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(54) **Reset device for a safety electrical device with reduced reset time**

Rückstellvorrichtung für eine elektrische Sicherheitsvorrichtung mit reduzierter Rückstellzeit

Dispositif de réarmement pour un dispositif électrique de sécurité à temps de restauration réduite

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Description

[0001] The present invention relates to the field of safety devices installed between a power supply network and an electrical load circuit.

[0002] Safety devices (such as earth leakage circuit breakers, and automatic earth leakage circuit breakers) play a fundamental role for the safety of the users of an electrical load circuit, such as, by way of example, a household electric installation, or an installation in a work environment).

[0003] Known safety devices are electro-mechanical equipment intended to "trigger" and "open" to electrically disconnect the power supply network from the load circuit when an anomaly occurs, such as an increase in the earth leakage current relative to a rated value, in the case of earth leakage circuit breakers.

[0004] However, the safety device can open not only after an anomaly has occurred, which is potentially dangerous for users, but also in an ill-timed manner, i.e. in the absence of an actual dangerous situation, or this opening can be forced by an equipment suitably provided in order to test the functionalities of the safety device at predetermined time intervals.

[0005] In case of ill-timed opening or opening due to tests that have been carried out on the safety device, the need is felt to re-close the safety device, thus allowing normal power supply to the installation, as soon as possible.

[0006] Devices are known, which allow resetting safety devices, i.e. bring them from the opened to the closed state, in an automatic manner. Particularly, a reset device is known which uses a thermal actuator which provides heating an amount of wax by Joule effect, thus incrementing the pressure thereof, in order to operate a re-closure kinematism.

[0007] This type of safety devices have reset times which are totally unsatisfactory, because they are not sufficiently short not to be a drawback for the electrical equipment being a part of the installation, such as microwave ovens, clock-radios, washing machines or other household appliances.

[0008] The US 5 894 398 A1 discloses a reset device according to the preamble of claim 1.

[0009] The object of the present invention is to provide a reset device which has a shorter reset time than conventional devices.

[0010] The object of the present invention is achieved by means of a reset device such as described in the annexed claim 1. Preferred embodiments of said device are described in the dependent claims 2 to 20. The object of the present invention is also an electrical apparatus such as defined in the dependent claim 21 and preferred embodiments thereof such as defined in claims 22 to 37.

[0011] In order to better understand the invention and appreciate the advantages thereof, some non-limiting exemplary embodiments thereof will be described below, with reference to the annexed drawings, in which:

- Fig. 1 shows by means of functional blocks an exemplary electrical apparatus including a safety device, a control device, and a reset module that are provided according to an example of the present invention;
- Fig. 2 shows a perspective view of said electrical apparatus in the assembled configuration;
- Fig. 3 shows a perspective view of an example of said safety device;
- Fig. 4 shows a schematic view of a circuit board of said control device and a diagram of the safety device;
- Fig. 5A shows a schematic view of several electro-mechanical parts of said control device;
- Fig. 5B shows an example of a resistor of said control device;
- Fig. 6 shows a perspective view of an enclosure of said control device;
- Fig. 7 shows a front perspective view of the interior of said reset module comprising a cover in a first position;
- Fig. 8A and 8B show, by way of example, an electromagnet core and a moving element used in said reset module, in two different operating positions;
- Fig. 9A shows a view of the interior of said reset module in a closure configuration;
- Fig. 9B shows a perspective view of a spring that can be used in said reset module;
- Fig. 10 and 11 show a side view and a perspective view of a mechanical coupling element used in said reset module, respectively;
- Fig. 12 schematically shows a mechanical coupling mode between the reset module and a drive lever of said control device;
- Fig. 13 shows a partial view of the interior of said reset module in which two micro-switches are seen;
- Fig. 14 shows a partial view of the interior of said reset module, in which the cover is in a second position, different from the position in Fig. 7;
- Fig. 15 shows a control circuit of an electromagnet included within said reset module;
- Fig. 16A and 16B show the configuration adopted by the moving element and by the motion transmission means in two different operating configurations of the reset module.

[0012] Fig. 1 shows the electrical assembly or apparatus 300, in the assembled configuration, which comprises a safety electrical device 100 that is operatively associated with a control electronic device 500, which is, in turn, associated with a reset device or module 200.

[0013] As will be detailed below, the apparatus 300 is suitable, for example, to carry out automatic testing on the electro-mechanical functionalities of the safety device 100, by forcibly causing the latter to open and is capable of automatically resetting the safety device 100. Furthermore, according to a preferred though not limiting embodiment, the apparatus 300 is such to perform other

functions, such as particularly, the automatic check of the state of the load circuit to which it is connected, such as to detect whether a spontaneous trigger of the safety device 100 is due to an actual failure or ill-timed, i.e. undesired. The various functions performed by the apparatus 300 have been implemented such as to maintain a high safety level for the users, in full compliance with the current regulations.

Safety device 100

[0014] As illustrated in the diagram in Fig. 1, the safety device 100 is provided with input terminals Li and Ni (such as phase and neutral terminals) for connection to a power supply network NW and output terminals Lo and No for connection to an external electrical circuit which is outlined in the figure as a load LD (such as a household electrical installation).

[0015] The safety device 100 is such as to adopt a closed state in which it connects the load LD to the power supply network NW and an opened state in which it disconnects the load LD from the power supply network NW.

[0016] The safety device 100 can be, for example, one of the following conventional circuit breakers: earth leakage circuit breaker, automatic earth leakage circuit breaker or other types of circuit breakers. In Fig. 1 a earth leakage circuit breaker has been outlined, which comprises a earth leakage 400 with contacts 600.

[0017] With reference to Fig. 3, the safety device 100 comprises a respective enclosure made of insulating material 107 and a first drive lever 112 (such as a handle rotating about an axis 113) that can be manually displaced between two different positions to switch the safety device from the closed state to the opened state, and vice versa. The insulating body 107 houses electro-mechanical means therein(not shown, as known per se), which automatically cause the same to open with the consequent displacement of the first drive lever 112, after a failure, such as, for example, a earth leakage current or a short-circuit has been detected in the load LD. Furthermore, this safety device 100 has on a side wall 107' thereof, in a manner known per se, an opening 110 (seen only in Fig. 3) in which a pivot can be inserted from the outside such as to be coupled with a coupling and releasing mechanism (not shown, as conventional) housed in the enclosure 107 either to cause the switching of the safety device 100, or on the contrary, to obtain the translation of the pin following the switching by the safety device 100. On the side wall 107' there are also formed openings 115 for mounting to the control device 500.

[0018] An upper wall 102 and a lower wall 103 of the safety device 100 are provided with terminals 109 for the input Li and Ni and output Lo and No phase and neutral leads that are connected to the control device 500.

Control electronic device 500

[0019] With reference to Fig. 1, 4, 5 and 6, the control

electronic device 500, according to a preferred embodiment, comprises an insulating enclosure body 501, such as including two portions to be fixed by means of screws or rivets (not shown), which engage within seats 502.

[0020] It should be noted that, advantageously, the control device 500 is a module separated from the safety device 100 in that the enclosure 501 is independent from the enclosure 107 of the safety device 100. In any case, the control device 500 may also be inserted in the same enclosure 107 as the safety device 100. The enclosure 501 of the control device 500 is provided with reversible fixing means that allow coupling and releasing the latter to/from the enclosure 107 of the safety device 100. These fixing means comprise, for example, clips 550 (Fig. 6) to be inserted within openings 115 (Fig. 3) that are formed in the enclosure body 107 of the safety device 100. One or more of these clips 550 is fixed to a respective support element 551 that can be inserted within a seat of the enclosure 501 and fixed thereto by means of a respective screw.

[0021] As may be seen in Fig. 1, the enclosure 501 is provided with a first plurality of terminals 503. As will be better explained below, two terminals 1 and 2 of the plurality 503 are connected to the power supply network NW, i.e. the phase Li and neutral Ni input leads, by means of the reset module 200. Furthermore, the enclosure 501 is provided with a second plurality of terminals 503' having two terminals 3 and 4 for connection to the phase Lo and neutral No leads originating from the safety device 100, which thus connect the control device to the load LD. Advantageously, a terminal of the second plurality of terminals 503' is connected by means of a lead PE to a safety circuit (i.e. the earth), with which the load may be provided.

[0022] The terminals 503 and/or 503' can also be used to send suitable command signals to the reset module 200, which are transmitted by remote control units (by means of terminals C1 and C2 illustrated in Fig. 4), either to close the safety device 100 or monitor the load LD. Particularly, the second plurality of terminals 503' comprises a driving terminal 5 for a reset actuation signal Srm to be sent to the reset module 200 and a tripping detection terminal 6 to receive a signal Sop that opening (tripping) has occurred from the reset module 200 (Fig. 1 and 4).

[0023] The control device 500 is capable of causing a switching for testing purposes of the safety device 100 from the closed to the opened state such as to test the electro-mechanical functionalities thereof. As will be better understood below, the control device 500 is capable of simulating a failure or anomaly condition of the load LD which will cause the opening of the safety device 100 when this safety device is properly working, i.e. it has intact electromechanical functionalities.

[0024] Furthermore, the control device 500 is such that, after the switching to the opened state has been carried out, it holds the load LD disconnected from the power supply network NW. In other words, the control

device has an inner electrical circuitry, which in addition to allow the simulation of the anomaly condition, also forms an open circuit between the load LD and network NW, i.e. it is not an electrical connection circuit capable of shortcircuiting the safety device and placing the load in communication with the power supply network, after the safety device has opened.

[0025] In greater detail, as illustrated in Fig. 1, and still better in Fig. 4, the control block 500 comprises control electronic means 50 and a test circuit 70.

[0026] The control electronic means 50 will be considered first, which are shown in Fig. 4 and preferably provided on a printed circuit board that is entirely housed within the enclosure 501. This circuit board 50 comprises a central electronic block or unit 52 (μ C) that has the function of managing the entire board 50 and is capable of carrying out suitable data processing operations. The central unit 52 is, for example, an integrated microcontroller provided with a processing unit and memories thereof.

[0027] The central unit 52 is programmed to automatically command the beginning of the test on the mechanical functionalities of the safety device 100, and for example, is capable of sending command signals Sc and Sr to the test circuit 70 and reset device 200 such as to cause the opening and closure of the safety device 100.

[0028] Particularly, a software resides in the central unit 52, based on which the beginning of the test on the functionalities of the safety device 100 is carried out at preset intervals, and for example, this test is periodically repeated, i.e. weekly, monthly, or any other period, and at times, such as at night, when the circuit loads LD are likely to be less used.

[0029] Optionally, the electronic board 50 includes an electronic check block 51 (MEAS) in communication with the central unit 52 (μ C) and advantageously, a power supply device 53. The power supply device 53 is connected to the input phase and neutral leads Li and Ni to receive alternating current (such as, of 50 Hz frequency) from the network NW and includes, for example, a rectifier circuit that converts it to direct current and provides the circuit board 50 with a suitable voltage rate. Preferably, this power supply device 53 is provided with a safety transformer allowing the load LD to be suitably insulated from the power supply network NW. Advantageously, a fuse FU is provided on the input phase lead Li to protect the circuit board from high currents from the network NW, which may damage it.

[0030] The check block 51 and central unit 52 are connected to the output of the power supply device 53.

The check block 51, which can be provided with technologies known in the field, is output connected to the load LD (by means of the leads Lo and No, terminals 3 and 4) and is capable of carrying out measurements of electrical parameters of the load LD.

[0031] It should be observed that, advantageously, the central unit 52 is such as to drive the check block 51 such that these measurements on the status of the load LD

are started only when the trigger to the opened state has not been imposed to the safety device 100 by the central unit 52 in order to test the electro-mechanical functionalities, but it is a spontaneous trigger.

[0032] For example, in case of spontaneous trigger, the check block 51 is capable of carrying out a direct current measurement of the impedance between phase lead Lo and neutral lead No of the load LD. Advantageously, when a safety circuit is provided (grounding GND), the check block 51 by means of the lead PE can carry out (alternatively or in addition to the above measurement) an alternating current measurement (at a suitable frequency) of impedance between the output phase and neutral leads Lo and No and the safety circuit. Furthermore, the control device can carry out a measurement of the leakage current by applying a voltage, between the output phase Lo and output neutral No leads and the safety circuit, respectively.

[0033] These measured values of the impedances or leakage current can be provided in the form of corresponding data to the central unit 52.

The central unit 52 receives these data and compares them with reference electrical parameters that have been previously stored therein. When the impedance or current values resulting from the comparison are consistent with a normal condition of the load LD, the central unit 52 activates the reset-enable signal Sr. On the contrary, when the impedance or current values resulting from the comparison are consistent with a failure condition, the reset-enable signal Sr is not activated, thereby the resetting of the safety device 100 by the reset module 200 is inhibited. Furthermore, when a failure condition has been detected, the central unit 52 can activate the command signal Sc which, as will be seen below, can also act to "release", i.e. disable the manual closure of the safety device 100.

[0034] According to a preferred embodiment of the invention, the check block 51 is also capable of carrying out a measurement of the maximum electrical voltage provided by the power supply network NW and sending corresponding data to the central unit 52 that provides to activate the command signal Sc if the measured voltage exceeds a maximum reference value. This measurement of the maximum voltage is particularly useful for protecting single-phase users connected in three-phase installations, because in these installations the interruption of the neutral lead implies that an overvoltage exists between the phase and the neutral leads as a function of the type of single-phase loads that are distributed between the neutral and phase leads. The interruption of the neutral lead can be due to accidental causes (opening of the main switch pole, interruption of conduits, interruption of cable joints, or the like) and the resulting overvoltage is the cause of considerable damages to the electrical equipment.

[0035] Advantageously, the central unit 52 also acts as an interface with the user and is equipped with a communication port CP, such as of the serial type, for the

remote monitoring of the load LD and exchange of information concerning the measurements that have been carried out.

Test circuit 70

[0036] Reference will be now made to the above-cited test circuit 70 that, as stated above, is such as to receive a command signal Sc from the central unit 52, which signal will cause the opening of the safety device 100.

[0037] According to a particular embodiment, the test circuit 70 comprises a first circuit breaker 54, a first contact 57 and a resistor R. The first circuit breaker 54 is, particularly, an electronic circuit breaker (such as a TRIAC or other semiconductor circuit breaker) and is connected to the network NW by means of terminal 1. An output of the first circuit breaker 54 is connected, by means of the first contact 57, to the resistance R. The first circuit breaker 54 can be driven by means of the command signal Sc described above, and is closed when the command signal Sc is activated.

[0038] The first contact 57 is, for example, of a type that can be mechanically opened and closed, and has a fixed terminal and a moving terminal that is mechanically coupled to the safety device 100. The first contact 57 is normally closed and the mechanical coupling with the safety device 100 is such that the first contact will be opened when the safety device 100 is opened.

[0039] The first contact 57 can be provided in various manners and Fig. 5A relates to a possible exemplary embodiment, according to which the first contact 57 comprises a fixed terminal 57a connected to the first circuit breaker 54 and a moving terminal 57b connected to the resistance R and mechanically coupled to a release device with which the safety device 100 is normally provided. As shown in Fig. 5A, and in greater detail in Fig. 5B, the moving terminal 57b is a rod-like metal element having an end fixed to a rocker body 56 and extends to contact the resistance R being hinged thereto.

[0040] The rocker body 56 is free to perform limited rotations about a first pivot 59 and supports a motion transmission element, such as particularly, a pin 60. This pin 60 projects outside the enclosure 501 (Fig. 6) of the control device 500 for insertion in the opening 110 (Fig. 3) of the safety device 100. The pin 60 is such as to be engaged with the release mechanism included in the enclosure 107 of the safety device 100, such that the opening of the safety device causes the rotation (arrow F2) of the rocker body 56 and the opening of contact 57 with the detachment of terminals 57a and 57b.

[0041] The resistance R, interposed between the fixed terminal 57b and the neutral output terminal No (downstream of the safety device 100) has the function of limiting the current derived from the phase input terminal Li to bring the same to an "imbalance" value that is non-excessively high but sufficient to cause the opening of the safety device 100. For example, this resistance R has a value of 7600 Ohm and the current I_R suitable to

cause the trigger is 30 mA. According to an exemplary embodiment illustrated in Fig. 5B, the resistance R comprises an insulating outer envelope 71, a resistive body 72 being connected therein, the one end thereof being electrically and mechanically connected to the moving terminal 57b, and the other end being connected to a terminal 73 intended to be connected to the neutral output terminal No. It should be observed that the test circuit 70 described above can also act as a release device, in order to inhibit the manual switching from the opened state to the closed state when the central unit 52, based on the check module 51, indicates that a failure condition has been detected for the load LD. In this case, the same signal Sc holds the first circuit breaker 54 closed, and thus a manual closure of the safety device 100 in the event of an actual failure of load LD will cause an immediate reopening of the device 100 due to the imbalance current I_R .

[0042] Alternatively, a release device can be also provided which is at least partially independent from the test circuit 70 and can be provided, for example, by means of a respective electronic circuit breaker (not shown) that is controlled by the central unit 52, a further electric contact (of a type similar to contact 57) having a moving terminal provided with an end being fixed to a further rocker body (similar to 56) and another end connected to an electric coil. This electric coil can be energized such as to cause an oscillation of the further rocker body by means of a magnetic field, which results in the safety device 100 being opened, which is coupled to the further rocker body by means of a pin similar to the pin 60 described above. In this case, the release (and accordingly the forced opening) of the safety device 100 is obtained by means of a mechanical coupling between members included within the control device 500 (for example, the further rocker body) to those of the safety device 100 and not due to the imbalance current I_R .

[0043] With reference to the reset-enable signal Sr, the test circuit 70 advantageously comprises a circuit breaker 62 (for example, a conventional electronic circuit breaker, such as a TRIAC) supplied by means of said terminal 1, and that can be driven by said signal Sr emitted from the central unit 52. When the reset-enable signal Sr is activated, the circuit breaker 62 is closed such that a corresponding actuation signal Srm is sent to the terminal 5 that is also shown in Fig. 1. This actuation signal Srm causes the activation of the reset module 200, which will provide to close the safety device 100 in an automatic (i.e. not manual) manner. When the reset-enable signal Sr is deactivated (actual failure condition), the circuit breaker 62 remains opened, thereby the actuation signal Srm is not generated, and the reset module 200 is held in a locked-out condition according to which the automatic closure of the safety device 100 is not carried out.

[0044] According to a particularly advantageous embodiment, the central unit 52 can be arranged to store a number and respective time intervals of automatic opening events and consequent resetting of the safety device

100, and to maintain the reset-enable signal Sr deactivated when two of these events occur at a time interval being shorter than a preset time.

[0045] Preferably, the control device 500 further comprises the second drive lever 522 (Fig. 6 and 9) that can be rotated about a second pivot 523 and held, when no further action is taken, in the closed position together with a helical spring wound on the second pivot 523 and having ends 524 and 525. The end 524 of the spring is a part of a contact 61, which, when closed, (i.e. the contact 61 being in the position of Fig. 5A and the safety device 100 being in the opened state) connects an output terminal of the check block 51 to the output neutral lead No, thereby allowing said measurements to be taken.

[0046] The second drive lever 522 is mechanically connected to the first drive lever 112 of the safety device 100, such as by means of a projecting element 530 (Fig. 6) of the second lever 522 which is inserted within a side cavity of the first lever 112.

[0047] Furthermore, different devices signalling the state of the safety device 100, and preferably also the state of the control device 500 can be provided. For example, the enclosure 501 of the control device 500 is provided with a first LED (Light Emitting Diode) signalling the malfunctioning of the safety device 100 and/or a short-circuit and a second LED signalling a ground failure, which are not shown but can be seen even when they are covered by the cover of the reset module. A sound signal device (to be activated by the central unit 52, similarly to the LEDs) may also be provided, which warns the user about the presence of a permanent failure. This sound signal can be useful when the control device 500 is installed in a junction box located in a decentred area. The sound signal can be silenced by acting on the front push-button PA or eliminating the failure condition. The sound signal can be used to identify the failure occurring on the installation (i.e. according to the example, the load LD), by removing the plugs of the users or sectioning the parts of the installation until the failure area is identified, and the sound signal turns off. The central unit 52 is preferably capable of storing failure signalings such that, even in case of temporary absence of voltage from the power supply network NW, the failure will be signalled when the voltage is restored.

Reset module 200

[0048] The reset module 200 should be now considered, such as illustrated in Fig. 1 and Fig. 2. The reset module 200 comprises an insulating enclosure body 201, for example, comprising two portions that can be fixed by means of screws passing through through holes 202. A side of the enclosure 201 is provided with a plurality of terminals 203 for connecting the reset module 200 to the power supply network NW. For example, two input terminals 6 and 7 of the plurality 203 are connected to the input phase Li and neutral Ni leads of the safety device 100. The terminals 203 can be also used to send suitable

command signals to the reset module 200, which are transmitted by remote control units, in order to close the safety device 100.

[0049] As schematically illustrated in Fig. 1, according to a preferred but non-limiting example described herein, the input terminals 6 and 7 of the reset module 200 are electrically connected to corresponding input terminals of sectioning means 240 having two output terminals 8 and 9, which are, in turn, connected to supply terminals 10 and 11 of the inner equipment of the reset module 200 and said terminals 1 and 2 of the control device 500. As will be described below with reference to a particular embodiment, the sectioning means 240 can be activated during a manual opening of the safety device 100 and are such as to switch from a closed configuration to an opened configuration, and vice versa. In the closed configuration, the sectioning means 240 connect the input terminals 6 and 7 to the output terminals 8 and 9 and thus connect both the inner equipment of the reset module 200 and the control device 500 to the safety device 100 and, by means of the latter, to the power supply network NW.

[0050] In the opened configuration, the sectioning means 240 disconnect the input terminals 6 and 7 from the output terminals 8 and 9 and thus disconnect both the inner equipment of the reset module 200 and the control device 500 from the safety device 100 and, by means of the latter, from the power supply network NW. To the purposes of the present invention, by the word "sectioning", when used with reference to the means 240, is meant that the latter are suitable to vacuum-interrupt the electrical conduction between the input 6 and 7 and output 8 and 9 terminals. In other words, the means 240 are capable of providing the interruption of the conduction when the safety device 100 is in the opened state, i.e. the output terminals 8 and 9 are not electrically connected to the terminals Lo and No being connected to the electrical circuit LD, due to the opening of the interruption block 600 (Fig. 1).

[0051] Particularly, the sectioning means 240 can comprise a conventional circuit breaker (described below) suitable to section the power supply network NW and the electric circuit LD, preferably in accordance with product standards for safety devices, such as device 100. The modes by which the sectioning means 240 can be activated will appear from the description below of an exemplary reset module 200.

[0052] As may be seen in Fig. 7, the reset module 200 comprises mechanical means 250 for transmitting a reset motion to said safety device 100 and an actuating apparatus 260 suitable to operate the transmission means 250.

[0053] In greater detail, the actuating apparatus 260 comprises an electromagnet 206 and a moving element 208 that is mechanically coupled to the transmission means 250. Particularly, the electro-magnet 206 can be of a conventional type and comprise a core 209 (see Fig. 8A and 8B) that is made of, for example, ferromagnetic

material, about which a winding W (schematically illustrated only in Fig. 15) is wound, which can be traversed by electric current. The winding W of the electro-magnet 206 is suitable to magnetize the core 209 when traversed by an electric current.

[0054] With particular reference to Fig. 8A and 8B, the core 209 (for example, comprising a plurality of riveted laminations) is C-shaped with substantially rectilinear sides and particularly comprising a first long side L_1 , a second long side L_2 , a first short side I_1 and a second short side I_2 provided with an opening or air-gap 210. The core 209 forms an inner region 211 in which the moving element 208 can slide through the opening 210.

[0055] Advantageously, the first short side I_1 has a low-thickness region 212, and in the example having a tapered profile, which is placed, for example, in a middle area of the same side and facing a first end 213 of the moving element 208. The tapered region 212 has a lower thickness than the other portions of the first short side I_1 . Particularly, the tapered region 212 has a complementary profile to that of the first end 213 such as to accommodate the latter, and has the purpose of being a region suitable to modulate the magnetic attraction force of the core 209, as will be explained below.

[0056] According to the example described herein, the moving element 208 (particularly, a plate-like parallelepiped) is an individual piece made of iron and is capable of translating, along the longitudinal axis thereof, within the inner region 211 of the core 209 due to variations in the magnetic field produced by the electro-magnet 206. Furthermore, the moving element 208 is provided with a second end 219 suitable to be mechanically coupled to the transmission means 250 and being provided, in the example, with a through hole 220.

[0057] According to a preferred embodiment, the transmission means 250 are such as to convert the rectilinear motion of the moving element 208 into rotary motion, and transferring the same to the first drive lever 112 of the safety device 100.

[0058] In greater detail, and in a particular case, the transmission means 250 comprise connecting rod/lever mechanisms and include a first connecting rod 243 (Fig. 9A) hinged to the moving element 208, and particularly, rotatably engaged to the through hole 220 provided on the second end 219.

[0059] Another end of the first connecting rod 243 is hinged to a, for example, substantially middle region 244 of a first lever 245. The first lever 245 has a first portion hinged to the enclosure 201 by means of a third pivot 246, and a second portion hinged to an end 247 of a second connecting rod 248.

[0060] The first lever 245 is forced by a return spring 249 to the position in Fig. 7 and 9A, i.e. in a position in which the end 247 of the first lever 245 is spaced away from the electromagnet 206 and the moving element 208 is outside the region 211 (as shown in Fig. 8A). The return spring 249 is anchored, for example, to an inner wall of the enclosure 201 and can be provided, particularly, by

means of the helical torsion spring shown in Fig. 8B (or equivalent elastic means), and in which the elastic work is provided by coils 249' thereof.

[0061] The second connecting rod 248 has another end hinged to a cam end 251 of a second lever 252 having the other end 253 hinged to a fourth pivot 217 parallel to, in the example, to the above-cited axis 113 of the first drive lever 112 of the safety device 100. The second lever 252 has an abutment rib 254 projecting parallel to the fourth pivot 217.

[0062] The motion transmission means 250 also include a rotating body 234 intended to perform partial and alternated rotations about the fourth pivot 217 to which it is coupled.

[0063] The rotating body 234 (Fig. 10 and 11) comprises a substantially cylindrical main body hinged on the fourth pivot 217 and from which there extends, orthogonal to the axis 113 (according to the particular example illustrated herein) a first moving rod 218. The first moving rod 218 is such as to result abutted against the rib 254 of the second lever 252, in several operating conditions.

[0064] Furthermore, the rotating body 234 is provided with a rotating bar 204 parallel to the axis of rotation 113 of the first drive lever 112 and to the bottom wall of the enclosure 201. In the rotating bar 204, a longitudinal channel 205 is formed, in which the second drive lever 522 of the control device 500 (Fig. 9A) and the first drive lever 112 of the safety device 100 can be inserted, for example.

[0065] The rotating body 234 is also provided with a second rod 224 (Fig. 11 and 10) and is such as to extend, in the example shown as being parallel to the axis 113, in the opposite direction to bar 204.

[0066] The first and second drive levers 112 and 522 (Fig. 12) slide within the channel 205, in the same direction as the axis 113, such as to allow the electric assembly 300 to be assembled and such that the drive lever 112 results rotatably integral with the bar 204.

[0067] The enclosure 201 of the reset module 200 is also advantageously provided with a first microswitch 222 (shown in Fig. 13) having a respective leaf spring 223 acting on respective electric contacts and intended to be biased by the second rod 224 (not seen in Fig. 13) that is integral with the rotating body 234. The first microswitch 222 is sensitive to the "tripped" condition of the safety device 100 and allows sending the opened signal Sop (Fig. 1 and Fig. 4) to the central unit 52 of the control device 200. It should be observed that, preferably, the central unit 52 activates the reset-enable signal Sr only in the absence of failure conditions and when it has received the opened signal Sop.

[0068] Preferably, the reset module 200 is also provided with a second microswitch 214 having a leaf spring 215 associated therewith, which can be biased by the above-cited second rod 224 and such as to signal the state of the bar 204 and thus the opened or closed state of the safety device 100.

[0069] Advantageously, the reset module 200 is further

equipped with a cover 225 (Fig. 7) coupled with the enclosure 201 such as to be manually moved relative to the enclosure. Particularly, the cover 225 is coupled with the respective enclosure by means of guide means allowing the cover to slide (preferably, along an axis orthogonal to axis 113) between a first position 1P and a second position 2P.

[0070] In the first position 1P (shown in Fig. 7), the cover 225 is aligned with a side wall 226 of the enclosure 201. Depending on the particular operating condition, in the first position, the bar 204 can be in the "lowered" position corresponding to the opened state, or it can be in a "raised" position, (such as in the particular case of Fig. 7), corresponding to the closed state of the safety device 100.

[0071] In the second position 2P (Fig. 14), the cover 225 is misaligned relative to the side wall 226 of the enclosure 201. As will be explained below, when the cover is in the second position (Fig. 14), the bar 204 can be only in the "lowered" position (as illustrated in Fig. 14), corresponding to the opened state of the safety device 100. To cause the sliding movement between the first and second positions and vice versa, the cover 225 can be manually gripped and advantageously has an ergonomic recess 227 that facilitates this manual operation (well visible in Fig. 2).

[0072] The cover 225, which is made of an electrically insulating material, comprises a front wall 228 (Fig. 2), an upper wall 229, a lower wall 230, and an outer side wall 230' and an inner side wall 229' (illustrated in Fig. 14). This cover 225 further projects past the enclosure 201 such that, when the reset module 200 is assembled to the control device 500 and safety device 100, it covers both the second drive lever 522 and the first drive lever 112, thereby protecting them and preventing any manual contact.

[0073] The cover 225 is such as to engage the bar 204 (or the first 112 or second 522 drive levers) such as to cause, by sliding from the first to the second position, the rotation of the bar 204 (and the first drive lever 112) with consequent switching of the safety device 100 from the closed to the opened state. Particularly, to the purpose, the cover 225 is provided with an engaging element 231 (Fig. 14) extending inside the cover to abut against the bar 204 and cause the rotation of both the latter and the first drive lever 112. According to the example of Fig. 13, this abutment element 231 is embodied by a projection provided inside the upper side wall 229 such as to pull the bar 204 (at least to half the travel thereof) during the sliding of the cover 225.

[0074] Advantageously, the cover 225 comprises a door 232 to be opened/closed (Fig. 2) which allows access to the bar 204, and particularly to a handle 242 (Fig. 10) integral with the bar, in order to rotate the same and bring the safety device 100 from the opened to the closed state, when the cover is in the first position and when the automatic closure provided by the reset module 200 has been inhibited.

[0075] Preferably, the reset module 200 includes locking means that inhibit the raising of the bar 204 and thus the manual closure of the safety device 100, when the cover 225 is in the second position of Fig. 14. Particularly, these locking means are associated with the cover 225 and are embodied by a projection 233 (seen in Fig. 14) protruding from the inner side wall 229' such as to be inserted in an aperture 235 (indicated with the numeral reference only in Fig. 14) being formed in the rotating body 234. When the cover 225 is caused to slide from the first (Fig. 7) to the second (Fig. 14) position, the projection 233 is inserted in the slot 235 of the rotating body 234, thereby the rotation of the bar in the opposite direction is inhibited. When the cover 225 is moved from the second position back to the first position, then the projection 233 is disengaged from the slot 235 and the bar 204 can be rotated to close the safety device.

[0076] Advantageously, the reset module 200 is provided with a reset deactivation/activation device 80 (schematically illustrated in Fig. 1 and Fig. 15). Preferably, this deactivation/activation device comprises a conventional operating relay of the electromagnet 206 or is a power supply terminal of the electromagnet 206. This activation/deactivation device 80 can receive the actuation signal S_{rm} (corresponding to the phase voltage L_i) sent by the control device 500 to carry out the automatic closure of the safety device 100 (the cover being in the first position in Fig. 7). The actuation signal S_{rm} will cause, for example, the closure of the operating relay 80 of the reset module 200, such that the electromagnet 206 is powered and the body 234 is rotated along with the first drive lever 112 of the safety device 100.

[0077] Preferably, the reset module 200 further comprises a control DC circuit (Fig. 15) for the electromagnet 206 including a control and/or timing unit CK (comprising a conventional clock) and a current limiting block CLM inserted between the relay 80 and the winding W of the electromagnet 206.

[0078] The current limiting block can be advantageously switched between active and passive states and comprises, for example, a limiting resistor R_L and an electronic current breaker, such as a diode D arranged parallel to the resistor R_L . Alternatively, or in addition to the limiting resistor R_L , another type of impedance can be used, such as for example a capacitor or a transistor. The control and/or timing unit CK is capable of controlling the switching of the diode D between a forward biased state which causes the short-circuit of the limiting resistor R_L and a reverse bias state which causes the connection of the limiting resistor R_L in the power supply circuit of the electromagnet 206.

[0079] The possibility of connecting and disconnecting the limiting resistor R_L allows permits a useful adjustment of the closing speed of the reset module. The DC control circuit of the electromagnet 206 can be provided by means of known techniques, and is for example a printed circuit board that can be preferably housed within the same enclosure 201 as the reset module 200.

[0080] With reference to a possible structure of the sectioning means 240 schematically shown in Fig. 1, reference should be made to Fig. 13.

[0081] The sectioning means 240 comprise fixed contacts 236 and moving contacts 237. The moving contacts are brought from the closed to the opened (Fig. 13) configuration, and vice versa, by means of engagement with a framework structure 238 that moves integrally with the cover 225.

[0082] When the moving contacts 237 are separated from the fixed 238 ones, the electromagnet 206 is disconnected from the power supply network NW thereby preventing the automatic resetting of the safety device 100. Furthermore, this sectioning disconnects the power supply network NW from the electrical circuit LD, despite the provision of the control device 500 connected to the circuit LD. The connection to the power supply network NW is reactivated when the cover 225 is brought in the first position with the consequent closure of the sectioning means 240.

[0083] It should be observed that, for clarity purposes, neither the electrical wires of the electromagnet 206 and the wires connecting the first microswitch 222 to the second microswitch 214, nor the above-mentioned activation/deactivation device 80 have been shown in the figures. The electrical connections of these switches appear from the description of their operation given above.

[0084] It should be observed that the teachings concerning the reset module 200 can also be applied to reset apparatuses, which are not modular, rather included for example in the control device 500 or in the safety device 100. Furthermore, the reset module 200 can operate separately from the various functionalities described for the control device 500.

Operation of the reset module 200.

[0085] The reset module 200 can adopt a closed configuration C1 (Fig. 9A), an opened configuration C2 (Fig. 16A), and an intermediate closed configuration C3 (Fig. 16B).

[0086] The closed configuration C1 (Fig. 9A) corresponds to the situation in which the safety device 100 is closed, and thus the bar 204 is according to the example, in the raised position. Furthermore, in the closed configuration C1, the relay 80 (Fig. 15) is opened, and thus the winding W of the electromagnet 206 is not energized.

[0087] In this situation, the return spring 249 acts on the first lever 245 which is held such as to hold the moving element 208 extracted from the inner region 211 of the core 209 (by means of the first connecting rod 243). Furthermore, the first lever 245 has adopted a first position in which the end 247 is spaced away from the electromagnet 206 and such that the second connecting rod 248 holds the second lever 252 oriented such that its abutment edge 254 does not act on the first rod 218 of the rotating body 234.

[0088] It will be now assumed that a trigger to the

opened state is carried out by the safety device 100. The rotation of the first drive lever 112 causes a corresponding rotation of the bar 204, which moves from the position adopted in Fig. 9A to the opened position in Fig. 16A, corresponding to the opened configuration C2 of the reset module 200. In this configuration C2, the first rod 218 of the rotating body 234 is abutted against the abutment edge 254 of the second lever 252. Furthermore the second rod 224 (Fig. 11) acts on the first microswitch 222 (such as by closing it) such that the latter causes the transmission of the opened signal (or "tripped" signal) Sop (Fig. 1 and Fig. 4) to the central unit 52 of the control device 500.

[0089] According to modalities that will be described herein below, the control device 500 thus generates the reset actuation signal Srm which acts on the relay 80 by closing the latter and allowing the winding W of the electromagnet 206 to be energized. The action of the optional current limiting block CLM will be described below.

[0090] When the winding W is traversed by the direct current deriving from the power supply network NW (through the input terminal Li), it generates a magnetic field that magnetizes the core 209, which applies an attraction force on the moving element 208 (for example, made of iron) and attracts the latter within the region 211. The moving element 208 translates to the inner region 211 of the electromagnet 206 by overcoming the action of the return spring 249. For example, the electromagnet 206 is designed such as to be capable of exerting a suitable magnetic attraction force on the moving element 208 when its winding is traversed by an alternated current of, for example, about 2-3 A intensity for a 230 V power supply network NW.

[0091] The first connecting rod 243 transmits the translational motion of the moving element 208 to the first lever 245 that, by rotating, moves down to the electromagnet 206. The rotation of the first lever 245 towards the electromagnet 206 causes the second connecting rod 248 to act on the second lever 252, thus bringing the latter to rotate about the fourth pivot 217 and in the orientation indicated by an arrow F_R in Fig. 16A.

[0092] The second lever 252, by rotating, applies a thrust on the first rod 218, against which it is abutted, thus causing the rotating body 234 to rotate, which results in the bar 204 being raised. When the electromagnet 206 is energized, the reset module then passes from the opened configuration C2 (Fig. 16A) to the intermediate closed configuration C3 (Fig. 16B), the safety device 100 being consequently closed.

[0093] When the intermediate closed configuration C3 is adopted, the second rod 224 (Fig. 10 and 11) of the rotating body disengages the contact of the first microswitch 222, thus interrupting the transmission of the triggered signal Sop. Consequently, the control device 500 commands, by inhibiting the reset actuation signal Srm, the opening of the relay 80, thus disabling the power supply to the electromagnet 206. The magnetic field produced by the electromagnet 206 is thus reduced to zero

and the first lever 245 along with the moving element 208 is recalled upwards by the return spring 243. Furthermore, as the first lever 245 moves upwards, the second lever 252 rotates according to the direction indicated in Fig. 16B with the arrow FR1, thus disengaging from the rotating body 234. As a result of the inhibition of the power supply to the electromagnet 206, the reset module 200 passes from the intermediate closed configuration C3 to the closed configuration C1 (Fig. 9A), thus resulting ready for any further opening and closure cycle.

[0094] From the tests that have been carried out, it has been appreciated that a reset time lower than 100 ms can be obtained by a reset module such as described herein, for example, ranging between 100 ms and 20 ms, and particularly, ranging between 70 ms and 20 ms. Preferably, reset times can be used between 50 and 20 ms or between 50 and 30 ms.

[0095] The action of the current limiting block CLM on the power supply to the electromagnet 206 (Fig. 15) will be now discussed. The control and/or timing circuit CK is activated, for example, by the reset actuation signal S_{rm} and is such as to send an actuation signal S_{CK} to bias, either in a forward or reverse manner, the diode D according to predetermined timing. Particularly, the control and/or timing circuit CK reverse biases the diode D such that the limiting resistor R_L reduces the current passing through the circuit comprising the winding W in an initial step of the reset, i.e. for example, in the early 10 ms after the closure of relay 80. Subsequent to this initial step and until when the closure has been completed (passage from the configuration C2 to C3), the actuation signal S_{CK} forward biases the diode D (except for the limiting resistor R_L) from the circuit and allows that a higher electric current passes through the winding W of the electromagnet 206 than that in the initial step.

[0096] These way of controlling the electromagnet 206 results to be very advantageous, in that it allows changing (particularly, reducing) the closing speed of the reset module, thus making it suitable for various safety devices. In fact, due to the intensity variation in the current supply to the electromagnet 206, a translation speed of the moving element 208 is obtained which is lower in the first step than that achieved in the remaining part of the closure cycle. This avoids that safety devices miss the closure coupling due to an excessive closing speed imposed by the reset module.

[0097] Another advantageous characteristic, which could prevent an undesired opening release of the safety device 100 upon re-closing, relates to the provision of the low-thickness tapered region 212 (Fig. 8A and 8B) in the core 209. In fact, this tapered region 212 allows obtaining an attraction force applied by the core 209 on the moving element 208 which is lower in the closure final step (i.e. when the moving element 208 is very close to the first short side I₁ of core 209) than that of the closure initial step. According to the tests that have been carried out on a particular embodiment of the invention, this reduction in the translation speed of the moving element

occurs in a final time interval of about 20% the total translation time of the moving element.

Mounting of apparatus 300

[0098] With reference to the mounting of assembly 300, the reset module 200 (which may have, for example, a size equal to two DIN modules) is structurally coupled to the control device 500 (having, for example, the width of an individual DIN module), for example, by means of clips to be inserted in apertures provided in the enclosure body 501 of the control device 500. Furthermore, the clips 550 (Fig. 6) of the control device 500 are inserted in the apertures 115 (Fig. 3) of the safety device 100.

[0099] Advantageously, the cover 225 can be adapted such as to extend and cover the front surface of the control 500 and safety 100 devices, whatever the standardized width of the devices. To the purpose, additional covering elements (not shown) are provided to be (removably) fittingly fixed (and preferably with screws) to the outer side wall 230' of the cover 225 to increase the size thereof.

[0100] Furthermore, as illustrated in Fig. 12 and 13, the cover 225 can be provided with a through hole 255 for a padlock to be applied in the second position 2P, such that unauthorized users are prevented from causing the cover 225 to slide to the first position.

Operation of assembly 300

[0101] With reference to the operation of the electrical assembly 300, the following operative steps will be now described: the test on the electromechanical functionalities followed by an automatic closure, automatic opening in the event of a failure or ill-time tripping, automatic closure after an installation diagnostic, manual opening and manual closure.

[0102] The safety device 100 is initially closed and the cover 225 is in the first position 1P, and the bar 204 is raised (unlike what is shown in Fig. 7). Based on a program previously stored in the memory of the central unit 52, at periodical intervals, and for example, at night, the central unit 52 activates the command signal Sc, which closes the first circuit breaker 54.

[0103] The first contact 57 is already in the closed state, and thus the resistance R is connected to the phase input Li. The imbalance current I_R is provided downstream of the safety device 100, which - as it is for example of a earth leakage type - senses a current on the neutral output terminal No other than that provided on the phase output terminal Lo.

[0104] In this condition, the earth leakage safety device 100, when it has intact electrical and mechanical functionalities, opens (particularly, the contacts 600 thereof open) such as to disconnect the power supply network NW from the load circuit LD. In this case, the first drive rod 112 rotates and pulls the bar 204 therewith thus causing the body 234 to rotate.

[0105] The cover 225 remains in the first position 1P (Fig. 7), but the rotation of the body 234 integral with the second rod 224 causes the switching of the first microswitch 222. The first microswitch 222 causes the transmission of the opened signal Sop (Fig. 1 and Fig. 4) to the central unit 52 of the control device 500.

[0106] The opening of the contacts 600, due to a release mechanism, conventional per se, which is provided in the safety device 100, is also transmitted to the pin 60 of the control device 500 (Fig. 5A), which causes the rocker body 56 to rotate, which, by rotating according to the arrow F2 opens the contact 57 thus interrupting the power supply to the resistance R.

[0107] It is important to observe that, advantageously, in said opened condition, the load circuit LD is not connected to the power supply network NW, either via the safety device 100 (which is opened), or via the test circuit 70 (opened contact 57), or via other devices or circuit elements included in the control device 500 or in the reset module 200. This allows stating that, according to this particular embodiment, the operation of testing the functionalities of the safety device 100 is carried out in a completely safe manner for the users of the load circuit LD.

[0108] The central unit 52 is informed that the safety device 100 has triggered by means of the above-described signal Sop, and thus can activate the reset command signal Sr sent to the circuit breaker 62 such as to enable the automatic closure.

[0109] For the automatic closure of the safety device 100, the control device 500 activates the reset module 200 in the manner as detailed above. As stated above, the automatic closure operation following the tripping due to the test is carried out in a short time (e.g., 60 ms), such that all those apparatuses (currently more and more widespread) that have a temporary substitute power supply do not suffer from the short interruption of the power supply provided by the network NW.

[0110] In the event that, after the command signal Sc has been sent to cause the opening of the safety device 100, the latter does not trip due to a malfunctioning of the same, the central unit 52 does not receive the opened signal Sop and thus can either signal this danger condition to the suitable LED, or operate the sound signal.

[0111] Reference will be now made to the automatic opening of the earth leakage device 100 due to a failure of load LD or ill-timed tripping. In a normal operation initial step, the check block 51 of the control device 500 detects that voltage is present on the load LD and places itself in a rest condition.

[0112] In the automatic opening, starting from the safety device 100 in the closed state, an event (leakage current or a short-circuit) may occur, which causes the same to open, which causes the rotation of the first drive lever 112 and the switching of the microswitch 22, similar to the case illustrated above.

[0113] Following the opening not due to automatic testing, the check block 51 of the control device 500 does not detect the voltage on the load LD and activates, au-

tomatically and under the management of the central unit 52, the check of the state of load LD. The check block 51 then carries out either all or some of the above measurements (impedances or leakage currents) to define the corresponding electrical parameters. These electrical parameters are then provided to the central unit 52 that (by running a pre-stored software) compares them with reference values, which are set by the current standards, for example. This condition corresponds to Fig. 5A, in which the second drive lever 522 is seen lowered and the contact 61 is closed.

[0114] If, following this comparison, the central unit 52 identifies one or more anomalous values of the electrical parameters, it believes that an actual failure has occurred and does not activate the reset-enable signal Sr, and thus does not close the circuit breaker 62. Therefore, in a failure condition, the automatic closure of the reset module 200 is not commanded, thereby the electromagnet 206 of the reset module is maintained deenergized.

[0115] According to an optional operating mode, when a failure is detected, the command signal Sc is activated, which closes the first electronic current breaker 54. Furthermore, the central unit 52 can activate the above-mentioned signalling devices. When a user closes the safety device 100 by manually acting on the first drive lever 112, the inner mechanism of the safety device 100 via the pin 60 causes the rotation of the rocker body 56 (arrow F1, Fig. 5A) which causes the first contact 57 to close. In this condition, the resistance R is powered and the unbalance current I_R is provided to the safety device 100, which immediately triggers again, thus opening.

[0116] Furthermore, it should be noted that in the opened state, the indication ON/OFF that is normally written on the drive lever of safety devices is not visible, because it is covered by the (preferably, opaque) cover 225. For example, the reset module 200 may be provided with a window 241 (Fig. 2) from which one of two alternative indications I-ON and I-OFF can be seen. The indication ION, seen through the window 241 following an automatic opening, indicates that the reset module is in the active state.

[0117] In the case where, following said automatic opening, the measurements and processing carried out by the circuit board 50 lead to the conclusion that the tripping of the safety device 100 has been ill-timed (absence of failure), the central unit 52 (informed on the tripping, also by the opened signal Sop) activates the reset-enable signal Sr. The reset-enable signal Sr closes the circuit breaker 62 which activates the actuation signal Srm acting on the activation/deactivation device 80, thereby causing the electromagnet 206 to be powered and i.e. activating the automatic closure described above.

[0118] With reference to the manual opening, an initial condition is considered where the safety device 100 is in the closed state. The manual opening can be carried out by directly acting on the cover 225 (particularly, on recess 227), which is caused to slide and brought from the first

position (Fig. 7) to the second position (Fig. 14). During this step, the abutment element 231 (Fig. 14) acts on the bar 204 thus causing the latter to rotate, and consequently opening the safety device 100.

[0119] Advantageously, by moving the cover 225 to the second position (Fig. 14), due to the projection 233 being inserted in the slot 235 of the body 234, a blockage of the bar 204 is caused, which bar may not be rotated to close the safety device 100.

[0120] Furthermore, while the cover 225 is sliding, the moving contacts 337 (that are engaged with the movable frame 238) are moved away from the fixed contacts 236 (Fig. 13) of the circuit breaker suitable for the sectioning 240, thereby the power supply to the reset module 200 and control device 500 is interrupted.

[0121] For example, in the second position following the manual opening, the window 241 will indicate the wording I-OFF to indicate the opened condition but also that the resetting, either manual or automatic, is inhibited. The wordings I-ON and I-OFF are reported, for example, on a suitable portion of the cover 225 which slides below the window 241.

[0122] After a manual opening, an automatic closure can be carried out, which is provided by simple manoeuvres. Firstly, the cover 225 must be brought back to the first position (Fig. 7) by causing the projection 233 to disengage from the slot 235 of body 234. This manoeuvre leads to the closure of the circuit breaker suitable for the sectioning 240 such that both the reset module 200 and the control device 500 are restored to operation. When the control device 500 does not detect any failure, it commands the reset module to carry out the automatic closure.

[0123] In the particular case where the control device is disabled from operation by means of the front push-button provided to this purpose, then a manual closure can also be carried out. The cover 225 must be brought back to the first position 1P (Fig. 7) by causing the projection 233 to be disengaged from the slot 235 of the body 234. Then, the door 232 is opened (for example, manually) such as to gain access to the handle 242 which is then manually rotated to close the safety device 100. The door 232 can be advantageously provided with an elastic element or other means causing the same to close again.

Advantages

[0124] The teachings of the present invention are particularly advantageous.

[0125] A first advantage is concerned to the use of a reset actuating apparatus 260 comprising the electromagnet 206 and the moving element 208, which allow obtaining reset times that are considerably shorter than those obtained with conventional resetting techniques.

[0126] The shortness of the reset time that can be obtained with this invention is advantageous not only in the event that the functionality of automatic testing on the

safety device at periodical intervals is provided, but also when, in addition or in replacement of this test, a high reset speed is required following ill-time openings of the safety device.

[0127] Furthermore, those preferred embodiments of the invention are particularly advantageous, which provide using the current limiting block CLM and, in addition or alternatively, have a low-thickness region in a suitable core region such that the attraction force on the moving element is reduced during a reset final step.

[0128] An advantage offered by the preferred embodiments of the control device 500 is due to the fact that the electromechanical functionality test is not relied only to the user (who, however, can manually test the earth leakage device), but is carried out automatically, thus ensuring that the testing is performed at due intervals. Furthermore, the test on the safety device 100 does not entail any risk for the users, because it is carried out by holding the load LD disconnected from the power supply network NW.

[0129] Any consequences on apparatuses being a part of the load circuit LD, which are operating while the test is being carried out, are reduced, when not eliminated, by programming the test at night.

[0130] Another advantage is due to the provision of the circuit breaker suitable for the sectioning 240 which ensures that after the power contacts of block 600 have been opened (automatic opening of the safety device 100), a connection cannot be established between the power supply network NW and the load LD via the circuit board 50 which is connected to the load. This allows operating on the load LD, for example, to repair a failure in total safety.

[0131] Furthermore, it will be noted that the manual opening of the device 100 associated with the reset module 200 is particularly advantageous, since it can take place with a single manoeuvre (i.e. by acting only on cover 225 without having to remove the same to gain access to the first lever 112) and in total safety, since the cover is made of an insulating material and the first drive lever 112 is not accessible.

[0132] As the mechanical lock of the bar 204, when the cover is in the second position 2P, can be removed only by bringing the cover 225 to the first position 1P, any inadvertent manual resetting is prevented. The fact that the signalling of the opened state (I-OFF, at window 232) is provided only when it is ensured that the automatic resetting is inhibited makes the inventive assembly particularly safe.

[0133] It should be observed that using a reset module provided in the form of an independent module has the advantage that it can be structurally coupled with several safety devices or other types of electrical apparatuses (having a standardized shape).

[0134] Other relevant advantages relate to, for example, the use of the safety transformer and the possibility of providing a maximum voltage protection. Furthermore, the following advantageous aspect are reported:

- the measurement carried out on the installation (load LD) by means of the safety lead PE allows using the control device 500 in phase-to-phase and phase-to-neutral systems;
- the exclusion of the check concerning the ground failure current can be carried out simply by avoiding to connect the safety lead PE;
- the control device can be also used for the remote release function.

[0135] Obviously, to the electrical apparatus according to the present invention, those skilled in the art, aiming at satisfying contingent and specific requirements, may carry out a number of modifications and variations, all being however contemplated within the scope of protection of the invention, such as defined in the annexed claims.

Claims

1. A reset device (200) associable with a safety electrical device (100) of an electric circuit (LD), which is suitable to adopt opened and closed states, comprising mechanical means (250) for transmitting a reset motion to said safety device from the opened to the closed state, and an actuating apparatus (260) for operating the transmission means; said actuating apparatus (260) comprising an electromagnet (206) for generating a magnetic field and a moving element (208) mechanically coupled to the transmission means (250) and such as to be moved following to variation in said magnetic field to cause the reset of the safety device (100); said electromagnet (206) comprising a core (209) and a winding (W) that can be traversed by electric current to magnetize the core and produce the magnetic field and a corresponding attraction force on the moving element; said reset device (200) being arranged to assume:
 - a closed configuration (C1), corresponding to the closed state of the safety device (100), wherein the electromagnet (206) produces a zero magnetic field and said moving element (208) is held in a first position under the bias of elastic means (249); or
 - an operative configuration (C2, C3) in which said electromagnet (206) is supplied by an electric current such as to produce a magnetic field and attracting the moving element to cause a translation of the latter in contrast to the action of said elastic means;
 said reset device (200) being **characterized in that** it further comprises a control circuit (CC) of the electromagnet (206) comprising a current limiting block (CLM), arranged to limit the current intended to pass

through said winding (W), when the reset device (200) is in the operative configuration (C2, C3); and wherein said current limiting block (CLM) can be activated such as to reduce the current passing through the winding (W) and reducing a reset speed at which the moving element translates, and can be deactivated to increase said reset speed.

2. The reset device (200) according to claim 1, wherein said core (209) has an air-gap (210) for the moving element to pass therethrough and forms an inner region (211) within which the moving element (208) can slide.
3. The reset device (200) according to claim 1, wherein the core (209) is made of ferromagnetic material and the moving element is made of metallic material, preferably iron.
4. The reset device (200) according to claim 2, wherein the core (209) is substantially C-shaped and the moving element (208) is substantially plate-like and comprises an end (219) connected to said transmission means and a further end (213) opposite said end; the moving element being translatable along a longitudinal axis thereof.
5. The reset device (200) according to claim 1, wherein the moving element (208) is translatable, and said transmission means (250) are such as to convert the translatory motion of the moving element (208) into rotary motion.
6. The reset device (200) according to claim 5, wherein said transmission means (250) are of the connecting rod/lever type.
7. The reset device (200) according to claim 5 or 6, wherein the transmission means (250) can be mechanically coupled to a drive lever (112) of the safety device (100) in order to cause a closing rotary motion of the safety device.
8. The reset device (200) according to claim 5 and 7, wherein the transmission means (250) include:
 - a first connecting rod (243) having a first portion hinged to the moving element (208);
 - a first lever (245) hinged to a second portion of the first connecting rod (243) and suitable to rotate about a pivot (246) following translations of the moving element.
9. The reset device (200) according to claims 1 and 7, wherein said elastic means comprise a spring anchored to said first lever (245).
10. The reset device (200) according to claim 8, further

comprising:

- a second connecting rod (248) having a first region hinged to the first lever (245);
 - a second lever (252) suitable to rotate about a further pivot (217) and hinged to a second region of the second connecting rod (248).
11. The reset device (200) according to claim 10, further comprising a body (234) suitable to carry out rotations about said further pivot (217) and provided with:
- a coupling element (204) that can be mechanically connected to the drive lever (112) of said safety device (100) ;
 - an abutment element (218) suitable to abut against a portion (254) of the second lever (252) such that said second lever can impress a rotary motion to said body (234) and to the drive lever (112) of the safety device (100) by means of the coupling element (204).
12. The reset device (200) according to at least one of the preceding claims, which is sized such as to obtain a reset time ranging between 100 ms and 20 ms.
13. The reset device (200) according to claim 1, wherein said control circuit (CC) comprises a timing circuit (CK) to generate a timing signal (S_{CK}) which activates the current limiting block (CLM) in a closure initial step of the reset module and deactivates the current limiting block (CLM) in a subsequent closure final step of the reset module.
14. The reset device (200) according to claim 1 or 13, wherein the current limiting block (CLM) is arranged in series to said winding (W) and comprises an electronic circuit breaker (D) and a limiting impedance (R_L) arranged in parallel to the electronic circuit breaker.
15. The reset device (200) according to claims 13 and 14, wherein said circuit breaker can be activated/deactivated by means of the timing signal such as to be an opened circuit or short-circuit said limiting impedance (R_L).
16. The reset device (200) according to claim 15, wherein said circuit breaker is a diode.
17. The reset device (200) according to at least one of the preceding claims, further comprising a reset activation/deactivation device (80) that can be electrically connected to an external power supply network (NW) and said electromagnet, the activation/deactivation device (80) being controllable by means of an electric signal (S_{rm}) to connect/disconnect the electromagnet (206) to/from the external power supply

network (NW).

18. The reset device (200) according to at least one of the preceding claims, wherein said reset device (200) is housed within a enclosure (201).
19. The reset device (200) according to claim 18, wherein said reset device (200) is of a modular type the enclosure is separated from another enclosure of the safety device (100).
20. The reset device (200) according to claims 11 and 19, wherein said enclosure comprises a cover (225) coupled to the enclosure (20) such as to be manually movable relative to the enclosure, the cover comprising an engaging element (231) extending within the cover to abut against said body (234) and causing a rotation of the latter, along with that of said drive lever (112), to open the safety device (100).
21. An electrical apparatus (300) comprising:
- a safety electrical device (100) for switching between a closed and an opened state wherein a power supply network (NW) and a load electric circuit (LD) are connected and disconnected from each other, respectively;
 - a reset device (200) associated with the electrical device (100) **characterized in that** said reset device is provided according to at least one of the preceding claims.
22. The electric apparatus (300) according to claim 21, further comprising a control device (500) suitable to cause a first switching of the safety device from the closed to the opened state, such as to test electro-mechanical functionalities of the same.
23. The electrical apparatus (300) according to claim 22, wherein the control device (500) is such that in the opened state, adopted following the first switching, said load circuit is held disconnected from the power supply network.
24. The apparatus (300) according to claim 22 or 23, wherein said control device (500) is configured to send an electric signal (I_R) to the safety device (100) to cause the first switching and a further electric signal (S_{rm}) to the reset device (200) such as to supply said electromagnet (206) and causing a second switching of the reset device from the opened to the closed state.
25. The apparatus according to claim 24, wherein the control device (500) includes a processing and managing electronic block (52) to generate a command (S_c) and a test electric circuit (70) suitable to receive the command (S_c) and supplying the electric signal

(I_R) to the safety device.

26. The apparatus (300) according to claim 25, wherein the test electric circuit comprises at least one test actuating circuit breaker (54) having a first terminal to be connected to the power supply network (NW) and a second terminal for the electric signal (I_R) to be sent to the safety device (100).
27. The apparatus (300) according to claim 26, wherein said at least one circuit breaker comprises a first electronic circuit breaker (54) that can be opened/closed based on the command (Sc) sent from said electronic block (52).
28. The apparatus (300) according to claim 27, wherein said at least one switch further comprises a first electric contact (57) mechanically couplable to said safety device and such as to adopt a closed and opened configuration when said safety device is in the closed and opened state, respectively.
29. The apparatus according to claim 28, wherein the test electric circuit further comprises a resistor (R) interposed between said second terminal and a terminal of the safety device; the resistor (R) having such a resistance as to obtain, starting from the electric signal, said electric signal (I_R) to be sent to the safety device (100) for the first switching.
30. The apparatus (300) according to claim 29, wherein the electric signal (I_R) is an electric current simulating a failure current of said load circuit.
31. The apparatus (300) according to claim 30, wherein said processing and managing block (52) is configured such as to provide the close command (Sc) of the electronic circuit breaker (54) at preset time intervals, periodically repeated.
32. The apparatus (300) according to claim 31, wherein said processing and managing block (52) is configured such as to receive a signal (Sop) indicating that the first switching has been carried out, and consequently generating an opening signal of said electronic switch (54), such as to disconnect said resistance (R) from the power supply network.
33. The apparatus (300) according to claim 21, wherein the safety device (100) is one of the following devices:
 - a earth leakage circuit breaker, an automatic earth leakage circuit breaker.
34. The apparatus (300) according to claims 30 and 33, wherein the electric current stimulating a failure current of said load circuit is an unbalance current for

said earth leakage circuit breaker or said automatic earth leakage circuit breaker.

35. The apparatus (300) according to claim 21, of the modular type wherein the safety device (100), reset device (200), and control device (500) are housed within respective separate enclosures (107, 201, 501) and are reversibly mechanically and electrically coupled to each other.
36. The apparatus (300) according to claim 22, wherein said control device (500) comprises a check electronic block (51) to carry out measurements of electric parameters of said load circuit (LD) following a switching of the safety device from the closed to the opened state that is not caused by the control block for testing purposes; said check electronic block (51) allowing to detect failure conditions of the load circuit and normal operating conditions of the load circuit (LD).
37. The apparatus (300) according to claims 25 and 36, wherein the processing electronic block (52) is configured to compare data corresponding to said electric parameters with reference electric parameters and generating a reset-enable signal (Sr) of said safety device.

Patentansprüche

1. Einer elektrischen Sicherheitsvorrichtung (100) eines elektrischen Schaltkreises (LD) zuordenbare Zurücksetzvorrichtung (200), welche dazu geeignet ist, geöffnete und geschlossene Zustände einzunehmen, umfassend mechanische Mittel (250) zum Übertragen einer Zurücksetz-Bewegung an die Sicherheitsvorrichtung von dem geöffneten in den geschlossenen Zustand, und eine Aktuator-Anordnung (260) zum Betreiben der Übertragungsmittel; wobei die Aktuator-Anordnung (260) einen Elektromagneten (206) zum Erzeugen eines Magnetfeldes und ein bewegliches Element (208) umfasst, welches mechanisch an die Übertragungsmittel (250) gekoppelt ist, derart, dass es Variationen in dem Magnetfeld folgend bewegt wird, um das Zurücksetzen der Sicherheitsvorrichtung (100) zu bewirken; wobei der Elektromagnet (206) einen Kern (209) und eine Wicklung (W) umfasst, welche von elektrischem Strom durchflossen werden kann, um den Kern zu magnetisieren und das Magnetfeld und eine entsprechende anziehende Kraft auf das bewegliche Element zu erzeugen; wobei die Zurücksetzvorrichtung (200) dazu eingerichtet ist, einzunehmen:
 - eine geschlossene Konfiguration (C1), welche dem geschlossenen Zustand der Sicherheits-

vorrichtung (100) entspricht, wobei der Elektromagnet (206) ein Magnetfeld von Null erzeugt und das bewegliche Element (208) unter Vorspannung durch elastische Mittel (249) in einer ersten Position gehalten wird; oder
 - eine Betriebskonfiguration (C2, C3), in welcher der Elektromagnet (206) mit einem elektrischen Strom versorgt wird, um ein Magnetfeld zu erzeugen, und das bewegliche Element anzieht, um eine Verschiebung desselben entgegen der Wirkung der elastischen Mittel hervorzurufen;

wobei die Zurücksetzvorrichtung (200) **dadurch gekennzeichnet ist, dass** sie ferner einen Steuer-/Regelschaltkreis (CC) des Elektromagneten (206) umfasst, welcher einen Strombegrenzungs-Block (CLM) umfasst, welcher dazu eingerichtet ist, den zum Fließen durch die Wicklung (W) vorgesehenen Strom zu begrenzen, wenn die Zurücksetzvorrichtung (200) sich in der Betriebskonfiguration (C2, C3) befindet;

und wobei der Strombegrenzungs-Block (CLM) derart aktiviert werden kann, dass er den durch die Wicklung (W) fließenden Strom reduziert, wobei eine Zurücksetz-Geschwindigkeit reduziert wird, mit welcher sich das bewegliche Element verschiebt, und deaktiviert werden kann, um die Zurücksetz-Geschwindigkeit zu erhöhen.

2. Zurücksetzvorrichtung (200) nach Anspruch 1, wobei der Kern (209) einen Luftspalt (210) aufweist, durch welchen das bewegliche Element hindurchtreten kann, und welcher einen inneren Bereich (211) bildet, innerhalb welchem das bewegliche Element (208) gleiten kann.

3. Zurücksetzvorrichtung (200) nach Anspruch 1, wobei der Kern (209) aus ferromagnetischem Material hergestellt ist und das bewegliche Element aus metallischem Material, bevorzugt Eisen, hergestellt ist.

4. Zurücksetzvorrichtung (200) nach Anspruch 2, wobei der Kern (209) im Wesentlichen C-förmig ist und das bewegliche Element (208) im Wesentlichen Platten-artig ist und ein Ende (219) umfasst, welches mit den Übertragungsmitteln verbunden ist, und ein weiteres Ende (213) gegenüber dem Ende umfasst, wobei das bewegliche Element verschiebbar entlang einer Längsachse davon ist.

5. Zurücksetzvorrichtung (200) nach Anspruch 1, wobei das bewegliche Element (208) verschiebbar ist und die Übertragungsmittel (250) derart vorgesehen sind, dass sie die Verschiebungsbewegung des beweglichen Elements (208) in eine Rotationsbewegung umwandeln.

6. Zurücksetzvorrichtung (200) nach Anspruch 5, wo-

bei die Übertragungsmittel (250) vom Pleuelstangen/Hebel-Typ sind.

7. Zurücksetzvorrichtung (200) nach Anspruch 5 oder 6, wobei die Übertragungsmittel (250) mechanisch an einen Antriebshebel (112) der Sicherheitsvorrichtung (100) koppelbar sind, um eine Schließ-Drehbewegung der Sicherheitsvorrichtung hervorzurufen.

8. Zurücksetzvorrichtung (200) nach Anspruch 5 und 7, wobei die Übertragungsmittel (250) umfassen:

- eine erste Pleuelstange (243) mit einem ersten an das bewegliche Element (208) angelenkten Abschnitt;
- einen ersten Hebel (245), welcher an einen zweiten Abschnitt der ersten Pleuelstange (243) angelenkt ist und geeignet ist, Verschiebungen des beweglichen Elements folgend um eine Drehachse (246) zu rotieren.

9. Zurücksetzvorrichtung (200) nach Anspruch 1 und 7, wobei die elastischen Mittel eine Feder umfassen, welche an dem ersten Hebel (245) verankert sind.

10. Zurücksetzvorrichtung (200) nach Anspruch 8, ferner umfassend:

- eine zweite Pleuelstange (248) mit einem ersten an den ersten Hebel (245) angelenkten Bereich;
- einen zweiten Hebel (252), welcher dazu geeignet ist, um eine weitere Drehachse (217) zu rotieren und an einen zweiten Bereich der zweiten Pleuelstange (248) angelenkt ist.

11. Zurücksetzvorrichtung (200) nach Anspruch 10, ferner umfassend einen Körper (234), welcher dazu geeignet ist, Rotationen um die weitere Drehachse (217) auszuführen und bereitgestellt ist mit:

- einem Kopplungselement (204), welches mechanisch an den Antriebshebel (112) der Sicherheitsvorrichtung (100) koppelbar ist;
- einem Anlageelement (218), welches dazu geeignet ist, gegen einen Abschnitt (254) des zweiten Hebels (252) derart anzuliegen, dass der zweite Hebel dem Körper (234) und dem Antriebshebel (112) der Sicherheitsvorrichtung (100) mittels des Kopplungselements (204) eine Rotationsbewegung auferlegen kann.

12. Zurücksetzvorrichtung (200) nach wenigstens einem der vorhergehenden Ansprüche, welche derart bemessen ist, dass eine Zurücksetzzeit von zwischen 100ms und 20ms erhalten wird.

13. Zurücksetzvorrichtung (200) nach Anspruch 1, wo-

bei der Steuer-/Regelschaltkreis (CC) einen Timing-Schaltkreis (CK) zum Erzeugen eines Zeit-Signals (S_{CK}) umfasst, welches den Strombegrenzungs-Block (CLM) in einem Schließ-Ausgangsschritt des Zurücksetzmoduls aktiviert und den Strombegrenzungs-Block (CLM) in einem darauf folgenden Schließ-Endschritt des Zurücksetzmoduls deaktiviert.

14. Zurücksetzvorrichtung (200) nach Anspruch 1 oder 13, wobei der Strombegrenzungs-Block (CLM) in Reihe zu der Wicklung (W) angeordnet ist und einen elektronischen Schutzschalter (D) und eine Begrenzungs-Impedanz (R_L) in Parallelschaltung zu dem elektronischen Schutzschalter umfasst.
15. Zurücksetzvorrichtung (200) nach den Ansprüchen 13 und 14, wobei der Schutzschalter mittels des Zeit-Signals aktiviert/deaktiviert werden kann, so dass er ein geöffneter Schaltkreis ist oder die Begrenzungs-Impedanz (R_L) kurzschließt.
16. Zurücksetzvorrichtung (200) nach Anspruch 15, wobei der Schutzschalter eine Diode ist.
17. Zurücksetzvorrichtung (200) nach wenigstens einem der vorhergehenden Ansprüche, ferner umfassend eine Zurücksetz-Aktivierungs/Deaktivierungs-Vorrichtung (80), welche elektrisch an ein externes Energieversorgungs-Netzwerk (NW) und den Elektromagneten angeschlossen ist, wobei die Aktivierungs/Deaktivierungs-Vorrichtung (80) mittels eines elektrischen Signals (S_{rm}) steuerbar/regelbar ist, um den Elektromagneten (206) mit dem externen Energieversorgungs-Netzwerk (NW) zu verbinden / davon zu lösen.
18. Zurücksetzvorrichtung (200) nach wenigstens einem der vorhergehenden Ansprüche, wobei die Zurücksetzvorrichtung (200) innerhalb eines Gehäuses (201) aufgenommen ist.
19. Zurücksetzvorrichtung (200) nach Anspruch 18, wobei die Zurücksetzvorrichtung (200) von einem modularen Typ ist, wobei das Gehäuse getrennt von einem weiteren Gehäuse der Sicherheitsvorrichtung (100) ist.
20. Zurücksetzvorrichtung (200) nach den Ansprüchen 11 und 19, wobei das Gehäuse eine derart an das Gehäuse (20) gekoppelte Abdeckung (225) umfasst, dass sie relativ zu dem Gehäuse manuell bewegbar ist, wobei die Abdeckung ein Eingriffselement (231) umfasst, welches sich innerhalb der Abdeckung erstreckt, um gegen den Körper (234) anzuliegen und eine Rotation desselben, zusammen mit derjenigen des Antriebshebels (112), auszulösen, um die Sicherheitsvorrichtung (100) zu öffnen.

21. Elektrisches Gerät (300), umfassend:

- eine elektrische Sicherheitsvorrichtung (100) zum Schalten zwischen einem geschlossenen und einem geöffneten Zustand, wobei ein Energieversorgungs-Netzwerk (NW) und ein elektrischer Last-Schaltkreis (LD) jeweils miteinander verbunden und voneinander getrennt werden;
- eine der elektrischen Vorrichtung (100) zugeordnete Zurücksetzvorrichtung (200), welche **dadurch gekennzeichnet ist, dass** die Zurücksetzvorrichtung gemäß wenigstens einem der vorhergehenden Ansprüche bereitgestellt ist.

22. Elektrisches Gerät (300) nach Anspruch 21, ferner umfassend eine Steuer-/Regelvorrichtung (500), welche dazu geeignet ist, ein erstes Schalten der Sicherheitsvorrichtung von dem geschlossenen in den geöffneten Zustand auszulösen, so dass elektro-mechanische Funktionalitäten davon getestet werden.
23. Elektrisches Gerät (300) nach Anspruch 22, wobei die Steuer-/Regelvorrichtung (500) derart vorgesehen ist, dass in dem geöffneten Zustand, welcher nach dem ersten Schalten eingenommen worden ist, der Last-Schaltkreis von dem Energieversorgungs-Netzwerk getrennt gehalten wird.
24. Gerät (300) nach Anspruch 22 oder 23, wobei die Steuer-/Regelvorrichtung (500) dazu eingerichtet ist, ein elektrisches Signal (I_R) an die Sicherheitsvorrichtung (100) zu schicken, um das erste Schalten auszulösen und ein weiteres elektrisches Signal (S_{rm}) an die Zurücksetzvorrichtung (200) zu schicken, um den Elektromagneten (206) zu versorgen und ein zweites Schalten der Zurücksetzvorrichtung von dem geöffneten in den geschlossenen Zustand auszulösen.
25. Gerät nach Anspruch 24, wobei die Steuer-/Regelvorrichtung (500) einen elektronischen Prozessierungs- und Verwaltungsblock (52) zum Erzeugen einer Anweisung (S_c) und einen elektrischen Testschaltkreis (70) umfasst, welcher geeignet ist, die Anweisung (S_c) zu empfangen und das elektrische Signal (I_R) an die Sicherheitsvorrichtung zu liefern.
26. Gerät (300) nach Anspruch 25, wobei der elektrische Testschaltkreis wenigstens einen testausführenden Schutzschalter (54) umfasst, welcher einen ersten Anschluss aufweist, welcher an das Energieversorgungs-Netzwerk (NW) anschließbar ist und einen zweiten Anschluss für das elektrische Signal (I_R) aufweist, welches an die Sicherheitsvorrichtung (100) gesendet werden soll.
27. Gerät (300) nach Anspruch 26, wobei der wenig-

stens eine Schutzschalter einen ersten elektronischen Schutzschalter (54) umfasst, welcher auf Grundlage der von dem elektronischen Block (52) gesendeten Anweisung (Sc) geöffnet/geschlossen werden kann.

28. Gerät (300) nach Anspruch 27, wobei der wenigstens eine Schalter ferner einen ersten elektrischen Kontakt (57) umfasst, welcher mechanisch an die Sicherheitsvorrichtung koppelbar ist und zwar derart, dass er eine geschlossene und geöffnete Konfiguration einnehmen kann, wenn die Sicherheitsvorrichtung in jeweils dem geschlossenen beziehungsweise geöffneten Zustand ist.

29. Gerät nach Anspruch 28, wobei der elektrische Testschaltkreis ferner einen Widerstand (R) umfasst, welcher zwischen dem zweiten Anschluss und einem Anschluss der Sicherheitsvorrichtung angeordnet ist, wobei der Widerstand (R) einen derartigen Widerstand aufweist, dass, ausgehend von dem elektrischen Signal, das elektrische Signal (I_R) erhalten wird, welches an die Sicherheitsvorrichtung (100) für das erste Schalten geschickt werden soll.

30. Gerät (300) nach Anspruch 29, wobei das elektrische Signal (I_R) ein elektrischer Strom ist, welcher einen Versagensstrom des Last-Schaltkreises simuliert.

31. Gerät (300) nach 30, wobei der Prozessierungs- und Verwaltungsblock (52) derart eingerichtet ist, dass er die Schließ-Anweisung (Sc) des elektronischen Schutzschalters (54) zu vorbestimmten Zeitintervallen bereitstellt, welche sich periodisch wiederholen.

32. Gerät (300) nach Anspruch 31, wobei der Prozessierungs- und Verwaltungsblock (52) derart eingerichtet ist, dass er ein Signal (Sop) empfängt, welches anzeigt, dass das erste Schalten ausgeführt worden ist, und in Folge dessen ein Öffnungs-Signal des elektronischen Schalters (54) erzeugt, so dass der Widerstand (R) von dem Energieversorgungs-Netzwerk getrennt wird.

33. Gerät (300) nach Anspruch 21, wobei die Sicherheitsvorrichtung (100) eine der folgenden Vorrichtungen ist:

ein Fehlerstrom-Schutzschalter, an automatischer Fehlerstrom-Schutzschalter.

34. Gerät (300) nach den Ansprüchen 30 und 33, wobei der einen Versagensstrom des Last-Schaltkreises simulierende elektrische Strom ein unsymmetrischer Strom für den Fehlerstrom-Schutzschalter oder den automatischen Fehlerstrom-Schutzschalter ist.

35. Gerät (300) nach Anspruch 21 vom modularen Typ, wobei die Sicherheitsvorrichtung (100), Zurücksetzvorrichtung (200) und Steuer-/Regelvorrichtung (500) innerhalb jeweiliger separater Gehäuse (107, 201, 501) aufgenommen sind und reversibel mechanisch und elektrisch miteinander gekoppelt sind.

36. Gerät (300) nach Anspruch 22, wobei die Steuer-/Regelvorrichtung (500) einen elektronischen Überprüfungs-Block (51) zum Ausführen von Messungen von elektrischen Parametern des Last-Schaltkreises (LD) umfasst, welche einem Schalten der Sicherheitsvorrichtung von dem geschlossenen in den geöffneten Zustand nachfolgen, welches nicht von dem Steuer-/Regelblock aus Testgründen veranlasst worden ist; wobei der elektronische Überprüfungs-Block (51) es erlaubt, Versagens-Zustände des Last-Schaltkreises und normale Betriebszustände des Last-Schaltkreises (LD) zu detektieren.

37. Gerät (300) nach den Ansprüchen 25 und 36, wobei der elektronische Verarbeitungsblock (52) dazu eingerichtet ist, den elektrischen Parametern entsprechende Daten mit elektrischen Referenzparametern zu vergleichen und ein Zurücksetz-Freigabesignal (S_r) der Sicherheitsvorrichtung zu erzeugen.

Revendications

1. Dispositif de réarmement (200) pouvant être associé à un dispositif électrique de sécurité (100) d'un circuit électrique (LD), lequel est apte à adopter des états ouverts et fermés, comprenant un moyen mécanique (250) pour transmettre un mouvement de restauration, audit dispositif de sécurité, de l'état ouvert à l'état fermé, et un appareil d'actionnement (260) destiné à exploiter le moyen de transmission ; ledit appareil d'actionnement (260) comprenant un électro-aimant (206) destiné à générer un champ magnétique, et un élément mobile (208) couplé mécaniquement au moyen de transmission (250) et de manière à être déplacé à la suite de variations dans ledit champ magnétique, en vue d'occasionner le réarmement du dispositif de sécurité (100) ; ledit électro-aimant (206) comprenant un noyau (209), et un enroulement (W) pouvant être parcourus par un courant électrique, en vue de magnétiser le noyau et de produire le champ magnétique ainsi qu'une force d'attraction correspondante sur l'élément mobile ; ledit dispositif de réarmement (200) étant agencé de manière à prendre :

- une configuration fermée (C1), correspondant à l'état fermé du dispositif de sécurité (100), dans laquelle l'électro-aimant (206) produit un champ magnétique nul, et ledit élément mobile

- (208) est maintenu dans une première position sous la sollicitation du moyen élastique (249) ;
ou
- une configuration fonctionnelle (C2, C3) dans laquelle ledit électro-aimant (206) est alimenté par un courant électrique de manière à produire un champ magnétique et à attirer l'élément mobile, en vue de provoquer une translation de ce dernier par opposition à l'action dudit moyen élastique ;
- ledit dispositif de réarmement (200) étant **caractérisé en ce qu'il** comprend en outre un circuit de commande (CC) de l'électro-aimant (206), comprenant un bloc de limitation de courant (CLM), agencé de manière à limiter le courant destiné à parcourir ledit enroulement (W), lorsque le dispositif de réarmement (200) est dans la configuration fonctionnelle (C2, C3) ; et
dans lequel ledit bloc de limitation de courant (CLM) peut être activé de manière à réduire le courant parcourant l'enroulement (W) et à réduire une vitesse de restauration à laquelle l'élément mobile effectue la translation, et peut être désactivé de manière à augmenter ladite vitesse de restauration.
2. Dispositif de réarmement (200) selon la revendication 1, dans lequel ledit noyau (209) présente un entrefer (210) pour permettre le passage de l'élément mobile à travers celui-ci, et forme une zone intérieure (211) dans laquelle l'élément mobile (208) peut coulisser.
 3. Dispositif de réarmement (200) selon la revendication 1, dans lequel le noyau (209) est constitué d'un matériau ferromagnétique et l'élément mobile est constitué d'un matériau métallique, du fer de préférence.
 4. Dispositif de réarmement (200) selon la revendication 2, dans lequel le noyau (209) est sensiblement en forme de C et l'élément mobile (208) est sensiblement en forme de plaque et comporte une extrémité (219) reliée audit moyen de transmission et une extrémité supplémentaire (213) opposée à ladite extrémité ; l'élément mobile pouvant être translaté le long d'un axe longitudinal de celui-ci.
 5. Dispositif de réarmement (200) selon la revendication 1, dans lequel l'élément mobile (208) peut être translaté, et ledit moyen de transmission (250) est tel qu'il permet de convertir le mouvement de translation de l'élément mobile (208) en un mouvement de rotation.
 6. Dispositif de réarmement (200) selon la revendication 5, dans lequel ledit moyen de transmission (250) est du type tige de raccordement / levier.
 7. Dispositif de réarmement (200) selon la revendication 5 ou 6, dans lequel le moyen de transmission (250) peut être couplé mécaniquement à un levier de commande (112) du dispositif de sécurité (100) afin d'occasionner un mouvement de rotation de fermeture du dispositif de sécurité.
 8. Dispositif de réarmement (200) selon les revendications 5 et 7, dans lequel le moyen de transmission (250) inclut :
 - une première tige de raccordement (243) présentant une première partie articulée sur l'élément mobile (208) ;
 - un premier levier (245) articulé sur une seconde partie de la première tige de raccordement (243) et apte à tourner autour d'un pivot (246) à la suite de translations de l'élément mobile.
 9. Dispositif de réarmement (200) selon les revendications 1 et 7, dans lequel ledit moyen élastique comporte un ressort ancré audit premier levier (245).
 10. Dispositif de réarmement (200) selon la revendication 8, comprenant en outre :
 - une seconde tige de raccordement (248) présentant une première zone articulée sur le premier levier (245) ;
 - un second levier (252) apte à tourner autour d'un pivot supplémentaire (217) et articulé sur une seconde zone de la seconde tige de raccordement (248).
 11. Dispositif de réarmement (200) selon la revendication 10, comprenant en outre un corps (234) apte à effectuer des rotations autour dudit pivot supplémentaire (217), et comportant :
 - un élément de couplage (204) qui peut être relié mécaniquement au levier de commande (112) dudit dispositif de sécurité (100) ;
 - un élément de butée (218) apte à venir en butée contre une partie (254) du second levier (252), de sorte que ledit second levier peut conférer un mouvement de rotation audit corps (234) et au levier de commande (112) du dispositif de sécurité (100) au moyen de l'élément de couplage (204).
 12. Dispositif de réarmement (200) selon au moins l'une des revendications précédentes, lequel est dimensionné de manière à obtenir un temps de restauration compris entre 100 ms et 20 ms.
 13. Dispositif de réarmement (200) selon la revendication 1, dans lequel ledit circuit de commande (CC) comprend un circuit de temporisation (CK) destiné

- à générer un signal de temporisation (S_{CK}) qui active le bloc de limitation de courant (CLM) dans une étape initiale de fermeture du module de restauration, et qui désactive le bloc de limitation de courant (CLM) dans une étape finale de fermeture subséquente du module de restauration.
14. Dispositif de réarmement (200) selon la revendication 1 ou 13, dans lequel le bloc de limitation de courant (CLM) est agencé en série avec ledit enroulement (W) et comprend un disjoncteur électronique (D) et une impédance de limitation (R_L) agencée en parallèle au disjoncteur électronique.
 15. Dispositif de réarmement (200) selon les revendications 13 et 14, dans lequel ledit disjoncteur peut être activé/désactivé au moyen du signal de temporisation de manière à être un circuit ouvert, ou peut court-circuiter ladite impédance de limitation (R_L).
 16. Dispositif de réarmement (200) selon la revendication 15, dans lequel ledit disjoncteur est une diode.
 17. Dispositif de réarmement (200) selon au moins l'une des revendications précédentes, comprenant en outre un dispositif d'activation / désactivation de restauration (80) qui peut être connecté électriquement à un réseau d'alimentation électrique externe (NW) et audit électro-aimant, le dispositif d'activation / désactivation (80) pouvant être commandé au moyen d'un signal électrique (S_{rm}) en vue de connecter / déconnecter l'électro-aimant (206) au / du réseau d'alimentation électrique externe (NW).
 18. Dispositif de réarmement (200) selon au moins l'une des revendications précédentes, dans lequel ledit dispositif de réarmement (200) est logé dans un boîtier (201).
 19. Dispositif de réarmement (200) selon la revendication 18, dans lequel ledit dispositif de réarmement (200) est de type modulaire, et le boîtier est séparé d'un autre boîtier du dispositif de sécurité (100).
 20. Dispositif de réarmement (200) selon les revendications 11 et 19, dans lequel ledit boîtier comprend un couvercle (225) couplé au boîtier (20), de manière à pouvoir être déplacé manuellement relativement au boîtier, le couvercle comprenant un élément de mise en prise (231) s'étendant à l'intérieur du couvercle en vue de venir en butée contre ledit corps (234) et de provoquer une rotation de ce dernier, ainsi que celle dudit levier de commande (112), afin d'ouvrir le dispositif de sécurité (100).
 21. Appareil électrique (300) comprenant :
 - un dispositif électrique de sécurité (100) destiné à commuter entre un état fermé et un état ouvert, dans lequel un réseau d'alimentation électrique (NW) et un circuit électrique de charge (LD) sont mutuellement connectés et déconnectés, respectivement ;
 - un dispositif de réarmement (200) associé au dispositif électrique (100), **caractérisé en ce que** ledit dispositif de réarmement est fourni selon au moins l'une des revendications précédentes.
 22. Appareil électrique (300) selon la revendication 21, comprenant en outre un dispositif de commande (500) apte à occasionner une première commutation du dispositif de sécurité de l'état fermé à l'état ouvert, de manière à tester les fonctionnalités électromécaniques de celui-ci.
 23. Appareil électrique (300) selon la revendication 22, dans lequel le dispositif de commande (500) est tel que, à l'état ouvert, adopté à la suite de la première commutation, ledit circuit de charge est maintenu déconnecté du réseau d'alimentation électrique.
 24. Appareil (300) selon la revendication 22 ou 23, dans lequel ledit dispositif de commande (500) est configuré de manière à envoyer un signal électrique (I_R) au dispositif de sécurité (100), en vue d'occasionner la première commutation, et à envoyer un signal électrique supplémentaire (S_{rm}) au dispositif de réarmement (200), de manière à alimenter ledit électro-aimant (206) et à occasionner une seconde commutation du dispositif de réarmement, de l'état ouvert à l'état fermé.
 25. Appareil selon la revendication 24, dans lequel le dispositif de commande (500) inclut un bloc électronique de gestion et de traitement (52) destiné à générer une commande (S_c), et un circuit électrique de test (70) apte à recevoir la commande (S_c) et appliquant le signal électrique (I_R) au dispositif de sécurité.
 26. Appareil (300) selon la revendication 25, dans lequel le circuit électrique de test comprend au moins un disjoncteur d'activation de test (54) présentant une première borne à connecter au réseau d'alimentation électrique (NW) et une seconde borne destinée à permettre l'envoi du signal électrique (I_R) au dispositif de sécurité (100).
 27. Appareil (300) selon la revendication 26, dans lequel ledit au moins un disjoncteur comprend un premier disjoncteur électronique (54) qui peut être ouvert / fermé sur la base de la commande (S_c) envoyée à partir dudit bloc électronique (52).
 28. Appareil (300) selon la revendication 27, dans lequel

- ledit au moins un commutateur comprend en outre un premier contact électrique (57) pouvant être couplé mécaniquement audit dispositif de sécurité et de manière à adopter une configuration fermée, et une configuration ouverte, lorsque ledit dispositif de sécurité est dans l'état fermé, ou dans l'état ouvert, respectivement.
29. Appareil selon la revendication 28, dans lequel le circuit électrique de test comprend en outre une résistance (R) interposée entre ladite seconde borne et une borne du dispositif de sécurité ; la résistance (R) présentant une valeur de résistance telle qu'elle permet d'obtenir, à partir du signal électrique, que ledit signal électrique (I_R) soit envoyé au dispositif de sécurité (100) pour la première commutation.
30. Appareil (300) selon la revendication 29, dans lequel le signal électrique (I_R) est un courant électrique simulant un courant de panne dudit circuit de charge.
31. Appareil (300) selon la revendication 30, dans lequel ledit bloc de gestion et de traitement (52) est configuré de manière à fournir la commande de fermeture (Sc) du disjoncteur électronique (54) à des intervalles de temps prédéfinis, répétés périodiquement.
32. Appareil (300) selon la revendication 31, dans lequel ledit bloc de gestion et de traitement (52) est configuré de manière à recevoir un signal (Sop) indiquant que la première commutation a été mise en oeuvre, et générant par conséquent un signal d'ouverture dudit commutateur électronique (54), de façon à déconnecter ladite résistance (R) du réseau d'alimentation électrique.
33. Appareil (300) selon la revendication 21, dans lequel le dispositif de sécurité (100) est l'un des dispositifs suivants :
- un disjoncteur de perte à la terre, un disjoncteur automatique de perte à la terre.
34. Appareil (300) selon les revendications 30 et 33, dans lequel le courant électrique simulant un courant de panne dudit circuit de charge est un courant de déséquilibre pour ledit disjoncteur électronique de perte à la terre ou ledit disjoncteur automatique de perte à la terre.
35. Appareil (300) selon la revendication 21, de type modulaire, dans lequel le dispositif de sécurité (100), le dispositif de réarmement (200), et le dispositif de commande (500) sont logés à l'intérieur de boîtiers individuels respectifs (107, 201, 501) et sont mécaniquement, de manière réversible, et électriquement, couplés les uns aux autres.
36. Appareil (300) selon la revendication 22, dans lequel ledit dispositif de commande (500) comprend un bloc électronique de contrôle (51) destiné à mettre en oeuvre des mesures de paramètres électriques dudit circuit de charge (LD) à la suite d'une commutation du dispositif de sécurité, de l'état fermé à l'état ouvert, qui n'est pas occasionnée par le bloc de commande à des fins de test ; ledit bloc électronique de contrôle (51) permettant de détecter des états de panne du circuit de charge et des états de fonctionnement normal du circuit de charge (LD).
37. Appareil (300) selon les revendications 25 et 36, dans lequel le bloc électronique de traitement (52) est configuré de manière à comparer des données correspondant auxdits paramètres électriques à des paramètres électriques de référence, et générant un signal de restauration-activation (Sr) dudit dispositif de sécurité.

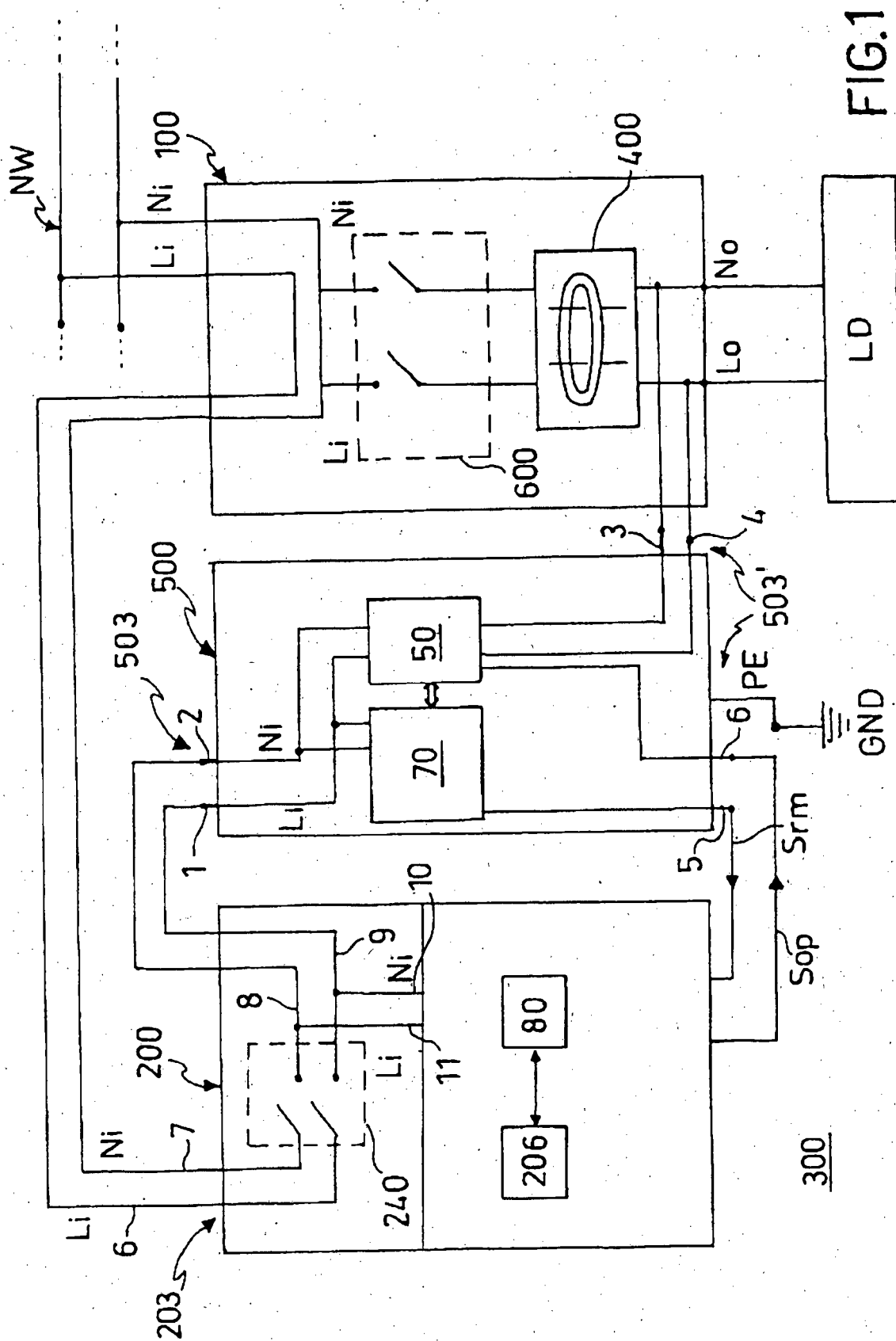


FIG. 1

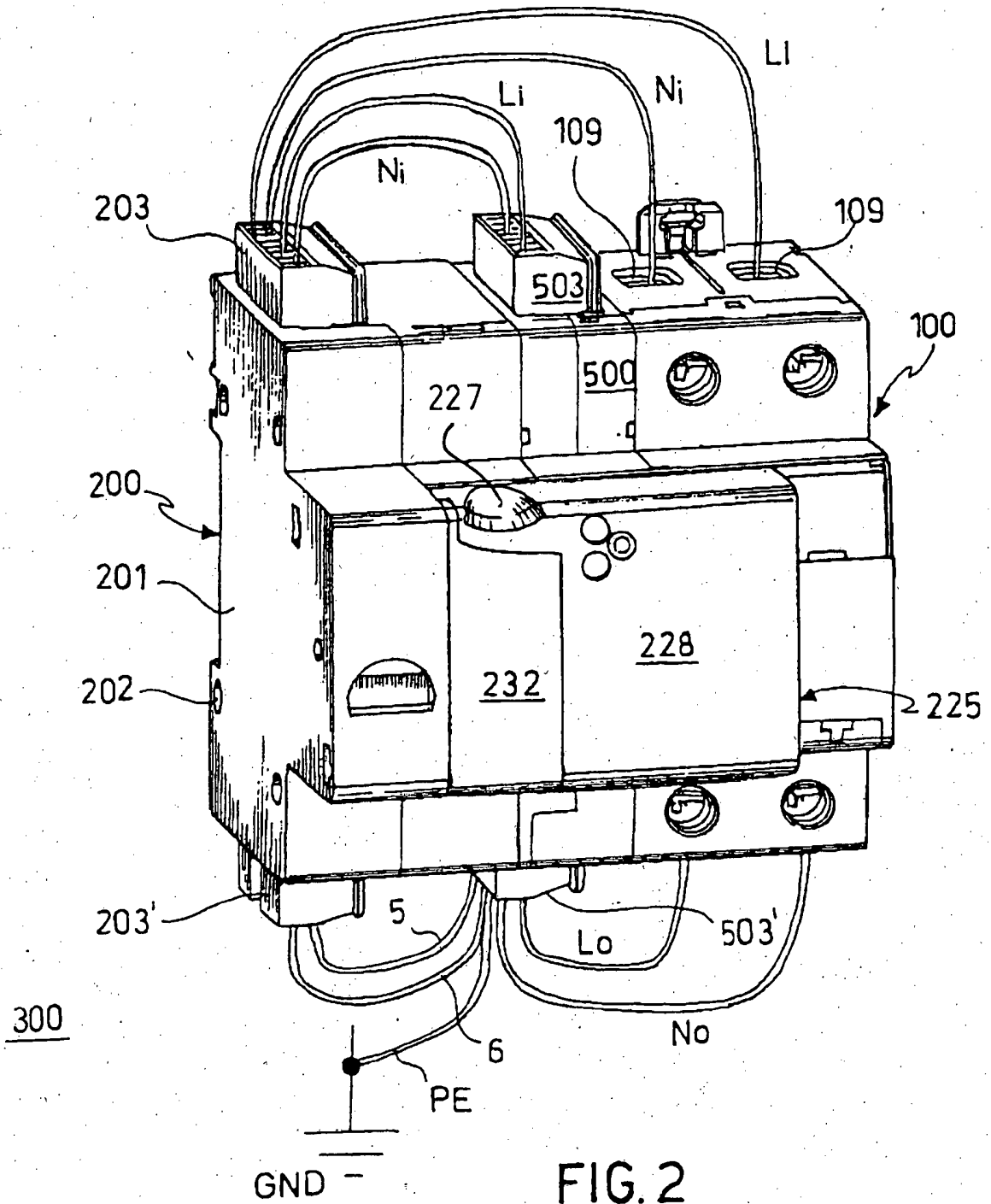
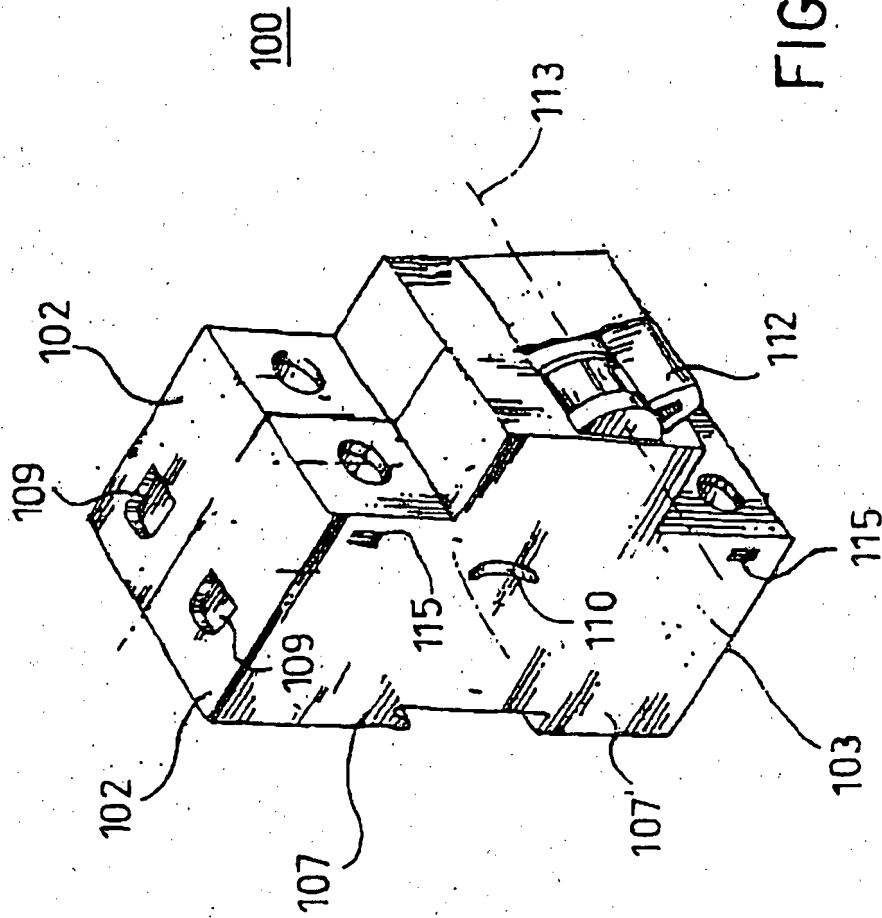


FIG. 2



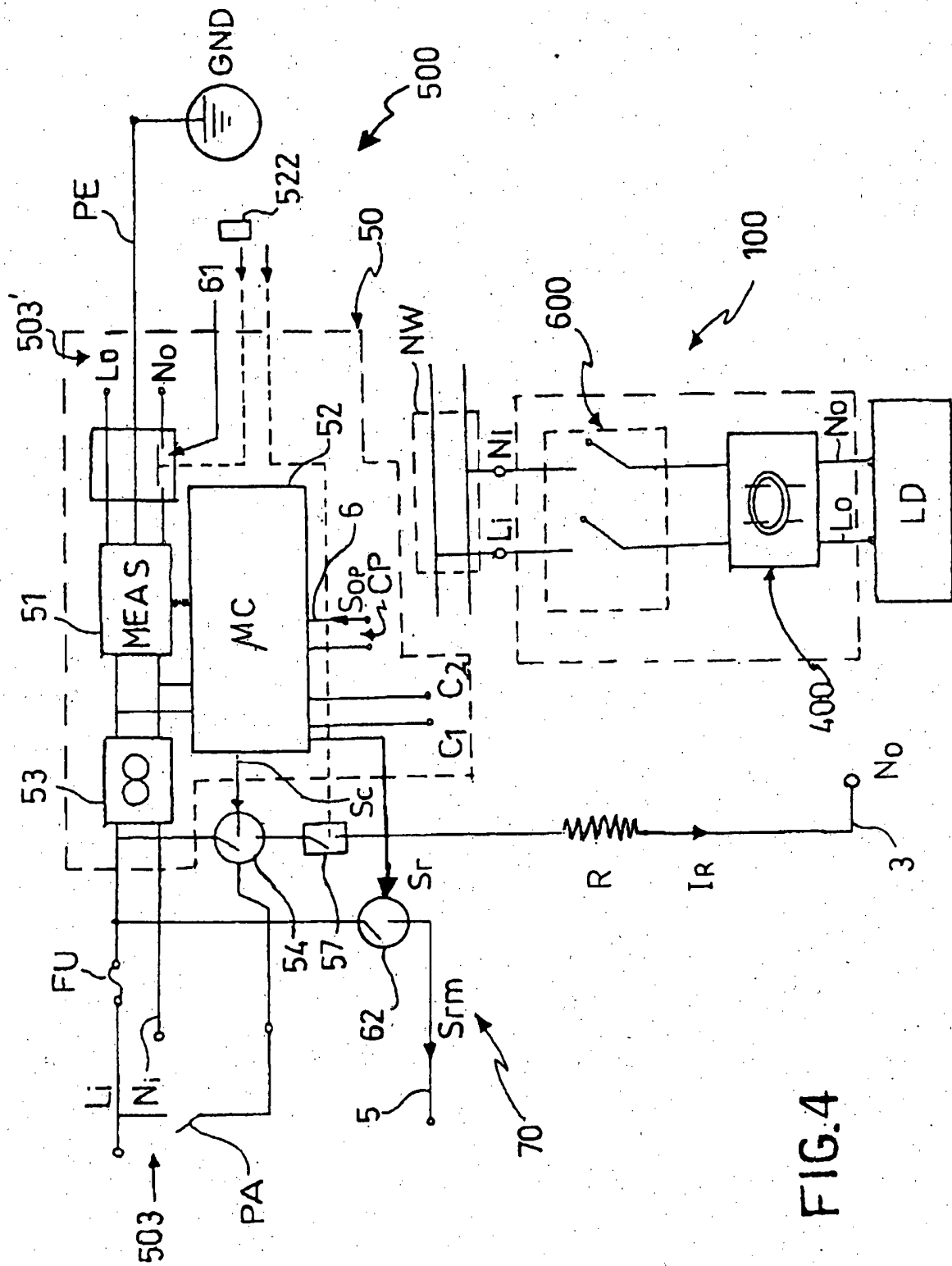


FIG. 4

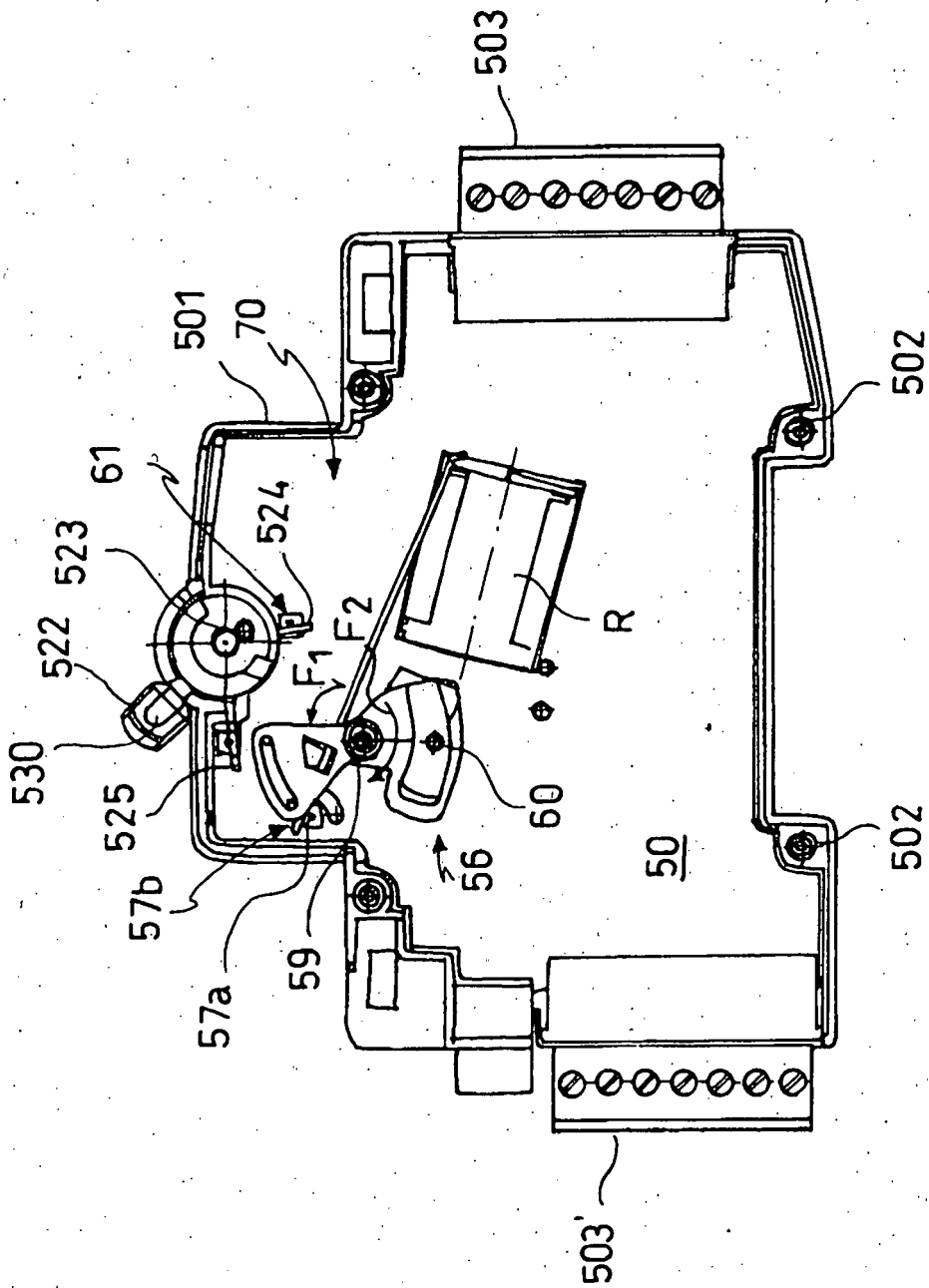


FIG. 5A

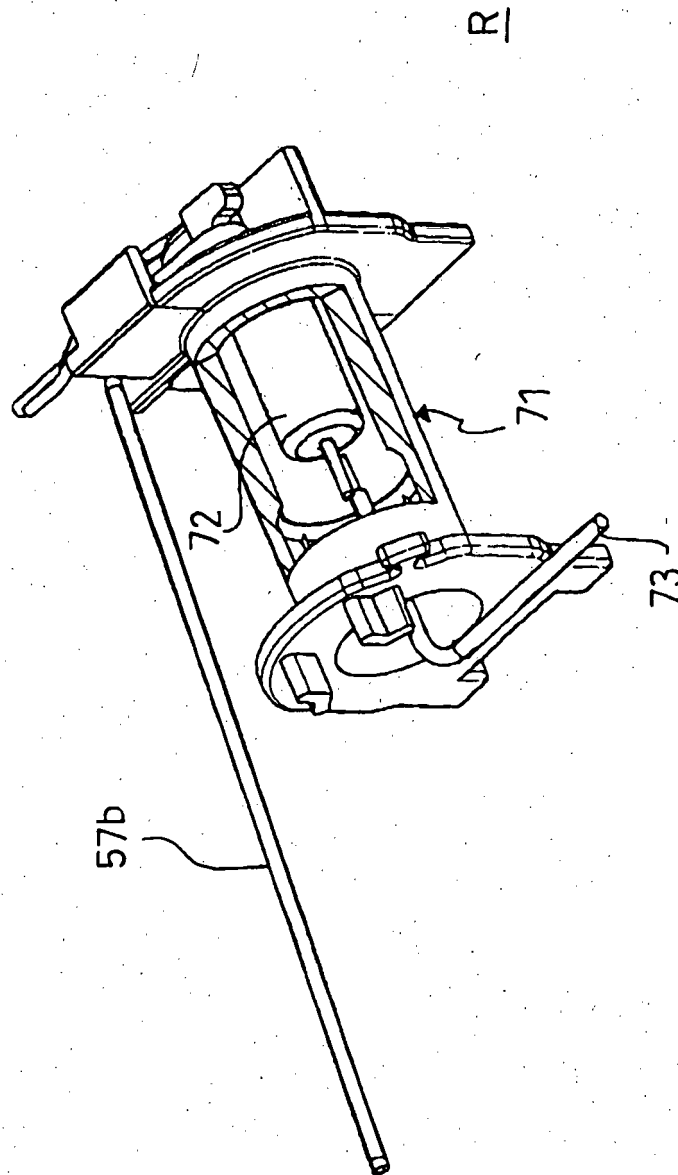


FIG. 5B

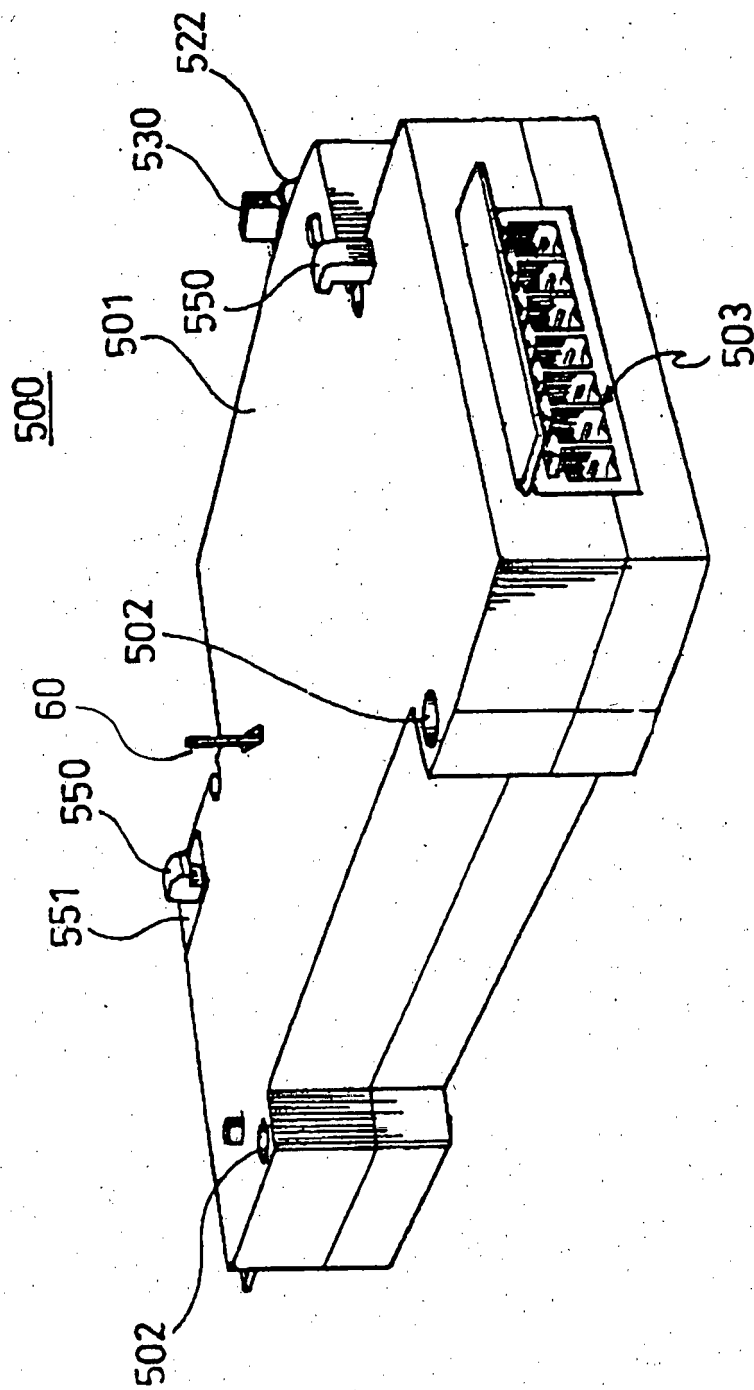


FIG. 6

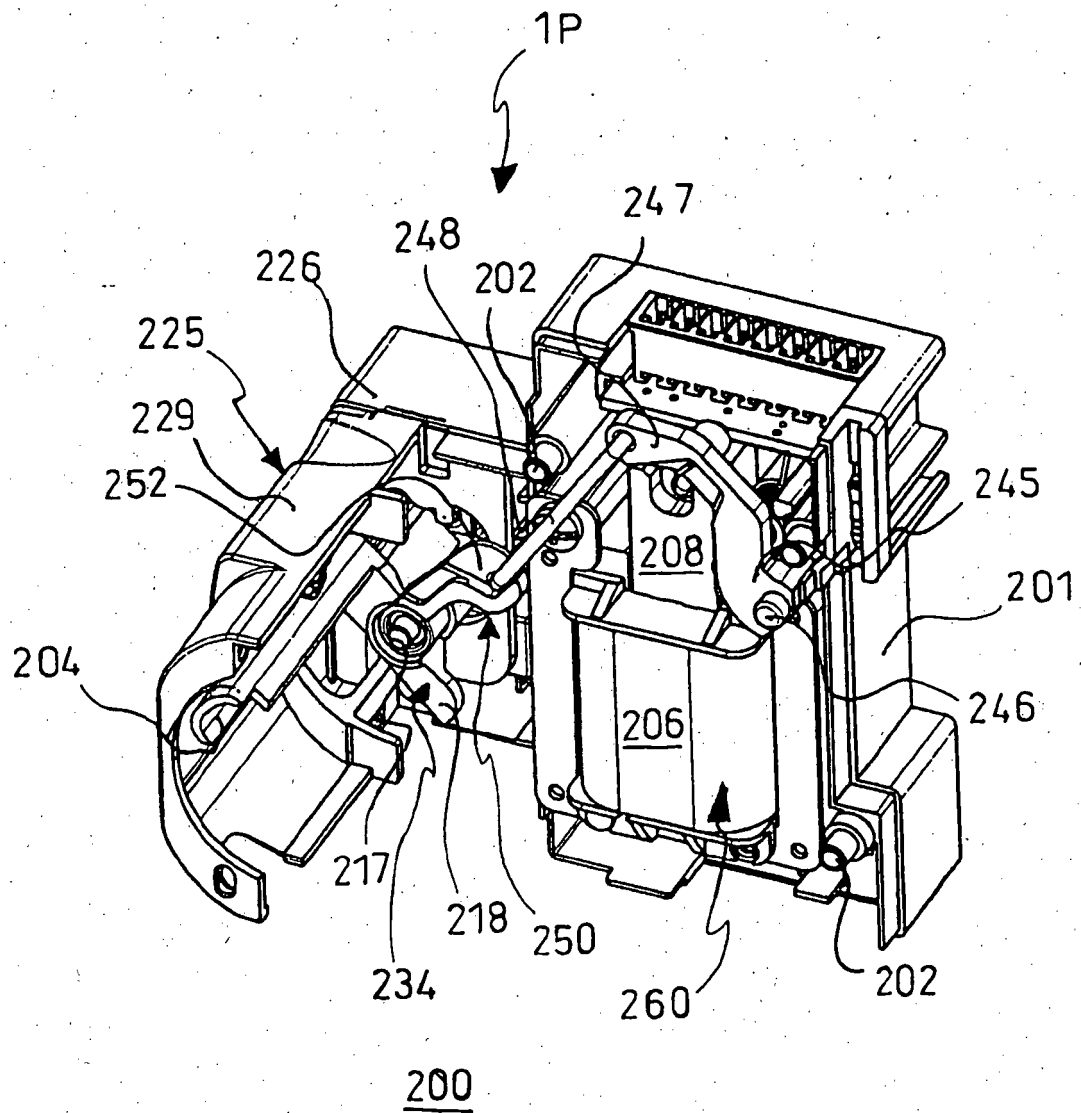


FIG. 7

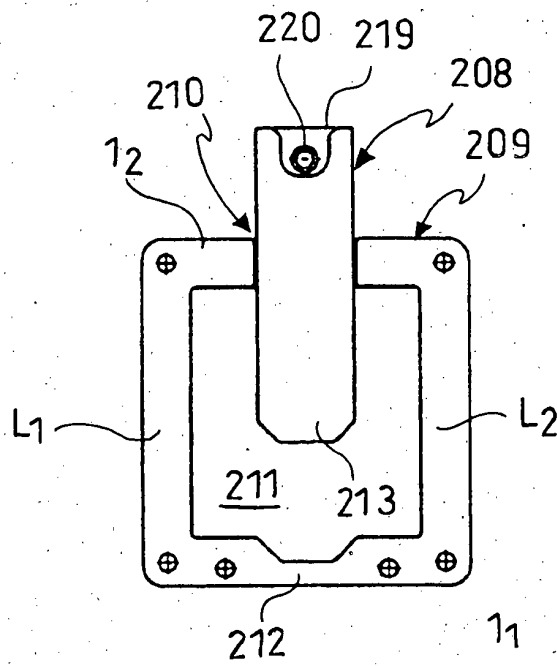


FIG. 8A

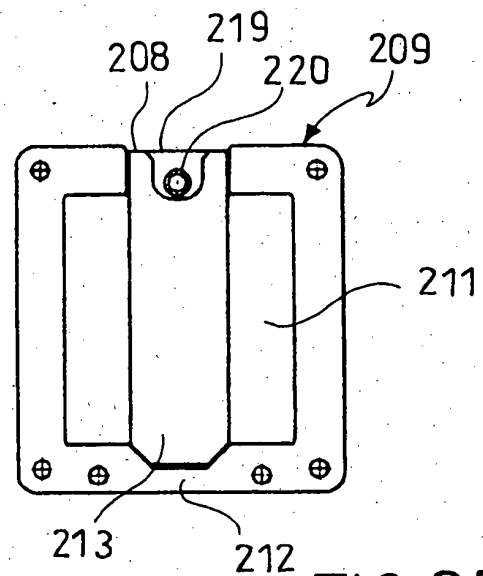


FIG. 8B

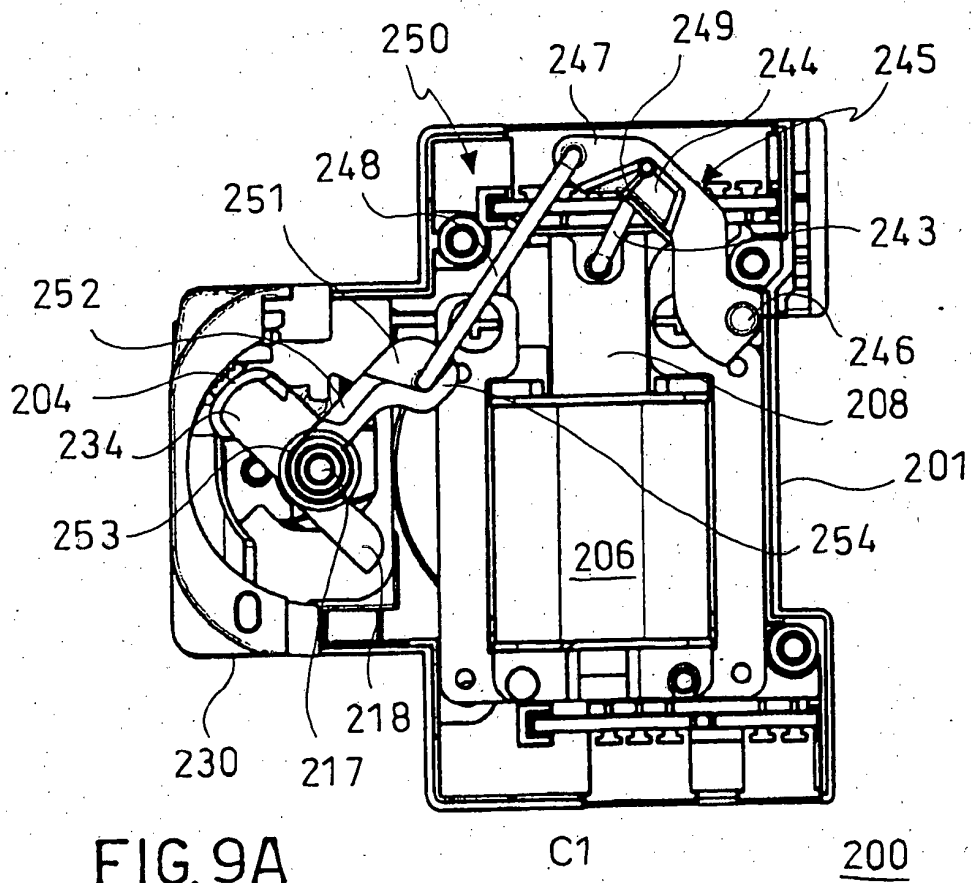


FIG. 9A

C1

200

249

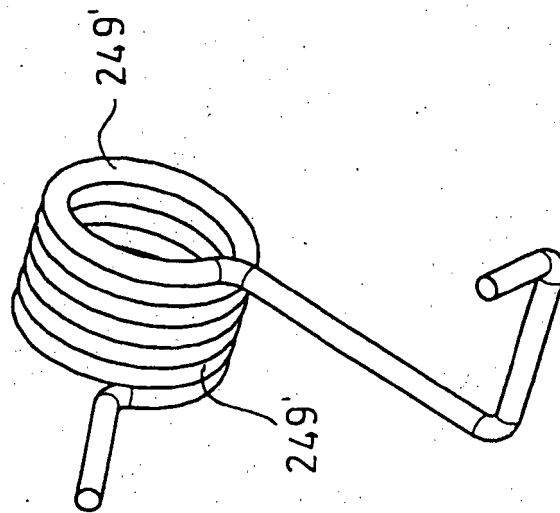


FIG. 9B

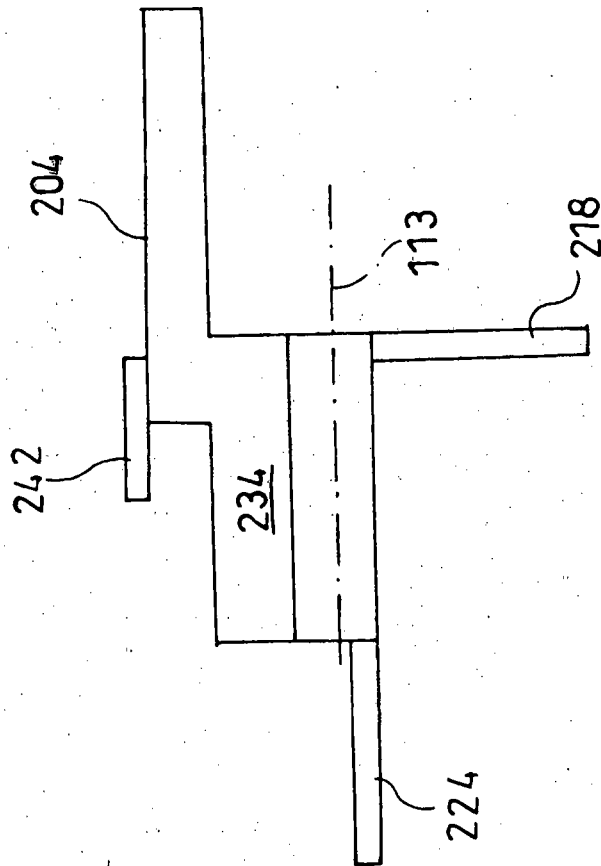


FIG. 10

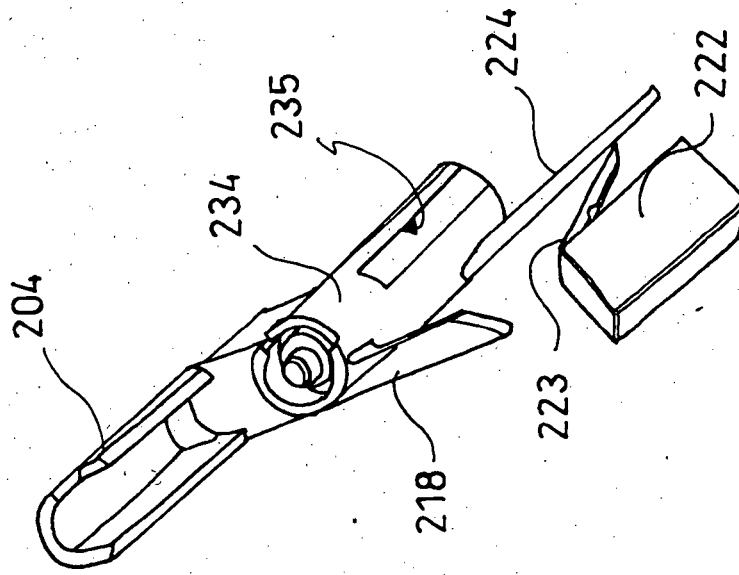


FIG. 11

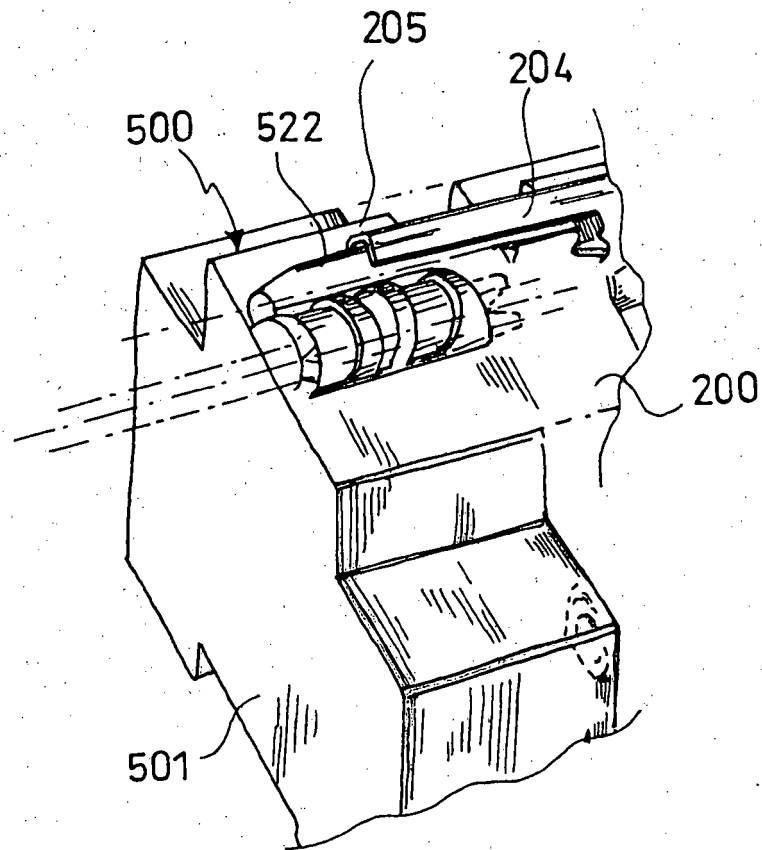


FIG. 12

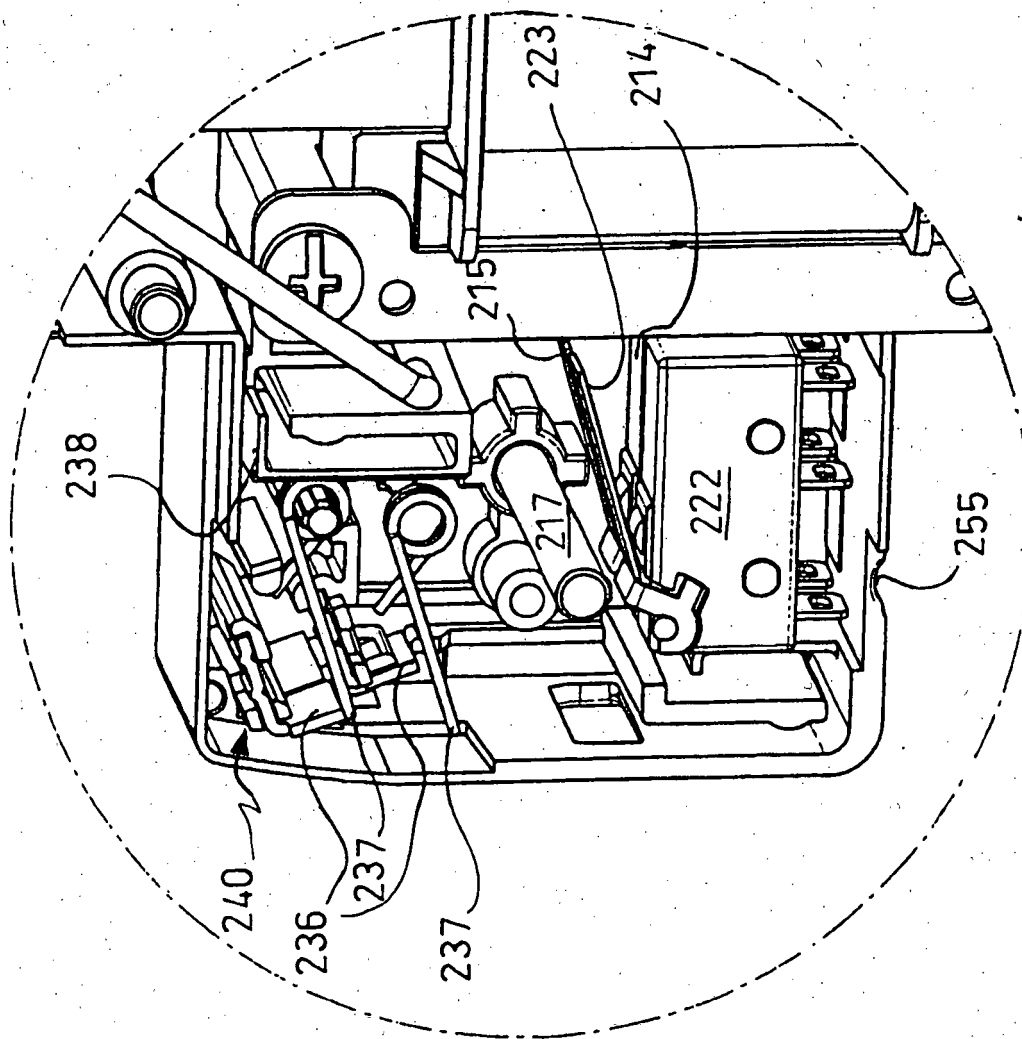


FIG.13

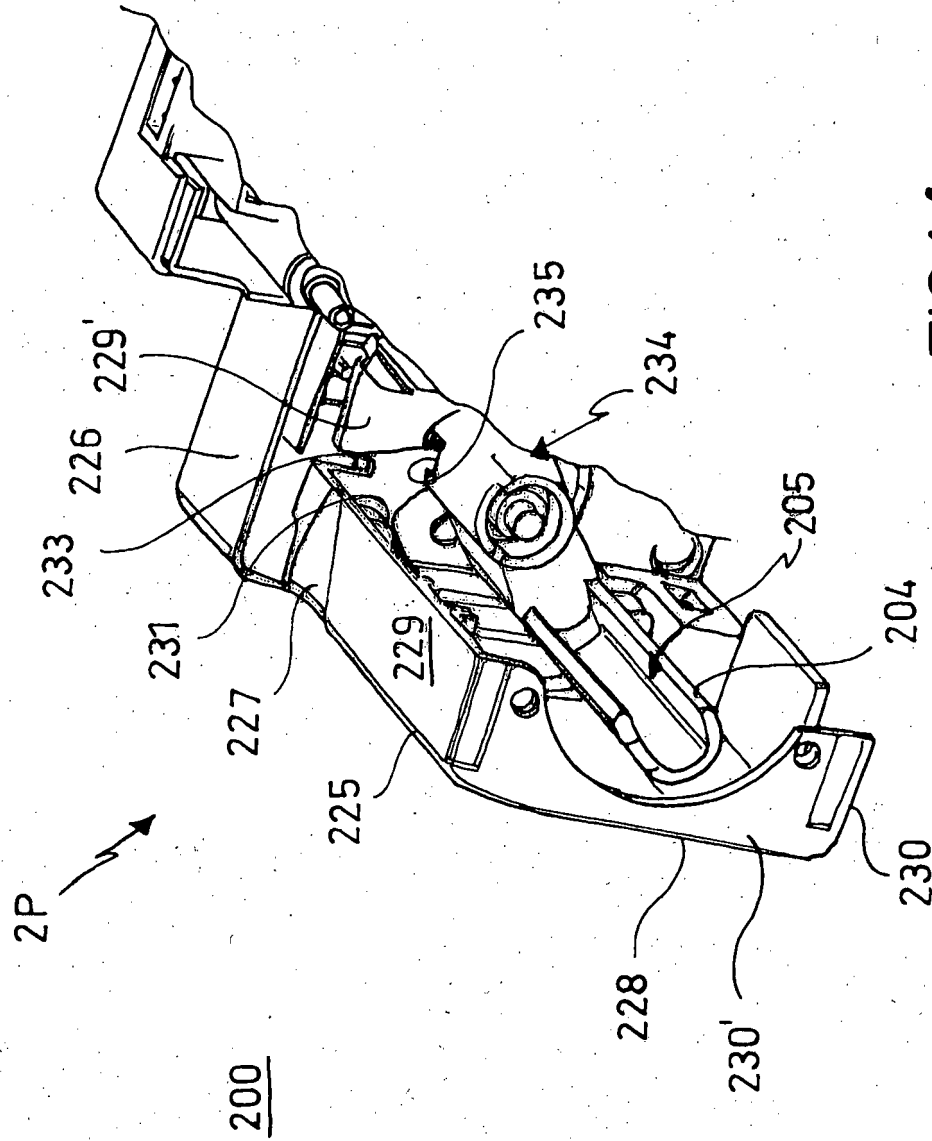


FIG. 14

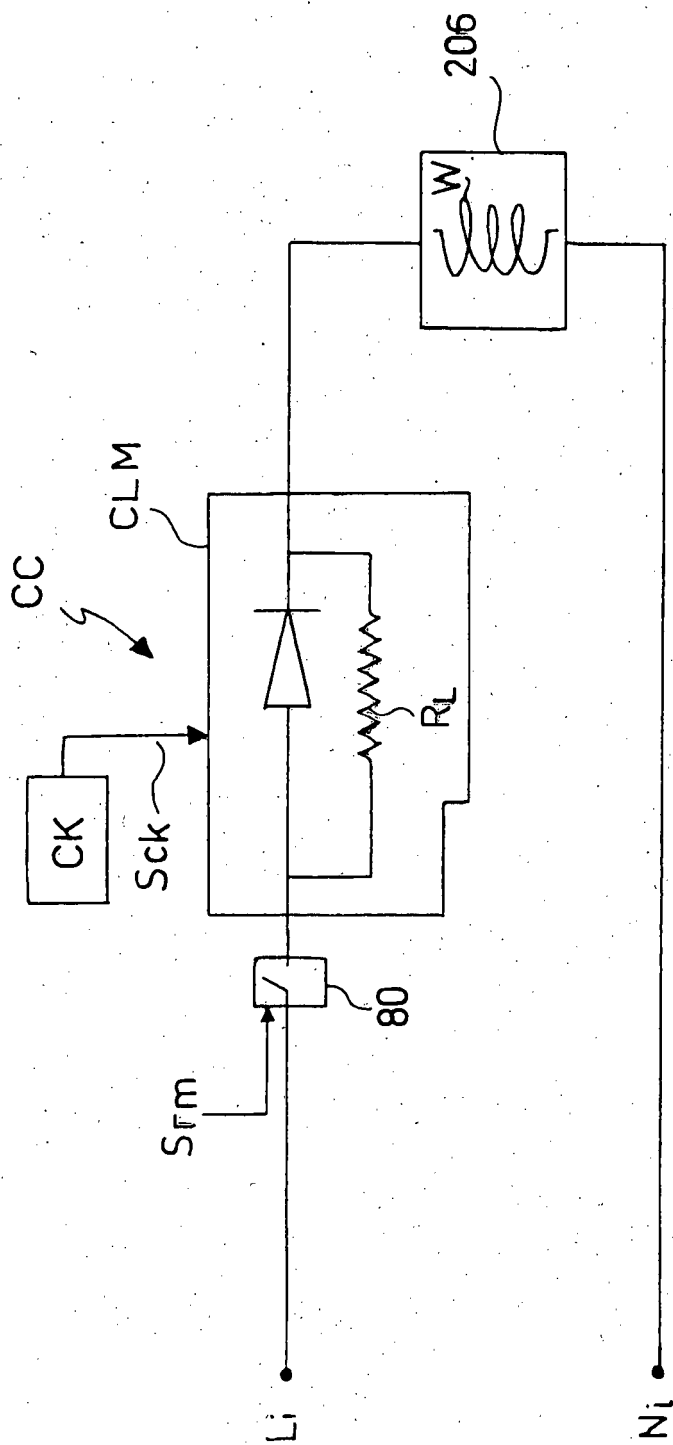
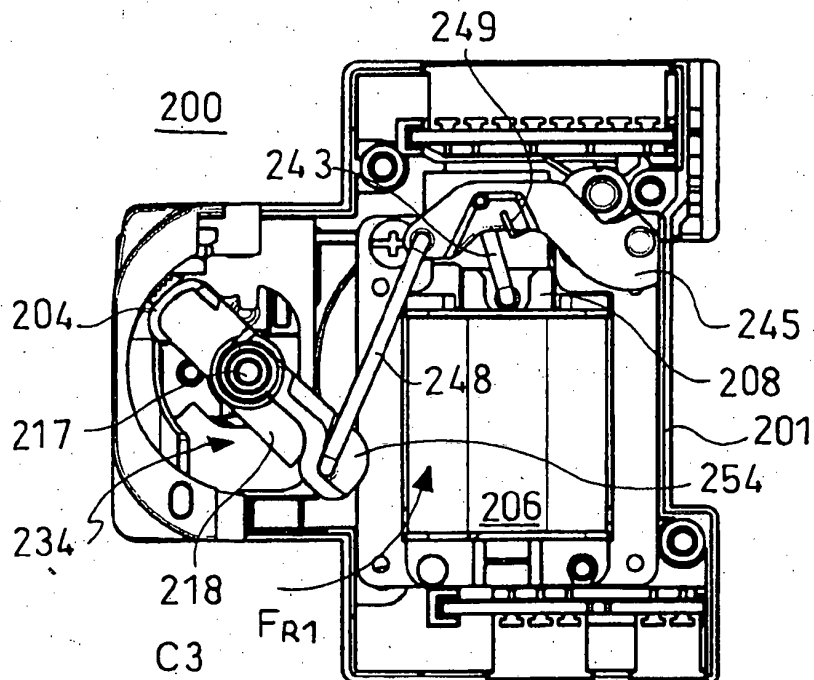
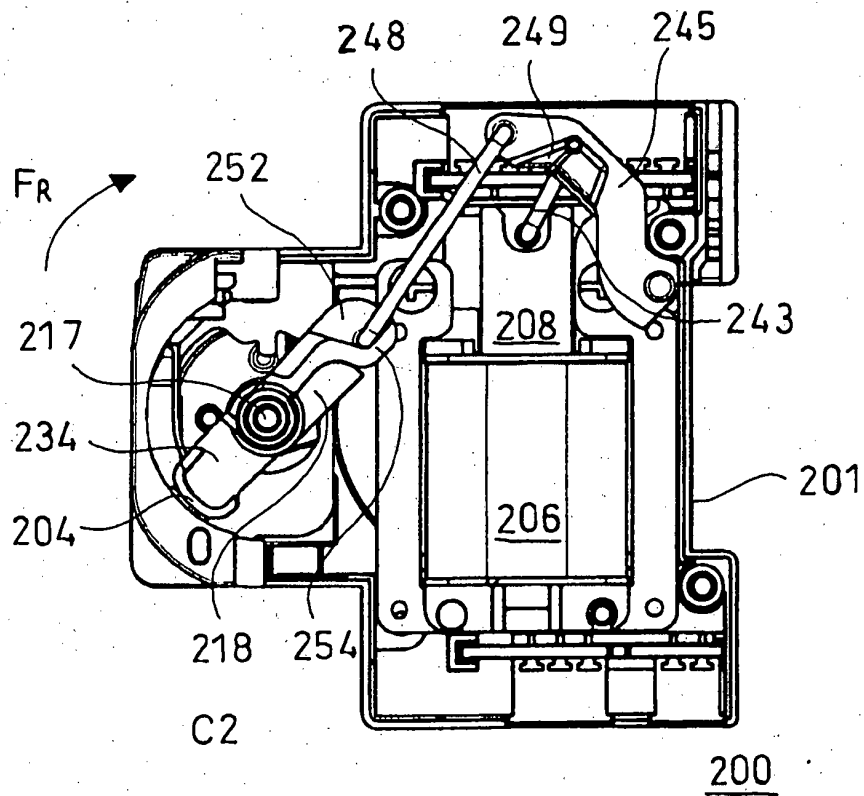


FIG.15



REFERENCES CITED IN THE DESCRIPTION

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