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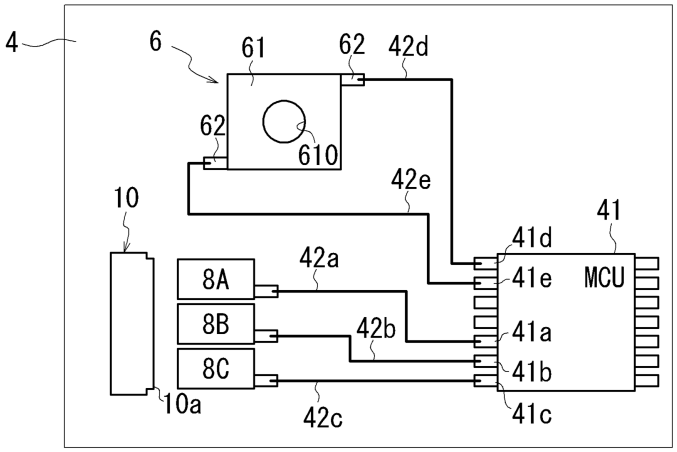
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(54) **SWITCH DEVICE**

(57) [Problem] To provide a switch device having a plurality of operable portions which are independently displaceable while suppressing manufacturing costs.

[Solution] The switch device 1 has a plurality of operation knobs 7 (7A to 7D) which are independently displaceable, a movable member 9 displaceable in conjunction with displacement of an operated operation knob 7 regardless of which of the plurality of operation knobs 7 (7A to 7D) is operated, a magnet 10 attached to the movable member 9, a plurality of magnetic sensors 8 (8A, 8B, 8C) arranged opposite to the magnet 10 in the radial direction of the displacement direction of the movable member 9, fixed electrodes 6 provided in a one-to-one correspondence with the plurality of operation knobs 7 (7A to 7D) and detecting operation of the operation knobs 7 (7A to 7D), and an MCU 41 as a processing unit configured to identify the operated operation knob 7 among the plurality of operation knobs 7 (7A to 7D) based on output signals of the plurality of magnetic sensors 8 (8A, 8B, 8C) and output signals of the fixed electrodes 6.

[Figure 7]



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Description

[Technical Field]

[0001] The present invention relates to a switch device.

[Background Art]

[0002] PTL 1 discloses a switch device having one push knob with a plurality of operable regions set on the surface.

[Prior Art Documents]

[PTL]

[0003] [PTL 1] JP 5260241 B

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0004] In the switch device of PTL 1, a push knob and a printed circuit board on which a push switch is mounted are arranged to face each other with a gap in the displacement direction of the push knob.

[0005] The push knob has a leg portion extending toward the printed circuit board side, and when the push knob is displaced toward the printed circuit board side by a pressing operation of the operable region, the push switch on the printed circuit board is pressed by the leg portion and turned on. Inside the switch device, a capacitive sensor is arranged between the push knob and the printed circuit board. The capacitive sensor is provided in a one-to-one correspondence with the operable regions.

[0006] In the switch device, when one of the operable regions is pressed further by a user, the push knob is displaced toward the printed circuit board side, and the push switch on the printed circuit board is turned on by the leg portion. Furthermore, as a result of the push knob approaching the capacitive sensor, the output of the capacitive sensor arranged opposite to the pressed operable region changes, enabling identification of which operable region of the operable regions has been pressed.

[0007] That is, by using one common push knob (operation knob) without using independent push knobs for each operable region, and making it possible to separately identify the pressed operable region, the number of parts is reduced, and the manufacturing cost of the switch device is minimized. However, there is still a need for providing independent operation knobs (push knobs) for each operable region from the viewpoint of ease of recognition by the operator and prevention of erroneous operation or the like. There is therefore demand for a switch device having independent operation knobs for each operable region while minimizing manufacturing costs.

[0008] Note that, not limited to such demands, the effects and actions derived from each configuration disclosed in the "Embodiments for Carrying out the Invention" described below, which produce effects and actions not obtainable by conventional technology, can also be positioned as other objectives of the present invention.

[Means for Solving the Problem]

[0009] The present invention is a switch device comprising:

a plurality of operable portions which are independently displaceable;
a movable member that displaces in conjunction with displacement of an operated operable portion regardless of which of the plurality of operable portions is operated;
a magnet attached to the movable member;
a plurality of detection elements arranged opposite to the magnet in the radial direction of the displacement direction of the movable member; operation sensors that are provided in a one-to-one correspondence with the plurality of operable portions and detect operation of the operable portions; and
a processing unit configured to identify the operated operable portion among the plurality of operable portions based on output signals of the plurality of detection elements and output signals of the operation sensors.

[Effects of the Invention]

[0010] According to the present invention, a switch device having a plurality of operable portions which are independently displaceable can be provided while minimizing manufacturing costs.

[Brief Description of the Drawings]

[0011]

Figure 1 is a diagram for explaining the switch device.
Figure 2 is a cross-sectional view of the switch device.
Figure 3 is a cross-sectional view of the switch device.
Figure 4 is a cross-sectional view of the switch device.
Figure 5 is a cross-sectional view of the switch device.
Figure 6 is a diagram for explaining the arrangement of the magnet and the magnetic sensor.
Figure 7 is a schematic configuration diagram of a

processing unit for processing output signals of the magnetic sensor and the capacitive sensor.

Figure 8 is a flowchart explaining processing in the processing unit.

Figure 9 is a flowchart explaining processing according to a modification in the processing unit.

Figure 10 is a diagram explaining a switch device employing a movable member according to a modification.

Figure 11 is a diagram explaining a switch device employing a movable member according to a modification.

Figure 12 is a diagram explaining a switch device employing a movable member according to a modification.

Figure 13 is a diagram explaining a switch device employing a movable member according to a modification.

Figure 14 is a diagram explaining a switch device employing a movable member according to a modification.

[Embodiments for Carrying Out the Invention]

[0012] Hereinafter, embodiments of the present invention will be described by taking as an example a switch device 1 provided with a plurality of operation knobs 7 (7A, 7B, 7C, 7D) to which different functions are assigned.

[0013] Figure 1 is a diagram for explaining the switch device 1.

[0014] Figure 1(A) is a perspective view of the switch device 1. Figure 1(B) is a plan view seen from the Z direction enlarged around the operation knob 7A. Figure 1(C) is a diagram showing an enlarged cross section of the switch device 1 cut along the plane A in Figure 1(A). Note that in Figure 1(B), the positions of parts of the key top 71 (detection unit 61, opening 610, mounting portion 52) located on the back side of the page surface are indicated by broken lines for convenience of explanation.

[0015] Figures 2 to 4 are cross-sectional views of main parts of the switch device 1.

[0016] Figure 2(A) is an enlarged view of the region B in Figure 1(C). Figure 2(B) shows a state where the operation knob 7A is pressed down from the initial position shown in Figure 2(A) to the operation position.

[0017] Figure 3 schematically shows a cross section of the switch device 1 along line A-A in Figure 2(A). Figure 4 schematically shows a cross section of the switch device 1 along line A-A in Figure 3.

[0018] In the following description, for convenience of explanation, the vertical direction (Z direction), the X direction, and the Y direction in Figure 1(C) are used as references to explain the positional relationships of the components.

[0019] For example, when "upper side" is described, this means the upper side in the vertical direction in Figure 1(C). Therefore, depending on the usage state of the switch device 1, even when "a part located on the upper side" is described, the part may be located diagonally upward or on the lower side.

[0020] As shown in Figure 1, the switch device 1 includes a total of four operation knobs 7 (7A to 7D). Each of the operation knobs 7 (7A to 7D) is assigned a different function.

[0021] As an example, when the switch device 1 is a switch device used for specifying a vehicle driving mode, functions such as parking (P), reverse driving (R), neutral (N), and forward driving (D) are assigned individually to the operation knobs 7A to 7D.

[0022] In the switch device 1, when any one of the operation knobs 7A to 7D is pressed, the function assigned to the pressed operation knob 7 is specified, and the specification of the function specified prior to that ends.

[0023] As shown in Figure 1(C), the switch device 1 has a lower case 3 housing a printed circuit board **4.** The lower case 3 has a bottom wall portion 31 and a peripheral wall portion 32 surrounding the outer periphery of the bottom wall portion 31 over the entire circumference.

[0024] The lower case 3 is assembled to an upper case 2 with the peripheral wall portion 32 fitted inside the peripheral wall portion 22 provided in the upper case 2. In this state, the lower case 3 is attached to the upper case 2 by screws not shown.

[0025] Inside the peripheral wall portion 32, a support base 33 for the printed circuit board 4 is provided. The printed circuit board 4 is placed on the upper end of the support base 33. A rubber member 5 made of an elastic material is placed on the printed circuit board 4. The operation knobs 7 (7A to 7D) are placed on the mounting portion 52 of the rubber member 5.

[0026] Note that in the following description, when the operation knobs 7 (7A to 7D) are not particularly differentiated, they may be simply referred to as operation knobs 7.

[0027] Hereinafter, the configuration around the operation knob 7A will be described, using the operation knobs 7 as a representative example.

[0028] As shown in Figure 2, the switch device 1 has an operation knob 7A operated by a user. The operation knob 7A has a key top 71 and a peripheral wall portion 72.

[0029] The key top 71 has a substantially rectangular shape in a top view (see Figure 1(B)). A mark (not shown) suggesting the function assigned to the operation knob 7 may be attached to the centre of the key top 71.

[0030] As shown in Figure 2, the peripheral wall portion 72 is a cylindrical portion surrounding the entire outer periphery of the key top 71. A plurality of guide pieces 73 are provided on the outer periphery of the peripheral wall portion 72. As shown in Figure 1(B), the guide pieces 73 protrude from the outer periphery of

the peripheral wall portion 72 in the Y and X directions. The guide pieces 73 are provided as four pieces at 90° intervals in the circumferential direction around a central axis Za.

[0031] As shown in Figure 1(C), the upper case 2 has an upper wall portion 21 and a peripheral wall portion 22 surrounding the outer periphery of the upper wall portion 21 over the entire circumference. An opening 23 exposing the key top 71 of the operation knob 7 is provided in the upper wall portion 21. The opening 23 penetrates the upper wall portion 21 in the thickness direction (Z direction).

[0032] The opening 23 is provided in the Y direction at predetermined intervals in the same number as the number of operation knobs 7 (7A to 7D).

[0033] As shown in Figure 1(B), the opening 23 is formed in a rectangular shape by a pair of side wall portions 231, 231 arranged with a gap in the X direction and a pair of side wall portions 232, 232 arranged with a gap in the Y direction. Each of the side wall portions 231 and 232 has a guide groove 233 at the centre in the width direction. The guide pieces 73 on the operation knob 7 side are each inserted into the guide grooves 233.

[0034] In the present embodiment, the movement of the operation knob 7 in the Z direction (axis Za direction) is guided by the guide pieces 73 on the operation knob 7 side and the guide grooves 233 on the upper case 2 side.

[0035] As shown in Figure 2(A), the surface of the key top 71 on the printed circuit board 4 side is in contact with the mounting portion 52 on the rubber member 5 side. The mounting portion 52 contacts the centre of the key top 71 from the axis Za direction. Here, the axis Za is a straight line perpendicular to the printed circuit board 4 and passing through the centre of the key top 71. Furthermore, the axis Za is a straight line along the displacement direction when the operation knob 7 is pressed, being a straight line along the Z direction.

[0036] The rubber member 5 has a base portion 51, a mounting portion 52, and a support wall portion 53. The rubber member 5 is an integral part formed of an elastic material having flexibility, such as rubber. The base portion 51 is a portion placed on the printed circuit board 4. The mounting portion 52 is a portion supporting the surface of the key top 71 of the operation knob 7 on the printed circuit board 4 side. The support wall portion 53 is a portion connecting the mounting portion 52 and the base portion 51. Furthermore, the support wall portion 53 holds the mounting portion 52 at a position separated upward from the base portion 51 and supports the mounting portion 52 and the key top 71 so as to be displaceable in the axis Za direction (vertical direction in the figure).

[0037] The mounting portion 52 of the rubber member 5 supports the operation knob 7 so as to be movable back and forth in the axis Za direction.

[0038] When an operation force for moving the operation knob 7 toward the printed circuit board 4 side is input by a pressing operation of the operation knob 7, the key top 71 of the operation knob 7 displaces in a direction approaching the printed circuit board 4 while deforming the support wall portion 53. The mounting portion 52 displaces toward the printed circuit board 4 side up to a position where a stopper portion 54 contacts the printed circuit board 4 (see Figure 2(B)). When the operation force acting on the operation knob 7 is released, the mounting portion 52 displaces in a direction away from the printed circuit board 4 by the restoring force of the support wall portion 53. The support wall portion 53 constantly applies a biasing force to the operation knob 7 (key top 71) placed on the mounting portion 52 in a direction to return to the initial position before displacement (see Figure 2(A)).

[0039] As shown in Figure 3, the peripheral wall portion 72 of the operation knob 7A has engagement portions 74, 74 extending toward the printed circuit board 4 side on both sides in the X direction. As shown in Figure 4, the engagement portion 74 is a band-shaped portion extending from the centre in the Y direction of the peripheral wall portion 72 toward the printed circuit board 4 side. The end 74a on the printed circuit board 4 side of the engagement portion 74 is located on the printed circuit board 4 side (lower side in the figure) relative to the end 72a on the printed circuit board 4 side of the peripheral wall portion 72.

[0040] On both sides of the engagement portion 74 sandwiching the axis Za, recesses 75, 75 are provided recessed toward the key top 71 side. The recesses 75, 75 open at the end 74a. The recesses 75, 75 are formed in a tapered shape narrowing in the Y direction as they move away from the end 74a toward the key top 71 side (upper side in the figure).

[0041] In the engagement portion 74, the distance W75 between the recesses 75, 75 increases toward the key top 71 side.

[0042] A pair of connecting pieces 91, 91 on the movable member 9 side are engaged with the recesses 75, 75. The connecting pieces 91, 91 are provided to transmit displacement due to pressing operation of the operation knob 7 to the ring-shaped movable member 9 (see Figure 5).

[0043] Figure 5 is a cross-sectional view of the switch device 1. In Figure 5(A), a cross section of the entire switch device 1 based on the cross section along line A-A in Figure 4 is schematically shown. In Figure 5(B), a cross section of the switch device 1 along line A-A in Figure 5(A) is schematically shown.

[0044] As shown in Figure 5(A), in the upper case 2, an annular movable member 9 is housed inside the peripheral wall portion 22. The movable member 9 is housed in a state where displacement in the Z direction is allowed.

[0045] Viewed from the Z direction, the movable member 9 has a ring-shaped base portion 90 formed of a pair of first beam portions 901, 901 and a pair of

second beam portions 902, 902.

[0046] The first beam portions 901, 901 are provided parallel to each other in the Y direction. The second beam portions 902, 902 are provided parallel to each other in the X direction. The second beam portions 902, 902 connect the ends of the first beam portions 901, 901.

[0047] Viewed from the Z direction, the ring-shaped base portion 90 of the movable member 9 is arranged so as to surround the region where the operation knobs 7 (7A to 7D) of the switch device 1 are provided.

[0048] The base portion 90 is positioned in the X direction so that the centres in the X direction of the operation knobs 7 (7A to 7D) are aligned on the centre line CX in the X direction of the base portion 90.

[0049] The movable member 9 is positioned so that the operation knobs 7 (7A to 7D) are arranged side by side in the Y direction inside the base portion 90.

[0050] Inside the base portion 90, a pair of engagement portions 74, 74 of each operation knob 7 (7A to 7D) are positioned close to each other inside the first beam portions 901, 901.

[0051] A pair of connecting pieces 91, 91 are provided on the opposing parts of the first beam portions 901, 901.

[0052] On one of the first beam portions 901, four pairs of connecting pieces 91, 91 are provided with intervals in the Y direction. On the other first beam portion 901, four pairs of connecting pieces 91, 91 are also provided with intervals in the Y direction.

[0053] The pairs of connecting pieces 91, 91 on one first beam portion 901 and the pairs of connecting pieces 91, 91 on the other first beam portion 901 are provided aligned in the Y direction. The pairs of connecting pieces 91, 91 on one first beam portion 901 and the pairs of connecting pieces 91, 91 on the other first beam portion 901 are provided in the same number as the total number of operation knobs 7 (7A to 7D).

[0054] Each of the pairs of connecting pieces 91, 91 has the engagement portion 74 of the corresponding operation knob 7 (7A to 7D) placed thereon (see Figure 4). The movable member 9 is provided so as to be displaceable in the Z direction by an elastic member such as a spring not shown. As shown in Figure 4, in the present embodiment, the movable member 9 is arranged on the operation knob 7A side relative to the printed circuit board 4. In this state, the connecting pieces 91, 91 on the movable member 9 side are engaged with the recesses 75, 75 of the engagement portion 74 from the printed circuit board 4 side by a biasing force from the elastic member.

[0055] As shown in Figure 5(A), a pair of guide arms 92, 92 are provided on the outer periphery of the second beam portions 902, 902. The guide arms 92, 92 protrude in the Y direction from the outer periphery of the second beam portions 902.

[0056] As shown in Figure 5(A), a pair of guide arms 92, 92 are provided on the outer periphery of the second beam portions 902, 902.

[0057] The guide arms 92, 92 protrude in the Y direction from the outer periphery of the second beam portions 902. The guide arms 92, 92 are provided in a symmetrical positional relationship on either side of the centre line CX in the X direction of the base portion 90. The guide arms 92, 92 are inserted from the Y direction into concave grooves 221, 221 provided on the inner periphery of the peripheral wall portion 22 of the upper case 2.

[0058] As shown in Figure 5(B), a pair of concave grooves 221, 221 are provided on the inner periphery of the peripheral wall portion 22 of the upper case 2 in a symmetrical positional relationship sandwiching the centre line CX. The concave grooves 221, 221 have widths W221, W221 in the X direction. This width W221 is slightly greater than the width W92 of the guide arms 92 (W221 > W92).

[0059] In the Z direction, the concave grooves 221, 221 extend linearly downward toward the lower case 3 side. The lower ends of the concave grooves 221, 221 open to a stepped portion 223 of the upper case 2.

[0060] The guide arms 92, 92 move in the Z direction inside the concave grooves 221, 221 when the movable member 9 displaces in conjunction with displacement of the operation knobs 7 toward the printed circuit board 4 side. The guide arms 92, 92 are provided to prevent tilting of the movable member 9 when displacing in the Z direction and to guide displacement in the Z direction. In the present embodiment, the concave grooves 221, 221 and the guide arms 92, 92 constitute a tilt suppression mechanism 15.

[0061] As shown in Figure 5(A), on one of the first beam portions 901 of the movable member 9, a support portion 95 for the magnet 10 is provided near the centre in the Y direction. The support portion 95 has a pair of locking arms 951, 951 arranged with intervals in the Y direction. The locking arms 951, 951 are provided in a symmetrical positional relationship sandwiching the centre line CY in the Y direction of the first beam portion 901.

[0062] The locking arms 951, 951 extend linearly in the X direction. Claw portions 951a, 951a are provided at the tips of the locking arms 951, 951. The claw portions 951a, 951a protrude in directions approaching each other. The claw portions 951a, 951a are locked to a stepped portion 11 provided on the magnet 10. In this state, the magnet 10 is held between the claw portions 951a, 951a and the first beam portion 901, and positioning in the direction facing the magnetic sensor 8 (8A, 8B, 8C) (X direction in the figure) is performed.

[0063] Figure 6 is a diagram for explaining the arrangement of the magnet and the magnetic sensor. In Figure 6(A), the positional relationship in the Z direction between the magnet 10 and the magnetic sensor 8B when the operation knob 7 is arranged at the initial position is schematically shown. In Figure 6(B), the positional relationship in the Z direction between the mag-

net 10 and the magnetic sensor 8B when the operation knob 7 is arranged at the operation position is schematically shown.

[0064] As shown in Figure 6, the magnet 10 is provided in an orientation where the N pole is positioned on one side in the Z direction (upper side in the figure) and the S pole is positioned on the other side (lower side in the figure). Note, however, the arrangement of the N pole and the S pole may be reversed.

[0065] As shown in Figure 5(A), the magnetic sensors 8 (8A, 8B, 8C) are arranged opposite to the magnet 10 on the side of the magnet 10. The opposing surface 10a of the magnet 10 facing the magnetic sensors 8 is basically a flat surface orthogonal to the direction facing the magnetic sensors 8 (X direction in the figure). The opposing surface 10a is a magnetic flux emission surface and has a width W10 in the Y direction.

[0066] In the present embodiment, three magnetic sensors 8 (8A, 8B, 8C) are provided for one magnet 10. The magnetic sensors 8 (8A, 8B, 8C) are arranged at predetermined intervals in the Y direction along the opposing surface 10a of the magnet 10. When viewed from the direction facing the magnetic sensors 8 and the magnet 10, the magnetic sensors 8 (8A, 8B, 8C) are arranged in a position overlapping the magnet 10.

[0067] As shown in Figure 6(A), the magnetic sensors 8 (8A, 8B, 8C) have detection portions 81 and leg portions 82 extending from the detection portions 81. The magnetic sensors 8 (8A, 8B, 8C) are supported by a common support 45. The leg portions 82 of each magnetic sensor 8 (8A, 8B, 8C) penetrate the printed circuit board 4. The regions where the leg portions 82 penetrate the printed circuit board 4 are soldered on the back surface of the printed circuit board 4.

[0068] In this state, the detection surfaces 8a of each magnetic sensor 8 (8A, 8B, 8C) are arranged at a position separated from the printed circuit board 4 by a height h8.

[0069] The support 45 is used to prevent tilting of each magnetic sensor 8 (8A, 8B, 8C) and to align the height positions of each magnetic sensor 8 (8A, 8B, 8C) from the printed circuit board 4.

[0070] As shown in Figure 5(A), the magnetic sensors 8 (8A, 8B, 8C) are provided with the detection surfaces 8a facing the magnet 10. The detection surfaces 8a of the magnetic sensors 8 (8A, 8B, 8C) are positioned on a common straight line Lm. The straight line Lm is a straight line along the arrangement direction of the magnetic sensors 8 (8A, 8B, 8C). The straight line Lm is parallel to the opposing surface 10a of the magnet 10, which is the magnetic flux emission surface. Therefore, the distance from the opposing surface 10a of the magnet 10 to each detection surface 8a of the magnetic sensors 8 (8A, 8B, 8C) is set to be the same distance d.

[0071] Figure 7 is a schematic configuration diagram of a processing unit for output signals of the magnetic sensor and the capacitive sensor.

[0072] Note that in Figure 7, one of the plurality of fixed electrodes 6 is shown as a representative.

[0073] As shown in Figure 7, an MCU 41 as a control device is mounted on the printed circuit board 4. Each of the magnetic sensors 8 (8A, 8B, 8C) is connected to terminals 41a, 41b, 41c of the MCU 41 via wiring 42 (42a, 42b, 42c) on the printed circuit board 4.

[0074] As shown in Figure 6, the magnetic sensors 8 (8A, 8B, 8C) are sensors that detect magnetic force in the direction facing the magnet 10 and the magnetic sensors 8 (8A, 8B, 8C) (X direction in the figure) and output a voltage value corresponding to the magnitude of the detected magnetic force.

[0075] When the operation knob 7 is pushed, the movable member 9 reciprocates in the Z direction in conjunction with the operation of the operation knob 7. At this time, the magnet 10 attached to the movable member 9 displaces from an initial position (see Figure 6(A)) where the S pole is arranged opposite to the detection surface 8a of the magnetic sensor 8 to an operation position (see Figure 6(B)) where the N pole is arranged opposite to the detection surface 8a of the magnetic sensor 8, and then returns to the initial position (see Figure 6(A)).

[0076] Then, the direction and intensity of the magnetic force detected by the detection surface 8a of the magnetic sensor 8 change with displacement of the magnet 10.

[0077] As shown in Figure 6(A), when the magnet 10 is stationary at the initial position, the magnetic sensor 8 is arranged opposite to the S pole. In this state, the magnetic sensor 8 detects magnetic force in the direction toward the magnet 10 (left direction in the figure).

[0078] From the state shown in Figure 6(A), when the magnet 10 displaces toward the printed circuit board 4 side, the magnet 10 reaches the operation position shown in Figure 6(B). When the magnet 10 is arranged at the operation position, the magnetic sensor 8 is arranged opposite to the N pole. In this state, the magnetic sensor 8 detects magnetic force in the direction away from the magnet 10 (right direction in the figure).

[0079] For example, when the magnetic sensor 8 outputs a positive voltage value when the magnet 10 is arranged at the initial position, the magnetic sensor 8 outputs a negative voltage value when the magnet 10 is arranged at the operation position.

[0080] Therefore, when the magnet 10 displaces from the initial position toward the operation position in conjunction with the operation of the operation knob 7, the magnetic force detected by the magnetic sensor 8 changes, and at the timing when the boundary between the S pole and the N pole crosses the front of the detection portion 81, the direction of the magnetic force detected by the magnetic sensor 8 is reversed. That is, at the timing when the boundary between the S pole and the N pole crosses the front of the detection portion 81, the phase of the output voltage of the magnetic sensor 8 is reversed.

[0081] Each magnetic sensor 8 (8A, 8B, 8C) outputs to the MCU 41 a voltage value corresponding to the magnetic force detected by the detection surface 8a when the magnet 10 reciprocates in the Z direction.

[0082] The MCU 41 can detect that any one of the operation knobs 7 (7A to 7D) has been operated by the fact that the polarity of the input voltage value is reversed (phase is reversed).

[0083] Here, in the switch device 1 of the present embodiment, the magnet 10 displaces in the Z direction together with the movable member 9 in conjunction with the pressing operation of the operation knob 7. The change in magnetic force at this time is detected, and it is determined that a pressing operation on any one of the operation knobs 7 (7A to 7D) has occurred.

[0084] Then, which operation knob among the operation knobs 7 (7A to 7D) has been pressed is identified using the fixed electrode 6 (see Figure 2) functioning as a capacitive sensor.

[0085] The fixed electrode 6 is a metal member having conductivity. As shown in Figure 1(C), the fixed electrode 6 is provided in a one-to-one correspondence with the operation knobs 7 (7A to 7D).

[0086] As shown in Figure 2, the fixed electrode 6 has a plate-like detection portion 61 and leg portions 62, 62 provided on both sides in the width direction of the detection portion 61. The leg portions 62, 62 extend respectively on one side in the thickness direction (lower side in the figure) of the detection portion 61.

[0087] As shown in Figure 2, the fixed electrode 6 is attached to the surface of the printed circuit board 4 on the operation knob 7 side. The leg portions 62, 62 of the fixed electrode 6 penetrate the printed circuit board 4 in the thickness direction.

[0088] In the Z direction, the detection portion 61 is arranged parallel to the printed circuit board 4 and the key top 71 of the operation knob 7 between the printed circuit board 4 and the key top 71. An opening 610 is provided in the centre of the detection portion 61. The opening 610 is provided with an opening diameter through which the mounting portion 52 of the rubber member 5 can pass. As shown in Figure 1(B), the detection portion 61 has a size overlapping the key top 71 when viewed from the axis Za direction. In the detection portion 61 viewed from the axis Za direction, the opening 610 is provided in a region overlapping the centre of the key top 71.

[0089] As shown in Figure 7, the leg portions 62, 62 of the fixed electrode 6 are positioned diagonally in the rectangular detection portion 61. The leg portions 62, 62 are connected to terminals 41d, 41e of the MCU 41 via wiring 42 (42d, 42e). The MCU 41 constantly monitors changes in capacitance between terminals 41d and 41e.

[0090] As shown in Figure 2, when the operation knob 7A is pushed, the distance Dz in the X direction between the key top 71 and the detection portion 61 of the fixed electrode 6 changes (Dz -> Dz': Dz > Dz'). Then, on the MCU 41 side, the capacitance between terminals 41d and 41e changes, and a value different from the capacitance when the operation knob 7A is not operated is detected.

[0091] Here, although only one fixed electrode 6 is shown as an example in Figure 7, the same number of fixed electrodes 6 as the operation knobs 7A are installed on the printed circuit board 4 (see Figure 1). Each fixed electrode 6 is connected to different terminals of the MCU 41. Hence, the MCU 41 identifies the one fixed electrode 6 whose capacitance has changed. Accordingly, the operation knob 7 facing the identified fixed electrode 6 can be determined as the actually operated operation knob 7.

[0092] Here, the MCU 41 constantly monitors changes in capacitance between terminals 41d and 41e of each fixed electrode 6. Therefore, even if operation of the operation knob 7 is not confirmed from the output voltage of the magnetic sensors 8 (8A, 8B, 8C), if an abnormality is recognized in the capacitance value, it may be determined that an abnormality has occurred in the fixed electrode 6 (capacitive sensor) having the abnormal capacitance value.

[0093] Hereinafter, processing in the MCU 41 will be described.

[0094] Figure 8 is a flowchart explaining processing in the processing unit.

[0095] The MCU 41 repeatedly executes processing to confirm the presence or absence of operation of the operation knob 7 while power is supplied from the vehicle side on which the switch device 1 is mounted.

[0096] First, the MCU 41 confirms the presence or absence of a push operation on any of the operation knobs 7 (7A to 7D) from the output signals (output voltages) of the magnetic sensors 8 (8A, 8B, 8C) (step S101).

[0097] Specifically, when the voltage value input from the magnetic sensors 8 (8A, 8B, 8C) fluctuates and a polarity inversion of the voltage value is confirmed, the MCU 41 determines that an operation of any of the operation knobs 7 (7A to 7D) has occurred.

[0098] Here, (a) it may be determined that an operation of any of the operation knobs 7 (7A to 7D) has occurred when a polarity inversion of the voltage value occurs in the output voltages of all the magnetic sensors 8 (8A, 8B, 8C). Also, (b) it may be determined that an operation of any of the operation knobs 7 (7A to 7D) has occurred when a polarity inversion of the voltage value occurs in the output voltages of at least two magnetic sensors 8.

[0099] (c) When a polarity inversion of the voltage value occurs in the output voltages of some of the magnetic sensors 8 (8A, 8B, 8C) and no polarity inversion occurs in the output voltages of the remaining magnetic sensors, it is preferable to adopt the result of the majority. Therefore, the total number of magnetic sensors 8 is preferably an odd number.

[0100] When a push operation of any of the operation

knobs 7 (7A to 7D) is detected from the output signals (output voltages) of the magnetic sensors 8 (8A, 8B, 8C) (step S101, Yes), the MCU 41 confirms the presence or absence of a push operation on any of the operation knobs 7 (7A to 7D) from the outputs of the fixed electrodes 6 functioning as capacitive sensors.

[0101] Here, as an example, the MCU 41 confirms whether there is a fixed electrode 6 among the plurality of fixed electrodes 6 whose capacitance detected by the MCU 41 has changed and whose change amount ΔI exceeds a threshold Tha. Then, when there is a fixed electrode 6 whose change amount ΔI exceeds the threshold Tha, it is determined that an operation of the operation knobs 7 (7A to 7D) has occurred.

[0102] When a push operation of the operation knobs 7 (7A to 7D) is detected from the outputs of the fixed electrodes 6 (step S102, Yes), the MCU 41 confirms whether the total number of fixed electrodes 6 (target electrodes) whose change amount ΔI exceeds the threshold Tha is "1" (step S103).

[0103] When the total number of fixed electrodes 6 identified as target electrodes is "1" (step S103, Yes), the MCU 41 identifies which of the operation knobs 7 (7A to 7D) corresponds to the fixed electrode 6 identified as the target electrode (step S104).

[0104] In the present embodiment, since the fixed electrodes 6 are provided in a one-to-one correspondence with the operation knobs 7 (7A to 7D), the operated operation knob 7 (7A to 7D) can be identified by identifying the target electrode.

[0105] Then, the MCU 41 outputs information indicating the identified operation knob to a control device on the vehicle body side (step S105), and then returns to the processing of step S101.

[0106] Here, the information indicating the operation knob may simply be an identifier for identifying each of the operation knobs 7A to 7D. Also, the information may indicate the function assigned to the operation knob. Both the identifier and the information indicating the function may be included. The information items included in the output information can be appropriately added or changed according to the requirements of the in-vehicle device, which is the destination of the output signal of the switch device 1.

[0107] Accordingly, the control device on the vehicle body side realizes the function assigned to the identified operation knob. For example, when the function assigned to the identified operation knob is forward driving (D), the driving mode of the vehicle is changed to a forward driving mode in which the vehicle can drive forward.

[0108] Note that when the total number of fixed electrodes 6 identified as target electrodes in the above step S103 is not "1", for example, when it is "2" or more, the processing returns to step S101.

[0109] For example, when two or more operation knobs 7 are pressed simultaneously, two fixed electrodes 6 corresponding to the pressed operation knobs 7 are extracted as target electrodes.

[0110] Here, since the possibility of erroneous operation is high when multiple operation knobs 7 are pressed simultaneously, the processing returns to step S101 to wait for the operation knobs 7 to be operated again.

[0111] Figure 9 is a flowchart explaining a modification of the processing in the MCU 41.

[0112] Here, the flowchart shown in Figure 8 illustrates a case where detection of operation of the operation knobs 7 (7A to 7D) by the magnetic sensors 8 is confirmed, and then detection of operation of the operation knobs 7 (7A to 7D) by the fixed electrodes 6 functioning as capacitive sensors is confirmed.

[0113] As shown in Figure 9, detection of operation of the operation knobs 7 (7A to 7D) by the fixed electrodes 6 functioning as capacitive sensors may be confirmed first, and then detection of operation of the operation knobs 7 (7A to 7D) by the magnetic sensors 8 may be confirmed. Steps S201 to S203 in Figure 9 correspond to steps S102 to S104 in Figure 8. Step S204 in Figure 9 corresponds to step S101 in Figure 8. Step S205 in Figure 9 corresponds to step S105 in Figure 8.

[0114] In the above embodiment, as an example, a ring-shaped movable member 9 is exemplified. Any member capable of displacing in conjunction with operation of each operation knob 7 (7A to 7D) and to which the magnet 10 can be attached may be appropriately selected, for example, a columnar rod or a band-shaped plate.

[0115] In the above embodiment, a case where the displacement amount of the movable member 9 displacing in conjunction with operation of the operation knob 7 substantially matches the displacement amount due to the pushing operation of the operation knob 7 is exemplified. For example, an increase gear train may be interposed to amplify and transmit the displacement of the operation knob 7 in the Z direction to another linear moving member via a gear train, and the displacement of the magnet 10 attached to the linear moving member may be detected by the magnetic sensors 8.

[0116] In such a case, while suppressing the displacement amount of the operation knob 7 in the Z direction, the stroke amount of the magnet necessary for detection of magnetic force change by the magnetic sensors 8 can be secured. While suppressing the thickness in the Z direction of the entire switch device, detection by the magnetic sensors 8 can be appropriately performed. Also, since the stroke amount of the magnet can be secured, use of a cheaper ferrite magnet instead of an expensive neodymium magnet can be expected.

[0117] In this case, the displacement direction of the linear moving member is not limited to the displacement direction (Z direction) of the operation knob 7. For example, the displacement direction of the linear moving member may be the Y direction or the X direc-

tion. In this case, the thickness of the switch device in the Z direction can be further suppressed.

[0118] Figures 10 and 11 are diagrams explaining a switch device 1A employing a movable member 9A according to a modification.

[0119] Figure 10(A) is a cross-sectional view of the switch device 1A cut along a surface along the movable member 9A. Figure 10(B) is a diagram schematically showing a cross section of the switch device 1A along line A-A in Figure 10(A). Figure 10(C) is an enlarged view of the region C in Figure 10(B) and is a diagram explaining a change in the relative positional relationship between the magnet 10 and the magnetic sensors 8. Figure 11(A) is a cross-sectional view of the switch device 1A along line B-B in Figure 10(A). Figure 11(B) shows a state where the operation knob 7D of the switch device 1A is pressed from the initial position in Figure 11(A) to the operation position.

[0120] As shown in Figure 10(A), in the upper case 2, an annular movable member 9A is housed inside the peripheral wall portion 22.

[0121] The movable member 9A has a ring-shaped base portion 90A formed of a cylindrical first shaft portion 905, a cylindrical second shaft portion 906, and a pair of connecting beams 907, 907.

[0122] The connecting beams 907, 907 are provided parallel to each other in the X direction. The first shaft portion 905 and the second shaft portion 906 are provided parallel to each other in the Y direction. One end and the other end in the longitudinal direction of the first shaft portion 905 and the second shaft portion 906 are connected to the connecting beams 907, 907.

[0123] Viewed from the Z direction, the base portion 90A of the movable member 9A is arranged so as to surround the region where the operation knobs 7 (7A to 7D) of the switch device 1 are provided. The movable member 9A is positioned so that the operation knobs 7 (7A to 7D) are arranged side by side in the Y direction inside the base portion 90A.

[0124] A pair of hinge parts 96, 96 are extrapolated on the first shaft portion 905. The hinge parts 96, 96 are arranged with intervals in the Y direction. The hinge parts 96, 96 are provided in a symmetrical positional relationship sandwiching the centre line CY in the Y direction of the base portion 90A. The hinge parts 96, 96 are fixed to the inner periphery of the peripheral wall portion 22 of the upper case 2.

[0125] The first shaft portion 905 penetrates the support holes 96a, 96a of the hinge parts 96, 96 in the Y direction. The first shaft portion 905 is rotatably supported by the hinge parts 96, 96. Therefore, the movable member 9A is rotatable about an axis Y1 along the longitudinal direction of the first shaft portion 905. In the movable member 9A, at least one of the second shaft portion 906 and the connecting beams 907 is supported by an elastic member such as a spring not shown.

[0126] Therefore, the base portion 90A of the movable member 9A is arranged in a horizontal line HL by a biasing force from the elastic member when the operation knobs 7 (7A to 7D) are not pressed in the normal state (see Figure 10(B)).

[0127] On the second shaft portion 906, a support portion 95 for the magnet 10 is provided near the centre in the Y direction. As shown in Figure 10(B), the support portion 95 is extrapolated and fixed to the second shaft portion 906. The support portion 95 is provided in a direction along the Z direction. The support portion 95 extends from the second shaft portion 906 in a direction away from the printed circuit board 4 side (downward in the figure). When viewed from the X direction, a part of the lower portion of the support portion 95 overlaps the printed circuit board **4.**

[0128] On the printed circuit board 4 side of the support portion 95 (left side in the figure), the magnet 10 is provided. The magnet 10 is provided in an orientation where the N pole is positioned on one side in the Z direction (upper side in the figure) and the S pole is positioned on the other side (lower side in the figure).

[0129] On the printed circuit board 4, a magnetic sensor 8 is arranged opposite to the magnet 10 at a position on the side of the magnet 10 (see Figure 10(C)). Also in this modification, although not shown, three magnetic sensors 8 (8A, 8B, 8C) are provided for one magnet 10. The magnetic sensors 8 (8A, 8B, 8C) are arranged at predetermined intervals in the Y direction along the opposing surface 10a of the magnet 10.

[0130] The operation knobs 7 (7A to 7D) of the switch device 1A have the same configuration as in the above embodiment. Here, the operation knob 7D is described as a representative example.

[0131] As shown in Figure 11(A), on the peripheral wall portion 72 of the operation knob 7D, a locking portion 76 is provided on the second shaft portion 906 side in the X direction (right side in the figure). The locking portion 76 is provided in a direction along the key top 71. One end 76a of the locking portion 76 is connected to the lower end of the peripheral wall portion 72. The other end 76b of the locking portion 76 crosses the second shaft portion 906 in the X direction and reaches a position extending to the end 907a of the connecting beam 907. The locking portion 76 is provided in a direction along the horizontal line HL and is placed on the second shaft portion 906 from the Y direction.

[0132] In the switch device 1A, when an operation force for moving the operation knob 7D toward the printed circuit board 4 side is input by a pressing operation of the operation knob 7D, the key top 71 of the operation knob 7 displaces toward the printed circuit board 4 side up to a position where the stopper portion 54 contacts the printed circuit board 4 (operation position: see Figure 11(B)) while deforming the support wall portion 53 of the rubber member 5.

[0133] At this time, the second shaft portion 906 of the movable member 9A is pushed by the locking portion 76 on the operation knob 7D side and rotates in the

circumferential direction about the axis Y1 to displace toward the side approaching the printed circuit board 4. Accordingly, the movable member 9A displaces so that the second shaft portion 906 side reaches a position below the horizontal line HL. Here, since the first shaft portion 905 is supported at two points by the pair of hinge parts 96, 96, tilting in the Y direction when the second shaft portion 906 displaces in the Z direction is suppressed. In this modification, the pair of hinge parts 96, 96 constitute the tilt suppression mechanism 15.

[0134] In this process, the magnet 10 supported by the support portion 95 of the second shaft portion 906 changes the relative positional relationship with the magnetic sensors 8 (8A, 8B, 8C) from the positional relationship shown on the left side in Figure 10(C) to the positional relationship shown on the right side. Then, the direction of the magnetic force detected by the magnetic sensors 8 (8A, 8B, 8C) is reversed between the positional relationship shown on the left side in Figure 10(C) and the positional relationship shown on the right side. Accordingly, as in the above embodiment, the MCU 41 can detect that any of the operation knobs 7 (7A to 7D) has been pressed.

[0135] Figures 12 and 13 are diagrams explaining a switch device 1B employing a movable member 9B according to another modification.

[0136] Figure 12(A) is a cross-sectional view of the switch device 1B cut along a surface along the movable member 9B. Figure 12(B) is a diagram schematically showing a cross section of the switch device 1A along line A-A in Figure 12(A). Figure 12(C) is an enlarged view of the region D in Figure 12(B) and is a diagram explaining a change in the relative positional relationship between the magnet 10 and the magnetic sensors 8.

[0137] Figure 13(A) is a cross-sectional view of the switch device 1B along line B-B in Figure 12(A). Figure 13(B) is a diagram explaining displacement of the guide piece 97 when any of the operation knobs 7 (7A to 7D) is pushed.

[0138] Figure 14 is a cross-sectional view of the switch device 1B along line C-C in Figure 12(A).

[0139] As shown in Figure 12(A), in the upper case 2, the movable member 9B is housed inside the peripheral wall portion 22.

[0140] The movable member 9B is a rod-shaped member composed of a cylindrical shaft portion 908. The movable member 9B is provided so as to be displaceable in the Z direction by an elastic member such as a spring not shown.

[0141] The movable member 9B is provided along the inner periphery of the peripheral wall portion 22 in the Y direction. In the switch device 1B, the movable member 9B is positioned so as to be arranged side by side in the Y direction on the side of each operation knob 7 (7A to 7D).

[0142] A pair of guide pieces 97, 97 and a support portion 95 are extrapolated on the shaft portion 908 of the movable member 9B. The guide pieces 97, 97 are arranged with intervals in the Y direction. The pair of guide pieces 97, 97 are provided in a symmetrical positional relationship sandwiching the centre line CY in the Y direction of the movable member 9B (shaft portion 908). Note that the movable member 9B may have three or more guide pieces 97.

[0143] The support portion 95 is located between the pair of guide pieces 97, 97. In the present embodiment, the support portion 95 is positioned overlapping the centre line CY.

[0144] As shown in Figures 12(B) and (C), the support portion 95 is extrapolated and fixed to the shaft portion 908. The support portion 95 is provided in a direction along the Z direction. The support portion 95 extends from the shaft portion 908 in a direction away from the printed circuit board 4 side (downward in the figure). When viewed from the X direction, a part of the lower portion of the support portion 95 overlaps the printed circuit board 4. On the printed circuit board 4 side of the support portion 95 (left side in the figure), the magnet 10 is provided. The magnet 10 is provided in an orientation where the N pole is positioned on one side in the Z direction (upper side in the figure) and the S pole is positioned on the other side (lower side in the figure).

[0145] On the printed circuit board 4, magnetic sensors 8 (8A, 8B, 8C) are arranged opposite to the magnet 10 at a position on the side of the magnet 10 (see Figure 12(C)).

[0146] Also in this modification, although not shown, three magnetic sensors 8 (8A, 8B, 8C) are provided for one magnet 10. The magnetic sensors 8 (8A, 8B, 8C) are arranged at predetermined intervals in the Y direction along the opposing surface 10a of the magnet 10.

[0147] As shown in Figure 12(A), the guide piece 97 has a base portion 971 extrapolated from the movable member 9B. An insertion hole 97a is provided at one end side of the base portion 971. The insertion hole 97a penetrates the base portion 971 in the Y direction.

[0148] As shown in Figure 13(A), the base portion 971 of the guide piece 97 is a quadrangular column-shaped member. The base portion 971 is arranged in a direction along a horizontal line HL orthogonal to the central axis Y2 of the movable member 9B. The tip 97c of the base portion 971 faces the peripheral wall portion 22 of the upper case 2 with a gap.

[0149] The guide piece 97 is restricted from rotating about the central axis Y2 so as to be always arranged in a direction along the horizontal line HL in the base portion 90 of the movable member 9B.

[0150] As shown in Figure 12(A), the tip 97c side of the guide piece 97 is inserted into a guide groove 341 between a pair of guide walls 34, 34. The guide walls 34, 34 protrude inward from the inner periphery of the peripheral wall portion 32 of the lower case 3. The guide walls 34, 34 are provided with an interval W34 in the Y direction. This interval W34 is wider than the

width W97 of the guide piece 97 in the Y direction (W34 > W97).

[0151] As shown in Figure 13(B), the guide groove 341 is provided in a range of height h341 in the Z direction extending to the bottom wall portion 31 of the lower case 3 along the Z direction.

[0152] In the present modification, the movable member 9B displaces toward the printed circuit board 4 side in conjunction with the pressing operation of the operation knobs 7 (7A to 7D) toward the printed circuit board 4 side. At this time, the guide piece 97 on the movable member 9B side moves along the guide groove 341, thereby guiding the movement of the movable member 9B in the Z direction. Also, since the guide grooves 341 are provided with intervals in the Y direction, tilting of the movable member 9B during displacement is suppressed. In the present modification, the guide piece 97 on the movable member 9B side and the guide groove 341 constitute a tilt suppression mechanism 15.

[0153] The operation knobs 7 (7A to 7D) of the switch device 1B have the same configuration as in the above embodiment. Here, the operation knob 7D is described as a representative example.

[0154] As shown in Figure 14, on the peripheral wall portion 72 of the operation knob 7D, a locking portion 76 is provided on the shaft portion 908 side in the X direction (right side in the figure). The locking portion 76 is provided in a direction along the key top 71. One end 76a of the locking portion 76 is connected to the lower end of the peripheral wall portion 72. The other end 76b of the locking portion 76 reaches a position crossing the shaft portion 908 in the X direction. The locking portion 76 is provided in a direction along the horizontal line HL and is placed on the shaft portion 908 from the Y direction.

[0155] In the switch device 1B, when an operation force for moving the operation knob 7D toward the printed circuit board 4 side is input by a pressing operation of the operation knob 7D, the key top 71 of the operation knob 7 displaces toward the printed circuit board 4 side while deforming the support wall portion 53 up to a position where the stopper portion 54 contacts the printed circuit board 4.

[0156] At this time, the shaft portion 908 of the movable member 9B is pushed by the locking portion 76 on the operation knob 7D side and displaces toward the printed circuit board 4 side along the Z direction. Accordingly, the shaft portion 908 side of the movable member 9B displaces below the original horizontal line HL.

[0157] That is, the locking portion 76 is provided to displace the movable member 9B in conjunction with displacement of the operation knobs 7 (7A to 7D) toward the printed circuit board 4 side.

[0158] Here, since the locking parts 76 of the operation knobs 7 (7A to 7D) are placed on the movable member 9B, the movable member 9B can displace in conjunction with displacement of an operated operation knob 7 regardless of which operation knob 7 (7A to 7D) is operated.

[0159] As shown in Figure 13(B), at this time, the guide piece 97 inserted between the pair of guide walls 34, 34 also displaces toward the printed circuit board 4 side. Here, the guide piece 97 is inserted between the pair of guide walls 34, **34.** Therefore, when the operation knob 7D located at the end is pressed in the switch device 1B, the side of the movable member 9B on the operation knob 7D side (right side in Figure 12(A)) is less likely to tilt more toward the printed circuit board 4 side than the side on the operation knob 7A side (left side in Figure 12(A)) where the operation knob 7 is not pressed.

[0160] In the process of displacement of the movable member 9B, the magnet 10 supported by the support portion 95 changes the relative positional relationship with the magnetic sensors 8 (8A, 8B, 8C) from the positional relationship shown on the left side in Figure 12(C) to the positional relationship shown on the right side. Then, the direction of the magnetic force detected by the magnetic sensors 8 (8A, 8B, 8C) is reversed between the positional relationship shown on the left side in Figure 12(C) and the positional relationship shown on the right side. Accordingly, as in the above embodiment, the MCU 41 can detect that any of the operation knobs 7 (7A to 7D) has been pressed.

[0161] In the above embodiment, a case where the operation of the operation knobs 7 is detected using the fixed electrodes 6 functioning as capacitive sensors is exemplified. Instead of the detection method using the change in capacitance, an inductive sensor (inductive proximity sensor) may be used to detect operation of the operation knobs 7.

[0162] As an example, the inductive sensor includes a sensor coil provided on the printed circuit board 4 opposite to the operation knobs 7 and a metal or conductor provided on the operation knobs 7 opposite to the sensor coil. In this case, a high-frequency signal is supplied to the sensor coil to generate an electromagnetic field around the sensor coil. When the metal or conductor approaches the electromagnetic field due to operation of the operation knobs 7, the inductance of the sensor coil changes. Therefore, by detecting this change in inductance, operation of the operation knobs 7 can be detected.

[0163] Also, instead of the fixed electrodes 6 functioning as capacitive sensors, a film with electrodes printed on the back surfaces of the operation knobs 7 (7A, 7B, 7C) may be attached. In this case, by connecting the film-shaped electrodes to wiring on the printed circuit board 4 side via a flat cable or the like, the MCU 41 can detect changes in capacitance and identify the operated operation knob 7.

[0164] Also, instead of the leg portions 62 of the fixed electrodes 6 functioning as capacitive sensors, the fixed electrodes 6 may be finally connected to the MCU 41 via a flat cable or spring.

[0165] In the above embodiment, a case where the magnetic sensor outputs a voltage value corresponding to the magnitude of the detected magnetic force is exemplified. The magnetic sensor may be a latching Hall sensor IC outputting a digital signal corresponding to the magnitude of the detected magnetic force.

[0166] Furthermore, in the above embodiment, a case where the detection portion 81 is a magnetic sensor 8 with legs positioned away from the printed circuit board 4 in the axis Za direction is exemplified. Also, in the above modification, a case where a plurality of magnetic sensors surface-mounted on one substrate are employed to detect changes in magnetic force due to displacement of the magnet 10 in the axis Za direction is exemplified. The substrate supporting the magnetic sensors 8 may be a plurality of substrates on the same plane.

[0167] In the above embodiment, a case where all the magnetic sensors 8 (8A, 8B, 8C) have detection surfaces 8a facing the magnet 10 is exemplified.

[0168] The magnetic sensors 8 may include detection elements with detection surfaces 8a facing the magnet 10 and reverse detection elements with detection surfaces 8a facing the opposite side to the magnet 10. In this case, it is preferable that the distances between the detection surfaces 8a of each magnetic sensor 8 and the opposing surface 10a of the magnet 10 are the same distance d.

[0169] In such a case, by arranging at least one magnetic sensor with the detection surface 8a facing opposite to the magnet 10, the output voltage of the magnetic sensor with the detection surface 8a facing the opposite side and the output voltages of the other magnetic sensors have opposite phases.

[0170] Therefore, when an abnormality is recognized in the output voltage of any magnetic sensor, it is possible to identify which magnetic sensor has a problem by comparing output voltages with different phases. Accordingly, the presence or absence of operation of the operation knobs 7 can be determined from output signals (output voltages) of other magnetic sensors excluding the identified magnetic sensor.

[0171] In the above embodiment, a case where the magnetic sensor 8 outputs a positive voltage value when the magnet 10 is arranged at the initial position and outputs a negative voltage value when the magnet 10 is arranged at the operation position is exemplified.

[0172] The magnetic sensor 8 may output a positive voltage value both when the magnet 10 is arranged at the initial position and when the magnet 10 is arranged at the operation position. For example, the output voltage when the magnet 10 is arranged at the initial position may be higher than the output voltage when the magnet 10 is arranged at the operation position. In this case, the MCU 41 can detect that any of the operation knobs 7 (7A to 7D) has been operated by detecting that the output voltage of the magnetic sensor 8 has changed crossing an intermediate value between the output voltage when the magnet 10 is arranged at the initial position and the output voltage when the magnet 10 is arranged at the operation position.

[0173] As described above, the switch device 1 according to the embodiment has the following configuration.

(1) The switch device 1 has:

a plurality of operation knobs 7 (7A to 7D) (operable portions) which are independently displaceable in the same direction along the axis Za;
a movable member 9 that displaces in the Za direction in conjunction with displacement of an operated operation knob 7 regardless of which of the plurality of operation knobs 7 (7A to 7D) is operated;
a magnet 10 attached to the movable member 9;
a plurality of magnetic sensors 8 (8A, 8B, 8C) (detection elements) arranged opposite to the magnet 10 in the radial direction of the displacement direction of the movable member 9;
operation sensors (fixed electrodes 6) that are provided in a one-to-one correspondence with the plurality of operation knobs 7 (7A to 7D) and detect operation of the operation knobs 7 (7A to 7D); and
an MCU 41 as a processing unit configured to identify the operated operation knob 7 among the plurality of operation knobs 7 (7A to 7D) based on output signals of the plurality of magnetic sensors 8 (8A, 8B, 8C) and output signals of the operation sensors (fixed electrodes 6).

[0174] With such a configuration, it is possible to identify that any of the operation knobs 7 has been operated from output signals of the plurality of magnetic sensors 8 (8A, 8B, 8C), and identify which operation knob 7 (7A to 7D) has been operated from output signals of the operation sensors (fixed electrodes 6).

[0175] Here, when providing a switch device 1 having a plurality of operation knobs 7 (7A to 7D) independently displaceable, the total number of magnets and magnetic sensors (detection elements) can be reduced compared to a case where magnets 10 and a plurality of magnetic sensors 8 are provided for each operation knob 7 to identify the operated operation knob 7.

[0176] Accordingly, a switch device 1 having a plurality of operation knobs 7 (7A to 7D) independently displaceable can be provided while suppressing manufacturing costs of the switch device 1.

[0177] (2) In (1) above,
the operation sensors have fixed electrodes 6 arranged with a gap between the operation knobs 7 (7A to 7D) and the fixed electrodes 6 on the displacement side

(printed circuit board 4 side) when the operation knobs 7 (7A to 7D) are operated.

[0178] The MCU 41 is a capacitive sensor (capacitive sensor) configured to identify the operated operation knob 7 (7A to 7D) based on changes in capacitance caused by the operated operation knob 7 (7A to 7D) approaching the fixed electrodes 6.

[0179] With such a configuration, the operated operation knob 7 (7A to 7D) can be identified by adding fixed electrodes 6 on the printed circuit board 4. Therefore, the operated operation knob 7 (7A to 7D) can be identified with a low-cost configuration.

[0180] Also, (a) even if physical displacement of the movable member 9 is detected by the magnetic sensors 8, when operation of the operation knobs 7 (7A to 7D) is not confirmed by the capacitive sensor, identification of the operated operation knob 7 is not performed. Therefore, even if there is an erroneous operation of the operation knob caused by collision with an object, the possibility of erroneously determining that the operation knob 7 has been operated can be reduced.

[0181] Furthermore, (b) even if operation of the operation knobs 7 (7A to 7D) is confirmed by the capacitive sensor, when physical displacement of the movable member 9 cannot be detected by the magnetic sensors 8, identification of the operated operation knob 7 is not performed. When neither a change in capacitance nor physical displacement of the movable member 9 is recognized, identification of the operated operation knob 7 is not performed. Therefore, the possibility of erroneously determining that the operation knob 7 has been operated can be reduced.

[0182]

(I) In (2) above,
when operation of a plurality of operation knobs 7 (7A to 7D) is detected at the same timing by the capacitive sensor, the MCU 41 does not identify the operated operation knob 7.

[0183] When a plurality of operation knobs 7 (7A to 7D) are pressed at the same timing, erroneous identification of the operated operation knob can be suitably prevented.

[0184] (3) In (2) or (I) above,
a rubber member 5 (mounting portion 52: elastic member) supporting the operation knobs 7 so as to be displaceable in the axis Xa direction is provided on the side opposite to the operation knobs 7 (7A to 7D) in the printed circuit board 4 supporting the fixed electrodes 6.

[0185] The fixed electrode 6 has a plate-like detection portion 61 arranged parallel to the key top 71 of the operation knob 7.

[0186] An opening 610 for avoiding interference with the mounting portion 52 is provided in the detection portion 61.

[0187] With such a configuration, the reciprocating displacement of each of the plurality of operation knobs 7 (7A to 7D) in the axis Xa direction can be realized by the rubber member 5 (elastic member) without significantly impairing the opposing area with the key top 71 in the detection portion 61. Accordingly, a switch device having a plurality of operation knobs 7 (7A to 7D), which are independently displaceable and capable of identifying the operated operation knob 7 (7A to 7D), can be identified.

[0188] (II) In (3) above,
the detection portion 61 of the fixed electrode 6 has a size overlapping the key top 71 when viewed from the axis Za direction along the displacement direction of the operation knobs 7 (7A to 7D). In the detection portion 61 viewed from the axis Za direction, the opening 610 is provided in a region overlapping the centre of the key top 71.

[0189] With such a configuration, the central part of the operation knob 7 (key top 71) can be supported by the mounting portion 52 of the rubber member 5. Compared to a case where the peripheral part of the key top 71 is supported, the support stability of the operation knob 7 is improved. Furthermore, when the operation knob 7 is pressed down, the possibility that the operation knob 7 displaces in a tilted state with respect to the axis Za can be reduced. Furthermore, the operability when pressing the key top 71 can be made uniform for all the operation knobs 7A to 7D.

[0190] Also, the fixed electrode 6 has other regions facing the key top 71 in the Z direction except for a part of the centre region (the region of the opening 610). Accordingly, an effective opposing area with the detection portion 61 in the key top 71 is secured, and changes in capacitance due to operation of the operation knobs 7 (7A to 7D) can be appropriately detected.

[0191] (III) In (II) above,
the rubber member 5 is an integral part having a cylindrical mounting portion 52, a base portion 51 placed on the printed circuit board 4, and a support wall portion 53 surrounding the outer periphery of the mounting portion 52 over the entire circumference.

[0192] The support wall portion 53 connects the outer periphery of the mounting portion 52 and the base portion 51 and supports the mounting portion 52 so as to be displaceable in the axis Xa direction at a position separated from the operation knob 7 side.

[0193] In the rubber member 5, the combination of the mounting portion 52 and the support wall portion 53 is provided at least in the same number as the operation knobs 7 (7A to 7D).

[0194] With such a configuration, displacement in the axis Za direction of each of the operation knobs 7 (7A to 7D) can be managed by one rubber member 5. Compared to a case where the combination of the mounting portion 52 and the support wall portion 53 is provided for each operation knob 7 (7A to 7D), a switch device 1 can be provided with a lower cost configura-

tion.

[0195] (4) In any one of (1) to (3) and (I) to (III) above, the switch devices 1, 1A, 1B are provided with a tilt suppression mechanism 15 for suppressing tilting of the movable members 9, 9A, 9B when displacing.

[0196] When the operated operation knob 7 is located at an end position of the plurality of operation knobs 7 (7A to 7D) arranged side by side, the movable members 9, 9A, 9B may displace in a tilted state with respect to the axis Za. By providing the tilt suppression mechanism 15, the possibility that the movable members 9, 9A, 9B displace in a tilted state with respect to the axis Za can be reduced.

[0197] (IV) In (4) above,
as shown in Figure 5, the tilt suppression mechanism 15 restricts at least one of the tilt of the movable member 9 with respect to the axis Za along the displacement direction of the operation knobs 7, the tilt of the movable member 9 with respect to the straight line CX along the arrangement direction of the operation knobs 7, and the tilt of the movable member 9 with respect to the straight line CY orthogonal to the straight line CX along the arrangement direction of the operation knobs 7.

[0198] As an example, the tilt suppression mechanism 15 includes a pair of guide arms 92, 92 protruding in the Y direction from the second beam portions 902 located on both sides in the straight line CX direction of the movable member 9, and a pair of concave grooves 221, 221 provided on the inner periphery of the peripheral wall portion 22 of the upper case 2.

[0199] Viewed from the axis Za direction, the pair of guide arms 92, 92 and the pair of concave grooves 221, 221 are provided in a symmetrical positional relationship sandwiching the centre line CX in the X direction of the base portion 90. The guide arms 92, 92 are inserted into the concave grooves 221, 221 from the Y direction (see Figure 5).

[0200] With such a configuration, the possibility that the movable member 9 displaces in a tilted state with respect to the axis Za can be reduced.

[0201] (5) In any one of (1) to (4) and (I) to (IV) above,
one magnet 10 is attached to the movable member 9.

[0202] At least two magnetic sensors 8 are provided.

[0203] With such a configuration, even if an abnormality occurs in at least one magnetic sensor, operation of the operation knobs 7 can be detected from output signals of the remaining magnetic sensors. Accordingly, a highly redundant switch device 1 is realized.

[0204] (V) In (5) above,
the opposing surface 10a of the magnet 10, which is the magnetic flux emission surface, has a predetermined width W10 in the Y direction orthogonal to the direction facing the magnetic sensors 8 (8A, 8B, 8C).

[0205] The magnetic sensors 8 (8A, 8B, 8C) are arranged with intervals in the Y direction.

[0206] With such a configuration, even if a part of the magnetic sensors 8 (8A, 8B, 8C) has a problem, the presence or absence of operation of the operation knobs 7 can be determined from output voltages of the remaining magnetic sensors without problems.

[0207] Therefore, even if any of the magnetic sensors 8 has a problem, detection of the presence or absence of operation of the operation knobs 7 is not affected. Accordingly, robustness against failure of the magnetic sensors 8 can be improved.

[0208] (VI) In (V) above,
the magnetic sensors 8 include detection elements with detection surfaces 8a facing the magnet 10 and reverse detection elements with detection surfaces 8a facing the opposite side to the magnet 10.

[0209] The total number of the plurality of magnetic sensors 8 is at least three.

[0210] With such a configuration, at least one magnetic sensor 8B is arranged with the detection surface 8a facing opposite to the magnet 10. The magnetic sensors 8A, 8C arranged with the detection surfaces 8a facing the magnet 10 and the magnetic sensor 8B arranged with the detection surface 8a facing opposite to the magnet 10 have output signals with inverted phases.

[0211] Therefore, the magnetic sensors 8A and 8C arranged with the detection surfaces 8a facing the magnet 10 and the magnetic sensor 8B arranged with the detection surface 8a facing opposite to the magnet 10 have output signals with different phases.

[0212] Then, by comparing the output signals with different phases, it can be confirmed that one of the magnetic sensors 8A, 8C arranged with the detection surfaces 8a facing the magnet 10 and the magnetic sensor 8B arranged with the detection surface 8a facing opposite to the magnet 10 has a problem. By providing at least three magnetic sensors 8, it is possible to identify which magnetic sensor has a problem by changing the combination of output signals to be compared. The presence or absence of operation of the operation knobs 7 can be determined from output signals of other magnetic sensors excluding the identified magnetic sensor.

[0213] (VII) In (VI) above,
the magnetic sensors 8 (8A, 8B, 8C) are arranged with positions aligned in the axis Za direction and arranged so that the distances d from the surface (opposing surface 10a) of the magnet 10 are aligned.

[0214] With such a configuration, the output voltages (output signals) of the magnetic sensors 8 (8A, 8B, 8C) are basically aligned, making comparison of output signals of each magnetic sensor 8 easier.

[0215] (6) In any one of (1) to (5) and (I) to (VII) above,
the movable member 9B is provided in a direction along the printed circuit board 4 and is a rod-shaped member displaceable in the Z direction along the operation direction of the operation knobs 7 (7A to 7D).

[0216] The plurality of operation knobs 7 (7A to 7D)

are arranged along the longitudinal direction of the movable member 9B.

[0217] Each of the plurality of operation knobs 7 (7A to 7D) has a locking portion 76 as an operator for displacing the movable member.

[0218] With such a configuration, a movable member 9 displaceable in the Za direction in conjunction with displacement of an operated operation knob 7 can be provided with a simple configuration regardless of which of the plurality of operation knobs 7 (7A to 7D) is operated.

[0219] (VIII) In (5) above,
a pair of guide pieces 97, 97 are provided on the movable member 9B with intervals in the longitudinal direction.

[0220] Each of the guide pieces 97, 97 is inserted into a guide groove 341 along the displacement direction (Z direction) of the movable member 9B.

[0221] As an example, the tilt suppression mechanism 15 is constituted by the guide pieces 97, 97 and the guide grooves 341, 341.

[0222] With such a configuration, when an operation knob positioned at an end among the plurality of operation knobs 7 (7A to 7D) arranged along the longitudinal direction of the movable member 9B, for example, the operation knobs 7A and 7D, is operated, the possibility that the movable member 9D displaces in a tilted state with respect to the horizontal line can be reduced.

[0223] (7) In any one of (1) to (5) and (I) to (VII) above,
the movable member 9A is an annular member surrounding the region where the operation knobs 7 (7A to 7D) are provided and displaceable in the operation direction of the operation knobs 7 (7A to 7D).

[0224] In the movable member 9A, one of a pair of shaft portions (first shaft portion 905, second shaft portion 906) facing each other sandwiching the operation knobs 7 (7A to 7D) is the first shaft portion 905, which is rotatably supported about an axis Y1 along the longitudinal direction of the first shaft portion 905. The magnet 10 is attached to the other second shaft portion 906.

[0225] Each of the operation knobs 7 (7A to 7D) has a locking portion 76 as an operator for displacing the second shaft portion 906 in conjunction with operation of the operation knobs 7 (7A to 7D).

[0226] With such a configuration, enlargement of the switch device in the operation direction of the operation knobs 7 (7A to 7D) is prevented, and the displacement amount of the magnet 10 when the operation knobs 7 (7A to 7D) are operated can be secured.

[0227] Accordingly, operation of the operation knobs 7 (7A to 7D) can be appropriately detected using the magnetic sensors 8 (8A to 8C).

[0228] (IX) In (7) above,
as shown in Figure 10, the tilt suppression mechanism 15 restricts at least one of the tilt of the movable member 9 with respect to the axis Za along the displacement direction of the operation knobs 7 and the tilt of the movable member 9 with respect to the straight line CY orthogonal to the straight line CX along the arrangement direction of the operation knobs 7.

[0229] As an example, the tilt suppression mechanism 15 includes one of the first shaft portion 905 of the movable member 9A and a pair of hinge parts 96, 96 fixed to the inner periphery of the peripheral wall portion 22 of the upper case 2. The pair of hinge parts 96, 96 are provided in a symmetrical positional relationship sandwiching the straight line CY.

[0230] With such a configuration, the possibility that the movable member 9 displaces in a tilted state with respect to the axis Za can be reduced.

[0231] (8) In any one of (1) to (7) and (I) to (VIII) above,
different functions are assigned to each of the plurality of operation knobs 7 (7A to 7D).

[0232] The assigned functions are modes related to stopping or driving of a vehicle.

[0233] As an example, when functions such as parking (P), reverse driving (R), neutral (N), and forward driving (D) are assigned one by one to the operation knobs 7A to 7D in the switch device 1, a highly redundant and inexpensive switch device 1 can be provided.

[0234] The embodiments and modifications of the present invention have been described above, but the present invention is not limited to these and can be appropriately changed within the technical scope of the invention.

[Explanation of the Reference Numerals]

[0235]

1, 1A, 1B: switch device
2: upper case
21: upper wall portion
22: peripheral wall portion
221: concave groove
23: opening
233: guide groove
3: lower case
4: printed circuit board
41: MCU
5: rubber member
51: base portion
52: mounting portion
53: support wall portion
54: stopper portion
6: fixed electrode
61: detection portion
610: opening
7 (7A, 7B, 7C, 7D): operation knob
71: key top
72: peripheral wall portion
73: guide piece
74: engagement portion

75: recess
76: locking part
8 (8A, 8B, 8C): magnetic sensor
81: detection portion
82: leg portion
9, 9A, 9B: movable member
90: base portion
901: first beam portion
902: second beam portion
905: first support shaft
906: second support shaft
907: connecting beam
91: connecting piece
92: guide arm
95: support portion
951: locking arm
97: connecting part
10: magnet
10a: opposing surface
15: tilt suppression mechanism
Za: axis

Claims

1. A switch device comprising:

a plurality of operable portions which are independently displaceable;
a movable member that displaces in conjunction with displacement of an operated operable portion regardless of which of the plurality of operable portions is operated;
a magnet attached to the movable member;
a plurality of detection elements arranged opposite to the magnet in the radial direction of the displacement direction of the movable member;
operation sensors that are provided in a one-to-one correspondence with the plurality of operable portions and detect operation of the operable portions; and
a processing unit configured to identify the operated operable portion among the plurality of operable portions based on output signals of the plurality of detection elements and output signals of the operation sensors.

2. The switch device according to claim 1,

wherein the operation sensors have fixed electrodes arranged with a gap between the operable portions and the fixed electrodes on the displacement side of the operable portions when the operable portions are operated, and
the processing unit is a capacitive sensor configured to identify the operated operable portion based on changes in capacitance caused by the operated operable portion approaching the fixed electrodes.

3. The switch device according to claim 2,

wherein an elastic member supporting the operable portions so as to be displaceable is provided on the side opposite to the operable portions in a substrate supporting the fixed electrodes,
the fixed electrodes have plate-like detection portions arranged opposite to the operable portions, and
openings for avoiding interference with the elastic member are provided in the detection portions.

4. The switch device according to claim 1,
further comprising a tilt suppression mechanism for suppressing tilting of the movable member when displacing.

5. The switch device according to any one of claims 1 to 4,

wherein one magnet is attached to the movable member, and
at least two detection elements are provided.

6. The switch device according to claim 5,

wherein the movable member is a rod-shaped member displaceable in the operation direction of the operable portions, and
each of the plurality of operable portions has an operator for the movable member.

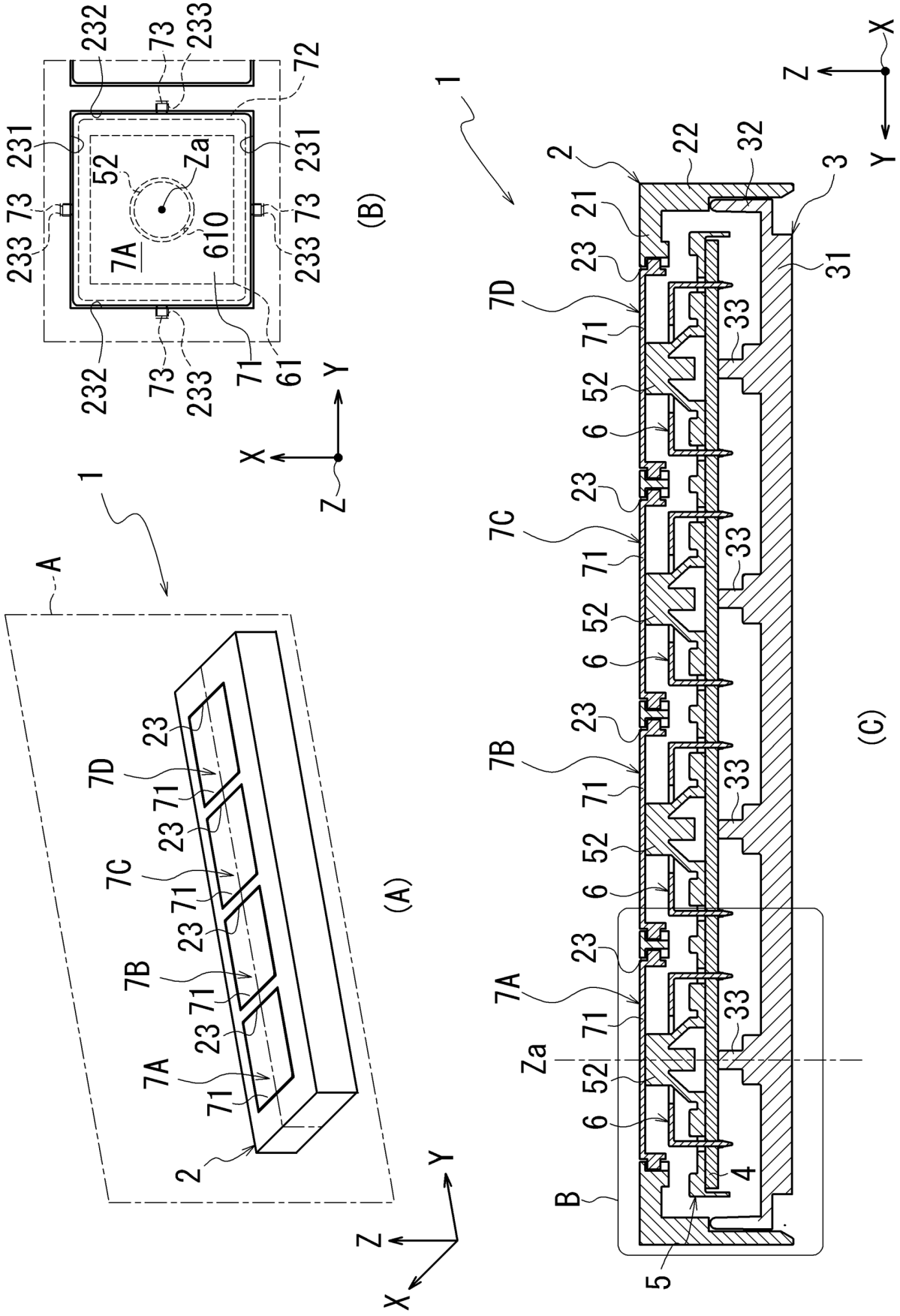
7. The switch device according to claim 5,

wherein the movable member is an annular member surrounding a region where the operable portions are provided and displaceable in the operation direction of the operable portions,
one of a pair of shaft portions facing each other sandwiching the plurality of operable portions is rotatably supported about an axis along the longitudinal direction of the shaft portion,
the magnet is attached to the other shaft portion of the pair of shaft portions, and
each of the plurality of operable portions has an operator for displacing the other shaft portion in conjunction with operation of the operable portions.

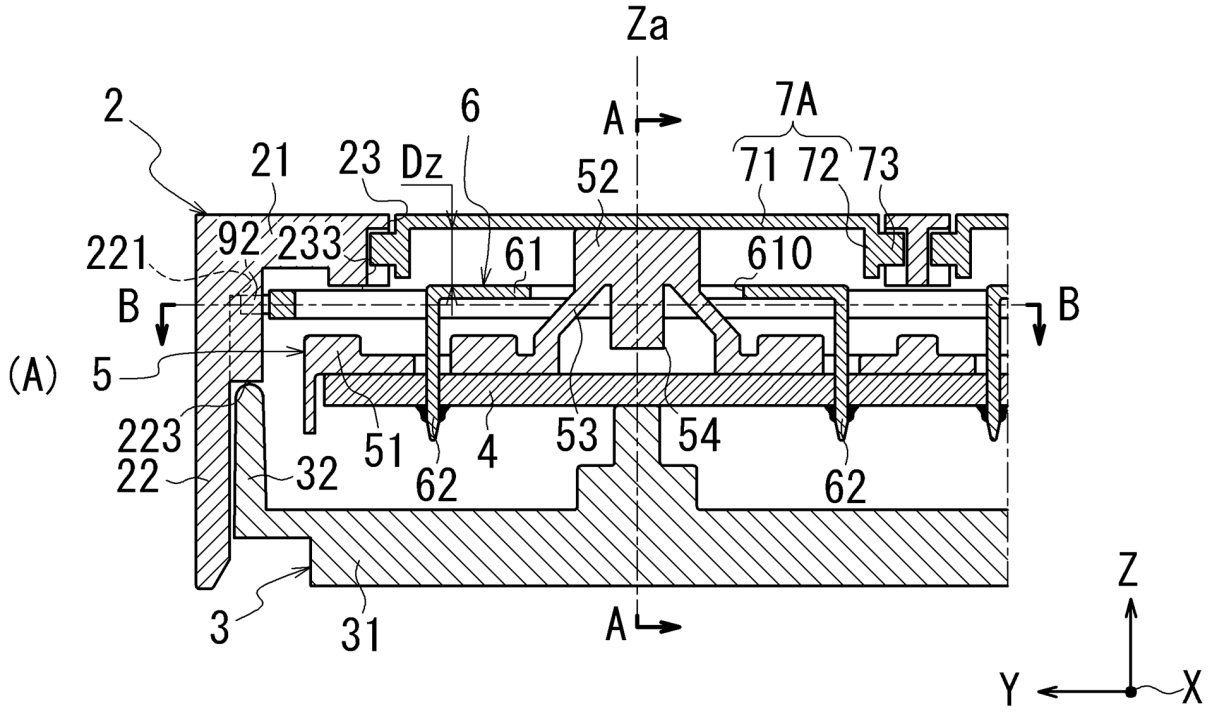
8. The switch device according to claim 5,

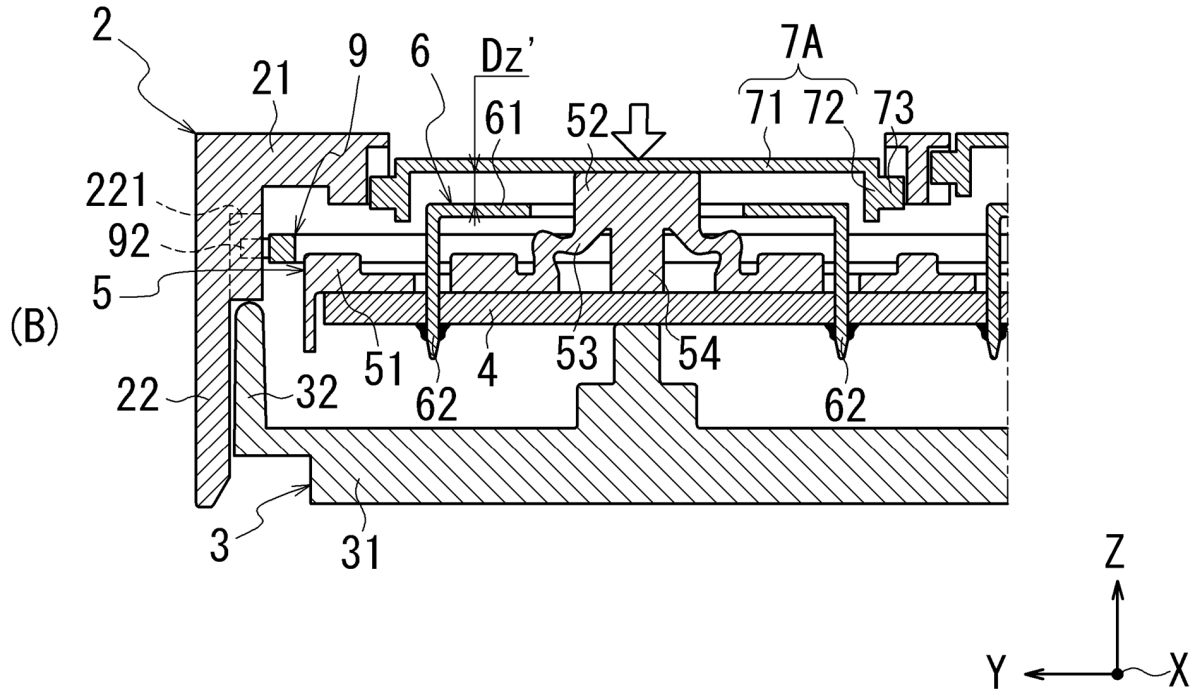
wherein different functions are assigned to each of the plurality of operable portions, and the functions are modes related to stopping or driving of a vehicle.

[Figure 1]

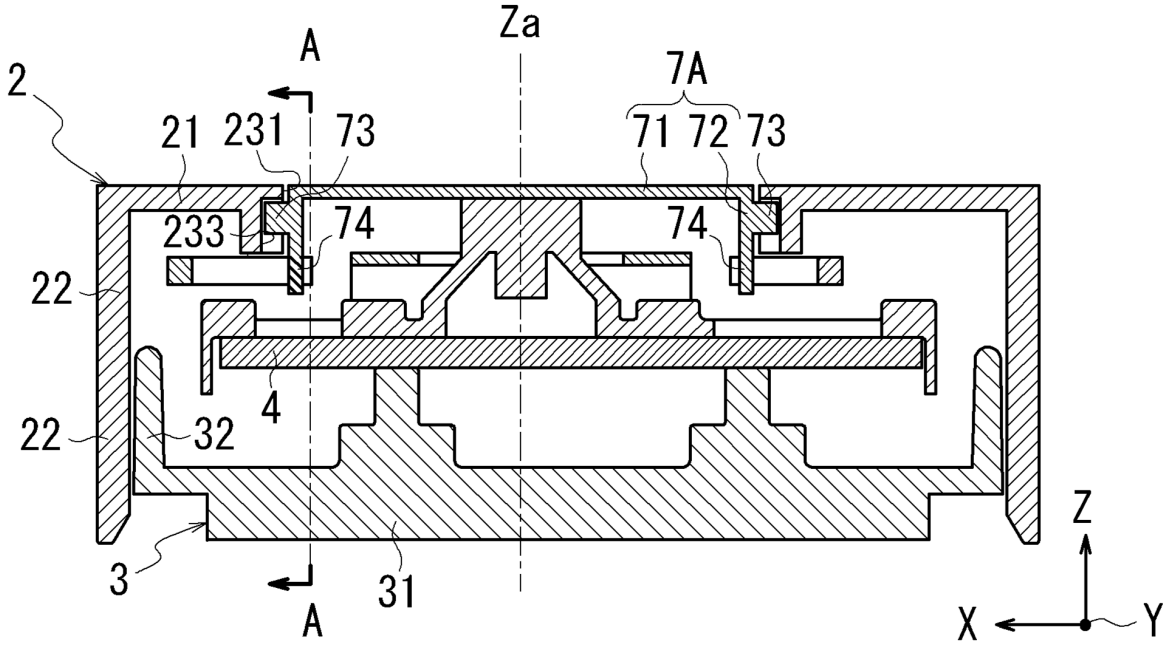

(A)
(B)
(C)
1
2
3
4
5
6
7A
7B
7C
7D
Za
A
B
X
Y
Z
22
23
31
32
33
52
71
72
73
231
232
233
610
61

[Figure 2]

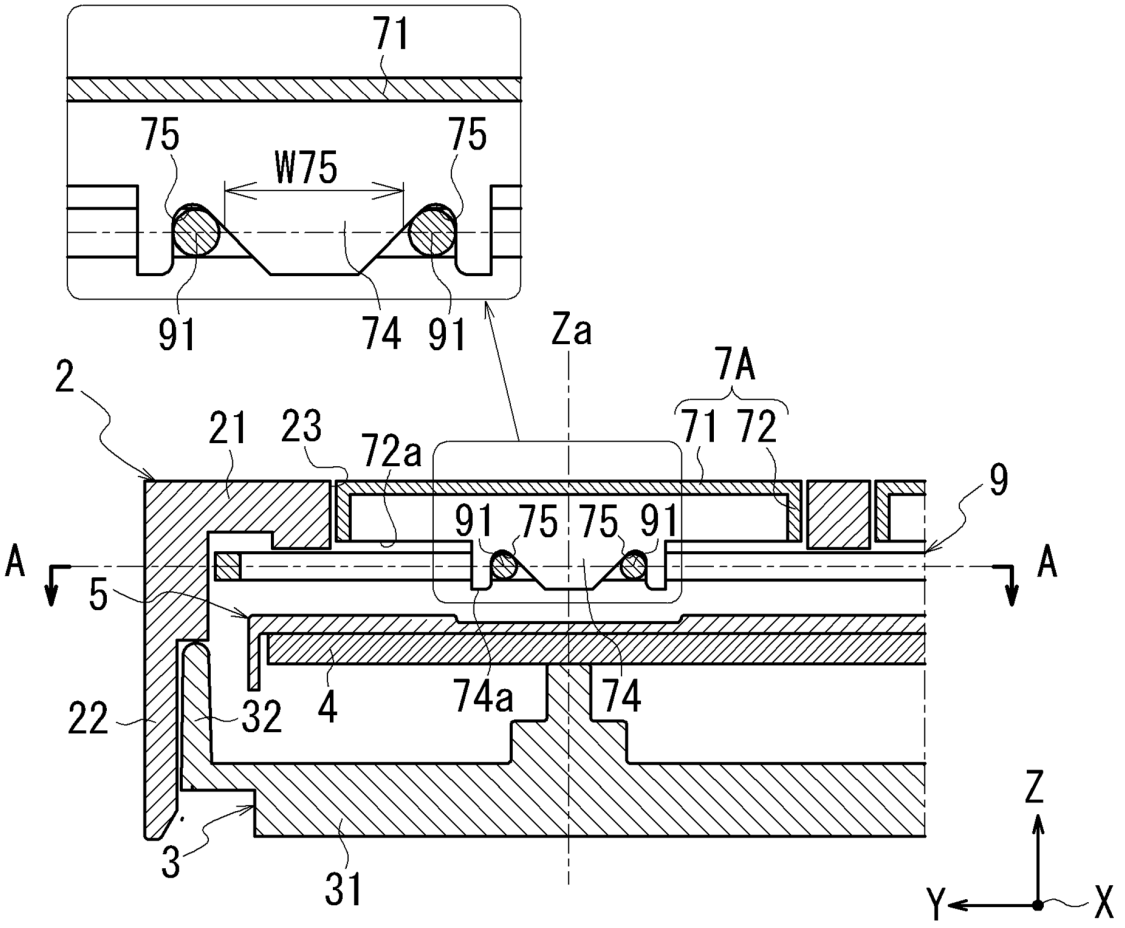

(A)
Za
2
21
23
Dz
6
A
7A
71
72
73
52
221
92
233
61
610
B
5
223
22
32
51
62
4
53
54
62
3
31
A
Z
Y
X


(B)
2
21
9
6
Dz'
61
52
7A
71
72
73
221
92
5
22
32
51
62
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53
54
62
3
31
Z
Y
X

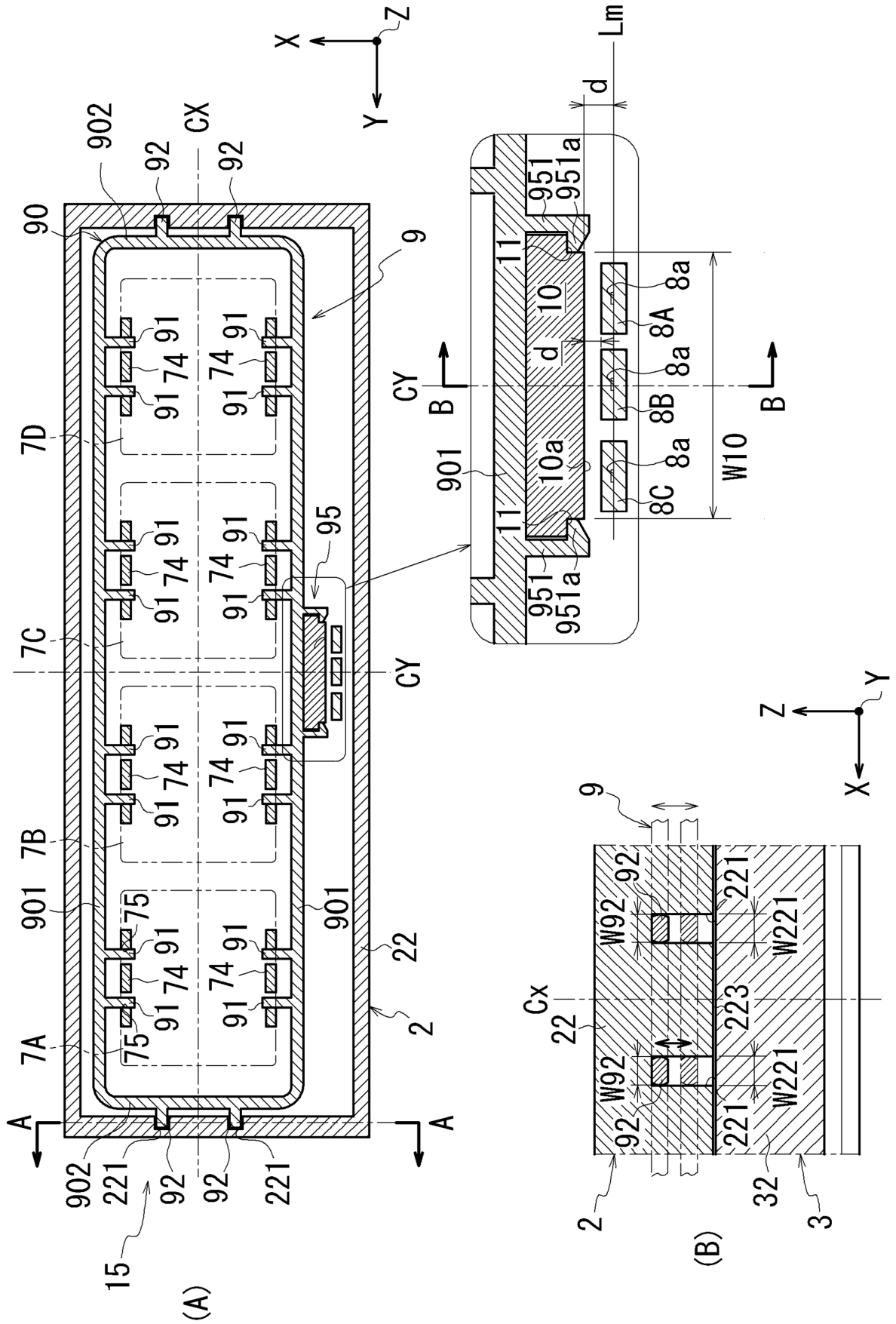
[Figure 3]



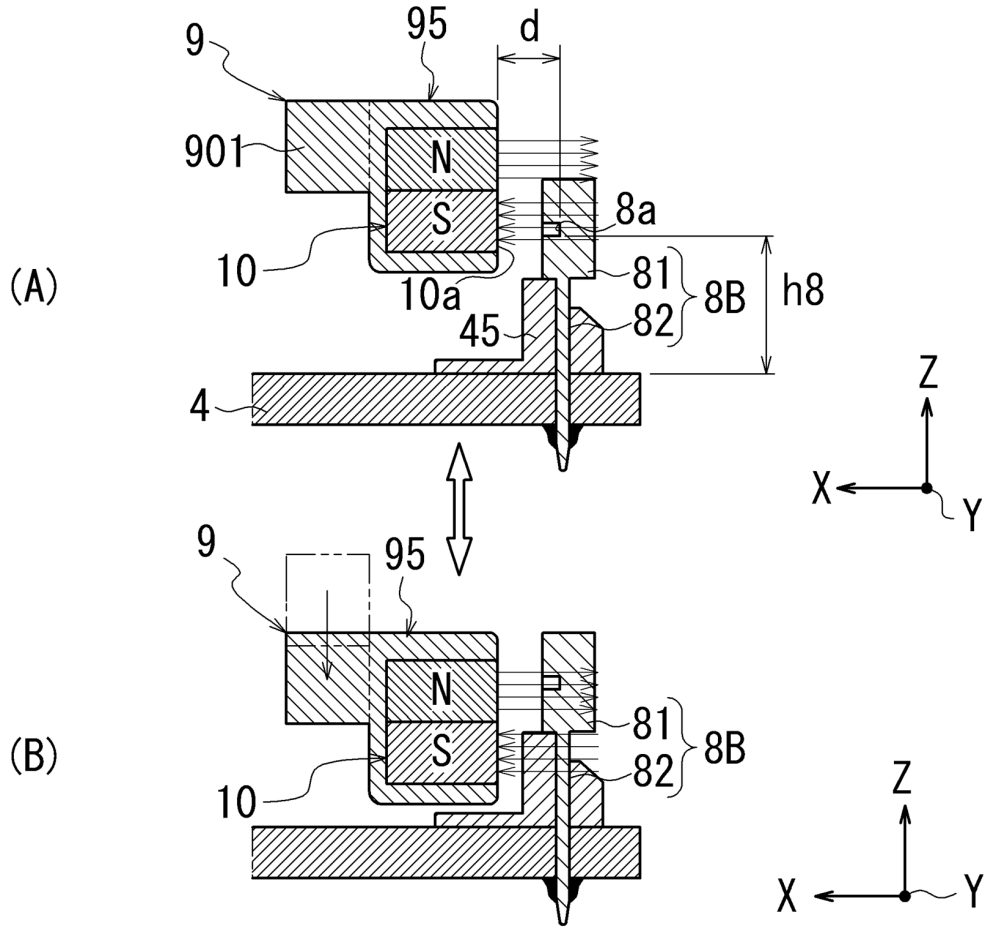
[Figure 4]



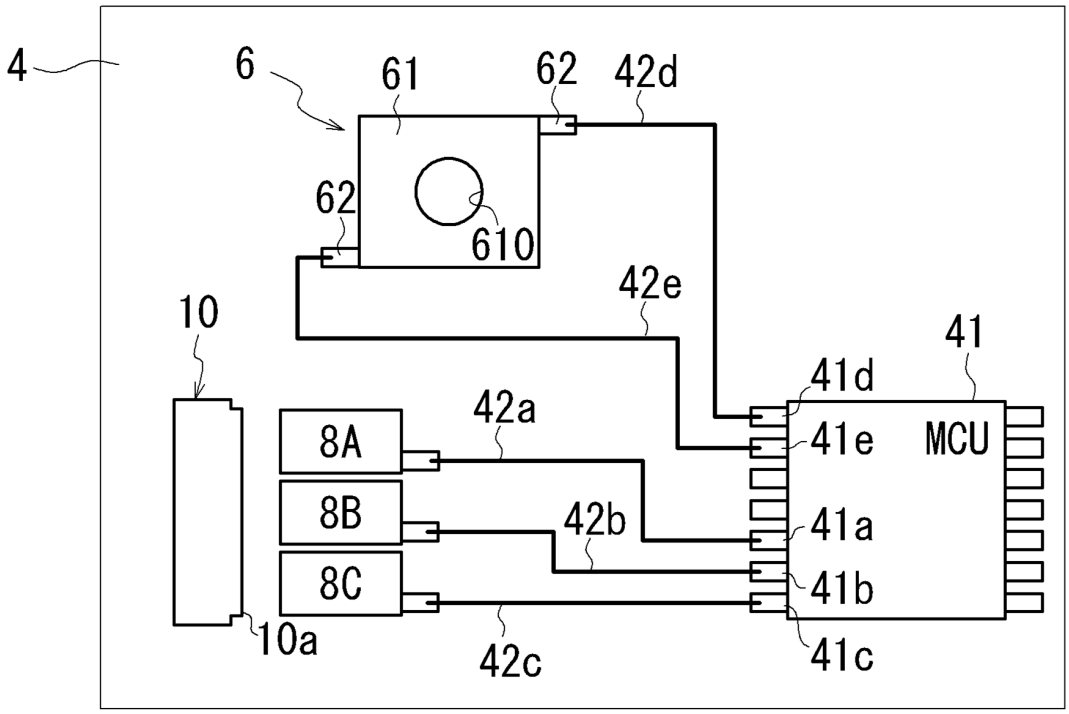
[Figure 5]


X
Z
Y
902
92
CX
92
90
9
7D
7C
CY
7B
901
75
7A
A
A
902
221
92
92
221
15
(A)
Lm
d
951
951a
11
10
d
8a
8A
8a
8B
8a
8C
W10
B
CY
B
901
10a
11
951
951a
Z
Y
X
9
92
W92
221
W221
Cx
22
223
W92
92
221
W221
2
32
3
(B)

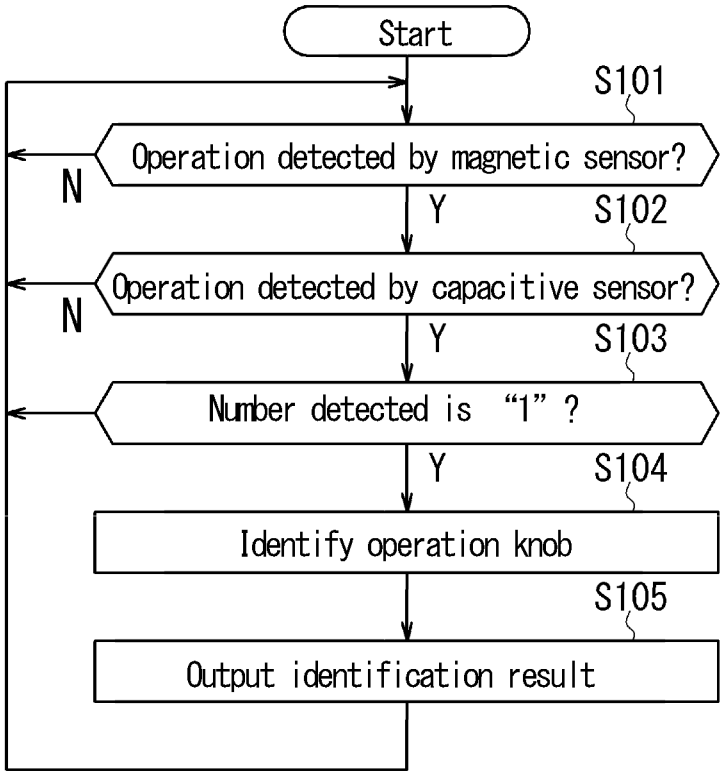
[Figure 6]



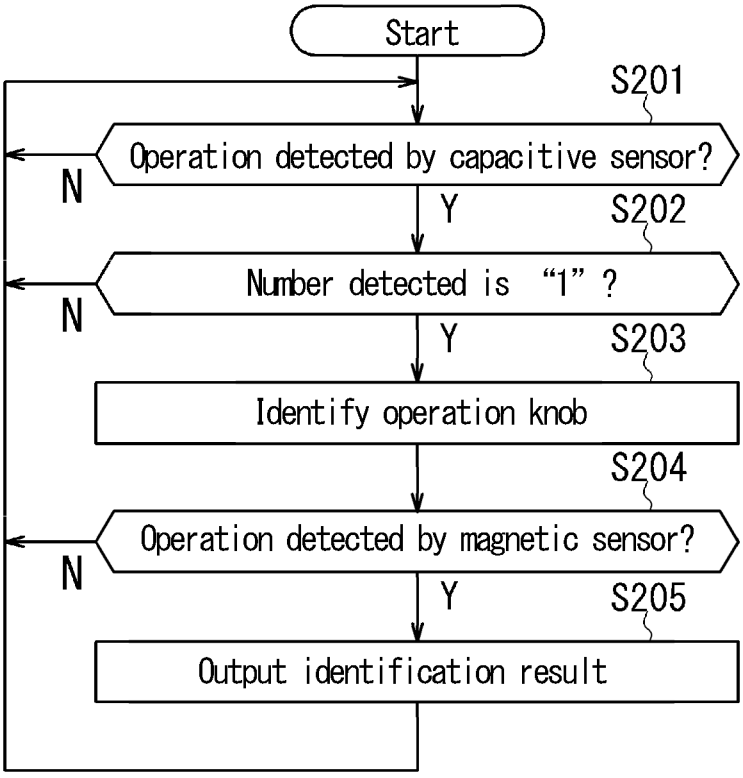
[Figure 7]



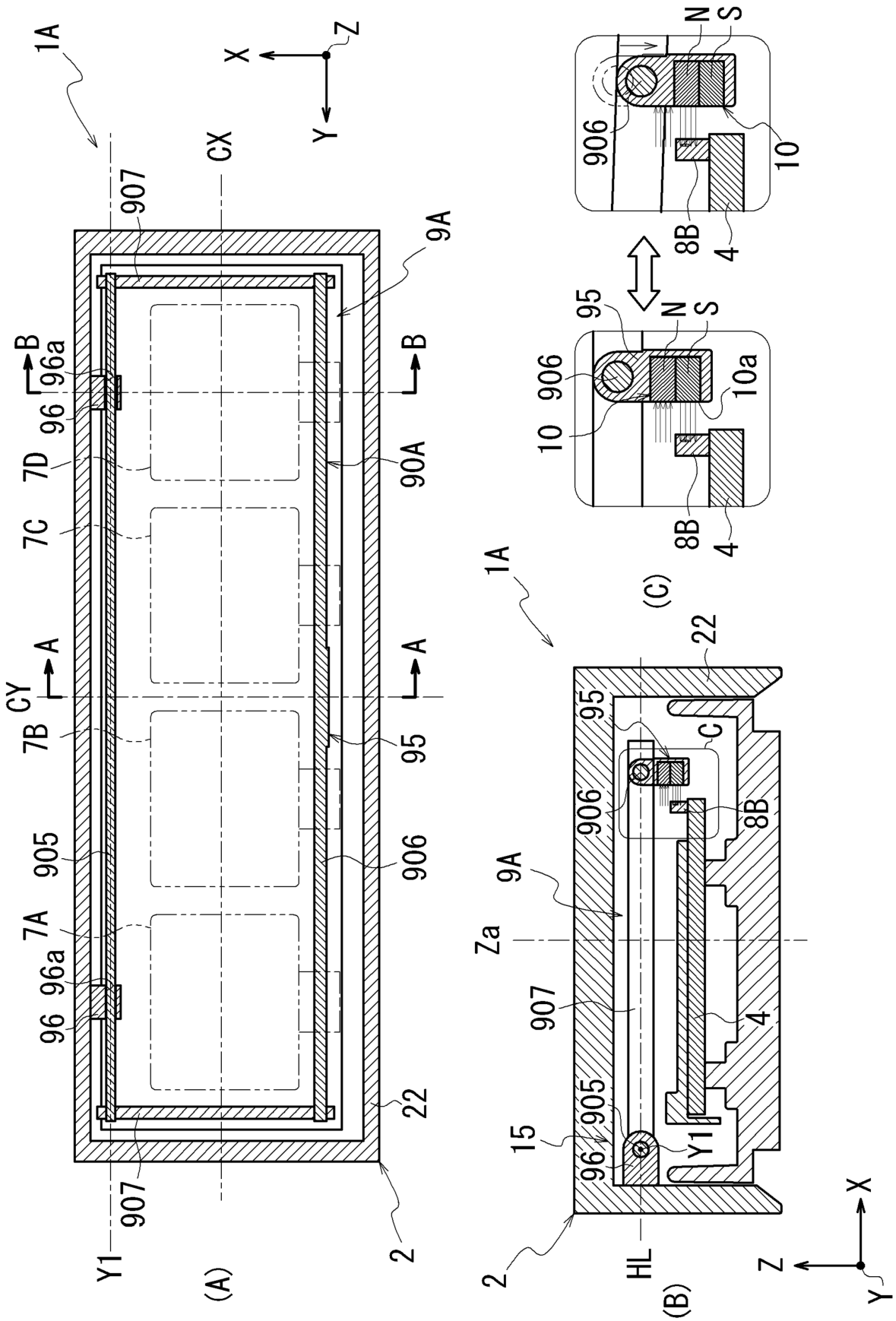
[Figure 8]



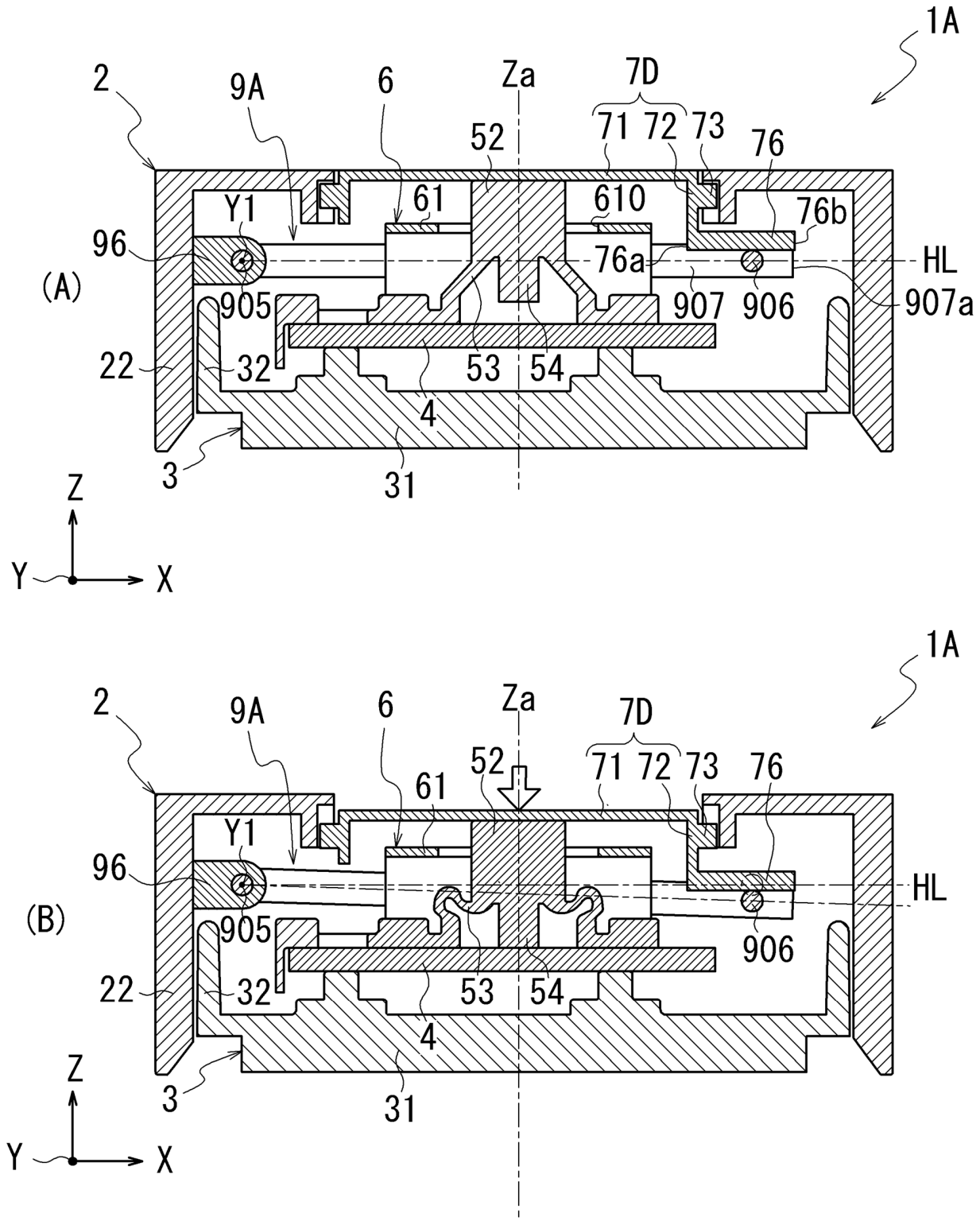
[Figure 9]



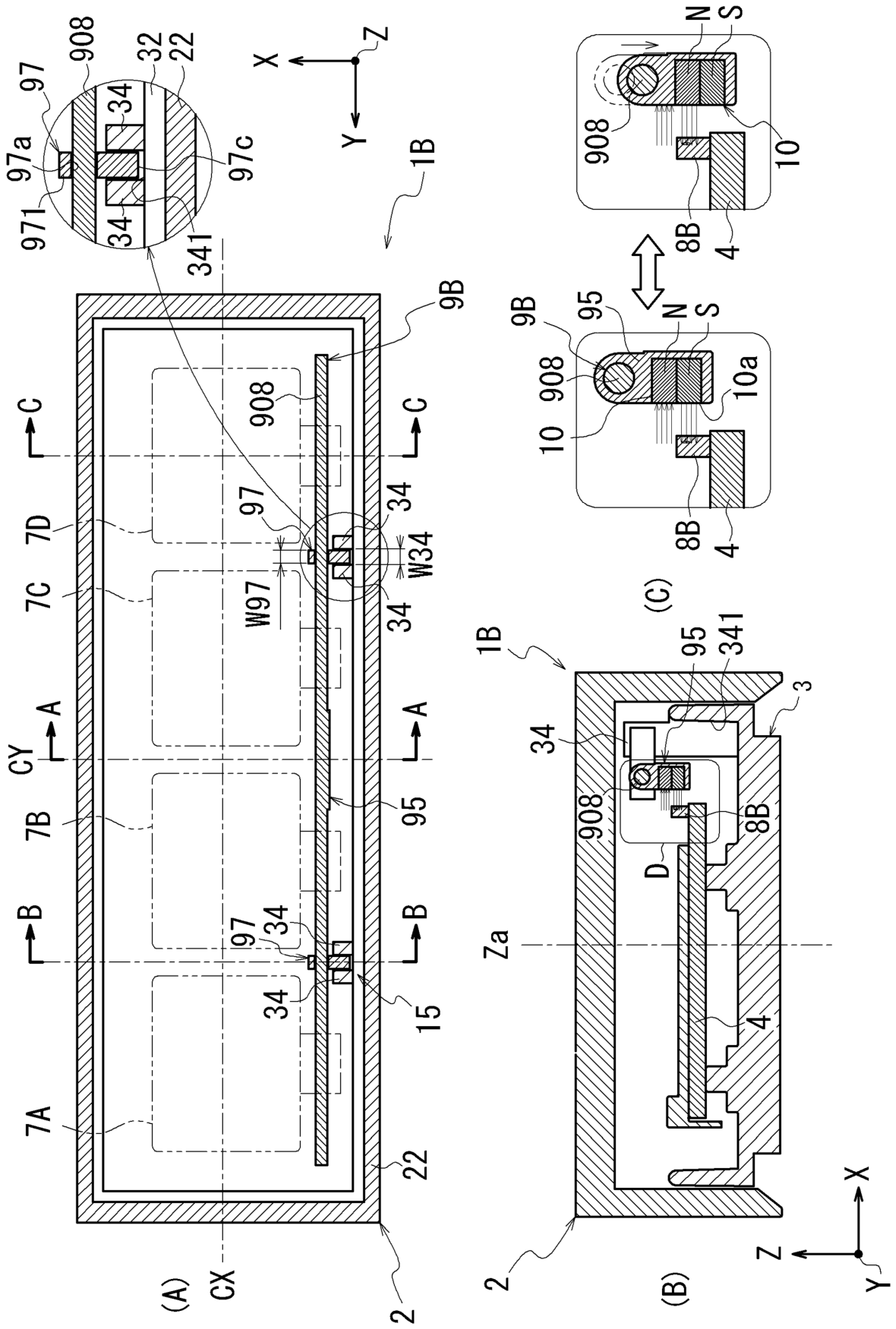
[Figure 10]


1A
X
Z
Y
CX
907
9A
B
96a
96
7D
90A
7C
A
CY
7B
95
905
906
7A
96a
96
907
22
Y1
2
(A)
N
S
906
10
8B
4
95
10
906
10a
8B
4
(C)
1A
22
95
C
906
8B
9A
Za
907
4
15
905
Y1
96
2
HL
(B)
X
Z
Y

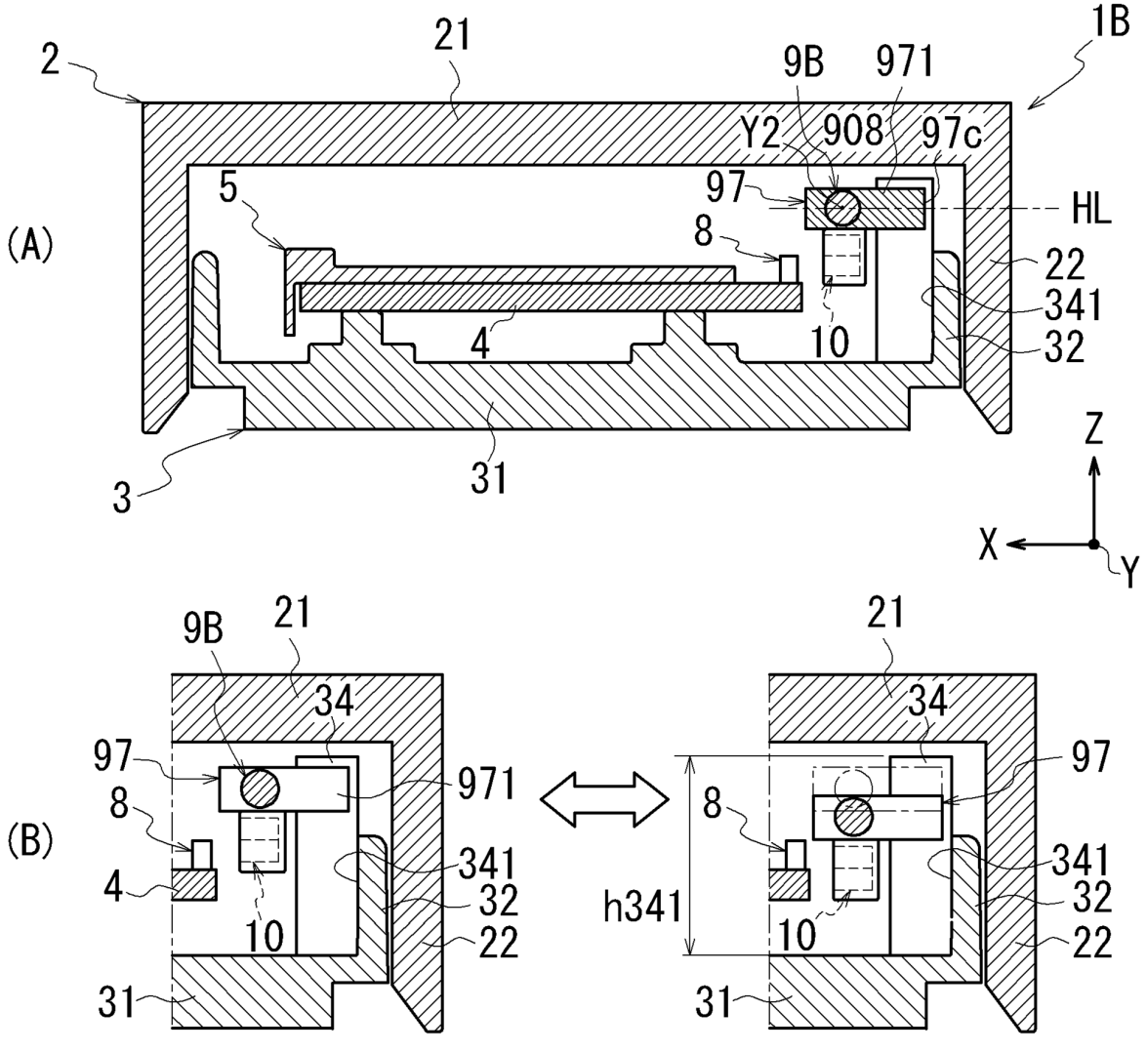
[Figure 11]


1A
2
9A
6
Za
7D
71 72 73
76
52
Y1
61
610
76b
96
76a
HL
(A)
905
907
906
907a
22
32
53
54
4
3
31
Z
Y
X
1A
2
9A
6
Za
7D
71 72 73
76
52
61
Y1
96
HL
(B)
905
906
22
32
53
54
4
3
31
Z
Y
X

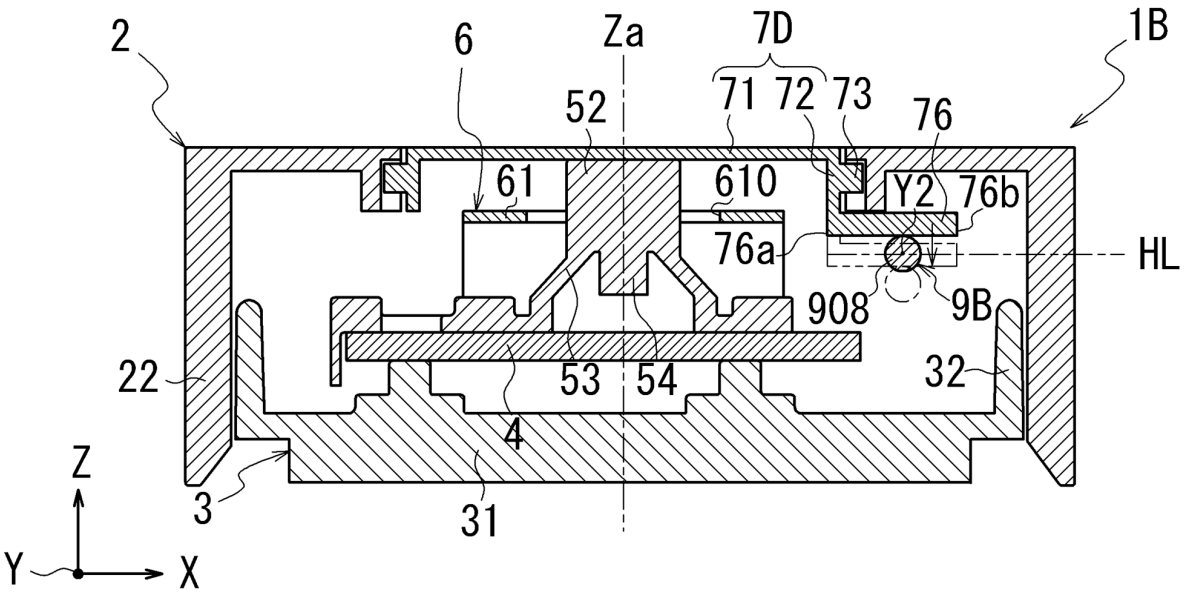
[Figure 12]


908
32
22
97
34
97a
97c
971
341
X
Z
Y
1B
9B
C
7D
7C
A
CY
7B
B
7A
97
34
W34
W97
95
15
22
2
(A)
CX
N
S
908
10
8B
4
10a
(C)
341
3
D
Za
(B)

[Figure 13]



[Figure 14]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/024674

A. CLASSIFICATION OF SUBJECT MATTER

H01H 13/00(2006.01)i; ***H01H 36/00***(2006.01)i
FI: H01H13/00 D; H01H13/00 B; H01H36/00 J; H01H36/00 M

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01H13/00; H01H36/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-317393 A (ALPS ELECTRIC CO., LTD.) 06 December 2007 (2007-12-06) paragraphs [0026]-[0068], fig. 1-8	1-8
Y	JP 2016-159776 A (SHIN-ETSU POLYMER CO., LTD.) 05 September 2016 (2016-09-05) paragraphs [0023]-[0035], fig. 1-8	1-8
Y	JP 2011-243399 A (SHIN-ETSU POLYMER CO., LTD.) 01 December 2011 (2011-12-01) paragraphs [0028]-[0032], fig. 1-5	1-8
Y	JP 2014-186814 A (PANASONIC CORPORATION) 02 October 2014 (2014-10-02) paragraphs [0021]-[0037], fig. 5	1-8
Y	JP 2021-44150 A (FANUC CORPORATION) 18 March 2021 (2021-03-18) paragraph [0032], fig. 11	1-8

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 2024	**10 September 2024**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/024674

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2007-317393 A	06 December 2007	EP 1859992 A1 paragraphs [0028]-[0055], fig. 1-8 CN 101090039 A	
JP 2016-159776 A	05 September 2016	(Family: none)	
JP 2011-243399 A	01 December 2011	(Family: none)	
JP 2014-186814 A	02 October 2014	(Family: none)	
JP 2021-44150 A	18 March 2021	(Family: none)	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5260241 B **[0003]**