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(54) **ELECTRIC CLEANING DEVICE**

(57) An electric cleaning apparatus, which comprises an autonomous cleaning unit which moves autonomously over a surface to be cleaned and collects dust, and a station unit which has a charging electrode for the autonomous cleaning unit, wherein the autonomous cleaning unit includes a first body case having a first inlet, a secondary battery which accumulates electric power supplied from the charging electrode, a first dust collecting container which accumulates dust sucked from the first inlet, and an electric blower which is driven by electric power supplied from the secondary battery and makes negative pressure act on the first dust collecting container, and wherein the station unit is provided with a second body case having a second inlet which sucks other dust which the autonomous cleaning unit collects.

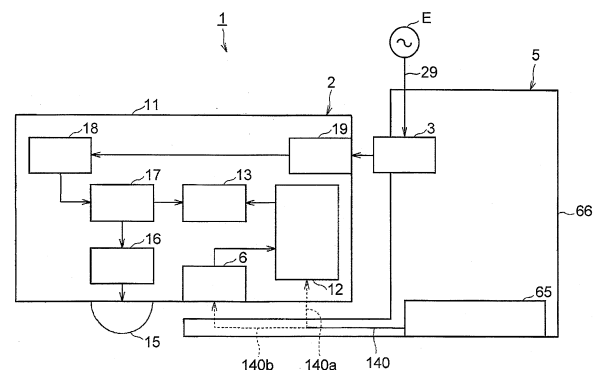


FIG. 1

Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2015-180758, filed on September 14, 2015 and the prior Japanese Patent Application No. 2015-181013, filed on September 14, 2015, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] Embodiments according to the invention relate to an electric cleaning apparatus.

BACKGROUND ART

[0003] A cleaning apparatus, which is provided with a dust control product such as a dust mop and a dust collecting device for sucking dust gathered with the dust control product into a dust collecting container, is known.

[0004] In recent years, an autonomous cleaner i.e. a so-called robotic cleaner, which moves autonomously over a surface to be cleaned and collects dust, is known. A robotic cleaner requires a working of a time unit from tens of minutes to an hour in order to clean a whole of residential rooms. Accordingly, the robotic cleaner has high convenience in cleaning residential rooms autonomously during absence of a dweller. On the other hand, the convenience decreases necessarily in a case of a use such as collecting and disposing of wastes of snacks which children spilt, i.e., a use such as cleaning a part of a residential room immediately. In a use such as removing wastes of snacks which children spilt, a mop, a broom or a means for sweeping and collecting dust with a floor cleaning tool, for example, which is other than an autonomous cleaning device, can respond more promptly.

[0005] However, even in a case in which a means other than an autonomous cleaning device, for example, a mop, a broom or a means for sweeping and collecting dust with a floor cleaning tool can respond more promptly, there is also an aspect that an additional work in which a dustpan is necessary to be used arises in disposing of dust after sweeping and collecting the dust.

[0006] An electric cleaning apparatus, which combines an autonomous cleaning unit for moving autonomously over a surface to be cleaned and collecting dust, and a station unit for accumulating dust transported for disposal from the autonomous cleaning unit, is known as an autonomous cleaning apparatus. This kind of electric cleaning apparatus connects an autonomous cleaning unit and a station unit fluidically in order to transport dust from the autonomous cleaning unit to the station unit. The station unit has a dust transport duct which is coupled with a first dust collecting container of the autonomous cleaning unit and is connected to the first dust collecting container fluidically, a second dust collecting container which accu-

mulates dust transported for disposal from the first dust collecting container through the dust transport duct, and a second electric blower which makes negative pressure act on the dust transport duct via the second dust collecting container.

[0007] A conventional electric cleaning apparatus is provided with a dust collecting container of a filtration separating type (a second dust collecting container) which adopts a filter to filter and separate dust from air. In the dust collecting container of the filtration separating type, the filter becomes blocked and a suction negative pressure is weakened as an accumulation amount of dust increases so that the capability of transporting dust from an autonomous cleaning unit lowers gradually. Even immediate after disposing of dust, i.e., even when dust is not yet accumulated in the dust collecting container of the filtration separating type, a case where dust cannot be transported from an autonomous cleaning unit may occur, when openings of a filtering surface of the filter are blocked due to sucking of dust such as a large amount of powder bodies which blocks the filtering surface of the filter at once. On the other hand, it is desired that an autonomous cleaning unit can be continued to be used without caring or working for maintenance from several days to a long period of a degree of several weeks, i.e., in a so-called maintenance-free state. In other words, the function to transport dust from an autonomous cleaning unit to a station unit is desired to be demonstrated for a long period as much as possible.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0008]

Patent document 1: JP2003-210361

Patent document 2: US2012/0011677 specification

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0009] Embodiments provide an electric cleaning apparatus which includes a charging function for an autonomous cleaning unit and is capable of autonomous cleaning by an autonomous cleaning unit and easy disposal of dust gathered after local cleaning is rapidly performed using a means other than an autonomous cleaning unit, for example, a mop, a broom or a floor cleaning tool, by utilizing a station unit to be placed in a residential room.

MEANS FOR SOLVING THE PROBLEM

[0010] An embodiment provides an electric cleaning apparatus comprising an autonomous cleaning unit which moves autonomously over a surface to be cleaned and collects dust, and a station unit which has a charging

electrode for the autonomous cleaning unit, wherein the autonomous cleaning unit includes a first body case having a first inlet, a secondary battery which accumulates electric power supplied from the charging electrode, a first dust collecting container which accumulates dust sucked from the first inlet, and an electric blower which is driven by electric power supplied from the secondary battery and makes negative pressure act on the first dust collecting container, and wherein the station unit is provided with a second body case having a second inlet which sucks other dust different from the dust which the autonomous cleaning unit collects.

[0011] Further, when desired, the station unit includes a dust transport duct which is coupled with the autonomous cleaning unit and is fluidically connected to the first dust collecting container, a second dust collecting container which accumulates dust transported for disposal from the first dust collecting container through the dust transport duct, and a second electric blower which makes negative pressure act on the dust transport duct via the second dust collecting container, wherein the second dust collecting container is provided with a multi-stage centrifugal separating unit including a first centrifugal separating portion which centrifugally separates dust flowing from the dust transport duct from air, and a second centrifugal separating portion which separates dust passing the first centrifugal separating portion from air.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a block diagram of an electric cleaning apparatus according to a first embodiment of the invention.

FIG. 2 is a block diagram of an electric cleaning apparatus according to a second embodiment of the invention.

FIG. 3 is a perspective view showing an external appearance of an electric cleaning apparatus according to a third embodiment of the invention.

FIG. 4 is a perspective view showing a bottom of the autonomous cleaning unit of the electric cleaning apparatus according to the third embodiment of the invention.

FIG. 5 is a perspective view showing a station unit of the electric cleaning apparatus according to the third embodiment of the invention.

FIG. 6 is a sectional view of a second dust collecting container of the electric cleaning apparatus according to the third embodiment of the invention.

FIG. 7 is a sectional view of a second centrifugal separating portion of the second dust collecting container of the electric cleaning apparatus according to the third embodiment of the invention.

FIG. 8 is a longitudinal sectional view showing joining portions of the autonomous cleaning unit and the station unit of the electric cleaning apparatus accord-

ing to the third embodiment of the invention.

FIG. 9 is a longitudinal sectional view showing joining portions of the station unit of the electric cleaning apparatus according to the third embodiment of the invention.

EMBODIMENTS FOR PRACTICING THE INVENTION

[0013] Hereinafter, embodiments of an electric cleaning apparatus according to the invention will be described below with reference to the drawings.

[First Embodiment]

[0014] A first embodiment of the electric cleaning apparatus according to the invention, will be described with reference to Fig. 1.

[0015] Fig. 1 is a block diagram of an electric cleaning apparatus according to the embodiment of the invention.

[0016] As illustrated in Fig. 1, the electric cleaning apparatus 1 according to the embodiment is provided with an autonomous cleaning unit 2 which autonomously moves over a surface to be cleaned to collect dust and a station unit 5 including a charging electrode 3 for the autonomous cleaning unit 2.

[0017] The electric cleaning apparatus 1 causes the autonomous cleaning unit 2 to autonomously move over a surface to be cleaned in a residential room to collect the dust. Then, the electric cleaning apparatus 1 causes the autonomous cleaning unit 2 to home to the station unit 5 and to stand ready until the next cleaning.

[0018] The station unit 5 is placed at any location in the residential room. When charge is necessary or cleaning of the residential room is finished, the autonomous cleaning unit 2 returns to the station unit 5 to shift into a standby mode or a charging mode. A position, at which the station unit 5 and the autonomous cleaning unit 2 are electrically connected with each other such that the autonomous cleaning unit 2 is rechargeable, is referred to as a "home position" of the autonomous cleaning unit 2. Return of the autonomous cleaning unit 2 to the station unit 5 and shift of the autonomous cleaning unit 2 into a standby mode or a charging mode after the return to the station unit 5 are referred to as "homing".

[0019] The autonomous cleaning unit 2 is a so-called robotic cleaner. The autonomous cleaning unit 2 includes a first body case 11 having a first inlet 6, a secondary battery 18 provided to the first body case 11, a dust collecting container 12 (first dust collecting container) which accumulates dust sucked from the first inlet 6, an electric blower 13 which is driven by power supplied from the secondary battery 18 to make negative pressure act on the dust collecting container 12, a moving unit 15 which supports the first body case 11 movably on the surface to be cleaned, a drive unit 16 which drives with the power supplied from the secondary battery 18 to operate the moving unit 15, and a robotic control unit 17 which controls the drive unit 16 to cause the first body case 11 to

move autonomously on the surface to be cleaned.

[0020] The first body case 11 is, for example, a synthetic-resin discoid box, and easily circles on the surface to be cleaned. The bottom surface of the first body case 11 has the first inlet 6 extending laterally.

[0021] The first inlet 6 in width is approximate to two thirds of the first body case 11 in width, namely, in diameter. The first inlet 6 is fluidically connected to the electric blower 13 through the dust collecting container 12.

[0022] The dust collecting container 12 is provided to the first body case 11. The dust collecting container 12 accumulates the dust sucked from the first inlet 6 due to the suction negative pressure generated by the electric blower 13. The dust collecting container 12 includes a filter which filters and collects the dust, and a separating device which separates the air and the dust with inertial separation such as centrifugation (cyclone separation) or translatory separation to accumulate the dust and to allow the air to pass.

[0023] The moving unit 15 supports the first body case 11 with at least three wheels. The moving unit 15 includes left and right paired driving wheels (not illustrated) provided on the bottom surface of the first body case 11, and a driven wheel (not illustrated) provided on the bottom surface of the first body case 11.

[0024] The autonomous cleaning unit 2 rotates the paired driving wheels mutually in the same direction to move forward or backward, and rotates the paired driving wheels mutually opposite to circle right or left. The driven wheel is, for example, a caster capable of circling.

[0025] The drive unit 16 includes paired electric motors which drive the paired respective driving wheels. The drive unit 16 drives the paired driving wheels independently.

[0026] The robotic control unit 17 includes a microprocessor (not illustrated), and a storage device (not illustrated) which stores, for example, various computing programs to be executed by the microprocessor and parameters. The robotic control unit 17 is electrically connected to the electric blower 13 and the drive unit 16. The robotic control unit 17 controls the electric blower 13 to make the negative pressure act on the first inlet 6 and controls the drive unit 16 to cause the autonomous cleaning unit 2 to travel autonomously.

[0027] The secondary battery 18 is a power source for the electric blower 13, the drive unit 16, and the robotic control unit 17. The secondary battery 18 is electrically connected to a charging terminal 19 provided on the bottom surface of the first body case 11. Connection of the charging terminal 19 to the charging electrode 3 of the station unit 5 allows the secondary battery 18 to be charged.

[0028] The station unit 5 is placed at any location on the surface to be cleaned in the residential room. The station unit 5 includes a second body case 66 having a second inlet 65 which sucks dust different from the dust collected by the autonomous cleaning unit 2, the charging electrode 3, a power cord 29 which guides power from a

commercial alternating current power source E to the charging electrode 3, and a suction air passage 140 which allows the second inlet 65 and the first inlet 6 to communicate with each other when the autonomous cleaning unit 2 homes to the station unit 5.

[0029] The second body case 66 is a box of an appropriate shape capable of being placed on the surface to be cleaned in the residential room. The second body case 66 has an appropriate shape not to interfere with the autonomous cleaning unit 2 even when the autonomous cleaning unit 2 homes.

[0030] The second inlet 65 is applied for use in sucking dust collected by a means except the autonomous cleaning unit 2, such as a mop, a broom or a floor cleaning tool, or dust adhering to the mop, the broom or the floor cleaning tool itself. Thus, the second inlet 21 is disposed at the lower portion of the second body case 66, and has, for example, an appropriate width along the surface to be cleaned and an appropriate height along the perpendicular of the surface to be cleaned.

[0031] The suction air passage 140 may be in either a mode in which the second inlet 65 is directly connected to the dust collecting container 12 without the first inlet 6 (suction air passage 140a) or a mode in which the second inlet 65 is connected to the dust collecting container 12 through the first inlet 6 (suction air passage 140b).

[0032] The suction air passage 140 (140a, 140b) is provided to the second body case 66. One end portion of the suction air passage 140 (140a, 140b) is connected to the second inlet 65.

[0033] The other end portion of the suction air passage 140a is disposed at an appropriate location to communicate with the dust collecting container 12 of the autonomous cleaning unit 2 when the autonomous cleaning unit 2 homes. The dust collecting container 12 preferably includes a lid (not illustrated) which opens to allow the dust collecting container 12 and the suction air passage 140a to communicate with each other, in response to the homing of the autonomous cleaning unit 2.

[0034] The other end portion of the suction air passage 140a is disposed at an appropriate location to communicate with the first inlet 6 of the autonomous cleaning unit 2 when the autonomous cleaning unit 2 homes.

[0035] The charging electrode 3 is provided to the second body case 66. The charging electrode 3 is disposed at an appropriate location to establish electrical connection in contact with the charging terminal 19 of the autonomous cleaning unit 2 when the autonomous cleaning unit 2 homes.

[0036] When the autonomous cleaning unit 2 homes to the home position, the electric cleaning apparatus 1 allows the charging terminal 19 of the autonomous cleaning unit 2 and the charging electrode 3 of the station unit 5 to be in contact with each other, so that electrical connection is established to charge the secondary battery 18. At this time, the electric cleaning apparatus 1 fluidically connects the second inlet 65 of the station unit 5 to the electric blower 13 of the autonomous cleaning unit 2

through the dust collecting container 12 through or without the first inlet 6 of the autonomous cleaning unit 2.

[0037] The electric cleaning apparatus 1 drives the electric blower 13 of the autonomous cleaning unit 2, on the basis of a direct command to the autonomous cleaning unit 2 or the operation of a sensor (not illustrated) which detects approach of the mop, the broom, or the floor cleaning tool itself to the second inlet 65. The negative pressure generated by the operation of the electric blower 13 acts on the second inlet 65 of the station unit 5 through the dust collecting container 12, the first inlet 6 and the suction air passage 125, so that the dust is sucked from the second inlet 65. The dust sucked from the second inlet 65 is a dust collected by the means except the autonomous cleaning unit 2, such as the mop, the broom or the floor cleaning tool, or a dust adhering to the mop, the broom or the floor cleaning tool itself.

[0038] Since the electric cleaning apparatus 1 having the configuration according to the embodiment includes the second inlet 65 of the station unit 5, a dust collected by the means except the autonomous cleaning unit 2, such as the mop, the broom or the floor cleaning tool, or a dust adhering to the mop, the broom or the floor cleaning tool itself can be sucked. The dust suction function of the electric cleaning apparatus 1 is suitable for locally cleaning part of the residential room, for example, for cleaning dust such as pieces of snacks spilled by a child. The electric cleaning apparatus 1 takes several tens of minutes to several hours when the autonomous cleaning unit 2 autonomously drives to clean the entire residential room, and can promptly suck and accumulate the dust swept in several tens of seconds to several minutes from the second inlet 65 when the residential room is locally cleaned by the means except the autonomous cleaning unit 2, such as the mop, the broom or the floor cleaning tool.

[0039] The electric cleaning apparatus 1 according to the embodiment sucks the dust with the suction system of the autonomous cleaning unit 2 (the electric blower 13, the dust collecting container 12 and the first inlet 6) in communication with the second inlet 65 of the station unit 5 so that a promptly dust suction function can be provided with no increase in the number of components.

[Second Embodiment]

[0040] A second embodiment of the electric cleaning apparatus according to the invention, will be described with reference to Fig. 2.

[0041] Fig. 2 is a block diagram of an electric cleaning apparatus according to the second embodiment of the invention.

[0042] In the embodiment, constituents in common with those of the electric cleaning apparatus 1 according to the first embodiment are denoted with the same reference signs, and thus the descriptions to be duplicated will be omitted.

[0043] As illustrated in Fig. 2, an electric cleaning ap-

paratus 1A according to the embodiment includes an autonomous cleaning unit 2 which autonomously moves over a surface to be cleaned to collect dust, and a station unit 5A including a charging electrode 3 for the autonomous cleaning unit 2.

[0044] The electric cleaning apparatus 1A causes the autonomous cleaning unit 2 to autonomously move over a surface to be cleaned in a residential room to collect the dust. Then, the electric cleaning apparatus 1A causes the autonomous cleaning unit 2 to home to the station unit 5A and subsequently to stand ready until the next cleaning.

[0045] The station unit 5A is placed at any location in the residential room. When needing charge or finishing cleaning the residential room, the autonomous cleaning unit 2 returns to the station unit 5A to migrate into a standby mode or a charging mode. A position, at which the station unit 5A and the autonomous cleaning unit 2 are electrically connected with each other such that the autonomous cleaning unit 2 is rechargeable, is referred to as the "home position" of the autonomous cleaning unit 2. Return of the autonomous cleaning unit 2 to the station unit 5A and shift of the autonomous cleaning unit 2 into a standby mode or a charging mode after the return to the station unit 5A are referred to as "homing".

[0046] The station unit 5A is placed at any location on the surface to be cleaned in the residential room. The station unit 5A includes a second body case 66 having a second inlet 21 which sucks dust different from the dust collected by the autonomous cleaning unit 2, the charging electrode 3, a power cord 29 which guides power from a commercial alternating current power source E to the charging electrode 3, a second dust collecting container 68 which accumulates the dust sucked from the second inlet 65, a second electric blower 69 which applies negative pressure to the second dust collecting container 68, and a station control unit 133 which controls the second electric blower 69 to make the negative pressure act on the second inlet 65.

[0047] The second dust collecting container 68 is provided to the second body case 66. The second dust collecting container 68 accumulates the dust sucked from the second inlet 65 due to the suction negative pressure generated by the second electric blower 69. The second dust collecting container 68 includes a filter which filters and collects the dust, and a separating device which separates the air and the dust with inertial separation such as centrifugation (cyclone separation) or translatory separation to accumulate the dust and equally to allow the air to pass. The second dust collecting container 68 is included in the stationary station unit 5A without moving together with the autonomous cleaning unit 2, differently from a dust collecting container 12, so that the second dust collecting container 68 easily ensures larger capacity than that of the dust collecting container 12.

[0048] The second electric blower 69 can directly acquire the power from the commercial alternating current power source E, and thus may have output larger than

that of an electric blower 13 driven by the secondary battery 18.

[0049] A station control unit 143 includes a microprocessor (not illustrated), and a storage device (not illustrated) which stores, for example, various computing programs executed by the microprocessor and parameters. The station control unit 143 is electrically connected to the second electric blower 69. The station control unit 143 controls the second electric blower 69 to make the negative pressure act on the second inlet 65.

[0050] Regardless of whether the autonomous cleaning unit 2 is home at the home position, the electric cleaning apparatus 1A operates the second electric blower 69 on the basis of a direct command to the station unit 5A or the operation of a sensor (not illustrated) which detects approach of a mop, a broom or a floor cleaning tool itself, to the second inlet 65. The negative pressure generated by the operation of the second electric blower 69 acts on the second inlet 65 through the second dust collecting container 68 so that the dust is sucked from the second inlet 65. The dust sucked from the second inlet 65 is a dust collected by a means except the autonomous cleaning unit 2, such as the mop, the broom or the floor cleaning tool, or a dust adhering to the mop, the broom, or the floor cleaning tool itself.

[0051] The station unit 5A includes a transit air passage 145 which allows the dust collecting container 12 and the second dust collecting container 68 to communicate with each other when the autonomous cleaning unit 2 homes to the station unit 5A.

[0052] The transit air passage 145 may be in either a mode in which the dust collecting container 12 is directly connected to the second dust collecting container 68 without a first inlet 6 (transit air passage 145a) or a mode in which the dust collecting container 12 is connected to the second dust collecting container 68 through the first inlet 6 (transit air passage 145b).

[0053] The transit air passage 145 (145a, 145b) is provided at the second body case 66. One end portion of the transit air passage 145 (145a, 145b) is connected to the second dust collecting container 68.

[0054] The other end portion of the transit air passage 145a is disposed at an appropriate location to communicate with the dust collecting container 12 of the autonomous cleaning unit 2 when the autonomous cleaning unit 2 homes. The dust collecting container 12 preferably includes a lid (not illustrated) which opens to allow the dust collecting container 12 and the transit air passage 145a to communicate with each other in response to the homing of the autonomous cleaning unit 2.

[0055] The other end portion of the transit air passage 145b is disposed at an appropriate location to communicate with the first inlet 6 of the autonomous cleaning unit 2 when the autonomous cleaning unit 2 homes.

[0056] When the autonomous cleaning unit 2 homes to the home position, the electric cleaning apparatus 1A allows the charging terminal 19 of the autonomous cleaning unit 2 and the charging electrode 3 of the station unit

5A to be in contact with each other so that electrical connection is established to charge the secondary battery 18. At this time, the electric cleaning apparatus 1A fluidically connects the dust collecting container 12 of the autonomous cleaning unit 2 to the second electric blower 69 of the station unit 5A through the second dust collecting container 68 of the station unit 5A through or without the first inlet 6 of the autonomous cleaning unit 2, and then operates the second electric blower 69. A negative pressure generated by operation of the second electric blower 69 acts on the dust collecting container 12 of the autonomous cleaning unit 2 through the second dust collecting container 68 and the transit air passage 145 (transit air passage 145a or transit air passage 145b) so that the dust is transported from the dust collecting container 12 to the second dust collecting container 68.

[0057] For adding the function of transporting dust from the dust collecting container 12 to the second dust collecting container 68, to the electric cleaning apparatus 1A, a switching mechanism 146 which applies the negative pressure acting on the second dust collecting container 68 to the side of the second inlet 65 or to the dust collecting container 12 of the autonomous cleaning unit 2 is preferably provided.

[0058] Since the electric cleaning apparatus 1A having the configuration according to the embodiment includes the second inlet 65 of the station unit 5A, the dust collected by the means except the autonomous cleaning unit 2 such as the mop, the broom or the floor cleaning tool, or the dust adhering to the mop, the broom or the floor cleaning tool itself, can be sucked. The dust suction function of the electric cleaning apparatus 1A is suitable for locally cleaning part of the residential room, for example, for cleaning dust such as wastes of snacks spilled by a child. In other words, the electric cleaning apparatus 1A takes a time unit from several tens of minutes to an hour when the autonomous cleaning unit 2 autonomously drives to clean the entire residential room, and can promptly suck and accumulate the dust swept in a time unit from several tens of seconds to several minutes from the second inlet 65 when the residential room is locally cleaned by the means except the autonomous cleaning unit 2 such as the mop, the broom or the floor cleaning tool.

[0059] The electric cleaning apparatus 1A according to the embodiment can provide a promptly dust suction function by the station unit 5A independently.

[0060] Furthermore, the electric cleaning apparatus 1A according to the embodiment transports the dust collected by the autonomous cleaning unit 2 to the station unit 5A to accumulate the dust so that a large amount of dust can be successively accumulated over a longer period and an interval until the next working for maintenance can be prolonged.

[0061] Thus, According to the electric cleaning apparatuses 1, 1A of the embodiments, cleaning can be performed autonomously with the autonomous cleaning unit 2 and disposal of the swept dust can be easily carried

out after the prompt local cleaning by the means except the autonomous cleaning unit 2, such as the mop, the broom or the floor cleaning tool, by using the station units 5, 5A having the function of charging the autonomous cleaning unit 2 and to be placed in the residential rooms.

[Third Embodiment]

[0062] A third embodiment of the electric cleaning apparatus according to the invention, will be described with reference to Figs. 3 to 9.

[0063] Fig. 3 is a perspective view of the external appearance of an electric cleaning apparatus according to the third embodiment of the invention.

[0064] As illustrated in Figs. 3 and 4, an electric cleaning apparatus 1 according to the embodiment includes an autonomous cleaning unit 2 which autonomously moves over a surface to be cleaned to collect dust on the surface to be cleaned, and a station unit 5 having charging electrodes 3 for the autonomous cleaning unit 2. The electric cleaning apparatus 1 causes the autonomous cleaning unit 2 to autonomously move over a surface to be cleaned in a residential room to collect the dust. Then, the electric cleaning apparatus 1 causes the autonomous cleaning unit 2 to home to the station unit 5 and subsequently transports the dust collected by the autonomous cleaning unit 2 to the side of the station unit 5 to collect the dust.

[0065] A position at which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 of the station unit 5 is the home position of the autonomous cleaning unit 2 which homes to the station unit 5. The autonomous cleaning unit 2 homes to the home position when charge is necessary or cleaning of the residential room is finished. The position at which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 of the station unit 5 is determined according to a relative positional relationship between the autonomous cleaning unit 2 which autonomously moves and the station unit 5 capable of being placed at any location.

[0066] In Fig. 3, an arrow A represents a forward direction of the autonomous cleaning unit 2, and an arrow B represents a backward direction of the autonomous cleaning unit 2. The width direction of the autonomous cleaning unit 2 is orthogonal to the arrow A and the arrow B.

[0067] The autonomous cleaning unit 2 moves forward and separates from the station unit 5 to autonomously move in the residential room, and moves backward and couples with the station unit 5 in homing to the station unit 5.

[0068] The autonomous cleaning unit 2 is a so-called robotic cleaner. The autonomous cleaning unit 2 includes a hollow and discoid first body case 11, a first dust collecting container 12 detachably provided at the rear portion of the first body case 11, a first electric blower 13 connected to the first dust collecting container 12 and

housed in the first body case 11, a moving unit 15 which moves the autonomous cleaning unit 2 on the surface to be cleaned, a drive unit 16 which drives the moving unit 15, a robotic control unit 17 which controls the drive unit 16 to cause the first body case 11 to autonomously move over a surface to be cleaned, and a secondary battery 18 as a power source.

[0069] The station unit 5 is placed at an arbitrary location on the surface to be cleaned. The station unit 5 includes a base 21 onto which the autonomous cleaning unit 2 moving to the position to be connected electrically to the charging electrodes 3 (a home position) goes up, a dust collector 22 integrally formed with the base 21, a dust transport duct 25 hermetically coupled to the first dust collecting container 12 of the autonomous cleaning unit 2 in the positional relationship in which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 (home position), a lever 26 protruding from the dust transport duct 25, and a power cord 29 which guides power from a commercial alternating current power source.

[0070] The autonomous cleaning unit 2 according to the third embodiment of the invention will be described in detail.

[0071] Fig. 4 is a perspective view of the bottom surface of the autonomous cleaning unit of the electric cleaning apparatus according to the third embodiment of the invention.

[0072] As illustrated in Fig. 4, the autonomous cleaning unit 2 of the electric cleaning apparatus 1 according to the third embodiment of the invention includes a central brush 31 provided on the bottom surface 11a of the first body case 11, a central-brush drive portion 32 which drives the central brush 31, left and right paired side brushes 33 provided on the bottom surface 11a of the first body case 11, and left and right paired side-brush drive portions 35 which drive the respective side brushes 33.

[0073] The discoid first body case 11 is formed of, for example, a synthetic resin, and can easily circle on the surface to be cleaned. A laterally long first inlet 36 is provided at a central portion in the width direction of the posterior half of the bottom surface 11a.

[0074] The first inlet 36 in width is approximate to two thirds of the first body case 11 in width, namely, in diameter. The first inlet 36 is fluidically connected to the first electric blower 13 through the first dust collecting container 12.

[0075] The first body case 11 has a dust container opening 37 on the bottom surface 11a. The dust container opening 37 is disposed at a portion covering the lower portion of the first dust collecting container 12, behind the first inlet 36. The dust container opening 37 has a rectangular shape with rounded corners, and partially exposes the first dust collecting container 12 attached to the first body case 11.

[0076] The first dust collecting container 12 accumulates the dust sucked from the first inlet 36 due to suction

negative pressure generated by the first electric blower 13. The first dust collecting container 12 includes a filter which filters and collects the dust from the air, and a separating device which separates the dust from the air with inertial separation such as centrifugation (cyclone separation) or translatory separation to accumulate the dust. The first dust collecting container 12 is disposed at the rear portion of the first body case 11, behind the first inlet 36. The first dust collecting container 12 includes a container body 38 which is provided detachably to the first body case 11 and accumulates the dust collected by the autonomous cleaning unit 2, a coupling portion 39 exposed from the dust container opening 37 with the first dust collecting container 12 attached to the first body case 11, a disposal opening 41 which is provided at the coupling portion 39 and disposes of the dust in the container body 38, and a disposal lid 42 which opens or closes the disposal opening 41.

[0077] The moving unit 15 includes left and right paired driving wheels 45 disposed on the bottom surface 11a of the first body case 11, and a circling wheel 46 disposed on the bottom surface 11a of the first body case 11.

[0078] The paired driving wheels 45 protrude from the bottom surface 11a of the first body case 11, and are in contact with the surface to be cleaned with the autonomous cleaning unit 2 placed on the surface to be cleaned. The paired driving wheels 45 are disposed at a substantially central portion in the longitudinal direction of the first body case 11, and are also disposed close to the respective left and right portions of the first body case 11, without blocking ahead of the first inlet 36. The rotary shaft of the paired driving wheels 45 is disposed on a straight line extending in the width direction of the first body case 11. The autonomous cleaning unit 2 rotates the left and right driving wheels 45 mutually in the same direction to move forward or backward, and rotates the left and right driving wheels 45 mutually opposite to circle right or left.

[0079] The circling wheel 46 is a driven wheel capable of circling. The circling wheel 46 is disposed at a substantially central portion in the width direction of the first body case 11 and at the front portion.

[0080] The drive unit 16 includes paired electric motors connected to the paired respective driving wheels 45. The drive unit 16 drives the left and right driving wheels 45 independently.

[0081] The robotic control unit 17 includes a microprocessor (not illustrated), and a storage device (not illustrated) which stores, for example, various computing programs to be executed by the microprocessor and parameters. The robotic control unit 17 is electrically connected to the first electric blower 13, the central-brush drive portion 32, the drive unit 16, and the side-brush drive portions 35.

[0082] The secondary battery 18 is a power source for the first electric blower 13, the central-brush drive portion 32, the drive unit 16, the side-brush drive portions 35, and the robotic control unit 17. The secondary battery 18

is disposed, for example, between the circling wheel 46 and the first inlet 36. The secondary battery 18 is electrically connected to paired charging terminals 47 disposed on the bottom surface 11a of the first body case 11. Connection of the charging terminals 47 to the charging electrodes 3 of the station unit 5 allows the secondary battery 18 to be charged.

[0083] The central brush 31 is provided at the first inlet 36. The central brush 31 is an axle-shaped brush rotatable around a rotational center line extending in the width direction of the first body case 11. For example, the central brush 31 includes a long shaft portion (not illustrated), and a plurality of brushes (not illustrated) which extends in the radial direction of the shaft portion and is spirally arranged in the longitudinal direction of the shaft portion. The central brush 31 protrudes from the first inlet 36 below the bottom surface 11a of the first body case 11, and makes the brushes into contact with the surface to be cleaned with the autonomous cleaning unit 2 placed on the surface to be cleaned.

[0084] The central-brush drive portion 32 is housed in the first body case 11.

[0085] The paired side brushes 33 each are an auxiliary sweeper which gathers the dust on the surface to be cleaned alongside a wall where the central brush 31 does not reach, to guide the dust to the first inlet 36, the paired side brushes 33 being disposed on the respective left and right sides in the forward direction of the central brush 31. The side brushes 33 each include a brush base 48 having a rotational center slightly inclining forward to the perpendicular of the surface to be cleaned, and, for example, three linear sweepers 49 radially protruding in the radial direction of the brush base 48.

[0086] The left and right brush bases 48 are disposed close to the left and right sides from the first inlet 36 respectively, ahead of the first inlet 36 and the left and right driving wheels 45 and behind the circling wheel 46. The rotational center line of each of the brush bases 48 slightly inclines forward to the perpendicular of the surface to be cleaned. Thus, the linear sweepers 49 circle along a plane inclining forward to the surface to be cleaned. The linear sweeper 49 which circles to the front side of each brush base 48 is pressed against the surface to be cleaned as closer to the leading end, and the linear sweeper 49 which circles to the rear side of each brush base 48 separates away from the surface to be cleaned as closer to the leading end.

[0087] The plurality of linear sweepers 49 is disposed radially from each of the brush bases 48 into, for example, three directions at regular intervals. Each side brush 33 may have four linear sweepers 49 or more for each brush base 48. Each linear sweeper 49 has a plurality of bristles as a sweeping member on the side of the leading end. Furthermore, the bristles circle to draw a trajectory expanding outside the outer circumferential edge of the first body case 11.

[0088] Each side-brush drive portion 35 has a rotary shaft protruding downward which is connected to the

brush base 48 of the side brush 33. Each side-brush drive portion 35 rotates the side brush 33 in order to gather the dust on the surface to be cleaned toward the first inlet 36.

[0089] The station unit 5 according to the third embodiment of the invention will be described in detail.

[0090] Fig. 5 is a perspective view of the station unit of the electric cleaning apparatus according to the third embodiment of the invention.

[0091] As illustrated in Fig. 5, the base 21 of the station unit 5 according to the embodiment projects forward from the station unit 5 and expands in a rectangular shape. The base 21 includes a high-floor portion 61 connected to the bottom portion of the dust collector 22, and a low-floor portion 62 projecting from the high-floor portion 61. The low-floor portion 62 and the high-floor portion 61 zonally extend in the width direction of the station unit 5. The charging electrodes 3 and the inlet of the dust transport duct 25 are disposed at the high-floor portion 61.

[0092] The autonomous cleaning unit 2 arrives at the home position with the paired driving wheels 45 positioned on the low-floor portion 62 and the first dust collecting container 12 disposed above the high-floor portion 61.

[0093] The base 21 has uneven traveling surfaces 63 which reduce the respective contact areas of the paired driving wheels 45 when the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position). Each traveling surface 63 has unevenness having a plurality of lines, lattice-like unevenness or unevenness having a plurality of hemispheres which is provided at part of the base 21.

[0094] The dust collector 22 includes a second body case 66 having a second inlet 65 which sucks dust different from the dust collected by the autonomous cleaning unit 2, a second dust collecting container 68 which accumulates the dust of which the first dust collecting container 12 disposes through the dust transport duct 25, a second electric blower 69 connected to the second dust collecting container 68 and housed in the second body case 66, and the power cord 29 which guides the power from the commercial alternating current power source to the second electric blower 69 and the charging electrodes 3.

[0095] The second body case 66 is disposed at the rear portion of the station unit 5, extends above the base 21, is a box of an appropriate shape capable of being placed on the surface to be cleaned in the residential room, and includes a wall surface 66a having a height to a surface to be placed. The second body case 66 has an appropriate shape not to interfere with the autonomous cleaning unit 2 even when the autonomous cleaning unit 2 homes.

[0096] The second body case 66 is short in the depth direction (direction in which the autonomous cleaning unit 2 moves in homing) and is long in the width direction. The second body case 66 has one half portion in the width direction, specifically, a right half portion at which

the second dust collecting container 68 is disposed, and has the other half portion in the width direction, specifically, a left half portion at which the second electric blower 69 is housed.

[0097] The front wall of the second body case 66 has an arc-shaped recess portion 71 corresponding to the rear end portion of the autonomous cleaning unit 2. The inlet of the dust transport duct 25 is provided within a range from the high-floor portion 61 of the base 21 over the recess portion 71. The recess portion 71 is provided with a homing check detecting unit 72 which detects whether the autonomous cleaning unit 2 is present at the position electrically connected to the charging electrodes 3 (home position).

[0098] The homing check detecting unit 72 is a so-called proximity sensor which detects the relative distance to the autonomous cleaning unit 2 with visible light or infrared light. The homing check detecting unit 72 includes a first sensing portion 73 which detects the relative distance to the autonomous cleaning unit 2 in the front direction of the dust collector 22, and a second sensing portion 75 which detects the relative distance to the autonomous cleaning unit 2 in the height direction of the second body case 66.

[0099] The second inlet 65 is applied for use in sucking a dust collected by a means except the autonomous cleaning unit 2, such as a mop, a broom or a floor cleaning tool, or a dust adhering to the mop, the broom, or the floor cleaning tool itself. The second inlet 65 is provided at the lower portion of the right wall surface of the second body case 66 which is the wall surface 66a having the height to the surface to be placed. The second inlet 65 has an appropriate width along the placed surface and an appropriate height in the perpendicular direction of the surface to be cleaned.

[0100] The paired charging electrodes 3 are disposed such that the inlet of the dust transport duct 25 is interposed between the electrodes 3. The charging electrodes 3 are arranged in front of the respective left and right edges of the recess portion 71.

[0101] The second dust collecting container 68 is detachably attached to the right side of the dust collector 22 and is exposed.

[0102] The second electric blower 69 applies suction negative pressure to the dust transport duct 25 or the second inlet 65 through the second dust collecting container 68.

[0103] The second body case 66 is internally provided with a suction air passage 76 fluidically connecting the second inlet 65 with the second dust collecting container 68 and a downstream air passage 77 fluidically connecting the second dust collecting container 68 with the second electric blower 69, in addition to the dust transport duct 25.

[0104] Both of the dust transport duct 25 and the suction air passage 76 are connected to the suction side (upstream side) of the second dust collecting container 68. In Other words, the negative pressure generated by

the second electric blower 69 acts on both of the dust transport duct 25 and the suction air passage 76 through the second dust collecting container 68. Thus, the station unit 5 includes an air passage switching mechanism 78. The air passage switching mechanism 78 interrupts fluid connection between the suction air passage 76 and the second dust collecting container 68 in transporting the dust from the autonomous cleaning unit 2 while establishing fluid connection between the dust transport duct 25 and the second dust collecting container 68, and establishes the fluid connection between the suction air passage 76 and the second dust collecting container 68 in making the negative pressure act on the second inlet 65 while interrupting the fluid connection between the dust transport duct 25 and the second dust collecting container 68.

[0105] The dust transport duct 25 is hermetically coupled to the disposal opening 41 in contact with the coupling portion 39 of the first dust collecting container 12 of the autonomous cleaning unit 2, in the positional relationship in which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 (home position).

[0106] The lever 26, which is disposed at the inlet of the dust transport duct 25, includes a hook 79 extending in the front direction of the dust collector 22 and upward.

[0107] Fig. 6 is a sectional view of the second dust collecting container of the electric cleaning apparatus according to the third embodiment of the invention.

[0108] Fig. 7 is a sectional view of a second centrifugal separating portion of the second dust collecting container of the electric cleaning apparatus according to the third embodiment of the invention.

[0109] As illustrated in Figs. 6 and 7, the second dust collecting container 68 of the electric cleaning apparatus 1 according to the embodiment includes a multistage centrifugal separating portion 83 including a first centrifugal separating portion 81 which centrifugally separates the dust flowing from the dust transport duct 25 or the second inlet 65 from the air, and a second centrifugal separating portion 82 which separates the dust passing through the first centrifugal separating portion 81 from the air.

[0110] The first centrifugal separating portion 81 centrifugally separates coarse dust from the air guided by the second dust collecting container 68. The second centrifugal separating portion 82 centrifugally separates fine dust from the air passing through the first centrifugal separating portion 81. The coarse dust is fibriform dust such as lint or fluff, or large-mass dust such as a grain of sand. The fine dust is particulate or powdery small-mass dust.

[0111] The second dust collecting container 68 includes an exhaust air passage 85 which supplies the air passing through the second centrifugal separating portion 82 to the second electric blower 69, and a top cover 86 which covers the exhaust air passage 85.

[0112] The first centrifugal separating portion 81 is disposed on one side of the second dust collecting container

68, specifically, on the lower half side. The second centrifugal separating portion 82, a second-separating-unit upper cover 87, the exhaust air passage 85 and the top cover 86 are disposed on the other side of the second dust collecting container 68, specifically, on the upper half side. The first centrifugal separating portion 81 and the second centrifugal separating portion 82 are adjacently arranged in a height direction of the second dust collecting container 68 having a cylindrical shape.

[0113] The first centrifugal separating portion 81, the second-separating-unit upper cover 87 and the top cover 86 are arranged together such that the external appearance of the second dust collecting container 68 has a substantially cylindrical shape.

[0114] The first centrifugal separating portion 81 separates dust from dusty air in a centrifugation manner (cyclone manner). The first centrifugal separating portion 81 includes a cup-shaped dust collecting container 92 (cup of the second dust collecting container 68) as a hull of a first centrifugally separating room 91, a cylindrical first filter portion 93 arranged in the dust collecting container 92, and a dust capturing cup 95 arranged in the dust collecting container 92 and connected to the first filter portion 93.

[0115] The dust collecting container 92 is a hull of the lower half portion of the second dust collecting container 68, and doubles as the hull of the first centrifugally separating room 91 and a full of a dust collecting room 97. The side wall of the dust collecting container 92 is provided with an air inlet 98. The air inlet 98 is fluidically connected to the dust transport duct 25 and the suction air passage 76.

[0116] The dust collecting container 92 includes a large-diameter portion 101 disposed at an open end portion, a slant portion 102 which is connected to the large-diameter portion 101 and narrows toward a small diameter, and a small-diameter portion 103 which is connected to the slant portion 102 and extends to the bottom wall with a substantially uniform diameter.

[0117] The connected portion between the large-diameter portion 101 and the small-diameter portion 103, namely, the slant portion 102 has a slant surface 105 narrowing from the large-diameter portion 101 toward the small-diameter portion 103 inside the dust collecting container 92.

[0118] The small-diameter portion 103 is connected to the bottom wall of the dust collecting container 92.

[0119] The first filter portion 93 is housed in the dust collecting container 92 such that the first filter portion 93 is substantially coaxially disposed. An annular space separating the first filter portion 93 and the dust collecting container 92 is the first centrifugally separating room 91 which allows the dusty air flowing from the air inlet 98 of the dust collecting container 92 into the first centrifugal separating portion 81 to circle so that the coarse dust is centrifugally separated.

[0120] The first filter portion 93 is fixed to the second centrifugal separating portion 82 such that the first filter

portion 93 protrudes inside the dust collecting container 92 and extends toward the bottom wall of the dust collecting container 92. The first filter portion 93 fluidically connects the first centrifugally separating room 91 and the second centrifugal separating portion 82, and allows of communication therebetween. The first filter portion 93 includes a frame 107 having a plurality of bones 106 which is cylindrically disposed and is spaced apart from each other, and a first meshed filter 108 cylindrically surrounding the circumference of the frame 107. A first opening 109 to the bones 106 of the frame 107 allows the air to flow from the first centrifugally separating room 91 into the second centrifugal separating portion 82. The side surface of the first filter portion 93, in more detail, the first meshed filter 108 faces the air inlet 98.

[0121] The first meshed filter 108 prevents the coarse dust from flowing from the first centrifugal separating portion 81 into the side of the second centrifugal separating portion 82, during a period during which a swirl flow is undeveloped in the first centrifugally separating room 91 such as immediately after the start of the second electric blower 69 or transition to the stop, and rightfully after the development of the swirl flow.

[0122] The first filter portion 93 does not necessarily need the first meshed filter 108 to the extent to which the coarse dust can be prevented from flowing into the downstream side. For example, when the frame 107 of the first filter portion 93 has a fine-lattice shape to the extent to which the coarse dust can be prevented from passing, or has small holes to the extent to which the coarse dust can be prevented from passing, the first meshed filter 108 is not necessarily needed.

[0123] The dust capturing cup 95 is provided at the end portion of the first filter portion 93 which is close to the bottom wall of the dust collecting container 92, namely, at the protruding end portion or the lower end portion. The dust capturing cup 95 has a bottomed cylindrical shape, and includes a bottom wall connected to the first filter portion 93 and a side wall extending toward the bottom wall of the dust collecting container 92. The dust capturing cup 95 is open to the bottom wall of the dust collecting container 92. The side wall of the dust capturing cup 95 faces the inner circumferential surface of the dust collecting container 92 across a gap. The dust capturing cup 95 is larger in diameter than the first filter portion 93, and has a second opening 111 on the bottom wall connected to the first filter portion 93.

[0124] A space separating the dust capturing cup 95 and the dust collecting container 92 is the dust collecting room 97 which accumulates the dust separated by the first centrifugal separating portion 81. The air in the dust collecting room 97 returns to the first centrifugally separating room 91 through the second opening 111.

[0125] The second opening 111 is provided with a second meshed filter 112. The second meshed filter 112 may be coarse to the extent to which the coarse dust (fibriform dust, such as lint or fluff) flowing into the dust collecting room 97 is inhibited from returning to the first centrifugally

separating room 91.

[0126] Removing of the dust collecting container 92 from the second dust collecting container 68 allows the first filter portion 93 and the dust capturing cup 95 to come out of the dust collecting container 92 together with the second centrifugal separating portion 82.

[0127] The second centrifugal separating portion 82 separates the fine dust from the dusty air passing through the first centrifugal separating portion 81. The second centrifugal separating portion 82 includes a transit air passage 113 which guides the air passing through the first centrifugally separating room 91, a second centrifugally separating room 115 which separates the fine dust from the air flowing from the transit air passage 113, and the exhaust air passage 85 which guides the air flowing from the second centrifugally separating room 115 after the separation of the fine dust, to the second electric blower 69.

[0128] The second centrifugal separating portion 82 is detachably coupled to the dust collecting container 92 and covers an open end 92a of the dust collecting container 92. The second centrifugal separating portion 82 supports the first filter portion 93 and the dust capturing cup 95 on the center line C of the dust collecting container 92.

[0129] The second-separating-unit upper cover 87 corresponding to the hull of the second centrifugal separating portion 82 has a cylindrical shape. A plurality of second centrifugally separating rooms 115 is annularly arranged inside the second-separating-unit upper cover 87. The transit air passage 113 having an annular shape is arranged inside the plurality of second centrifugally separating rooms 115 annularly arranged. Furthermore, the exhaust air passage 85 is disposed on the extension of the center line C of the dust collecting container 92 inside the annular transit air passage 113 or at the center portion of the second centrifugal separating portion 82 having a cylindrical shape. In other words, the second centrifugal separating portion 82 is a triple structure in which the annularly arranged second centrifugally separating rooms 115, the annular transit air passage 113 and the exhaust air passage 85 are arranged in the order from the side of the second-separating-unit upper cover 87.

[0130] The transit air passage 113 guides the air (dusty air) flowing from the first filter portion 93 in a direction in which the air moves away from the dust collecting container 92, in order to guide the air to the second centrifugally separating rooms 115.

[0131] The plurality of second centrifugally separating rooms 115 is arranged along the inner circumference of the cylindrical second-separating-unit upper cover 87 or is arranged surrounding the transit air passage 113, in a substantially annular shape. Each of the second centrifugally separating rooms 115 has a cylindrical wall 116 which generates a swirl flow, and a truncated-cone-shaped wall 117 which generates a spiral flow.

[0132] The cylindrical wall 116 and the truncated-cone-

shaped wall 117 have respective center lines arranged on substantially the same line. Each of the center lines, namely, the center line of the second centrifugally separating room 115 is arranged in parallel to the center line C of the cylindrical second dust collecting container 68. The center lines of the second centrifugally separating rooms 115 may radially incline such that the center lines of the second centrifugally separating rooms 115 form a conical surface which narrows on the side of the first centrifugal separating portion 81 and expands at the second centrifugal separating portion 82. When the entire plurality of second centrifugally separating rooms 115 is viewed, the center lines of the cylindrical walls 116 and the truncated-cone-shaped walls 117, are circularly disposed at the circumference of the center line C of the second dust collecting container 68.

[0133] Each truncated-cone-shaped walls 117 has an upper bottom having a large diameter and a lower bottom having a smaller diameter than that of the upper bottom. The upper bottoms of the truncated-cone-shaped walls 117 are disposed on the far side of the first centrifugal separating portion 81, and the lower bottoms are disposed on the near side of the first centrifugal separating portion 81. Each cylindrical walls 116 has a diameter substantially the same as that of the upper bottom of the truncated-cone-shaped wall 117, and is connected to the upper bottom of the truncated-cone-shaped wall 117.

[0134] The cylindrical walls 116 are disposed further from the first centrifugal separating portion 81 than the respective truncated-cone-shaped walls 117. The side wall of each of the cylindrical walls 116 is provided with a dusty-air introducing opening 118. The introducing opening 118 is disposed on the side surface of the cylindrical wall 116 and on the center side of the second dust collecting container 68, and is connected to the transit air passage 113.

[0135] Each cylindrical walls 116 has a bottom plate at a portion furthest from the first centrifugal separating portion 81. Each bottom plates of the truncated-cone-shaped walls 117 is provided with a tubular inner cylinder 119 extending along the center line in the cylindrical wall 116. The inside of the inner cylinder 119 is an outlet 121 which exhausts clean air separated from the dusty air in the second centrifugally separating room 115. The outlet 121 is connected to the exhaust air passage 85. The outside of the inner cylinder 119 faces the introducing opening 118. An annular space which separates the inner cylinder 119 and the cylindrical wall 116 allows the flow of the dusty air flowing from the introducing opening 118 to swirl.

[0136] Furthermore, the cylindrical wall 116 is open at a portion closest to the first centrifugal separating portion 81. The portion communicates with an opening of the upper bottom of the truncated-cone-shaped wall 117.

[0137] The truncated-cone-shaped wall 117 reduces in diameter as closer to the first centrifugal separating portion 81. The upper bottom of the truncated-cone-shaped wall 117 has the opening communicating with

the cylindrical wall 116 internally, and the opening allows the swirl flow occurring between the cylindrical wall 116 and the inner cylinder 119 to be introduced so that the spiral flow occurs in the truncated-cone-shaped wall 117.

The lower bottom of the truncated-cone-shaped wall 117 has a disposal opening 122 communicating with the dust collecting container 92 internally.

[0138] The second centrifugally separating room 115 introduces the dusty air from the introducing opening 118.

The dusty air flowing from the introducing opening 118 into the second centrifugally separating room 115 swirls along the inner surface of the cylindrical wall 116, and furthermore, the swirling spiral flow which moves toward the disposal opening 122 along the inner surface of the truncated-cone-shaped wall 117 is generated to separate the fine dust from the air. The fine dust separated is discharged from the disposal opening 122 to the side of the dust collecting container 92. The clean air separated from the dust flows on the center line of the second centrifugally separating room 115, namely, on the center lines of the cylindrical wall 116 and the truncated-cone-shaped wall 117, to flow from the outlet 121 to the exhaust air passage 85 through the inner cylinder 119.

[0139] A dust capturing umbrella 125 is provided ahead of the disposal opening 122 of the second centrifugally separating room 115. The dust capturing umbrella 125 is provided at the base of the first filter portion 93, and is used as a partition wall partitioning the first centrifugal separating portion 81 and the second centrifugal separating portion 82. The outer diameter of the dust capturing umbrella 125 is smaller than the second centrifugal separating portion 82 and is larger than the first filter portion 93. The dust capturing umbrella 125 has one surface 125a which guides the fine dust discharged from the disposal opening 122 of the second centrifugally separating room 115 to the dust collecting container 92, and the other surface 125b expands and inclines into the dust collecting container 92.

[0140] The dust capturing umbrella 125 protrudes to and abuts on the slant portion 102 of the dust collecting container 92 to cover the dust collecting container 92. The large-diameter portion 101 and slant portion 102 of the dust collecting container 92 and the dust capturing umbrella 125 partition a fine dust collecting room 126 which accumulates the dust discharged from the second centrifugally separating room 115. The fine dust collecting room 126 has a substantially wedge-shaped space narrowing as further from the second centrifugally separating room 115, namely, as further from the disposal opening 122 of the second centrifugally separating room 115. The substantially wedge-shaped space is interposed between the inner surface of the large-diameter portion 101, the slant surface of the slant portion 102, and the one surface 125a of the dust capturing umbrella 125.

[0141] The other surface 125b of the dust capturing umbrella 125 is larger in diameter than the first filter portion 93 and the dust capturing cup 95, and increases in

diameter toward the first filter portion 93 and the dust capturing cup 95.

[0142] The exhaust air passage 85 leads from a most outer circumferential portion connected to the outlet 121 such that the most outer circumferential portion covers the second centrifugally separating room 115, toward the side of the center portion of the second centrifugal separating portion 82 while reducing in diameter, and enters the center portion of the transit air passage 113 on the center line C of the dust collecting container 92. The exhaust air passage 85 bends in a direction crossing the extension of the center line C of the dust collecting container 92 (the center line of the second dust collecting container 68) from a portion surrounded by the plurality of second centrifugally separating rooms 115, and leads to a second outlet 127 provided to the side wall of the second centrifugal separating portion 82. The exhaust air passage 85 has a recess portion 128 recessed toward the first centrifugal separating portion 81 at a portion furthest from the first centrifugal separating portion 81 which is adjacent to the top cover 86. The exhaust air passage 85 intensively gathers the air flowing from the outlets 121 of the second centrifugally separating rooms 115 toward the center side of the second dust collecting container 68 and simultaneously orients the air toward the first centrifugal separating portion 81 once by the recess portion 128. Then, the exhaust air passage 85 changes the orientation of the flow at a substantially right angle to exhaust the air to the second outlet 127. The second outlet 127 is connected to the downstream air passage 77.

[0143] When the autonomous cleaning unit 2 returns to the home position of the station unit 5, the charging terminals 47 of the autonomous cleaning unit 2 are electrically connected to the charging electrodes 3 of the station unit 5. At this time, the dust transport duct 25 of the station unit 5 is connected to the coupling portion 39 of the first dust collecting container 12. Then, the station unit 5 drives the second electric blower 69 to suck air, and transports the dust from the first dust collecting container 12 to the second dust collecting container 68. In the second dust collecting container 68, the first centrifugal separating portion 81 separates the coarse dust from the air to accumulate the coarse dust into the dust collecting room 97. In the second dust collecting container 68, the second centrifugal separating portion 82 separates the fine dust from the air passing through the first centrifugal separating portion 81, to accumulate the fine dust into the fine dust collecting room 126.

[0144] Regardless of whether the autonomous cleaning unit 2 is home at the home position, the station unit 5 operates the second electric blower 69, on the basis of a direct command or the operation of a sensor (not illustrated) which detects approach of the mop, the broom, or the floor cleaning tool itself, to the second inlet 65. The negative pressure generated by the drive of the second electric blower 69, acts on the second inlet 65 of the station unit 5 through the second dust collecting container 68, to suck dust from the second inlet 65. The dust

sucked from the second inlet 65 is a dust collected by the means except the autonomous cleaning unit 2, such as the mop, the broom or the floor cleaning tool, or a dust adhering to the mop, the broom, or the floor cleaning tool itself.

[0145] Figs. 8 and 9 are longitudinal sectional views of a coupling portion between the autonomous cleaning unit and station unit of the electric cleaning apparatus according to the embodiment of the invention.

[0146] Figs. 8 and 9 illustrate approaches of the autonomous cleaning unit 2 to the position electrically connected to the charging electrodes 3, namely, to the home position. When the autonomous cleaning unit 2 moves away from the station unit 5, an inverse aspect from Fig. 9 to Fig. 8 is provided.

[0147] As illustrated in Figs. 8, 9 and Fig. 4, the first dust collecting container 12 of the autonomous cleaning unit 2 according to the embodiment, includes the container body 38 which accumulates the dust collected by the autonomous cleaning unit 2, to be detachably provided to the first body case 11, the coupling portion 39 exposed from the dust container opening 37 with the first dust collecting container 12 attached to the first body case 11, the disposal opening 41 which is provided at the coupling portion 39 and disposes of the dust in the container body 38, and the disposal lid 42 which opens or closes the disposal opening 41.

[0148] The coupling portion 39 is integrally formed with the container body 38. The coupling portion 39 protrudes in a rectangular shape with rounded corners, corresponding to the dust container opening 37. The attachment of the first dust collecting container 12 to the first body case 11 allows the coupling portion 39 to engage with the dust container opening 37. The coupling portion 39 has an outer circumferential edge portion flush with the outer surface of the first body case 11, and equally has a recess portion at the circumferential edge portion of the disposal opening 41. The disposal opening 41 is disposed at the center of the recess portion. The disposal lid 42 is disposed at the recess portion.

[0149] The coupling portion 39 may be disposed at a location facing the dust container opening 37, with the first dust collecting container 12 attached to the first body case 11. In the case, the coupling portion 39 is disposed at a location at which the coupling portion 39 can be viewed from the dust container opening 37, inside the first body case 11. The dust transport duct 25 preferably has a protruding length reachable to the coupling portion 39 through the dust container opening 37.

[0150] The disposal opening 41 is open below the autonomous cleaning unit 2, with the first dust collecting container 12 attached to the first body case 11.

[0151] The disposal opening 41 is disposed closer to the station unit 5 than the center of the autonomous cleaning unit 2, in the positional relationship in which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 (home position). In other words, when the autonomous cleaning unit 2 moves

backward and comes close to the station unit 5 and the paired driving wheels 45 come onto the base 21 of the station unit 5, the disposal opening 41 comes close to the dust collector 22 of the station unit 5.

[0152] The disposal lid 42 is exposed on the external appearance of the autonomous cleaning unit 2, and is flush with the outer surface of the first body case 11. The disposal lid 42 includes a lever hook 131 which hooks the lever 26 of the station unit 5. Note that, similarly to the coupling portion 39, the disposal lid 42 attached to the first body case 11 may be disposed at a location facing the dust container opening 37. In the case, the disposal lid 42 is disposed at a location at which the disposal lid 42 can be viewed from the dust container opening 37, inside the first body case 11.

[0153] On the other hand, the lever 26 of the station unit 5 according to the embodiment, is hooked up to the disposal lid 42 of the autonomous cleaning unit 2 on the way on which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position). When the autonomous cleaning unit 2 arrives at the position electrically connected to the charging electrodes 3 (home position), the disposal lid 42 opens to fluidically connect the disposal opening 41 and the dust transport duct 25 (Fig. 9).

[0154] The disposal lid 42 of the autonomous cleaning unit 2 and the lever 26 of the station unit 5 rock around a rotational center line C3 crossing in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3. Note that, a rotational center line C4 of the disposal lid 42 and the rotational center line C3 of the lever 26 are desirably orthogonal to the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position).

[0155] The rotational center line C3 of the lever 26 is disposed at an edge portion at which the autonomous cleaning unit 2 first arrives, in the opening edge portion of the dust transport duct 25 in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position), namely, at the front end portion of the opening edge of the dust transport duct 25.

[0156] The rotational center line C3 of the lever 26 is supported movably in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position). As a result, movement of the rotational center line C3 of the lever 26 in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position) allows the hook 79 to be hooked up to the lever hook 131 without the influence of a variation in the positional precision of homing control of the autonomous cleaning unit 2.

[0157] Furthermore, the rotational center line C3 of the lever 26 is covered with a shaft cover 132 provided at

the edge portion at which the autonomous cleaning unit 2 first arrives, in the opening edge portion of the dust transport duct 25 in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position), namely, at the front end portion of the opening edge of the dust transport duct 25.

[0158] The rotational center line C4 of the disposal lid 42 is disposed on the far side of the disposal lid 42 in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position). The rotational center line C4 of the disposal lid 42 is disposed further than the lever hook 131 is, in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position). Furthermore, the rotational center line C4 of the disposal lid 42 is disposed further than a lid body 133 which comes in or out of contact with the disposal opening 41, is, in the disposal lid 42 in the direction in which the autonomous cleaning unit 2 moves toward the position electrically connected to the charging electrodes 3 (home position).

[0159] The arrangements of the rotational center line C3 of the lever 26 and the rotational center line C4 of the disposal lid 42, allow the disposal lid 42 to have a slant surface which guides the dust from the container body 38 of the autonomous cleaning unit 2 to the dust transport duct 25 when the lever 26 opens the disposal lid 42 (Fig. 9).

[0160] The spring force of a coil spring 135 acts on the disposal lid 42 in a direction in which the disposal lid 42 closes. The disposal lid 42 opens when thrust toward the position at which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 (home position), exceeds the spring force of the coil spring 135. The coil spring 135 is compressed to store energy when the disposal lid 42 opens due to the lever 26, while the coil spring 135 releases the energy to close the disposal lid 42 when the autonomous cleaning unit 2 separates from the station unit 5 and the lever 26 comes out of the lever hook 131.

[0161] The spring force of a coil spring (not illustrated) acts on the lever 26 in a direction in which the lever 26 erects (Fig. 8). The lever 26 is pushed down when the thrust toward the position at which the autonomous cleaning unit 2 is electrically connected to the charging electrodes 3 (home position) exceeds the spring force of the coil spring. The coil spring is compressed to store energy when the disposal lid 42 is open by the lever 26, while the coil spring releases the energy to erect the lever 26 when the autonomous cleaning unit 2 separates from the station unit 5 and the lever 26 comes out of the lever hook 131.

[0162] The electric cleaning apparatus 1 having the configuration according to the embodiment includes the multistage centrifugal separating portion 83 including the first centrifugal separating portion 81 which centrifugally

separates the dust flowing from the dust transport duct 25 from the air, and the second centrifugal separating portion 82 which separates the dust passing through the first centrifugal separating portion 81 from the air. Thus, the separation performance deteriorates hardly and is maintained, even when the accumulated amount of dust increases, and accordingly the suction negative pressure is maintained and the ability of transporting the dust from the autonomous cleaning unit 2 can be kept. Since the electric cleaning apparatus 1 includes the multistage centrifugal separating portion 83, the suction performance is maintained without sudden failing even if the electric cleaning apparatus 1 sucks a large amount of powder bodies at once, so that the ability of transporting the dust from the autonomous cleaning unit 2 can be maintained.

[0163] Furthermore, since the electric cleaning apparatus 1 according to the embodiment includes the second inlet 65 of the station unit 5, the dust collected by the means except the autonomous cleaning unit 2 such as the mop, the broom or the floor cleaning tool, or the dust adhering to the mop, the broom or the floor cleaning tool itself can be sucked. The dust suction function of the electric cleaning apparatus 1 is suitable for locally cleaning part of the residential room, for example, for cleaning dust, such as pieces of snacks spilled by a child. In other words, while the electric cleaning apparatus 1 takes several tens of minutes to several hours when the autonomous cleaning unit 2 autonomously drives to clean the entire residential room, the electric cleaning apparatus 1 can promptly suck and accumulate dust swept in several tens of seconds to several minutes from the second inlet 65 when the residential room is locally cleaned by the means except the autonomous cleaning unit 2, such as the mop, the broom, or the floor cleaning tool.

[0164] The electric cleaning apparatus 1 according to the embodiment maintains the sucking force of the second inlet 65 easily since the multistage centrifugal separating portion 83 accumulates the dust sucked from the second inlet 65 of the station unit 5.

[0165] Accordingly, in a case that an object to clean for the second inlet 65 is set to a cleaning tool which sweeps dust in proper width such as the mop, the broom or the floor cleaning tool, the dust swept by the cleaning tool such as the mop, the broom or the floor cleaning tool can be certainly sucked without lowering the suction negative pressure over a long period, even when the size of the second inlet 65 is set such that the second inlet 65 has a wide width along the placed surface and a proper height.

[0166] Thus, the electric cleaning apparatus 1 according to the embodiment maintains the ability of transporting the dust from the autonomous cleaning unit 2 to the station unit 5 over a long period, and keeps the function of transporting the dust easily, even when sucking a large amount of powder bodies at once.

[0167] According to the third embodiment, there can be provided the electric cleaning apparatus which maintains the ability of transporting the dust from the auton-

omous cleaning unit to the station unit over a long period and keeps the function of transporting the dust easily, even when sucking a large number of powder bodies at once.

5 **[0168]** Desirable embodiments of the invention include the following features.

[0169]

10 1. An electric cleaning apparatus, comprising an autonomous cleaning unit which moves autonomously over a surface to be cleaned and collects dust, and a station unit which has a charging electrode for the autonomous cleaning unit, wherein the autonomous cleaning unit includes a first body case having a first inlet, a secondary battery which accumulates electric power supplied from the charging electrode, a first dust collecting container which accumulates dust sucked from the first inlet, and an electric blower which is driven by electric power supplied from the secondary battery and makes negative pressure act on the first dust collecting container, and wherein the station unit is provided with a second body case having a second inlet which sucks other dust different from the dust which the autonomous cleaning unit collects.

25 2. The electric cleaning apparatus according to the No. 1, wherein the station unit includes a suction air passage which connects the second inlet with the first inlet or the first dust collecting container when the autonomous cleaning unit homes to the station unit.

30 3. The electric cleaning apparatus according to the No. 1 or 2, wherein the station unit includes a second dust collecting container which accumulates dust sucked from the second inlet, and a second electric blower which makes negative pressure act on the second dust collecting container.

35 4. The electric cleaning apparatus according to the No. 3, wherein the station unit includes a transit air passage which connects the first dust collecting container and the second dust collecting container when the autonomous cleaning unit homes to the station unit.

40 5. The electric cleaning apparatus according to any one of the Nos. 1 to 4, wherein the station unit includes a dust transport duct which is coupled with the autonomous cleaning unit and is fluidically connected to the first dust collecting container, a second dust collecting container which accumulates dust transported for disposal from the first dust collecting container through the dust transport duct, and a second electric blower which makes negative pressure act on the dust transport duct via the second dust collecting container, wherein the second dust collecting container is provided with a multistage centrifugal separating unit including a first centrifugal separating portion which centrifugally separates dust flowing from the dust transport duct from air,

and a second centrifugal separating portion which separates dust passing the first centrifugal separating portion from air.

6. An electric cleaning apparatus, comprising an autonomous cleaning unit which moves autonomously over a surface to be cleaned and collects dust, and a station unit which has a charging electrode for the autonomous cleaning unit, wherein the autonomous cleaning unit includes a first body case having a first inlet, a secondary battery which accumulates electric power supplied from the charging electrode, a first dust collecting container which accumulates dust sucked from the first inlet, and an electric blower which is driven by electric power supplied from the secondary battery and makes negative pressure act on the first dust collecting container, the station unit including a dust transport duct which is coupled with the autonomous cleaning unit and is fluidically connected to the first dust collecting container, a second dust collecting container which accumulates dust transported for disposal from the first dust collecting container through the dust transport duct, and a second electric blower which makes negative pressure act on the dust transport duct via the second dust collecting container, wherein the second dust collecting container is provided with a multi-stage centrifugal separating unit including a first centrifugal separating portion which centrifugally separates dust flowing from the dust transport duct from air, and a second centrifugal separating portion which separates dust passing the first centrifugal separating portion from air.

7. The electric cleaning apparatus according to the No. 6, wherein the station unit is provided with a second body case having a second inlet which sucks other dust different from the dust which the autonomous cleaning unit collects.

[0170] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Claims

1. An electric cleaning apparatus, comprising:

an autonomous cleaning unit which moves autonomously over a surface to be cleaned and collects dust; and

a station unit which has a charging electrode for the autonomous cleaning unit, wherein the autonomous cleaning unit includes a first body case having a first inlet, a secondary battery which accumulates electric power supplied from the charging electrode, a first dust collecting container which accumulates dust sucked from the first inlet, and an electric blower which is driven by electric power supplied from the secondary battery and makes negative pressure act on the first dust collecting container, and wherein the station unit is provided with a second body case having a second inlet which sucks other dust different from the dust which the autonomous cleaning unit collects.

2. The electric cleaning apparatus according to claim 1, wherein the station unit includes a suction air passage which connects the second inlet with the first inlet or the first dust collecting container when the autonomous cleaning unit homes to the station unit.
3. The electric cleaning apparatus according to claim 1 or 2, wherein the station unit includes a second dust collecting container which accumulates dust sucked from the second inlet, and a second electric blower which makes negative pressure act on the second dust collecting container.
4. The electric cleaning apparatus according to claim 3, wherein the station unit includes a transit air passage which connects the first dust collecting container and the second dust collecting container when the autonomous cleaning unit homes to the station unit.
5. The electric cleaning apparatus according to any one of claims 1 to 4, wherein the station unit includes a dust transport duct which is coupled with the autonomous cleaning unit and is fluidically connected to the first dust collecting container, a second dust collecting container which accumulates dust transported for disposal from the first dust collecting container through the dust transport duct, and a second electric blower which makes negative pressure act on the dust transport duct via the second dust collecting container, wherein the second dust collecting container is provided with a multistage centrifugal separating unit including a first centrifugal separating portion which centrifugally separates dust flowing from the dust transport duct from air, and a second centrifugal separating portion which separates dust passing the first centrifugal separating portion from air.

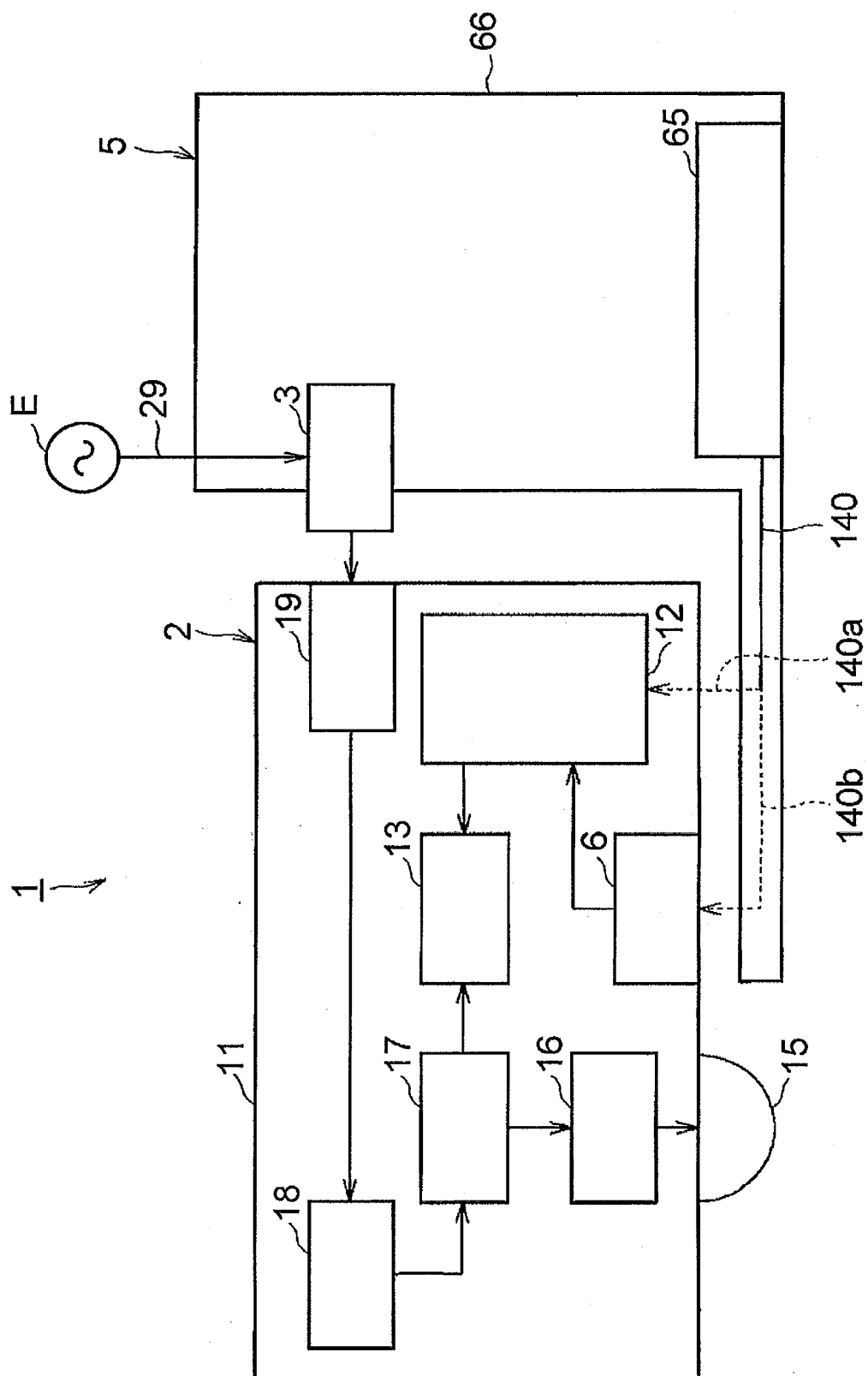


Fig. 1

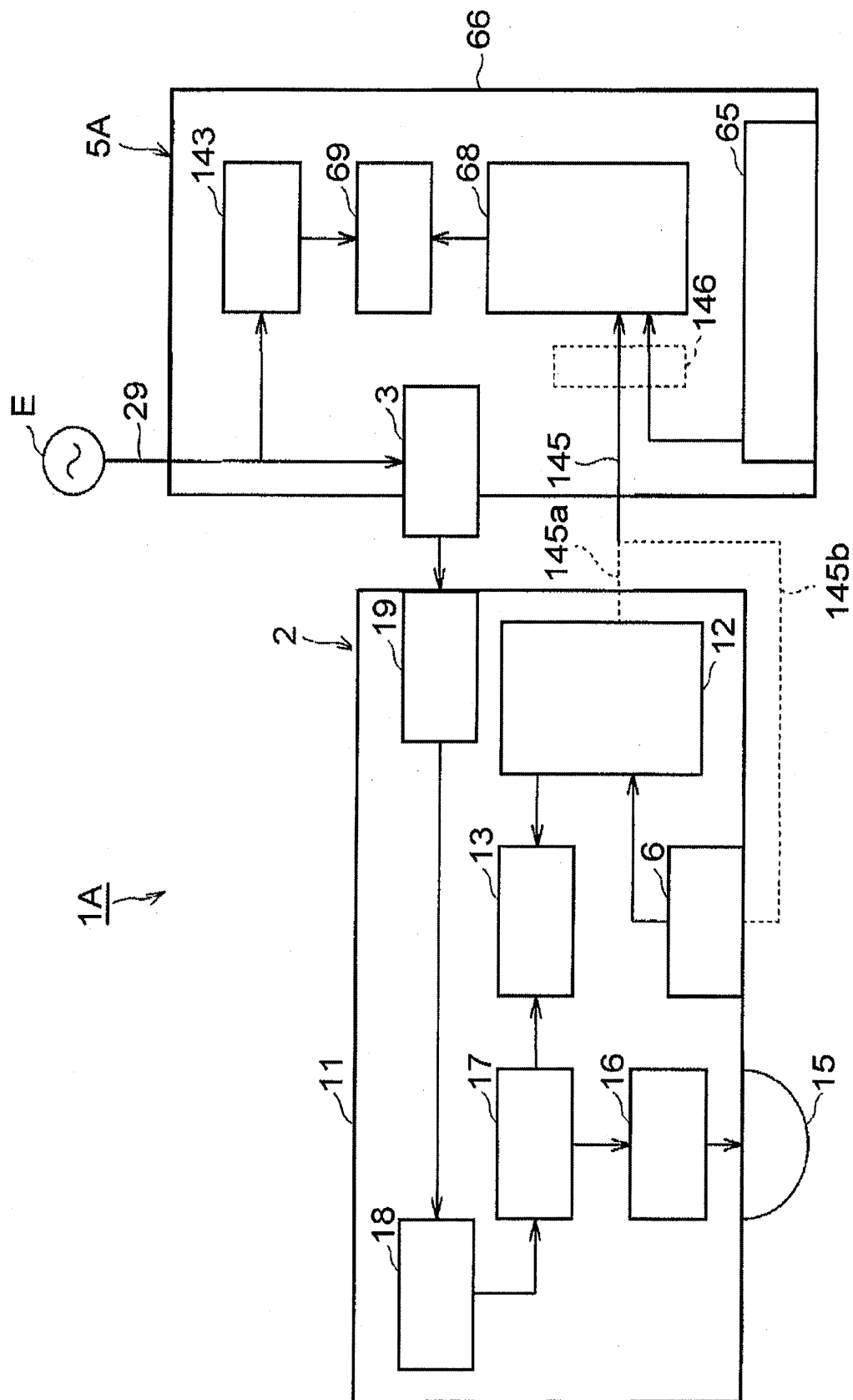


FIG. 2

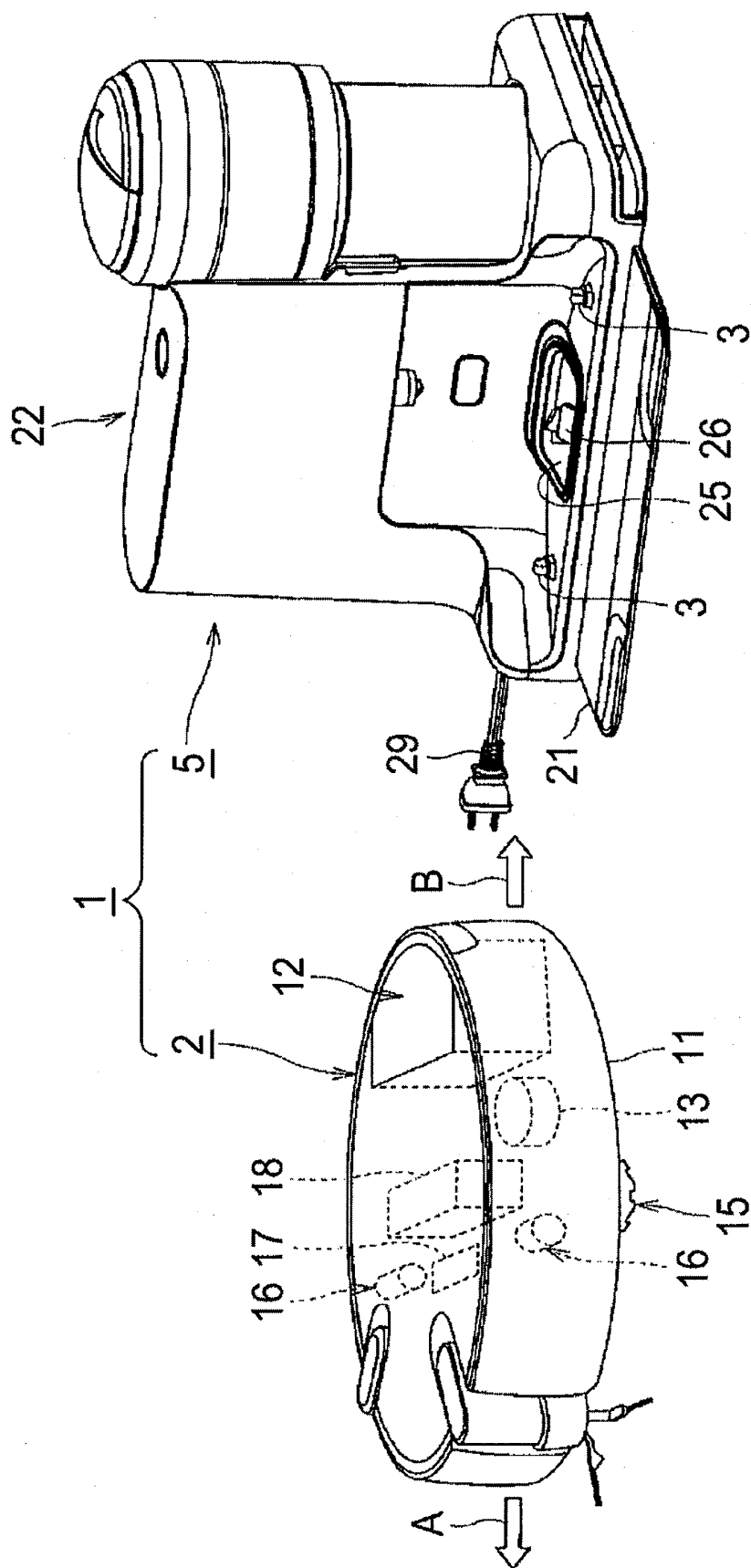


FIG. 3

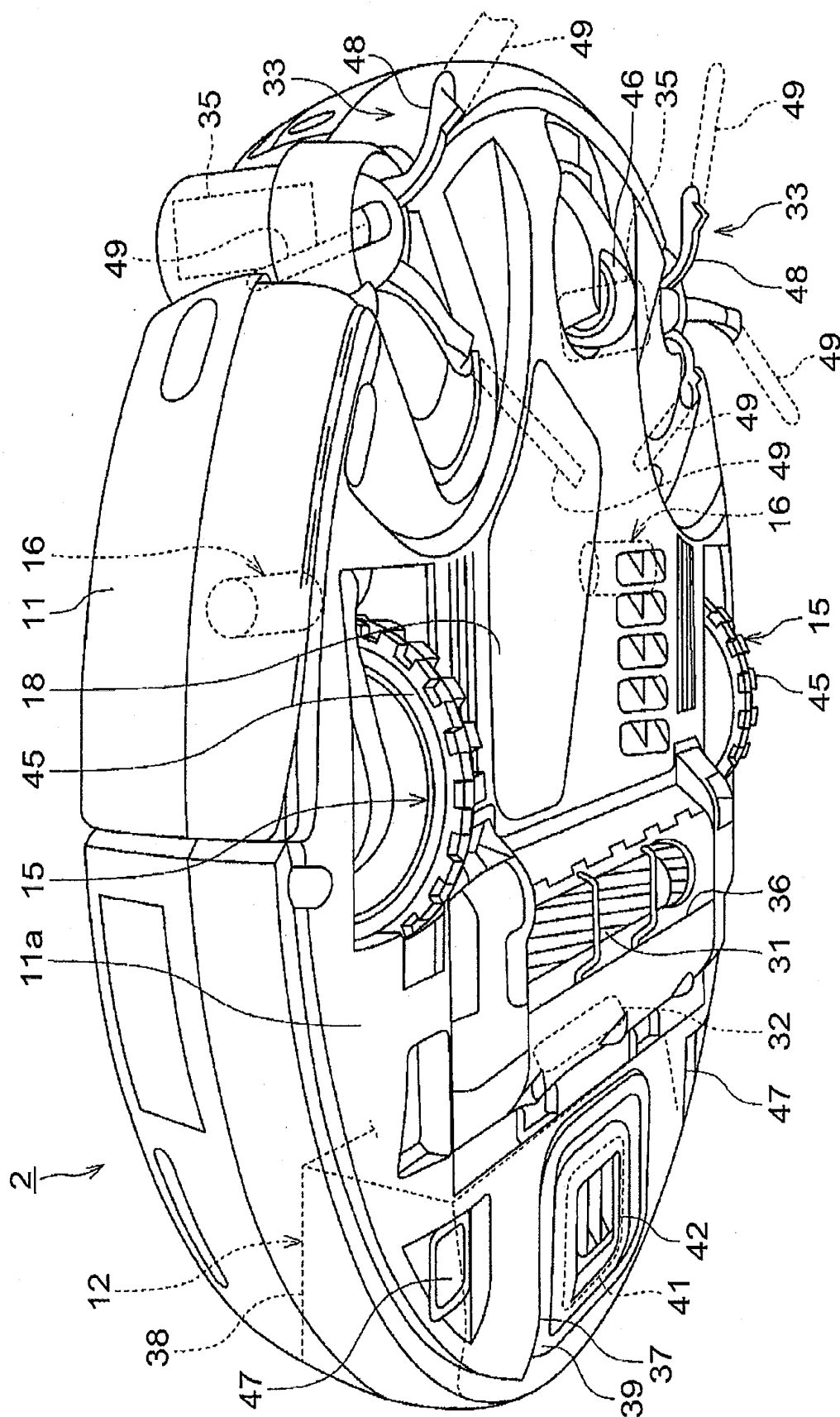


FIG. 4

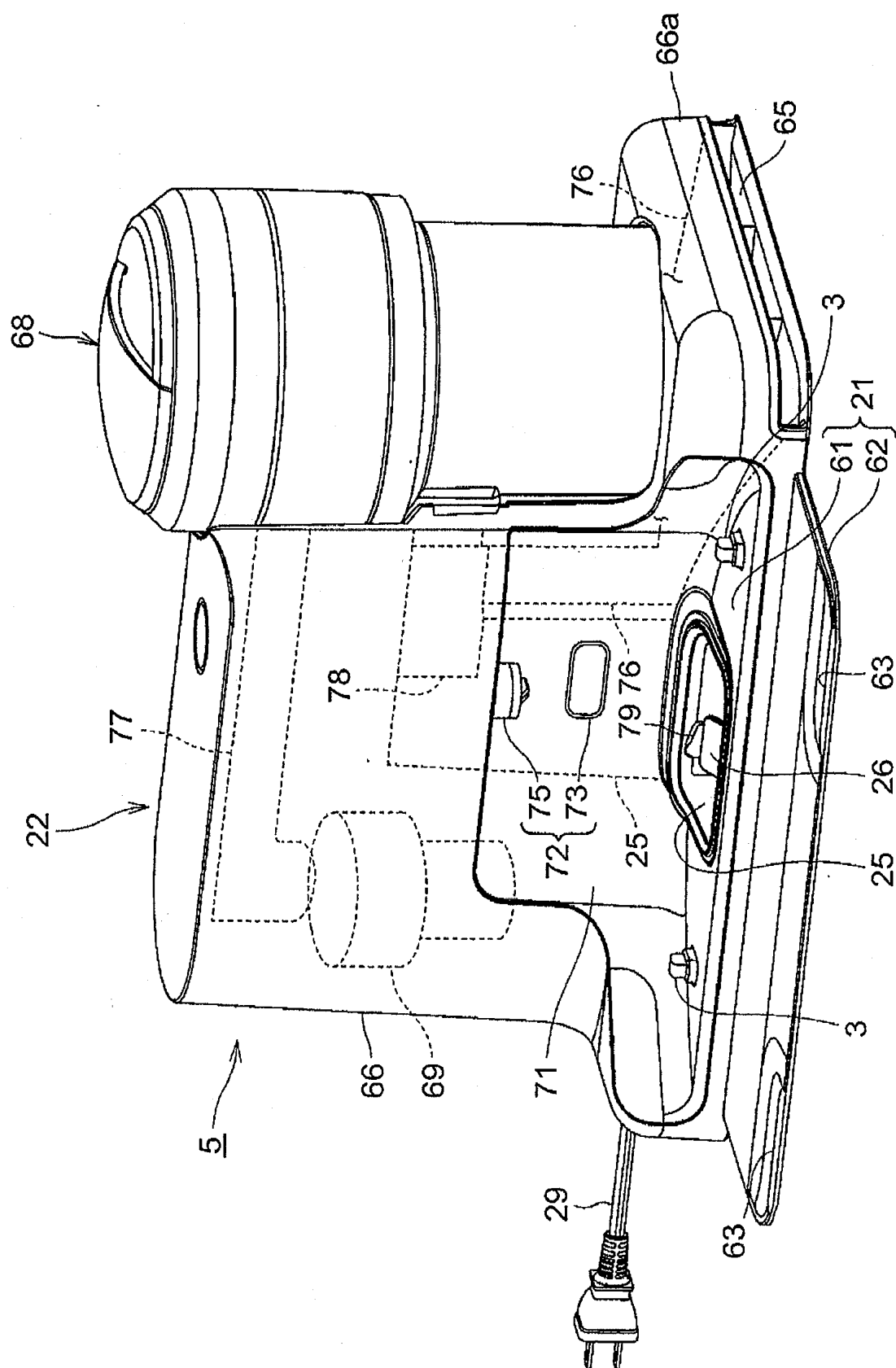


FIG. 5

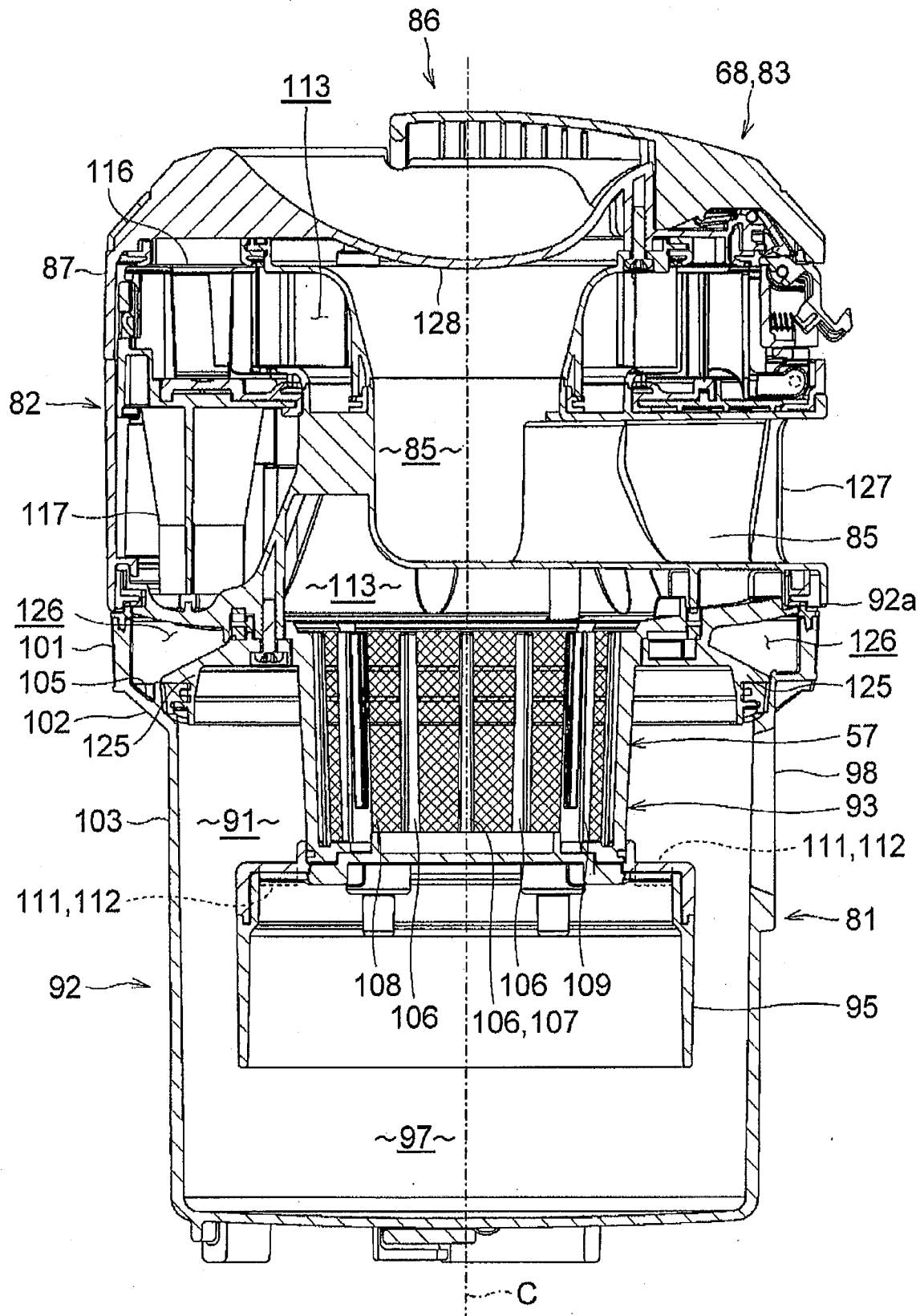


FIG. 6

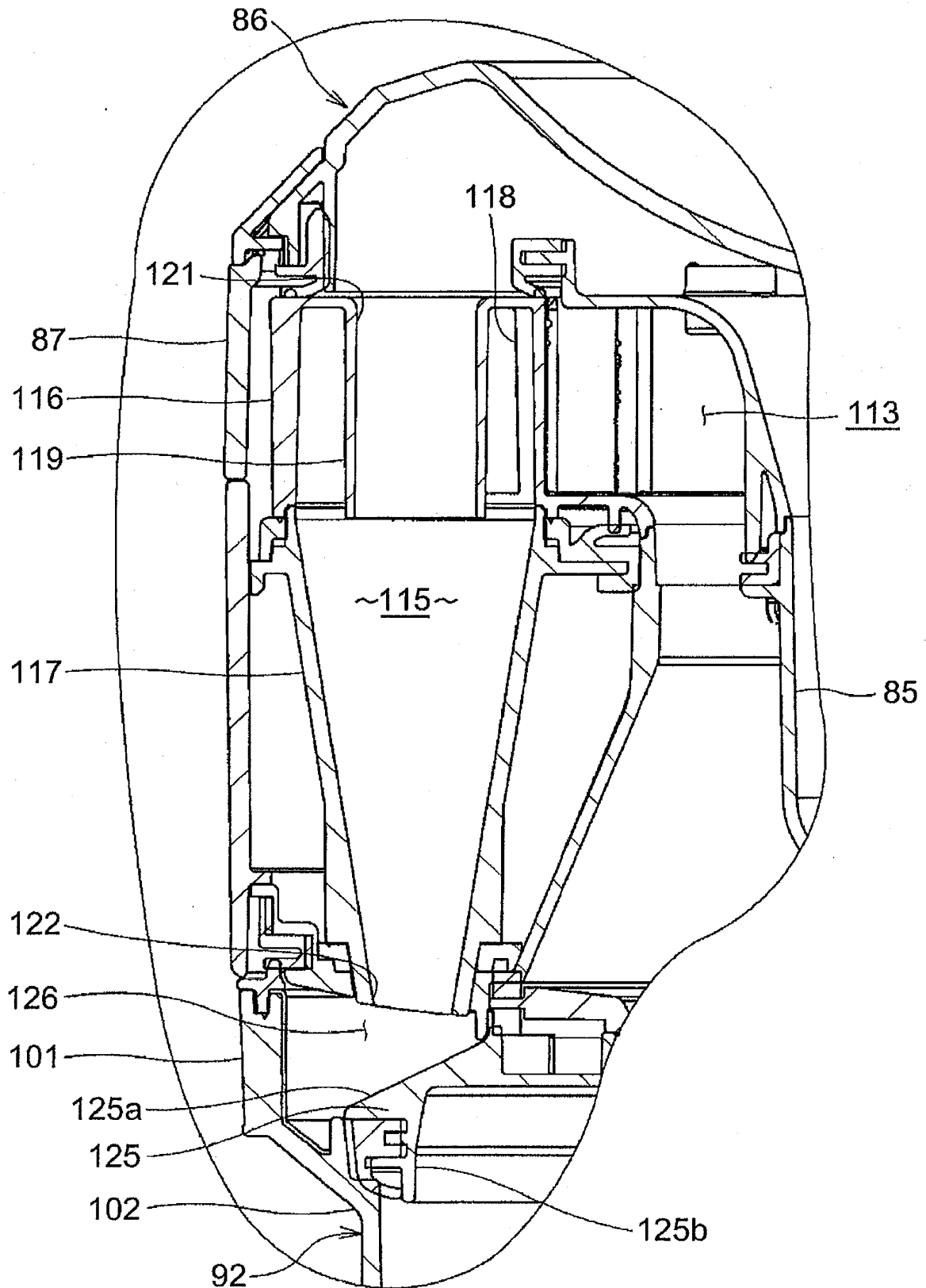


FIG. 7

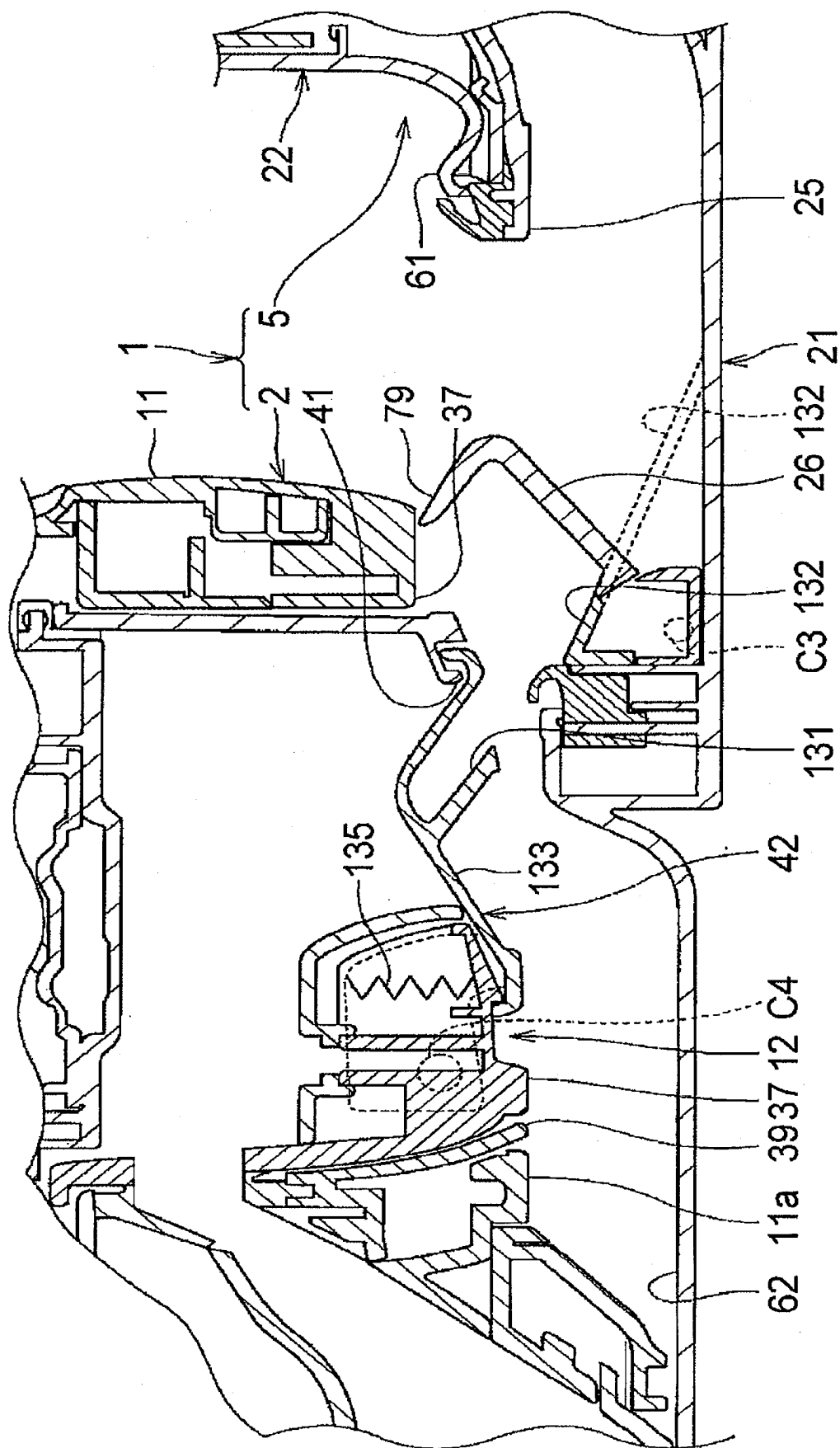


FIG. 8

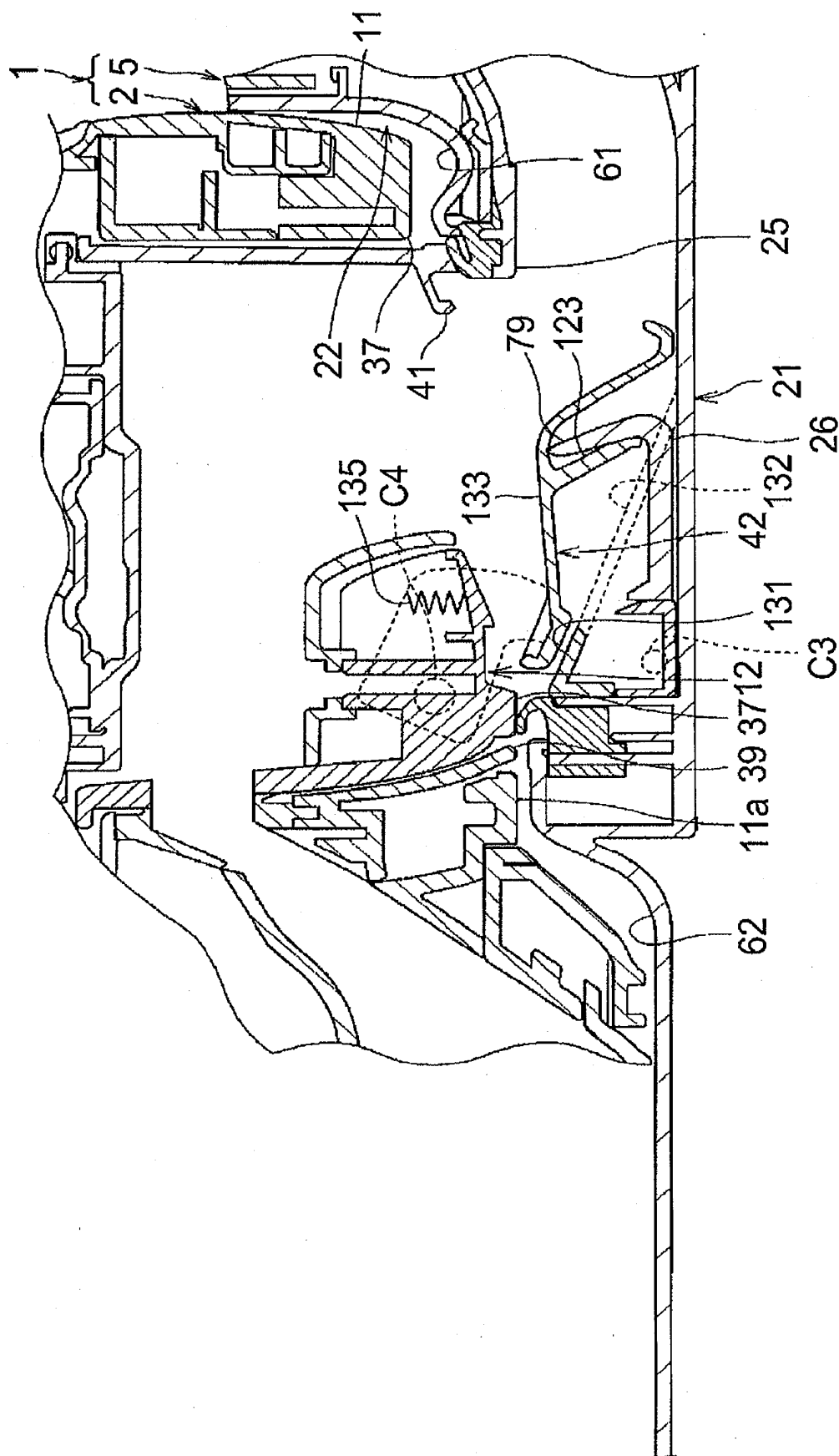


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/073458

A. CLASSIFICATION OF SUBJECT MATTER

A47L9/28(2006.01)i, A47L9/00(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)

A47L9/28, A47L9/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
 Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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 2007-181656 A (Samsung Electronics Co., Ltd.), 19 July 2007 (19.07.2007), paragraphs [0038] to [0049]; fig. 5 to 7 & US 2007/0157415 A1 & EP 1806086 A2 & DE 602006011263 D & KR 10-2007-0074146 A & CN 1994212 A	1, 3-5 2
Y	JP 2012-152479 A (Hitachi Appliances, Inc.), 16 August 2012 (16.08.2012), paragraphs [0086] to [0090]; fig. 10 (Family: none)	2
A	JP 2005-110787 A (Duskin Co., Ltd.), 28 April 2005 (28.04.2005), paragraphs [0025] to [0037] (Family: none)	2

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

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Date of the actual completion of the international search
08 November 2016 (08.11.16)Date of mailing of the international search report
15 November 2016 (15.11.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/073458

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/0049640 A1 (Samsung Electronics Co., Ltd.), 26 February 2009 (26.02.2009), fig. 6 to 7 & KR 10-2009-0020755 A	1-5

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2015181013 A [0001]
- JP 2003210361 A [0008]
- US 20120011677 A [0008]