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(54) SELF-PROPELLED VACUUM CLEANER

(57) An autonomous vacuum cleaner is provided which can promote reductions in size and load by simplifying the structure of a surrounding cleaning means. An autonomous vacuum cleaner (1) includes a vacuum cleaner body (2) having a wheel (121) for travelling autonomously, and a pivoting cleaner (3) that can vacuum and clean around the vacuum cleaner body (2). The pivoting cleaner (3) is configured including: an arm (21) that can pivot outward from the vacuum cleaner body (2); a vacuum inlet (74) that is provided to the arm (21) to suck up dirt and the like on the floor surface; a rotation support (61, 144) configured to rotatably support the arm (21) on the vacuum cleaner body (2); and a vacuum channel (66) that is provided along a rotation axis of the rotation support (61, 144) to cause the inside of the arm (21) and a sub-duct (143) to communicate with each other.

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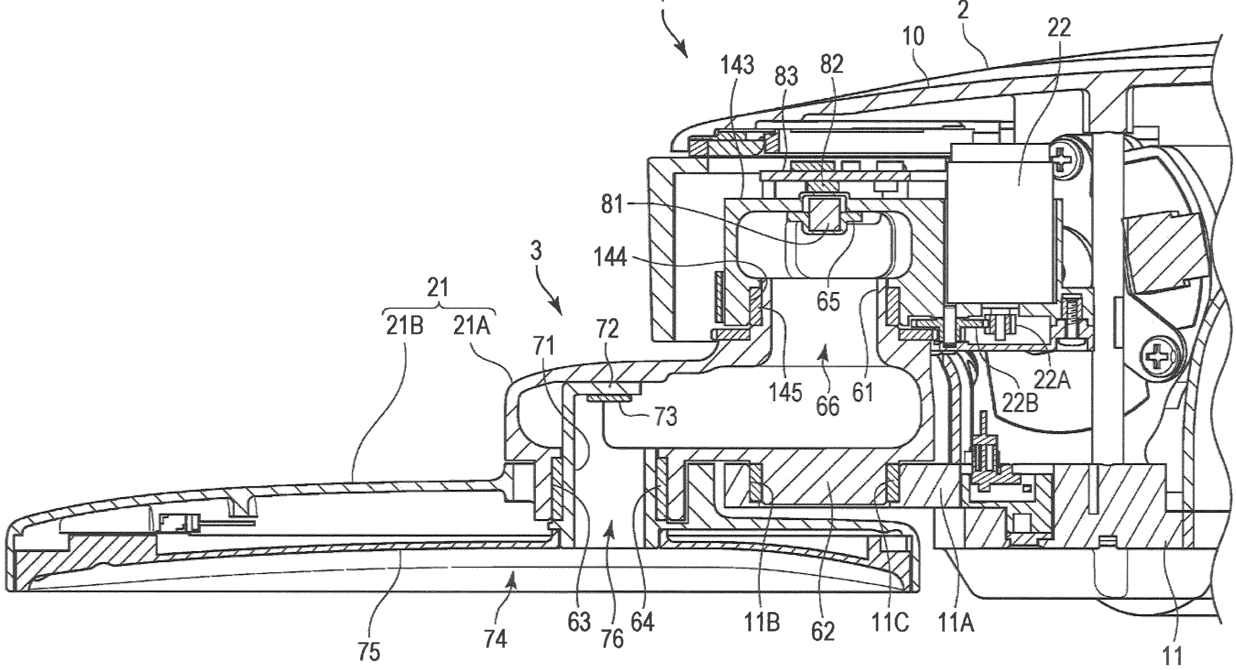
FIG. 20


1
2
10
22
143
83
82
81
65
3
144
21
21B
21A
71
72
73
145
66
61
22A
22B
63
76
64
11B
62
11C
11A
11
75
74

Description

TECHNICAL FIELD

[0001] The present invention relates to an autonomous vacuum cleaner.

BACKGROUND ART

[0002] As an autonomous vacuum cleaner (vacuum cleaning robot) for cleaning the floor surface, an autonomous vacuum cleaner is conventionally known which includes a travel means for causing a vacuum cleaner body to travel, a main cleaning means that is provided on an undersurface of the vacuum cleaner body to suck up dust and the like on the floor surface, and a surrounding cleaning means that is provided, configured to be capable of protruding sideway from the vacuum cleaner body (refer to, for example, Patent Literature 1). The travel means is configured by a pair of left and right wheels to drive each wheel in a forward direction and a backward direction and cause the vacuum cleaner body to travel in a front-and-rear direction and turn in any direction. The main cleaning means includes a duct communicating with a main vacuum inlet, and a suction fan, and is configured to send the dust and the like that are sucked up through the main vacuum inlet into a dust collection chamber.

[0003] The surrounding cleaning means of the autonomous vacuum cleaner described in Patent Literature 1 includes a movable vacuum member (pivoting member) that can protrude outward from the vacuum cleaner body, a torsion spring (biasing means) that biases the movable vacuum member in the protruding direction, and a speed-reduction mechanism-equipped motor (drive means) that stores the movable vacuum member into the vacuum cleaner body against the basing force of the torsion spring. The drive force from the speed-reduction mechanism-equipped motor to the movable vacuum member is transmitted in the storage direction via first and second transmission means, and is cut off in the protruding direction by the first and second transmission means; accordingly, the drive force is not transmitted but only the biasing force of the torsion spring acts on the movable vacuum member. Therefore, it is configured in such a manner that when the protruding movable vacuum member comes into contact with an obstacle or the like, the movable vacuum member is stored into the vacuum cleaner body against the biasing force of the torsion spring, and when the movable vacuum member moves away from the obstacle, the movable vacuum member protrudes again on the basis of the biasing force of the torsion spring.

CITATION LIST

PATENT LITERATURE

[0004] PATENT LITERATURE 1: JP-A-2008-279066

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] However, such a known autonomous vacuum cleaner as is described in Patent Literature 1, the surrounding cleaning means is configured in such a manner that the pivoting member (movable vacuum member) is pivotably supported by the vacuum cleaner body, and sends dirt and the like into the dust collection chamber of the vacuum cleaner body through the inside of the pivoting member. However, the structures of the rotation support and a vacuum channel of the pivoting member are complicated. Hence, there are, for example, problems that the surrounding cleaning means is increased in size, drive load is increased, and suction performance decreases.

[0006] An object of the present invention is to provide an autonomous vacuum cleaner that can promote reductions in size and load by simplifying the structure of a surrounding cleaning means.

SOLUTIONS TO THE PROBLEMS

[0007] An autonomous vacuum cleaner according to the present invention is capable of cleaning while traveling along a floor surface, the vacuum cleaner including: a vacuum cleaner body including a wheel for travelling autonomously; and a surrounding cleaning means capable of vacuum cleaning around the vacuum cleaner body. The vacuum cleaner body is provided with: a dust collection chamber configured to store dirt and the like that have been sucked up by the surrounding cleaning means; and a dust collection path causing the surrounding cleaning means and the dust collection chamber to communicate with each other, and the surrounding cleaning means is configured including: a pivoting member capable of pivoting outward from the vacuum cleaner body; a vacuum inlet provided to the pivoting member, the vacuum inlet being configured to suck up dirt and the like on the floor surface, a rotation support configured to rotatably support the pivoting member on the vacuum cleaner body; and a vacuum channel provided along a rotation axis of the rotation support, the vacuum channel causing the inside of the pivoting member and the dust collection path to communicate with each other.

[0008] According to such a present invention, the surrounding cleaning means has the pivoting member, the rotation support, and the vacuum channel. The vacuum channel is provided along the rotation axis of the rotation support. The vacuum channel allows the inside of the pivoting member and the dust collection path to communicate with each other. Accordingly, it is possible to simplify the structures of the rotation support and the vacuum channel of the pivoting member. Therefore, it is possible to promote a reduction in drive load and an improvement in suction performance while promoting a reduction in size of the surrounding cleaning means.

[0009] In the present invention, it is preferred that the rotation support of the surrounding cleaning means includes an annular outer tube provided to the vacuum cleaner body; and a cylindrical inner tube provided to the pivoting member, the inner tube being inserted into the outer tube. The inside of the inner tube preferably configures the vacuum channel.

[0010] According to such a configuration, the rotation support has the outer tube on the vacuum cleaner body side, and the inner tube on the pivoting member side. The inner tube is inserted into the outer tube, and the inside of the inner tube configures the vacuum channel. Accordingly, it is possible to smoothly send dirt and the like that have been sucked up through the vacuum inlet to the dust collection path through the inside of the inner tube and prevent the dirt and the like from being trapped and left in the vacuum channel.

[0011] In the present invention, preferably, the surrounding cleaning means further has a rotation drive means configured to drive and rotate the pivoting member with respect to the vacuum cleaner body.

[0012] According to such a configuration, the pivoting member is driven and rotated by active drive of the rotation drive means. Consequently, it is possible to appropriately change the cleaning area by the surrounding cleaning means and efficiently clean around the vacuum cleaner body.

[0013] In the present invention, it is preferred that the pivoting member is provided with a rotor configured to rotate together with the pivoting member, and the vacuum cleaner body is provided on an outer side of the dust collection path with an angle detection means configured to detect a pivot angle of the pivoting member on the basis of the position of the rotor.

[0014] According to such a configuration, the pivoting member is provided with the rotor. The outer side of the dust collection path of the vacuum cleaner body is provided with the angle detection means. Accordingly, it is possible to prevent dirt and the like from adhering to the angle detection means. Moreover, the angle detection means detects the pivot angle of the pivoting member on the basis of the position of the rotor. Accordingly, it is possible to grasp the state of the surrounding cleaning means.

[0015] In the present invention, it is preferred that the rotor is a permanent magnet, and the angle detection means is configured including a detection circuit configured to detect changes in a magnetic field with the rotation of the permanent magnet.

[0016] According to such a configuration, the rotor is the permanent magnet, and the detection circuit detects changes in a magnetic field with the rotation of the permanent magnet. Accordingly, it is possible to detect the pivot angle of the pivoting member in a non-contact manner.

[0017] In the present invention, it is preferred that the pivoting member includes: a first pivoting member rotatably supported on one end side thereof by the vacuum cleaner body; a second pivoting member provided with the vacuum inlet, the second pivoting member being rotatably supported on the other end side of the first pivoting member; and a second rotation support configured to support the second pivoting member in such a manner as to be rotatable with respect to the first pivoting member. The second rotation support is preferably configured to include: a second outer tube provided to the first pivoting member; a cylindrical second inner tube provided to the second pivoting member, the second inner tube being inserted into the second outer tube; and a second vacuum channel causing the vacuum inlet and the inside of the first pivoting member to communicate with each other through the inside of the second inner tube.

[0018] According to such a configuration, the pivoting member has the first pivoting member, the second pivoting member, and the second rotation support. Accordingly, it is possible to enlarge the cleaning area by the surrounding cleaning means and efficiently clean corners of a wall and an obstacle by causing the second pivoting member to reach the corners. Moreover, the second rotation support has the second outer tube, the second inner tube, and the second vacuum channel. The second inner tube is inserted into the second outer tube, and the inside of the second inner tube configures the second vacuum channel. Accordingly, it is possible to smoothly send dirt and the like that have been sucked up through the vacuum inlet to the first pivoting member through the inside of the second inner tube and prevent the dirt and the like from being trapped and left in the second vacuum channel.

[0019] In the present invention, it is preferred that the pivoting member is provided with a rotation biasing means configured to bias the second pivoting member with respect to the first pivoting member in a rotation direction.

[0020] According to such a configuration, the rotation biasing means biases the second pivoting member in the rotation direction. Accordingly, the second pivoting member pivots and is displaced by the elasticity of the rotation biasing means upon an external force acting on the second pivoting member. Consequently, it is possible to reduce loads on the first pivoting member and the rotation support and reduce damage to a wall, furniture, and the like that the second pivoting member comes into contact with.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a perspective view of an autonomous vacuum cleaner according to one embodiment of the present invention as viewed from above.

Fig. 2 is a perspective view of the autonomous vacuum cleaner as viewed from below.

Fig. 3 is a perspective view of a protruding state of a surrounding cleaning means in the autonomous vacuum cleaner as viewed from above.

Fig. 4 is a perspective view of the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner as viewed from below.

Fig. 5 is a front view illustrating a stored state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 6 is a top view illustrating the stored state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 7 is a right-side view illustrating the stored state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 8 is a left-side view illustrating the stored state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 9 is a back view illustrating the stored state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 10 is a bottom view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 11 is a front view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 12 is a top view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 13 is a right-side view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 14 is a left-side view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 15 is a back view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 16 is a bottom view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 17 is a bottom view of the changed protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 18 is a cross-sectional view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner.

Fig. 19 is a functional block diagram illustrating the schematic configuration of the autonomous vacuum cleaner.

Fig. 20 is a cross-sectional view illustrating the enlarged surrounding cleaning means.

Fig. 21 is a perspective view illustrating a cross section of the surrounding cleaning means.

Fig. 22 is a perspective view illustrating a cross section of the surrounding cleaning means.

Fig. 23 is a bottom view of the enlarged surrounding cleaning means as viewed from below.

Figs. 24(A) to 24(D) are bottom views illustrating the operation of the surrounding cleaning means.

Figs. 25(A) and 25(B) are plan views illustrating the operation of the autonomous vacuum cleaner.

Figs. 26(A) to 26(C) are plan views illustrating another operation of the autonomous vacuum cleaner.

DESCRIPTION OF THE EMBODIMENTS

[0022] One embodiment of the present invention is described hereinafter on the basis of Figs. 1 to 24(A) to 24(D).

[0023] Fig. 1 is a perspective view of an autonomous vacuum cleaner according to one embodiment of the present invention as viewed from above. Fig. 2 is a perspective view of the autonomous vacuum cleaner as viewed from below. Fig. 3 is a perspective view of a protruding state of a surrounding cleaning means in the autonomous vacuum cleaner as viewed from above. Fig. 4 is a perspective view of the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner as viewed from below. Figs. 5 to 10 are a six-view drawing (front view, top view, right-side view, left-side view, back view, bottom view) illustrating a stored state of the surrounding cleaning means in the autonomous vacuum cleaner. Figs. 11 to 16 are a six-view drawing (front view, top view, right-side view, left-side view, back view, bottom view) illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner. Fig. 17 is a bottom view of the changed protruding state of the surrounding cleaning means in the autonomous vacuum cleaner. Fig. 18 is a cross-sectional view illustrating the protruding state of the surrounding cleaning means in the autonomous vacuum cleaner, and is a cross-sectional view at a position indicated by line A-A in Fig. 17. Fig. 19 is a functional block diagram illustrating the schematic configuration of the autonomous vacuum cleaner.

[0024] An autonomous vacuum cleaner 1 is a vacuum cleaning robot that cleans the floor surface, travelling along the floor surface and, as illustrated in Figs. 1 to 18, includes a vacuum cleaner body 2, pivoting cleaners 3 as a surrounding cleaning means (sub-cleaning means) for cleaning around the vacuum cleaner body 2, a sensor system 4 for detecting an obstacle around the vacuum cleaner body 2, and a controller 5 (refer to Fig. 19) as a control means for controlling and driving the vacuum cleaner body 2, the pivoting cleaners 3, and the sensor system 4.

[0025] The vacuum cleaner body 2 includes a body 10 having a top surface 101, a front surface 102, left and right side surfaces 103, and a rear surface 104, a chassis 11 forming an undersurface 105, a travel driver 12 having a pair of left and right wheels 121 for travelling autonomously, a lift 13 that is provided, configured to be capable of lifting up from the top surface 101 of the body 10, a vacuum assembly (main cleaning means) 14 that is provided on the undersurface 105 of the body 10 to suck up dust and dirt on the floor surface, and a body operator 15 (refer to Fig. 19) for operating the vacuum cleaner body 2. The body operator 15 is, for example, a touch sensor switch (not illustrated) provided on the top surface 101 of the vacuum cleaner body 2, and operates the autonomous vacuum cleaner 1 with a touch operation by a user and stops the autonomous vacuum cleaner 1 with a touch operation during operation.

[0026] The pivoting cleaners 3 are provided in a pair on left and right sides of a front part of the vacuum cleaner body 2. The pivoting cleaner 3 includes an arm 21 as a pivotable pivoting member (protrusion) that protrudes sideway from the vacuum cleaner body 2, a motor 22 described below as a drive means that drives the arm 21 to pivot, a load sensor 23 (refer to Fig. 19) as a load detection means that detects load (torque) acting on the motor 22 from the outside, and an angle sensor 24 (refer to Fig. 19) as an angle detection means that detects the pivot angle of the arm 21 and is described below. The arm 21 is configured including a first arm 21A as a first pivoting member that is rotatably supported on one end side thereof by the vacuum cleaner body 2, and a second arm 21B as a second pivoting member that is rotatably supported on the other end side of the first arm 21A.

[0027] The sensor system 4 is configured including a front sensor 31 provided on the front surface 102 of the body 10, a surroundings sensor 32 as a surrounding detection means provided in the lift 13, and a rear sensor 33 provided on the rear surface 104 of the body 10. The front sensor 31 includes an ultrasonic sensor, an infrared sensor, or the like, and detects an obstacle ahead of the vacuum cleaner body 2. The surroundings sensor 32 is a laser scanner (LIDAR (Light Detection and Ranging or Laser Imaging Detection and Ranging)) that is driven and rotated inside the lift 13 and measures distance by applying laser light such as infrared laser light, and calculates the distance to an obstacle and the shape of the obstacle. The surroundings sensor 32 is not limited to the one provided in the lift 13 and is simply required to be provided at any position in the body 10. The rear sensor 33 is for detecting the distance to and the position of an unillustrated recharging station or the like, and communicates with infrared light or the like with the recharging station or the like.

[0028] The travel driver 12 includes the pair of left and right wheels 121, and a motor (not illustrated) that drives and rotates the pair of wheels 121 independently. Moreover, an auxiliary wheel 122 is provided to a rear part of the chassis 11. The vacuum assembly 14 is connected to a roller brush 141, a duct 142 (refer to Fig. 18), an unillustrated suction fan, a dust collection chamber, and an exhaust port. The vacuum assembly 14 is configured to collect the sucked dust and the like through a filter of the dust collection chamber and exhaust the sucked air from the exhaust port. As illustrated in Fig. 18, the duct 142 or the dust collection chamber for the vacuum assembly 14 is connected to a sub-duct 143 as a dust collection path communicating with the arm 21 of the pivoting cleaner 3.

[0029] As illustrated in Fig. 19, the controller 5 includes a travel controller 41 that controls the travel driver 12, a vacuum controller 42 that controls the vacuum assembly 14, a detection computer 43 that processes detection signals from the front sensor 31, the surroundings sensor 32, and the rear sensor 33 of the sensor system 4, and the load sensor 23 and the angle sensor 24 of the pivoting cleaner 3, and an arm controller 44 that controls and drives the motor 22 of the pivoting cleaner 3 and causes the arm 21 to pivot.

[0030] The structure and operation of the pivoting cleaner 3 are described in detail below with reference also to Figs. 20 to 24(A) to 24(D). Fig. 20 is a cross-sectional view illustrating the enlarged pivoting cleaner 3. Figs. 21 and 22 are perspective views illustrating a cross section of the pivoting cleaner 3. Fig. 23 is a bottom view of the enlarged pivoting cleaner 3 as viewed from below. Figs. 24(A) to 24(D) are bottom views illustrating the operation of the pivoting cleaner 3.

[0031] As illustrated in Figs. 20 to 22, the first arm 21A of the arm 21 as a whole is formed into a hollow shape. A cylindrical first inner tube member (inner tube) 61 that protrudes and opens upward and a column 62 that protrudes downward are formed on one end side of the first arm 21A. An annular second outer tube member (second outer tube) 63 that opens downward is formed on the other end side. An annular first outer tube member (outer tube) 144 that opens downward is formed in the sub-duct 143. The first inner tube member 61 is inserted into the first outer tube member 144, and is rotatably supported by the first outer tube member 144 via a sliding ring 145 with a low coefficient of friction.

[0032] On the other hand, an annular bearing 11B is formed on a support 11A provided to the chassis 11. The column 62 is inserted into the bearing 11B, and is rotatably supported by the bearing 11B via a sliding ring 11C with a low coefficient of friction. The first inner tube member 61 and the column 62 of the first arm 21A, and the first outer tube member 144 of the sub-duct 143 and the bearing 11B of the chassis 11 configure a rotation support that rotatably supports the first arm 21A on the vacuum cleaner body 2.

[0033] The second arm 21B as a whole is formed into an extra-long cup shape that opens downward. In addition, a cylindrical second inner tube member (second inner tube) 71 that protrudes and opens upward is formed in a middle portion of the second arm 21B. An extension 72 that extends upward and is bent is formed on the second inner tube member 71. The extension 72 is pivotally supported by a pin 73 on an inner surface of the first arm 21A. Moreover, the second inner tube member 71 is inserted into the second outer tube member 63 of the first arm 21A, and rotatably supported on the second outer tube member 63 via a sliding ring 64 with a low coefficient of friction. The second inner tube member 71 of the second arm 21B and the second outer tube member 63 of the first arm 21A configure a second rotation support that rotatably supports the second arm 21B on the first arm 21A.

[0034] The motor 22 is fixed inside the body 10, and is configured to drive and rotate the first arm 21A by reducing the speed of rotation of the motor 22 via a drive gear 22A fixed to an output shaft of the motor 22, and a driven gear 22B supported inside the body 10 and transmit the rotation to the first arm 21A. The motor 22 is provided with an unillustrated load detection circuit that detects a load (rotational resistance) acting from the first arm 21A. The load detection circuit configures the load sensor 23 (refer to Fig. 19).

[0035] A magnet holder 65 that extends upward and is in sliding contact with an inner surface of a top of the sub-duct 143 is formed in the first inner tube member 61 of the first arm 21A. A permanent magnet 81 as a rotor is held by the magnet holder 65. Moreover, an outer surface of the top of the sub-duct 143, that is, an outer side of the dust collection path, is provided with a magnetic field sensor 82 that detects changes in a magnetic field caused by the rotation of the permanent magnet 81, and a board 83 equipped with a detection circuit including the magnetic field sensor 82. The magnetic field sensor 82 and the board 83 configure the angle sensor 24 (refer to Fig. 19) as an angle detection means that detects the pivot angle of the first arm 21A.

[0036] The second arm 21B includes a vacuum inlet 74 that opens downward and sucks up dirt and the like on the floor surface. A downward concave cover 75 is mounted on an inner side of the vacuum inlet 74. The vacuum inlet 74 communicates with an internal space of the first arm 21A through the inside of the second inner tube member 71; in other words, the inside of the second inner tube member 71 configures a second vacuum channel 76. Furthermore, the internal space of the first arm 21A communicates with an internal space of the sub-duct 143 being the dust collection path through the inside of the first inner tube member 61; in other words, the inside of the first inner tube member 61 configures a vacuum channel 66.

[0037] As illustrated in Figs. 22 and 23, a coil spring 77 as a pivoting biasing means is provided above the cover 75 inside the second arm 21B. The coil spring 77 is a tension spring, and is latched at one end thereof onto a projection 78 provided on a distal end side of the second arm 21B, and at the other end thereof onto a projection 67 extending downward from a distal end side of the first arm 21A (an outer side of the second outer tube member 63). An arc-shaped long hole 79 (refer to Fig. 23) is formed on the second arm 21B along an outer perimeter of the second inner tube member 71. The projection 67 is inserted into the long hole 79, and is guided along the circumferential direction of the long hole 79. Therefore, the pivot angle of the second arm 21B with respect to the first arm 21A is regulated according to the length of the long hole 79 in the circumferential direction (the angle about the center of the second inner tube member 71).

[0038] As illustrated in Figs. 24(A) to 24(D), the second arm 21B is supported in such a manner as to be pivotable on the first arm 21A, and is biased by the coil spring 77 toward an initial position illustrated in Fig. 24(A). At the initial position, the projection 67 of the first arm 21A comes into contact with an edge at one end of the long hole 79 of the second arm 21B to regulate the pivotal movement of the second arm 21B. When an external force acts on the second arm 21B from the front (up in the drawing) to the rear (down in the drawing), the distal end side of the second arm 21B pivots toward the rear against the biasing force of the coil spring 77 as illustrated in Figs. 24(B) and 24(C). When the distal end side pivots to a maximum pivot position illustrated in Fig. 24(D), the projection 67 comes into contact with an edge at the other end of the long hole 79 to regulate the pivotal movement of the second arm 21B. It is configured in such a manner that the biasing force of the coil spring 77 causes the second arm 21B to return to the initial position when the external force is removed.

[0039] Moreover, when an external force acts on the second arm 21B to cause the second arm 21B to pivot against the biasing force of the coil spring 77, resistance produced by the pivotal movement is transmitted to the first ram 21A and is detected by the load sensor 23 (refer to Fig. 19) of the motor 22 that drives and rotates the first arm 21A. As the pivot angle of the second arm 21B with respect to the first arm 21A increases, the biasing force of the coil spring 77 increases, and the load detected by the load sensor 23 also increases. Therefore, it is possible to cause the pivoting cleaner 3 to function as a contact sensor (collision sensor) with the second arm 21B as a contact (bumper).

[0040] As illustrated in Fig. 17, the above pivoting cleaner 3 is configured in such a manner that the arm 21 pivots between the stored state and the protruding state. When the arm 21 is in the stored state, the second arm 21B is located, overlapping, frontward of the vacuum assembly 14 as indicated by a virtual line (chain double dashed line) in Fig. 17. Here, the width dimension of the vacuum assembly 14 is W1, the width dimension of the second arm 21B is W2, and the width dimension of the second arm 21B excluding the portion overlapping with the vacuum assembly 14 is W2a. Therefore, when the arm 21 is in the stored state, the cleaning width dimension including the vacuum assembly 14 and the left and right pivoting cleaners 3 is (W1 + 2W2a). Moreover, the width dimension between a side end of the vacuum assembly 14 and an outermost edge of the side surface 103 of the body 10 is W1a. The width dimension between an outer end of the second arm 21B and the outermost edge of the side surface 103 of the body 10 is W3.

[0041] On the other hand, when the arm 21 is in a maximum protruding state orthogonal to the front-and-rear direction as indicated by a solid line in Fig. 17, the second arm 21B is located substantially sideward of the vacuum assembly 14, spaced apart from the vacuum assembly 14. The width dimension of the space between them is W4. In the maximum protruding state, the cleaning width dimension including the vacuum assembly 14 and the left and right second arms 21B is (W1 + 2W2), and the width dimension between outer ends of the left and right second arms 21B is (W1 + 2W2 + 2W4). Moreover, the arm 21 is configured to be capable of pivoting farther rearward than in the maximum protruding state.

[0042] Next, the operation of the autonomous vacuum cleaner 1 is described. When the autonomous vacuum cleaner 1 is turned on, the controller 5 raises the lift 13 and drives the surroundings sensor 32, and drives the front sensor 31 and the rear sensor 33. Furthermore, the travel controller 41 of the controller 5 controls and drives the travel driver 12 in accordance with a preset travel program, and causes the motor to rotate the wheels 121 and causes the vacuum cleaner body 2 to travel autonomously. With the travel of the vacuum cleaner body 2, the vacuum controller 42 controls the vacuum assembly 14 to start a vacuuming operation. At the start of cleaning, the arm 21 of the pivoting cleaner 3 is in the stored state illustrated in Figs. 1, 2, and 5 to 10.

[0043] The autonomous vacuum cleaner 1, which has started the operation, travels autonomously with the travel driver 12, detecting the presence or absence of an obstacle in the surroundings and the distance to the obstacle with the front sensor 31 and the surroundings sensor 32, while cleaning the floor surface with the vacuum assembly 14. In other words, the detection computer 43 computes the distance to an obstacle on the basis of detection signals from the front sensor 31 and the surroundings sensor 32; accordingly, the position and shape of the obstacle around the vacuum cleaner body 2 can be recognized. It may be configured in such a manner that the position and shape of an obstacle is recognized by computations by the front sensor 31 and the surroundings sensor 32 without the computation by the detection computer 43. In this manner, the autonomous vacuum cleaner 1 executes cleaning, storing the pivoting cleaners 3 into the stored state, and causing the arms 21 to pivot into the protruding state, while continuing travelling, recognizing obstacles around the vacuum cleaner body 2.

[0044] Specific control over the drive of the pivoting cleaner 3 during autonomous cleaning is described with reference to Figs. 25(A) and 25(B) and 26(A) to 26(C). Figs. 25(A) and 25(B) are plan views illustrating the operation of the autonomous vacuum cleaner. Figs. 26(A) to 26(C) are plan views illustrating another operation of the autonomous vacuum cleaner, and are drawings illustrating an operation of cleaning against a wall or in a corner of the wall.

[0045] As illustrated in Fig. 25(A), when the arms 21 of the pivoting cleaners 3 are in the stored state, the autonomous vacuum cleaner 1 moves forward to clean the width of the cleaning width dimension (W1 + 2W2a) by the vacuum assembly 14 and the left and right pivoting cleaners 3. In such a stored state of the arm 21, the part with the width dimension W3 between the outer end of the second arm 21B and the outermost edge of the body 10 is not cleaned. Even if the distance to the wall is reduced in the stored state, a band-shaped area near the wall cannot be cleaned. Therefore, when the surroundings sensor 32 detects a wall surface W (refer to Figs. 26(A) to 26(C)), the arms 21 are caused to pivot into the protruding state according to the distance to the wall surface W as illustrated in Fig. 25(B).

[0046] When the arm 21 of the pivoting cleaner 3 is caused to pivot into the maximum protruding state, the width dimension W2 of the second arm 21B is greater than the width dimension W3 as illustrated in Fig. 25(B). Accordingly, it is possible to thoroughly clean against the wall including the band-shaped area that cannot clean in the stored state. The autonomous vacuum cleaner 1 in the state where the arms 21 have been caused to pivot into the maximum protruding state in this manner drives the travel driver 12, moves forward and closer to the wall surface W, and then travels parallel to the wall surface W. At this point in time, the distance between the vacuum cleaner body 2 and the wall surface W may be based on a map of a cleaning area prestored in the controller 5, or the distance detected by the front sensor 31 and the surroundings sensor 32. The autonomous vacuum cleaner 1 travels along the wall surface W in such a manner as to maintain a distance that the distal end of the second arm 21B comes into contact with the wall surface W, or the shortest distance without coming into contact with the wall surface W.

[0047] As illustrated in Figs. 26(A) to 26(C), when cleaning is conducted along the wall with the arm 21 of the pivoting cleaner 3 in contact with the wall surface W, the angle sensor 24 detects the pivot angle of the first arm 21A, and the motor 22 causes the first arm 21A to pivot to a predetermined angle. As illustrated in Fig. 26(A), if the autonomous vacuum cleaner 1 continues moving forward with the distal end of the second arm 21B in contact with the wall surface W, when the distance between the wall surface W and the vacuum cleaner body 2 is reduced, the distal end of the second arm 21B is pushed backward; accordingly, the second arm 21B pivots toward the rear against the biasing force of the coil spring 77. In this manner, even if the distance to the wall surface W changes, the second arm 21B pivots to trace and clean along the wall surface W.

[0048] The front sensor 31 and the surroundings sensor 32 detect the wall surface W ahead. When the distance to the wall surface W ahead is reduced to a predetermined distance, the controller 5 causes the travel controller 41 to control the drive of the travel driver 12 and stops the travel driver 12, and changes direction (turns left) in such a manner as to move away from the wall surface W on the side (the right side in Figs. 26(A) to 26(C)). In this manner, the autonomous vacuum cleaner 1 turns. Accordingly, the distal end of the second arm

21B moves away from the wall surface W on the side, and the biasing force of the coil spring 77 causes the second arm 21B to return to the initial position. The load sensor 23 detects the disappearance of the load on the second arm 21B. On the basis of the detection, the controller 5 stops the turn by the travel controller 41, and then causes the arm controller 44 to drive the motor 22 and cause the arm 21 to pivot back and forth, and consequently causes the pivoting cleaner 3 to vacuum and clean the corner of the wall surface W, as illustrated in Fig. 26(B). In this manner, when the arm 21 is caused to pivot back and forth, the pivot area of the arm 21 is adjusted on the basis of the distance to the wall surface W, and the motor 22 is controlled to reduce the pivot speed of the arm 21 before the distal end of the second arm 21B comes into contact with the wall surface W.

[0049] When the arm 21 is caused to pivot back and forth a predetermined number of times and the cleaning in the corner is finished, the arm controller 44 stops the motor 22 to fix the first arm 21A. The controller 5 then causes the travel controller 41 to control and drive the travel driver 12 to change direction again. With a further forward movement, tracing and cleaning along the wall surface W ahead is conducted as illustrated in Fig. 26(C).

[0050] According to such an embodiment, the following operations and effects can be exerted.

(1) The inside of the first inner tube member 61 in the first arm 21A of the pivoting cleaner 3 forms the vacuum channel 66. The vacuum channel 66 is provided along the rotation axis of the rotation support of the first arm 21A. The vacuum channel 66 causes the inside of the first arm 21A and the inside (dust collection path) of the sub-duct 143 to communicate with each other. Accordingly, it is possible to simplify the structures of the rotation support and the vacuum channel 66 of the first arm 21A. Therefore, it is possible to promote a reduction in drive load and an improvement in suction performance while promoting downsizing of the pivoting cleaner 3.

(2) The rotation support of the first arm 21A includes the first outer tube member 144 of the vacuum cleaner body 2 and the first inner tube member 61 of the first arm 21A. The first inner tube member 61 is inserted into the first outer tube member 144, and the inside of the first inner tube member 61 configures the vacuum channel 66. Accordingly, it is possible to smoothly send the sucked dirt and the like to the sub-duct 143 through the inside of the first inner tube member 61 and prevent the dirt and the like from being trapped and left in the vacuum channel 66.

(3) The second rotation support of the second arm 21B includes the second outer tube member 63, the second inner tube member 71, and the second vacuum channel 76. The second inner tube is inserted into the second outer tube, and the inside of the second inner tube configures the second vacuum channel 76. Accordingly, it is possible to smoothly send the dirt and the like that have been sucked up through the vacuum inlet 74 to the inside of the first arm 21A through the inside of the second inner tube member 71 and prevent the dirt and the like from being trapped and left in the second vacuum channel 76.

(4) The first arm 21A is provided with the permanent magnet 81. The outer side of the sub-duct 143 of the vacuum cleaner body 2 is provided with the magnetic field sensor 82 and the board 83. Accordingly, it is possible to prevent dirt and the like from adhering to the magnetic field sensor 82 and the board 83. Moreover, the angle sensor 24 detects the pivot angle of the first arm 21A on the basis of the position of the permanent magnet 81. Accordingly, it is possible to grasp the state of the pivoting cleaner 3.

(5) The pivoting cleaner 3 includes the first arm 21A and the second arm 21B. Accordingly, the arms 21A and 21B pivot with flexibility in accordance with the shape of an obstacle. It is possible to enlarge the cleaning area by the pivoting cleaner 3 and efficiently clean corners of a wall and an obstacle by causing the second arm 21B to reach the corners.

(6) The motor 22 drives the first arm 21A to rotate with respect to the vacuum cleaner body 2. The coil spring 77 biases the second arm 21B with respect to the first arm 21A in the rotation direction. Accordingly, the active drive of the motor 22 can cause the first arm 21A to pivot. Moreover, when an external force acts on the second arm 21B, the second arm 21B pivots and is displaced by the elasticity of the coil spring 77. Consequently, loads on the first arm 21A and the motor 22 can be reduced. Furthermore, the second arm 21B pivots; accordingly, even if the distance to the wall surface W changes to some extent, tracing and cleaning along the wall surface W can be conducted without the second arm 21B moving away from the wall surface W.

(7) The load sensor 23 detects a rotational load acting on the first arm 21A. Accordingly, the pivoting cleaner 3 can be used as a contact sensor, and the travel of the autonomous vacuum cleaner 1 can be efficiently controlled.

(8) The pivoting cleaner 3 has the vacuum cleaning function of sucking up dirt and the like through the vacuum inlet 74 of the second arm 21B. Accordingly, it is possible to more efficiently enlarge the cleaning area.

(9) When the first arm 21A and the second arm 21B are in the stored state, a part of the second arm 21B overlaps the vacuum assembly 14 and another part of the second arm 21B is located sideward of the vacuum assembly 14. Accordingly, it is possible to enlarge the cleaning area in the width direction during travel of the autonomous vacuum cleaner 1.

(10) The pair of left and right pivoting cleaners 3 is provided in the front part of the vacuum cleaner body 2. Accordingly, when the autonomous vacuum cleaner 1 moves closer to a corner, travelling for-

ward, it is possible to make sure of cleaning the corner, regardless of which side the corner is located, left or right.

(11) The motor 22 of the pivoting cleaner 3 is controlled and driven on the basis of the presence or absence of an obstacle detected by the surroundings sensor 32, and the travel controller 41 is controlled and driven on the basis of a load detected by the load sensor 23. Accordingly, it is possible to finely control the protrusion amount of the arm 21 and the travel operation of the vacuum cleaner body 2.

(12) When the autonomous vacuum cleaner 1 turns, the load sensor 23 detects the disappearance of the load on the second arm 21B. The turn is stopped on the basis of the detection, and the arm controller 44 drives the motor 22 to cause the arm 21 to pivot back and forth. Accordingly, it is possible to cause the arm 21 to efficiently pivot while reducing excessive load on the motor 22, and clean a corner.

(13) The motor 22 is controlled in such a manner as to reduce the pivot speed of the arm 21 with decreasing distance to an obstacle when the surroundings sensor 32 detects the obstacle. Accordingly, it is possible to prevent a collision of the arm 21 with the obstacle and reduce the load.

[Modifications of Embodiment]

[0051] The present invention is not limited to the embodiment, and includes modifications, improvements, and the like within the scope that can achieve the object of the present invention.

[0052] For example, the pair of left and right pivoting cleaners 3 (surrounding cleaning means) is provided to the front part of the vacuum cleaner body 2 of the autonomous vacuum cleaner 1 of the embodiment. However, the place where the surrounding cleaning means are provided is to not limited to the front part of the vacuum cleaner body and may be the side parts or the rear part. The surrounding cleaning means are not limited to being provided in a pair on the left and right sides and may be provided in only one place or three or more places.

[0053] Moreover, in the embodiment, the pivoting cleaner (surrounding cleaning means) 3 is configured including the pivotable arm (pivoting member) 21, and the arm 21 is configured including the first arm (first pivoting member) 21A and the second arm (second pivoting member) 21B. However, the configuration of the surrounding cleaning means is not limited to the one in the embodiment. In other words, the pivoting member of the surrounding cleaning means is not limited to the one that includes two members such as the first and second pivoting members and may be configured including one member or three or more members.

[0054] In the embodiment, it is configured in such a manner that the pivoting cleaner (surrounding cleaning means) 3 has the vacuum cleaning function of sucking up dirt and the like through the vacuum inlet 74 of the second arm 21B, and the dirt and the like that have been sucked up through the vacuum inlet 74 are sent from the sub-duct (dust collection path) 143 to the dust collection chamber via the duct 142 of the vacuum assembly (main cleaning means) 14. However, the configuration is not limited to this. In other words, it may be configured in such a manner that the surrounding cleaning means includes a sub-blower and a sub-dust collection chamber, which are independent of the main cleaning means, and the sub-blower sends the dirt and the like that have been sucked up through the vacuum inlet of the surrounding cleaning means from the dust collection path to the sub-dust collection chamber.

[0055] In the embodiment, the pivoting cleaner (surrounding cleaning means) 3 is configured in such a manner that the first arm (first pivoting member) 21A is driven and rotated by the motor (rotation drive means) 22 with respect to the vacuum cleaner body 2, and the second arm (second pivoting member) 21B is biased by the coil spring (rotation biasing means) 77 with respect to the first arm 21A in the rotation direction. However, the surrounding cleaning means is not limited to such a configuration. In other words, the first pivoting member may be biased by the rotation biasing means with respect to the vacuum cleaner body, and the second pivoting member may be driven and rotated by the rotation drive means with respect to the first pivoting member, or at least one of the rotation drive means and the rotation biasing means may be omitted. Moreover, the rotation drive means is not limited to the motor and may include another appropriate drive means, and the rotation biasing means is not limited to the coil spring and may include another appropriate biasing means.

[0056] In the embodiment, the pivoting cleaner (surrounding cleaning means) 3 is configured including the load sensor (load detection means) 23 that a rotational load acting on the first arm 21A, and the angle sensor (angle detection means) 24 that detects the pivot angle of the first arm 21A. However, at least one of the load detection means and the angle detection means may be omitted. Moreover, the load detection means is not limited to the one that includes the load detection circuit that detects rotational resistance acting on the motor 22, and may be one that directly detects load with a strain gauge, a load measuring device, or the like. Moreover, the angle detection means is not limited to the one that is configured including the permanent magnet 81 and the magnetic field sensor 82, and any sensor such as an optical sensor or electromagnetic sensor can be used as the angle detection sensor.

INDUSTRIAL APPLICABILITY

[0057] As described above, the present invention can be suitably used for an autonomous vacuum cleaner that can promote reductions in size and load by simplifying the structure of a surrounding cleaning means.

LIST OF REFERENCE NUMERALS

[0058]

1	Autonomous vacuum cleaner
2	Vacuum cleaner body
3	Pivoting cleaner (sub-cleaning means, surrounding cleaning means)
4	Sensor system
5	Controller (control means)
14	Vacuum assembly (main cleaning means)
21	Arm (pivoting member, protrusion)
21A	First arm (first pivoting member)
21B	Second arm (second pivoting member)
22	Motor (rotation drive means)
23	Load sensor (load detection means)
24	Angle sensor (angle detection means)
32	Surroundings sensor (surrounding detection means)
61	First inner tube member (inner tube, rotation support)
63	Second outer tube member (second outer tube, second rotation support)
66	Vacuum channel
71	Second inner tube member (second inner tube, second rotation support)
74	Vacuum inlet
76	Second vacuum channel
77	Coil spring (pivoting biasing means)
81	Permanent magnet
82	Magnetic field sensor
83	Board
121	Wheel
143	Sub-duct (dust collection path)
144	First outer tube member (outer tube, rotation support)

Claims

1. An autonomous vacuum cleaner capable of cleaning while traveling along a floor surface, comprising:

    a vacuum cleaner body including a wheel for travelling autonomously; and
    a surrounding cleaning means capable of vacuum cleaning around the vacuum cleaner body, wherein
    the vacuum cleaner body is provided with:

        a dust collection chamber configured to store dirt and the like that have been sucked up by the surrounding cleaning means; and
        a dust collection path causing the surrounding cleaning means and the dust collection chamber to communicate with each other, and

    the surrounding cleaning means is configured including:

        a pivoting member capable of pivoting outward from the vacuum cleaner body;
        a vacuum inlet provided to the pivoting member, the vacuum inlet being configured to suck up dirt and the like on the floor surface,
        a rotation support configured to rotatably support the pivoting member on the vacuum cleaner body; and
        a vacuum channel provided along a rotation axis of the rotation support, the vacuum channel causing the inside of the pivoting member and the dust collection path to communicate with each other.

2. The autonomous vacuum cleaner according to claim 1, wherein the rotation support of the surrounding cleaning means includes:

    an annular outer tube provided to the vacuum cleaner body; and
    a cylindrical inner tube provided to the pivoting member, the inner tube being inserted into the outer tube, wherein
    the inside of the inner tube configures the vacuum channel.

3. The autonomous vacuum cleaner according to claim 1 or 2, wherein the surrounding cleaning means further includes a rotation drive means configured to drive and rotate the pivoting member with respect to the vacuum cleaner body.

4. The autonomous vacuum cleaner according to any of claims 1 to 3, wherein
    the pivoting member is provided with a rotor configured to rotate together with the pivoting member, and the vacuum cleaner body is provided on an outer side of the dust collection path with an angle detection means configured to detect a pivot angle of the pivoting member on the basis of the position of the rotor.

5. The autonomous vacuum cleaner according to claim 4, wherein
    the rotor is a permanent magnet, and
    the angle detection means is configured including a detection circuit configured to detect changes in a magnetic field with the rotation of the permanent magnet.

6. The autonomous vacuum cleaner, wherein
    the pivoting member includes:

    a first pivoting member rotatably supported on

one end side thereof by the vacuum cleaner body;
a second pivoting member provided with the vacuum inlet, the second pivoting member being rotatably supported on the other end side of the first pivoting member; and
a second rotation support configured to support the second pivoting member in such a manner as to be rotatable with respect to the first pivoting member,

the second rotation support is configured including:

a second outer tube provided to the first pivoting member;
a cylindrical second inner tube provided to the second pivoting member, the second inner tube being inserted into the second outer tube; and
a second vacuum channel causing the vacuum inlet and the inside of the first pivoting member to communicate with each other through the inside of the second inner tube.

7. The autonomous vacuum cleaner according to claim 6, wherein the pivoting member is provided with a rotation biasing means configured to bias the second pivoting member with respect to the first pivoting member in a rotation direction.

FIG. 1

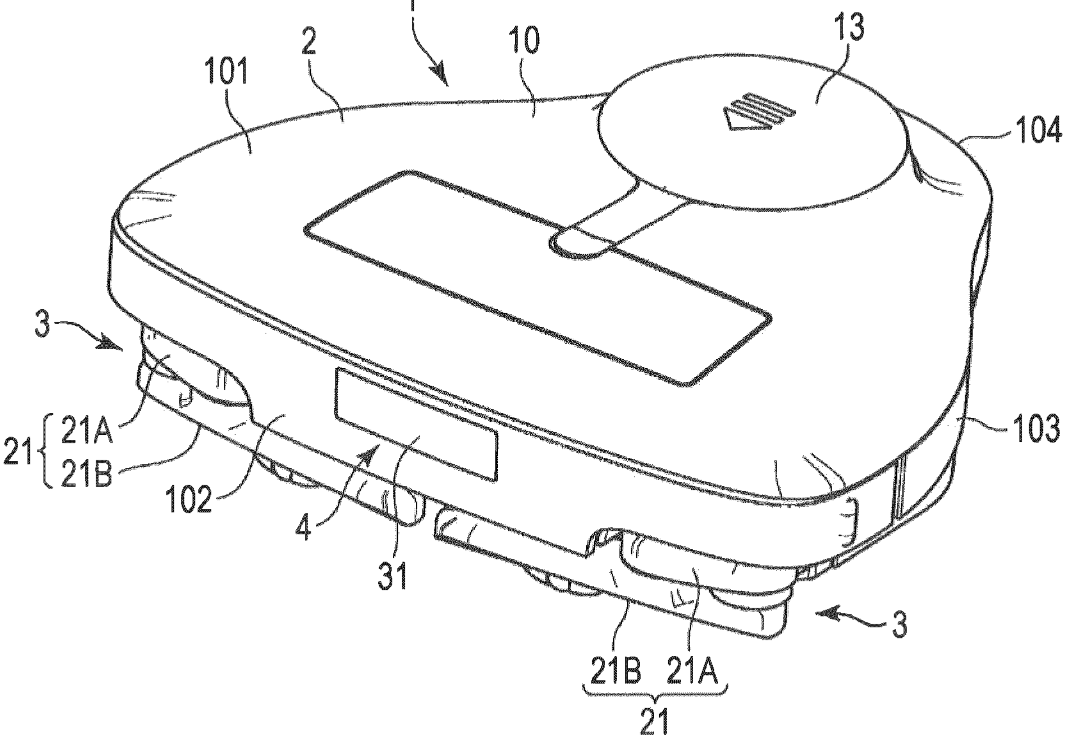

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FIG. 2

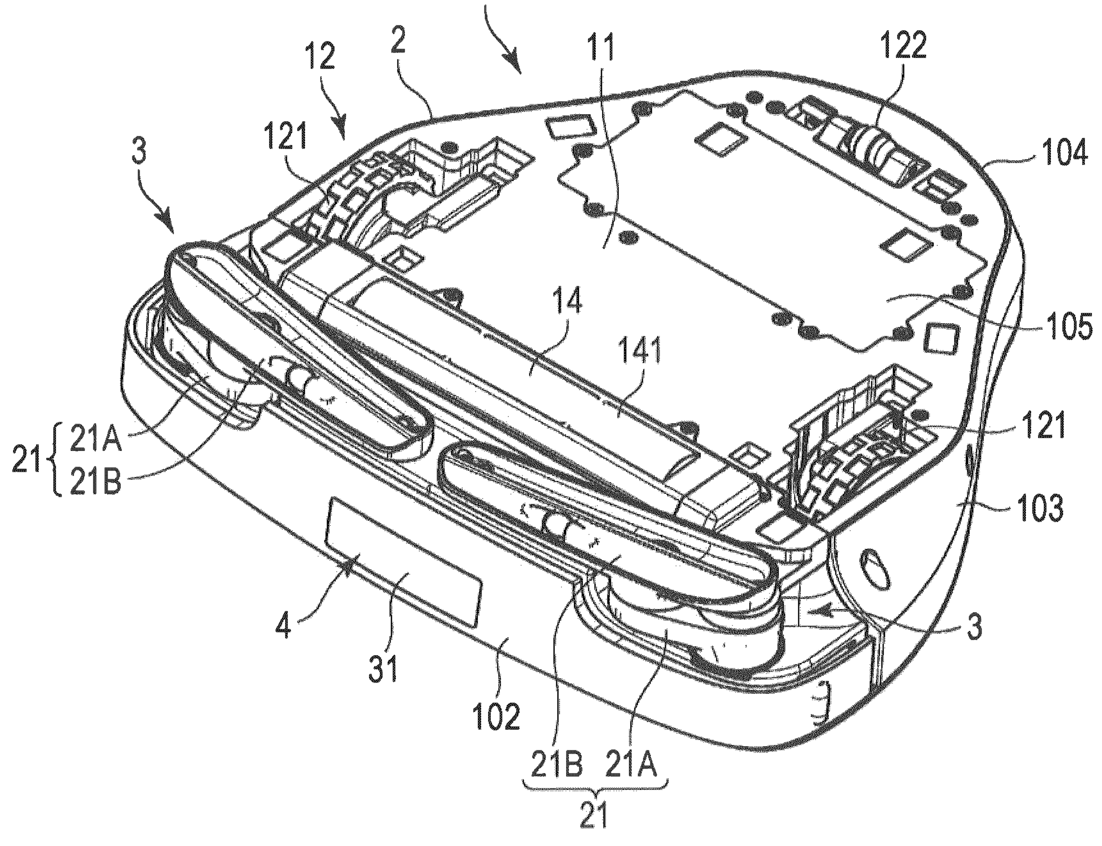
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FIG. 3

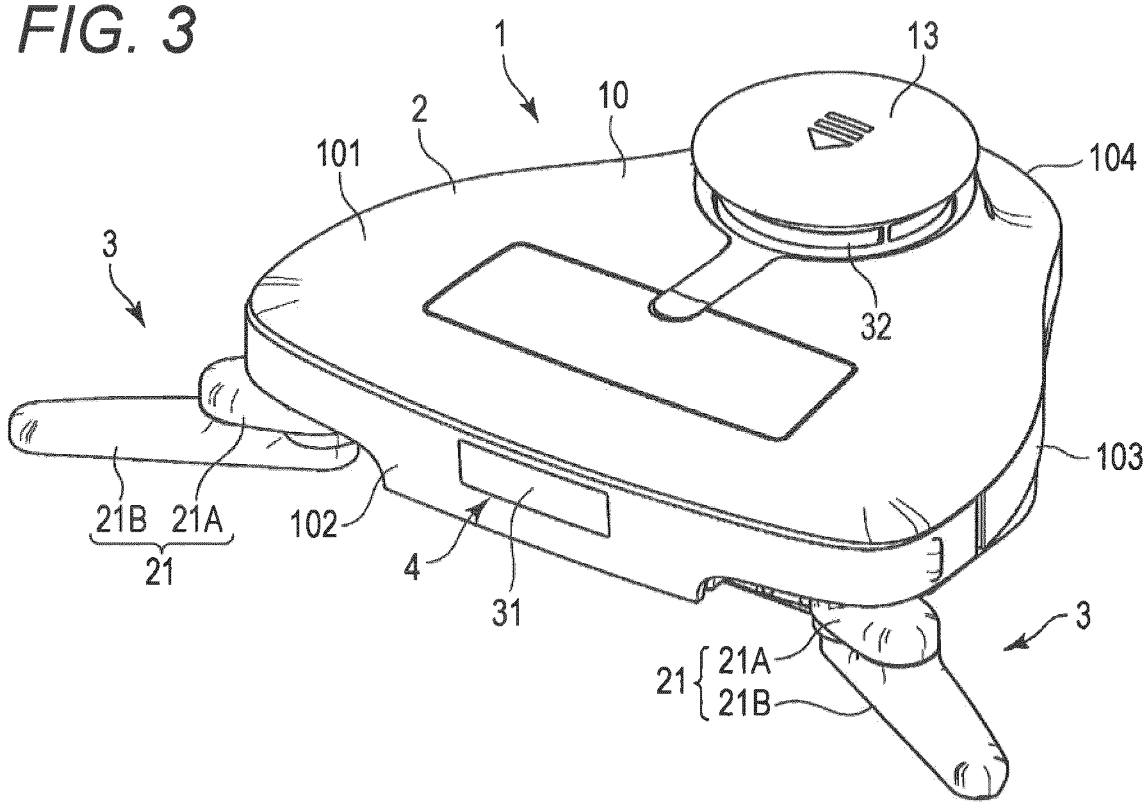
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FIG. 4

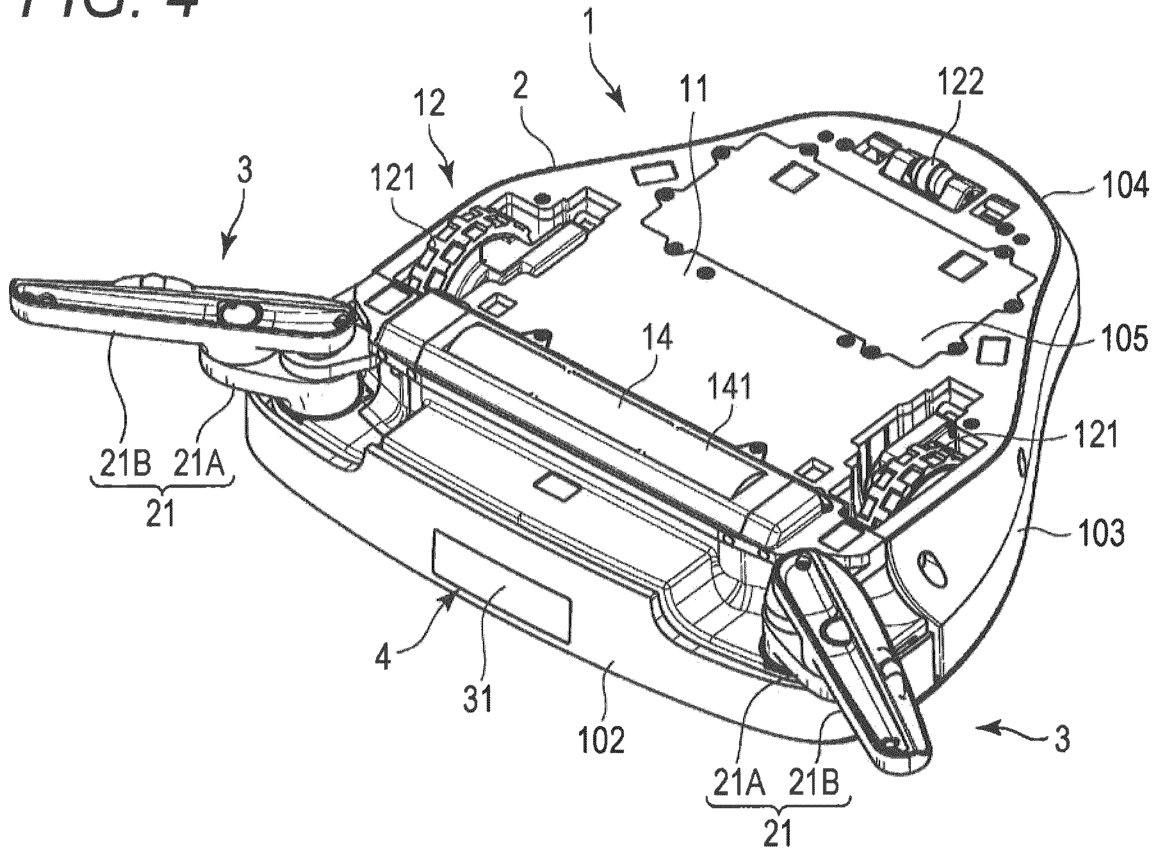
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FIG. 5

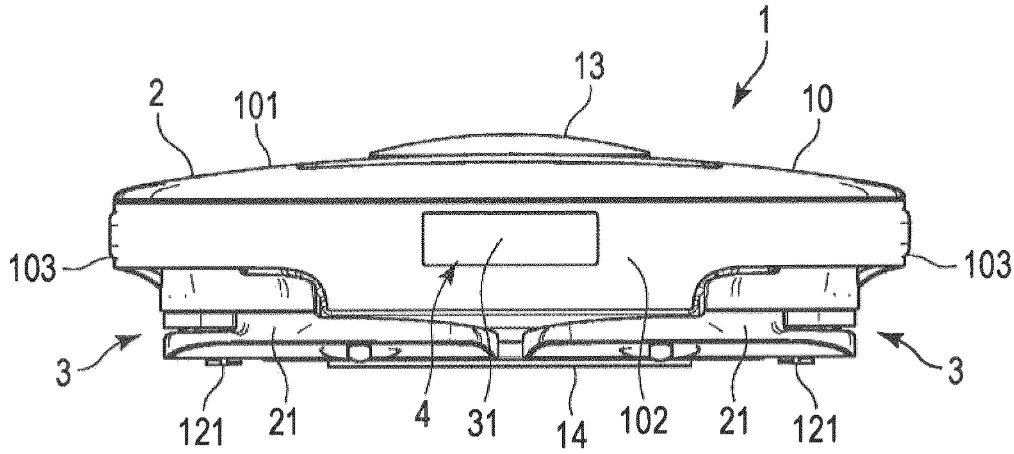
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FIG. 6

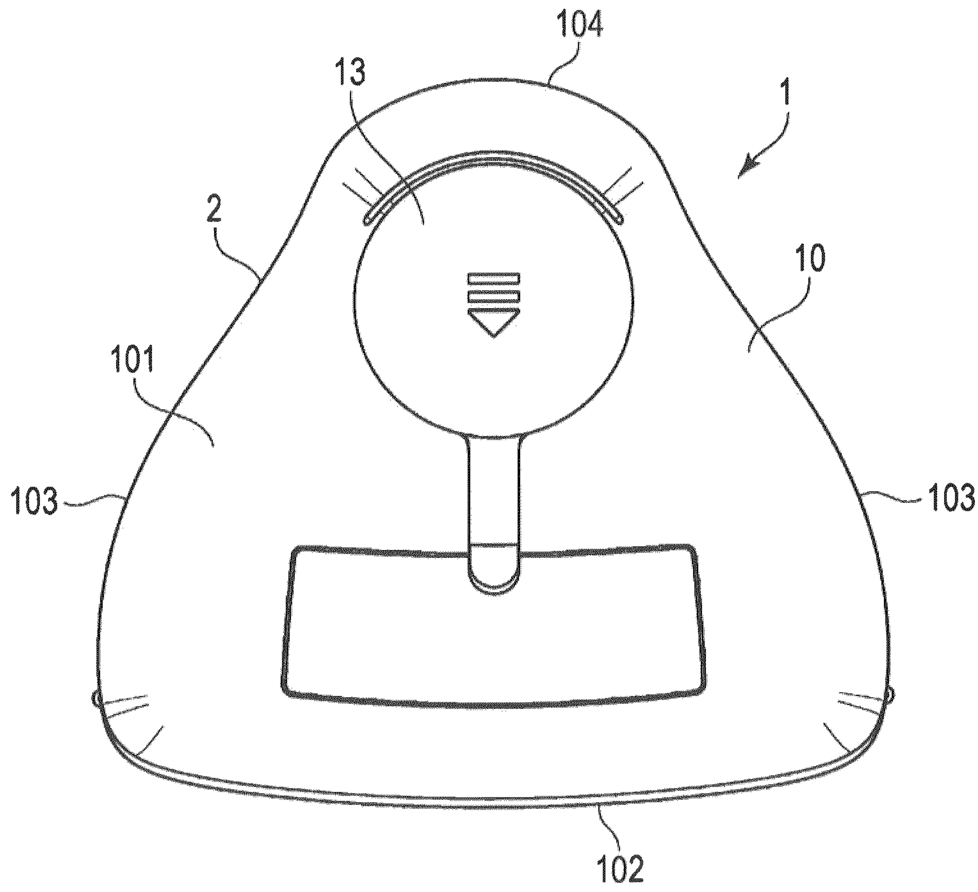
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FIG. 7

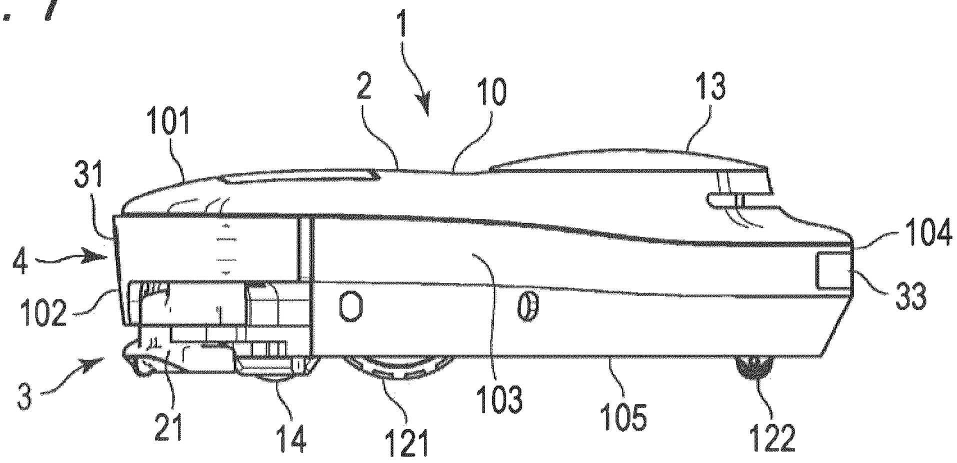

FIG. 8

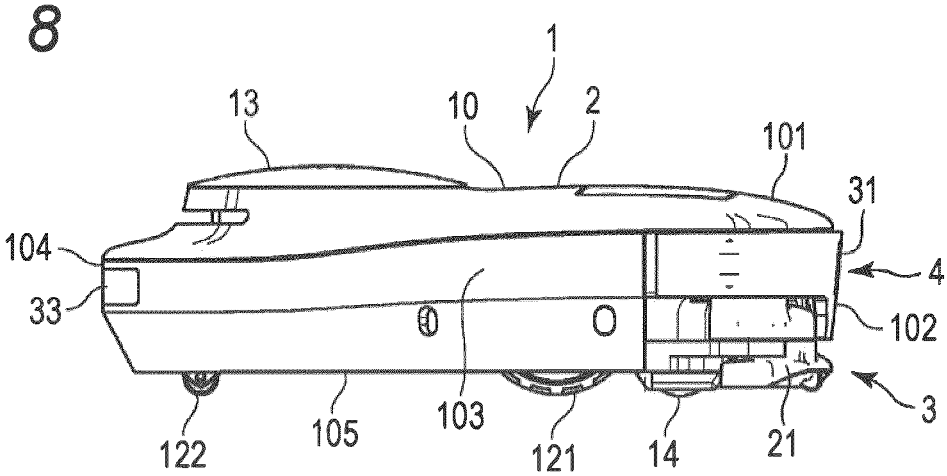

FIG. 9

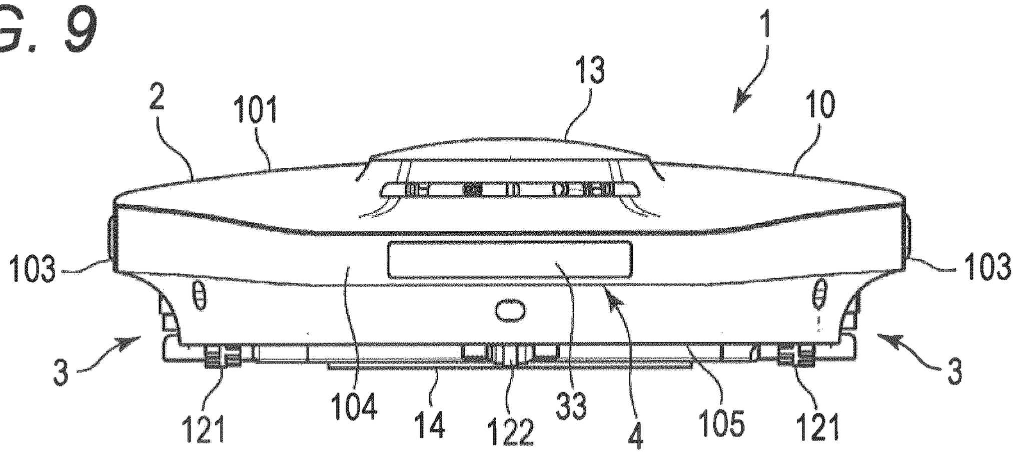

FIG. 10

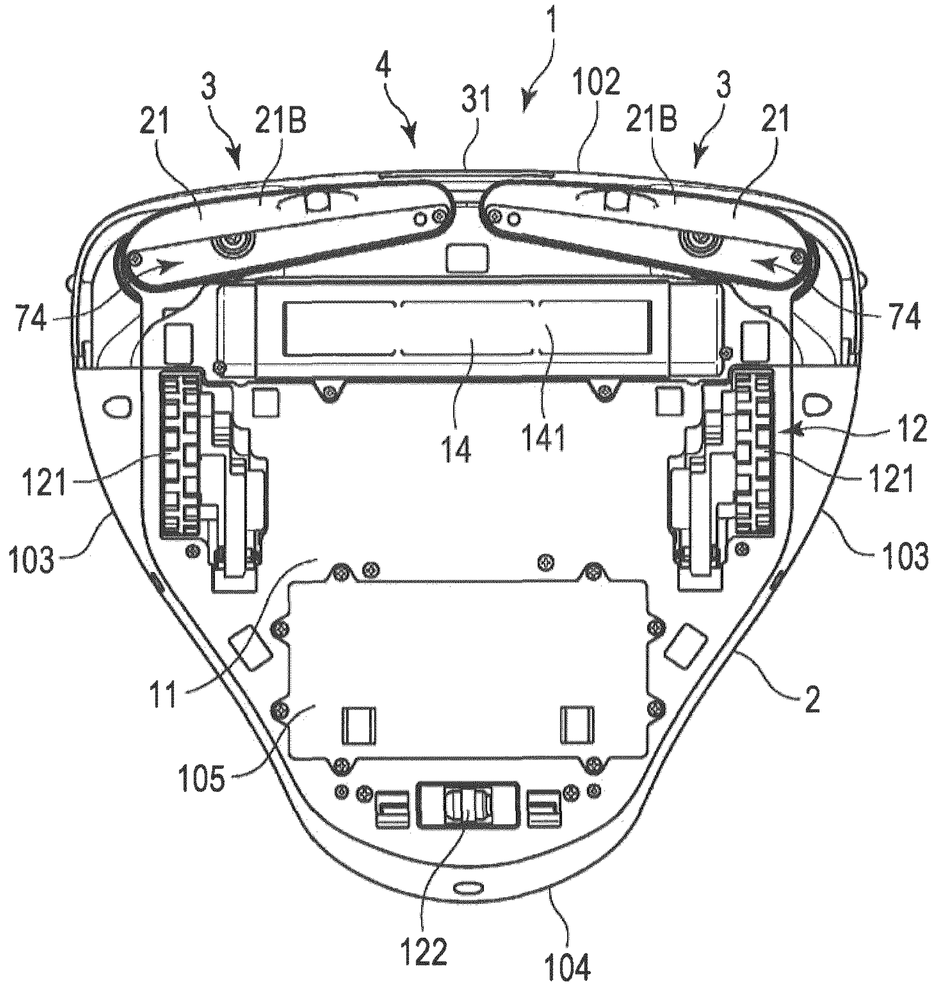
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FIG. 11

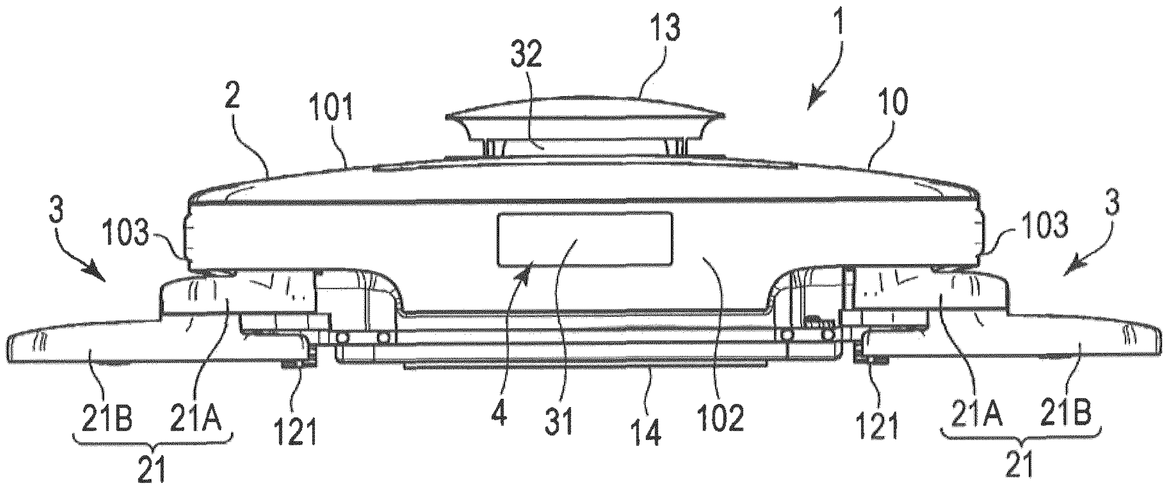
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FIG. 12

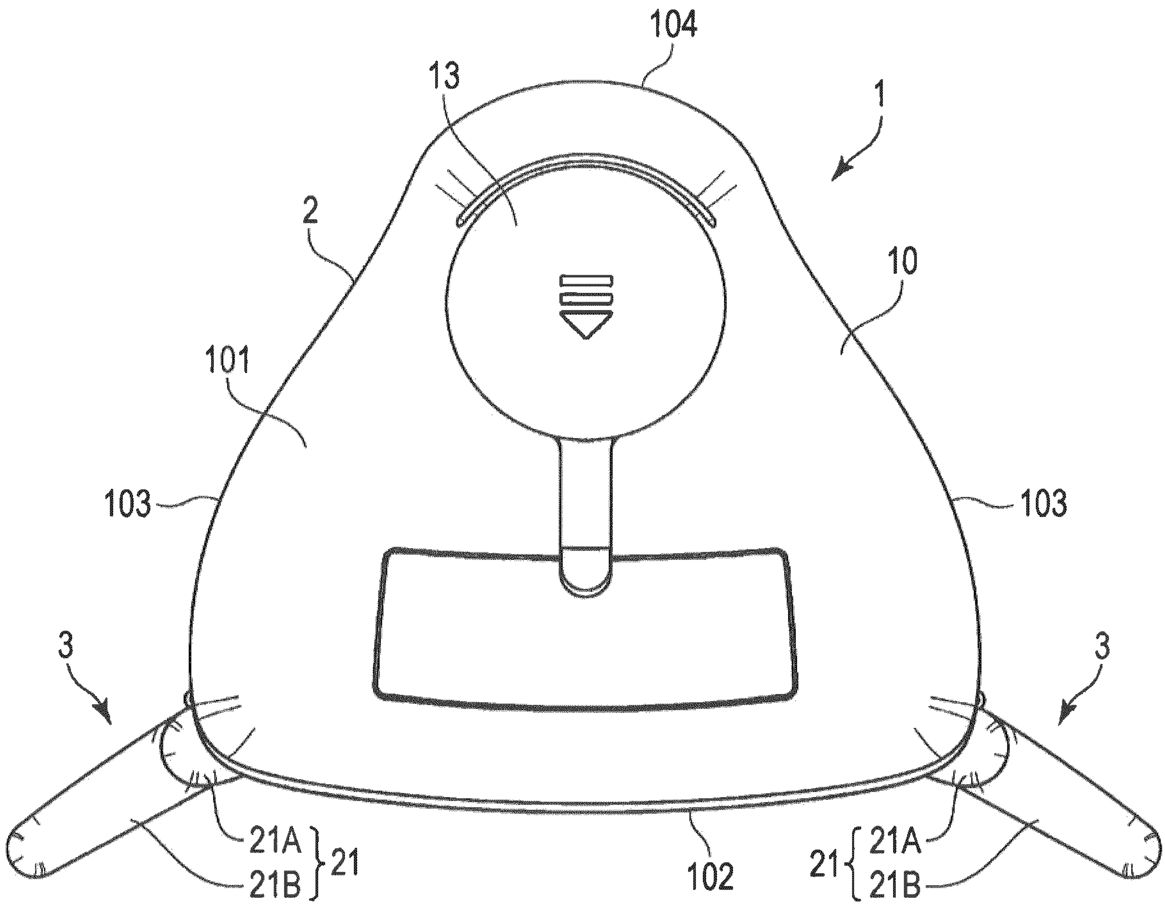
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FIG. 13

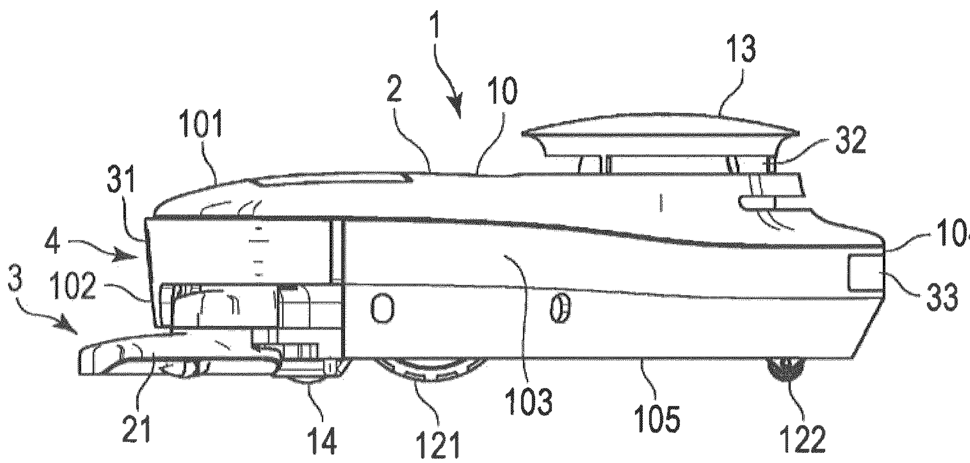
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FIG. 14

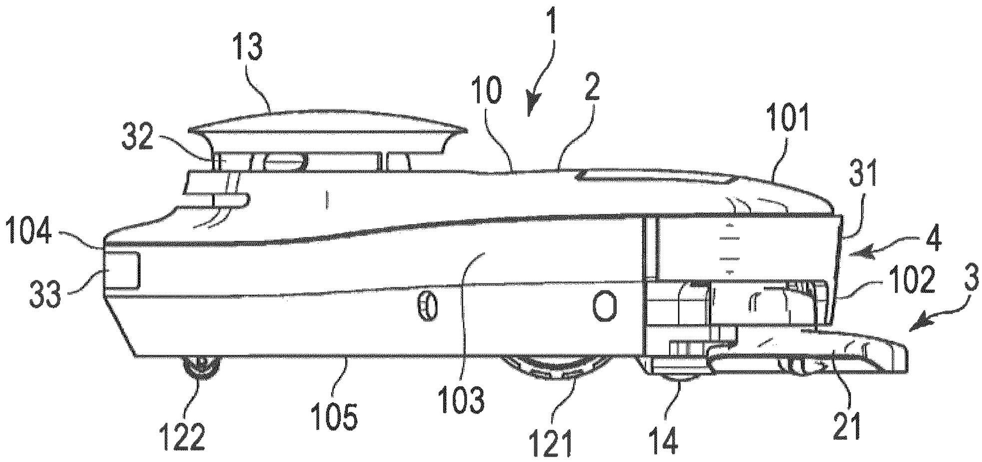
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FIG. 15

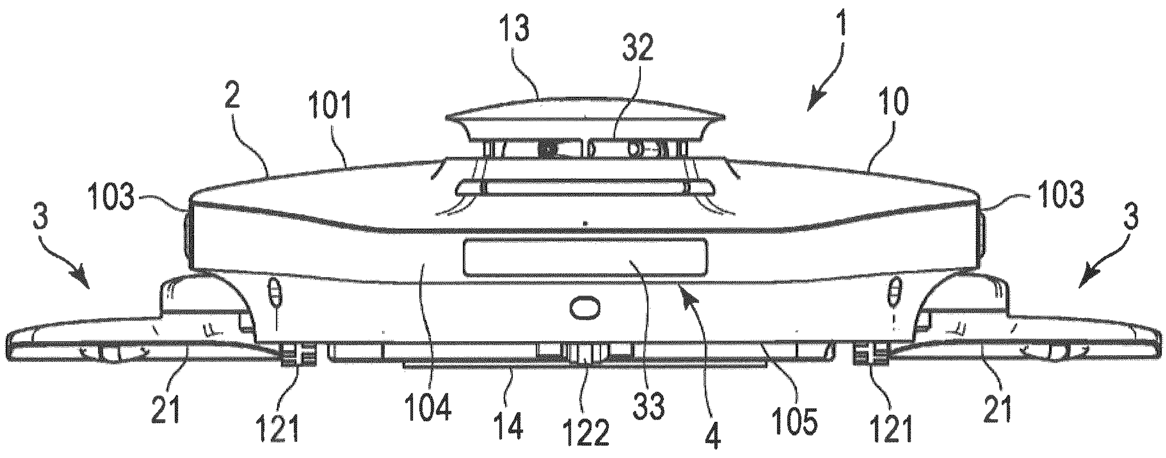
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FIG. 16

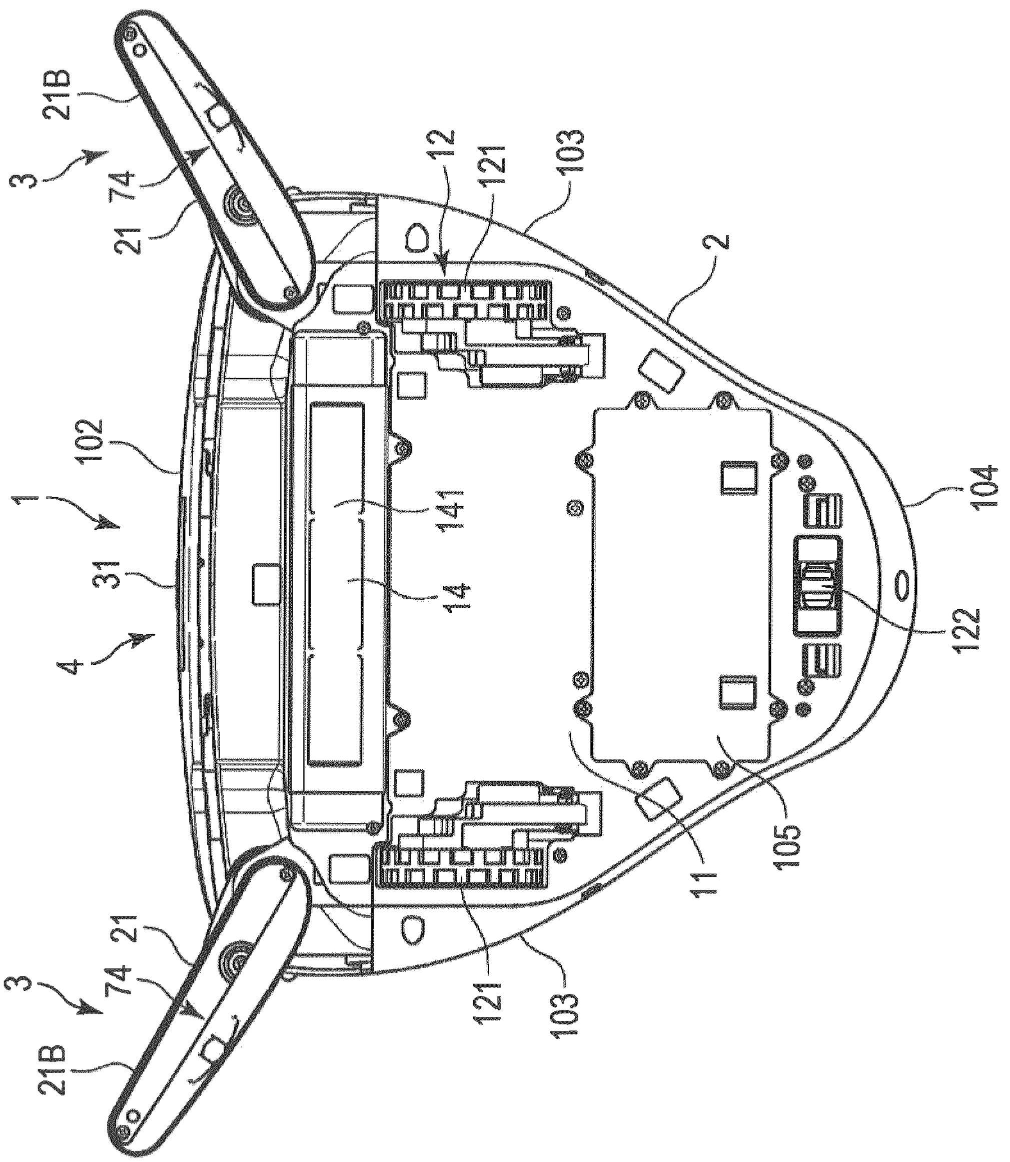
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FIG. 17

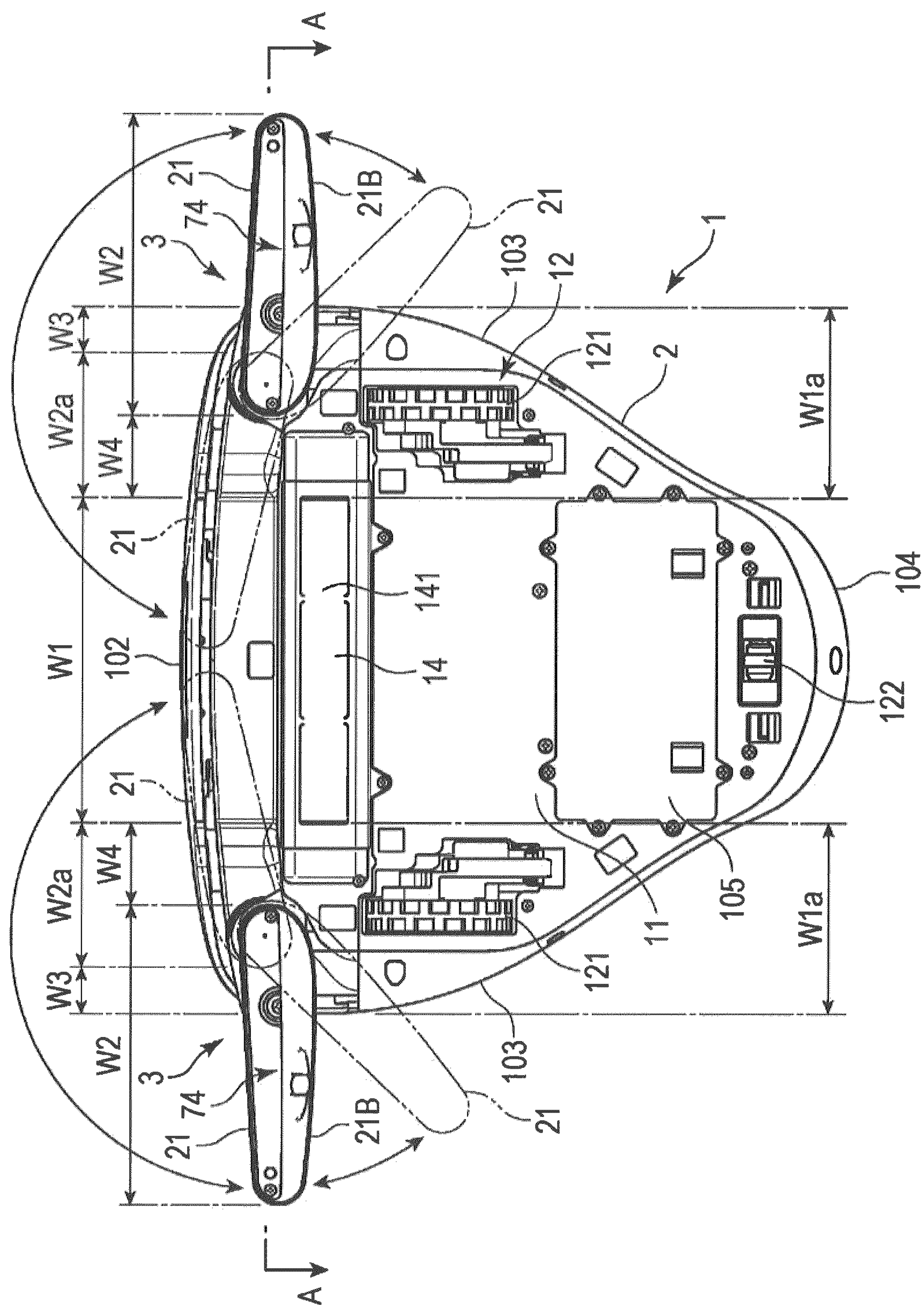
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FIG. 18

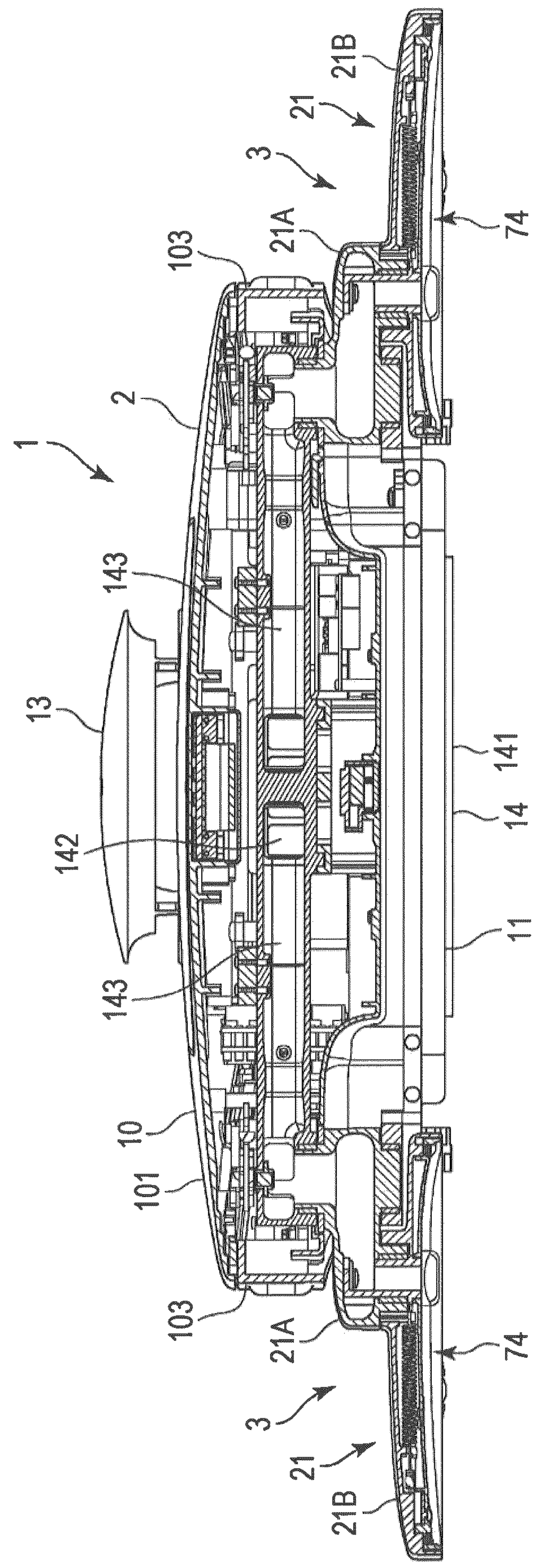
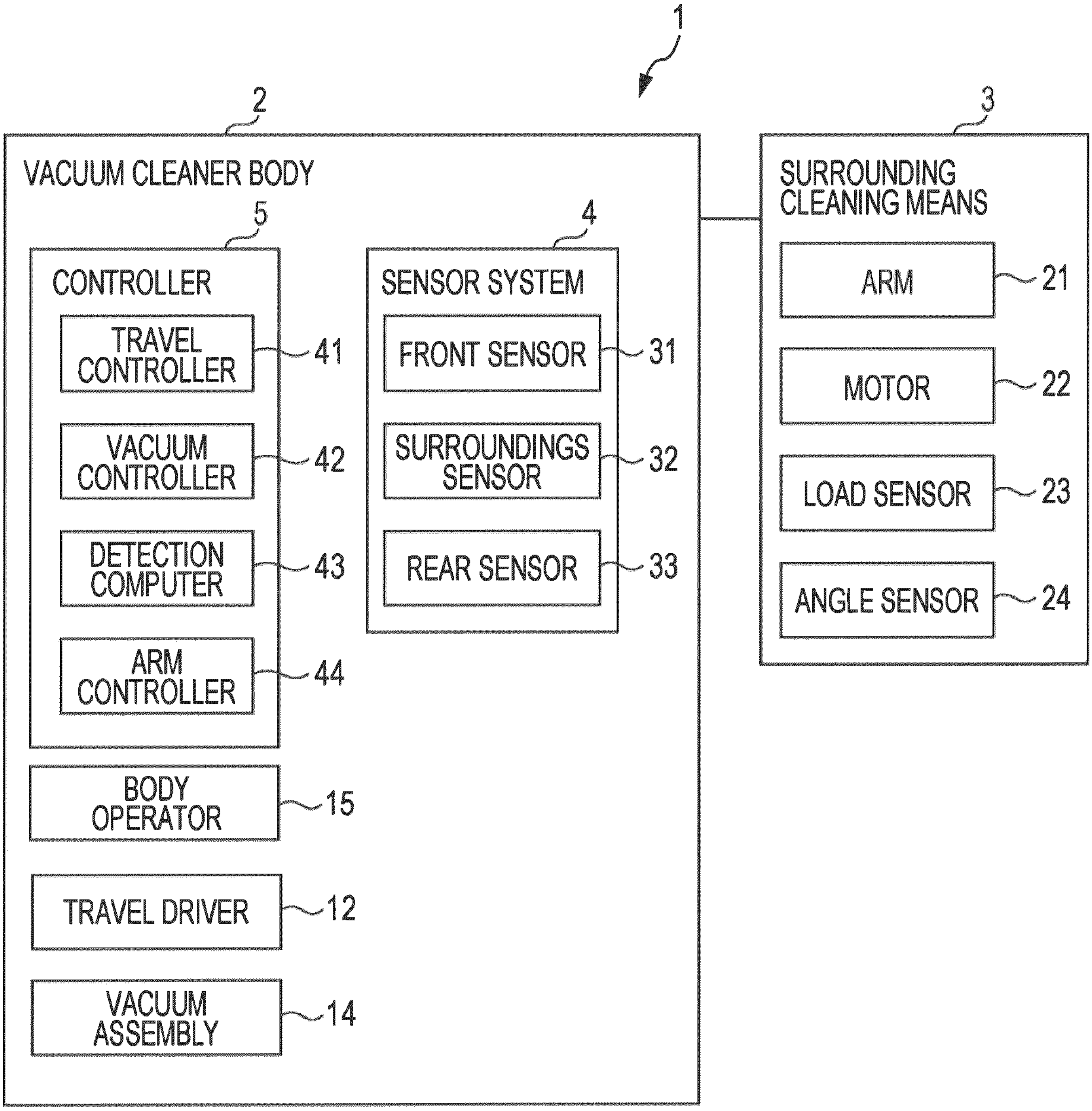


FIG. 19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TRAVEL CONTROLLER
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VACUUM CONTROLLER
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DETECTION COMPUTER
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ARM CONTROLLER
44
BODY OPERATOR
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TRAVEL DRIVER
12
VACUUM ASSEMBLY
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SENSOR SYSTEM
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SURROUNDINGS SENSOR
32
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LOAD SENSOR
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ANGLE SENSOR
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FIG. 20

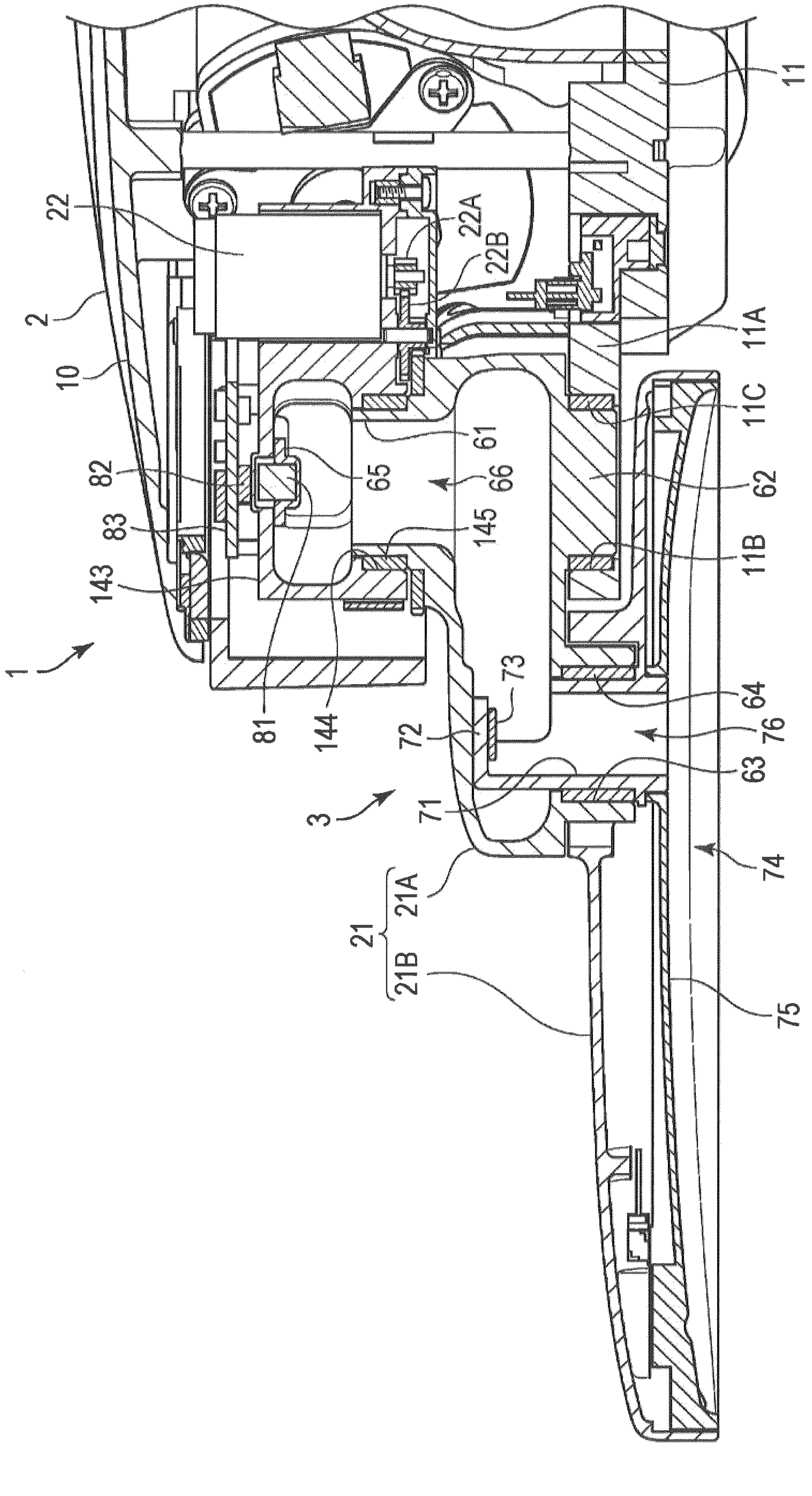
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FIG. 21

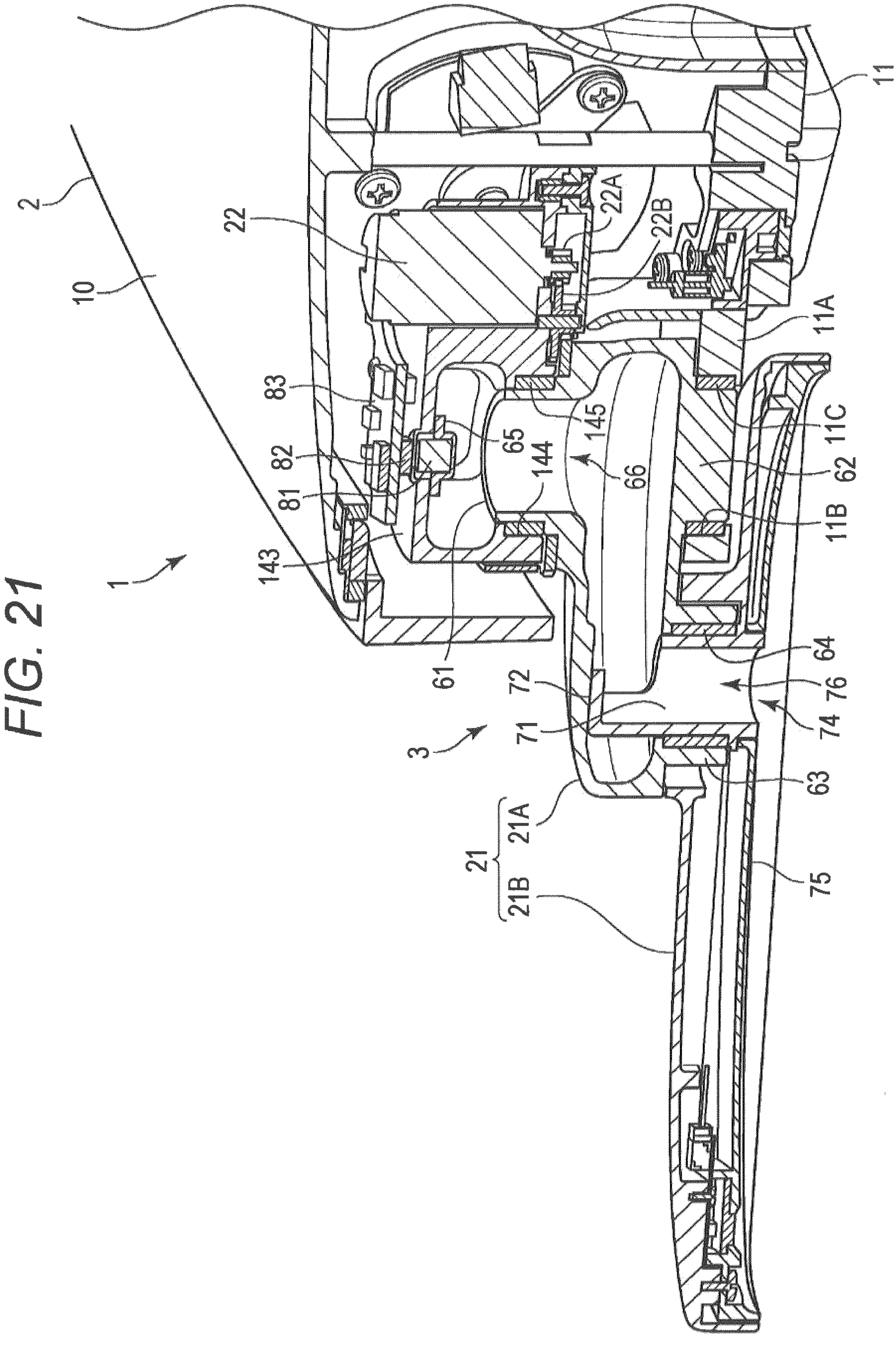
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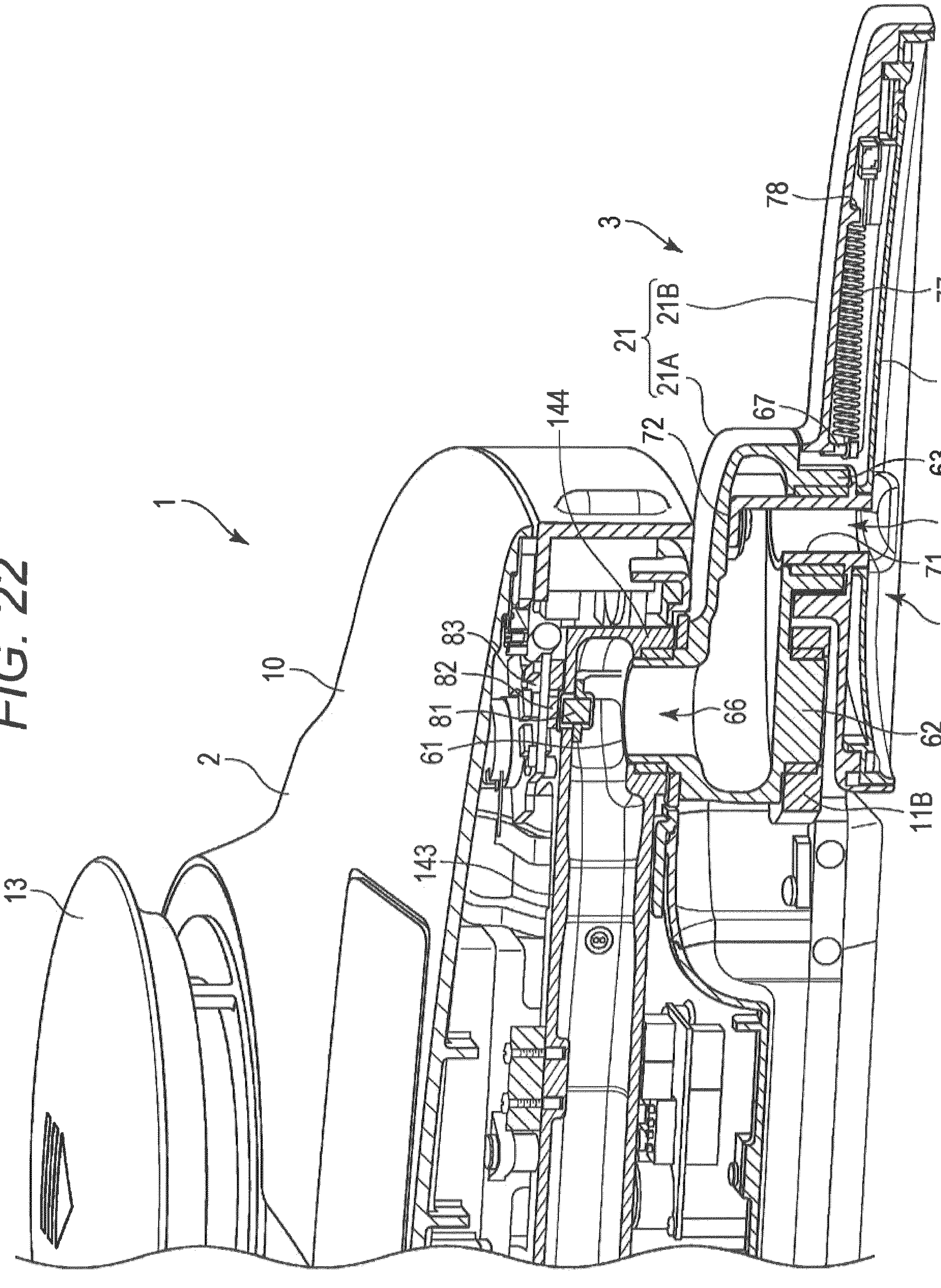
FIG. 22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144

FIG. 23

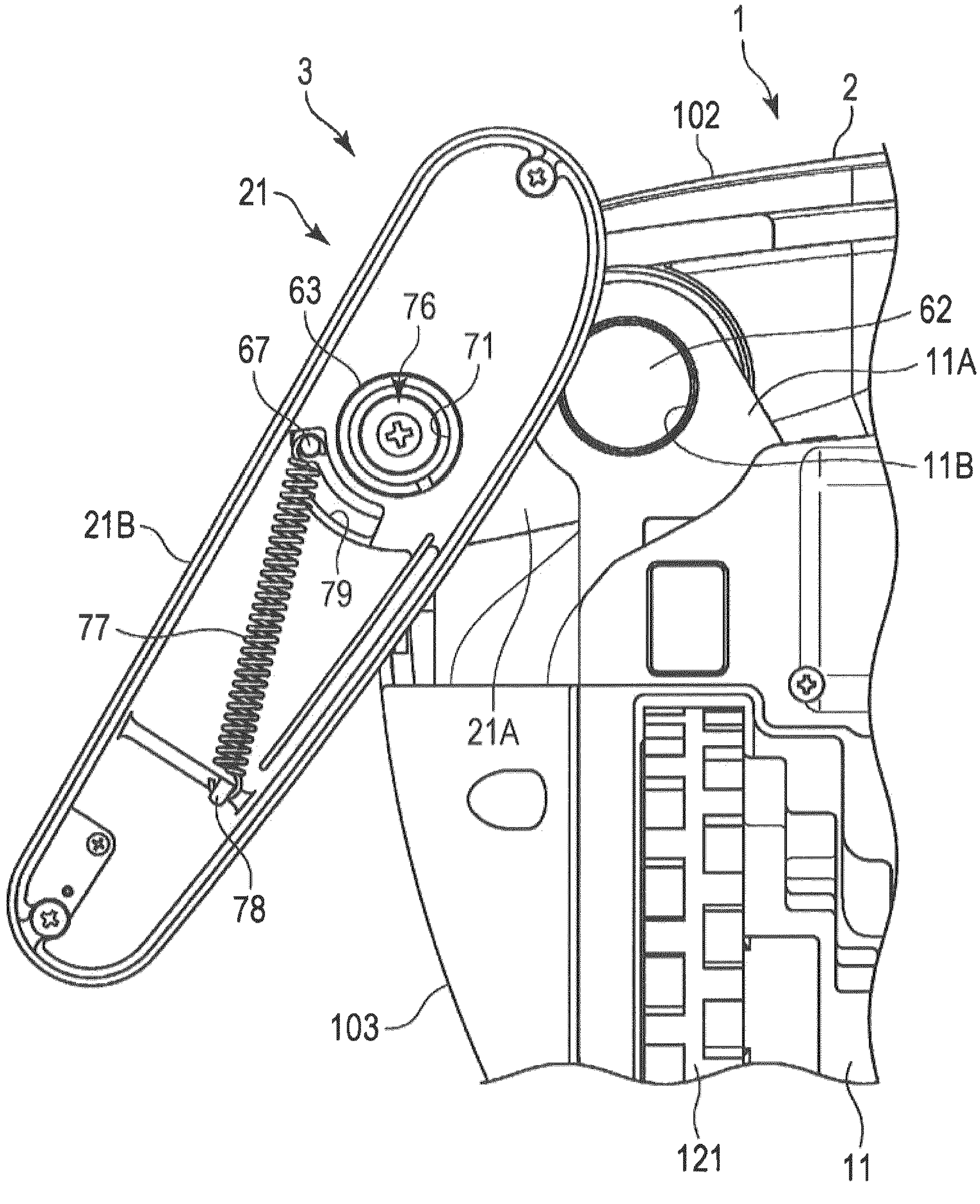
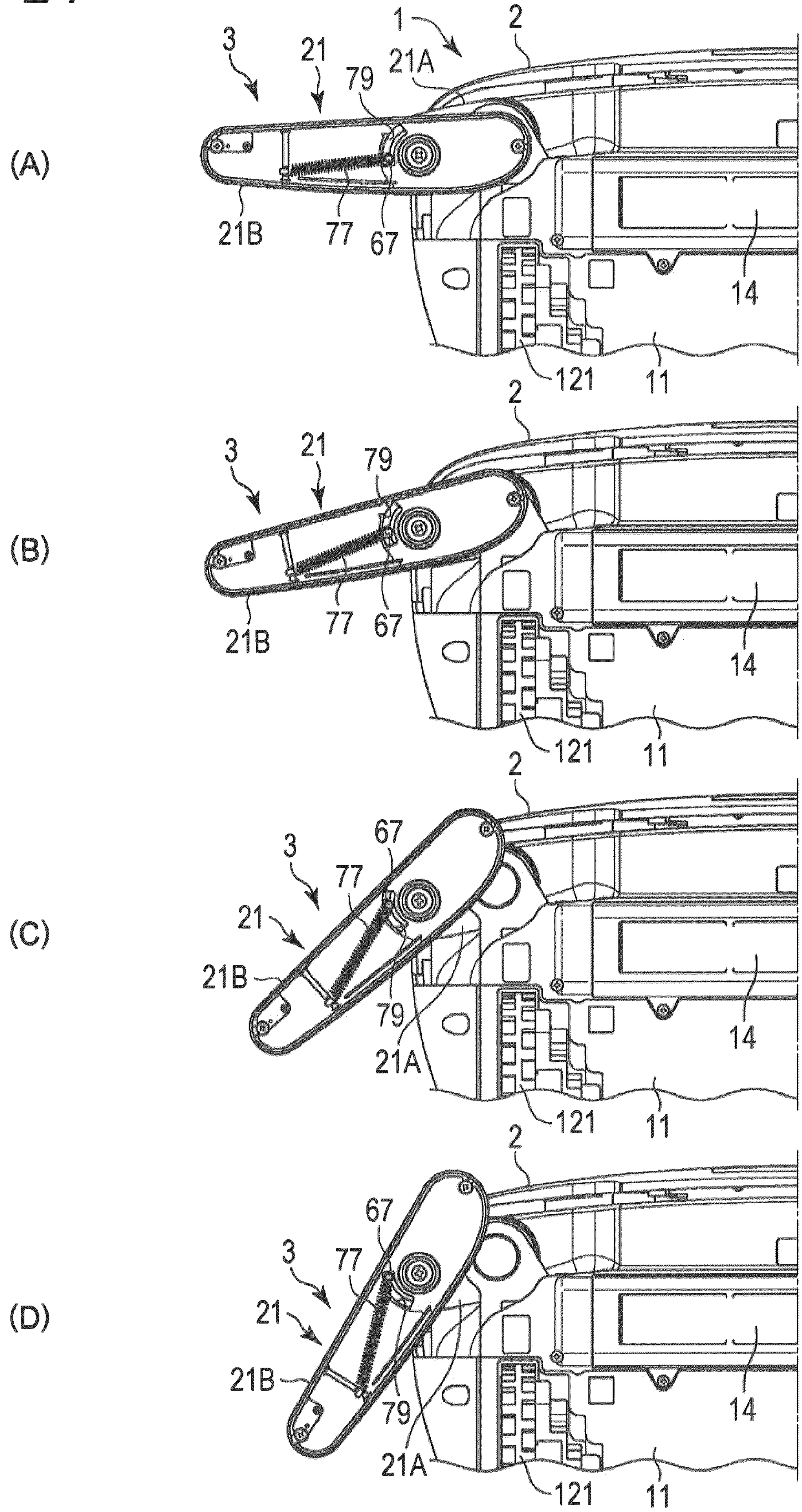


FIG. 24


(A)
3
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21A
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21B
77
67
14
121
11
(B)
3
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2
79
21B
77
67
14
121
11
(C)
2
67
3
77
21
21B
79
21A
14
121
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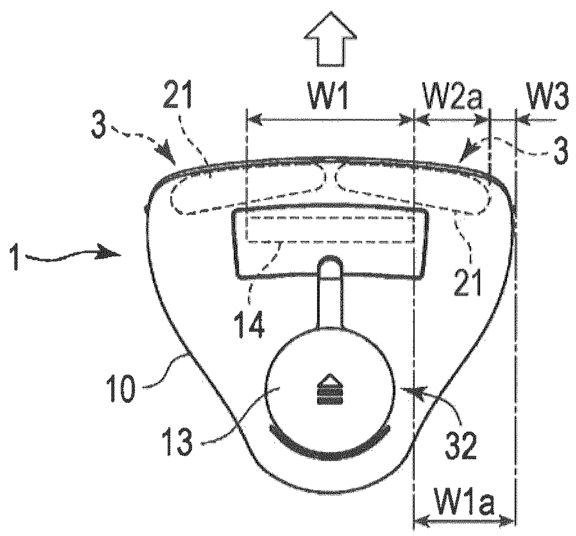
(D)
2
67
3
77
21
21B
79
21A
14
121
11

FIG. 25

(A)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W2a
W3
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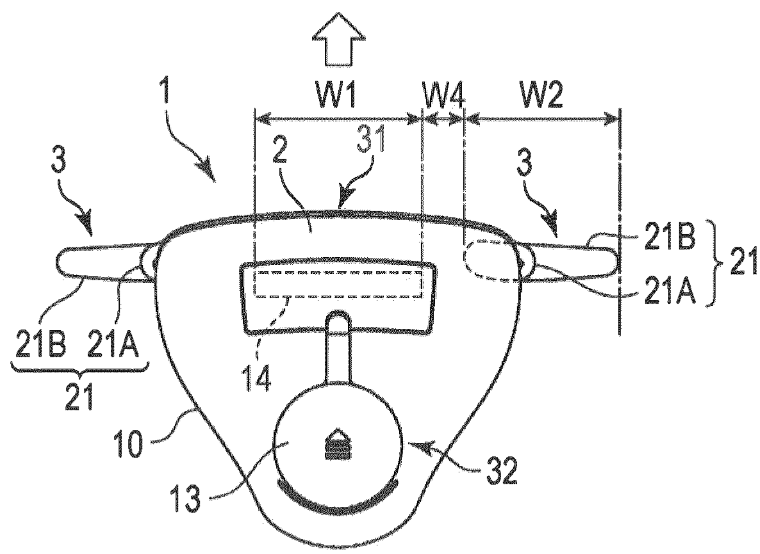
32
W1a

(B)


1
W1
W4
W2
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31
3
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21B
21A
21
21B
21A
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13
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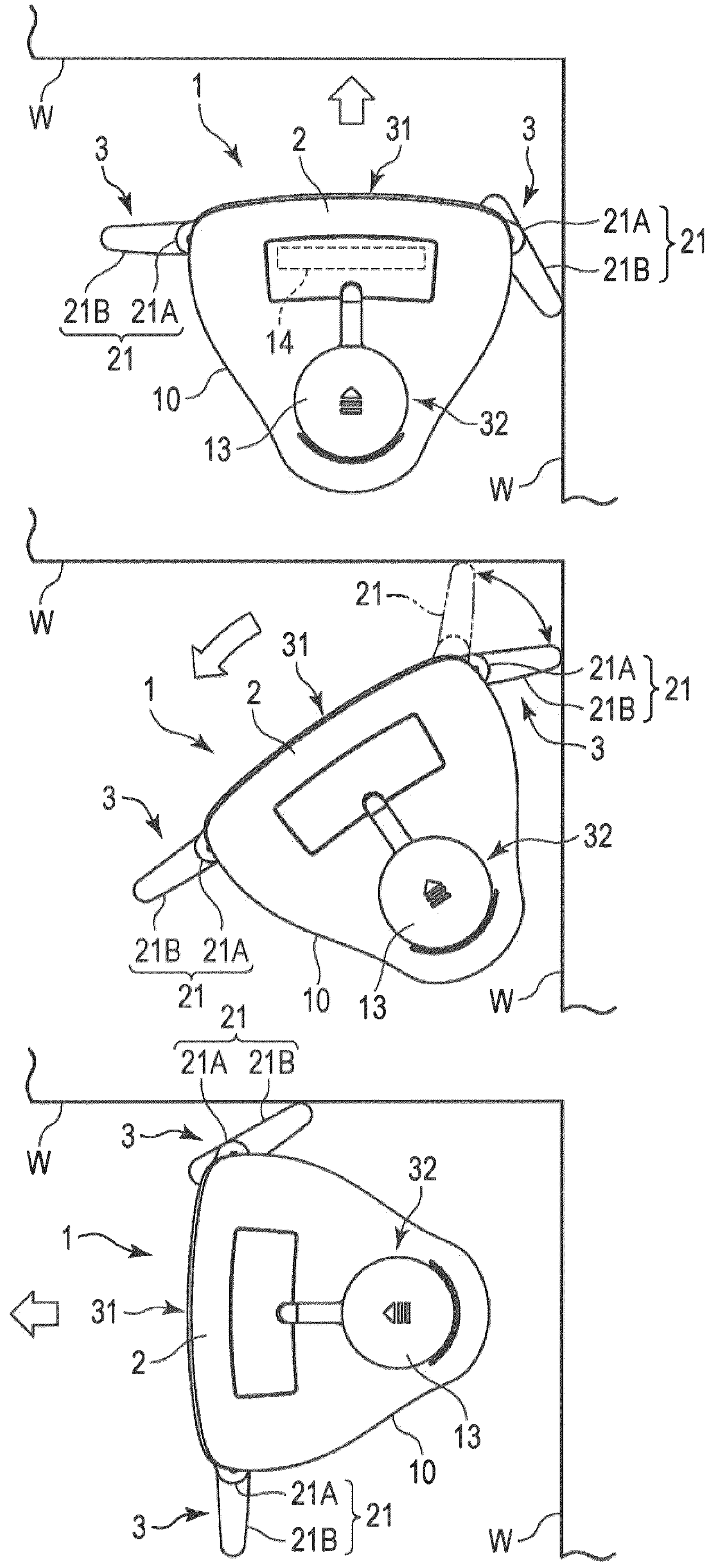
FIG. 26

(A)

(B)

(C)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21B
21B
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10
13
W
21
21A
21B
W
3
32
1
31
2
13
10
21A
21
3
21B
W

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/031741

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. A47L9/28(2006.01)i

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)
Int.Cl. A47L9/28

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	1971-2017
Registered utility model specifications of Japan	1996-2017
Published registered utility model applications of Japan	1994-2017

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.
X Y	JP 2008-149112 A (SAMSUNG ELECTRONICS CO., LTD.) 03 July 2008, paragraphs [0031]-[0052], fig. 1-5 & US 2008/0141485 A1, paragraphs [0049]-[0076], fig. 1-5 & EP 1935308 A2 & KR 10-2008-0056485 A & CN 101204311 A	1-3 4-7
Y	JP 2014-108356 A (SAMSUNG ELECTRONICS CO., LTD.) 12 June 2014, paragraph [0146] & US 2014/0150820 A1, paragraphs [0214], [0215] & EP 2738637 A2 & KR 10-2014-0070287 A & CN 103845002 A	4-7

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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
28.11.2017	05.12.2017

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/031741

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2009/034817 A1 (YASKAWA ELECTRIC CORPORATION) 19 March 2009, paragraph [0003] & US 2010/0107814 A1, paragraphs [0006]-[0008] & EP 2190104 A1 & CN 101779363 A & TW 200931774 A	4-7
Y	JP 2007-299374 A (SAMSUNG ELECTRONICS CO., LTD.) 15 November 2007, paragraphs [0026]-[0057], fig. 1, 2, 4-10 & US 2007/0252549 A1, paragraphs [0039]-[0070], fig. 1, 2, 4-10 & EP 1852761 A2 & KR 10-0772907 B1 & CN 101066198 A	6-7

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Patent documents cited in the description

- JP 2008279066 A **[0004]**