



(11)

EP 3 790 033 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.03.2021 Bulletin 2021/10

(51) Int Cl.:
H01H 71/02 (2006.01)

(21) Application number: **20193409.8**

(22) Date of filing: **28.08.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **YAMAZAKI, Satoshi**
Tokyo, 103-0011 (JP)
• **MACHIDA, Satoshi**
Tokyo, 103-0011 (JP)
• **TAGUCHI, Takahiro**
Tokyo, 103-0011 (JP)

(30) Priority: **05.09.2019 JP 2019162258**

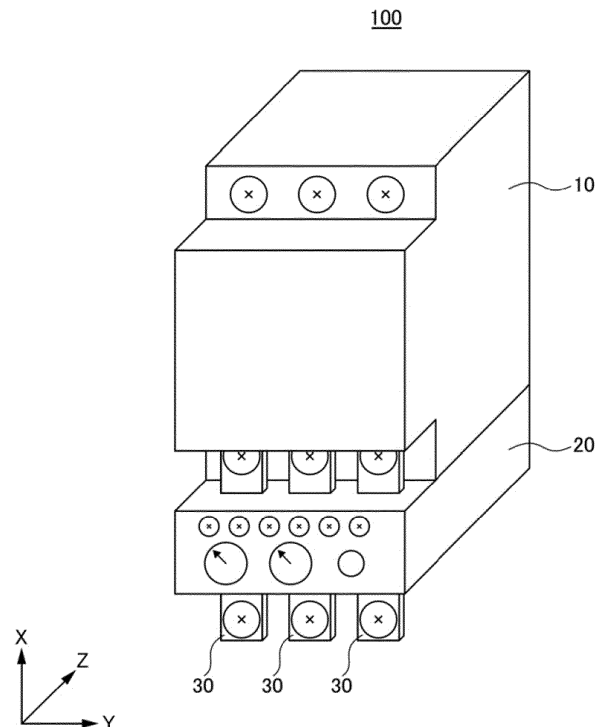
(74) Representative: **Appelt, Christian W.**
Boehmert & Boehmert
Anwaltpartnerschaft mbB
Pettenkoferstrasse 22
80336 München (DE)

(71) Applicant: **Fuji Electric FA Components & Systems Co. Ltd.**
Tokyo 103-0011 (JP)

(54) **ELECTRONIC OVERLOAD RELAY AND ELECTROMAGNETIC SWITCH**

(57) An electronic overload relay includes a bus bar formed by a conductive metallic material, provided between an electromagnetic contactor and a load, or between a circuit breaker and the electromagnetic contactor, and a resistor part arranged between one end and the other end of the bus bar, and including a shunt resistor for detecting a value of a current flowing through the bus bar.

FIG.1



EP 3 790 033 A1

Description**FIELD**

[0001] The present invention relates to an electronic overload relay used for overload protection or the like, and an electromagnetic switch including the electronic overload relay.

BACKGROUND

[0002] Electronic overload relays include a current transformer (CT) for detecting a current flowing through a load, such as a motor or the like (for example, refer to International Publication No. WO 2005/139333 A1, now registered as Japanese Patent No. 4738530). In this type of electronic overload relay, when the current flows through the load, for example, the current detected in the CT is input to an operation section where the input current is compared with an abnormal current determination value. When the value of the input current exceeds the abnormal current determination value, the operation section determines that an error, such as an overcurrent or the like, is generated, and outputs a trip signal, to operate a control circuit of an electromagnetic contactor, and open-circuit contacts. Hence, the load can be guarded from a burnout (that is, protected), even when the overcurrent is generated.

[0003] However, in the conventional electronic overload relay, since the CT is used for a current detector, the current detector becomes physically large, and only copes with alternating current (AC). Accordingly, there is room for improvement in the electronic overload relay when reducing the size thereof, while coping with AC and direct current

SUMMARY

[0004] Accordingly, it is an object in one aspect of the embodiments to provide an electronic overload relay and an electromagnetic switch, which can reduce the size thereof, while coping with both the AC and the DC.

[0005] According to one aspect of the embodiments, an electronic overload relay includes a bus bar formed by a conductive metallic material, provided between an electromagnetic contactor and a load, or between a circuit breaker and the electromagnetic contactor; and a resistor part arranged between one end and the other end of the bus bar, and including a shunt resistor for detecting a value of a current flowing through the bus bar.

[0006] According to another aspect of the embodiments, an electromagnetic switch includes the electronic overload relay described above, and the electromagnetic contactor to which the bus bar is connected.

[0007] Other objects and further advantages of the present invention will now be apparent from the description set forth below in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS**[0008]**

FIG. 1 is an outline view of an electromagnetic switch including an electronic overload relay according to one embodiment of the present invention;

FIG. 2 is an enlarged view of a shunt integrated bus bar illustrated in FIG. 1;

FIG. 3 is a diagram illustrating a circuit configuration of the electromagnetic switch;

FIG. 4 is a diagram illustrating a circuit configuration of the electromagnetic switch illustrated in FIG. 1 according to a comparison example;

FIG. 5 is a diagram illustrating the shunt integrated bus bar according to a first modification;

FIG. 6 is a diagram illustrating the shunt integrated bus bar according to a second modification;

FIG. 7 is a diagram illustrating the shunt integrated bus bar according to a third modification;

FIG. 8 is a diagram illustrating the shunt integrated bus bar according to a fourth modification;

FIG. 9 is a diagram illustrating an example of an internal configuration of a distribution panel;

FIG. 10 is an outline view of the electromagnetic switch according to a modification;

FIG. 11A is a diagram illustrating an example of a first configuration of an electromagnetic contactor having coil terminals; and

FIG. 11B is a diagram illustrating an example of a second configuration of the electromagnetic contactor having the coil terminals.

DESCRIPTION OF EMBODIMENTS

[0009] Although the electronic overload relays and electromagnetic switches according to embodiments of the present invention will be described in detail with reference to the accompanying drawings, the present invention is not limited to these embodiments.

[0010] In the description of each embodiment, the expressions parallel, perpendicular, horizontal, vertical, up-and-down, left-to-right, or the like, used to describe the direction, may include a deviation that does not impair the effects of the present invention. An X-axis direction, a Y-axis direction, and a Z-axis direction represent the direction parallel to the X-axis direction, the direction parallel to the Y-axis direction, and the direction parallel to the Z-axis, respectively. The X-axis direction, the Y-axis direction, and the Z-axis direction are perpendicular to each other. An XY-plane, a YZ-plane, and a ZX-plane represent the virtual plane parallel to the X-axis direction and the Y-axis direction, the virtual plane parallel to the Y-axis direction and the Z-axis direction, and the virtual plane parallel to the Z-axis direction and the X-axis direction, respectively.

[0011] From FIG. 1 subsequent figures, the direction of the X-axis direction indicated by an arrow is regarded

as a plus X-axis (+X-axis) direction, and the direction opposite to the +X-axis direction is regarded as a minus X-axis (-X-axis) direction. The direction of the Y-axis direction indicated by an arrow is regarded as a plus Y-axis (+Y-axis) direction, and the direction opposite to the +Y-axis direction is regarded as a minus Y-axis (-Y-axis) direction. The direction of the Z-axis direction indicated by an arrow is regarded as a plus Z-axis (+Z-axis) direction, and the direction opposite the +Z-axis direction is regarded as a minus Z-axis (-Z-axis) direction.

[0012] Further, in the drawings, identical or similar parts are designated by the same or similar reference numerals. It should be noted, however, that the drawings are schematic and not drawn to scale, and relationships of thicknesses and planar dimensions, ratios of the thicknesses of each of the layers, or the like, are different from the actual scale. Accordingly, the drawings include some parts in which the relationships and ratios of the dimensions differ from those as illustrated.

[0013] FIG. 1 is an outline view of an electromagnetic switch including an electronic overload relay according to one embodiment of the present invention. As illustrated in FIG. 1, an electromagnetic switch 100 includes an electromagnetic contactor 10 that is provided for protective coordination with a circuit (or wiring) breaker provided on a power supply side, and an electronic overload relay 20 that is connected in series with the electromagnetic contactor 10.

[0014] The electronic overload relay 20 is installed to prevent a burnout or the like of the load caused by continued overload state. The load is a motor or the like, for example, but may any load that is driven by AC power or DC power.

[0015] The electronic overload relay 20 is utilized in combination with the electromagnetic contactor 10, similar to a typical thermal relay (or thermal overload relay) utilizing mechanical contacts. The typical thermal relay is an overload relay having built-in bimetal and heat element, and is also referred to as a "thermal overload relay" because the relay is operated by heat. The thermal relay uses a bimetal formed by 2 laminated metals having different coefficients of expansion, such as brass and amber, and the bimetal bends when the brass expands as the temperature rises. When an overcurrent flows through a heat element (winding) that is provided on the bimetal and the bimetal is deformed thereby, the thermal relay performs trip operation to open-circuit contacts of the electromagnetic contactor 10, and interrupt a current supply from the power supply to the load. In contrast to the thermal relay utilizing such mechanical contacts, the electronic overload relay 20 according to this embodiment may be referred to as an "electronic thermal relay", or simply an "overload relay", which is a semiconductor switch and relay, or an overload relay utilizing a contact switch and relay.

[0016] The most standard element to be protected by the electronic overload relay 20 is the overload element. The causes of the overload are diverse, and may include

cases where the load becomes large, a current that is excessively large compared to a prescribed current flows due to a short-circuit fault, or the like, for example. When the load continues to be operated under such an overload state, the load may reach a high temperature and cause a burnout fault, and thus, a circuit (main circuit) must be cut off immediately.

[0017] On the other hand, when the load is a three-phase motor, for example, a large starting current, generated at the start of the operation, must be taken into consideration. Particularly in the case of a motor complying with the top runner standard (top runner induction motor or IE3 motor), a starting current that is larger than those of the conventional IE1 and IE2 motors flows for several seconds. Although the motor will not be damaged by this large starting current, it may become impossible to start the operation of the motor when the overload element acts thereon.

[0018] In order to cope with such inconveniences of not being able to start the motor by the starting current, an operating time of the electronic overload relay 20 is set so as not to operate until a time when this starting current is generated. The setting of the operating time includes a setting that tolerates the overload for a predetermined time similar to the protection upon starting, and a setting that instantaneously cuts off during times other than the starting, however, the setting is desirably selected according to the load of interest.

[0019] The electronic overload relay 20 includes functions similar to those of the general overload relay, such as a trip function in which an internal contact mechanism performs a trip operation when the overcurrent flows through the load, a manual reset (or manual return) function in which the operation is manually reset (or returned) to a steady state after the trip operation, and an automatic reset (or automatic return) function in which the operation is automatically reset (or returned) to the steady state after a predetermined time elapses, or the like, for example. In addition, the electronic overload relay 20 may be switched between the automatic reset and the manual reset. These functions are not essential to the present invention, and a detailed description thereof will be omitted.

[0020] Next, a configuration of a shunt integrated bus bar 30 having a shunt integrated therein, which is one feature of this embodiment, will be described with reference to FIG. 2.

[0021] FIG. 2 is an enlarged view of the shunt integrated bus bar illustrated in FIG. 1. FIG. 2 illustrates one of the three shunt integrated bus bars 30 illustrated in FIG. 1, but the remaining two shunt integrated bus bars 30 have configurations similar to that of the shunt integrated bus bar 30 illustrated in FIG. 2.

[0022] The shunt integrated bus bar 30 is an electrically conductive member in which a resistor part 40 that is a shunt resistor (that is, includes a shunt resistor), is integrated on a bus bar base 300.

[0023] The bus bar base 300 is a plate-shaped con-

ductive member formed by a high-conductivity metallic material for conducting a large amount of current, such as Cu, Cu-Zn alloys, or the like.

[0024] For example, two insertion holes 30a and 30b, and a resistor part 40 are formed in the bus bar base 300. The insertion holes 30a and 30b penetrate the bus bar base 300 in the Z-axis direction, and screws are inserted through the insertion holes 30a and 30b. The screws are fastening members for fixing the shunt integrated bus bar 30 to the electronic overload relay 20.

[0025] The insertion hole 30a is formed in a portion of the bus bar base 300 near a first end 31 along the plus X-axis direction. The insertion hole 30b is formed in a portion of the bus bar base 300 near a second end 32 along the minus X-axis direction.

[0026] The resistor part 40 is a resistor made of a resistive material such as Cu-Mn-Ni alloys, Cu-Ni alloys, Ni-Cr alloys, or the like. In this embodiment, manganin (registered trademark) is used as an example of the resistive material forming the resistor part 40. Manganin is a resistive material composed of copper (86%), manganese (12%), and nickel (2%), for example. Manganin is non-magnetic, has a high resistivity, and has a low temperature coefficient of resistance compared to that of a metallic material, such as Cu or the like, which forms the bus bar base 300.

[0027] The resistor part 40 is provided at a center part of the bus bar base 300 along the X-axis direction, for example. The center part of the bus bar base 300 corresponds to a region, located within the entire bus bar base 300, that divides the bus bar base 300 into two halves with respect to the X-axis direction. The position of the resistor part 40 is not limited to the central part of the bus bar base 300, and may be located in a region closer to the insertion hole 30a than the central part, or in a region closer to the insertion hole 30b than the central part.

[0028] Two conductive wires 51 and 52 are electrically connected to respective sides of the resistor part 40. For example, first ends of the wires 51 and 52 are connected near ends of the resistor part 40 along the plus-X-axis direction and the minus-X-axis direction, respectively. For example, both ends of the resistor part 40 correspond to connecting parts between the resistor part 40 and the bus bar base 300, or parts near the resistor part 40 within the entire bus bar base 300. Second ends of the wires 51 and 52, opposite to the first ends, are connected to a detector provided on the printed circuit board 50. Details of the detector will be described later.

[0029] Since the resistor part 40 has a resistance value that is low to an extent that enables detection of a current, it is necessary to make certain that the resistor part 40 does not affect the accuracy, stability, or the like of the current detection. For example, when the wires 51 and 52 are connected to positioned separated from the resistor part 40, such as positions near the insertion holes 30a and 30b, for example, a voltage drop due to the resistance of the bus bar base 300 is also detected, which may result in a large current detection error. In addition,

when the temperature coefficient of resistance of the bus bar base 300 is large, the resistance value of the bus bar base 300 varies in response to a slight temperature change, and the current detection error may also be caused by the variation in the resistance value of the bus bar base 300. For this reason, the wires 51 and 52 are preferably connected to the connecting parts between the resistor part 40 and the bus bar base 300, or to the parts near the resistor part 40 within the entire bus bar base 300. In this embodiment, the wires 51 and 52 are electrically connected to the resistor part 40. However, the resistor part 40 may be electrically connected to the detector by means other than the wires 51 and 52. For example, a conductive pin, a copper bar, a soldering, a connector, or the like may be used to electrically connect the resistor part 40 to the detector.

[0030] Next, an example of a method of manufacturing the shunt integrated bus bar 30 will be described. When manufacturing the shunt integrated bus bar 30, a plate-shaped conductive member formed by copper is butt welded on both sides of a plate-shaped resistive alloy including manganin, for example, to form an interface (or joint area). The welded plate-shaped composite member is shaped into a strip to form a vertically elongated shunt integrated bus bar 30 as illustrated in FIG. 2.

[0031] The method of manufacturing the shunt integrated bus bar 30 is not limited to the manufacturing method described above. For example, a resistive alloy film may be etched and formed, as the resistive material, on a base substrate that is formed by copper, aluminum, or the like having a low resistivity. The shunt integrated bus bar 30 may also be manufactured by connecting a chip-shaped resistor formed by a material having a micro-electrical resistance, such as a copper-nickel alloy, for example, to the bus bar base 300 formed by a material having a resistivity lower than that of the chip-shaped resistor, such as a copper alloy, and joining boundary portions of the chip-shaped resistor and the bus bar base 300 by compression bonding or crimping, for example.

[0032] Next, an operation of the electromagnetic switch 100 according to one embodiment of the present invention will be described, by referring to FIG. 3.

[0033] FIG. 3 is a diagram illustrating a circuit configuration of the electromagnetic switch. FIG. 3 illustrates a schematic configuration of the electromagnetic switch 100 including the electronic overload relay.

[0034] The electromagnetic contactor 10 and the electronic overload relay 20 forming the electromagnetic switch 100 are connected in series to electrical circuits (of three phases R, S, and T) between the power supply 200 and the load 400.

[0035] The electromagnetic contactor 10 includes a housing, a fixed core provided inside the housing, a movable core arranged to oppose the fixed core, and a coil arranged on an outer periphery of a main leg of the fixed core. When the coil is energized and the movable core is attracted toward the fixed core, a closing operation of a movable contact and a fixed contact of a fixed contactor

is performed.

[0036] The electronic overload relay 20 includes the resistor part 40, the printed circuit board 50, or the like.

[0037] The printed circuit board 50 includes a detector 1, a operation section 4, a power supply section 2, an operation current adjuster 3, an electromagnet section (for example, a solenoid section) 5, an a-contact 6, a b-contact 7, or the like, for example. Constituent elements of the printed circuit board 50 are examples, and the configuration of the electronic overload relay 20 according to this embodiment is not limited thereto.

[0038] The detector 1 detects a voltage across both ends of the resistor part 40 (that is, a potential difference in accordance with the value of the current flowing to the resistor part 40), through the wires 51 and 52. When the operation section 4 determines that an overcurrent is generated, based on the potential difference detected by the detector 1, the operation section 4 inputs a trip signal 4a to the power supply section 2.

[0039] The power supply section 2 includes a trip capacitor for accumulating a charge by inputting the current flowing through the resistor part 40, for example, and discharges the charge accumulated in the trip capacitor when the trip signal 4a is input thereto. Accordingly, the contact mechanism may be caused to perform the trip operation by driving the electromagnet section 5.

[0040] By driving the normally open contact (a-contact 6) by the trip operation, for example, an indicator lamp (not illustrated) for notifying a user of the trip operation is turned on, and by driving the normally closed contact (b-contact 7), the main circuit is open-circuited by releasing the energized coil of the electromagnetic contactor 10 provided in the main circuit. By open-circuiting the main circuit, the burnout or the like of the load 400 can be prevented.

[0041] The operation section 4 may be configured to vary a determination value for detecting the overcurrent (a value for setting a determination voltage) by varying a variable resistance value provided in the operation current adjuster 3, for example. As a result, it is possible to cope with various rated loads (for example, loads having set currents).

[0042] When a predetermined time elapses after the trip operation, the operation section 4 inputs a reset signal to the power supply section 2, so as to drive the electromagnet section 5 by a discharge of a reset capacitor of the power supply section 2, and cause the contact mechanism to perform a reset operation.

[0043] In a case where the electronic overload relay 20 is an external power supply type overload relay, power is supplied from a power supply wiring provided separately from the main circuit, even when the main circuit is cut off by the electromagnetic contactor 10 after the trip operation. For this reason, the steady state or the tripped state can be maintained, or both the steady state and the tripped state can be maintained, by the magnetic attraction of the electromagnet.

[0044] Further, in a case where the electronic overload

relay 20 is a self-powered overload relay, and the main circuit is cut off by the electromagnetic contactor 10 after trip operation, power is no longer supplied. Consequently, only the small amount of power accumulated in the capacitor or the like can be used to maintain the steady state or the tripped state. For this reason, the magnetic attraction of a permanent magnet or a mechanical mechanism may be used to maintain the steady state. Alternatively, an automatic reset operation may be performed and the steady state may be maintained, without using the permanent magnet, as described in Japanese Laid-Open Patent Publication No. 2006-332001, for example.

[0045] A relationship to be satisfied between the magnitude of the overcurrent and the time from the start of the overcurrent to the contact operation is prescribed in JIS C 8201-4-1 or the like. For example, JIS C 8201-4-1 prescribes that the operation takes 2 seconds to 30 seconds to start through a current that is 600% of the set current, the operation is performed within 4 minutes through a current that is 200% of the set current after the temperature becomes constant through the set current, the operation is not performed through the set current and the operation is performed within 2 hours through a current that is 125% of the set current after the temperature becomes constant, or the like.

[0046] Next, a configuration of a comparison example using a CT will be described with reference to FIG. 4.

[0047] FIG. 4 is a diagram illustrating a circuit configuration of the comparison example of the electromagnetic switch illustrated in FIG. 1. An electromagnetic switch 100A according to the comparison example includes a CT 70 in place of the shunt integrated bus bar 30. The CT 70 is provided on the bus bar base 300.

[0048] When an alternating (AC) current flows through the bus bar base 300 (primary side), an alternating (AC) current in accordance with the number of turns flows through a secondary winding of the CT 70, so as to cancel a magnetic flux generated inside the magnetic core of the CT 70. This AC current flows through the shunt resistor (not illustrated), and the operation section 4 determines the overcurrent based on the voltage generated across both ends of the shunt resistor.

[0049] Since the electromagnetic switch 100A according to the comparison example is configured to detect the overcurrent using the CT 70 having the magnetic core or the like, the current detector becomes physically large. In addition, because the CT 70 cannot detect a direct current (DC current), when using the load 400 to which DC power is input, for example, it is necessary to prepare a current detector for detecting the DC current. The load 400 to which the DC power is input may be an inverter or the like to which the DC power is input and converted into AC power for driving a motor, for example.

[0050] On the other hand, since the electromagnetic switch 100 according to this present embodiment uses the shunt integrated bus bar 30, it is possible to reduce the size of the current detector, and to reduce the size of the electronic overload relay 20. Hence, the electro-

magnetic switch 100 can be mounted on a compact switchboard, for example, without being constrained by the size of the electronic overload relay 20.

[0051] In addition, due to the size reduction of the electronic overload relay 20, a maintenance space inside the switchboard is expanded, the maintenance work performance is improved, and an error in the wiring or the like can be prevented.

[0052] Moreover, because the electronic overload relay 20 copes with both the AC and the DC, it is possible to increase the production of the electronic overload relay 20 having the same specifications, when compared to separately manufacturing the electronic overload relay that copes with the AC and the electronic overload relay that copes with the DC. Accordingly, it is possible to reduce the cost of the electronic overload relay 20, by mass production of the electronic overload relays 20.

[0053] Further, since the configuration of the shunt integrated bus bar 30 is simple compared to that of the CT 70, it is possible to facilitate managing of manufacturing tolerances of the shunt integrated bus bar 30. As a result, the yield of the current detector can be improved, and it is possible to further reduce the manufacturing cost of the electronic overload relay.

[0054] The shunt integrated bus bar 30 according to this embodiment may be configured as described below in conjunction with FIG. 5 through FIG. 8. In FIG. 5 through FIG. 8, those parts that are the same as those corresponding parts illustrated in FIG. 2 are designated by the same reference numerals, a description of the same parts will be omitted, and only the parts that differ will be described.

[0055] FIG. 5 is a diagram illustrating the shunt integrated bus bar according to a first modification. A shunt integrated bus bar 30-1 according to the first modification includes a bus bar base 300A, and the resistor part 40.

[0056] The bus bar base 300A is a conductive member in which two crank members are joined together. More particularly, the bus bar base 300A includes a first crank conductor 301 and a second crank conductor 302, which are crank-shaped conductive members arranged line symmetrically (or in axial symmetry) with respect to a virtual line VL1. The virtual line VL1 is parallel to the Z-axis direction, and passes through the center part of the bus bar base 300A along the X-axis direction. The center part of the bus bar base 300A corresponds to the region, located within the entire bus bar base 300A, that divides the bus bar base 300A into two halves with respect to the X-axis direction.

[0057] The resistor part 40 is provided at the center part of the bus bar base 300A. The resistor part 40 is provided between the first crank conductor 301 and the second crank conductor 302 that are arranged line symmetrically with respect to the virtual line VL1. The resistor part 40 is provided at a bottom portion 303a of a U-shaped conductor portion 303 that is formed to a generally U-shape by the first crank conductor 301 and the second crank conductor 302.

[0058] The U-shaped conductor portion 303 is a conductive member that is arranged and fitted inside the housing forming the electronic overload relay 20. The U-shaped conductor portion 303 fitted inside the housing include a state where the conductive member is fitted into and positioned by a positioning groove formed inside the housing, a state where the conductive member is fitted onto and positioned by a positioning projection formed inside the housing, or the like, for example.

[0059] By positioning the conductive member, the interface between the first crank conductor 301 and the resistor part 40, and the interface between the second crank conductor 302 and the resistor part 40, are less affected by the tightening of screws 60 when the bus bar base 300A is fastened onto the terminals of the electronic overload relay 20 by the screws 60.

[0060] When a rotation moment acts on the ends of the bus bar base 300A due to a tightening torque of the screws 60, a stress is applied to the welded portion (or interface) between the resistor part 40 and the bus bar base 300A. Consequently, this can result in a deformation or cracking at the welded portion, or a slight change in the resistance value of the welded portion, to thereby deteriorate the accuracy of the current detection. According to the shunt integrated bus bar 30-1, however, the conductive portion having the generally U-shape (that is, the U-shaped conductor portion 303) is formed by combining two crank-shaped conductive members. When the U-shaped conductor portion 303 contacts (or fits) inside the housing of the electronic overload relay 20, the U-shaped conductor portion 303 makes contact with and is positioned inside the housing of the electronic overload relay 20, even when the rotation moment acts on the ends of the bus bar base 300A. For this reason, even when the screws 60 are tightened with a large tightening torque, a movement of the U-shaped conductor portion 303 inside the housing is restricted. Hence, a misalignment or positional error of the bus bar base 300A connected to the resistor part 40 can be reduced. Accordingly, in addition to the interface between the second crank conductor 302 and the resistor part 40 being less affected by the tightening of screws 60 when the bus bar base 300A is fastened onto the terminals of the electronic overload relay 20 by the screws 60, the welded portion between the resistor part 40 and the bus bar base 300A are less affected by the tightening of screws 60, to thereby reduce the deterioration in the current detection accuracy.

[0061] In addition, by using the shunt integrated bus bar 30-1, even if the screw is threaded roughly, it is possible to reduce the deterioration in the current detection accuracy. Therefore, it is possible to further improve the yield of the current detector, and further reduce the manufacturing cost of the electronic overload relay.

[0062] FIG. 6 is a diagram illustrating the shunt integrated bus bar according to a second modification. In FIG. 6, the difference from the shunt integrated bus bar 30-1 illustrated in FIG. 5 is the position of the resistor part

40. In a shunt integrated bus bar 30-2, the resistor part 40 is provided near a distal end 303c of the U-shaped conductor portion 303, on the side of an opening 303b of the entire U-shaped conductor portion 303.

[0063] For example, in a case where a width of the electronic overload relay 20 along the X-axis direction is restricted, a width of the bottom portion 303a of the U-shaped conductor portion 303 along the X-axis direction becomes narrow. Accordingly, if the resistor part 40 were provided at the bottom portion 303a, the interface between the resistor part 40 and the bus bar base 300A may crack when the bus bar base 300A is bent into the crank-shape during the manufacturing stage.

[0064] But when the resistor part 40 is provided near the distal end 303c of the U-shaped conductor portion 303, the resistor part 40 can be provided at a portion other than the bottom portion 303a of the U-shaped conductor portion 303. Thus, the same effects obtainable by the shunt integrated bus bar 30-1 illustrated in FIG. 5 are also obtainable, and further, the design conditions of the shunt integrated bus bar 30-2 can have more degree of freedom.

[0065] FIG. 7 is a diagram illustrating the shunt integrated bus bar according to a third modification. In FIG. 7, the differences from the shunt integrated bus bar 30-1 illustrated in FIG. 5 are that a bus bar 30-3 uses a bus bar base 300B having one first crank conductor 301, and that the resistor part 40 is provided at a different location. More particularly, the resistor part 40 is provided at a portion excluding two bent portions, namely, a first bent portion 305 and a second bent portion 306 respectively having the crank shape, among the entire bus bar base 300B.

[0066] The portion excluding the two bent portions corresponds, for example, to a plate-shaped conductor portion 304 provided in a region between the second bent portion 306 and the second end 32 in the minus X-axis direction of the bus bar base 300B. The resistor part 40 is provided at an intermediate portion of the plate-shaped conductor portion 304, for example. The portion excluding the two bent portions may be a plate-shaped conductor portion provided in a region between the first bent portion 305 and the first end 31 in the plus-X-axis direction of the bus bar base 300B.

[0067] The second bent portion 306 and the plate-shaped conductor portion 304 are arranged inside the housing forming the electronic overload relay 20, similar to the U-shaped conductor portion 303 described above, and are fitted into a positioning groove formed inside the housing, or fitted on to make contact with a positioning projection formed inside the housing, for example.

[0068] Accordingly, when the bus bar base 300B is fastened onto the terminals of the electronic overload relay 20 by the screws 60, the interface between the plate-shaped conductor portion 304 and the resistor part 40 is less affected by the tightening of screws 60.

[0069] Further, since the shunt integrated bus bar 30-3 has a simplified structure compared to the shunt integrat-

ed bus bar 30-1 described above, a time required for the bending process is shortened, and it is possible to further facilitate managing of manufacturing tolerances of the shunt integrated bus bar 30-3. As a result, the yield of the current detector can further be improved, and the manufacturing cost of the electronic overload relay can be further be reduced.

[0070] FIG. 8 is a diagram illustrating the shunt integrated bus bar according to a fourth modification. In FIG. 8, the difference from the shunt integrated bus bar 30-3 illustrated in FIG. 7 is the position of the resistor part 40. In a shunt integrated bus bars 30-4, the resistor part 40 is provided in a region between the first bent portion 305 and the second bent portion 306. The region between the first bent portion 305 and the second bent portion 306 corresponds to a plate-shaped conductor portion 307 extending in a depth direction of the electronic overload relay 20.

[0071] For example, in a case where the width of the electronic overload relay 20 along the X-axis direction is restricted, the width of the plate-shaped conductor portion 304 along the X-axis direction, extending from one insertion hole 30a toward the other insertion hole 30b may become narrow. Accordingly, it may not be possible to secure a sufficient space in the plate-shaped conductor portion 304 for forming the resistor part 40.

[0072] According to the shunt integrated bus bar 30-4, even in the case where the sufficient space in the plate-shaped conductor portion 304 for forming the resistor part 40 cannot be secured, the resistor part 40 may be provided on the portion of the entire first crank conductor 301 extending in the Z-axis direction, that is, on the plate-shaped conductor portion 307 extending in the depth direction of the electronic overload relay 20. For this reason, the same effects obtainable by the shunt integrated bus bar 30-3 illustrated in FIG. 7 are obtainable, and further, the design conditions of the shunt integrated bus bar 30-4 can have more degree of freedom.

[0073] As described above, the electronic overload relays according to the embodiments and the modifications described above include a bus bar provided between an electromagnetic contactor and a load and formed by a conductive metallic material, and a resistor arranged in between one end and the other end of the bus bar, and including a shunt resistor for detecting a value of a current flowing through the bus bar. According to this configuration, it is possible to provide an electronic overload relay capable of both AC current detection and DC current detection, and also capable of coping with a wide current range. In addition, since the shunt resistor is connected to the bus bar, it is possible to significantly reduce the manufacturing cost of the electronic overload relay, while reducing the size of the current detector. Further, because the electronic overload relay may be realized as a thermal relay, it is possible to contribute to the size reduction of the control panel, unlike the conventional separately provided unit.

[0074] A monitoring relay is known as a device mount-

ed with a shunt resistor on the current detector. In such a monitoring relay, the current coping range is several A to approximately 10 A and narrow, because of the configuration in which the shunt resistor is mounted on the printed circuit board.

[0075] On the other hand, in the embodiments and the modifications described above, the current coping range can be several tens of A to several hundred A, by forming the current detector by the bus bar type shunt resistor.

[0076] In addition, since thermal relay is used in combination with the contactor, a configuration in which the two are integrated with each other may be required in the form of a product. However, the monitoring relay is conventionally only available in the form of a separate unit.

[0077] On the other hand, according to the embodiments and the modifications described above, by forming the current detector with the shunt resistor formed integrally on the bus bar, the configuration in which the thermal relay and the contactor are integrated with each other can be realized with a compact size.

[0078] The conventional electronic thermal relay using the CT is of course designed and manufactured according to specifications that satisfy the standard requirements, but basically only has a protection function against application to the line-start motor. For this reason, although it is possible to cope with the general load or the IE3 motor with an average starting current, it is necessary to use an expensive separate unit (monitoring relay, for example) having higher functions in order to cope with a special load or the IE3 motor with a high starting current. However, such a separate unit has a narrow current coping range of several A to approximately 10 A, and is not suited for achieving the size reduction of the control panel because of the separate configuration thereof.

[0079] According to the embodiments and the modifications described above, a product in the category of the generally used thermal relay can cope with a DC load and a special AC load (that is, load with a wide current variation width), and contribute to the size reduction of the control panel.

[0080] Until now, the overload protection is provided by a DC circuit breaker in a high layer of a DC part within the control panel, or a DC fuse that cannot be reused after the protection. However, according to the embodiments and the modifications described above, the DC load can be monitored, measured, and protected for each reusable branch circuit in a layer lower than the DC circuit breaker, which is ideal for the safety design of the DC circuit.

[0081] Further, until now, with respect to the starting current of the IE3 motor becoming larger than that of the conventional IE1 motor, a thermal relay having a rated current larger than normal is sometimes used as a countermeasure against an erroneous operation that tends to occur when a thermal relay having the normal rated current is used, however, such use of the thermal relay hav-

ing the rated current larger than normal may not always be an optimum selection for the protection. On the contrary, according to the embodiments and the modifications described above, it is possible to cope with the IE3 motor having variations in the starting current and characteristics thereof depending on each manufacturer, and the special motor (having an even higher starting current) based on the IE3 motor. It is also possible to perform a setting suited for the load, even in the case of a control system or the like having a unique load pattern. Hence, these advantageous features are obtainable in the embodiments and the modifications described above.

[0082] Further, in the embodiments and the modifications described above, the coping current range can be set to several tens of A to several hundred A. Moreover, by including the configuration of this embodiment in the thermal relay having the contact integrated configuration, it is possible to reduce the size of the product, and enable the size reduction of the control panel.

[0083] The shunt integrated bus bar according to the embodiments and the modifications described above may be provided between the circuit breaker (not illustrated) and the electromagnetic contactor 10. Details of this arrangement will be described with reference to FIG. 9 and FIG. 10. FIG. 9 is a diagram illustrating an example of an internal configuration of the distribution panel. In addition, FIG. 10 is an outline view of the electromagnetic switch according to a modification.

[0084] A distribution panel 600 illustrated in FIG. 9 includes a circuit breaker 81, an electromagnetic switch 100B, or the like. The distribution panel 600 may be included in the control panel.

[0085] The circuit breaker 81 is connected to the power supply 200 via a wiring 80. A wiring 82 is connected to a secondary side (that is, the load side) of the circuit breaker 81. One end of the shunt integrated bus bar 30 is connected to the wiring 82. The shunt integrated bus bar 30 is provided in the electronic overload relay 20 of the electromagnetic switch 100B. The electromagnetic switch 100B includes the electromagnetic contactor 10 and the electronic overload relay 20, and the electronic overload relay 20 is provided on the side of the power supply 200 of the electromagnetic contactor 10, that is, between the circuit breaker 81 and the electromagnetic contactor 10 illustrated in FIG. 9. The circuit breaker 81 is electrically connected to the electronic overload relay 20 of the electromagnetic switch 100B, through the wiring 82 and the shunt integrated bus bar 30. The other end of the shunt integrated bus bar 30 is connected to the electromagnetic contactor 10.

[0086] Although the shunt integrated bus bar 30 is used in the distribution panel 600, it is possible to use any one of the shunt integrated bus bar 30-1, the shunt integrated bus bar 30-2, the shunt integrated bus bar 30-3, and the shunt integrated bus bar 30-4 described above, in place of the shunt integrated bus bar 30.

[0087] The advantages of providing the electronic overload relay 20 including the shunt integrated bus bar

30 on the side of the power supply 200 of the electromagnetic contactor 10, are as follows.

[0088] A first advantage is that, because a voltage is applied to the electronic overload relay 20 when the circuit breaker 61 is turned on, and the voltage is not applied to the electronic overload relay 20 when the circuit breaker 61 is turned off, the electronic overload relay 20 can monitor the state of the circuit breaker 61, that is, whether the circuit breaker 61 is on or off, by detecting the voltage value.

[0089] A second advantage is that the electronic overload relay 20 can monitor the phase sequence state (that is, perform voltage phase-reversal monitoring) of the power supply by detecting the voltage value. In a case where the electronic overload relay 20 is connected to the load side of the electromagnetic contactor 10, the voltage phase-reversal monitoring cannot be performed.

[0090] A third advantage is that when the electronic overload relay 20 receives the supply of power from the main circuit, the electronic overload relay 20 can continue to operate regardless of the state (on/off) of the electromagnetic contactor 10. In the case where the electronic overload relay 20 is connected to the load side of the electromagnetic contactor 10, the electronic overload relay 20 cannot continue to operate when the electromagnetic contactor 10 is turned off.

[0091] A fourth advantage is that when the electromagnetic contactor 10 has the configuration in which coil terminals are provided on the side of the power supply, the connection from the electronic overload relay 20 to the coil terminals may be facilitated. FIG. 11A is a diagram illustrating a first configuration example of the electromagnetic contactor having the coil terminals. FIG. 11B is a diagram illustrating a second configuration example of the electromagnetic contactor having the coil terminals. As illustrated in FIG. 11A and FIG. 11B, the electromagnetic contactor 10 is provided with coil terminals 83 for inputting a control signal to control the on (or short-circuiting) operation or the off (or open-circuiting) operation. By providing the coil terminals 83 on the electromagnetic contactor 10, the connection is facilitated when providing the control function of the electromagnetic contactor 10 in the electronic overload relay 20.

[0092] According to the embodiments and the modifications described above, it is possible to cope with both the AC and the DC, while reducing the size of the electronic overload relay. In other words, it is possible to provide an electronic overload relay and an electromagnetic switch, which can perform both the AC current detection and the DC current detection, and also cope with a wide current range.

[0093] The configurations illustrated in the above embodiments and the modifications are examples of the contents of the present invention, and may be combined with other known techniques, or may be partially omitted or modified, without departing from the spirit of the present invention.

[0094] Furthermore, the embodiments and the modifi-

cations described above are examples of apparatuses and methods for realizing the technical concept of the present invention, and the technical concept of the present invention is not limited to the specific materials, shapes, configurations, layouts, or the like of the components or parts that are described.

[0095] Although the modifications are numbered with, for example, "first," "second," "third," or "fourth," the ordinal numbers do not imply priorities of the modifications. Many other variations and modifications will be apparent to those skilled in the art.

[0096] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the invention. Although the embodiments of the present invention have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

Claims

1. An electronic overload relay (20) comprising:

a bus bar (30, 30-1 to 30-4) formed by a conductive metallic material, provided between an electromagnetic contactor (10) and a load (400), or between a circuit breaker (81) and the electromagnetic contactor (10); and
a resistor part (40) arranged between one end and the other end of the bus bar, and including a shunt resistor for detecting a value of a current flowing through the bus bar.

2. The electronic overload relay (20) as claimed in claim 1, wherein the bus bar (30, 30-1 to 30-4) includes a plate-shaped conductive member (300, 301, 302, 303, 304).

3. The electronic overload relay (20) as claimed in claim 1 or 2, wherein the bus bar (30-1, 30-2) includes a U-shaped conductive member (303) fitted inside a housing forming the electronic overload relay.

4. The electronic overload relay (20) as claimed in claim 3, wherein the resistor part (40) is provided at a bottom portion (303a) of the U-shaped conductive member (303).

5. The electronic overload relay (20) as claimed in claim 3, wherein the resistor part (40) is provided at a distal end (303c) near an opening (303b) in the U-shaped

conductive member (303).

6. The electronic overload relay (20) as claimed in claim 1, wherein the bus bar (30-1 to 30-4) has a crank-shaped conductive member (301, 302) fitted inside 5
a housing forming the electronic overload relay.

7. The electronic overload relay (20) as claimed in claim 6, wherein 10
the crank-shaped conductive member (301) includes a first bent portion (305) and a second bent portion (306) formed in the crank shape, respectively, and 15
the resistor part (40) is provided in a region between one end of the bus bar (30-4) and the first bent portion (305), and in a region between the other end of the bus bar (30-4) and the second bent portion (306).

8. The electronic overload relay (20) as claimed in claim 6, wherein 20
the crank-shaped conductive member (301) includes a first bent portion (305) and a second bent portion (306) formed in the crank shape, respectively, and 25
the resistor part (40) is provided in a region between the first bent portion (305) and the second bent portion (306).

9. An electromagnetic switch (100, 100A, 100B) comprising: 30

the electronic overload relay (20) according to any one of claims 1 to 8; and
the electromagnetic contactor (10) to which the bus bar (30, 30-1 to 30-4) is connected. 35

40

45

50

55

FIG.1

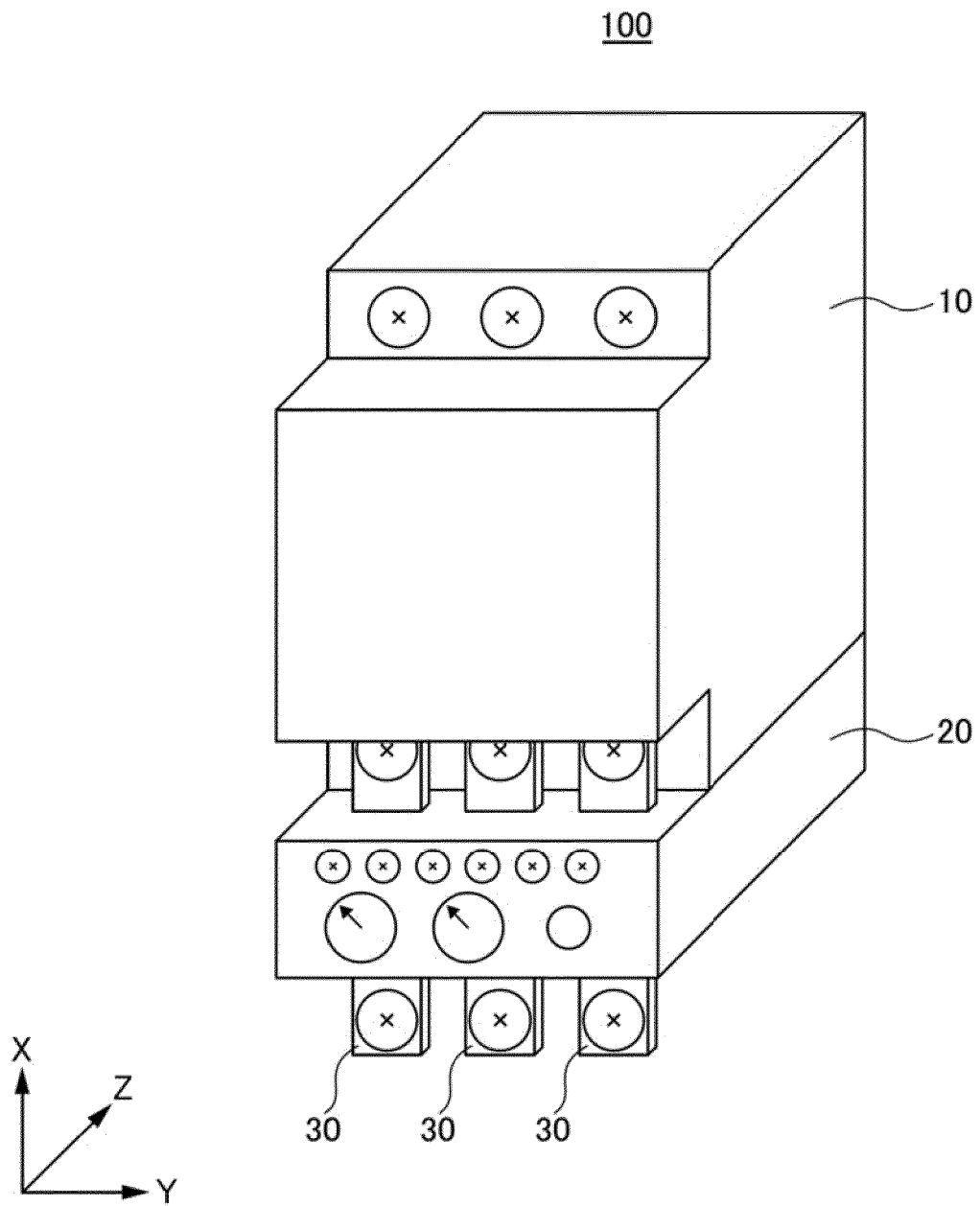


FIG.2

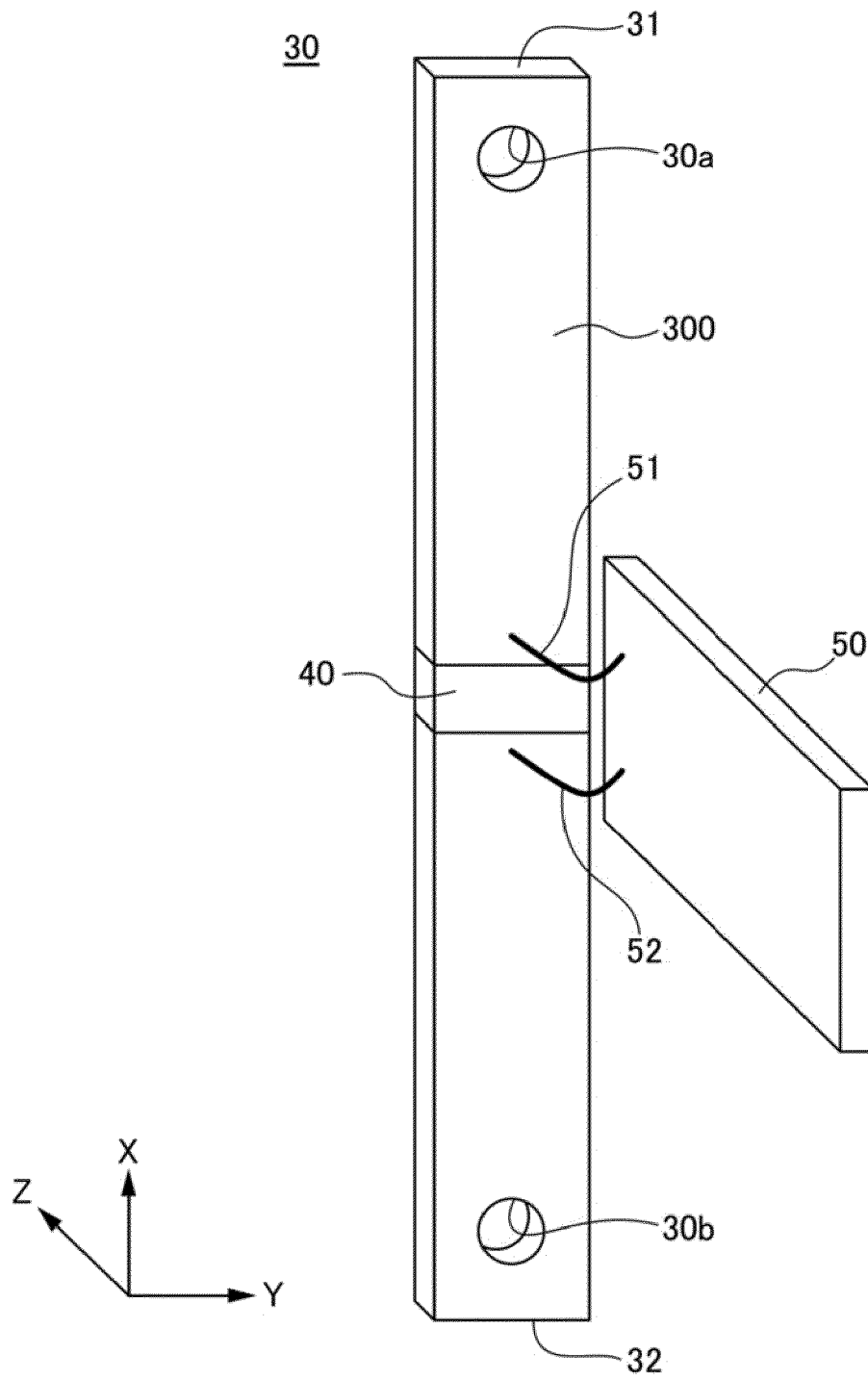
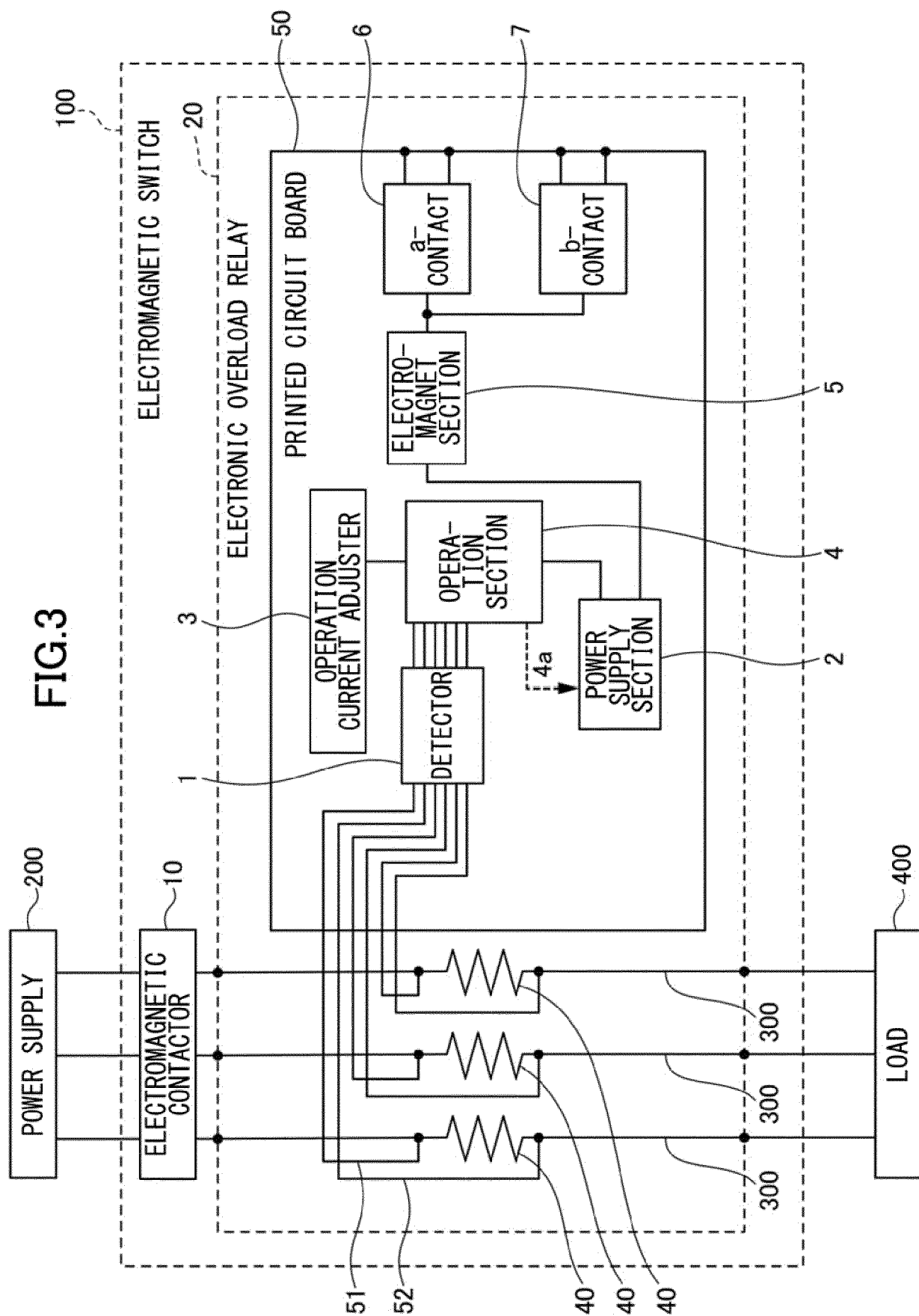


FIG. 3



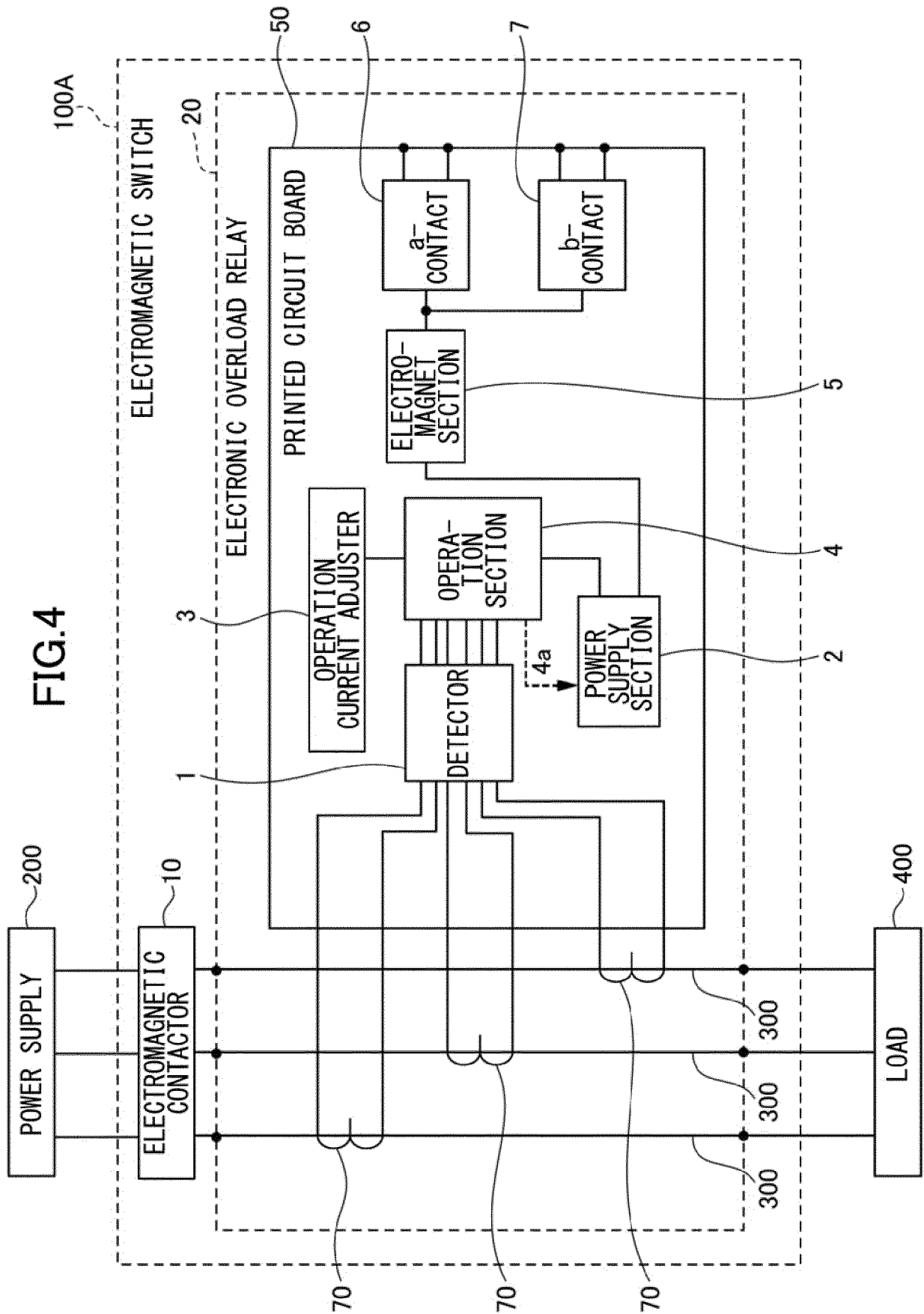


FIG.5

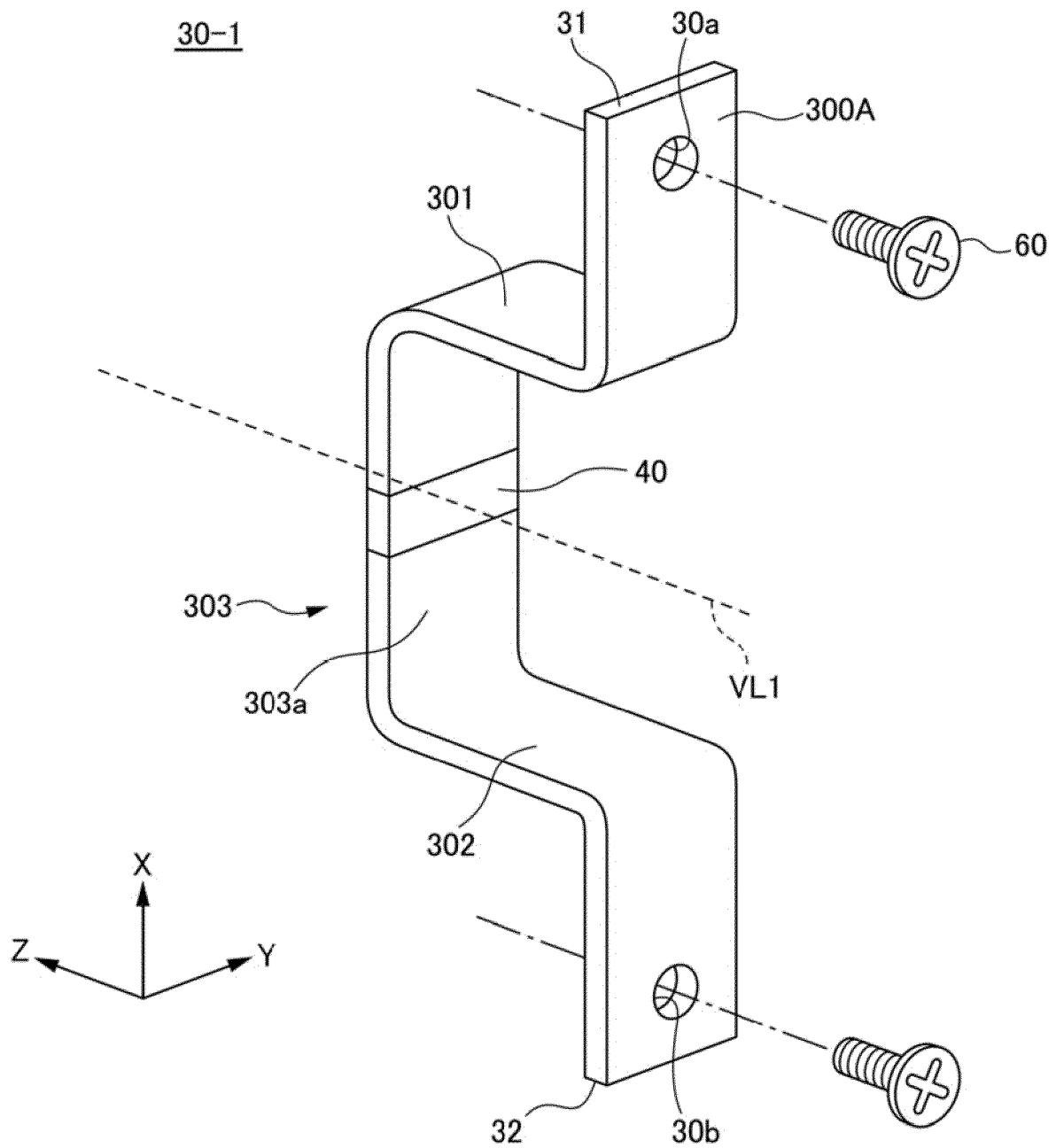


FIG.6

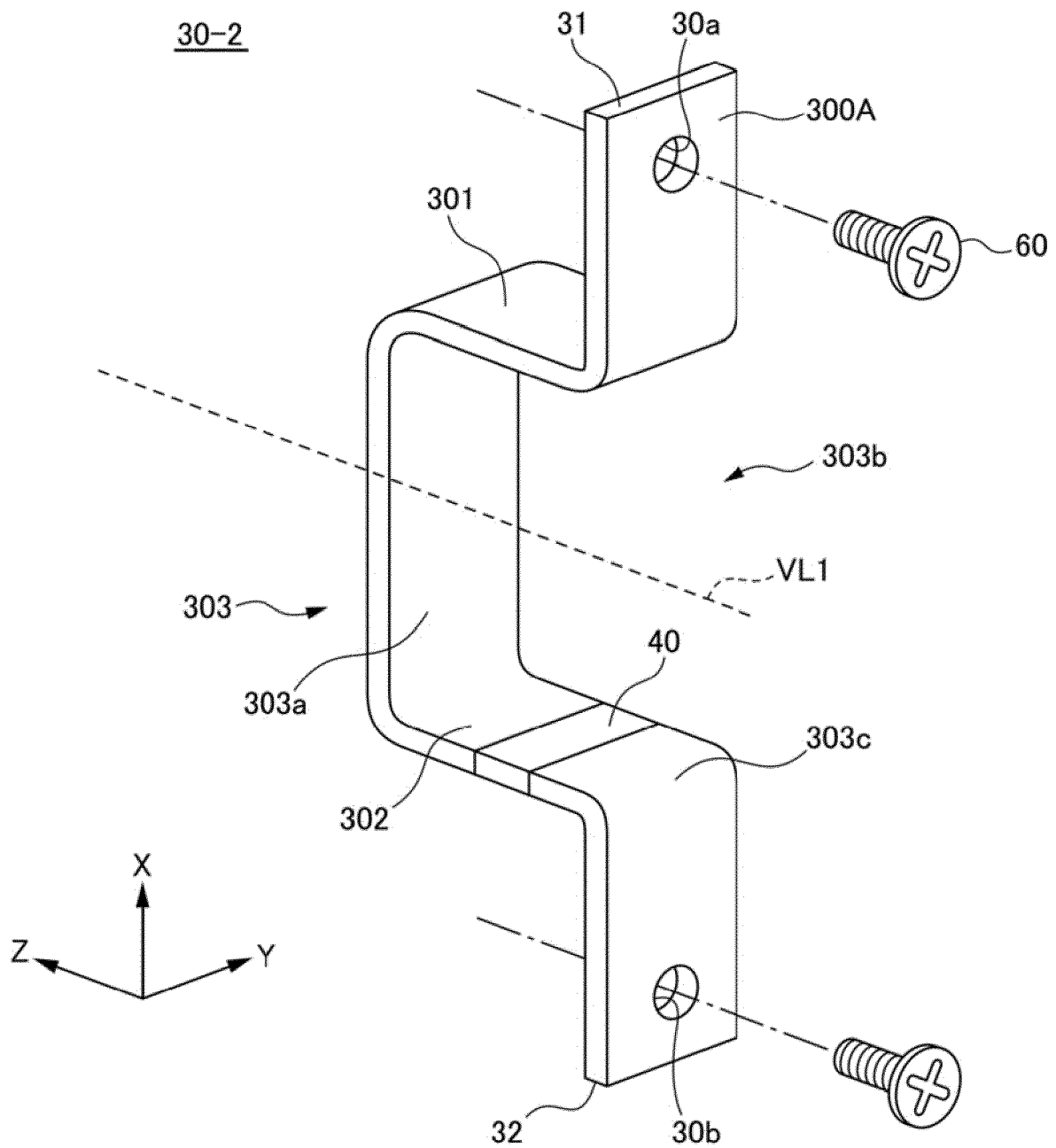


FIG.7

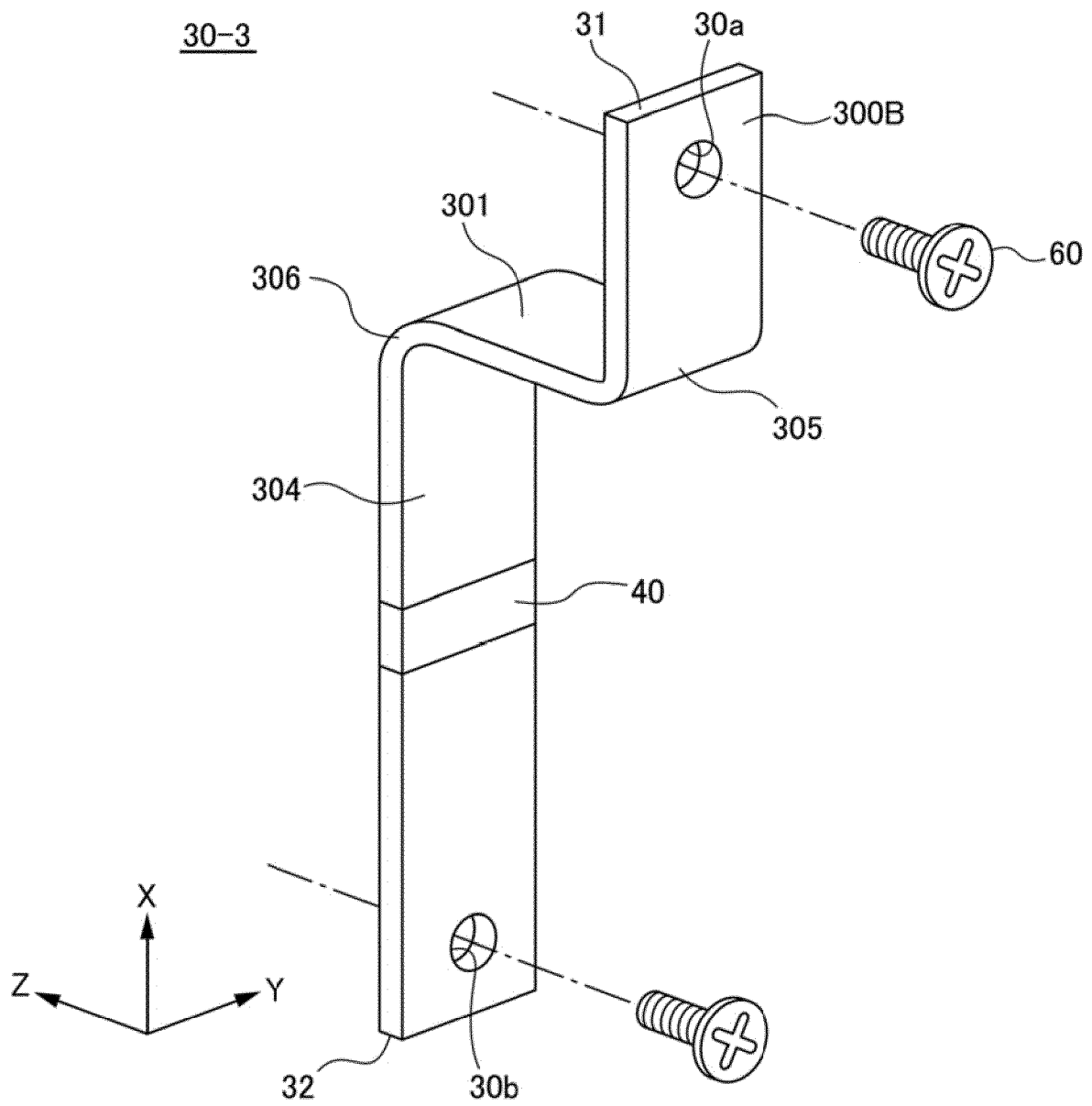


FIG.8

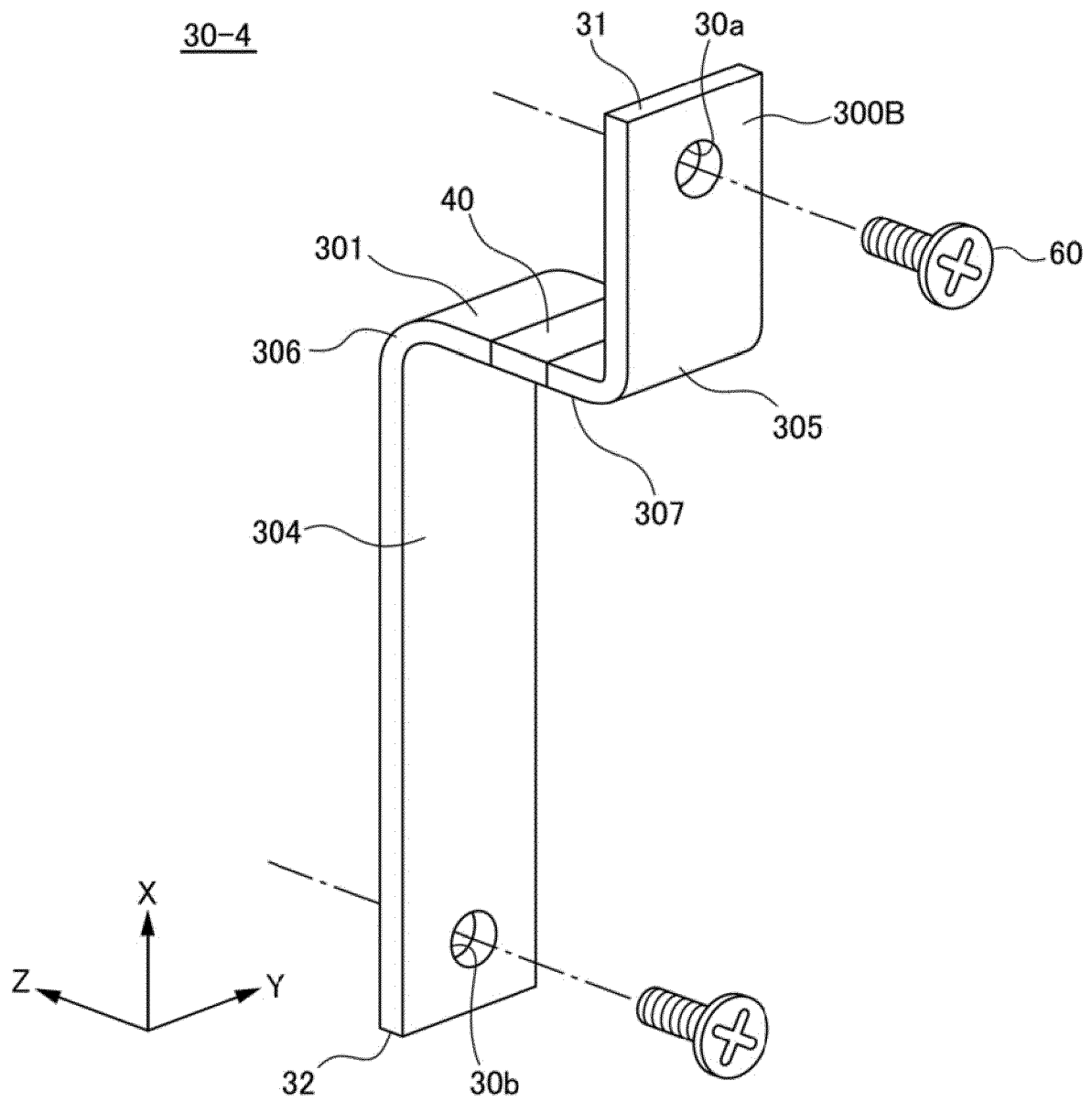


FIG.9

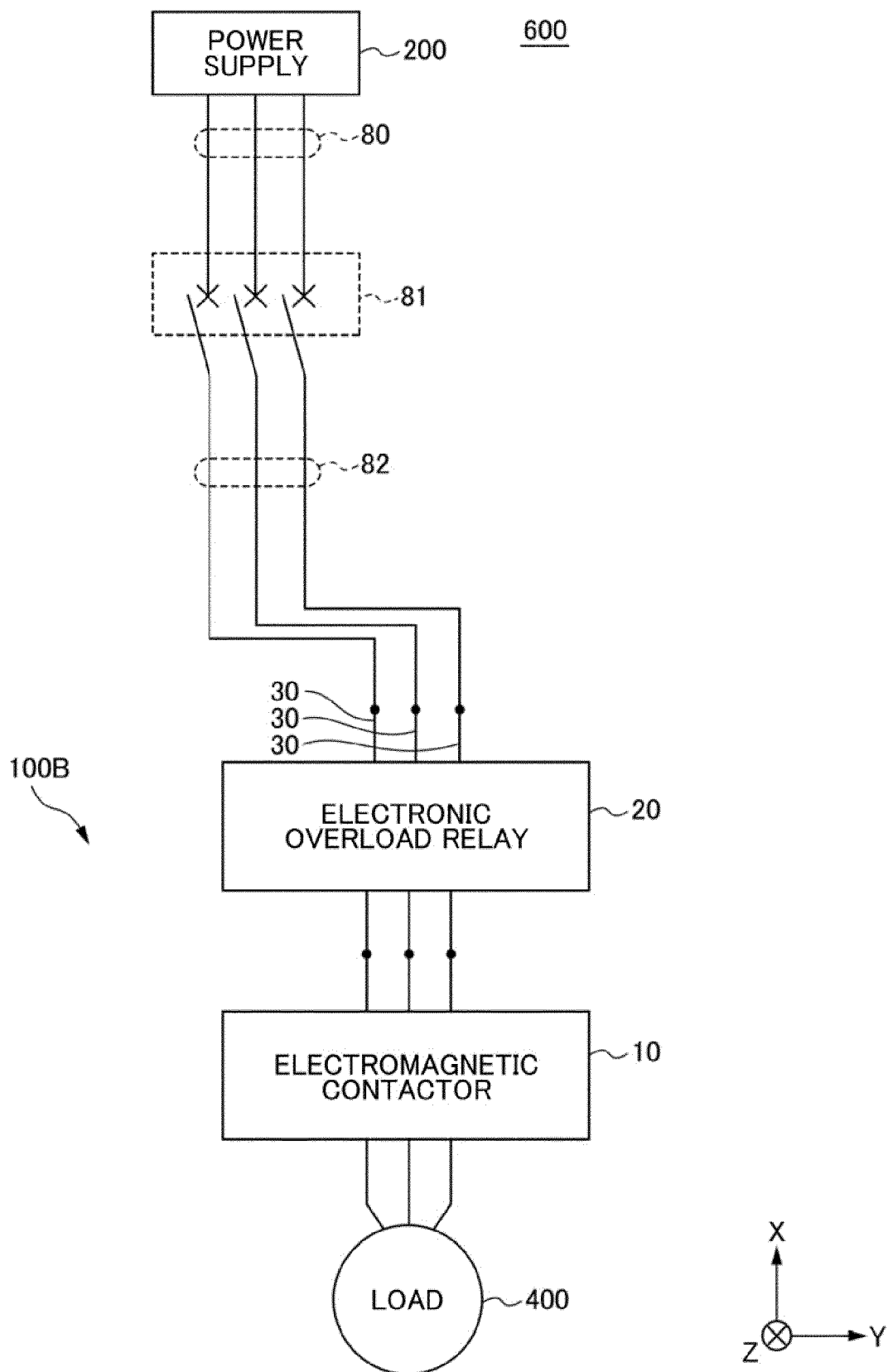


FIG.10

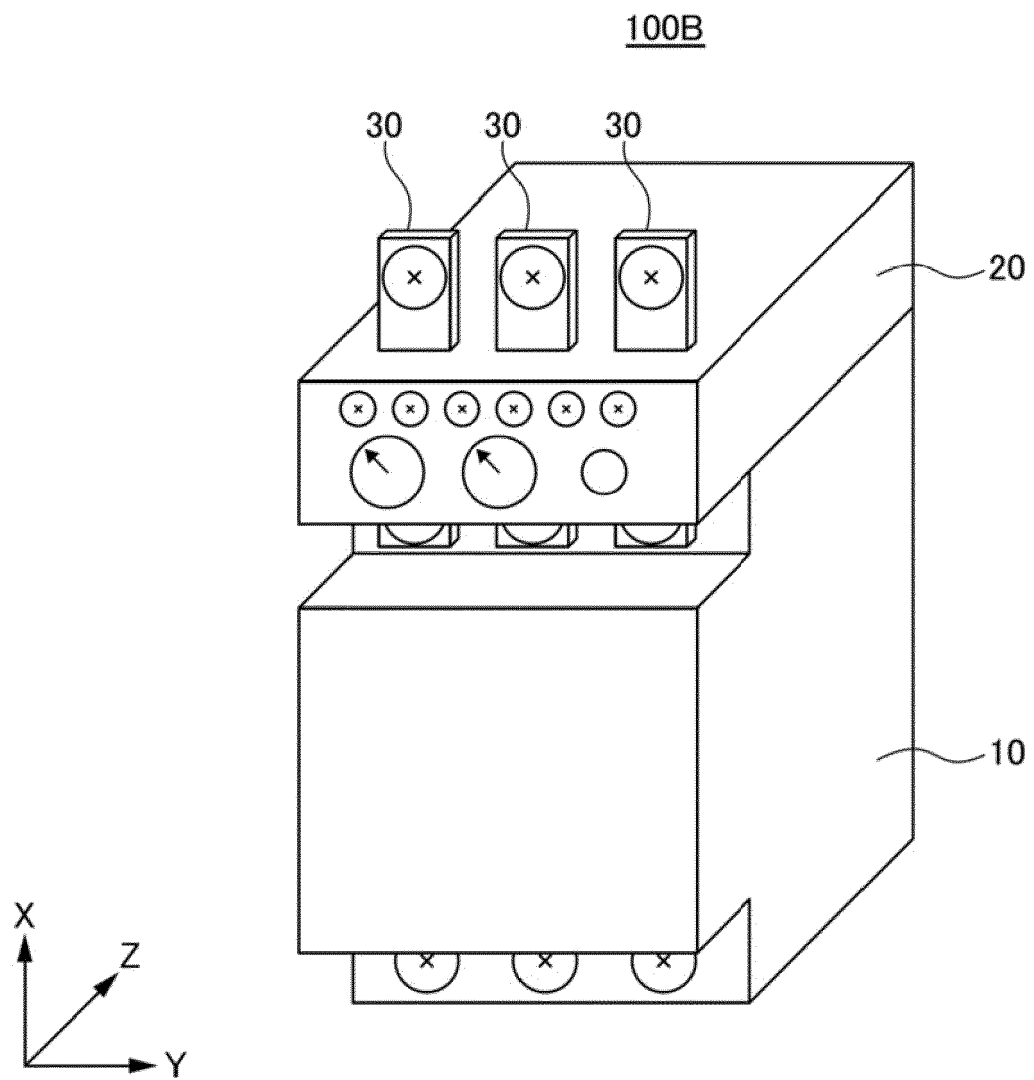


FIG.11A

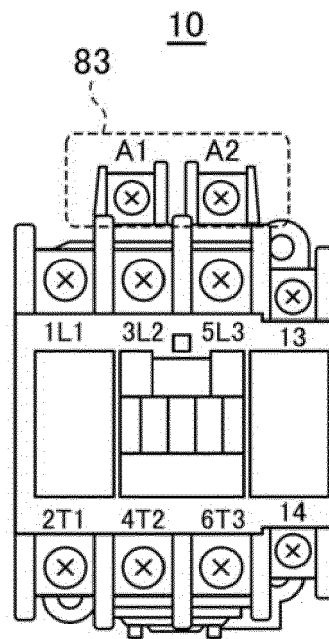
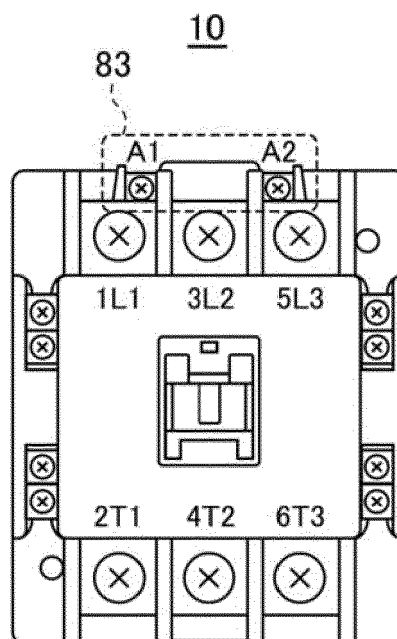


FIG.11B





EUROPEAN SEARCH REPORT

Application Number
EP 20 19 3409

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 2 462 421 A (DEEPSTREAM TECHNOLOGIES LTD [GB]) 10 February 2010 (2010-02-10)	1,9	INV. H01H71/02
Y	* abstract; figures 1,2 *	2,3,6	
A	-----	4,5,7,8	
X	US 4 346 424 A (HANSEN JAMES E) 24 August 1982 (1982-08-24) * abstract; figure 1 *	1	
X	DE 10 2006 025607 A1 (FRIEDRICH LUETZE GMBH & CO KG [DE]) 29 November 2007 (2007-11-29) * paragraph [0040]; figure 1 *	1	TECHNICAL FIELDS SEARCHED (IPC) H01H H02H
Y	DE 195 16 723 A1 (KLOECKNER MOELLER GMBH [DE]) 14 November 1996 (1996-11-14) * claim 1; figures 5,6 *	2,3,6	

The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 January 2021	Examiner Simonini, Stefano
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 19 3409

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-01-2021

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2462421	A	10-02-2010	AU 2009278984 A1	11-02-2010
			CN 102171904 A	31-08-2011
			EP 2319149 A1	11-05-2011
			GB 2462421 A	10-02-2010
			IL 211013 A	30-09-2014
			PL 2319149 T3	29-06-2020
			RU 2011108297 A	10-09-2012
			US 2012092797 A1	19-04-2012
			WO 2010015811 A1	11-02-2010

US 4346424	A	24-08-1982	NONE	

DE 102006025607 A1		29-11-2007	DE 102006025607 A1	29-11-2007
			DK 2020074 T3	30-07-2012
			EP 2020074 A2	04-02-2009
			ES 2386648 T3	24-08-2012
			PL 2020074 T3	30-11-2012
			WO 2007134767 A2	29-11-2007

DE 19516723	A1	14-11-1996	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2005139333 A1 [0002]
- JP 4738530 B [0002]
- JP 2006332001 A [0044]