may furthermore be replaced with other technically equivalent elements.

[0029] In practice, the materials used, as well as the dimensions, may be any according to the requirements and the state of the art.

Claims

1. A device for protecting an electric circuit against a condition of earth leakage current in excess of a preset limit, comprising:

- an interruption unit, which has at least one fixed contact and one moving contact which can be mutually coupled/uncoupled in order to close/open said circuit;
- a release unit, which is operatively associated with the interruption unit and comprises a kinematic mechanism which is suitable to open said contacts;
- a relay, which comprises a case, from which a release pin suitable to actuate said kinematic mechanism protrudes, and actuation means, arranged in the case, which are suitable to actuate the release pin when said condition of earth leakage current exceeding the preset limit occurs;
- means for adjusting the position of the release pin with respect to the kinematic mechanism;

characterized in that said adjustment means comprise a contoured pin which is operatively associated with said case and is suitable to adjust the position of the case relative to the release unit and thereby adjusts the position of the release pin with respect to said kinematic mechanism.

2. The device according to claim 1, **characterized in that** said contoured pin allows to adjust the position of the release pin with respect to said kinematic mechanism between a first position of minimum distance and a second position of maximum distance.

3. The device according to claim 2, **characterized in that** said contoured pin allows to arrange the release pin with respect to the kinematic mechanism in three different positions, namely a first position of minimum distance from the kinematic mechanism, a second position of maximum distance from the kinematic mechanism, and a third position which is intermediate between said first position and said second position.

4. The device according to one or more of the preceding claims, **characterized in that** said contoured pin has an elongated body which has a first end which is suitable to be inserted in a seat formed in the case of the interruption unit, said first end having at least one portion which protrudes from the seat and is suitable to operatively interact with a protrusion formed on the case of the relay.

5. The device according to claim 4, **characterized in that** said first end has a transverse cross-section

which has a first C-shaped portion, said first C-shaped portion being suitable to wrap around the protrusion and operatively interact with its walls.

6. The device according to claim 5, **characterized in that** said first end has a transverse cross-section provided with a second portion, which is contiguous to said first portion, which is shaped so as to form at least three slots which run along the length of the elongated body and can couple geometrically with a raised portion formed along a wall of said seat.

7. The device according to one or more of the preceding claims, **characterized in that** a protruding tooth for abutment against a surface of said protrusion is formed proximate to a second end which is opposite to the first one and lies on the opposite side with respect to said slots.

8. The device according to one or more of the preceding claims, **characterized in that** said contoured pin is made of plastics.

9. The device according to one or more of the preceding claims, **characterized in that** said relay is a relay of the magnetic release polarized type.

10. The device according to one or more of the preceding claims, **characterized in that** said interruption unit is a magnetothermal circuit breaker.

Patentansprüche

1. Vorrichtung zum Schützen eines elektrischen Stromkreises vor einer Bedingung mit Masselektrostrom, der größer als eine vorab gewählte Grenze ist, aufweisend:

- eine Unterbrechungseinheit, die zumindest einen feststehenden Kontakt und einen beweglichen Kontakt aufweist, die in Bezug aufeinander in Verbindung bzw. außer Verbindung gebracht werden, um den Stromkreis zu schließen bzw. zu öffnen;
- eine Auslöseeinheit, die betriebsmäßig mit der Unterbrechungseinheit verbunden ist und einen kinematischen Mechanismus umfasst, der geeignet ist, die Kontakte zu öffnen;
- ein Relais, das ein Gehäuse umfasst, von welchem ein Auslösestift, der geeignet ist, den kinematischen Mechanismus zu betätigen, vorsteht, und eine Betätigungseinrichtung, die in diesem Gehäuse angeordnet und dazu geeignet ist, den Auslösestift zu betätigen, wenn die Bedingung mit Masselektrostrom, der die vorab gewählte Grenze übersteigt, auftritt,
- eine Einrichtung zum Einstellen der Position

des Auslösestifts in Bezug auf den kinematischen Mechanismus,

dadurch gekennzeichnet, dass die Einstelleinrichtung einen konturierten Stift umfasst, der mit dem Gehäuse betriebsmäßig verbunden und dazu geeignet ist, die Position des Gehäuses relativ zu der Auslöseeinheit einzustellen und dadurch die Position des Auslösestifts in Bezug auf den kinematischen Mechanismus einstellt.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der konturierte Stift es ermöglicht, die Position des Auslösestifts in Bezug auf den kinematischen Mechanismus zwischen einer ersten Position minimaler Distanz und einer zweiten Position maximaler Distanz einzustellen.

3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der konturierte Stift es erlaubt, den Auslösestift unter Bezug auf den kinematischen Mechanismus in drei unterschiedlichen Positionen einzustellen, nämlich einer ersten Position minimaler Distanz von dem kinematischen Mechanismus, einer zweiten Position maximaler Distanz von dem kinematischen Mechanismus und einer dritten Position, die zwischen der ersten Position und der zweiten Position liegt.

4. Vorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der konturierte Stift einen länglichen Körper aufweist, der ein erstes Ende aufweist, das geeignet ist, in einen Sitz eingeführt zu werden, der in dem Gehäuse der Unterbrechungseinheit gebildet ist, wobei das erste Ende zumindest einen Abschnitt aufweist, der von dem Sitz vorsteht und dazu geeignet ist, mit einem Vorsprung betriebsmäßig zu interagieren, der auf dem Gehäuse des Relais gebildet ist.

5. Vorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** das erste Ende einen Querschnitt aufweist, der einen ersten C-förmigen Abschnitt aufweist, wobei der erste C-förmige Abschnitt dazu geeignet ist, um den Vorsprung gewickelt zu werden und mit seinen Wandungen betriebsmäßig zu interagieren.

6. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** das erste Ende einen Querschnitt aufweist, der mit einem zweiten Abschnitt versehen ist, der sich an den ersten Abschnitt anschließt und so geformt ist, dass er zumindest drei Schlitzte bildet, die über die Länge des länglichen Körpers verlaufen und geometrisch mit einem hochstehenden Abschnitt in Verbindung gelangen können, der entlang einer Wandung des Sitzes gebildet ist.

7. Vorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** ein vorstehender Zahn zur Anlage an einer Oberfläche des Vorsprungs neben einem zweiten Ende gebildet ist, das sich in Gegenüberlage zu dem ersten befindet und auf der gegenüberliegenden Seite in Bezug auf die Schlitzte liegt.

8. Vorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der konturierte Stift aus Kunststoff hergestellt ist.

9. Vorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Relais ein magnetisches Auslöserelais ist.

10. Vorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Unterbrechungseinheit ein magnetothermischer Sicherungsautomat ist.

Revendications

1. Dispositif de protection d'un circuit électrique contre une condition de courant de fuite à la terre dépassant une limite prédéterminée, comprenant :

- une unité de coupure, laquelle a au moins un contact fixe et un contact mobile qui peuvent être réciproquement couplés/découplés de manière à fermer/ouvrir ledit circuit ;
- une unité de déclenchement, lequel est associé de manière opérationnelle avec l'unité de coupure et comprend un mécanisme cinématique qui est adapté pour ouvrir lesdits contacts ;
- un relais, lequel comprend un boîtier, à partir duquel fait saillie une broche de déclenchement adaptée pour actionner ledit mécanisme cinématique et des moyens d'actionnement, disposés dans le boîtier, lesquels sont adaptés pour actionner la broche de déclenchement quand ladite condition de courant de fuite à la terre dépassant la limite prédéterminée se produit ;
- des moyens pour régler la position de la broche de déclenchement par rapport au mécanisme cinématique ;

caractérisé en ce que lesdits moyens d'ajustement comprennent une broche profilée qui est associée de manière opérationnelle avec ledit boîtier et est adaptée pour régler la position du boîtier par rapport à l'unité de déclenchement et régler ainsi la position de la broche de déclenchement par rapport audit mécanisme cinématique.

2. Dispositif selon la revendication 1, **caractérisé en**

ce que ladite broche profilée permet de régler la position de la broche de déclenchement par rapport audit mécanisme cinématique entre une première position de distance minimale et une deuxième position de distance maximale.

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3. Dispositif selon la revendication 2, **caractérisé en ce que** ladite broche profilée permet de disposer la broche de déclenchement par rapport au mécanisme cinématique dans trois positions différentes, une première position de distance minimale du mécanisme cinématique, une deuxième position de distance maximale du mécanisme cinématique et une troisième position qui est un intermédiaire entre ladite première position et ladite deuxième position. 10
15
4. Dispositif selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite broche profilée a un corps allongé qui a une première extrémité qui est adaptée pour être insérée dans un siège formé dans le boîtier de l'unité de coupure, ladite première extrémité ayant au moins une portion qui fait saillie à partir du siège et est adaptée pour interagir de manière opérationnelle avec une saillie formée sur le boîtier du relais. 20
25
5. Dispositif selon la revendication 4, **caractérisé en ce que** ladite première extrémité a une section transversale qui a une première portion en forme de C, ladite portion en forme de C étant adaptée pour envelopper la saillie et interagir de manière opérationnelle avec ses parois. 30
6. Dispositif selon la revendication 5, **caractérisé en ce que** ladite première extrémité a une section transversale pourvue d'une deuxième portion, qui est contiguë à ladite première portion, qui est profilée de manière à former au moins trois fentes qui s'étendent suivant la longueur du corps allongé et peuvent s'accoupler géométriquement avec une portion en relief formée le long d'une paroi dudit siège. 35
40
7. Dispositif selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'une** dent en saillie pour la butée contre une surface de ladite saillie est formée à proximité d'une deuxième extrémité qui est opposée à la première et se situe sur le côté opposé par rapport aux dites fentes. 45
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8. Dispositif selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite broche profilée est réalisée en matière plastique.
9. Dispositif selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit relais est un relais du type polarisé à déclenchement magnétique. 55

10. Dispositif selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite unité de coupure est un disjoncteur magnétothermique.

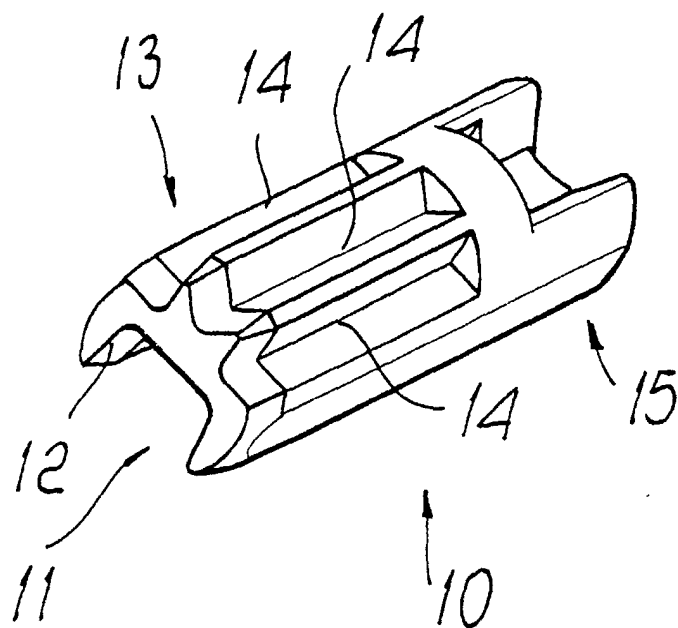


Fig. 1

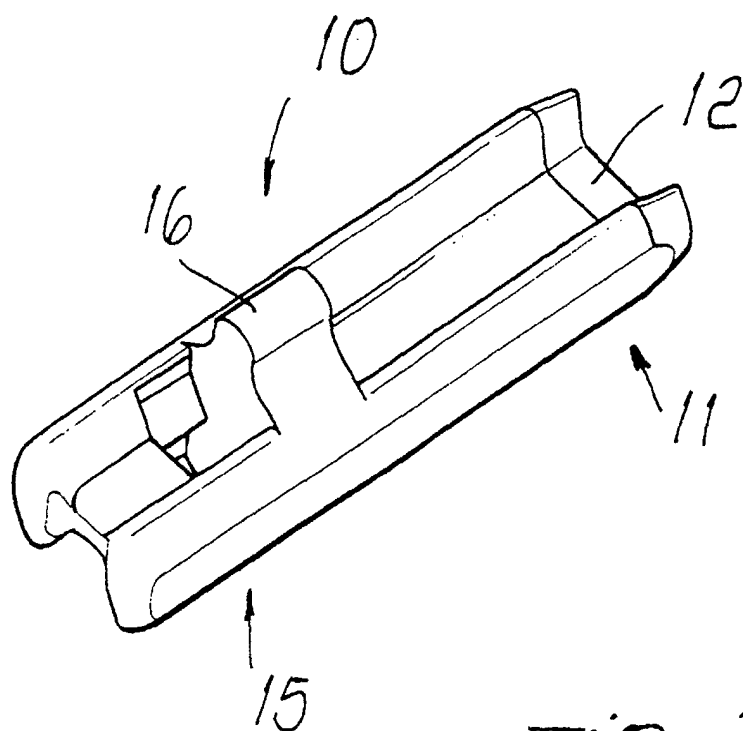


Fig. 2

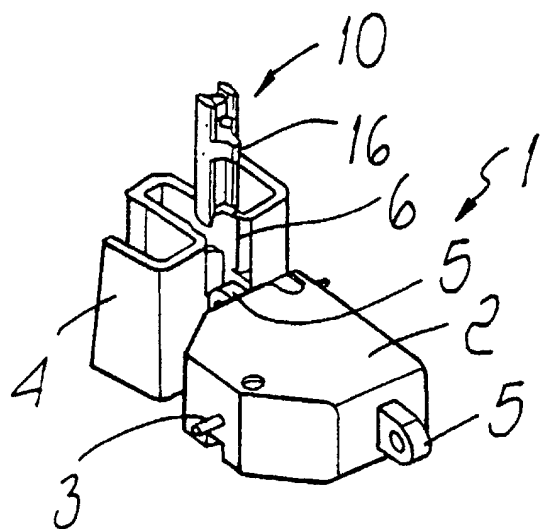


Fig. 3

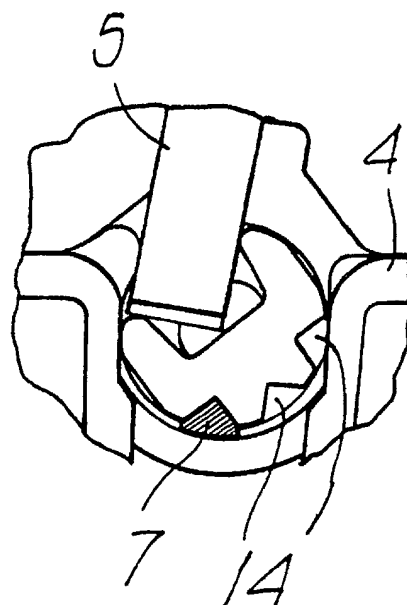


Fig. 4

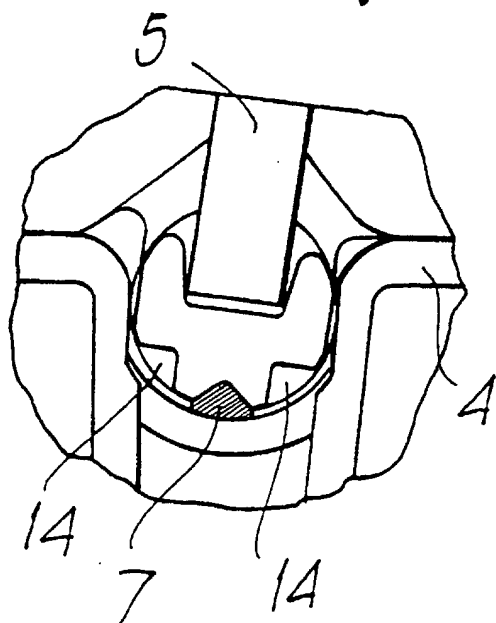


Fig. 5

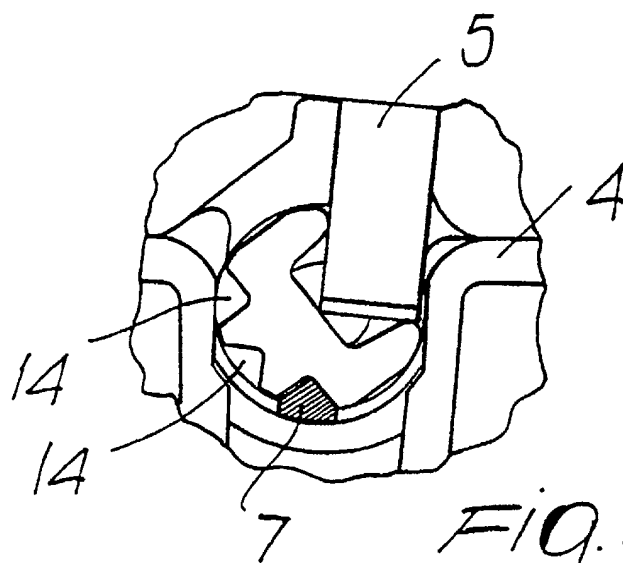


Fig. 6