(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 357 394 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
08.08.2018 Bulletin 2018/32

(21) Application number: **16851555.9**

(22) Date of filing: **27.09.2016**

(51) Int Cl.:
A47L 9/16 *(2006.01)* ***A47L 9/00*** *(2006.01)*

(86) International application number:
PCT/JP2016/078499

(87) International publication number:
WO 2017/057384 (06.04.2017 Gazette 2017/14)

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

(30) Priority: **29.09.2015 JP 2015191925**

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(54) ELECTRIC VACUUM CLEANER

(57) Provided is a vacuum cleaner capable of suppressing noise and sanitary disposing of dust and dirt, while efficiently collecting dust and dirt by use of a first centrifuge separator and a plurality of second centrifuge separators. The first centrifuge separator (47) centrifuges dust and dirt by swirling dust-including air around a shroud part (66) along an inner face of a casing (45). Each of the plurality of second centrifuge separators (48) centrifuges smaller dust and dirt compared to dust and dirt centrifuged by the first centrifuge separator (47) by swirling dust-including air having passed through the first centrifuge separator (47) along an inner face of a cone part (63). A first storage part (70) stores the dust and dirt centrifuged by the first centrifuge separator (47). A second storage part (71) stores the dust and dirt centrifuged by each of the plurality of second centrifuge separators (48). Each of the plurality of second centrifuge separators (48) is respectively located inside a separator part (67). The first storage part (70) and the second storage part (71) are partitioned into an outer part and an inner part of a separator body portion (61), due to close contact between the separator body portion (61) and the casing (45).

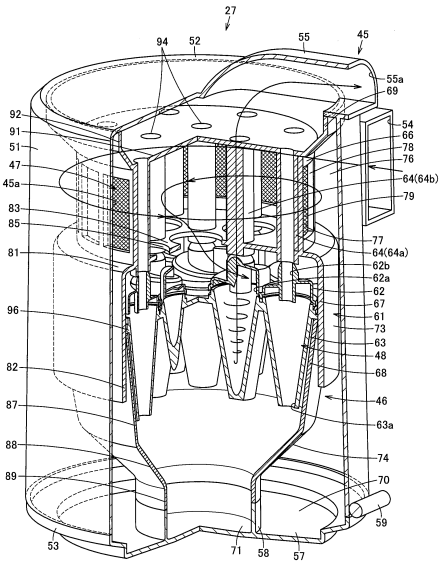

FIG. 1

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Description

TECHNICAL FIELD

[0001] Embodiments described herein relate generally to a vacuum cleaner equipped with a dust-collecting device having a first centrifuge separator that centrifuges dust and dirt, and a plurality of second centrifuge separators that centrifuge smaller dust and dirt compared to that centrifuged by the first centrifuge separator.

BACKGROUND ART

[0002] Some of conventional dust-collecting devices (dust-collecting cups) for use in a vacuum cleaner respectively include a first centrifuge separator that centrifuges coarse dust corresponding to relatively large dust and dirt, and a plurality of second centrifuge separators that communicate with the downstream side of the first centrifuge separator and centrifuge fine dust (ultrafine dust) corresponding to relatively small dust and dirt. By applying the configuration with these centrifuge separators for centrifuging dust and dirt different from each other, maintenance frequency and labor required of users have been reduced.

[0003] However, the second centrifuge separators become noise sources that generate relatively large fluid noise because each of the second centrifuge separators has a smaller diameter compared to the first centrifuge separator and thus the fluid speed is higher. Accordingly, there is a need to reduce the noise generated by these second centrifuge separators.

CITATION LIST

Patent Literature

[0004] PTL 1: Japanese Laid-open Patent Publication No. 2010-201167

SUMMARY OF INVENTION

Technical Problem

[0005] An object of the present invention is to provide a vacuum cleaner capable of suppressing noise and sanitary disposing of dust and dirt, while efficiently collecting dust and dirt by use of a first centrifuge separator and a plurality of second centrifuge separators.

Solution to Problem

[0006] A vacuum cleaner in an embodiment includes a vacuum cleaner body portion including an electric blower, and a dust-collecting device that separates and collects dust and dirt from dust-including air sucked by drive of the electric blower. The dust-collecting device includes a first centrifuge separator, a plurality of second centrifuge separators, a first dust-collecting unit and a second dust-collecting unit. The first centrifuge separator includes a casing and a separator body portion. The separator body portion includes a first cylindrical part having a substantially cylindrical shape with a ventilation opening on the circumferential face thereof. The separator body portion also includes a separator part having a cylindrical shape located below the first cylindrical part. In addition, the separator body portion is accommodated in the casing so that a lower end side of the separator body portion is brought in close contact with the casing. The first centrifuge separator centrifuges dust and dirt by swirling dust-including air around the first cylindrical part along an inner face of the casing. Each of the plurality of second centrifuge separators includes a second cylindrical part. The second cylindrical part is formed to have a substantially cylindrical shape with a smaller diameter compared to the first cylindrical part and communicates respectively in parallel with the first centrifuge separator. Each of the plurality of second centrifuge separators centrifuges smaller dust and dirt compared to that centrifuged by the first centrifuge separator by swirling dust-including air having passed through the first centrifuge separator along an inner face of the second cylindrical part. The first dust-collecting unit stores the dust and dirt centrifuged by the first centrifuge separator. The second dust-collecting unit stores the dust and dirt centrifuged by the plurality of second centrifuge separators. The plurality of second centrifuge separators are respectively located inside the separator part. The separator body portion partitions off, due to close contact with the casing, the interior of the casing into an outer part and an inner part, that is, the first dust-collecting unit and the second dust-collecting unit.

BRIEF DESCRIPTION OF DRAWINGS

[0007]

[Fig. 1]
Fig. 1 is a perspective sectional view showing a dust-collecting device of a vacuum cleaner in one embodiment;
[Fig. 2]
Fig. 2 is a cross sectional view showing the above dust-collecting device;
[Fig. 3]
Fig. 3 is a perspective view showing an operating state of the above dust-collecting device when dust and dirt in the dust-collecting device are disposed of;
[Fig. 4]
Fig. 4 is a disassembled perspective view showing the above dust-collecting device; and
[Fig. 5]
Fig. 5 is a perspective view showing the above vacuum cleaner.

DESCRIPTION OF EMBODIMENTS

[0008] Hereinbelow, one embodiment will be described in terms of its constitution with reference to Figs. 1 to 5.

[0009] In Fig. 5, reference sign 11 denotes a so-called canister type vacuum cleaner. This vacuum cleaner 11 includes a pipe part 12 corresponding to a suction air path element (air path forming body), and a vacuum cleaner body portion 13 to which the pipe part 12 is detachably connected.

[0010] The pipe part 12 includes a connecting pipe part 15 to be connected to the vacuum cleaner body portion 13, a flexible hose body 16 communicating with the tip side of the connecting pipe part 15, a hand operating part 17 arranged on the tip side of the hose body 16, an extension pipe 18 to be detachably connected to the tip side of the hand operating part 17, and a floor brush 19 corresponding to a suction port to be detachably connected to the tip side of the extension pipe 18 or the like.

[0011] The hand operating part 17 is provided with a looped gripping part 21 projecting toward the hose body 16 side, and a plurality of setting buttons 22 for operation on the gripping part 21.

[0012] As shown in Figs. 1 to 5, the vacuum cleaner body portion 13 includes a main casing 26 which has large-diameter traveling wheels 23 on the both sides thereof, a swing wheel (not shown in figures) and other elements on the lower part thereof, and also includes a detachable dust-collecting device 27 corresponding to a dust-collecting cup externally on the upper front part of the main casing 26. The vacuum cleaner body portion 13 is configured to be capable of traveling (moving) on a floor surface to be cleaned at least along a back-and-forth direction by use of the traveling wheels 23 and the swing wheel. Hereinafter, the back-and-forth direction is based on the traveling (moving) direction of the vacuum cleaner body portion 13 (main casing 26) .

[0013] The main casing 26, for example, made of synthetic resin, integrally includes a body portion 31 disposed behind the dust-collecting device 27, and a projecting receiver 32 corresponding to a dust-collecting device support part that projects in the lower front side of the body portion 31 and supports the lower part of the dust-collecting device 27.

[0014] Respectively on the both sides of the body portion 31, the traveling wheels 23 are pivotally and rotatably supported. The body portion 31 also accommodates an electric blower 35, a control circuit part (not shown in figures) corresponding to control means that controls the operation of the electric blower 35, and a power source part corresponding to a power source for the electric blower 35, the control circuit part or the like. As the power source part, a cord reel device with wound power cord for connection to an external power source such as a commercial AC power source, or a battery such as a secondary battery is used.

[0015] A communicating opening (not shown in figures) is formed at the front lower part of the body portion 31, which is airtightly connected to the upstream side of the dust-collecting device 27 attached to the main casing 26. Further, an air suction opening part (not shown in figures) is formed on the upper part of the body portion 31, which communicates between the downstream side of the dust-collecting device 27 attached to the main casing 26 and the suction side of the electric blower 35. An exhaust hole (not shown in figures) is formed on the rear part of the body portion 31, which discharges exhaust from the electric blower 35.

[0016] A main body suction port 41 is formed on the front face of the projecting receiver 32, to which the connecting pipe part 15 of the pipe part 12 is connected to suck dust-including air into the dust-collecting device 27. The main body suction port 41 communicates with the communicating opening. Thus, the main body suction port 41 can communicate with the upstream side of the dust-collecting device 27 attached to the main casing 26.

[0017] The operation of the electric blower 35 is controlled by the control circuit part in accordance with operation on the setting buttons 22. In the embodiment, the electric blower 35 is arranged, for example, so that the suction side of the electric blower 35 faces upward.

[0018] The control circuit part is electrically connected to the setting buttons 22, and is configured to set the operation of the electric blower 35 to the operation mode (for example, strong mode, middle mode, weak mode, automatic mode, stop mode, etc.) set by the operation on the setting buttons 22.

[0019] The dust-collecting device 27 includes a casing 45 that is a container corresponding to a first body portion, and a separator 46 that is a dust-and-dirt separator corresponding to a second body portion to be accommodated inside the casing 45. The dust-collecting device 27 is also constituted with a first centrifuge separator 47 and a plurality of second centrifuge separators 48. The first centrifuge separator 47 mainly centrifuges relatively large dust and dirt, that is, coarse dust, which is a part of the dust and dirt in the dust-including air sucked by drive of the electric blower 35. The second centrifuge separators 48 respectively centrifuge relatively small dust and dirt, that is, fine dust (ultrafine dust), which is the remaining dust and dirt not having been centrifuged by the first centrifuge separator 47. The dust-collecting device 27 is detachably locked to the main casing 26 by an attaching/detaching mechanism (not shown in figures). The back-and-forth direction and the left-and-right direction in terms of the dust-collecting device 27 is based on a state in which the dust-collecting device 27 is attached to the main casing 26, and the up-and-down direction in terms of the dust-collecting device 27 is based on a state in which the dust-collecting device 27 is detached from the main casing 26 and placed on a horizontal plane, that is, based on the dust-collecting device 27 (the state shown in Fig. 1). In the embodiment, the dust-collecting device 27 is attached to the main casing 26 so that the upper end side, corresponding to one end side,

of the dust-collecting device 27 is inclined backward. Therefore, the up-and-down direction described hereafter when the dust-collecting device 27 is attached to the main casing 26 may not correspond to the vertical up-and-down direction.

[0020] The casing 45 corresponds to the outer enclosure of the dust-collecting device 27, having a hollow and substantially cylindrical shape. The casing 45, in the embodiment, includes a casing body 51 that is a cylindrical container body, a cover part 52 that is a ceiling part attached on the top end part corresponding to one end part of the casing body 51, and a lid 53 that is a bottom portion that opens and closes a lower end part corresponding to the other end part of the casing body 51. The casing 45 also has on one side of the rear thereof, for example, on a location shifted to the right side thereof, an introduction port 54 for sucking dust-including air. Further, the rear part of the casing 45 is provided at the upper part thereof with an exhaust part 55 through which the air after separating of dust and dirt is discharged.

[0021] The casing body 51 is made of a member, for example, translucent (transparent) synthetic resin. The introduction port 54 is arranged on the casing body 51.

[0022] The cover part 52 having a substantially circular plate shape seals up the upper end part of the casing body 51. The exhaust part 55 is arranged on the cover part 52. The cover part 52 and the casing body 51 may be formed integrally or separately.

[0023] The lid 53 includes a lid body 57 having a substantially circular disk shape, a receiving part 58 having a cylindrical shape arranged concentrically with the lid body 57, and a hinge part 59 with which the lid 53 is pivotally and rotatably supported to the casing body 51. The lid 53 also includes a seal member and a locking mechanism (not shown in figures) . The seal member is brought into airtightly press-contact with the lower end part of the casing body 51, and the locking mechanism with which the lid 53 is locked to the casing body 51.

[0024] The receiving part 58 projecting from the upper side of the central part of the lid body 57 supports the separator 46 from below when the lid 53 is closed.

[0025] The hinge part 59 arranged on one side part of the lid body 57 or the like connects between the lid 53 and the casing body 51.

[0026] The seal member is arranged along the outer circumferential part of the lid body 57 or the like.

[0027] The locking mechanism is arranged, for example, opposite side to and in the other side part of the hinge part 59 on the lid body 57. The locking mechanism can release the locking of the lid 53 to the casing body 51 in accordance with operation on an operation part (not shown in figures).

[0028] The introduction port 54 is arranged in a location so as to face the body portion 31 with the dust-collecting device 27 being attached to the main casing 26. The introduction port 54 extending backward and substantially horizontally is airtightly connected to the communicating opening with the dust-collecting device 27 being attached to the main casing 26. Thus, the introduction port 54 is airtightly connected to the main body suction port 41 (via the communicating opening).

[0029] The exhaust part 55 extends cylindrically backward from the substantially central part of the cover part 52. The tip side of the exhaust part 55 forms an exhaust port 55a that faces the body portion 31 with the dust-collecting device 27 being attached to the main casing 26.

[0030] The separator 46 includes a separator body portion 61, a plurality of introduction parts 62 that are accommodated in the separator body portion 61, a plurality of cone parts 63 corresponding to second cylindrical parts, and a plurality of discharging cylindrical parts 64 corresponding to discharging parts. The separator 46 is detachably fixed to the casing body 51 or the cover part 52 of the casing 45.

[0031] The separator body portion 61, along with the casing 45, constituting the first centrifuge separator 47, has a shroud part 66 corresponding to a first cylindrical part, a separator part 67, a collective wall part 68 corresponding to a partition wall part, and an exhaust air path part 69. The separator body portion 61 is arranged inside the casing 45 along the central axis of the casing 45 so that the lower end side (lower end part) of the separator body portion 61 is supported in close contact with the casing 45 (the lid 53 (the receiving part 58)). Thus, the separator body portion 61 partitions off, due to the close contact with the casing 45, the interior of the casing 45 into an outer part and an inner part, that is, a first storage part 70 and a second storage part 71. The first storage part 70 is a first dust-collecting unit that stores the dust and dirt (coarse dust) centrifuged by the first centrifuge separator 47, and the second storage part 71 is a second dust-collecting unit that stores the dust and dirt (fine dust) centrifuged respectively by the second centrifuge separators 48. The separator body portion 61 is divided into a first structure 73 integrally including the shroud part 66, the separator part 67 and the exhaust air path part 69, and a second structure 74 including the collective wall part 68.

[0032] The shroud part 66 forms a swirling air path 76 to swirl dust-including air as the rotation center of the first centrifuge separator 47 between (around) the outer circumference of the shroud part 66 and an inner circumferential face 45a of the casing 45. The shroud part 66 having a cylindrical shape with the axis thereof set along up-and-down direction is located in the center of and coaxially with the casing 45. Further, the shroud part 66 is arranged at substantially the same height as the introduction port 54. The shroud part 66 also includes a plurality of ventilation openings 77 on the circumferential face thereof, and a partition 78 is arranged between the adjacent ventilation openings 77, 77. Further, each of the ventilation openings 77 is covered by a separation filter 79.

[0033] The ventilation openings 77 penetrate the circumferential face of the shroud part 66 so as to communicate between the outer circumferential side (the swirl-

ing air path 76) and the inner circumferential side of the shroud part 66. The ventilation openings 77 respectively having, for example, a square shape long in the up-and-down direction are opened and substantially equally separated from each other in the circumferential direction of the shroud part 66. Thus, the partitions 78 respectively having a shape long in the up-and-down direction are located in the circumferential direction of the shroud part 66 at substantially equal intervals, so as to form a grid shape (lattice shape).

[0034] The separation filter 79, for example, a mesh filter, filters and separates dust and dirt in dust-including air passing through the ventilation openings 77.

[0035] The separator part 67 partitions off the interior of the casing 45 into an upper part and a lower part, that is, the swirling air path 76 and the first storage part 70. The separator part 67 is located adjacent to the lower end part of the shroud part 66. That is, the separator part 67 is located below the shroud part 66. The separator part 67 is formed in a cylindrical shape with a lid with the axis thereof set along the up-and-down direction, having a larger diameter compared to the shroud part 66, and is arranged coaxially with the shroud part 66. That is, the separator part 67 includes a top plate part 81 having a circular plate shape and a circumferential plate part 82 having a substantially cylindrical shape that projects downward in the opposite direction to the shroud part 66 from the outer circumferential part of the top plate part 81. The separator part 67 also includes a straightening part 83 that straightens dust-including air passing from the swirling air path 76 respectively to the second centrifuge separators 48 via the ventilation openings 77.

[0036] The top plate part 81 is located so as to cover the lower end part of the shroud part 66. The top plate part 81 has a larger diameter compared to the shroud part 66, and the outer circumferential part of the top plate part 81 projects radially and outwardly with respect to the shroud part 66. The top plate part 81 has, for example, a plurality of opening parts 85 in an area corresponding to the inside area of the shroud part 66. The opening parts 85 introduce dust-including air having passed from the swirling air path 76 to the shroud part 66 via the ventilation openings 77 (separation filters 79), to the inside of the separator part 67 (each of the second centrifuge separators 48 (each of the cone parts 63)). The opening parts 85, for example, respectively formed in a circular shape, are arranged symmetrically on the top plate part 81. The opening parts 85 include a center opening part 85a arranged at the center of the top plate part 81, that is, at the central axis of the shroud part 66, and a plurality of outer opening parts 85b arranged at intervals on the same circle closer to the outer circumference of the center opening part 85a, that is, near the inner circumference of the shroud part 66.

[0037] The straightening part 83 is constituted with a part of the top plate part 81 in the inner circumferential side of the shroud part 66, and the plurality of opening parts 85. That is, the straightening part 83 communicates between the ventilation openings 77 and each of the second centrifuge separators 48.

[0038] The collective wall part 68 integrally includes an upper wall part 87 having a substantially cylindrical shape corresponding to a partition wall part body, a diameter reducing part 88 corresponding to a dust guide part that is continued to the lower end part of the upper wall part 87 and reduced in diameter from its upper end side to its lower end side, and a connecting part 89 having a cylindrical shape corresponding to a supported part continued to the lower end part of the diameter reducing part 88. As a whole, the collective wall part 68 is formed substantially in a cylindrical shape with the diameter thereof reduced from the upper end part side to the lower end part side. The upper end part side (the upper end part side of the upper wall part 87) of the collective wall part 68 is located inside the separator part 67, while the lower end part side (the lower end part side of the upper wall part 87, the diameter reducing part 88, and the connecting part 89) projects downward from the separator part 67 and located in the casing 45. The inner part of the collective wall part 68 communicates with the second storage part 71.

[0039] The upper wall part 87 is formed with the diameter gradually reduced from the upper end part side to the lower end part side. The lower end part of the upper wall part 87 has, for example, a larger diameter compared to the shroud part 66.

[0040] The diameter reducing part 88 that guides the dust and dirt (fine dust) centrifuged respectively by the second centrifuge separators 48 is inclined toward the second storage part 71.

[0041] The connecting part 89 is the part to make the separator body portion 61 (the separator 46) in close contact with the bottom portion (the lid 53) of the casing 45, and to support the separator body portion 61. The connecting part 89 is formed with a diameter having substantially the same size as the receiving part 58 of the lid 53 so as to be in close contact with the receiving part 58 with the lid 53 closing the lower end part of the casing 45.

[0042] The exhaust air path part 69 communicates between all of the second centrifuge separators 48 and the exhaust part 55 (the exhaust port 55a), and flows the air substantially free from dust and dirt having passed through the second centrifuge separators 48, through to the exhaust part 55 (the exhaust port 55a). The exhaust air path part 69 is adjacent to the upper end part of the shroud part 66, in the opposite side to the separator part 67. That is, the exhaust air path part 69 is located above the shroud part 66. The exhaust air path part 69 having a bottomed cylindrical shape with a larger diameter compared to the shroud part 66 and with the axis direction thereof set along the up-and-down direction is arranged coaxially with the shroud part 66. That is, the exhaust air path part 69 includes an air path partition wall part 91 having a circular plate shape and a circumferential wall part 92 that projects upward from the outer circumferential part of the air path partition wall part 91 in the opposite

side to the shroud part 66 so as to be in close contact with the inside of the casing 45 (the upper end side of the casing body 51 or the lower part of the cover part 52) .

[0043] The air path partition wall part 91 is located so as to cover the upper end part of the shroud part 66. The air path partition wall part 91 has, for example, a plurality of communicating openings 94 in an area corresponding to the inside area of the shroud part 66. These communicating openings 94 that introduce the air having passed through each of the second centrifuge separators 48 into the exhaust air path part 69 respectively communicate with the upper end parts (the downstream end parts) of each of the discharging cylindrical parts 64.

[0044] The circumferential wall part 92 is formed in a cylindrical shape with the diameter thereof gradually increased from the lower end side to the upper end side thereof.

[0045] The first storage part 70 is the space partitioned by the casing body 51 and the lid 53, and the outer side of the collective wall part 68 of the separator body portion 61, due to the close contact between the connecting part 89 of the collective wall part 68 of the separator body portion 61 and the receiving part 58 of the lid 53. That is, the first storage part 70 is the space in the outer circumferential side of the collective wall part 68 inside the casing 45.

[0046] The second storage part 71 is the space partitioned by the lid 53 (the receiving part 58) and the inner side of the collective wall part 68 of the separator body portion 61, due to the close contact between the connecting part 89 of the collective wall part 68 of the separator body portion 61 and the receiving part 58 of the lid 53. Further, the second storage part 71 is surrounded by the receiving part 58 of the lid 53 in the embodiment.

[0047] Therefore, the first storage part 70 is arranged in a doughnut shape (in an annular shape) around the second storage part 71. That is, the first storage part 70 and the second storage part 71 are positioned concentrically.

[0048] As for the first structure 73, the upper end side (the exhaust air path part 69 (the circumferential wall part 92)) is fixed to the casing 45 (the casing body 51 or the cover part 52), while the lower end side (the side of the separator part 67) is left free. As the second structure 74, the upper end side (the collective wall part 68 (the upper wall part 87)) is inserted into the separator part 67 of the first structure 73 so as to be detachably locked and held, while the lower end side (the lower end side of the collective wall part 68 (the connecting part 89)) is left free.

[0049] The introduction parts 62 are respectively disposed on the upper end parts of each of the cone parts 63 so as to introduce dust-including air having passed through the first centrifuge separator 47 into each of the cone parts 63 respectively and spirally along the tangential directions of the inner circumferential faces of the cone parts 63, and further respectively communicate between each of the cone parts 63 (each of the second centrifuge separators 48) and the discharging cylindrical parts 64. The introduction parts 62 are also located below the separator part 67 (the straightening part 83), and air suction openings 62a (the upstream side) respectively located around the introduction parts 62 communicate with the ventilation openings 77 via the opening parts 85. Thus, the suction sides of these introduction parts 62 communicate with the swirling air path 76 (via the straightening part 83 (the opening parts 85) and the ventilation openings 77). The directions of the openings of the air suction openings 62a of each of the introduction parts 62 are set respectively differently by a specified angle, so that the air having passed through the opening parts 85 (the straightening part 83) into the separator part 67 is distributed substantially equally to each of the cone parts 63. An air exhaust opening 62b located at the center of each of the introduction parts 62 (the downstream side) is connected to each of the discharging cylindrical parts 64. Thus, the exhaust sides of the introduction parts 62 communicate with the exhaust air path part 69 (via each of the discharging cylindrical parts 64).

[0050] Each of the cone parts 63 is paired with each of the introduction parts 62 so as to configure each of the second centrifuge separators 48, and communicates in parallel with the first centrifuge separator 47. These cone parts 63 respectively having a smaller diameter compared to the shroud part 66 are located with these axial directions set along a vertical up-and-down direction, that is, in substantially parallel to the central axis of the dust-collecting device 27, and are respectively formed in a substantially cylindrical shape with the diameter gradually reduced from the upper end side through which dust-including air flows to the lower end side. Thus, these cone parts 63 can centrifuge fine dust because in these cone parts 63 the swirling diameter of dust-including air is smaller than the swirling diameter in the swirling air path 76 of the first centrifuge separator 47 and the swirling speed is higher than the swirling speed in the swirling air path 76 of the first centrifuge separator 47. Further, these cone parts 63 are integrally connected by, for example, a connecting plate 96 corresponding to a connecting part. These cone parts 63 are supported by the connecting plate 96 at the upper end part of the second structure 74 (the collective wall part 68 (the upper wall part 87)), so as to be accommodated inside the collective wall part 68. Thus, these cone parts 63 are located inside the separator part 67. The lower end parts of these cone parts 63 are located at a position separated from and above the diameter reducing part 88 so as to face the diameter reducing part 88, and communicate with the second storage part 71. Thus, the lower end parts of these cone parts 63 are formed as discharging opening parts 63a, and discharge the fine dust centrifuged by the second centrifuge separators 48 to the second storage part 71.

[0051] Each of the discharging cylindrical parts 64 having an elongated cylindrical shape communicates between each of the second centrifuge separators 48 (each of the cone parts 63) and the exhaust air path part 69. That is, each of the discharging cylindrical parts 64 is

arranged so as to correspond to each of the second centrifuge separators 48 (each of the cone parts 63), and the lower end part (the upstream side) is airtightly connected to each of the air exhaust openings 62b of each of the introduction parts 62, while the upper end part (the downstream side) is airtightly connected to each of the communicating openings 94. These discharging cylindrical parts 64, with the axial directions set along a vertical up-and-down direction, that is, substantially in parallel to the central axis of the dust-collecting device 27, penetrate the top plate part 81 (the straightening part 83) of the separator part 67, and are located in the inside part of the shroud part 66. That is, these discharging cylindrical parts 64 are located in dust-including air to be branched from the ventilation openings 77 (via the straightening part 83) to each of the second centrifuge separators 48 (each of the cone parts 63) . These discharging cylindrical parts 64 include a plurality of outer discharging cylindrical parts 64a corresponding to the first discharging cylindrical parts located on one relatively-large circle so as to be separated from each other, and a plurality of inner discharging cylindrical parts 64b corresponding to the second discharging cylindrical parts located on one relatively-small circle so as to be separated from each other, and the outer discharging cylindrical parts 64a and the inner discharging cylindrical parts 64b are arranged concentrically and symmetrically. The outer discharging cylindrical parts 64a are arranged outside the opening parts 85 (the outer opening parts 85b) and on the back side of the partitions 78 of the shroud part 66, that is, in close contact with the inside of the shroud part 66. These outer discharging cylindrical parts 64a are arranged, for example, on every other partition 78 and also on both sides of each of the outer opening parts 85b (two for one outer opening part 85b). The inner discharging cylindrical parts 64b are arranged around the central axis of the shroud part 66 respectively between the adjacent outer opening parts 85b, 85b, and also outside the center opening part 85a. Thus, these discharging cylindrical parts 64 are arranged so as to surround each of the opening parts 85. Specifically, the adjacent outer discharging cylindrical parts 64a , 64a and the adjacent inner discharging cylindrical parts 64b, 64b are arranged so as to surround one of the outer opening parts 85b, and the inner discharging cylindrical parts 64b are arranged so as to surround the center opening part 85a (Fig. 2).

[0052] The first centrifuge separator 47 swirls dust-including air in the swirling air path 76 arranged around the shroud part 66 along the inner face of the casing 45 to centrifuge dust and dirt.

[0053] Each of the second centrifuge separators 48 respectively communicating in parallel with the first centrifuge separator 47 introduces dust-including air having passed through the first centrifuge separator 47 from the introduction parts 62 into the cone parts 63, swirls dust-including air along the inner faces of the cone parts 63 to centrifuge smaller dust and dirt (fine dust) than the dust and dirt (coarse dust) centrifuged by the first centrifuge separator 47, then stores them in the second storage part 71, and also discharges the air from which coarse dust has been separated and which is substantially free from dust and dirt, from the discharging cylindrical parts 64 to the exhaust air path part 69 (the exhaust part 55 (the exhaust port 55a)), that is, outside the dust-collecting device 27.

[0054] Hereafter, the cleaning motion in accordance with the embodiment described above will be described.

[0055] For start of cleaning, firstly, the separator 46 is attached to the casing 45 to make them integrally assembled. Specifically, as for the separator 46, the first structure 73 is inserted to be held and locked in the casing 45 with the lower end side thereof opened by the lid 53, and further the upper end side of the second structure 74 holding at the upper end side thereof the connecting plate 96 connecting the cone parts 63 respectively having each of the introduction parts 62 is inserted to be held and locked in the first structure 73. This allows the separator 46 to be held coaxially in the casing 45 in a state where each of the air suction openings 62a of each of the introduction parts 62 is airtightly connected to each of the discharging cylindrical parts 64. With the lid 53 closed, the lower end side of the casing 45 is closed, and further the lower end part (the connecting part 89) of the separator body portion 61 of the separator 46 is brought into close contact with the receiving part 58 of the lid 53. Thus, the space surrounded by the casing 45 and the separator body portion 61 is partitioned into the first storage part 70 and the second storage part 71.

[0056] Then, the assembled dust-collecting device 27 is attached to the main casing 26, and then the dust-collecting device 27 is locked to the main casing 26 by use of the attaching/detaching mechanism. This makes the introduction port 54 and the exhaust part 55 of the dust-collecting device 27 be airtightly connected respectively to the communicating opening and the air suction opening part of the main casing 26. Thus, the dust-collecting device 27 is attached to the main casing 26 in a state in which the dust-collecting device 27 is airtightly connected to the suction side of the electric blower 35 and the main body suction port 41. In a state where the dust-collecting device 27 is already attached to the main casing 26, the operation described above is not required.

[0057] In this state, the pipe part 12 is connected to the main body suction port 41 of the vacuum cleaner body portion 13 (main casing 26). Specifically, the connecting pipe part 15 of the pipe part 12 is inserted in and connected to the main body suction port 41, and, if necessary, the extension pipe 18 and the floor brush 19 are connected to the tip side of the hand operating part 17 one by one. In this state, the setting buttons 22 of the hand operating part 17 are electrically connected to the control circuit part or the like included in the vacuum cleaner body portion 13 (main casing 26). When the pipe part 12 is already connected to the vacuum cleaner body portion 13, the operation described above is not required.

[0058] After getting ready for power feeding to the elec-

tric blower 35, the control circuit part or the like, a user grips the gripping part 21 and operates a desired button of the setting buttons 22 to set an operation mode of the electric blower 35. The control circuit part controls input to the electric blower 35 in accordance with the set operation mode to start the electric blower 35 in the set operation mode.

[0059] The negative pressure generated by the start of the electric blower 35 acts on the pipe part 12 via the air suction opening part, the exhaust part 55, the exhaust air path part 69, the second centrifuge separators 48, the straightening part 83, the first centrifuge separator 47, the introduction port 54, the communicating opening, and the main body suction port 41.

[0060] A user uses the action generated by the negative pressure for sucking dust and dirt as well as air from the tip side of the floor brush 19, the extension pipe 18, or the hand operating part 17.

[0061] The air including dust and dirt, that is, dust-including air, is introduced from the pipe part 12 through the main body suction port 41 and the communicating opening to the introduction port 54, and then sucked from the introduction port 54 into the dust-collecting device 27, that is, into the first centrifuge separator 47.

[0062] In the first centrifuge separator 47, dust-including air swirls in the swirling air path 76 along the inner circumferential face 45a of the casing 45. This especially centrifuges coarse dust in dust-including air, and the centrifuged coarse dust falls along the inner circumferential face 45a of the casing 45, and then is stored in the first storage part 70 having a doughnut shape below the separator part 67.

[0063] When passing through the ventilation openings 77 of the shroud part 66, dust-including air swirling in the swirling air path 76 is filtered by the separation filters 79. Dust-including air after passing through the separation filters 79 is straightened by the straightening part 83 while being guided respectively to each of the opening parts 85 by the discharging cylindrical parts 64, then passes through from each of the opening parts 85 to the inside of the separator part 67, and is further equally distributed respectively from the air suction openings 62a of each of the introduction parts 62 into the second centrifuge separators 48 (into the cone parts 63).

[0064] In these second centrifuge separators 48 (the cone parts 63), dust-including air is swirled along the inner circumferential faces (the inner circumferential faces of the cone parts 63) to centrifuge fine dust from dust-including air, and the centrifuged fine dust falls along the second centrifuge separators 48 (the inner circumferential faces of the cone parts 63) then from the discharging opening parts 63a toward the lower part of the cone parts 63. The fine dust falls on the diameter reducing part 88 located below each of the cone parts 63 and then along the slope of the diameter reducing part 88 to the second storage part 71 for storage.

[0065] The air substantially free from dust and dirt after centrifuging of fine dust is discharged from the air exhaust openings 62b of the introduction parts 62 of each of the second centrifuge separators 48 respectively via each of the discharging cylindrical parts 64, and collectively to the exhaust air path part 69, and then discharged outside the dust-collecting device 27 via the exhaust air path part 69 from the exhaust part 55 (the exhaust port 55a).

[0066] Then, the air is sucked from the air suction opening part through to the electric blower 35 and cools the inside of the electric blower 35 when passing through, and then is discharged as exhaust air outside the main casing 26 via the exhaust hole from the electric blower 35.

[0067] After finishing the cleaning, a user operates a prescribed button of the setting buttons 22 to make the control circuit part decrease the input to the electric blower 35 to stop the electric blower 35.

[0068] When a certain amount of dust and dirt is stored in the dust-collecting device 27, the dust-collecting device 27 is removed from the main casing 26 and brought to a location for disposal such as a bin. Then operation on an operation part of the locking mechanism is performed to make the lid 53 rotate downward around the hinge part 59 by self-weight. This opens the lower part of the casing 45 to separate the lid 53 (the receiving part 58) and the lower end part (the collective wall part 68 (the connecting part 89)) of the separator body portion 61 from each other. Thus, the coarse dust and the fine dust stored above the lid 53 are disposed of collectively. Upon the disposal, as the coarse dust surrounds the fine dust, disposing of the fine dust surrounded by the coarse dust suppresses rising of the fine dust, thereby allowing sanitary disposing of the dust.

[0069] The embodiment described above has the configuration with the first centrifuge separator 47 that centrifuges dust and dirt by swirling dust-including air around the shroud part 66 along the inner circumferential face 45a of the casing 45, and the plurality of second centrifuge separators 48 that respectively communicate in parallel with the first centrifuge separator 47 and centrifuge smaller dust and dirt compared to the dust and dirt to be centrifuged by the first centrifuge separator 47 by swirling along the inner faces of each of the cone parts 63 dust-including air having passed through the first centrifuge separator 47. Thus, the use of the first centrifuge separator 47 and plurality of the second centrifuge separators 48 allows efficient collection of dust and dirt. The arrangement of each of the second centrifuge separators 48 inside the separator part 67 located below the shroud part 66 of the first centrifuge separator 47 allows the use of the structural space of the first centrifuge separator 47, and each of the second centrifuge separators 48 likely generating large noise due to the high speed of swirling flow compared to that in the first centrifuge separator 47 can be contained in the outer shell of the first centrifuge separator 47, thereby suppressing noise. Further, since the separator body portion 61 partitions off, due to the close contact with the casing 45, the interior of the casing 45 into an outer part and an inner part, that is, the first storage part 70 that stores the dirt and dust (coarse dust)

centrifuged by the first centrifuge separator 47, and the second storage part 71 that stores the dirt and dust (fine dust) centrifuged by the second centrifuge separators 48, the coarse dust stored in the first storage part 70 can surround the fine dust stored in the second storage part 71, thereby suppressing rising of the fine dust or the like and resulting in sanitary disposing of dust.

[0070] Moreover, since the cone parts 63 included in the second centrifuge separators 48 are arranged inside the separator part 67 and also inside the collective wall part 68, the noise generated at the cone parts 63 is insulated double, thereby suppressing the noise more effectively.

[0071] Out of the opening parts 85 that introduce inside of each of the cone parts 63 dust-including air having passed through the ventilation openings 77 opened on the circumferential face of the shroud part 66, the outer opening parts 85b are located close to the inner circumference of the shroud part 66. Thus, dust-including air having passed through the ventilation openings 77 easily, early and also effectively flows into the second centrifuge separators 48 via the opening parts 85 (the outer opening parts 85b). In addition, since dust-including air sucked into the dust-collecting device 27 is sucked toward the second centrifuge separators 48 early without drifting inside the dust-collecting device 27, especially the fine dust included in dust-including air is hardly stuck on respective parts.

[0072] Especially, since the shroud part 66 is located at substantially the same height as the introduction port 54, dust-including air introduced from the introduction port 54 to the first centrifuge separator 47 (the swirling air path 76) as is flows into the ventilation openings 77, and then is introduced via the opening parts 85 (the straightening part 83) respectively to each of the second centrifuge separators 48 (the cone parts 63). Thus, dust-including air smoothly flows respectively to each of the second centrifuge separators 48 (the cone parts 63) without moving up and down repeatedly, resulting in providing higher efficiency.

[0073] Out of the discharging cylindrical parts 64 that are located on upper end parts of each of the cone parts 63 and discharge the air from which the second centrifuge separators 48 have centrifuged dust and dirt, the outer discharging cylindrical parts 64a are the guides to guide a part of dust-including air to the opening parts 85 (the outer opening parts 85b). Thus, dust-including air having passed through the ventilation openings 77 can efficiently flow to the opening parts 85 (the outer opening parts 85b). Since each of the opening parts 85 is surrounded by the discharging cylindrical parts 64, each of the opening parts 85 is located at a place in which dust-including air having passed through the ventilation openings 77 is kept away from these discharging cylindrical parts 64, and thus the discharging cylindrical parts 64 as a whole can guide dust-including air to the opening parts 85.

[0074] In addition, since the outer discharging cylindrical parts 64a are located on the back side of the partitions 78, the outer discharging cylindrical parts 64a hardly disturb the flow of dust-including air passing through the ventilation openings 77, thus suppressing the noise generated by turbulence or the like.

[0075] In the embodiment described above, the dust-collecting device 27 has the configuration in which dust and dirt is disposed of from the lower part of the dust-collecting device 27 by opening the bottom portion of the casing 45 by use of the lid 53. However, for example, a dust-collecting device 27 may have another configuration in which a casing 45 has a bottomed cylindrical shape and dust and dirt is disposed of from the upper end side of the casing 45 after removing a separator 46 (a separator body portion 61) from the casing 45.

[0076] Other cleaners, not limited to a canister type cleaner, can also be applied as a vacuum cleaner 11, for example, a so-called upright vacuum cleaner that has a main casing 26 having an up-and-down long shape with a floor brush 19 connected to the lower end part of the main casing 26, a so-called stick type vacuum cleaner that has a main casing 26 to which an extension pipe 18 and a floor brush 19 are connected directly, or the like.

[0077] 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. A vacuum cleaner comprising:

a vacuum cleaner body portion including an electric blower; and
a dust-collecting device that separates and collects dust and dirt from dust-including air sucked by drive of the electric blower, wherein
the dust-collecting device includes:

a first centrifuge separator that includes:

a casing; and
a separator body portion that includes:

a first cylindrical part formed to have a substantially cylindrical shape with a ventilation opening on a circumferential face of the first cylindrical part; and
a separator part having a cylindrical shape located below the first

cylindrical part,

the separator body portion being accommodated in the casing so that a lower end side of the separator body portion is in close contact with the casing,

the first centrifuge separator centrifuging dust and dirt by swirling dust-including air around the first cylindrical part along an inner face of the casing;
a plurality of second centrifuge separators each of which has a second cylindrical part formed to have a substantially cylindrical shape with a smaller diameter compared to the first cylindrical part and communicating in parallel with the first centrifuge separator, and which centrifuges smaller dust and dirt compared to dust and dirt centrifuged by the first centrifuge separator by swirling dust-including air having passed through the first centrifuge separator along an inner face of the second cylindrical part;
a first dust-collecting unit that stores the dust and dirt centrifuged by the first centrifuge separator; and
a second dust-collecting unit that stores the dust and dirt centrifuged by each of the plurality of second centrifuge separators, wherein
each of the plurality of second centrifuge separators is respectively located inside the separator part, and
the separator body portion partitions off, due to close contact with the casing, an interior of the casing into an outer part and an inner part, that is, the first dust-collecting unit and the second dust-collecting unit.

2. The vacuum cleaner according to Claim 1, wherein the dust-collecting device includes opening parts that introduce dust-including air having passed through the ventilation opening into the second cylindrical parts, and
at least one of the opening parts is arranged near an inner circumference of the first cylindrical part.

3. The vacuum cleaner according to Claim 2, wherein the dust-collecting device includes discharging parts that are located on upper end parts of the second cylindrical parts and discharge air from which dust and dirt has been centrifuged by the second centrifuge separators, and
at least one of the discharging parts is a guide to partially introduce dust-including air to the opening parts.

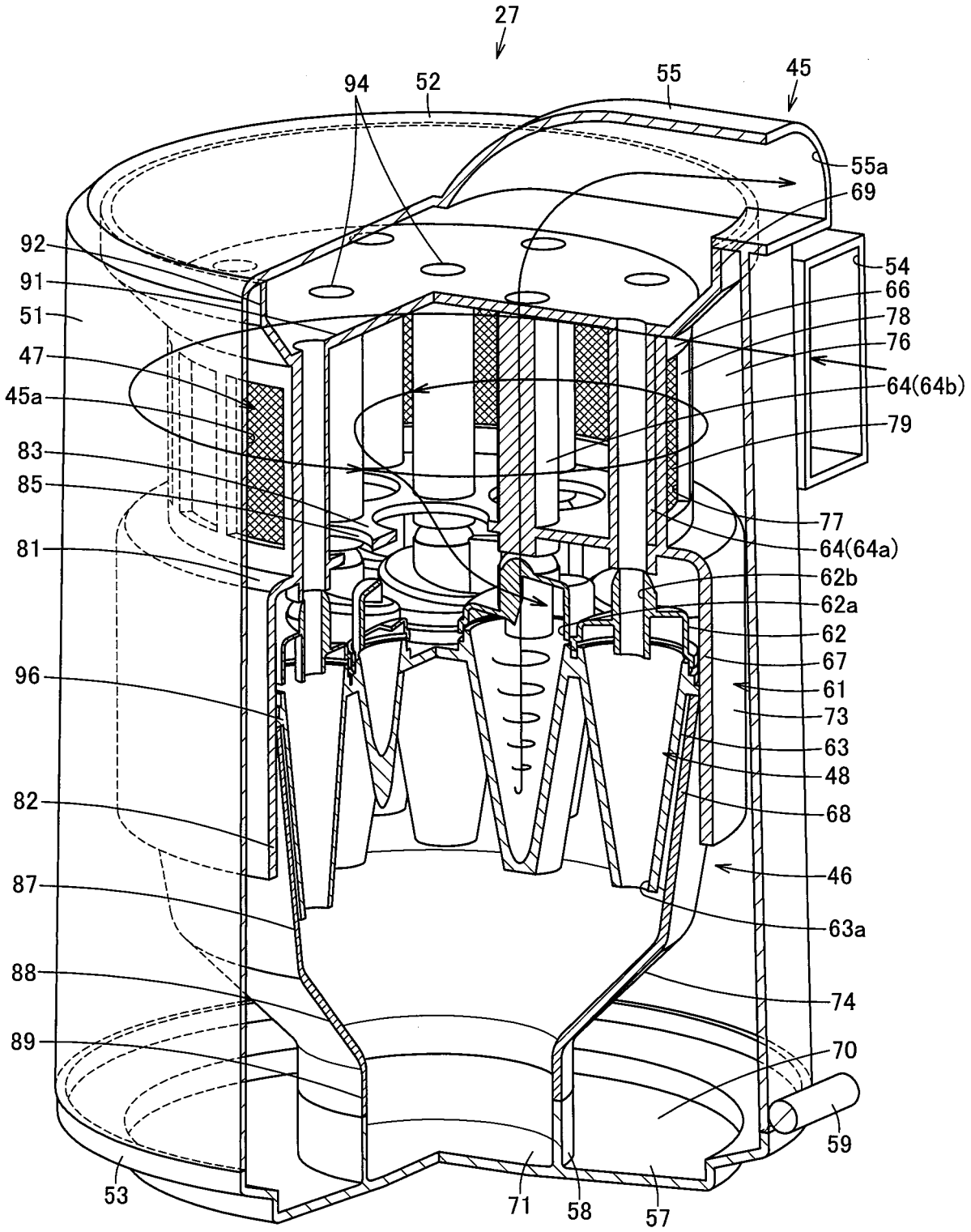
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FIG. 1

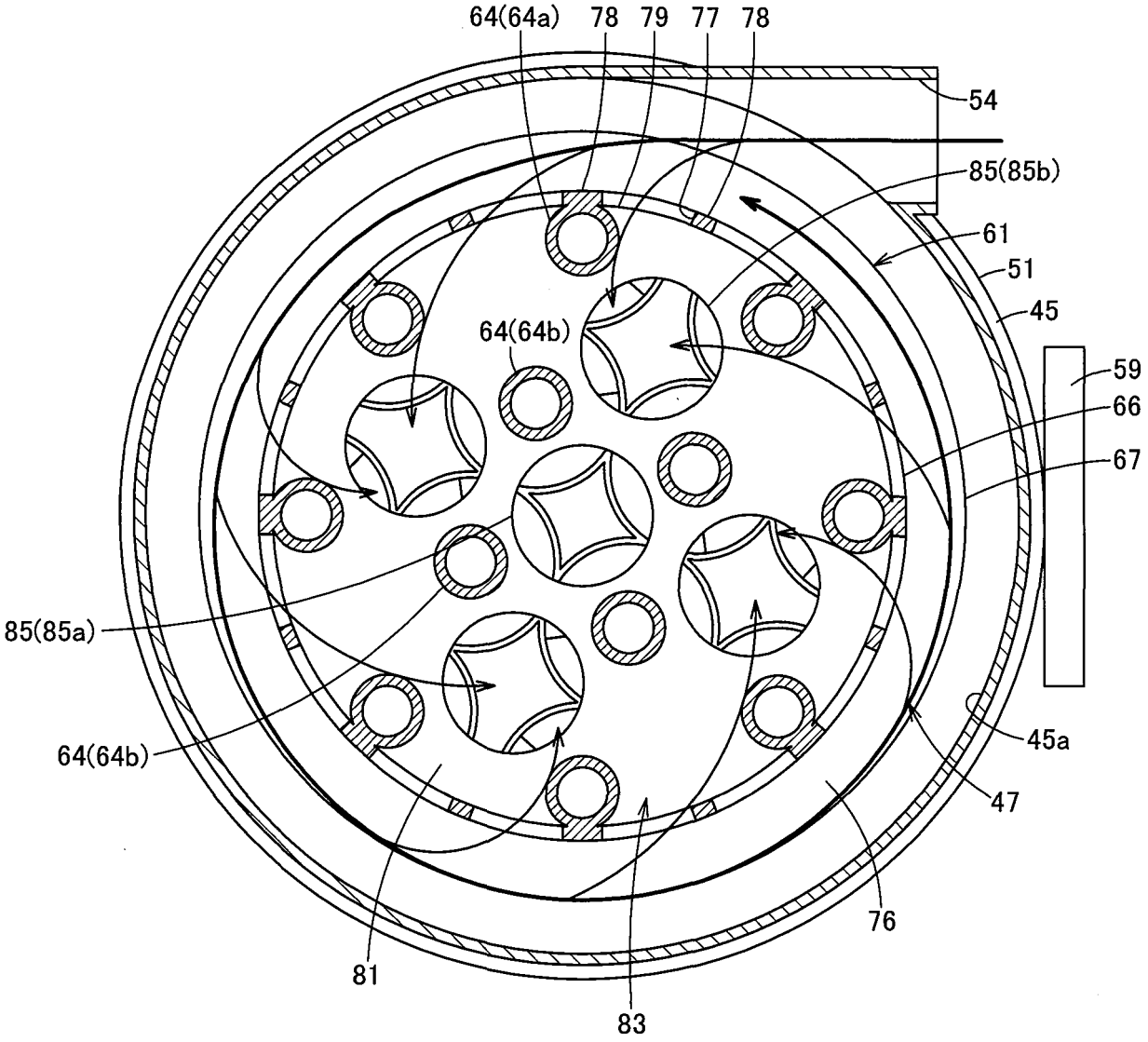
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FIG. 2

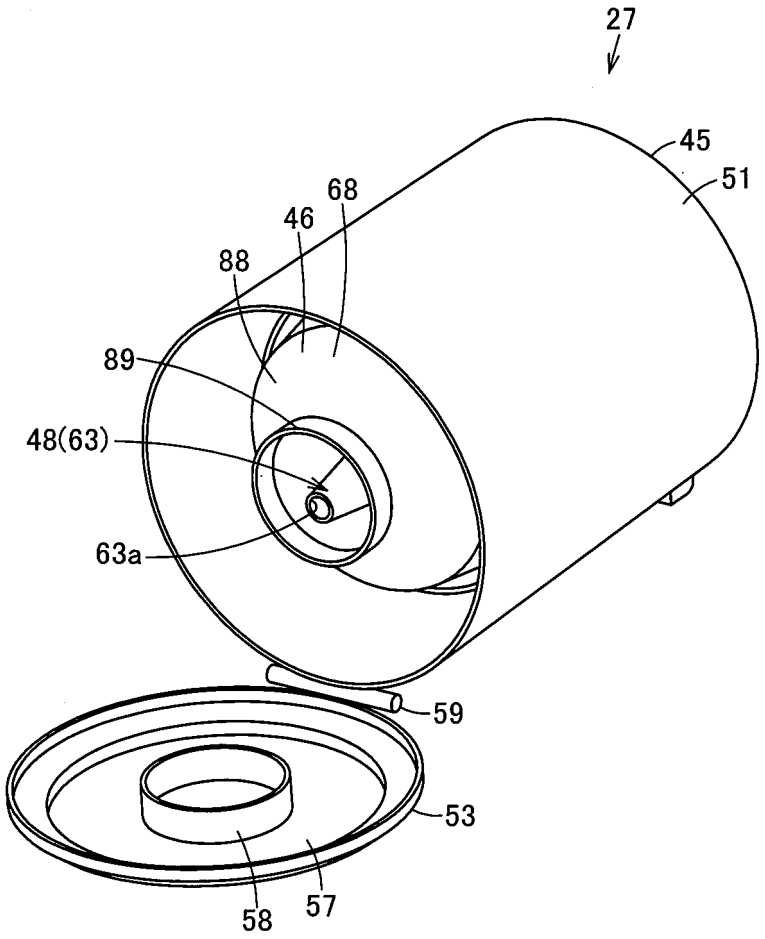

FIG. 3

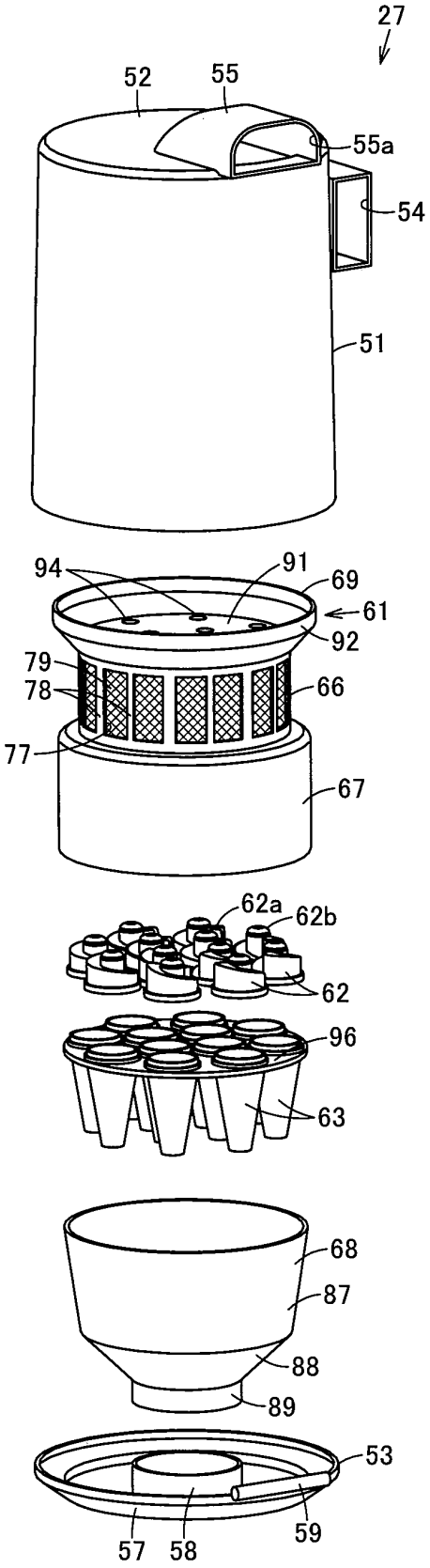
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FIG. 4

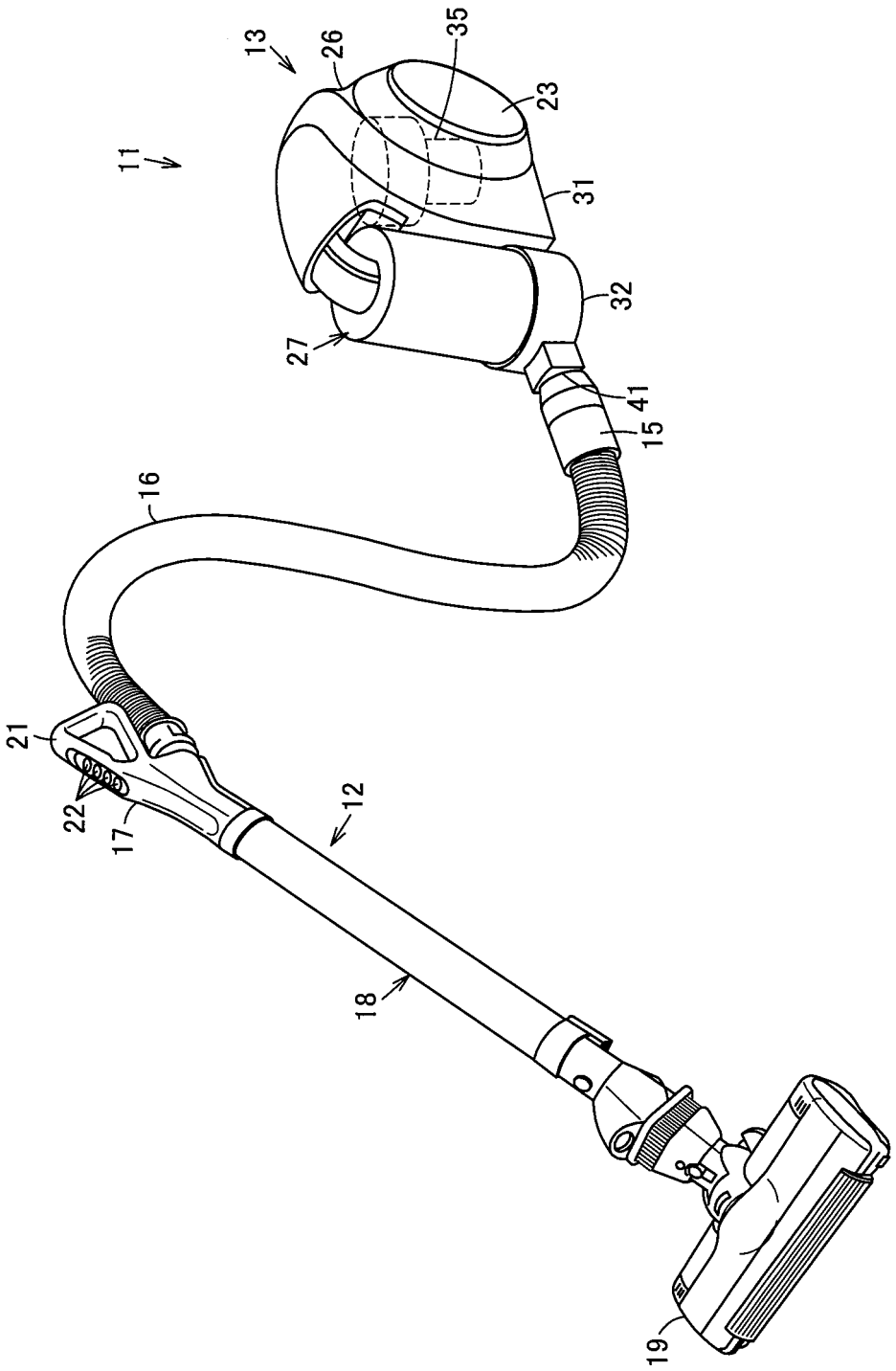

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/078499

A. CLASSIFICATION OF SUBJECT MATTER
A47L9/16(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)
A47L9/16, 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	US 2009/0113859 A1 (SAMSUNG GWANGJU ELECTRONICS CO., LTD.), 07 May 2009 (07.05.2009), fig. 2, 5 & GB 2454292 A & KR 10-2009-0046659 A & AU 2008203311 A	1-3
A	JP 2010-115513 A (Sanyo Electric Co., Ltd.), 27 May 2010 (27.05.2010), fig. 6 (Family: none)	1-3

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 November 2016 (01.11.16)	22 November 2016 (22.11.16)
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)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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