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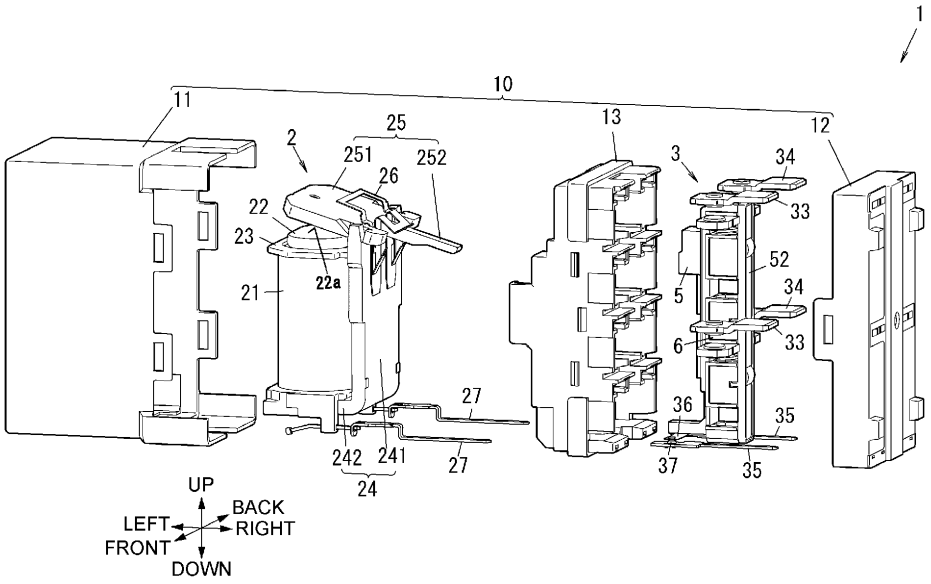
(54) ELECTROMAGNET DEVICE AND ELECTROMAGNETIC RELAY

(57) An electromagnet device includes: a coil; an iron core extending along a central axis of the coil and being disposed inside the coil; a coil bobbin on which the coil is wound; a yoke held on the coil bobbin and including a portion extending along the central axis of the coil; an armature coupled to the yoke and configured to come into contact with or move apart from an upper surface of the iron core; and a spring configured to cause the armature in contact with the upper surface of the iron core to move apart from the upper surface of the iron core. The spring includes: a first arm portion contacting the yoke and extending along the central axis of the coil; a second arm portion contacting the armature and extending from an upper end of the first arm portion to be directed away from the iron core; and a protruding portion protruding from at least one of the first arm portion and the second arm portion so as to be at least partially positioned above an upper surface of the armature.

FIG. 1



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Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to electromagnet devices and electromagnetic relays and more particularly relates to an electromagnet device including an armature and a spring and also relates to an electromagnetic relay including the electromagnet device.

2. Description of the Related Art

[0002] Patent Literature (PTL) 1 discloses one example of an electromagnetic relay including an electromagnet device that drives an armature.

[0003] The electromagnet device disclosed in PTL 1 includes a coil, an iron core, a yoke, an armature, and a hinge spring. The hinge spring is formed in the shape of a rectangle as viewed from the front and in the shape of the inverted letter "L" as viewed from the side and is disposed so as to contact the yoke and bias the armature.

Citation List

Patent Literature

[0004] PTL 1: Japanese Patent No. 6433706

SUMMARY

[0005] With the conventional hinge spring, for example, when the electromagnetic relay falls, the electromagnetic relay may deform and malfunction due to unintended movement of the armature.

[0006] An object of the present disclosure is to provide an electromagnet device and an electromagnetic relay in which a spring is less likely to deform even in the event of a fall or the like.

[0007] An electromagnet device according to one aspect of the present disclosure includes: a coil; an iron core extending along a central axis of the coil and being disposed inside the coil; a coil bobbin on which the coil is wound; a yoke held on the coil bobbin and including a portion extending along the central axis of the coil; an armature coupled to the yoke and configured to come into contact with or move apart from an upper surface of the iron core; and a spring configured to cause the armature in contact with the upper surface of the iron core to move apart from the upper surface of the iron core, wherein the spring includes: a first arm portion contacting the yoke and extending along the central axis of the coil; a second arm portion contacting the armature and extending from an upper end of the first arm portion to be directed away from the iron core; and a protruding portion protruding from at least one of the first arm portion or the second arm portion so as to be at least partially positioned above an upper surface of the armature.

[0008] An electromagnetic relay according to one aspect of the present disclosure includes: the electromagnet device; a first fixed contact; and a movable contactor including a first movable contact configured to come into contact with or move apart from the first fixed contact. The movable contactor causes the first movable contact to come into contact with or move apart from the first fixed contact according to movement of the armature.

[0009] In the electromagnet device and the electromagnetic relay according to the present disclosure, the spring is less likely to deform even in the event of a fall or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is an exploded perspective view of an electromagnetic relay according to an exemplary embodiment;
Fig. 2 is a side cross-sectional view of the electromagnetic relay;
Fig. 3 is a perspective view of the electromagnetic relay;
Fig. 4 is a perspective view of a spring of an electromagnet device included in the electromagnetic relay;
Fig. 5 is a perspective view of main components of the electromagnetic relay when an armature is separate from the upper surface of an iron core;
Fig. 6 is a perspective view of the main components of the electromagnetic relay when the armature is in contact with the upper surface of the iron core;
Fig. 7 is a side view of the main components of the electromagnetic relay when the armature is in contact with the upper surface of the iron core;
Fig. 8 is an enlarged view of a spring portion in a cross-sectional view of main components of the electromagnetic relay;
Fig. 9 is a top view of main components of the electromagnetic relay;
Fig. 10 is a perspective view of a spring included in an electromagnetic relay according to Variation 1;
Fig. 11 is a perspective view of main components of the electromagnetic relay when an armature is separate from the upper surface of an iron core;
Fig. 12 is a top view of main components of the electromagnetic relay;
Fig. 13 is an exploded perspective view of an electromagnetic relay according to Variation 2;
Fig. 14 is a cross-sectional view of the electromagnetic relay;
Fig. 15 is a perspective view of the electromagnetic relay;
Fig. 16 is a perspective view of a spring included in the electromagnetic relay;
Fig. 17 is a perspective view of main components of the electromagnetic relay when an armature is sep-

arate from the upper surface of an iron core;

Fig. 18 is a top view of main components of the electromagnetic relay;

Fig. 19 is a perspective view of a spring included in an electromagnetic relay according to Variation 3; and

Fig. 20 is a perspective view of main components of the electromagnetic relay when an armature is separate from the upper surface of an iron core.

DETAILED DESCRIPTIONS

(1) Exemplary Embodiment

[0011] Hereinafter, an electromagnet device and an electromagnetic relay according to an exemplary embodiment will be described with reference to the drawings. Note that the following exemplary embodiment is merely one of various exemplary embodiments of the present disclosure. Various changes can be made to the following exemplary embodiment according to the design or the like as long as the object of the present disclosure can be achieved. Furthermore, each figure described in the following exemplary embodiment is a schematic diagram, meaning that the ratio between the sizes of structural elements in each figure and the ratio between the thicknesses of structural elements in each figure do not necessarily reflect an actual dimension ratio.

[0012] Electromagnetic relay 1 according to the present exemplary embodiment is mounted on an electric vehicle and connected to an electrical circuit that connects a load and a battery for travel of the electric vehicle, for example. According to a control signal from an electronic control unit (ECU) of the electric vehicle, for example, electromagnetic relay 1 enables or disables the electrical connection between the load and the battery for travel and thus switches the state of direct-current power feeding from the battery for travel to the load.

[0013] As illustrated in Fig. 1 and Fig. 2, electromagnetic relay 1 according to the present exemplary embodiment includes electromagnet device 2, contact device 3, first cover 11, second cover 12, and intermediate case 13. Electromagnet device 2 drives contact device 3 by an electromagnetic force. First cover 11 combined with second cover 12 houses electromagnet device 2 and contact device 3. Intermediate case 13 houses contact device 3. First cover 11, second cover 12, and intermediate case 13 constitute housing 10 which holds (in this case, houses) electromagnet device 2 and contact device 3.

[0014] In the following description, for the sake of convenience, the direction in which iron core 2 of electromagnet device 2 extends is defined as the vertical direction, an area on the armature 25 (first portion 251) side as viewed from iron core 22 is defined as up/top, and an area on the iron core 22 side as viewed from armature 25 (first portion 251) is defined as low/bottom. The direction in which electromagnet device 2 and contact device 3 are arranged is defined as the horizontal direction, an area on the contact device 3 side as viewed from electromagnet device 2 is defined as right, and an area on the electromagnet device 2 side as viewed from contact device 3 is defined as left. The direction in which a pair of fixed contacts 31, 32 of contact device 3 are arranged is defined as the depth direction, an area on the fixed contact 31 side as viewed from fixed contact 32 is defined as front, and an area on the fixed contact 32 side as viewed from fixed contact 31 is defined as back.

[0015] First, electromagnet device 2 according to the present exemplary embodiment will be described with reference to the drawings.

[0016] As illustrated in Fig. 1, electromagnet device 2 includes coil 21, iron core 22, coil bobbin 23, yoke 24, armature 25, spring 26, and two coil terminals 27.

[0017] Coil 21 is a conducting wire wound on coil bobbin 23. The shape of coil bobbin 23 is the form of a cylinder. Iron core 22 extends along the central axis of coil 21 (vertically) and is disposed inside coil 21. A portion of iron core 22 is inserted into coil bobbin 23.

[0018] Yoke 24 includes portion (first portion) 241 extending along the central axis of coil 21. First portion 241 is in the form of a vertically extending plate. Yoke 24 further includes second portion 242 extending from one end (the lower end) of first portion 241 at a substantially right angle (to the left). Yoke 24 is in the approximate shape of the letter "L". Yoke 24 is held on coil bobbin 23. Yoke 24 forms a part of a magnetic circuit through which the magnetic flux produced at coil 21 passes.

[0019] Armature 25 is coupled to yoke 24 and comes into contact with or moves apart from upper surface 22a of iron core 22. More specifically, armature 25 is coupled to (the upper end of) first portion 241 of yoke 24. Armature 25 includes: first portion 251 which is an armature body; and second portion 252 which is a card part. First portion 251 of armature 25 is in the form of a plate. First portion 251 is disposed at a position opposite to upper surface 22a of iron core 22. Second portion 252 of armature 25 is in the form of a rod. Second portion 252 protrudes from first portion 251 toward contact device 3. More specifically, second portion 252 protrudes toward contact device 3 from the depthwise center of the right side surface of first portion 251. Armature 25 is supported on yoke 24 and can rotate about a section thereof supported on yoke 24.

[0020] Spring 26 is configured so as to cause armature 25 in contact with upper surface 22a of iron core 22 to move apart from upper surface 22a of iron core 22. Spring 26 is attached to span between armature 25 and yoke 24.

[0021] Two coil terminals 27 are electrically connected to coil 21. Two coil terminals 27 pass through through-holes formed in second cover 12 and extend to the outside of second cover 12 (refer to Fig. 3).

[0022] In the state where coil 21 is not energized, armature 25 maintains the posture of first portion 251 being separate from iron core 22 by the elastic force of spring 26 (refer to Fig. 2 and Fig. 5). Hereinafter, this posture

of armature 25 will be referred to as "the first posture". In the state where armature 25 has the first posture, contact device 3 is in an open state. The open state refers to a state where the pair of fixed contacts 31, 32 and the pair of movable contacts 41, 42 of movable contactor 4 are separate from each other and no electric power is supplied to the load. The position of movable contactor 4 when contact device 3 is in the open state will be referred to as an open position.

[0023] When coil 21 is energized through two coil terminals 27, armature 25 is rotated by an electromagnetic attractive force generated between armature 25 and iron core 22, and armature 25 comes into contact with iron core 22 (refer to Fig. 6 and Fig. 7). Specifically, first portion 251 of armature 25 comes into contact with iron core 22. At this time, along with the rotation of armature 25, spring 26 deforms elastically. Hereinafter, this posture of armature 25 will be referred to as "the second posture".

[0024] The rotational force of armature 25 acts on moving body 5, which will be described later, of contact device 3 and causes moving body 5 to move (upward). With this, contact device 3 transitions from the open state into a closed state. The closed state refers to a state where the pair of fixed contacts 31, 32 and the pair of movable contacts 41, 42 of movable contactor 4 are in contact and electric power is supplied to the load via the pair of fixed contacts 31, 32. The position of movable contactor 4 when contact device 3 is in the closed state will be referred to as a closed position.

[0025] When the state where coil 21 is energized transitions into the state where coil 21 is not energized, the magnetic attractive force generated between armature 25 and iron core 22 is lost, and armature 25 is rotated by the elastic force of spring 26 so as to move apart from iron core 22. Thus, armature 25 assumes the first posture (refer to Fig. 2 and Fig. 5). Furthermore, the rotational force of armature 25 acts on moving body 5 of contact device 3 and causes moving body 5 to move in the direction (downward) opposite to the aforementioned direction. Thus, movable contactor 4 of contact device 3 moves from the closed position to the open position, and contact device 3 transitions from the closed position to the open position. In other words, the state of contact device 3 changes between the open state and the closed state according to whether coil 21 is energized.

[0026] Spring 26 is formed, for example, by cutting and bending one metal plate.

[0027] As illustrated in Fig. 4, spring 26 includes first arm portion 261, second arm portion 262, third arm portion 263, and protruding portions 264. Spring 26 includes two protruding portions 264. A vertically extending flat plate-shaped portion of spring 26 is first arm portion 261. A portion extending in a curve at an acute angle from the upper end of first arm portion 261 that is located inward in the width direction thereof is second arm portion 262. A portion substantially perpendicularly extending in a curve from positions on the upper end of first arm portion 261 that are located outside in the width direction thereof is third arm portion 363. Two portions located in areas near the lower ends of third arm portion 263 that are located outside in the width direction thereof and protruding outward in the width direction (to the front and the back) are protruding portions 264.

[0028] As illustrated in Fig. 4, first arm portion 261 includes two hook portions 261a and one void portion 261b.

[0029] Void portion 261b is a slit formed at the depthwise center of first arm portion 261 and extending across the entire vertical length of first arm portion 261. First arm portion 261 is divided by void portion 261b into two portions that are a first portion in the shape of a plate located at the front and a second portion in the shape of a plate located at the back.

[0030] Hook portion 261a is formed by cutting and raising a portion of a flat plate-shaped member included in first arm portion 261. Hook portion 261a extends diagonally upward to the right from the base of the cut and raised portion. Two hook portions 261a are formed, one each on the first portion and the second portion.

[0031] In each of the first portion and the second portion of first arm portion 261, notch 261c extending downward from the upper end of first arm portion 261 is formed further out from the depthwise center.

[0032] As illustrated in Fig. 5, first arm portion 261 is in contact with (first portion 241 of) yoke 24 and extends along the central axis of coil 21.

[0033] As illustrated in Fig. 5, second arm portion 262 is in contact with armature 25 and extends from the upper end of first arm portion 261 so as to be directed away from iron core 22.

[0034] As illustrated in Fig. 4, second arm portion 262 extends diagonally downward to the right from the upper end of first arm portion 261. Second arm portion 262 extends from a portion of the upper end of first arm portion 261 that is further inward than notches 261c.

[0035] Second arm portion 262 contacts (second portion 252) of armature 25 as illustrated in Fig. 5 and thereby applies, to armature 25, a force acting in a direction in which armature 25 moves apart from upper surface 22a of iron core 22. In other words, second arm portion 262 applies, to armature 25, a force acting in a direction in which armature 25 is rotated from the second posture (refer to Fig. 6) to the first posture (refer to Fig. 5).

[0036] Second arm portion 262 includes void portion 262a. Void portion 262a is a cutout formed at the depthwise center of the left end of second arm portion 262 (the boundary between first arm portion 261 and second arm portion 262). With void portion 262a, second arm portion 262 is in the shape of the letter "C" as viewed from the top. Void portion 262a of second arm portion 262 is connected to void portion 261b of first arm portion 261.

[0037] As illustrated in Fig. 5, third arm portion 263 is located above upper surface 25a of armature 25 and extends from the upper end of first arm portion 261 in the direction opposite to the direction in which second arm portion 262 extends. Third arm portion 263 does not contact and is separate from upper surface 25a of armature

25.

[0038] As illustrated in Fig. 4, third arm portion 263 extends diagonally upward to the left from the upper end of first arm portion 261. Third arm portion 263 is in the shape of the letter "C" as viewed from the top. Third arm portion 263 extends from a portion of the upper end of first arm portion 261 that is located further out from notches 261c.

[0039] Third arm portion 263 is mainly used to hold the coupling between armature 25 and yoke 24. With third arm portion 263, even when armature 25 is lifted up from yoke 24, armature 25 can be kept from being lifted from yoke 24 to an excessive height.

[0040] Third arm portion 263 includes bent portion 2630 at a position connected to first arm portion 261. Bent portion 2630 is in the approximate shape of the letter "L" as viewed from the front. Bent portion 2630 includes: first portion 263a extending along upper surface 25a of armature 25; and second portion 263b extending upward from first portion 263a. Thus, third arm portion 263 includes, at a position above upper surface 25a of armature 25a, a portion (second portion 263b) extending in a direction crossing (substantially orthogonal to) upper surface 25a of armature 25.

[0041] As illustrated in Fig. 5, second portion 252 of armature 25 is disposed in void portion 261b of first arm portion 261 in spring 26.

[0042] As illustrated in Fig. 4, protruding portion 264 protrudes in a direction (the width direction; the depth direction) crossing the direction in which first arm portion 261 extends. Protruding portion 264 protrudes in a direction substantially orthogonal to the direction in which first arm portion 261 extends. Protruding portion 264 is located above upper surface 25a of armature 25. Protruding portion 264 is provided on third arm portion 263. Protruding portion 264 is provided on third arm portion 263, in an area near the boundary between first arm portion 261 and third arm portion 263.

[0043] Protruding portion 264 includes: first section 264a extending along upper surface 25a of armature 25; and second section 264b extending upward from first section 264a. In protruding portion 264, a horizontally extending portion is first section 264a, and a vertically extending portion is second section 264b. First section 264a faces upper surface 25a of armature 25. Second section 264b extends so as to cross (be substantially orthogonal to) upper surface 25a of armature 25.

[0044] In this example, first section 264a is provided on first portion 263a of bent portion 2630 of third arm portion 263 and protrudes from first portion 263a in the depth direction. Second section 264b is provided on second portion 263b of bent portion 2630 of third arm portion 263 and protrudes from second portion 263b in the depth direction.

[0045] As illustrated in Fig. 8, spring 26 is fixed in place between yoke 24 and bottom wall portion 131 of intermediate case 13 when hook portion 261a of first arm portion 261 comes into contact with recess 132 formed in the left side of bottom wall portion 131 of intermediate case 13. Furthermore, as a result of hook portion 261a coming into contact with recess 132 (particularly, the upper inner side surface of recess 132) of bottom wall portion 131 of intermediate case 13, spring 26 is prevented from moving upward.

[0046] Advantageous effects of protruding portion 264 will be described in comparison with the conventional electromagnetic relay. In the conventional electromagnetic relay, the spring does not include the protruding portion, as compared to electromagnetic relay 1 according to the exemplary embodiment. Furthermore, in the conventional electromagnetic relay, the third arm portion of the spring does not include the bent portion, as compared to electromagnetic relay 1 according to the exemplary embodiment. Note that in both electromagnetic relay 1 according to the exemplary embodiment and the conventional electromagnetic relay, armature 25 is coupled to yoke 24 by being pressed (down) against yoke 24 by the elastic force of second arm portion 262 of spring 26 in such a manner as to be able to rotate between the first posture and the second posture.

[0047] In the event of a fall or the like of the conventional electromagnetic relay, rapid upward movement of armature 25 may occur due to, for example, impact of the fall. When armature 25 moves rapidly upward, a large force may be exerted on a portion of the spring that is in contact with armature 25 (particularly, the second arm portion that contacts the second portion 252 of armature 25), and the spring (the second arm portion) may deform. If the spring (the second arm portion) deforms significantly, for example, if the spring (the second arm portion) deforms until the first arm portion and the second arm portion form an obtuse angle, the spring (the second arm portion) may become unable to apply a sufficient force (a force acting in a direction in which armature 25 is rotated from the second posture to the first posture) to armature 25.

[0048] In contrast, as illustrated in Fig. 5 and Fig. 9, in electromagnetic relay 1 according to the exemplary embodiment, spring 26 includes protruding portion 264 which is located above upper surface 25a of armature 25. Furthermore, protruding portion 264 includes first section 264a extending along upper surface 25a of armature 25. With this, in the event of a fall or the like of electromagnetic relay 1, armature 25 that is moving upward comes into contact with protruding portion 264, in particular, first section 264a. In other words, the area of spring 26 of electromagnetic relay 1 according to the exemplary embodiment that can be in contact is larger than that of the spring of the conventional electromagnetic relay. In this manner, spring 26 is in contact with armature 25 across a large area, and thus the upward movement of armature 25 can be minimized, resulting in a reduction in the likelihood of deformation of spring 26 that occurs in the event of a fall or the like.

[0049] Furthermore, in electromagnetic relay 1 according to the exemplary embodiment, protruding portion 264

includes second section 264b extending upward. Protruding portion 264 including second section 264b is less likely to deform (warp) even under an upward force, as compared to the case where second section 264b is not included. In other words, protruding portion 264 including second section 264b has rigidity against a vertical force. This rigidity of second section 264b allows protruding portion 264 to, even when upper surface 25a of armature 25 comes into contact with protruding portion 264 from below, receive this force without deformation and can provide strength against warping of spring 26 that occurs in the event of a fall or the like of electromagnet device 1. As a result, it is possible to reduce the likelihood of deformation of spring 26 that occurs in the event of a fall or the like.

[0050] Furthermore, in electromagnet device 1 according to the exemplary embodiment, because third arm portion 263 includes bent portion 2630, third arm portion 263 has rigidity, and the upward movement of armature 25 can be easily inhibited by bent portion 2630. As a result, it is possible to reduce the likelihood of deformation of spring 26 that occurs in the event of a fall or the like.

[0051] Note that first section 264a is a section protruding from first portion 263a of bent portion 2630 of third arm portion 263 in the depth direction in electromagnetic relay 1 according to the exemplary embodiment, but this is not limiting. For example, a lower edge of second section 264b (a section protruding from second portion 263b of bent portion 2630 in the depth direction) may be the first section. This means that protruding portion 264 does not need to include the section protruding from first portion 263a of bent portion 2630 of third arm portion 263 in the depth direction.

[0052] Next, contact device 3 according to the present exemplary embodiment will be described.

[0053] As illustrated in Fig. 2, Fig. 5, and Fig. 6, contact device 3 includes the pair of fixed contacts 31, 32 and movable contactor 4. More specifically, contact device 3 includes more than one set (in the present exemplary embodiment, two sets) of fixed contact 31, fixed contact 32, and movable contactor 4.

[0054] Each of fixed contact 31 and fixed contact 32 includes: a shaft portion in the shape of a column; and a head portion in the shape of a disc provided at the tip of the shaft portion. In other words, each of fixed contacts 31, 32 is a rivet contact.

[0055] Contact device 3 further includes a pair of fixed terminals 33, 34. More specifically, contact device 3 includes more than one pair (in the present exemplary embodiment, two pairs) of fixed terminals 33, 34. The shape of each of fixed terminals 33, 34 is the form of a rectangular plate. Fixed contact 31 is fixed to fixed terminal 33. Fixed contact 32 is fixed to fixed terminal 34. A portion of each of fixed terminals 33, 34 passes through a through-hole formed in second cover 12 and protrudes to the outside of second cover 12 (refer to Fig. 3). A load is electrically connected to the pair of fixed terminals 33, 34. Contact device 3 switches the state of power feeding to the load between a feeding state and a non-feeding state by switching between the state where the pair of fixed terminals 33, 34 are electrically connected and the state where the pair of fixed terminals 33, 34 are electrically disconnected. Since contact device 3 includes two pairs of fixed terminals 33, 34, contact device 3 is connected to a maximum of two system loads and can switch the state of power feeding to each of the two system loads between the feeding state and the non-feeding state.

[0056] Each movable contactor 4 includes a pair of movable contacts 41, 42 and body portion 43. Each of movable contacts 41, 42 includes: a shaft portion in the shape of a column; and a head portion in the shape of a disc provided at the tip of the shaft portion. In other words, each of movable contacts 41, 42 is a rivet contact. The shape of body portion 43 is the form of a rectangular plate. The pair of movable contacts 41, 42 are fixed to body portion 43. More specifically, movable contact 41 is fixed near one end (the front end) of body portion 43 in the longitudinal direction, and movable contact 42 is fixed near the other end (the rear end) of body portion 43 in the longitudinal direction. The pair of movable contacts 41, 42 are in one-to-one correspondence with the pair of fixed contacts 31, 32. Each of movable contacts 41, 42 is provided at a position opposite a corresponding one of fixed contacts 31, 32.

[0057] Contact device 3 further includes moving body 5. Moving body 5 includes: more than one holder 6 (in the present exemplary embodiment, two holders 6; refer to Fig. 2); more than one spring portion 51 (in the present exemplary embodiment, two spring portions 51; refer to Fig. 2); and cover portion 52 (refer to Fig. 1 and Fig. 2).

[0058] Two or more holders 6 are arranged vertically. Two or more holders 6 are in one-to-one correspondence with two or more movable contactors 4. Each holder 6 holds a corresponding one of movable contactors 4. Thus, two or more movable contactors 4 are arranged along one axis (vertically).

[0059] Two or more holders 6 are in one-to-one correspondence with two or more spring portions 51. Each holder 6 holds a corresponding one of spring portions 51. Each spring portion 51 is, for example, a helical compression spring. Spring portion 51 exerts, on movable contactor 4, a force acting in one direction (upward) toward fixed contact 31 and fixed contact 32.

[0060] Holder 6 includes first section 61, second section 62, and coupling portion 63. The shape of first section 61 is the form of a box with a rightward, downward opening. The shape of second section 62 is the form of a box with a rightward, upward opening. First section 61 is located above second section 62. Specifically, first section 61 and second section 62 have the openings thereof facing each other. First section 61 and second section 62 are separated vertically and a space is formed therebetween. Coupling portion 63 couples first section 61 and second section 62 together in this space area. Coupling portion 63 is in the form of a vertically extending plate.

Coupling portion 63 is disposed on the left side of the space formed between first section 61 and second section 62. The front, back, and right sides of holder 6 are open with respect to the space formed between first section 61 and second section 62.

[0061] As illustrated in Fig. 2, movable contactor 4 and spring portion 51 are held between first section 61 and second section 62. Movable contactor 4 and spring portion 51 are disposed in the space formed between first section 61 and second section 62. More specifically, spring portion 51 is disposed between movable contactor 4 and bottom surface 62a of second section 62 which is in the form of a recess, and movable contactor 4 is disposed between first section 61 and spring portion 51. Both ends (the front and back ends to which movable contacts 41, 42 are fixed) of body portion 43 of movable contactor 4 in the longitudinal direction protrude to the outside (the front and the back) of the space formed between first section 61 and second section 62.

[0062] Cover portion 52 covers holders 6 from the right (refer to Fig. 2). With this, the right-hand side opening of first section 61, the right-hand side opening of second section 62, and the right side of the space formed between first section 61 and second section 62, out of each holder 6, are closed.

[0063] As described above, electromagnetic relay 1 further includes intermediate case 13. Intermediate case 13 houses contact device 3. Intermediate case 13 includes bottom wall portion 131. The shape of bottom wall portion 131 is the form of a rectangle in the horizontal direction. Bottom wall portion 131 is disposed between electromagnet device 2 and moving body 5. As described above, bottom wall portion 131 of intermediate case 13 includes, in the left surface (the surface facing yoke 24) recess 132 for hooking and securing hook portion 261a of first arm portion 261 of spring 26 (refer to Fig. 8). With this, spring 26 is fixed in place with respect to housing 10.

[0064] Moving body 5 includes recess 501 into which second portion 252 of armature 25 is inserted (refer to Fig. 2). When second portion 252 pushes the inner peripheral wall of recess 501 during the rotation of armature 25, the rotational force of armature 25 acts on moving body 5 from second portion 242, causing moving body 5 to move. Specifically, when second portion 252 pushes the upper inner side surface of recess 501 during the rotation of armature 25 from the first posture (refer to Fig. 2 and Fig. 5) to the second posture (refer to Fig. 6 and Fig. 7), moving body 5 moves upward. Conversely, when second portion 252 pushes the lower inner side surface of recess 501 during the rotation of armature 25 from the second posture to the first posture, moving body 5 moves downward.

[0065] As described above, each holder 6 holds a corresponding one of movable contactors 4. Therefore, movable contactors 4 move in conjunction with the movement of moving body 5. Specifically, each movable contactor 4 moves along one axis between the closed position and the open position. Here, one axis is a vertically extending virtual axis. This means that each holder 6 holds movable contactor 4 in such a manner that movable contactor 4 can move in one direction (vertically). When movable contactor 4 is at the closed position (refer to Fig. 6 and Fig. 7), movable contact 41 is in contact with fixed contact 31, and movable contact 42 is in contact with fixed contact 32. When movable contactor 4 is at the open position (refer to Fig. 2 and Fig. 5), movable contact 41 is separate from fixed contact 31, and movable contact 42 is separate from fixed contact 32.

[0066] Movable contactors 4 move at the same time in conjunction with the movement of moving body 5. When one movable contactor 4 is at the closed position, remaining one movable contact 4 is also at the closed position. When one movable contactor 4 is at the open position, remaining one movable contact 4 is also at the open position. When coil 21 (refer to Fig. 1) is not energized, movable contactors 4 are at the open positions. When coil 21 is energized, movable contactors 4 move to the closed positions.

[0067] Note that the distance between fixed contact 31 (fixed contact 32) and movable contact 41 (movable contact 42) when movable contactor 4 is at the open position is less than the distance moving body 5 moves in one direction (vertically) at the time of the transition of contact device 3 from the open state into the closed state. Specifically, during the rotation of armature 25 from the first posture to the second posture, moving body 5 is pushed by second portion 252 of armature 25 and moves upward while pressing movable contactor 4 via spring portion 51, and in the course of this movement, movable contact 41 comes into contact with fixed contact 31, and movable contact 42 comes into contact with fixed contact 32. Subsequently, moving body 5 is further pushed by second portion 252 of armature 25 and thus moves further upward while compressing spring portion 51 (over-travel). Therefore, in contact device 3, in the closed state, the contact pressure between movable contact 41 and fixed contact 31 and the contact pressure between movable contact 42 and fixed contact 32 can be secured by the elastic force of spring portion 51.

[0068] As illustrated in Fig. 1, Fig. 2, and Fig. 5 to Fig. 7, contact device 3 further includes auxiliary fixed contact 37, auxiliary movable contactor 36, and a pair of auxiliary terminals 35.

[0069] Auxiliary movable contactor 36 is formed of a metal plate made of copper or the like. Auxiliary movable contactor 36 is electrically conductive. Furthermore, auxiliary movable contactor 36 is elastic. The shape of auxiliary movable contactor 36 is the form of a strip.

[0070] Each of the pair of auxiliar terminals 35 is formed of a metal plate made of copper or the like. Each of the pair of auxiliar terminals 35 is electrically conductive. The pair of auxiliar terminals 35 have the same shape. The pair of auxiliary terminals 35 pass through through-holes formed in second cover 12 (refer to Fig. 1) and protrude to the outside of second cover 12 (refer to Fig. 3).

[0071] Moving body 5 includes pressing portion 53.

Pressing portion 53 is a protrusion formed in an area at the lower end of moving body 5 and protruding to the left. In the state where coil 21 (refer to Fig. 1) is not energized, pressing portion 53 is in contact with auxiliary movable contactor 36. Thus, auxiliary movable contactor 36 is in contact with auxiliary fixed contact 37 (refer to Fig. 5).

[0072] When coil 21 is energized, moving body 5 moves upward and thus, pressing portion 53 moves apart from auxiliary movable contactor 36 (refer to Fig. 7). Thus, auxiliary movable contactor 36 moves apart from auxiliary fixed contact 37 (refer to Fig. 6). When coil 21 returns to the non-energized state, moving body 5 moves down, and pressing portion 53 pushes auxiliary movable contactor 36. Thus, auxiliary movable contactor 36 comes into contact with auxiliary fixed contact 37.

[0073] In other words, in conjunction with the movement of movable contactor 4 between the closed position and the open position, auxiliary movable contactor 36 moves between a closed position at which auxiliary movable contactor 36 is in contact with auxiliary fixed contact 37 and an open position at which auxiliary movable contactor 36 is separate from auxiliary fixed contact 37. When movable contactor 4 is at the closed position, auxiliary movable contactor 36 is at the open position, and when movable contactor 4 is at the open position, auxiliary movable contactor 36 is at the closed position. Note that conversely, when movable contactor 4 is at the closed position, auxiliary movable contactor 36 may be at the closed position, and when movable contactor 4 is at the open position, auxiliary movable contactor 36 may be at the open position.

[0074] Auxiliary fixed contact 37, auxiliary movable contactor 36, and the pair of auxiliary terminals 35 are used, for example, to detect whether the pair of fixed contacts 31, 32 and the pair of movable contacts 41, 42 are welded together. Specifically, in the state where coil 21 is not energized, when an electric current flows between the pair of auxiliary terminals 35, it is determined that the pair of fixed contacts 31, 32 and the pair of movable contacts 41, 42 are not welded together. On the other hand, in the state where coil 21 is not energized, when an electric current does not flow between the pair of auxiliary terminals 35, it is determined that the pair of fixed contacts 31, 32 and the pair of movable contacts 41, 42 are welded together. In other words, in principle, when moving body 5 moves down to the original position, pressing portion 53 pushes auxiliary movable contactor 36, and thus auxiliary movable contactor 36 returns to the state of being in contact with auxiliary fixed contact 37. However, when the pair of fixed contacts 31, 32 and the pair of movable contacts 41, 42 are welded together, moving body 5 cannot move to the original position, and thus auxiliary movable contactor 36 remains separate from auxiliary fixed contact 37.

[0075] Note that in electromagnetic relay 1 according to the exemplary embodiment, the number of fixed contacts in contact device 3 is four (two pairs), and the number of movable contacts in contact device 3 is four (two pairs), but the number of fixed contacts and the number of movable contacts are not limited to these numbers and may be one, two, three, or four or more. Furthermore, in electromagnetic relay 1 according to the exemplary embodiment, the number of movable contactors 4 is two, but the number of movable contactors 4 is not limited to this number and may be one, two, or three or more.

[0076] In electromagnetic relay 1 including such electromagnet device 2 and contact device 3, the likelihood of deformation of spring 26 can be reduced.

(2) Variations

[0077] The above-described exemplary embodiment is merely one of various exemplary embodiments of the present disclosure. Various changes can be made to the above-described exemplary embodiment according to the design or the like as long as the object of the present disclosure can be achieved. Hereinafter, variations of the above-described exemplary embodiment will be listed. The variations described below can be applied in appropriate combinations.

(2. 1) Variation 1

[0078] In electromagnetic relay 1 according to the exemplary embodiment, in spring 26 including first arm portion 261, second arm portion 262, and third arm portion 263, protruding portion 264 is provided on third arm portion 263, but protruding portion 264 may be provided on first arm portion 261 or second arm portion 262. Hereinafter, electromagnetic relay 1 according to Variation 1 will be described with reference to Fig. 10 to Fig. 12. Note that structural elements that are the same as those in electromagnetic relay 1 according to the exemplary embodiment will be assigned the same reference signs and description thereof will be omitted, as appropriate.

[0079] As illustrated in Fig. 10, spring 26 according to the present variation includes first arm portion 261, second arm portion 262, and third arm portion 263, as with spring 26 according to the exemplary embodiment. In spring 26 according to the present variation, third arm portion 263 does not include bent portion 2630. Furthermore, in spring 26 according to the present variation, protruding portion 264 is provided on first arm portion 261 and second arm portion 262, unlike spring 26 according to the exemplary embodiment. More specifically, spring 26 includes two protruding portions 264 each in the shape of the letter "C" protruding inward from a curved portion at the boundary between first arm portion 261 and second arm portion 262 in a direction (the width direction) crossing a direction in which the first arm portion 261 extends. In other words, protruding portion 264 is provided so as to bridge between first arm portion 261 and second arm portion 262.

[0080] As illustrated in Fig. 11 and Fig. 12, in electromagnetic relay 1 according to the present variation, pro-

truding portion 264 of spring 26 is located above second portion 252 of armature 25.

[0081] As illustrated in Fig. 10 to Fig. 12, a lower side portion (a lower end surface) of the C-shaped portion of protruding portion 264 that extends along upper surface 25a of armature 25 is first section 264a, and a portion of protruding portion 264 that extends upward from first section 264a is second section 264b.

[0082] In electromagnetic relay 1 according to the present variation, spring 26 includes protruding portion 264 as well, and thus in the event of a fall or the like of electromagnetic relay 1, protruding portion 264 can receive armature 25, meaning that unexpected movement of armature 25 can be minimized using protruding portion 264 located above the upper surface of second portion 252 of armature 25, and as a result, the likelihood of deformation of spring 26 can be reduced.

(2.2) Variation 2

[0083] In electromagnetic relay 1 according to the exemplary embodiment, spring 26 is attached to electromagnetic relay 1 illustrated in Fig. 1; various forms or structures are applicable to electromagnetic relay 1 to which spring 26 is attached. Furthermore, in electromagnetic relay 1 according to the exemplary embodiment, spring 26 including first arm portion 261, second arm portion 262, and third arm portion 263 is used, but third arm portion 263 is not an essential element; spring 26 not including third arm portion 263, that is, spring 26 including first arm portion 261 and second arm portion 262, may be used.

[0084] Hereinafter, electromagnetic relay 1 according to Variation 2 will be described with reference to Fig. 13 to Fig. 18. Note that structural elements that are the same as those in electromagnetic relay 1 according to the exemplary embodiment will be assigned the same reference signs and description thereof will be omitted, as appropriate.

[0085] Electromagnetic relay 1 according to the present variation is different from electromagnetic relay 1 according to the exemplary embodiment mainly in that in electromagnet device 2, armature 25 and spring 26 have different structures. Furthermore, electromagnetic relay 1 according to the present variation is different from electromagnetic relay 1 according to the exemplary embodiment in that contact device 3 has a different structure. As illustrated in Fig. 13, electromagnetic relay 1 according to the present variation includes electromagnet device 2, contact device 3, cover 14, and base 15. Contact device 3 is disposed to the right of electromagnet device 2. Cover 14 combined with base 15 houses electromagnet device 2 and contact device 3. Cover 14 and base 15 constitute housing 10 which holds (in this case, houses) electromagnet device 2 and contact device 3.

[0086] As illustrated in Fig. 13, electromagnet device 2 includes coil 21, iron core 22, coil bobbin 23, yoke 24, armature 25, spring 26, and two coil terminals 27.

[0087] Armature 25 is formed into the approximate shape of the letter "L" with first portion 251 in the form of a plate and second portion 252 in the form of a plate crossing each other at a predetermined angle (an obtuse angle). First portion 251 of armature 25 is disposed at a position opposite to upper surface 22a of iron core 22. Armature 25 is disposed in such a manner that the left side of second portion 252 of armature 25 is located on the right side of yoke 24 (first portion 241). Armature 25 is supported on (coupled to) yoke 24 and can rotate about a section thereof supported on yoke 24.

[0088] In the state where coil 21 is not energized, armature 25 assumes a first posture in which first portion 251 is separate from iron core 22 (refer to Fig. 17). When coil 21 is energized through two coil terminals 27, armature 25 is rotated by an electromagnetic attractive force generated between armature 25 and iron core 22 so that first portion 251 moves downward, and thus armature 25 assumes a second posture in which (first portion 251 of) armature 25 is in contact with iron core 22.

[0089] Second portion 252 of armature 25 is joined to two movable contactors 4 of contact device 3 using joining body 500 made of a resin and having electrical insulating properties, for example.

[0090] Spring 26 is configured so as to cause armature 25 in contact with upper surface 22a of iron core 22 to move apart from upper surface 22a of iron core 22. Spring 26 is attached to span between armature 25 and yoke 24.

[0091] As illustrated in Fig. 16, spring 26 includes first arm portion 261, second arm portion 262, and protruding portion 264 in the present variation. A vertically extending flat plate-shaped portion of spring 26 is first arm portion 261. A portion substantially perpendicularly extending in a curve from positions on the upper end of first arm portion 261 that are located outside in the width direction thereof is second arm portion 262. Two portions located near the boundary between first arm portion 261 and second arm portion 262 and protruding outward in the width direction are protruding portions 264.

[0092] As illustrated in Fig. 16, first arm portion 261 includes one hook portion 261a and two notches 261c. Notches 261c extend downward from the upper end of first arm portion 261. Hook portion 261a is formed by cutting and raising a portion of a flat plate-shaped member included in first arm portion 261. Hook portion 261a extends diagonally upward to the right from the base of the cut and raised portion.

[0093] As illustrated in Fig. 13, in electromagnet device 2, first arm portion 261 of spring 26 is in contact with yoke 24 (first portion 241) and extends along the central axis of coil 21.

[0094] As illustrated in Fig. 14, second arm portion 262 is in contact with armature 25 and extends from the upper end of first arm portion 261 so as to be directed away from iron core 22.

[0095] As illustrated in Fig. 16, second arm portion 262 extends to the right from the upper end of first arm portion 261. Second arm portion 262 is in the shape of the letter

"C" as viewed from the top. Second arm portion 262 extends from a portion of the upper end of first arm portion 261 that is located further out from notches 261c. Furthermore, second arm portion 262 includes angled portion 262b which is bent downward to the right from a portion protruding to the right from first arm portion 261. When second arm portion 262 includes angled portion 262b, the force of second arm portion 262 of spring 26 that pushes armature 25 downward can be increased.

[0096] Protruding portion 264 is provided on first arm portion 261 and second arm portion 262. At the boundary between first arm portion 261 and second arm portion 262, protruding portion 264 protrudes in a direction (the depth direction) crossing a direction in which first arm portion 261 extends. In other words, protruding portion 264 is provided so as to bridge between first arm portion 261 and second arm portion 262. As illustrated in Fig. 18, protruding portion 264 is located above upper surface 25a of armature 25.

[0097] As illustrated in Fig. 16 and Fig. 17, protruding portion 264 includes: first section 264a extending along upper surface 25a of armature 25; and second section 264b extending upward from first section 264a. In protruding portion 264, a lower side portion (a lower end surface) of a portion provided on first arm portion 261 is first section 264a, and a portion extending upward along a lateral side (the front side or the back side) of first arm portion 261 is second section 264b. First section 264a faces upper surface 25a of armature 25. Second section 264b extends so as to cross (be substantially orthogonal to) upper surface 25a of armature 25.

[0098] Furthermore, protruding portion 264 includes third portion 264c provided on second arm portion 262. Third section 264c extends from the upper end of second section 264b along an outer lateral side (the front side or the back side) of second arm portion 262.

[0099] Spring 26 is fixed in place between yoke 24 and base 15 when hook portion 261a of first arm portion 261 comes into contact with recess 121 (refer to Fig. 14) formed in the left side of base 15. Furthermore, as a result of hook portion 261a coming into contact with recess 121 (particularly, the upper inner side surface of recess 121) of base 15, spring 26 is prevented from moving upward.

[0100] As is clear from Fig. 16 to Fig. 18, in spring 26 according to the present variation, the lower side portion (the lower end surface) of a portion of protruding portion 264 that protrudes outward in the width direction of first arm portion 261, as first section 264a, is located immediately above first portion 251 of armature 25 so as to face first portion 251 of armature 25. Thus, in the event of a fall or the like of electromagnetic relay 1, protruding portion 264 can stop unexpected movement of armature 25 at the minimum level, and as a result, the likelihood of deformation of spring 26 can be reduced.

[0101] Furthermore, because protruding portion 264 includes, as second section 264b, a portion extending upward along a lateral side (the front side or the back side) of first arm portion 261, protruding portion 264 can be given rigidity against an upward force and can also be given strength against warping of spring 26 that occurs in the event of a fall or the like of electromagnetic relay 1. As a result, it is possible to further reduce the likelihood of deformation of spring 26.

[0102] Contact device 3 included in electromagnetic relay 1 according to the present variation includes a pair of fixed contacts 31, 32, movable contactor 4, and joining body 500, as illustrated in Fig. 17. Contact device 3 includes more than one set (in the present variation, two sets) of fixed contact 31, fixed contact 32, and movable contactor 4. Furthermore, contact device 3 includes: fixed terminal 33 to which fixed contact 31 is fixed; and fixed terminal 34 to which fixed contact 32 is fixed. A portion of each of fixed terminals 33, 34 passes through a through-hole formed in base 15 and protrudes to the outside of base 15 (refer to Fig. 15).

[0103] Movable contactor 4 includes a pair of movable contacts 41, 42 and body portion 43. Body portion 43 is in the form of a plate having the shape of the inverted letter "U". The upper end of body portion 43 is joined to second portion 252 of armature 25 using joining body 500. Movable contact 41 and movable contact 42 are fixed to a pair of lower ends of body portion 43, respectively.

[0104] When coil 21 is not energized and armature 25 assumes the first posture (refer to Fig. 17), movable contact 41 and movable contact 42 of movable contactor 4 are separate from fixed contact 31 and fixed contact 32, respectively (the open position). When coil 21 is energized and armature 25 assumes the second posture, movable contact 41 and movable contact 42 of movable contactor 4 come into contact with fixed contact 31 and fixed contact 32, respectively (the closed position).

[0105] As illustrated in Fig. 17 and Fig. 18, contact device 3 further includes auxiliary fixed contact 37, auxiliary movable contactor 36, a pair of auxiliary terminals 35, and auxiliary card portion 510.

[0106] Each of the pair of auxiliary terminals 35 is formed of a metal plate made of copper or the like. The pair of fixed terminals 35 pass through through-holes formed in base 15 (refer to Fig. 13) and protrude to the outside of base 15 (refer to Fig. 15).

[0107] Auxiliary movable contactor 36 is electrically conductive. Furthermore, auxiliary movable contactor 36 is elastic. The shape of auxiliary movable contactor 36 is the form of a strip. Auxiliary movable contactor 36 is integrally formed with one (front auxiliary terminal 35) of the pair of auxiliary terminals 35.

[0108] Auxiliary card portion 510 is made of a resin and has electrical insulating properties, for example. Auxiliary card portion 510 is fixed to the left end of first portion 251 of armature 25. Auxiliary card portion 510 is located below auxiliary movable contactor 36. Auxiliary card portion 510 vertically moves in conjunction with the rotation of armature 25.

[0109] In the state where coil 21 is not energized, auxiliary card portion 510 is in contact with auxiliary movable

contactor 36 from below. At this time, auxiliary movable contactor 36 is in contact with auxiliary fixed contact 37 from below.

[0110] When coil 21 is energized, first portion 251 of armature 25 moves downward, and thus auxiliary card portion 510 moves apart from auxiliary movable contactor 36. Accordingly, auxiliary movable contactor 36 moves apart from auxiliary fixed contact 37 by the elastic force of auxiliary movable contactor 36. When coil 21 returns to the non-energized state, first portion 251 moves up, and auxiliary card portion 510 pushes auxiliary movable contactor 36. Thus, auxiliary movable contactor 36 comes into contact with auxiliary fixed contact 37.

(2. 3) Variation 3

[0111] In electromagnetic relay 1 according to Variation 2, spring 26 includes protruding portion 264 formed to span between first arm portion 261 and second arm portion 262, but the installation position of protruding portion 264 is not limited to this position; protruding portion 264 may be provided on first arm portion 261 only or may be provided on second arm portion 262 only.

[0112] Hereinafter, electromagnetic relay 1 according to Variation 3 will be described with reference to Fig. 19 and Fig. 20.

[0113] As illustrated in Fig. 20, electromagnetic relay 1 according to the present variation is different from electromagnetic relay 1 according to Variation 2 described above in that protruding portion 264 of spring 26 is provided at a different position and has a different shape.

[0114] As illustrated in Fig. 19, spring 26 includes first arm portion 261, second arm portion 262, and protruding portion 264 in the present variation. A vertically extending flat plate-shaped portion of spring 26 is first arm portion 261. A portion substantially perpendicularly extending in a curve from positions on the upper end of first arm portion 261 that are located inside in the width direction thereof is second arm portion 262. Two portions located outside in the width direction of first arm portion 261 in the form of a plate and protruding outward in the width direction are protruding portions 264.

[0115] First arm portion 261 includes one hook portion 261a, two notches 261c, and two gap portions 261d. Notches 261c extend downward from the upper end of first arm portion 261. Hook portion 261a is formed by cutting and raising a portion of a flat plate-shaped member included in first arm portion 261. Hook portion 261a extends diagonally upward to the right from the base of the cut and raised portion.

[0116] Gap portions 261d are formed at positions on the upper end of first arm portion 261 that are located further out in the width direction from positions at which notches 261c are formed. In other words, gap portions 261d are formed further out in the width direction of first arm portion 261 from a position at which second arm portion 262 extends on the upper end of first arm portion 261. It can be said that since protruding portion 264 is formed at a position on first arm portion 261 that is located outside in the width direction thereof, a gap (gap portion 261d) is formed between the upper end of first arm portion 261 (a portion from which second arm portion 262 extends) and protruding portion 264. With this, even when second arm portion 262 moves, protruding portion 264 can be prevented from moving.

[0117] As illustrated in Fig. 19 and Fig. 20, in electromagnet device 2, first arm portion 261 of spring 26 is in contact with yoke 24 and extends along the central axis of coil 21. Furthermore, second arm portion 262 is in contact with armature 25 and extends from the upper end of first arm portion 261 so as to be directed away from iron core 22.

[0118] Protruding portion 264 is provided on first arm portion 261. Protruding portion 264 protrudes, at a position on first arm portion 261 that is located outside in the width direction thereof, in a direction (the width direction) crossing a direction in which first arm portion 261 extends, and is located above upper surface 25a of armature 25. Protruding portion 264 includes: first section 264a extending along upper surface 25a of armature 25; and second section 264b extending upward from first section 264a. In protruding portion 264, a lower side portion (a lower end surface) of a portion provided on first arm portion 261 is first section 264a, and a portion provided on first arm portion 261 other than first section 264a (a portion extending upward along a lateral side of first arm portion 261) is second section 264b. First section 264a faces upper surface 25a of armature 25. Second section 264b extends so as to cross (be substantially orthogonal to) upper surface 25a of armature 25.

[0119] As is clear from Fig. 19 and Fig. 20, in spring 26 according to the present variation, the lower side portion (the lower end surface) of a portion of protruding portion 264 that protrudes outward in the width direction of first arm portion 261, as first section 264a, is located immediately above first portion 251 of armature 25 so as to face first portion 251 of armature 25. Thus, in the event of a fall or the like of electromagnetic relay 1, protruding portion 264 can stop unexpected movement of armature 25 at the minimum level, and as a result, the likelihood of deformation of spring 26 can be reduced.

[0120] Furthermore, because protruding portion 264 includes, as second section 264b, a portion protruding outward in the width direction of first arm portion 261 other than first section 264a, protruding portion 264 can be given rigidity against an upward force and can also be given strength against warping of spring 26 that occurs in the event of a fall or the like of electromagnetic relay 1. As a result, it is possible to further reduce the likelihood of deformation of spring 26.

[Summary]

[0121] According to the exemplary embodiment, etc., described above, the following aspects are disclosed.

[0122] An electromagnet device (2) according to the

first aspect includes a coil (21), an iron core (22), a coil bobbin (23), a yoke (24), an armature (25), and a spring (26). The iron core (22) extends along a central axis of the coil (21) and is disposed inside the coil (21). The coil (21) is wound on the coil bobbin (23). The yoke (24) includes a portion (241) extending along the central axis of the coil (21) and is held on the coil bobbin (23). The armature (25) is coupled to the yoke (24) and configured to come into contact with or move apart from an upper surface (22a) of the iron core (22). The spring (26) is configured to cause the armature (25) in contact with the upper surface (22a) of the iron core (22) to move apart from the upper surface (22a) of the iron core (22). The spring (26) includes a first arm portion (261), a second arm portion (262), and a protruding portion (264). The first arm portion (261) is in contact with the yoke (24) and extends along the central axis of the coil (21). The second arm portion (262) extends from an upper end of the first arm portion (261) to be directed away from the iron core (22). The protruding portion (264) protrudes from at least one of the first arm portion (261) or the second arm portion (262) so as to be at least partially positioned above an upper surface (25a) of the armature (25).

[0123] According to this aspect, the spring (26) includes the protruding portion (264), and this protruding portion (264) is located above the upper surface (25a) of the armature (25) and shaped to protrude in the width direction of the first arm portion (261); thus, even when the armature (25) unexpectedly moves due to a fall or the like of the electromagnetic relay (1) including the electromagnet device (2), the armature (25) comes into contact with the protruding portion (264), thus the movement can be minimized, and as a result, the likelihood of deformation of the spring (26) can be reduced.

[0124] In the electromagnet device (2) according to the second aspect, the spring (26) further includes a third arm portion (263) located above the upper surface (25a) of the armature (25) and extending from the upper end of the first arm portion (261) in a direction opposite to a direction in which the second arm portion (262) extends.

[0125] According to this aspect, the third arm portion (263) of the spring (26) is disposed above the first portion (251) of armature (25); thus, the movement of the armature (25) in the event of a fall or the like can be further reduced because there is the third arm portion (263). As a result, it is possible to further reduce the likelihood of deformation of the spring (26).

[0126] In the electromagnet device (2) according to the third aspect, the protruding portion (264) is provided on the third arm portion (263) rather than the first arm portion (261) or the second arm portion (262).

[0127] According to this aspect, the protruding portion (264) is provided on the third arm portion (263); thus, because the protruding portion (264) is located above the first portion (251) of the armature (25), the movement of the armature (25) in the event of a fall or the like can be effectively reduced, and the likelihood of deformation of the spring (26) can be further reduced.

[0128] In the electromagnet device (2) according to the fourth aspect, the protruding portion (264) is provided on the first arm portion (261).

[0129] According to this aspect, the protruding portion (264) is provided on the first arm portion (261); thus, because the protruding portion (264) is located above the first portion (251) and/or the second portion (252) of the armature (25), the movement of the armature (25) in the event of a fall or the like can be effectively reduced, and the likelihood of deformation of the spring (26) can be further reduced.

[0130] In the electromagnet device (2) according to the fifth aspect, the protruding portion (264) is provided on the second arm portion (262).

[0131] According to this aspect, the protruding portion (264) is provided on the second arm portion (262); thus, because the protruding portion (264) is located above the second portion (252) of the armature (25), the movement of the armature (25) in the event of a fall or the like can be effectively reduced, and the likelihood of deformation of the spring (26) can be further reduced.

[0132] In the electromagnet device (2) according to the sixth aspect, the protruding portion (264) is provided so as to bridge between the first arm portion (261) and the second arm portion (262).

[0133] According to this aspect, the protruding portion (264) is provided so as to bridge between the first arm portion (261) and the second arm portion (262); thus, because the protruding portion (264) is located above the second portion (252) of the armature (25), the movement of the armature (25) in the event of a fall or the like can be effectively reduced, and the likelihood of deformation of the spring (26) can be further reduced.

[0134] In the electromagnet device (2) according to the seventh aspect, the protruding portion (264) includes a first section extending along the upper surface (25a) of the armature (25).

[0135] According to this aspect, the first section (264a) of the protruding portion (264) is located facing the upper surface (25a) of the armature (25); thus, the armature (25) that has moved in the event of a fall or the like comes into contact with the first section (264a), meaning that the likelihood of deformation of the spring (26) can be more effectively reduced.

[0136] In the electromagnet device (2) according to the eighth aspect, the protruding portion (264) further includes a second section (264b) extending upward from the first section (264a).

[0137] According to this aspect, the protruding portion (264) includes the second section (264b) having high rigidity and extending upward from the first section (264a) and thus can be given strength against warping of spring 26 that occurs in the event of a fall or the like, and as a result, the likelihood of deformation of the spring (26) can be further reduced.

[0138] In the electromagnet device (2) according to the ninth aspect, a gap (261d) is formed between the upper end of the first arm portion (261) and the protruding por-

tion (264).

[0139] According to this aspect, the spring (26) is configured so that the gap is formed between the upper end of the first arm portion (261) and the protruding portion (264) and the first arm portion (261) and the protruding portion (264) are separate; thus, even when the second arm portion (262) moves, the protruding portion (264) can be prevented from moving, and the likelihood of deformation of the spring (26) can be further reduced.

[0140] An electromagnetic relay (1) according to the tenth aspect includes: the electromagnet device (2) described above; a fixed contact (31); and a movable contactor (4) including a movable contact (41) configured to come into contact with or move apart from the fixed contact (31). The movable contactor (4) causes the movable contact (41) to come into contact with or move apart from the fixed contact (31) according to movement of the armature (25).

[0141] According to this aspect, the electromagnetic relay (1) including the electromagnet device (2) described above can be provided.

[0142] The electromagnetic relay (1) according to the eleventh aspect further includes a fixed contact (32) and a movable contact (42). The movable contact (42) is provided on the movable contactor (4). The movable contactor (4) causes the movable contact (42) to come into contact with or move apart from the fixed contact (32) according to movement of the armature (25).

[0143] According to this aspect, the electromagnetic relay (1) including the electromagnet device (2) described above can be provided.

Reference Signs List

[0144]

1	electromagnetic relay
11	first cover
12	second cover
13	intermediate case
14	cover
15	base
2	electromagnet device
21	coil
22	iron core
22a	upper surface
23	coil bobbin
24	yoke
241	first portion
242	second portion
25	armature
251	first portion
252	second portion
25a	upper surface
26	spring
261	first arm portion
261a	hook portion
261b	void portion
261c	notch
261d	gap portion
262	second arm portion
262a	void portion
263	third arm portion
263a	first portion
263b	second portion
2630	bent portion
264	protruding portion
264a	first section
264b	second section
31, 32	fixed contact
33, 34	fixed terminal
35	auxiliary terminal
36	auxiliary movable contactor
4	movable contactor
41, 42	movable contact
6	holder
61	first section
62	second section
63	coupling portion

Claims

1. An electromagnet device comprising:

a coil;
an iron core extending along a central axis of the coil and being disposed inside the coil;
a coil bobbin on which the coil is wound;
a yoke held on the coil bobbin and including a portion extending along the central axis of the coil;
an armature coupled to the yoke and configured to come into contact with and move apart from an upper surface of the iron core; and
a spring configured to cause the armature in contact with the upper surface of the iron core to move apart from the upper surface of the iron core, wherein
the spring includes:

a first arm portion contacting the yoke and extending along the central axis of the coil;
a second arm portion contacting the armature and extending from an upper end of the first arm portion to be directed away from the iron core; and
a protruding portion protruding from at least one of the first arm portion or the second arm portion, the protruding portion being at least partially positioned above an upper surface of the armature.

2. The electromagnet device according to claim 1, wherein
the spring further includes:

a third arm portion located above the upper surface of the armature and extending from the upper end of the first arm portion in a direction opposite to a direction in which the second arm portion extends.

3. The electromagnet device according to claim 2, wherein
the protruding portion is provided on the third arm portion instead of the first arm portion or the second arm portion.

4. The electromagnet device according to claim 1 or 2, wherein
the protruding portion is provided on the first arm portion.

5. The electromagnet device according to claim 1 or 2, wherein
the protruding portion is provided on the second arm portion.

6. The electromagnet device according to claim 1 or 2, wherein
the protruding portion is provided so as to bridge between the first arm portion and the second arm portion.

7. The electromagnet device according to any one of claims 1 to 6, wherein
the protruding portion includes:
a first section extending along the upper surface of the armature.

8. The electromagnet device according to claim 7, wherein
the protruding portion further includes:
a second section extending upward from the first section.

9. The electromagnet device according to any one of claims 1 to 8, wherein
a gap is formed between the upper end of the first arm portion and the protruding portion.

10. An electromagnetic relay comprising:

the electromagnet device according to any one of claims 1 to 9;
a first fixed contact; and
a movable contactor including a first movable contact configured to come into contact with or move apart from the first fixed contact, wherein the movable contactor causes the first movable contact to come into contact with or move apart from the first fixed contact according to movement of the armature.

11. The electromagnetic relay according to claim 10, further comprising:

a second fixed contact; and
a second movable contact, wherein
the second movable contact is provided on the movable contactor, and
the movable contactor causes the second movable contact to come into contact with or move apart from the second fixed contact according to the movement of the armature.

FIG. 1

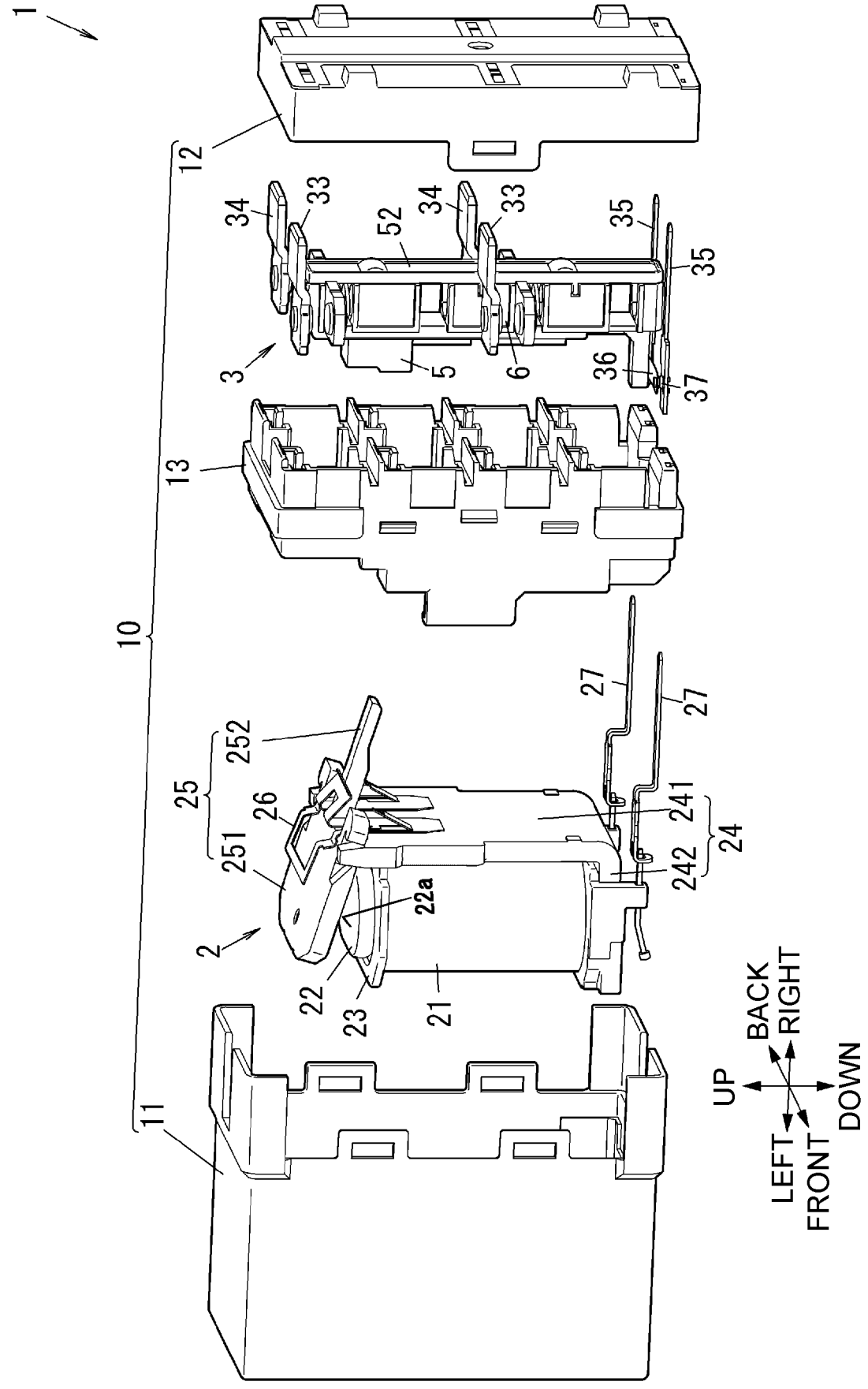
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FIG. 2

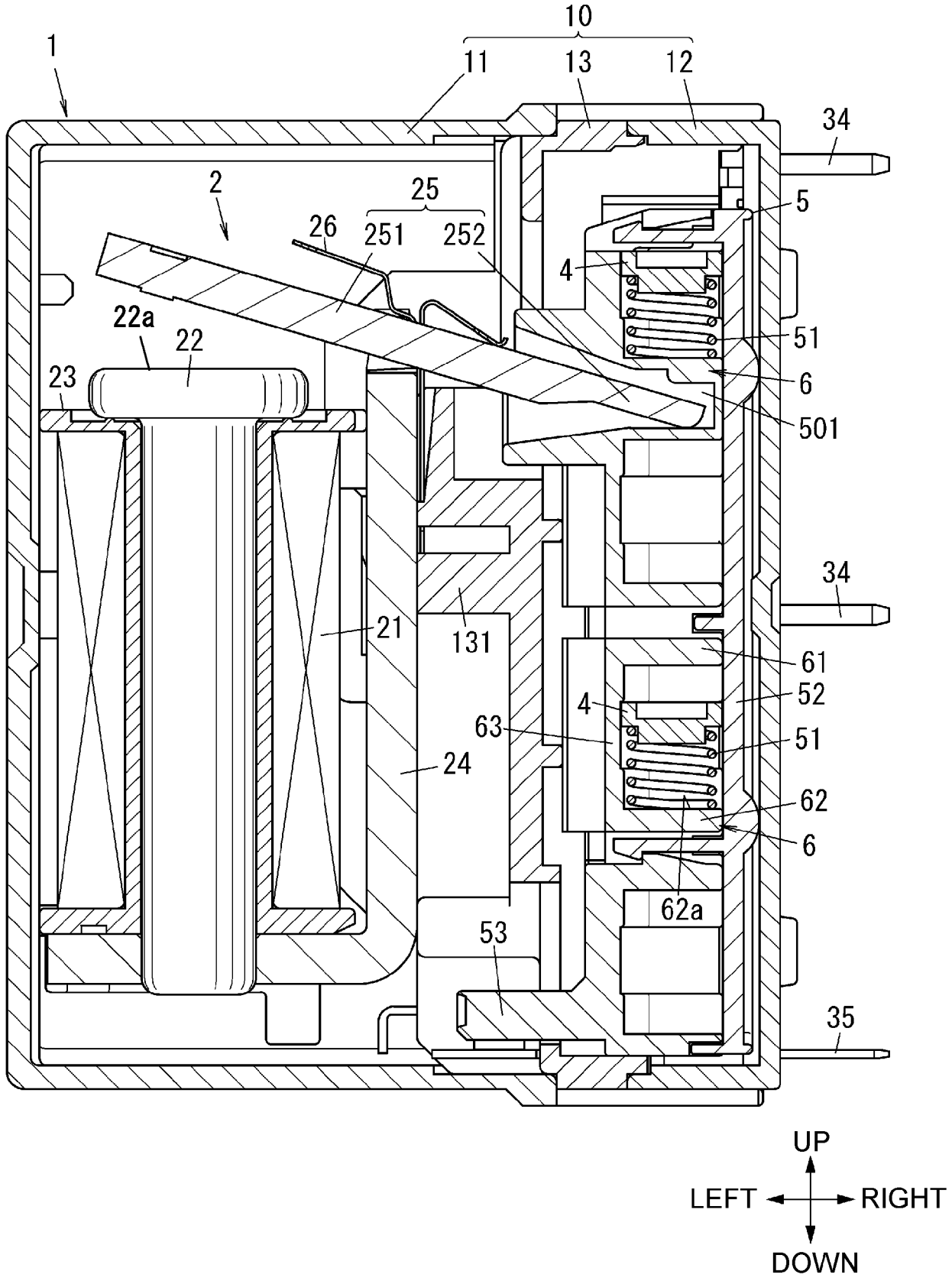
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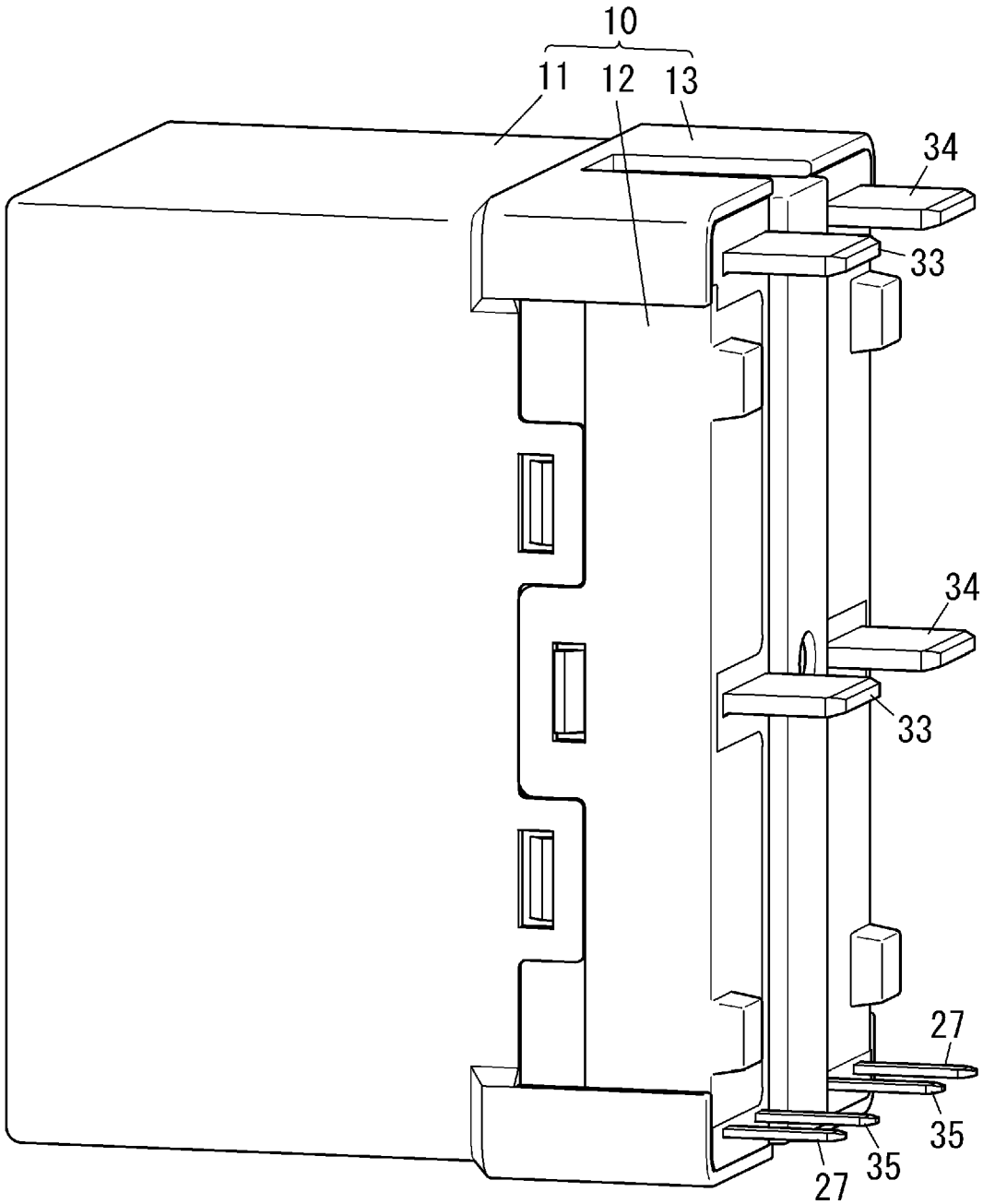
FIG. 3



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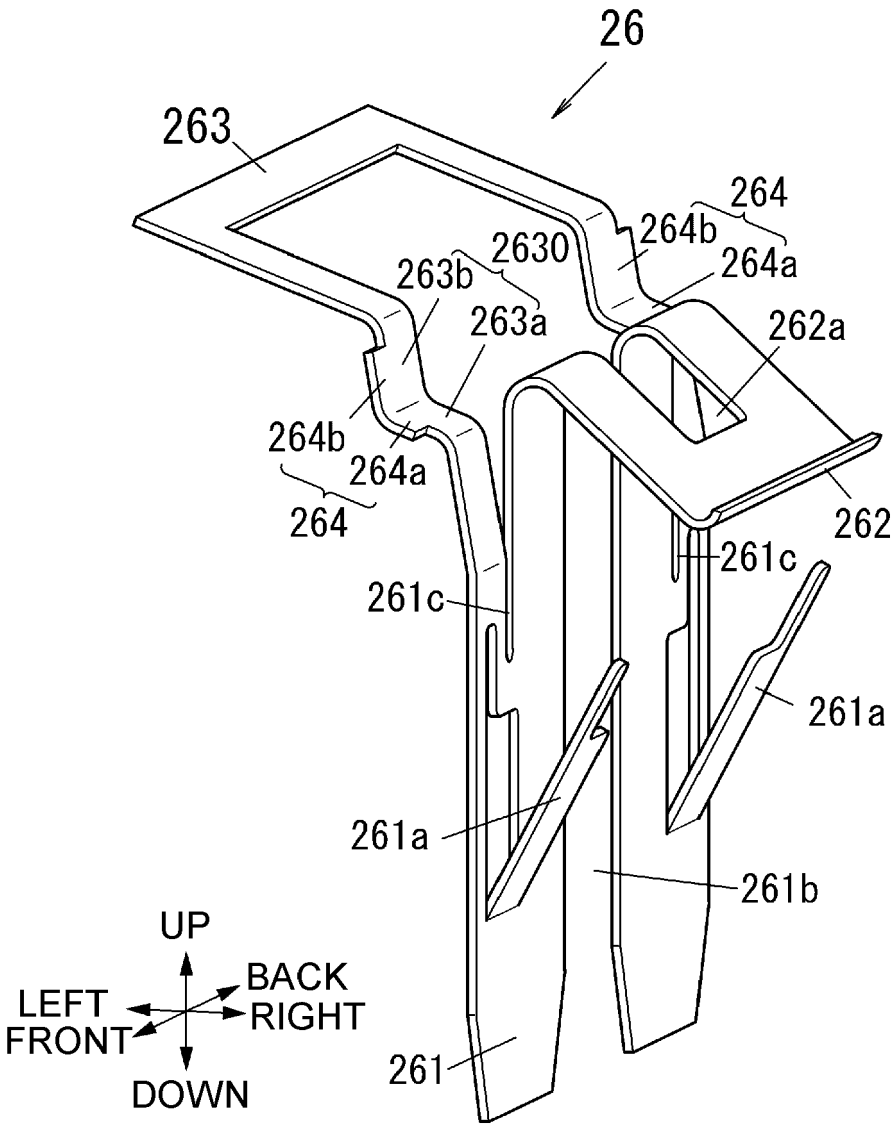
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FIG. 5

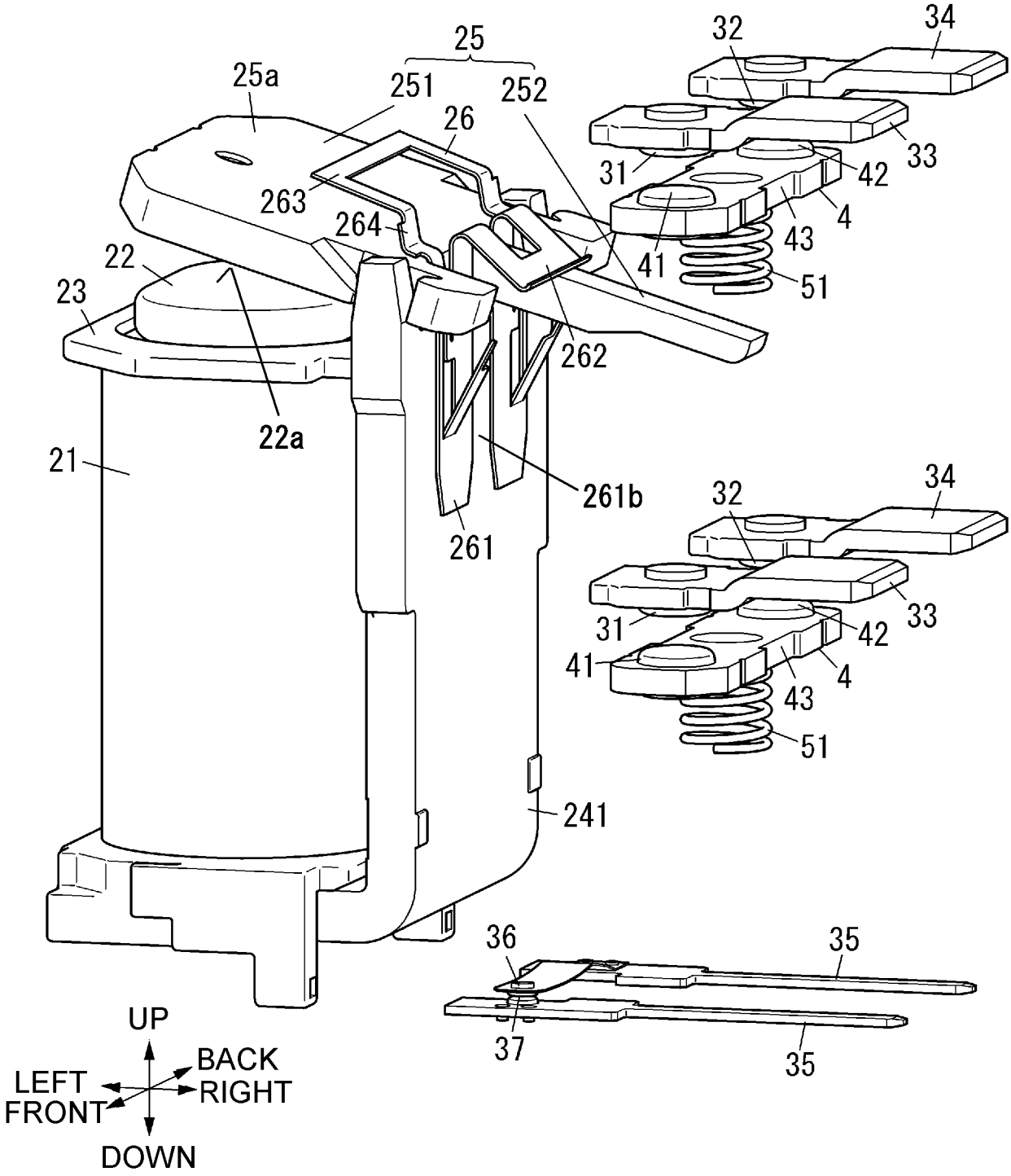
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FIG. 6

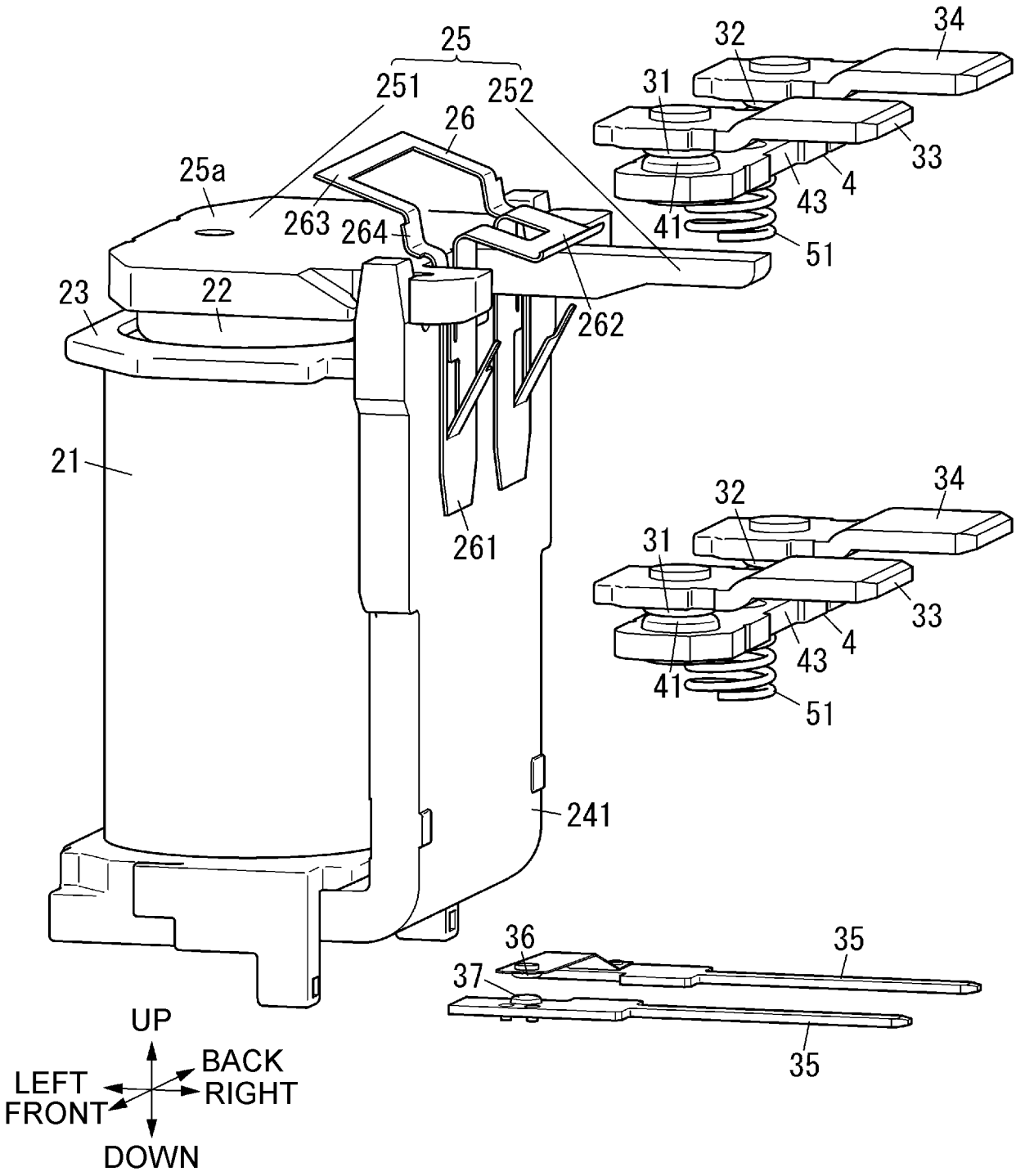
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FIG. 7

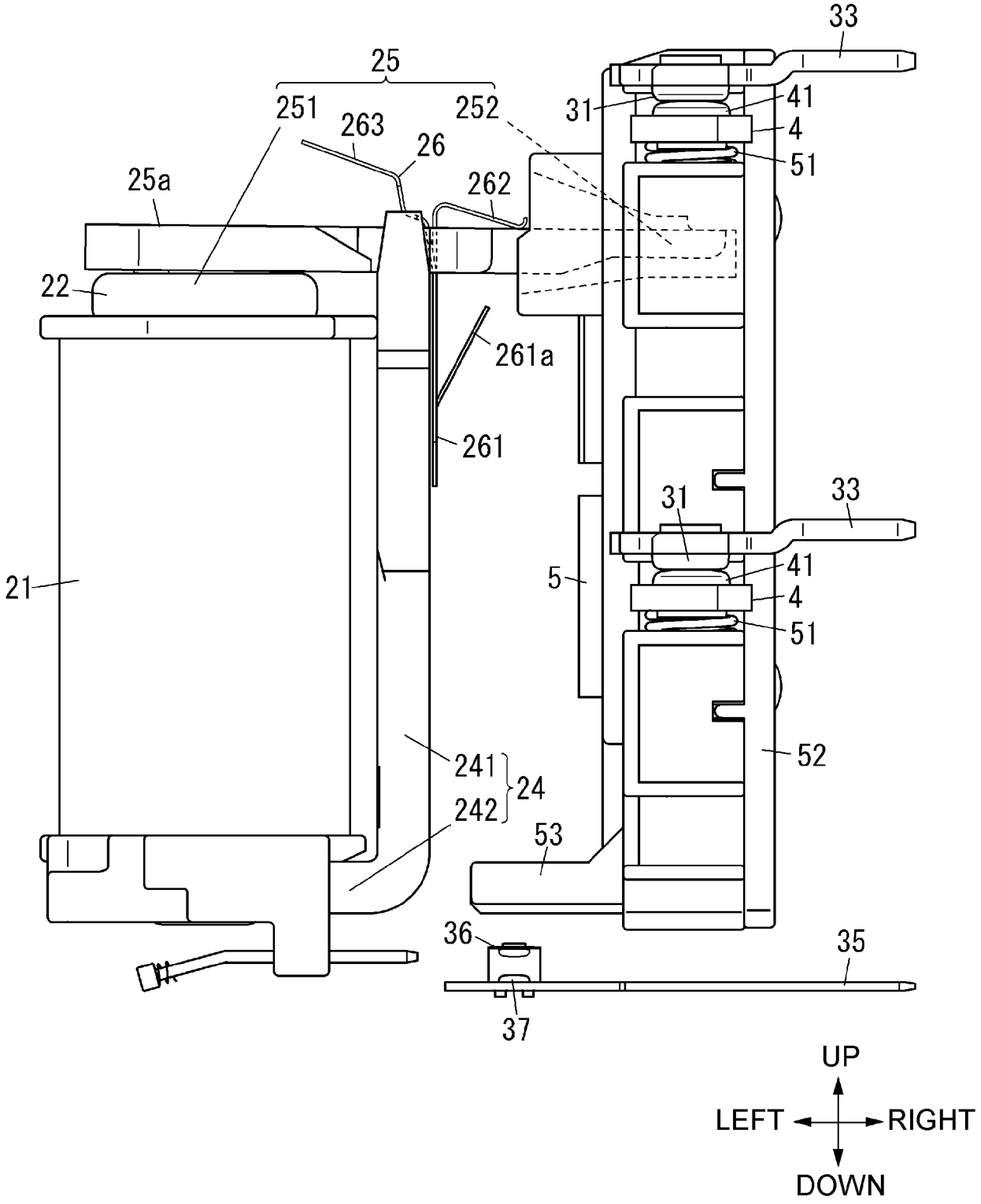
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FIG. 8

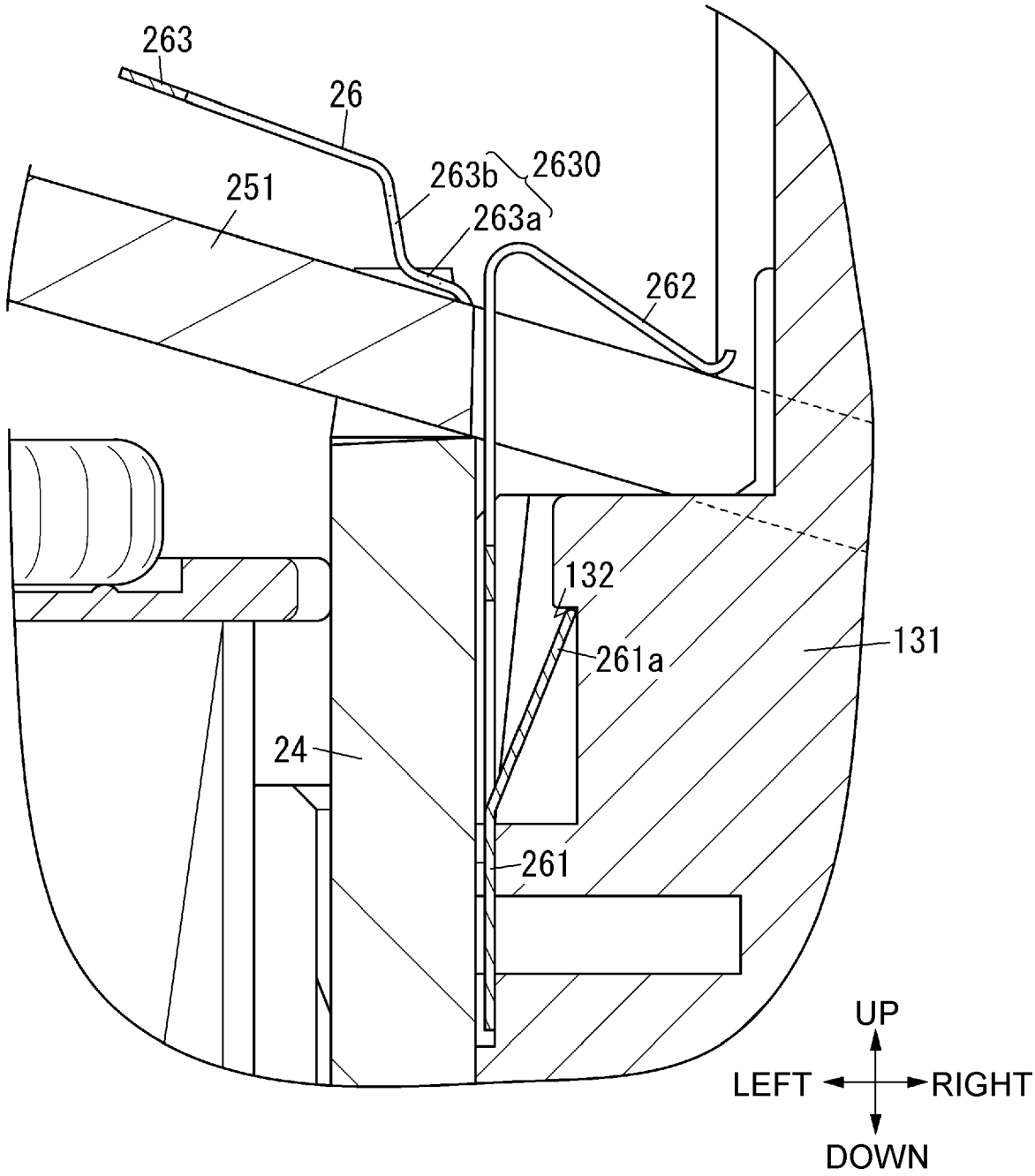
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FIG. 9

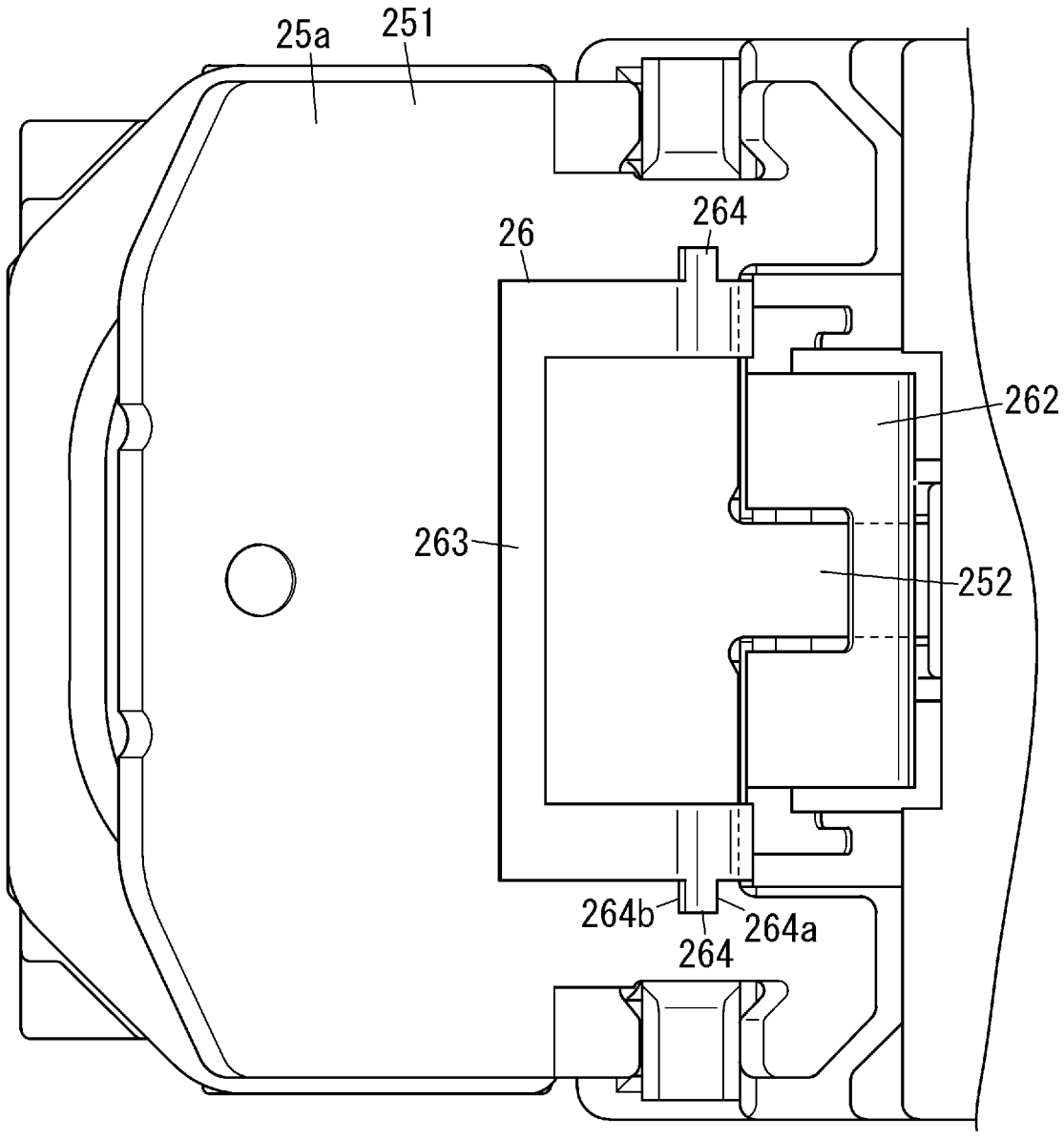

FIG. 10

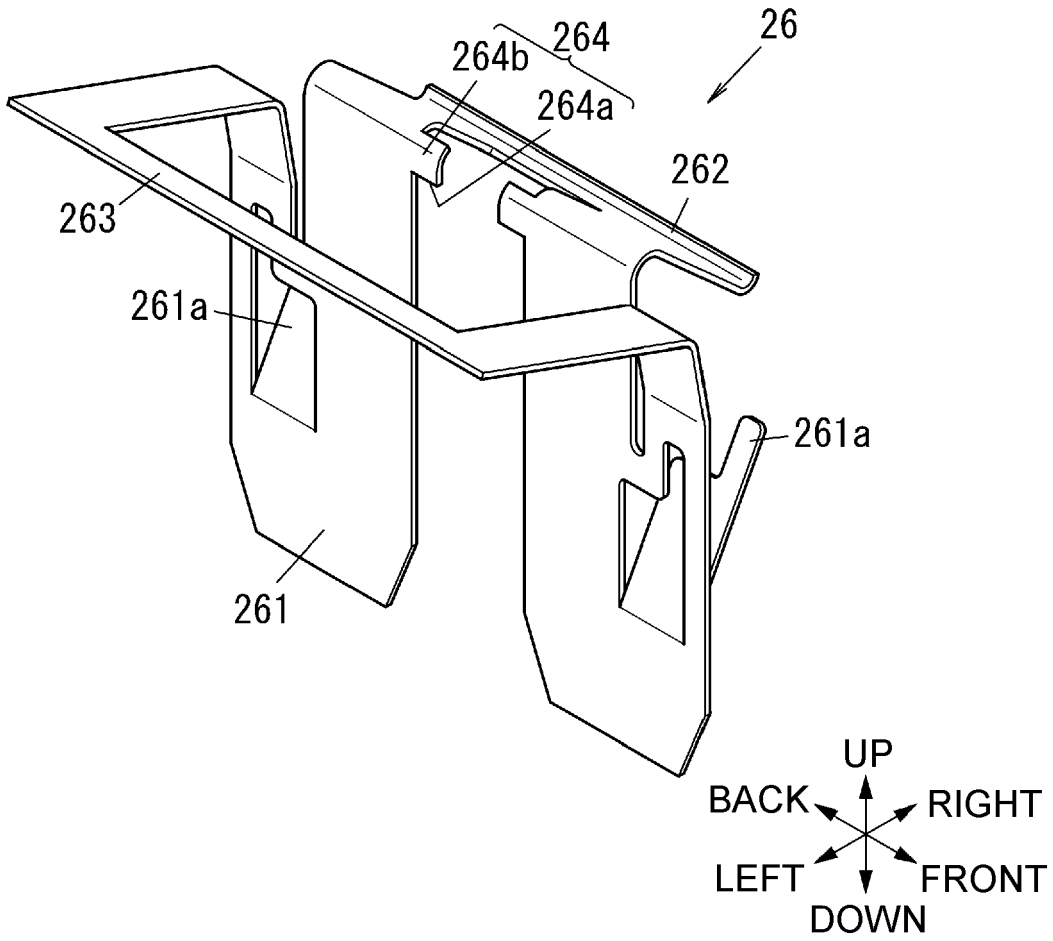
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FIG. 11

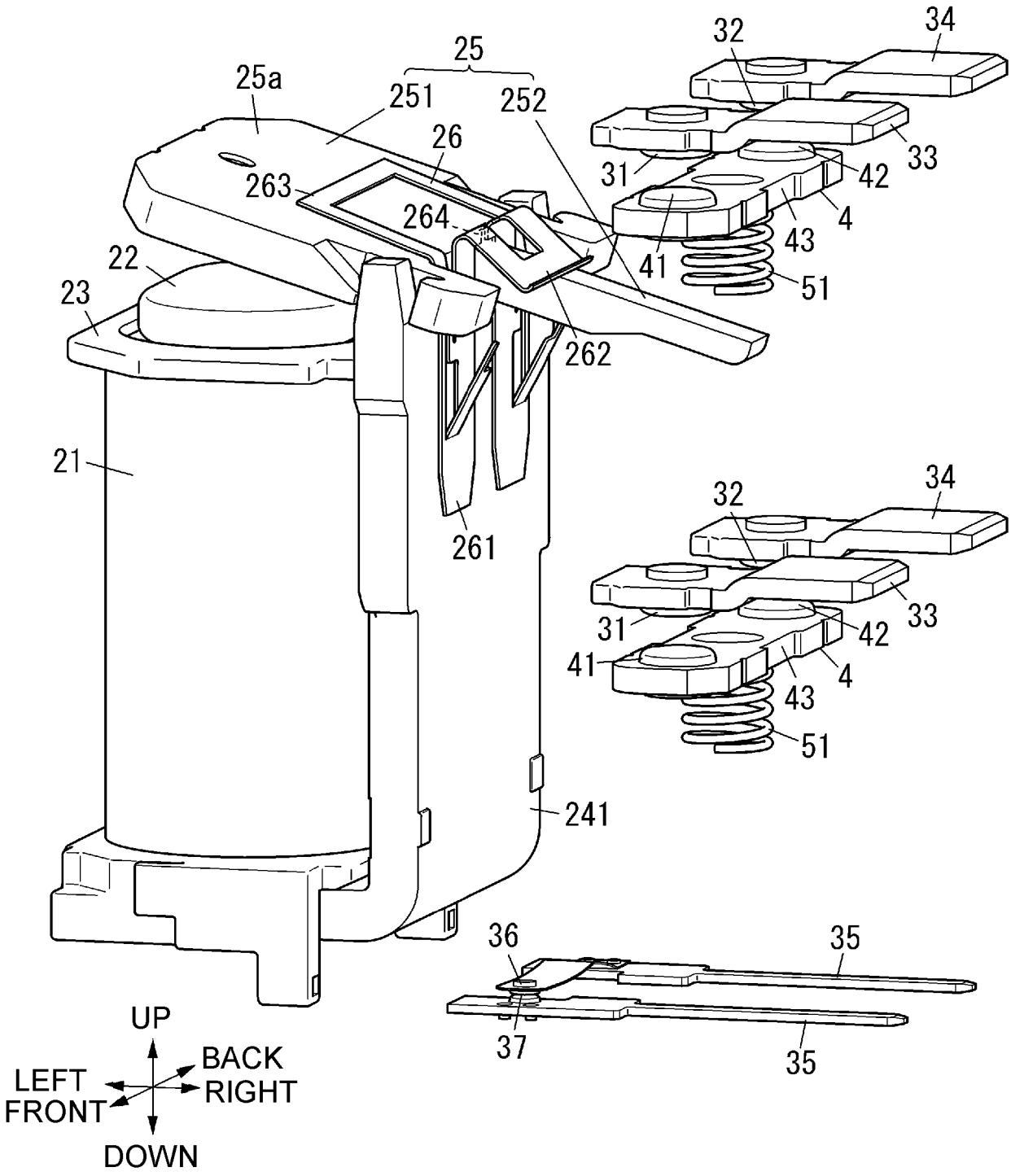
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FIG. 12

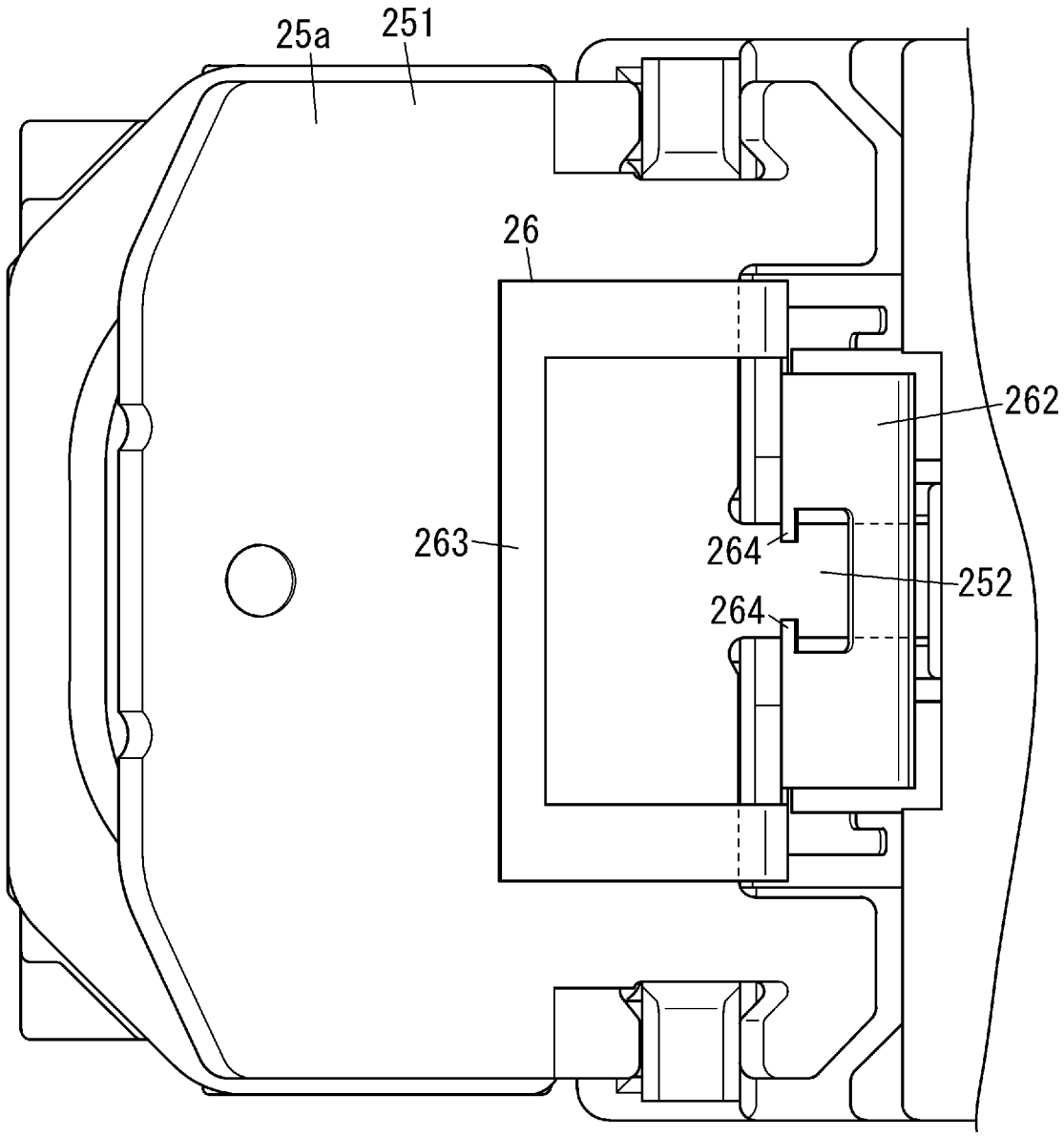

FIG. 13

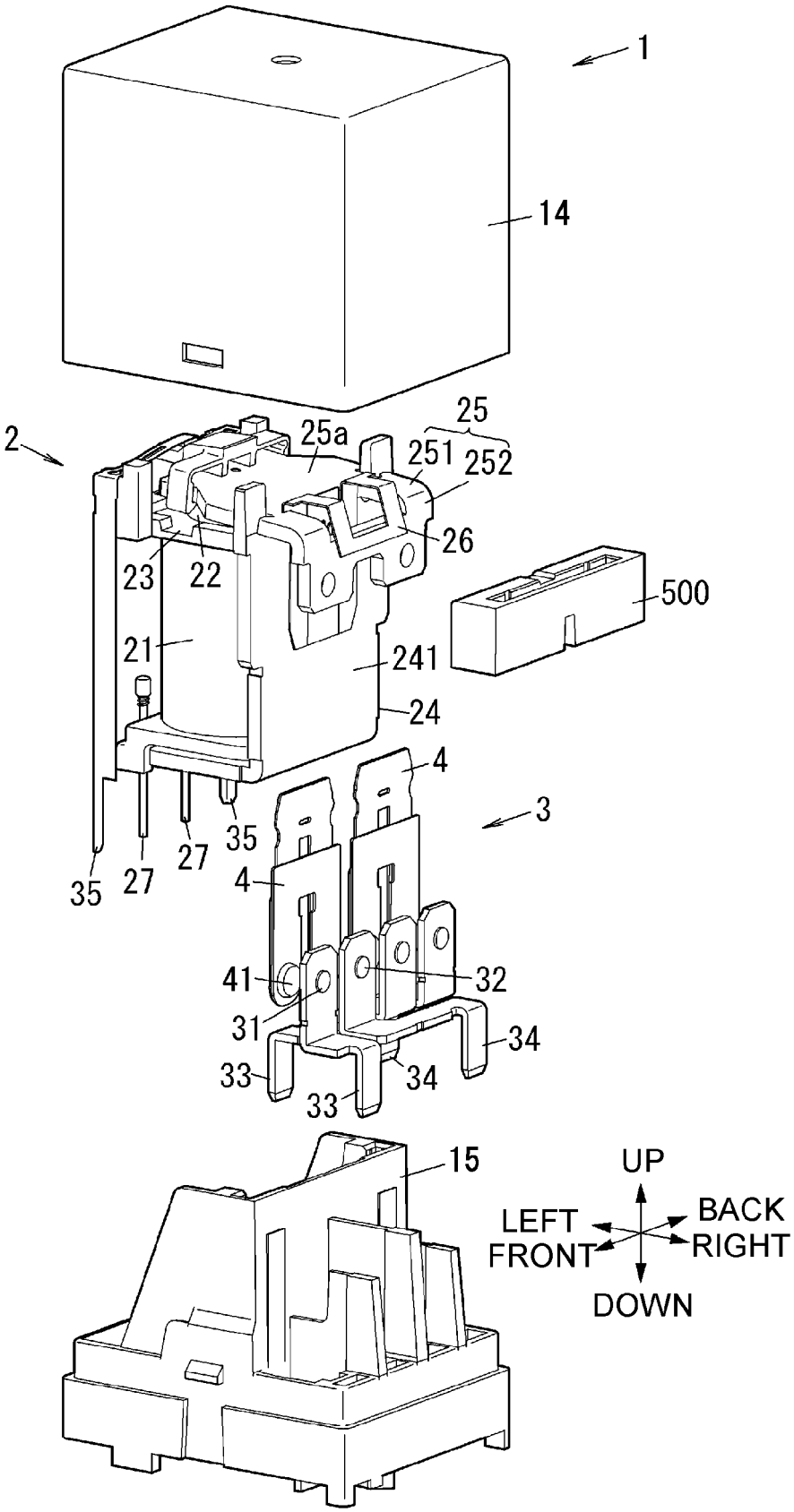
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FIG. 14

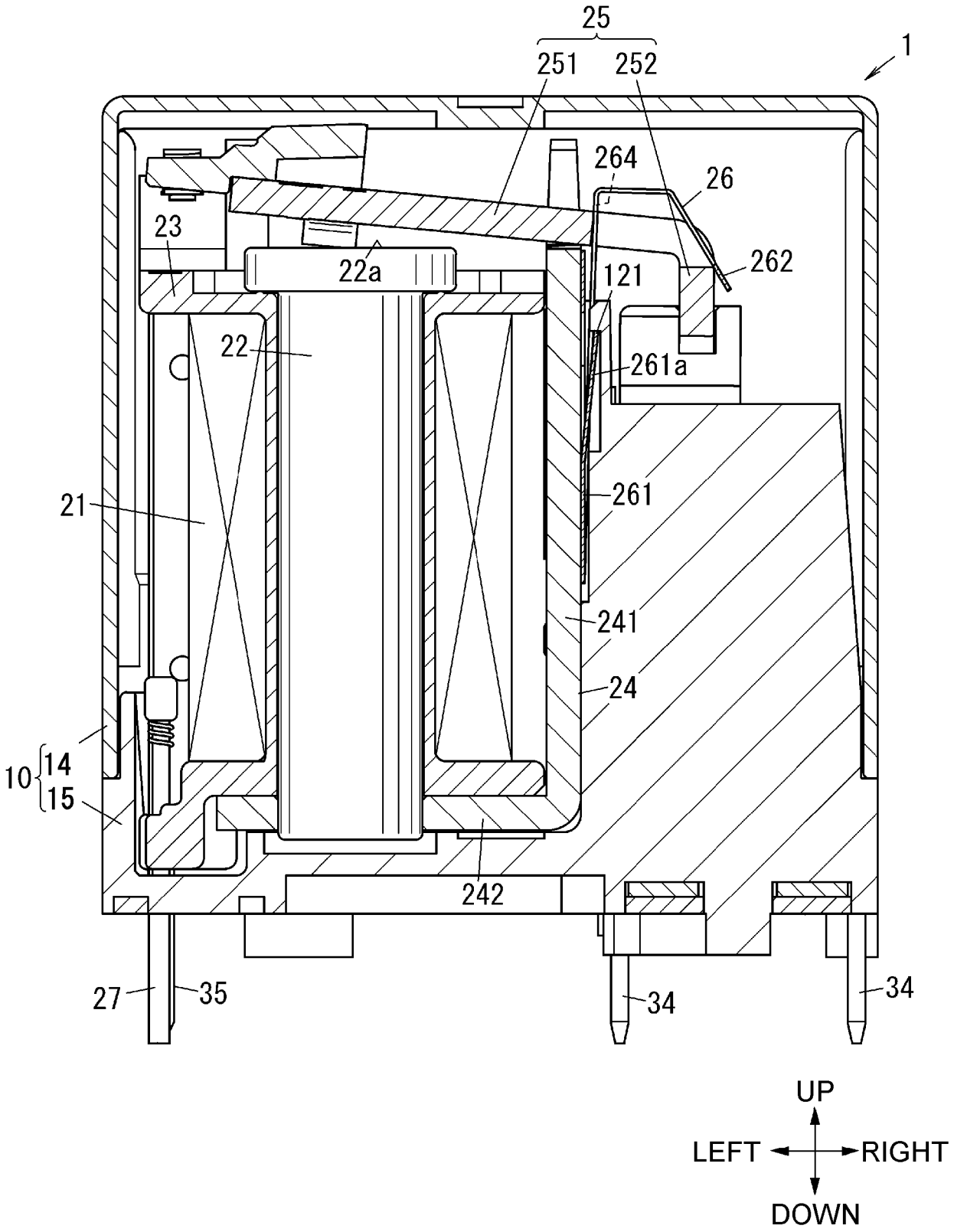
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FIG. 15

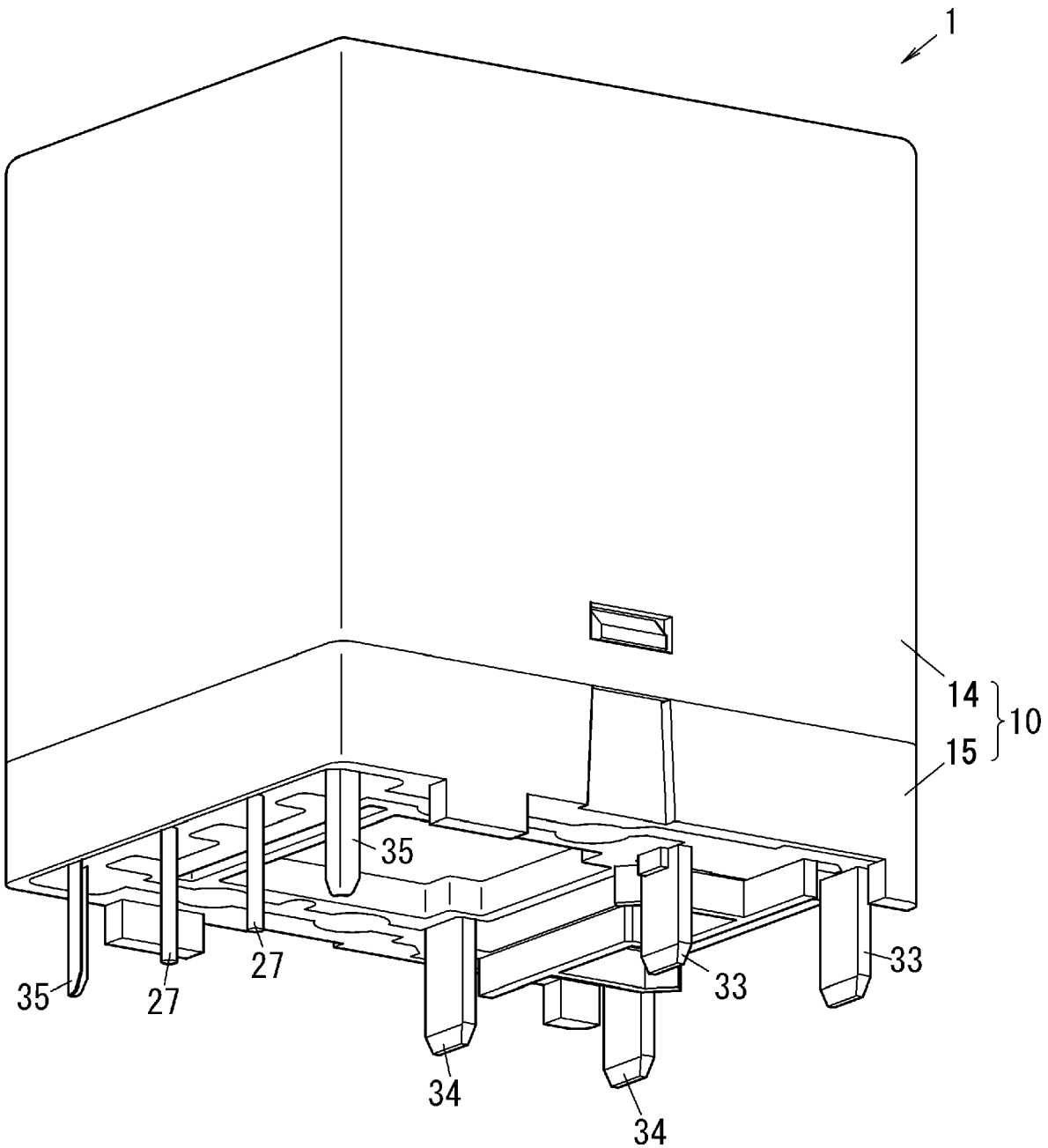

FIG. 16

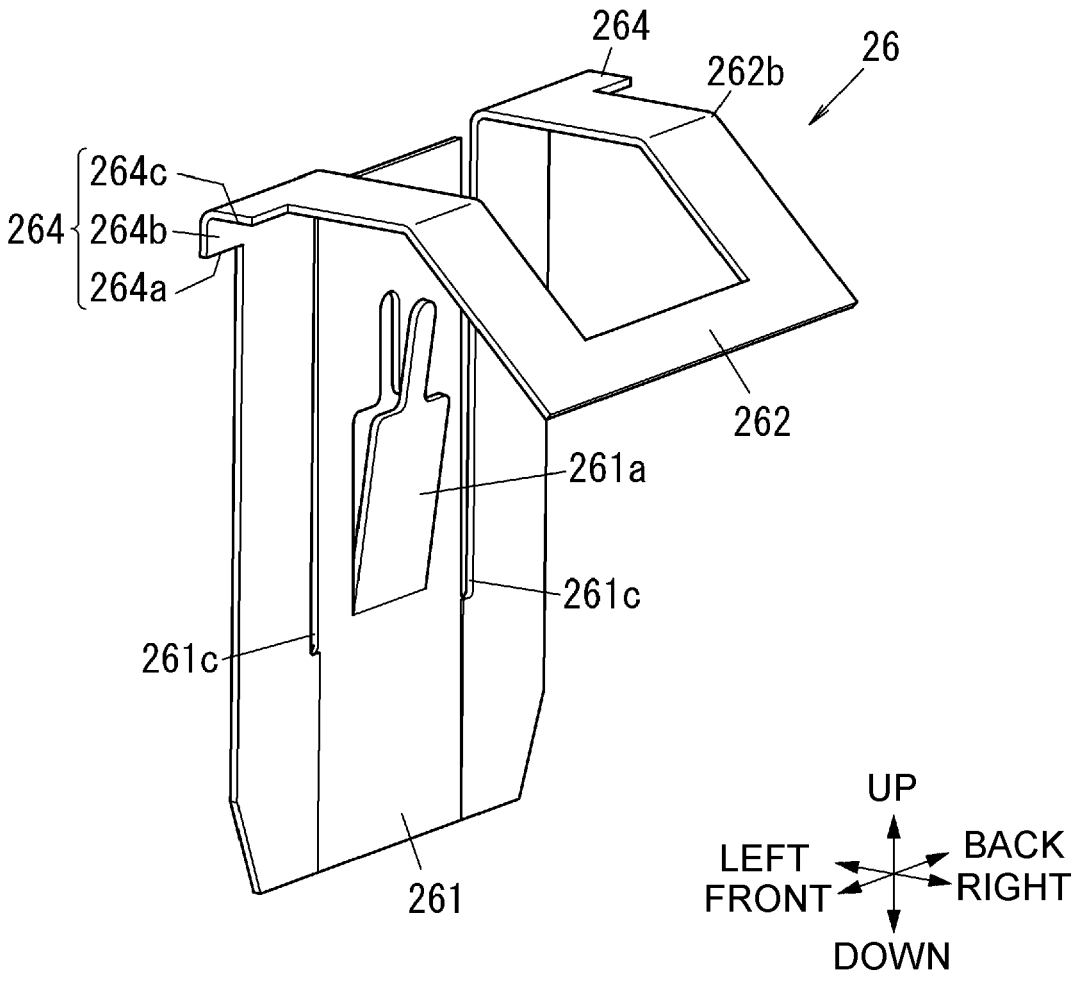
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FIG. 17

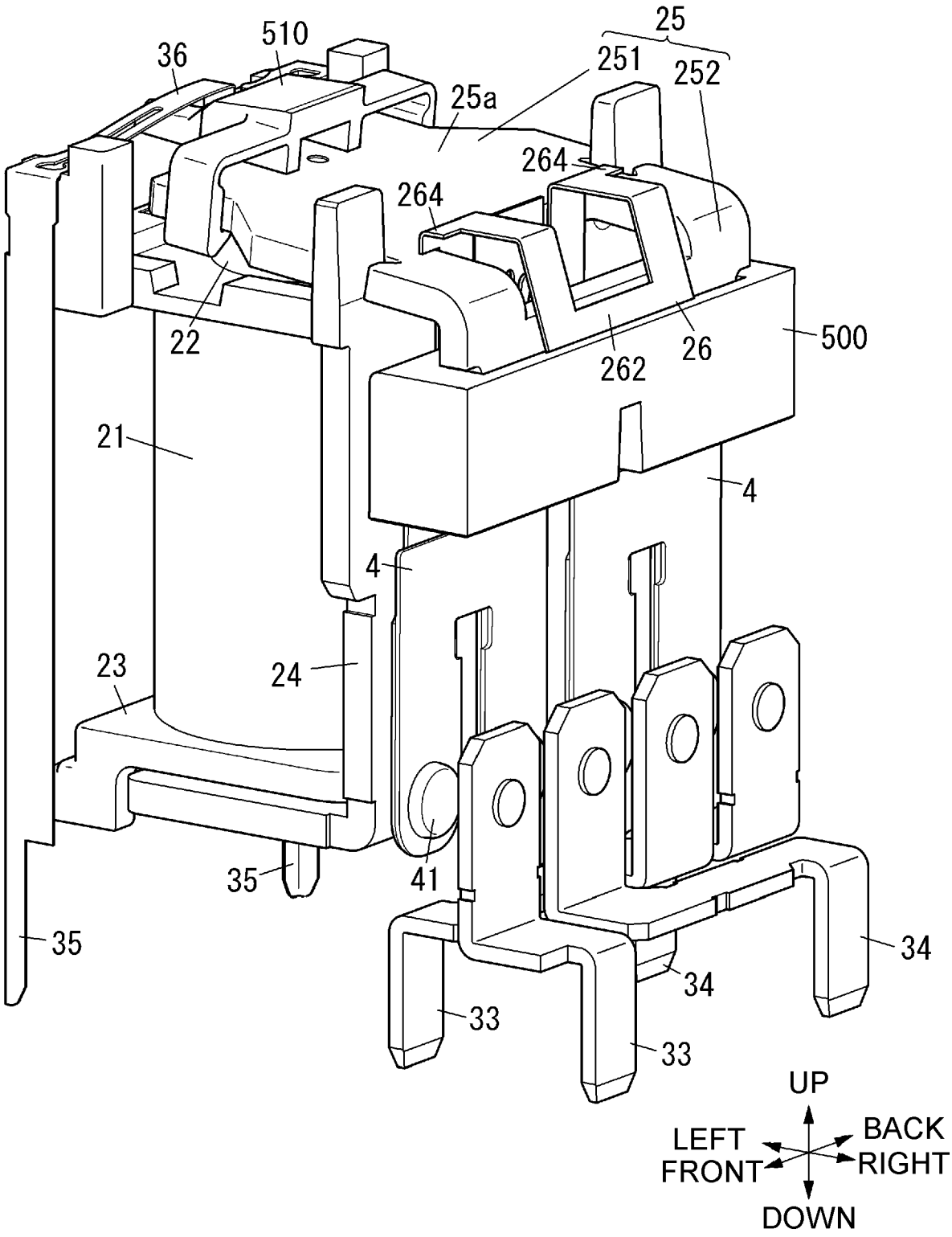
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FIG. 18

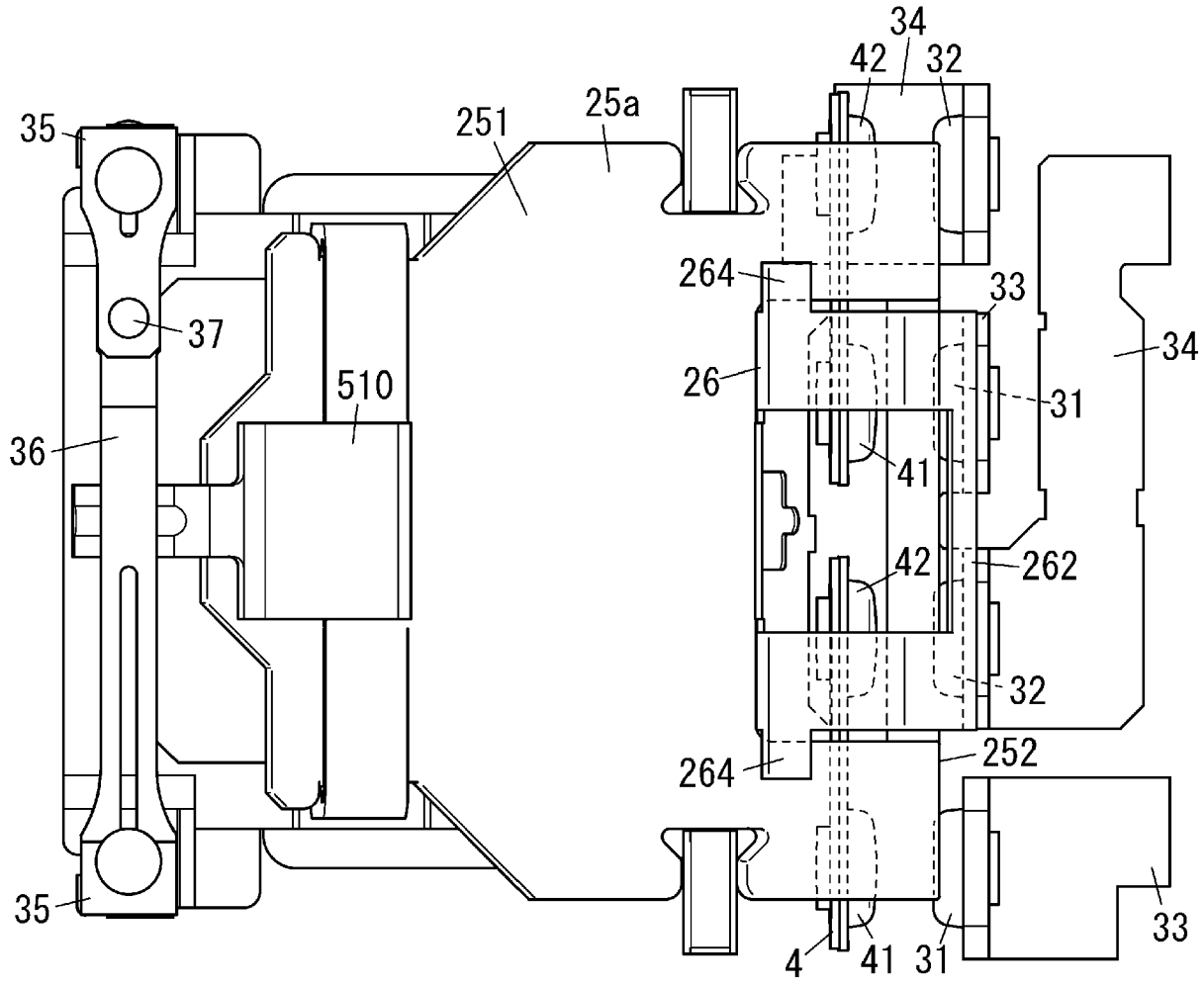
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FIG. 19

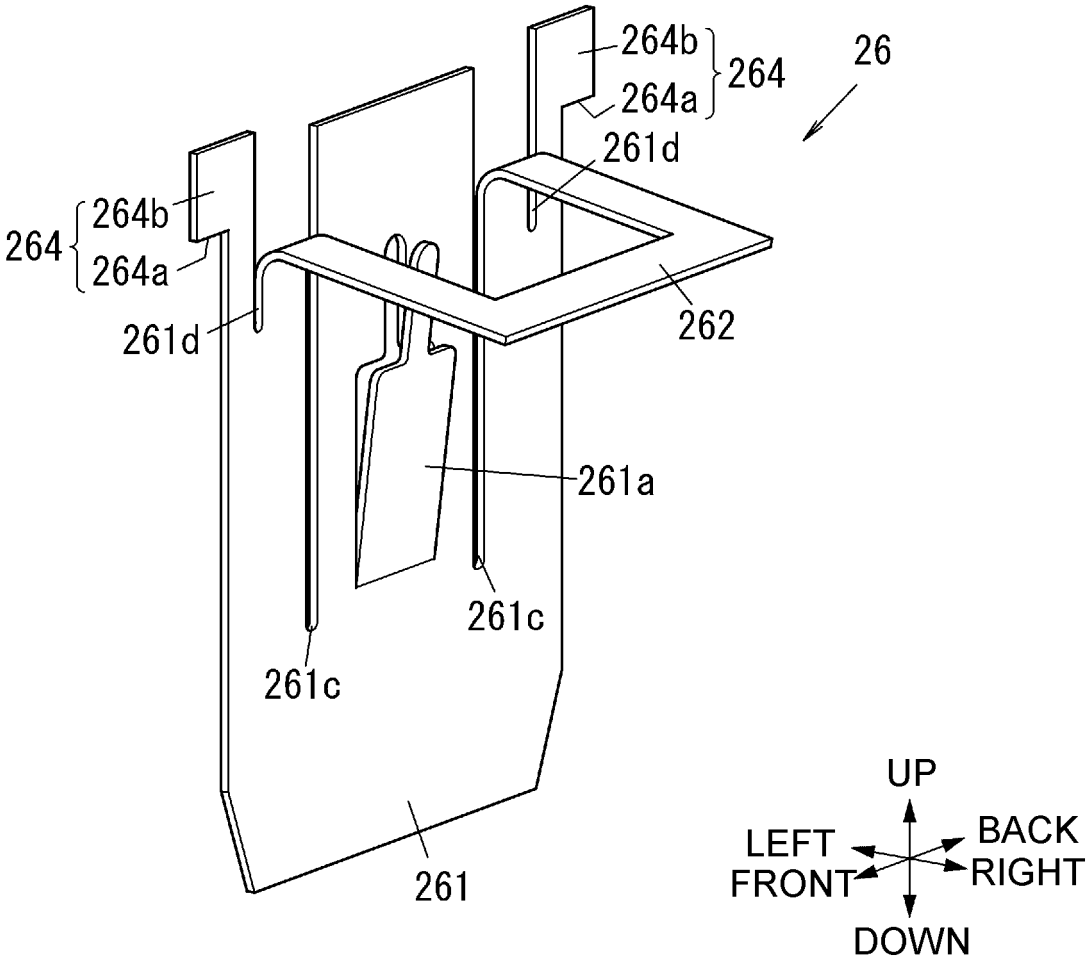
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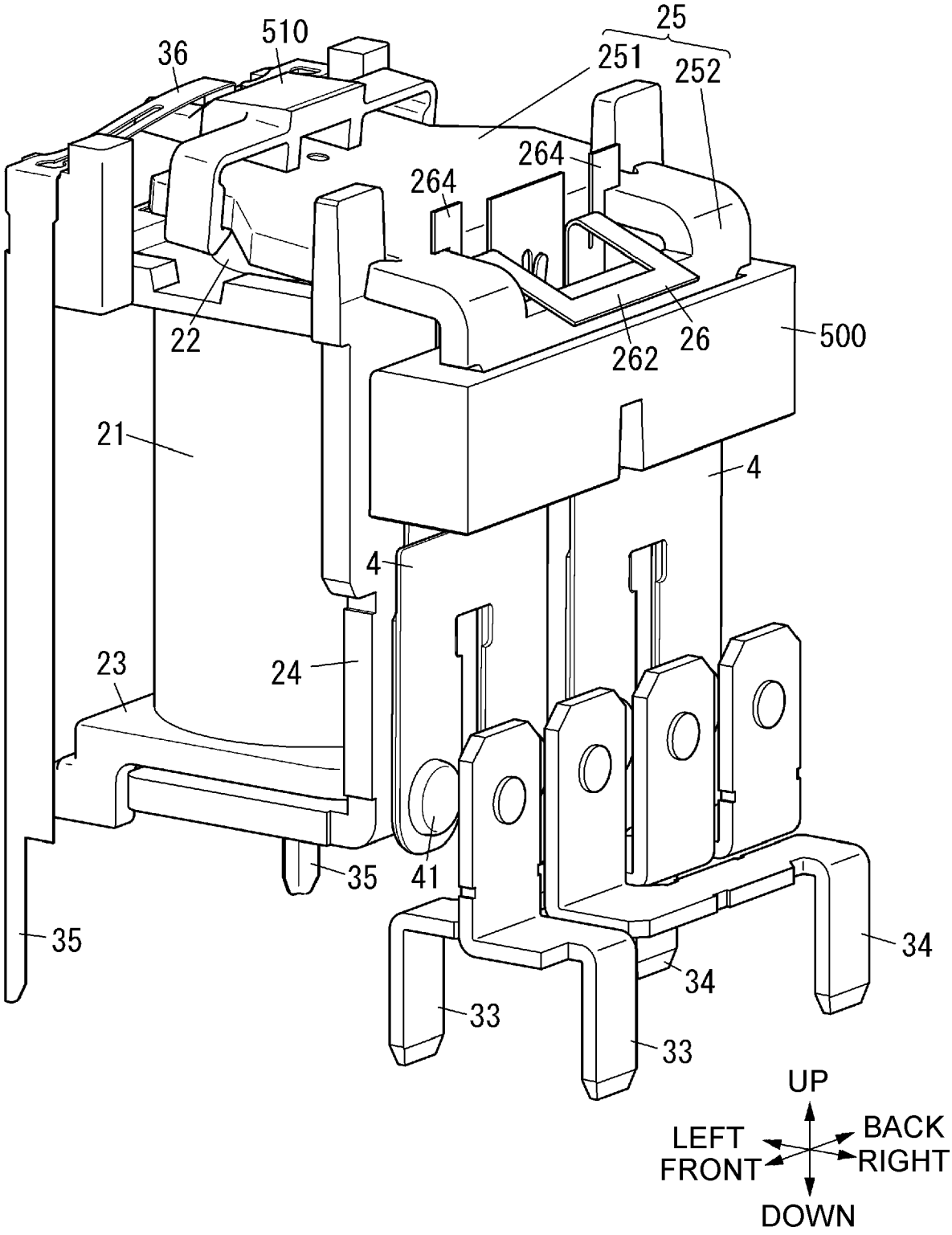
FIG. 20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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 8607

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	US 4 670 727 A (MUELLER ERWIN [DE] ET AL) 2 June 1987 (1987-06-02)	1,3-11	INV. H01H50/28
Y	* figures 1,2,4,5 *	2	H01H50/30
X	JP S58 82753 U (N.A.) 4 June 1983 (1983-06-04) * figures 1,4 *	1,10	
Y	JP H01 98450 U (N.A.) 30 June 1989 (1989-06-30) * figures 4,5 *	2	

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 January 2024	Arenz, Rainer

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02-01-2024

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- JP 6433706 B **[0004]**