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

(11) **EP 2 540 206 A1**

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

(43) Date of publication:
02.01.2013 Bulletin 2013/01

(21) Application number: **11747518.6**

(22) Date of filing: **25.02.2011**

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

(86) International application number:
PCT/JP2011/054334

(87) International publication number:
WO 2011/105562 (01.09.2011 Gazette 2011/35)

(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

(30) Priority: **26.02.2010 JP 2010043322**
26.02.2010 JP 2010043321

(71) Applicants:
- **Kabushiki Kaisha Toshiba**
  Minato-ku
  Tokyo 105-8001 (JP)
- **Toshiba Consumer Electronics Holdings Corporation**
  Tokyo 101-0021 (JP)
- **Toshiba Home Appliances Corporation**
  Tokyo 101-0021 (JP)

(72) Inventors:
- **ICHINO, Takayuki**
  Tokyo 105-8001 (JP)
- **EBE, Kiyoshi**
  Tokyo 105-8001 (JP)
- **TAKEMOTO, Ritsuo**
  Tokyo 105-8001 (JP)
- **TANAKA, Masatoshi**
  Tokyo 105-8001 (JP)
- **SUZUKI, Hitoshi**
  Tokyo 105-8001 (JP)
- **KAWAMURA, Naoko**
  Tokyo 105-8001 (JP)

(74) Representative: **O'Connell, David Christopher**
Haseltine Lake LLP
Redcliff Quay
120 Redcliff Street
GB-Bristol BS1 6HU (GB)

(54) DUST SEPARATING/DUST COLLECTING CONTAINER AND ELECTRIC CLEANER

(57) A dust collecting device and an electric vacuum cleaner capable of: performing centrifugal separation using a swirling flow generated in a cylindrical container body while accumulating centrifugally separated dust; and reliably collecting dust that have once been accumulated.

The dust collecting device comprising: a container body 33 having a closed-end cylindrical shape; a suction tube 34 that is connected to the container body 33 and generates a swirling flow along an inner periphery of the container body 33; a discharge tube 35 that is connected to the container body 33 so as to be closer to one end of the container body 33 than the suction tube 34; a partitioning wall 37 that includes a first opening 37a at substantially a center of the container body 33 and is provided between the suction tube 34 and the discharge tube 35; and a separating wall 41 that located closer to another end of the container body 33 than a connection portion of the suction tube 34, forms a gap 39 between an inner peripheral surface of the container body 33 and the separating wall 41, and includes an opening 41a on an outer side of the center of the container body 33.

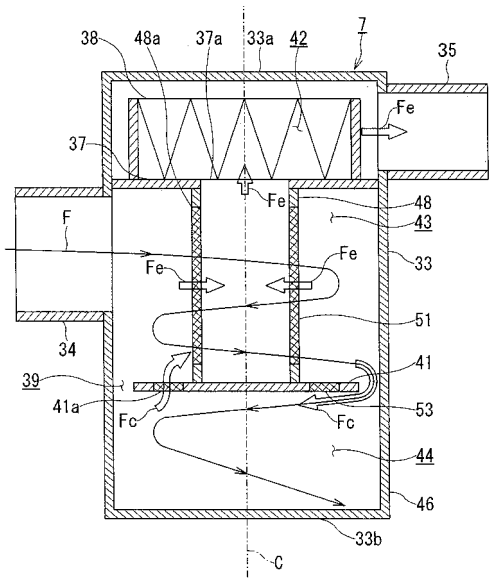

FIG. 2

EP 2 540 206 A1

Description

Technical Field

[0001] Embodiments of the present invention relate to a dust collecting device and an electric vacuum cleaner.

Background Art

[0002] Historically, there is known a centrifugal electric vacuum cleaner including: a container body having a cylindrical shap; and a suction tube that generates a swirling flow along an inner periphery of a container body. The centrifugal electric vacuum cleaner suctions dust together with air, centrifugally separates the dust from the air using the swirling flow in the container body, and accumulates the dust in the container body (see, for example, Patent Document 1). Note that the air flows to the outside of the container body from a central portion of a vortex of the swirling flow, that is, a portion in which the flow speed is relatively low.

Citation List

Patent Document

[0003]

Patent Document l: Japanese Patent Laid-Open No. 09-155239

Brief Description of the Drawings

[0004]

[Fig. 1] Fig. 1 is a perspective view illustrating an external appearance of an electric vacuum cleaner according to a first embodiment of the present invention.
[Fig. 2] Fig. 2 is a cross-sectional view schematically illustrating a dust collecting device according to the first embodiment of the present invention.
[Fig. 3] Fig. 3 is a perspective view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.
[Fig. 4] Fig. 4 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.
[Fig. 5] Fig. 5 is a cross-sectional view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.
[Fig. 6] Fig. 6 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.
[Fig. 7] Fig. 7 is a cross-sectional view schematically illustrating a dust collecting device according to a second embodiment of the present invention.
[Fig. 8] Fig. 8 is a perspective view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.
[Fig. 9] Fig. 9 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.
[Fig. 10] Fig. 10 is a cross-sectional view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.
[Fig. 11] Fig. 11 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.

Detailed Description

[0005] Embodiments of a dust collecting device and an electric vacuum cleaner according to the present invention are described with reference to the drawings.

[0006] First of all, a conventional electric vacuum cleaner, particularly, an electric vacuum cleaner including a dust collecting device does not include a member that clearly partitions a portion (space) for centrifugal separation and a portion (space) for dust accumulation, the dust collecting device performing centrifugal separation using a swirling flow in a container body having a cylindrical shape while accumulating centrifugally separated dust. For this reason, in the

conventional electric vacuum cleaner, dust that have once been accumulated in the portion (space) for dust accumulation may flow back to the portion (space) for centrifugal separation in some cases.

[0007] Further, an electric vacuum cleaner described in Patent Document 1 includes: a container body including a step; and a partitioning plate that forms a gap between the step and the partitioning plate, whereby a separating portion for centrifugal separation is separated from a dust collecting chamber for dust accumulation. The electric vacuum cleaner described in Patent Document 1 however includes a ventilation hole for allowing air that has once flown into the dust collecting chamber to flow back to the separating portion. This flow of air passing through the ventilation hole unfavorably causes granulated low-mass fine dust to flow from the dust collecting chamber back to the separating portion. Further, this flow of air linearly moves from the dust collecting chamber back to the separating portion in a central portion of the dust collecting chamber in which the flow speed of a swirling flow is lower (that is, a central portion of a vortex of the swirling flow), and moves out of the container body. Hence, this flow of air easily carries the fine dust from the dust collecting chamber to the separating portion.

[0008] As described above, the conventional electric vacuum cleaner has a problem that dust flow from the dust collecting chamber back to the separating portion and a problem that fine dust flows out of the dust collecting device due to the linear flow of air moving from the dust collecting chamber back to the separating portion.

[0009] In view of the above, the present invention proposes a dust collecting device and an electric vacuum cleaner capable of: performing centrifugal separation using a swirling flow generated in a cylindrical container body while accumulating centrifugally separated dust; and reliably collecting dust that have once been accumulated.

[0010] In order to solve the above-mentioned problems, a dust collecting device according to the embodiments of the present invention includes: a container body having a closed-end cylindrical shape; a suction tube that is connected to the container body and generates a swirling flow along an inner periphery of the container body; a discharge tube that is connected to the container body so as to be closer to one end of the container body than the suction tube; a partitioning wall that includes a first opening at substantially a center of the container body and is provided between the suction tube and the discharge tube; and a separating wall that located closer to another end of the container body than a connection portion of the suction tube, forms a gap between an inner peripheral surface of the container body and the separating wall, and includes a second opening on an outer side of the center of the container body.

[0011] Further, an electric vacuum cleaner according to the embodiments of the present invention includes: the above-mentioned dust collecting device; and a vacuum cleaner body to which the dust collecting device is detachably attached.

[First Embodiment]

[0012] A first embodiment of the dust collecting device and the electric vacuum cleaner according to the present invention is described with reference to Fig. 1 to Fig. 6.

[0013] Fig. 1 is a perspective view illustrating an external appearance of an electric vacuum cleaner according to the first embodiment of the present invention.

[0014] As illustrated in Fig. 1, an electric vacuum cleaner 1 according to the present embodiment is a so-called canister electric vacuum cleaner. The electric vacuum cleaner 1 includes: a vacuum cleaner body 2 that can run on a surface to be cleaned; and a tube portion 3 that is detachably connected to the vacuum cleaner body 2.

[0015] The vacuum cleaner body 2 includes: a main body case 5; a pair of wheels 6 that are respectively positioned at both sides of the main body case 5; a dust collecting container 7 (dust collecting device) that is detachably attached to the main body case 5; an electric blower 8 that is fluidically connected to the dust collecting container 7; a main body controller 9 that controls driving of the electric blower 8; and a power-supply cord 11 that feeds electric power to the electric blower 8.

[0016] The main body case 5 includes a main body connection port 12 that is fluidically connected to the dust collecting container 7. The main body connection port 12 is a fluidic entrance of the vacuum cleaner body 2.

[0017] The wheels 6 are large-diameter running wheels for running of the vacuum cleaner body 2.

[0018] The dust collecting container 7 separates and collects dust from air containing the dust (dust-containing air) suctioned by the electric vacuum cleaner 1, with the use of a negative pressure generated by the electric blower 8.

[0019] The main body controller 9 includes a plurality of preset working modes. The main body controller 9 alternatively selects a given working mode from the plurality of working modes such that the given working mode corresponds to an operation signal read from the tube portion 3, to thereby cause the electric blower 8 to work. Each working mode holds a different input power (an input power of the electric blower 8) in association with an operation signal read from the tube portion 3.

[0020] The power-supply cord 11 includes a power-supply plug 14 at its free end portion.

[0021] The tube portion 3 suctions the dust-containing air from the surface to be cleaned with the use of the negative pressure that is applied from the vacuum cleaner body 2 during working of the electric blower 8, and guides the dust-containing air to the vacuum cleaner main body 2. The tube portion 3 includes: a connection tube 19 that serves as a joint detachably connected to the main body connection port 12 of the vacuum cleaner body 2; a dust collecting hose

21 connected to the connection tube 19; a hand-side operation tube 22 connected to the dust collecting hose 21; a grip portion 23 that protrudes from the hand-side operation tube 22; an operation portion 24 provided in the grip portion 23; an extension tube 25 detachably connected to the hand-side operation tube 22; and a suction port body 26 detachably connected to the extension tube 25.

[0022] The dust collecting hose 21 is a flexible elongated hose having a substantially cylindrical shape. One end portion (back end portion) of the dust collecting hose 21 is fluidically connected to the connection tube 19. The dust collecting hose 21 is fluidically connected to the inside of the vacuum cleaner body 2 through the connection tube 19.

[0023] One end portion (back end portion) of the hand-side operation tube 22 is connected to another end portion of the dust collecting hose 21. The hand-side operation tube 22 is fluidically connected to the inside of the vacuum cleaner body 2 through the connection tube 19 and the dust collecting hose 21.

[0024] The grip portion 23 is gripped by a user of the electric vacuum cleaner 1 to operate the electric vacuum cleaner 1. The grip portion 23 protrudes from another end portion of the hand-side operation tube 22 to bend toward the one end portion of the hand-side operation tube 22.

[0025] The operation portion 24 includes switches respectively corresponding to the working modes. Specifically, the operation portion 24 includes: a stop switch 24a that receives a working stop operation of the electric blower 8; and a start switch 24b that receives a working start operation of the electric blower 8. The start switch 24b may separately include a weak working switch (omitted from the drawings), a middle working switch (omitted from the drawings), and a strong working switch (omitted from the drawings). The user of the electric vacuum cleaner 1 can operate the operation portion 24 to alternatively select one of the working modes of the electric blower 8.

[0026] The extension tube 25 is an extensible elongated tube having a substantially cylindrical shape. The extension tube 25 has a telescopic structure in which a plurality of tubular bodies is put on each other. One end portion (back end portion) of the extension tube 25 is detachably connected to another end portion of the hand-side operation tube 22. The extension tube 25 is fluidically connected to the inside of the vacuum cleaner body 2 through the connection tube 19, the hand-side operation tube 22, and the dust collecting hose 21.

[0027] The suction port body 26 is detachably connected to another end portion of the extension tube 25. The suction port body 26 has a structure that can run on the surface to be cleaned such as a wooden floor or a carpet, and includes a suction port 28 on its bottom surface that is opposed to the surface to be cleaned in a running state. The suction port body 26 further includes: a rotary cleaner 29 that is rotatably positioned at the suction port 28; and an electric motor 31 that rotationally drives the rotary cleaner 29. The suction port body 26 is fluidically connected to the inside of the vacuum cleaner body 2 through the extension tube 25, the hand-side operation tube 22, and the dust collecting hose 21.

[0028] When the start switch 24b receives a working start operation, the electric vacuum cleaner 1 causes the electric blower 8 to work, and thus generates a negative pressure (suctioning negative pressure) inside of the vacuum cleaner body 2. This negative pressure is applied from the main body connection port 12 to the suction port 28 of the suction port body 26 through the dust collecting hose 21, the hand-side operation tube 22, and the extension tube 25. With the use of the negative pressure applied to the suction port 28, the electric vacuum cleaner 1 suctions dust accumulating on the surface to be cleaned together with air from the suction port 28, to thereby clean the surface to be cleaned. The electric vacuum cleaner 1 sends the dust-containing air suctioned from the suction port 28 into the dust collecting container 7, causes the dust collecting container 7 to centrifugally separate the dust from the air, and collects the separated dust. Meanwhile, the air passes through the dust collecting container 7, and flows to the outside of the vacuum cleaner body 2 through the electric blower 8.

[0029] Fig. 2 is a cross-sectional view schematically illustrating the dust collecting device according to the first embodiment of the present invention.

[0030] As illustrated in Fig. 2, the dust collecting container 7 (dust collecting device) according to the present embodiment includes: a container body 33 having a closed-end cylindrical shape; a suction tube 34 that is connected to the container body 33 and generates a swirling flow F (in Fig. 2, a solid arrow F) along an inner periphery of the container body 33; a discharge tube 35 that is connected to the container body 33 so as to be closer to one end 33a of the container body 33 than the suction tube 34; a partitioning wall 37 that includes an opening 37a (first opening) at substantially the center of the container body 33 and is provided between the suction tube 34 and the discharge tube 35; a pleated filtering portion 38 that is positioned in a flow path between the opening 37a of the partitioning wall 37 and the discharge tube 35; and a separating wall 41 that is closer to another end 33b of the container body 33 than a connection portion of the suction tube 34, forms a gap 39 between an inner peripheral surface of the container body 33 and the separating wall 41, and includes an opening 41a (second opening) on an outer side of the center of the container body 33.

[0031] Note that the dust collecting container 7 may be coupled to the vacuum cleaner body 2 such that a central line C of the container body 33 having a cylindrical shape is set in a vertical direction, and may be coupled to the vacuum cleaner body 2 such that the central line C is set in a horizontal direction. Alternatively, the central line C may be set at a given other angle.

[0032] The container body 33 includes: an exhaust air path 42 provided between the partitioning wall 37 and an end surface on the one end 33a side; a separating portion 43 provided between the partitioning wall 37 and the separating

wall 41; and a dust collecting chamber 44 (first space) provided between the separating wall 41 and an end surface on the another end 33b side. The another end 33b of the container body 33 includes an openable/closable cover 46, whereby dust accumulated by the dust collecting chamber 44 can be discharged to the outside of the container body 33.

[0033] The suction tube 34 has a flow path that fluidically connects the main body connection port 12 of the vacuum cleaner body 2 to the separating portion 43 of the container body 33 and is inclined to the central line C of the container body 33 (the center of the container body 33). This flow path generates a flow moving in the container body 33 along the inner peripheral surface thereof. That is, when a negative pressure is applied to the inside of the container body 33 during working of the electric blower 8, the suction tube 34 makes the swirling flow F in dust-containing air that flows from the tube portion 3 into the container body 33 through the suction tube 34.

[0034] The discharge tube 35 fluidically connects the separating portion 43 of the container body 33 to a suction port (omitted from the drawings) of the electric blower 8.

[0035] Note that the suction tube 34 and the discharge tube 35 may be formed integrally with the container body 33.

[0036] The partitioning wall 37 partitions the separating portion 43 and the exhaust air path 42 so as to prevent dust-containing air that flows into the separating portion 43 from flowing directly into the exhaust air path 42. The partitioning wall 37 is held by the container body 33. The opening 37a is positioned in the vicinity of the central line C of the container body 33.

[0037] Further, the partitioning wall 37 includes an inner tube 48 that extends in the central line C direction of the container body 33. The inner tube 48 extends from the partitioning wall 37 to the separating wall 41 in the container body 33 and holds the separating wall 41. The inner tube 48 includes an opening 48a (first opening) that is fluidically connected to the opening 37a through an internal space of the inner tube 48. A mesh filtering member 51 (third filtering portion) closes the opening 48a, and filters air that passes through the opening 48a. The filtering member 51 prevents dust from flowing from the separating portion 43 into the exhaust air path 42, when the swirling flow F in the separating portion 43 does not sufficiently develop yet, for example, in a period immediately after working start of the electric blower 8 or shortly after working stop thereof (hereinafter, simply referred to as "transition period of the swirling flow F").

[0038] The pleated filtering portion 38 is provided in the exhaust air path 42, captures particulate fine dust that is small enough to pass through the filtering member 51, and prevents the electric blower 8 from suctioning the fine dust.

[0039] The gap 39 and the opening 41a fluidically connects the separating portion 43 to the dust collecting chamber 44. The gap 39 extends over the entire circumference of inner periphery of the container body 33.

[0040] The opening 41a is provided so as to be closer to the center of the container body 33 than the gap 39 and to be on an outer side of a projected area of the opening 37a onto the separating wall 41. A filtering member 53 (filtering portion) closes the opening 41a, and filters air that passes through the opening 41a. The filtering member 53 may be coarse as long as fibrous dust such as yarn waste and lint that have flown into the dust collecting chamber 44 do not return to the separating portion 43 through the filtering member 53. The filtering member 53 is provided on a surface of the separating wall 41, the surface facing the another end 33b of the container body 33 (that is, the dust collecting chamber 44).

[0041] Note that the opening 41 a may be an opening group formed of a plurality of openings that are provided at regular intervals and concentric with respect to the center of the container body 33. In this case, the filtering member 53 does not need to be provided, if an opening diameter of each opening is set to an appropriate value (for example, a diameter of 5 mm or less) that is small enough to block the fibrous dust such as yarn waste and lint that have flown into the dust collecting chamber 44 from returning to the separating portion 43.

[0042] Note that the gap 39 and the opening 41a do not necessarily need to be provided over the entire circumference of periphery around the center of the container body 33. Specifically, the gap 39 may be provided in an arc-like shape along the inner periphery of the container body 33. The opening 41a may be formed in an arc-like shape around the central line C of the container body 33. At this time, it is desirable that positions of the gap 39 and the opening 41a be different from each other.

[0043] In the dust collecting container 7 configured as described above, when the electric blower 8 starts to work, a negative pressure is applied to the exhaust air path 42 through the discharge tube 35. The negative pressure in the exhaust air path 42 is applied to the separating portion 43 through the opening 37a. Further, the negative pressure in the separating portion 43 is applied to the tube portion 3 through the suction tube 34. Consequently, the tube portion 3 suctions dust and dirt on a surface to be cleaned together with air. The dust-containing air suctioned by the tube portion 3 traces back through the tube portion 3 to flow into the dust collecting container 7.

[0044] The dust-containing air that has flown into the dust collecting container 7 is caused by the suction tube 34 to flow into the separating portion 43 toward the inner peripheral surface of the container body 33, and generates the swirling flow F. The swirling flow F centrifugally separates the dust-containing air into: air; and dust. The separated dust have specific gravity extremely larger than that of the air, and thus swirl along the inner peripheral surface of the container body 33. Meanwhile, a part of the separated air passes through the opening 48a positioned in the vicinity of the center of a vortex of the swirling flow F, and further passes through the internal space of the inner tube 48 and the opening 37a to reach the exhaust air path 42 (in Fig. 2, a solid arrow Fe). The other part of the separated air and the separated dust

pass through the gap 39 to flow into the dust collecting chamber 44 while swirling along the inner peripheral surface of the container body 33.

[0045] In the dust collecting chamber 44, the flow speed is lower and the pressure thus recovers more toward the central line C of the container body 33, which is the center of the swirling flow F, and hence the air that has flown into the dust collecting chamber 44 passes through the opening 41a of the separating wall 41 to return to the separating portion 43. Meanwhile, fibrous dust contained in the dust gather together while swirling in the separating portion 43 and the dust collecting chamber 44, and cannot pass through the opening 41a or the filtering member 53 anymore to be captured therearound.

[0046] A part of the air that has returned to the separating portion 43 through the opening 41a is caught in the swirling flow F to generate a circulating flow Fc that flows into the dust collecting chamber 44 again. The circulating flow Fc gradually presses together the fibrous dust captured by the opening 41a of the separating wall 41 or the filtering member 53 to increase a density of the fibrous dust. Further, the air that has returned to the separating portion 43 through the opening 41a contains particulate fine dust that is small enough to pass through the opening 41a and the filtering member 53, and the circulating flow Fc causes the fine dust to flow into the dust collecting chamber 44 again. The fine dust that has flown into the dust collecting chamber 44 again is captured by the fibrous dust that have been pressed together against the opening 41 a of the separating wall 41 or the filtering member 53 to have an increased density.

[0047] Note that the circulating flow Fc described above does not refer to only a flow in which the same air always circulates, but refers to a flow of air moving between the dust collecting chamber 44 and the separating portion 43 while being replaced with a part of air that continuously flows into the separating portion 43.

[0048] Next, another example of the dust collecting container 7 of the electric vacuum cleaner 1 is described.

[0049] Fig. 3 is a perspective view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.

[0050] Fig. 4 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.

[0051] Fig. 5 is a cross-sectional view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.

[0052] In a dust collecting container 7A of the electric vacuum cleaner 1 illustrated in Fig. 3 to Fig. 5, the same components as those of the dust collecting container 7 are denoted by the same symbols, and overlapping description is omitted.

[0053] As illustrated in Fig. 3 to Fig. 5, the dust collecting container 7A (dust collecting device) according to the present embodiment includes a separating wall 41A having a thickness that separates the dust collecting chamber 44 (first space) on the another end 33b side of a container body 33A from the separating portion 43 (second space) to which the suction tube 34 is connected. The dust collecting container 7A further includes a protruding portion 55 that is provided at substantially the center of a surface of the separating wall 41A, the surface facing the another end 33b of the container body 33A.

[0054] The separating wall 41A has not a mere plate-like shape but a disc-like shape with a thickness formed by a rib 56 that extends in the central line C direction of the container body 33A, and the separating wall 41A forms a gap 39A that separates the separating portion 43 from the dust collecting chamber 44. The separating wall 41A with the thickness separates the dust collecting chamber 44 from the separating portion 43 by means of the gap 39A, and can prevent a back-flow of the swirling flow F from reaching the separating portion 43 from the dust collecting chamber 44.

[0055] Further, the container body 33A includes a step portion 57 that is formed by increasing, in a discontinuous manner, a diameter of a portion of the container body 33A on the another end 33b side from the vicinity of the separating wall 41A. The step portion 57 prevents a back-flow of the swirling flow F that reaches the gap 39A from reaching the separating portion 43.

[0056] The protruding portion 55 is positioned at a central portion of fibrous dust collected by the filtering member 53, and guides an accumulation direction of the dust toward the another end 33b of the container body 33A. The protruding portion 55 extends from the separating wall 41A so as to reach the cover 46 of the container body 33A.

[0057] Further, the protruding portion 55 has a hollow conical trapezoidal shape, the diameter of which is smaller toward the cover 46. The protruding portion 55 includes an opening 55a on its side surface, the opening 55a fluidically connecting the dust collecting chamber 44 to the separating portion 43. Note that an inner tube cover 58 partitions an internal space of the protruding portion 55 and the internal space of the inner tube 48, and blocks fluidic connection between the two spaces. By means of a flow of air that passes through the opening 55a and then the internal space of the protruding portion 55 to reach the separating portion 43, the protruding portion 55 gathers together dust in the dust collecting chamber 44 to the center of the dust collecting chamber 44. By means of the flow of air that passes through the opening 55a and the flow of air that passes through the opening 41a, the protruding portion 55 more remarkably produces an effect of guiding the accumulation direction of dust. A filtering member 61 (second filtering portion) closes the opening 55a, and filters the air that passes through the opening 55a.

[0058] Note that the opening 55a may be an opening group formed of a plurality of small openings. In this case, the

filtering member 61 does not need to be provided, if an opening diameter of each small opening is set to an appropriate value (for example, a diameter of 5 mm or less) that is small enough to block the fibrous dust such as yarn waste and lint that have flown into the dust collecting chamber 44 from returning to the separating portion 43.

[0059] Fig. 6 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the first embodiment of the present invention.

[0060] In a dust collecting container 7B of the electric vacuum cleaner 1 illustrated in Fig. 6, the same components as those of the dust collecting container 7A are denoted by the same symbols, and overlapping description is omitted.

[0061] As illustrated in Fig. 6, the dust collecting container 7B (dust collecting device) according to the present embodiment includes a dust capturing wall 62 that extends in a radial direction of the container body 33A from a side surface of a protruding portion 55B. The dust capturing wall 62 extends over a height of the protruding portion 55B having a conical trapezoidal shape. The dust capturing wall 62 makes a region in which the flow speed is lower around the protruding portion 55B inside of the dust collecting chamber 44. Note that a plurality of the dust capturing walls 62 may be radially provided on the side surface of the protruding portion 55B.

[0062] In the dust collecting containers 7, 7A, and 7B configured as described above according to the present embodiment, the separating wall 41, 41A is provided between the separating portion 43 for dust centrifugal separation and the dust collecting chamber 44 for dust accumulation, and air in the dust collecting chamber 44 is caused to flow back into the separating portion 43 through the opening 41a of the separating wall 41, 41A or the filtering member 53. Accordingly, dust can be prevented from flowing from the dust collecting chamber 44 back into the separating portion 43.

[0063] In addition, in the dust collecting containers 7, 7A, and 7B according to the present embodiment, fine dust that passes through the opening 41a or the filtering member 53 to flow from the dust collecting chamber 44 back into the separating portion 43 can be returned again to the dust collecting chamber 44 by the circulating flow Fc. Meanwhile, in the dust collecting containers 7, 7A, and 7B according to the present embodiment, fibrous dust can be pressed together against the separating wall 41, 41A by the flow of air that passes through the opening 41a or the filtering member 53. Then, in the dust collecting containers 7, 7A, and 7B according to the present embodiment, the fine dust that is returned again to the dust collecting chamber 44 by the circulating flow Fc can be captured by the fibrous dust that have been pressed together against the separating wall 41, 41A to have an increased density, so that the fine dust that can pass through the opening 41a or the filtering member 53 can be captured in the dust collecting chamber 44.

[0064] Further, in the dust collecting containers 7, 7A, and 7B according to the present embodiment, the air that returns to the separating portion 43 through the opening 41a is caused by the circulating flow Fc to flow into the dust collecting chamber 44 again. Accordingly, this air is prevented from linearly flowing from the dust collecting chamber 44 to the separating portion 43 in the central portion of the container body 33, 33A in which the flow speed is lower, that is, fine dust is prevented from linearly flowing out from the dust collecting chamber 44 to the separating portion 43.

[0065] Still further, in the dust collecting containers 7A and 7B according to the present embodiment, a larger amount of fibrous dust can be captured and pressed together around the opening 41a and the opening 55a. In the dust collecting containers 7A and 7B, such a larger amount of fibrous dust are pressed together around the opening 41a and the opening 55a to have an increased density, whereby a still larger amount of fine dust can be captured.

[0066] Moreover, in the dust collecting containers 7A and 7B, dust are pressed together into a doughnut-like shape around the protruding portion 55. Accordingly, when the dust is discharged from the dust collecting chamber 44, if the cover 46 of the container body 33A is opened, a doughnut-like mass of the dust can be taken out of the protruding portion 55 to be easily discharged.

[0067] Further, in the dust collecting container 7B according to the present embodiment, the flow speed around the protruding portion 55B is reduced by the dust capturing wall 62, and accumulation of fibrous dust is promoted, so that a further larger amount of fibrous dust can be captured to be pressed together. In the dust collecting container 7B, because the amount of the fibrous dust pressed together is larger, an extremely larger amount of fine dust contained in the circulating flow Fc can be captured.

[Second Embodiment]

[0068] A second embodiment of the electric vacuum cleaner and the dust collecting device according to the present invention is described with reference to Fig. 7 to Fig. 11.

[0069] Fig. 7 is a cross-sectional view schematically illustrating a dust collecting device according to the second embodiment of the present invention.

[0070] In a dust collecting container 7C according to the present embodiment, the same components as those of the dust collecting container 7 according to the first embodiment are denoted by the same symbols, and overlapping description is omitted.

[0071] As illustrated in Fig. 7, the dust collecting container 7C (dust collecting device) according to the present embodiment includes: the container body 33 having a closed-end cylindrical shape; the suction tube 34 that is connected to the container body 33 and generates a swirling flow F (in Fig. 7, a solid arrow F) along an inner periphery of the

container body 33; the discharge tube 35 that is connected to the container body 33 so as to be closer to one end 33a of the container body 33 than the suction tube 34; the partitioning wall 37 that includes the opening 37a (first opening) at substantially the center of the container body 33 and is provided between the suction tube 34 and the discharge tube 35; the pleated filtering portion 38 that is positioned in a flow path between the opening 37a of the partitioning wall 37 and the discharge tube 35; and a separating wall 41C that is closer to another end 33b of the container body 33 than a connection portion of the suction tube 34, forms the gap 39 between an inner peripheral surface of the container body 33 and the separating wall 41C, and includes an opening 41b (second opening) on an outer side of the center of the container body 33.

[0072] Note that the dust collecting container 7C may be coupled to the vacuum cleaner body 2 such that a central line C of the container body 33 having a cylindrical shape is set in a vertical direction, and may be coupled to the vacuum cleaner body 2 such that the central line C is set in a horizontal direction. Alternatively, the central line C may be set at a given other angle.

[0073] The container body 33 includes: the exhaust air path 42 provided between the partitioning wall 37 and an end surface on the one end 33a side; the separating portion 43 provided between the partitioning wall 37 and the separating wall 41C; and the dust collecting chamber 44 (first space) provided between the separating wall 41C and an end surface on the another end 33b side.

[0074] The partitioning wall 37 includes the inner tube 48 that extends in the central line C direction of the container body 33. The inner tube 48 extends from the partitioning wall 37 to the separating wall 41C in the container body 33 and holds the separating wall 41C.

[0075] The opening 41b is provided so as to be closer to the center of the container body 33 than the gap 39, and fluidically connects the gap 39 between the container body 33 and the separating wall 41C to the dust collecting chamber 44. The filtering member 53 (filtering portion) closes the opening 41b, and filters air that passes through the opening 41b.

[0076] Note that the opening 41b may be an opening group formed of a plurality of openings that are provided at regular intervals and concentric with respect to the center of the container body 33. In this case, the filtering member 53 does not need to be provided, if an opening diameter of each opening is set to an appropriate value (for example, a diameter of 5 mm or less) that is small enough to block the fibrous dust such as yarn waste and lint that have flown into the dust collecting chamber 44 from returning to the separating portion 43.

[0077] The gap 39 and the opening 41b do not necessarily need to be provided over the entire circumference of periphery around the center of the container body 33. Specifically, the gap 39 may be provided in an arc-like shape along the inner periphery of the container body 33. The opening 41b may be formed in an arc-like shape around the central line C of the container body 33.

[0078] In the dust collecting container 7C configured as described above, when the electric blower 8 starts to work, a negative pressure is applied to the exhaust air path 42 through the discharge tube 35. The negative pressure in the exhaust air path 42 is applied to the separating portion 43 through the opening 37a. Further, the negative pressure in the separating portion 43 is applied to the tube portion 3 through the suction tube 34. Consequently, the tube portion 3 suctions dust and dirt on a surface to be cleaned together with air. The dust-containing air suctioned by the tube portion 3 traces back through the tube portion 3 to flow into the dust collecting container 7C.

[0079] The dust-containing air that has flown into the dust collecting container 7C is caused by the suction tube 34 to flow into the separating portion 43 toward the inner peripheral surface of the container body 33, and generates the swirling flow F. The swirling flow F centrifugally separates the dust-containing air into: air; and dust. The separated dust and dirt have specific gravity extremely larger than that of the air, and thus swirl along the inner peripheral surface of the container body 33. Meanwhile, a part of the separated air passes through the opening 48a positioned in the vicinity of the center of a vortex of the swirling flow F, and further passes through the internal space of the inner tube 48 and the opening 37a to reach the exhaust air path 42 (in Fig. 7, a solid arrow Fe). The other part of the separated air and the separated dust pass through the gap 39 to flow into the dust collecting chamber 44 while swirling along the inner peripheral surface of the container body 33.

[0080] In the dust collecting chamber 44, the flow speed is lower and the pressure thus recovers more toward the central line C of the container body 33, which is the center of the swirling flow F, and hence the air in the dust collecting chamber 44 passes through the opening 41b of the separating wall 41C to blow into the gap 39 between the container body 33 and the separating wall 41C. Meanwhile, fibrous dust and dirt contained in the dust gather together while swirling in the separating portion 43 and the dust collecting chamber 44, and cannot pass through the opening 41b or the filtering member 53 anymore to be captured therearound.

[0081] A part of the air that has blown into the gap 39 through the opening 41b is caught in the swirling flow F to generate a circulating flow Fc that flows into the dust collecting chamber 44 again. The circulating flow Fc gradually presses together the fibrous dust captured by the opening 41b of the separating wall 41C or the filtering member 53 to increase a density of the fibrous dust. Further, the air that has blown into the gap 39 through the opening 41b contains particulate fine dust that is small enough to pass through the opening 41b and the filtering member 53, and the circulating flow Fc causes the fine dust to flow into the dust collecting chamber 44 from the gap 39 again. The fine dust that has

flown into the dust collecting chamber 44 again is captured by the fibrous dust and dirt that have been pressed together against the opening 41b of the separating wall 41C or the filtering member 53 to have an increased density.

[0082] Next, another example of the dust collecting container 7C of the electric vacuum cleaner 1 is described.

[0083] Fig. 8 is a perspective view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.

[0084] Fig. 9 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.

[0085] Fig. 10 is a cross-sectional view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.

[0086] In a dust collecting container 7D of the electric vacuum cleaner 1 illustrated in Fig. 8 to Fig. 10, the same components as those of the dust collecting container 7C are denoted by the same symbols, and overlapping description is omitted.

[0087] As illustrated in Fig. 8 to Fig. 10, the dust collecting container 7D (dust collecting device) according to the present embodiment includes a separating wall 41D having a thickness that separates the dust collecting chamber 44 (first space) on the another end 33b side of a container body 33A from the separating portion 43 (second space) to which the suction tube 34 is connected. The dust collecting container 7D further includes the protruding portion 55 that is provided at substantially the center of a surface of the separating wall 41D, the surface facing the another end 33b of the container body 33A.

[0088] The separating wall 41D has not a mere plate-like shape but a disc-like shape with a thickness formed by a side surface 41 d that extends in the central line C direction of the container body 33A, and the separating wall 41D forms the gap 39A that separates the separating portion 43 from the dust collecting chamber 44. The opening 41b of the separating wall 41D is fluidically connected to the gap 39A through an internal space of the separating wall 41D and an opening 41c. The opening 41c is positioned in the side surface 41d. The side surface 41d is opposed to an inner peripheral surface of the container body 33A.

[0089] Further, the container body 33A includes the step portion 57 that is formed by increasing, in a discontinuous manner, a diameter of a portion of the container body 33A on the another end 33b side from the vicinity of the separating wall 41D.

[0090] In the dust collecting container 7D, the thickness of the separating wall 41D that separates the separating portion 43 from the dust collecting chamber 44 and the step portion 57 prevent a back-flow of the swirling flow F that reaches the gap 39A from reaching the separating portion 43.

[0091] The protruding portion 55 extends from the separating wall 41D so as to reach the cover 46 of the container body 33A.

[0092] The protruding portion 55 includes the opening 55a on its side surface, the opening 55a fluidically connecting the dust collecting chamber 44 to the gap 39A through the internal space of the separating wall 41D and the opening 41c. By means of a flow of air that passes through the opening 55a and then the internal space of the protruding portion 55 and the internal space of the separating wall 41D to reach the gap 39A, the protruding portion 55 gathers together dust and dirt in the dust collecting chamber 44 toward the center of the dust collecting chamber 44. By means of the flow of air that passes through the opening 55a and the flow of air that passes through the opening 41b, the protruding portion 55 more remarkably produces an effect of guiding the accumulation direction of dust. A filtering member 61 (second filtering portion) closes the opening 55a, and filters the air that passes through the opening 55a.

[0093] Fig. 11 is a perspective cross-sectional view illustrating the other example of the dust collecting device according to the second embodiment of the present invention.

[0094] In a dust collecting container 7E of the electric vacuum cleaner 1 illustrated in Fig. 11, the same components as those of the dust collecting container 7D are denoted by the same symbols, and overlapping description is omitted.

[0095] As illustrated in Fig. 11, the dust collecting container 7E (dust collecting device) according to the present embodiment includes the dust capturing wall 62 that extends in a radial direction of the container body 33A from a side surface of a protruding portion 55B.

[0096] In the dust collecting containers 7C, 7D, and 7E configured as described above according to the present embodiment, the separating wall 41C, 41D is provided between the separating portion 43 for dust centrifugal separation and the dust collecting chamber 44 for dust accumulation, and air in the dust collecting chamber 44 is discharged to the gap 39, 39A between the container body 33, 33A and the separating wall 41C, 41D through the opening 41b of the separating wall 41C, 41D or the filtering member 53. Accordingly, dust can be prevented from flowing from the dust collecting chamber 44 back into the separating portion 43.

[0097] In addition, in the dust collecting containers 7C, 7D, and 7E according to the present embodiment, fine dust that passes through the opening 41b or the filtering member 53 to flow from the dust collecting chamber 44 into the gap 39, 39A can be returned again to the dust collecting chamber 44 by the circulating flow Fc. Meanwhile, in the dust collecting containers 7C, 7D, and 7E according to the present embodiment, fibrous dust can be pressed together against the separating wall 41C, 41D by the flow of air that passes through the opening 41b or the filtering member 53. Then,

in the dust collecting containers 7C, 7D, and 7E according to the present embodiment, the fine dust that is returned again to the dust collecting chamber 44 by the circulating flow Fc can be captured by the fibrous dust that have been pressed together against the separating wall 4 1C, 41 D to have an increased density, so that the fine dust that can pass through the opening 41b or the filtering member 53 can be captured in the dust collecting chamber 44.

[0098] Further, in the dust collecting containers 7C, 7D, and 7E according to the present embodiment, the air that flows into the gap 39, 39A through the opening 41b is caused by the circulating flow Fc to flow into the dust collecting chamber 44 again. Accordingly, this air is prevented from linearly flowing from the dust collecting chamber 44 to the separating portion 43 in the central portion of the container body 33, 33A in which the flow speed is lower, that is, fine dust is prevented from linearly flowing out from the dust collecting chamber 44 to the separating portion 43.

[0099] Still further, in the dust collecting containers 7D and 7E according to the present embodiment, a larger amount of fibrous dust can be captured and pressed together around the opening 41b and the opening 55a. In the dust collecting containers 7D and 7E, such a larger amount of fibrous dust are pressed together around the opening 41b and the opening 55a to have an increased density, whereby a still larger amount of fine dust can be captured.

[0100] Moreover, in the dust collecting containers 7D and 7E, dust and dirt are pressed together into a doughnut-like shape around the protruding portion 55. Accordingly, when the dust is discharged from the dust collecting chamber 44, if the cover 46 of the container body 33A is opened, a doughnut-like mass of the dust and dirt can be taken out of the protruding portion 55 to be easily discharged.

[0101] Further, in the dust collecting container 7E according to the present embodiment, the flow speed around the protruding portion 55B is reduced by the dust capturing wall 62, and accumulation of fibrous dust is promoted, so that a further larger amount of fibrous dust can be captured to be pressed together. In the dust collecting container 7E, because the amount of the fibrous dust pressed together is larger, an extremely larger amount of fine dust contained in the circulating flow Fc can be captured.

[0102] Accordingly, the electric vacuum cleaner 1 and the dust collecting containers 7C, 7D, and 7E according to the present embodiment are capable of: performing centrifugal separation using the swirling flow F generated in the cylindrical container body 33, 33A while accumulating centrifugally separated dust and dirt; and reliably collecting dust that have once been accumulated.

[0103] Accordingly, the electric vacuum cleaner 1 and the dust collecting containers 7, 7A, 7B, 7C, 7D, and 7E according to the present embodiment are capable of: performing centrifugal separation using the swirling flow F generated in the cylindrical container body 33, 33A while accumulating centrifugally separated dust and dirt; and reliably collecting dust that have once been accumulated.

[0104] Note that the electric vacuum cleaner according to the present invention is not limited to the canister electric vacuum cleaner 1, and may be an upright, stick-type, or handy electric vacuum cleaner.

[0105] 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 invention. Indeed, the novel apparatuses and units described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the apparatuses and units described herein may be made without departing from the spirit of the invention. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

Description of Symbols

[0106]

1	electric vacuum cleaner
2	vacuum cleaner body
3	tube portion
5	main body case
6	pair of wheels
7, 7A, 7B, 7C, 7D, and 7E	dust collecting container
8	electric blower
9	main body controller

11	power-supply cord
12	main body connection port
14	power-supply plug
19	connection tube
21	dust collecting hose
22	hand-side operation tube
23	grip portion
24	operation portion
24a	stop switch
24b	start switch
25	extension tube
26	suction port body
28	suction port
29	rotary cleaner
31	electric motor
33, and 33A	container body
33a	one end
33b	another end
34	suction tube
35	discharge tube
37	partitioning wall
37a	opening
38	pleated filtering portion
39, and 39A	gap
41, 41A, 41B, 41C and 41D	separating wall
41a, 41b, and 41c	opening
41d	side surface
42	exhaust air path
43	separating portion

44	dust collecting chamber
46	cover
48	inner tube
48a	opening
51	mesh filtering member
53	filtering member
55, and 55B	protruding portion
55a	opening
56	rib
57	step portion
58	inner tube cover
61	filtering member
62	dust capturing wall

Claims

1. A dust collecting device comprising:

a container body having a closed-end cylindrical shape;
a suction tube that is connected to the container body and generates a swirling flow along an inner periphery of the container body;
a discharge tube that is connected to the container body so as to be closer to one end of the container body than the suction tube;
a partitioning wall that includes a first opening at substantially a center of the container body and is provided between the suction tube and the discharge tube; and
a separating wall that located closer to another end of the container body than a connection portion of the suction tube, forms a gap between an inner peripheral surface of the container body and the separating wall, and includes a second opening on an outer side of the center of the container body.

2. The dust collecting device according to claim 1, wherein
the second opening fluidically connects a first space on the another end side of the container body to a second space to which the suction tube is connected.

3. The dust collecting device according to claim 1, wherein
the second opening fluidically connects the gap between the container body and the separating wall to a first space on the another end side of the container body.

4. The dust collecting device according to any one of claims 1 to 3, further comprising a filtering portion that closes the second opening.

5. The dust collecting device according to claim 4, wherein
the filtering portion is provided on a surface of the separating wall, the surface facing the another end of the container body.

6. The dust collecting device according to any one of claims 1 to 5, wherein

the separating wall has a thickness that separates the first space on the another end side of the container body from the second space to which the suction tube is connected.

7. The dust collecting device according to any one of claims 1 to 6, wherein
the gap extends over the entire circumference of inner periphery of the container body.

8. The dust collecting device according to any one of claims 1 to 7, wherein
the second opening is formed of a plurality of openings that are provided at regular intervals and concentric with respect to the center of the container body.

9. The dust collecting device according to any one of claims 1 to 7, further comprising a protruding portion that is provided at substantially a center of a surface of the separating wall, the surface facing the another end of the container body.

10. The dust collecting device according to any one of claims 1 to 9, wherein
the protruding portion includes a third opening that fluidically connects the first space on the another end side of the container body to the second space to which the suction tube is connected.

11. The dust collecting device according to any one of claims 1 to 9, wherein
the protruding portion includes a third opening that fluidically connects the gap between the container body and the separating wall to the first space to which the suction tube is connected.

12. The dust collecting device according to claim 10 or 11, further comprising a second filtering portion that closes the third opening.

13. The dust collecting device according to any one of claims 8 to 12, further comprising a dust capturing wall that extends in a radial direction of the container body from a side surface of the protruding portion.

14. The dust collecting device according to any one of claims 1 to 13, wherein
the container body includes a step portion that is formed by increasing, in a discontinuous manner, a diameter of a portion of the container body on the another end side from a vicinity of the separating wall.

15. The dust collecting device according to any one of claims 1 to 14, further comprising a third filtering portion that closes the first opening.

16. An electric vacuum cleaner comprising:

the dust collecting device according to any one of claims 1 to 15; and
a vacuum cleaner body to which the dust collecting device is detachably attached.

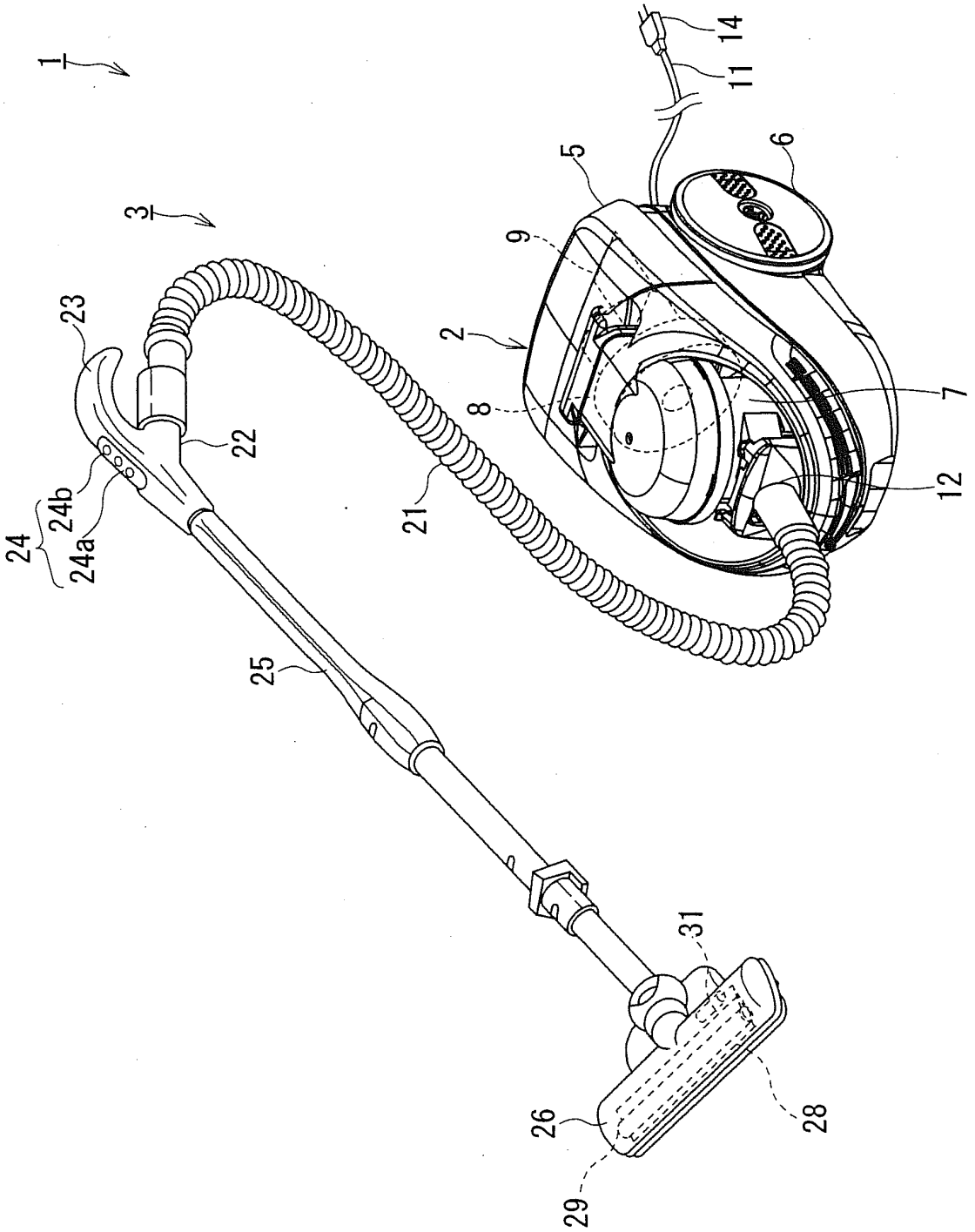

FIG. 1

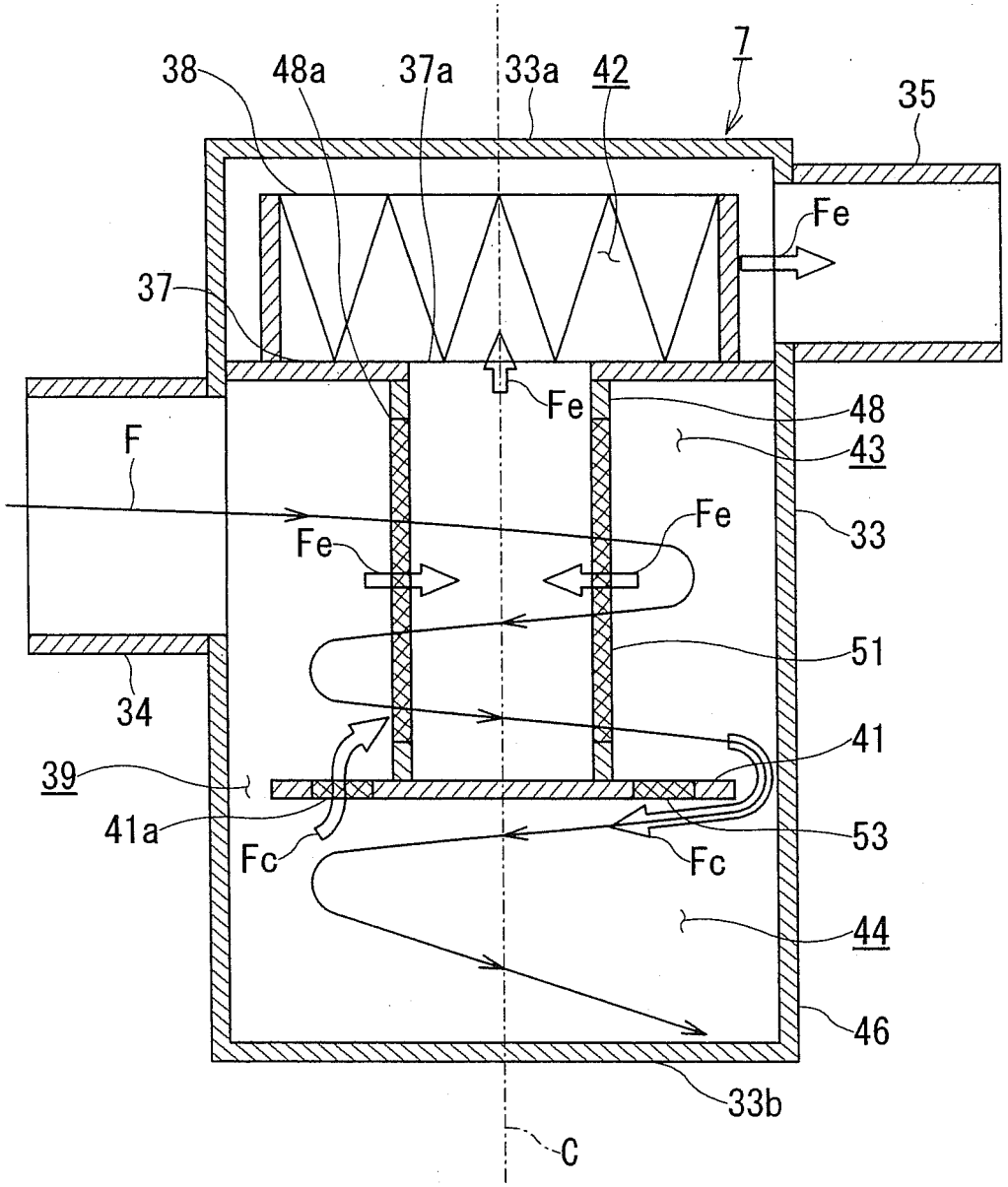
38
48a
37a
33a
42
7
35
Fe
37
Fe
48
43
F
Fe
Fe
33
51
34
41
39
41a
Fc
Fc
53
44
46
33b
C

FIG. 2

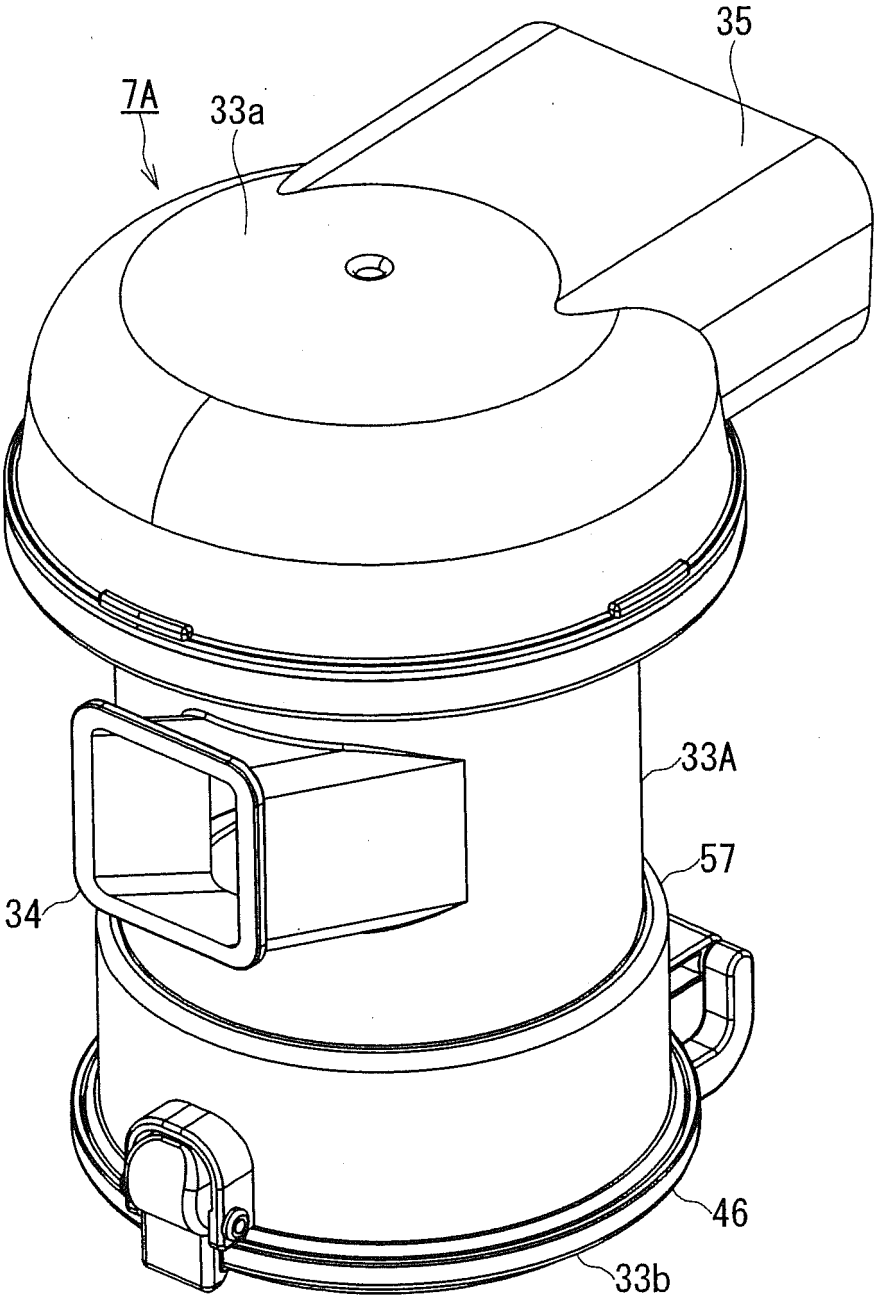

FIG. 3

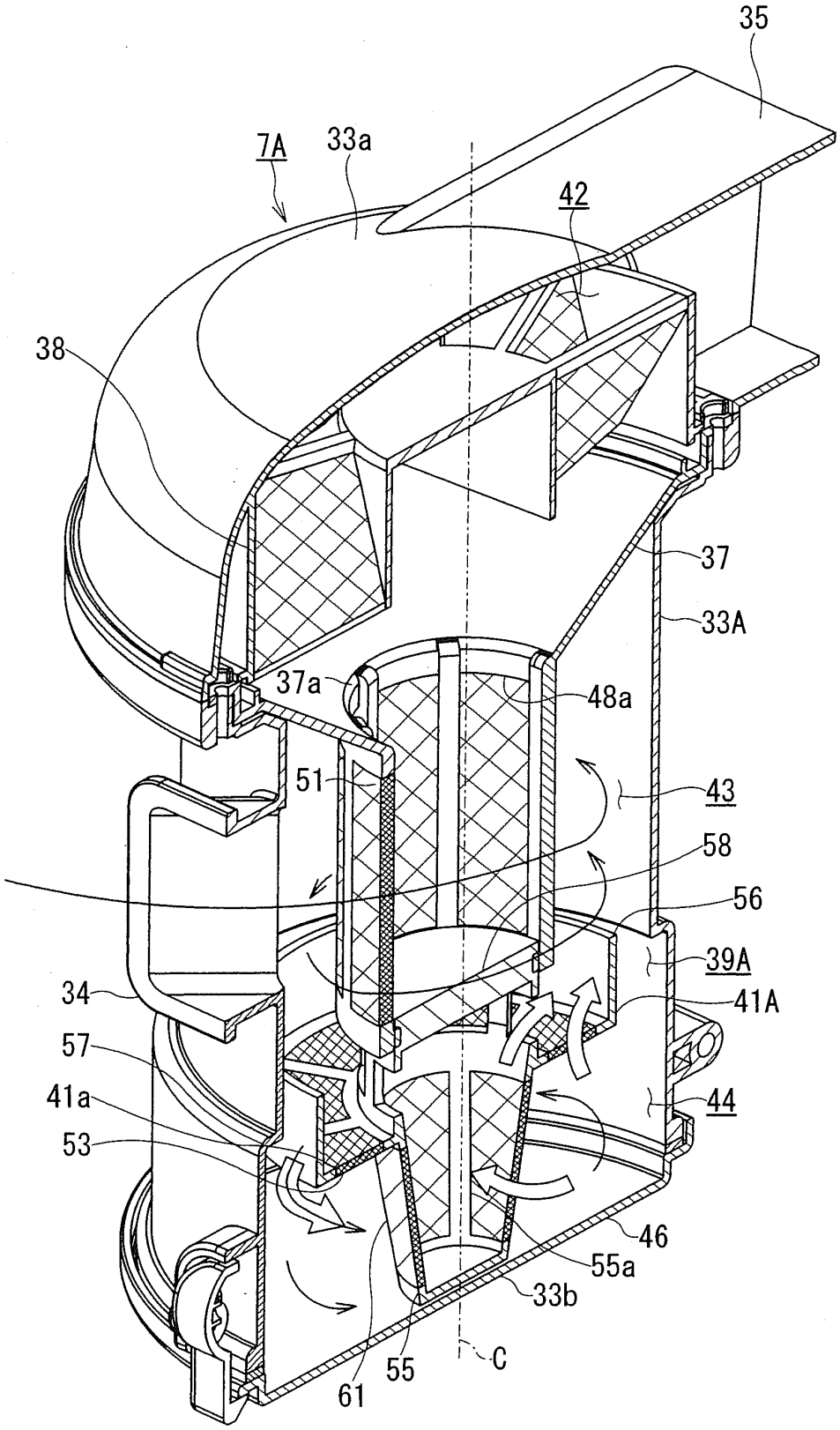
35
7A
33a
42
38
37
33A
37a
48a
51
43
58
56
39A
34
41A
57
41a
44
53
46
55a
33b
C
55
61

FIG. 4

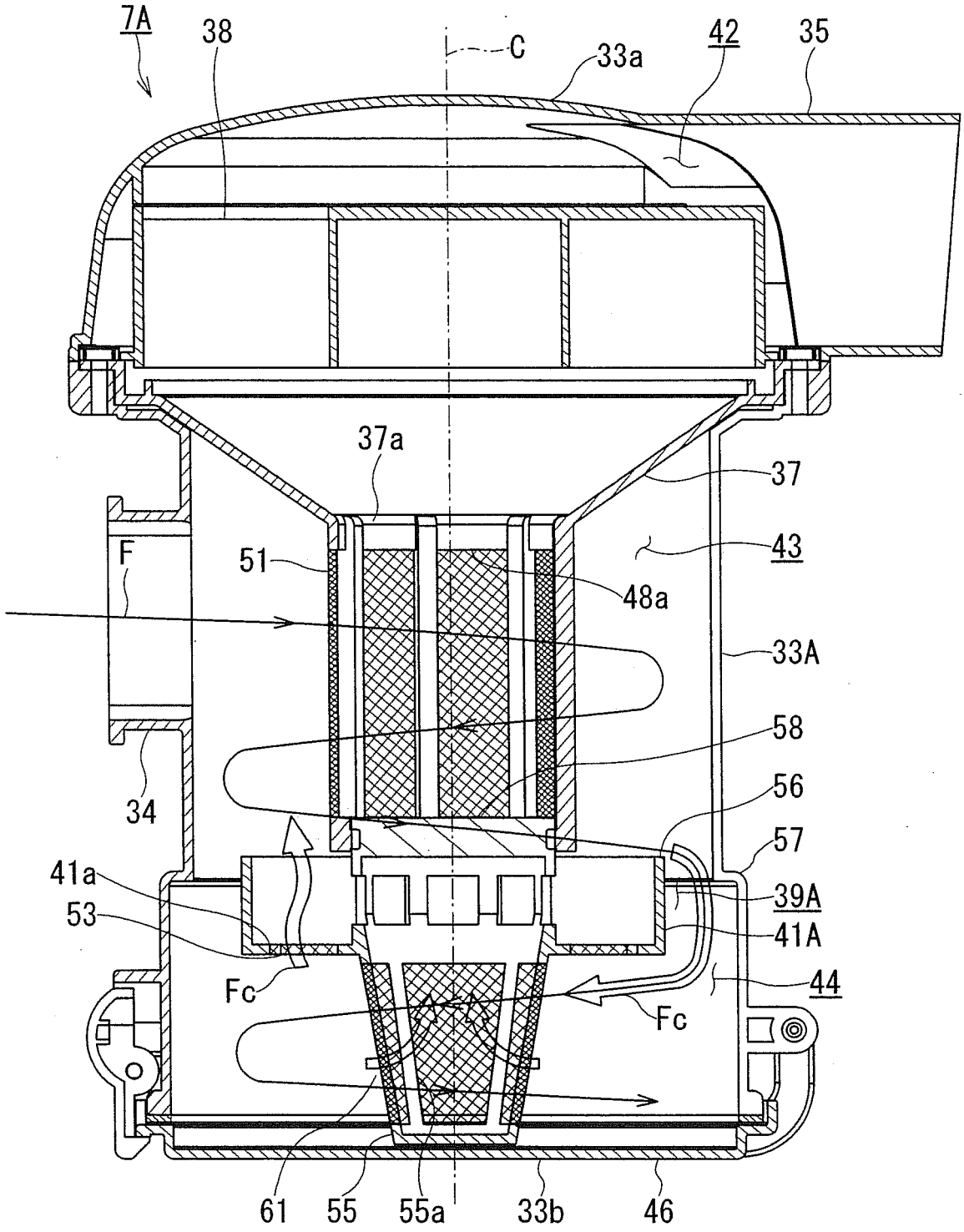
7A
38
C
33a
42
35
37a
37
F
51
43
48a
33A
58
34
56
57
41a
53
39A
41A
Fc
44
Fc
61
55
55a
33b
46

FIG. 5

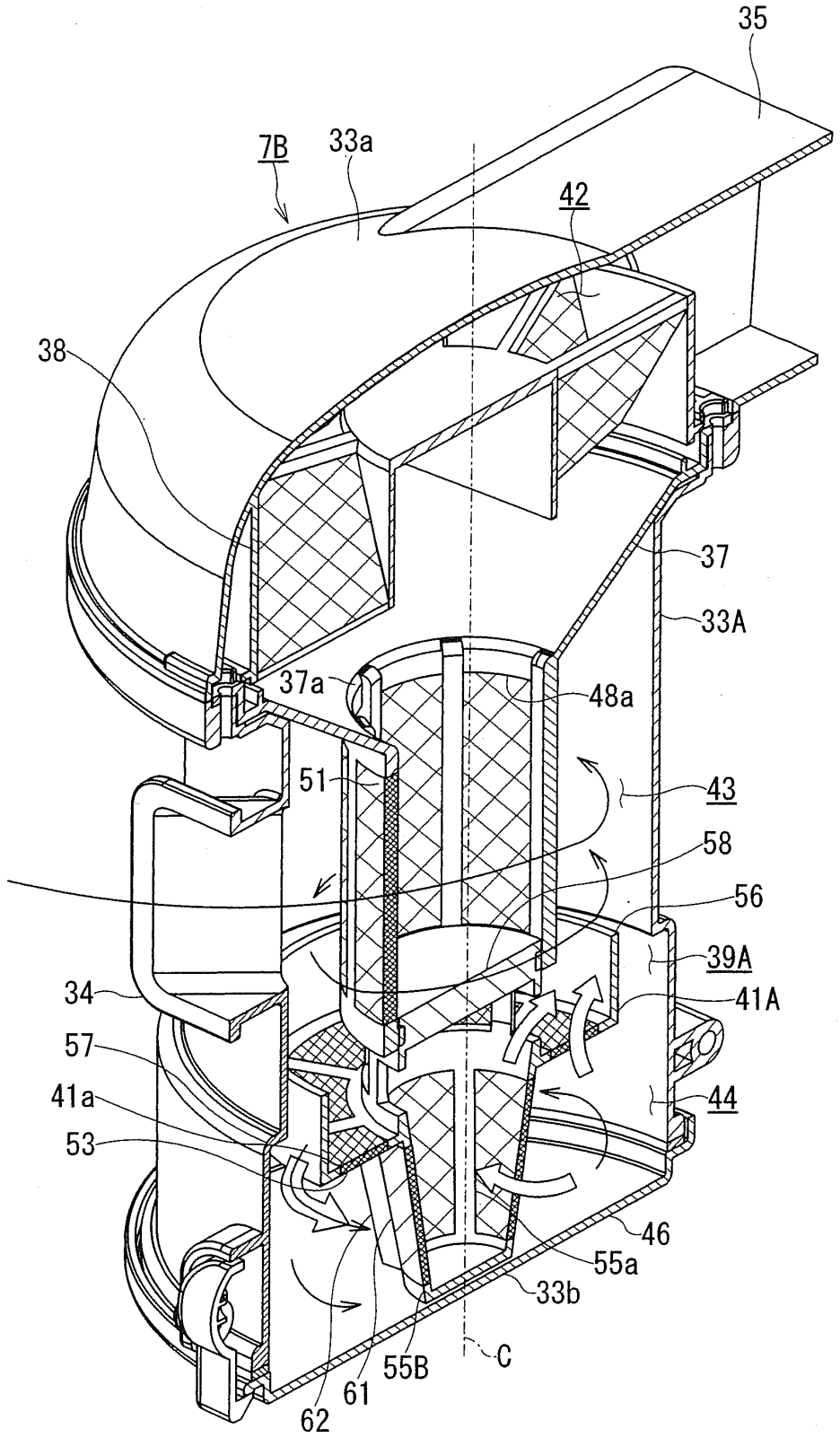
35
7B
33a
42
38
37
33A
37a
48a
51
43
58
56
39A
34
41A
57
41a
44
53
46
55a
33b
C
55B
61
62

FIG. 6

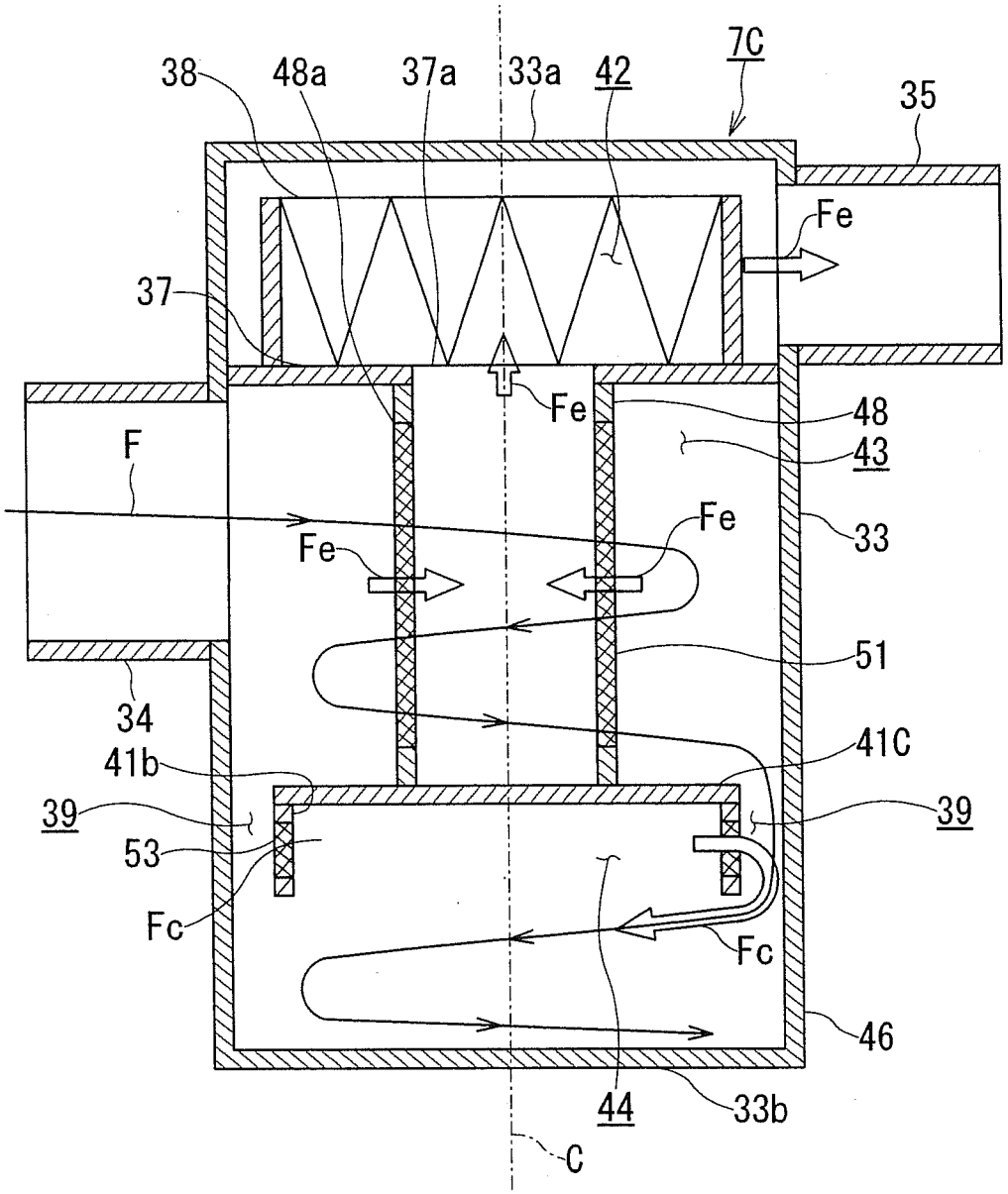
38
48a
37a
33a
42
7C
35
Fe
37
Fe
48
F
43
Fe
Fe
33
51
34
41C
41b
39
39
53
Fc
Fc
46
44
33b
C

FIG. 7

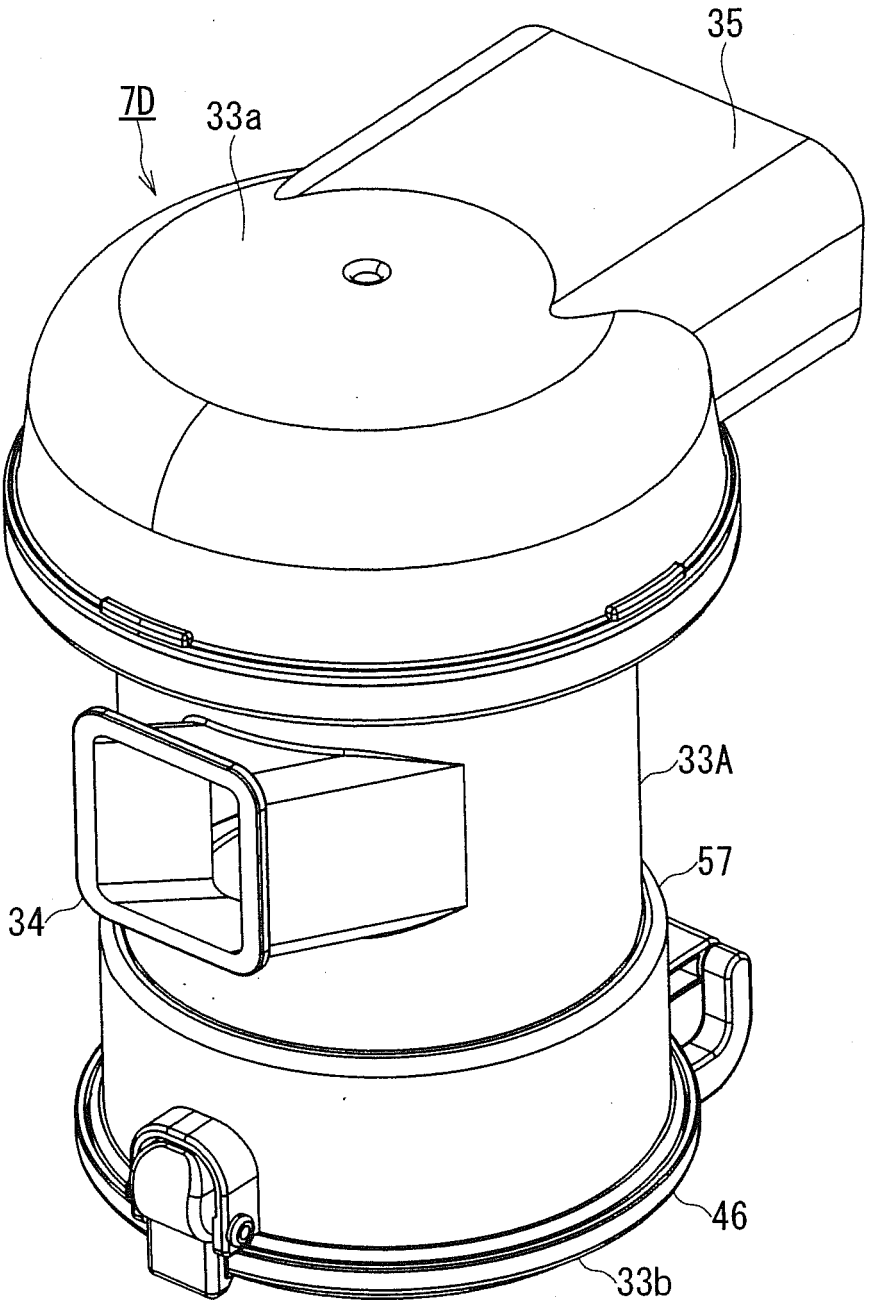

FIG. 8

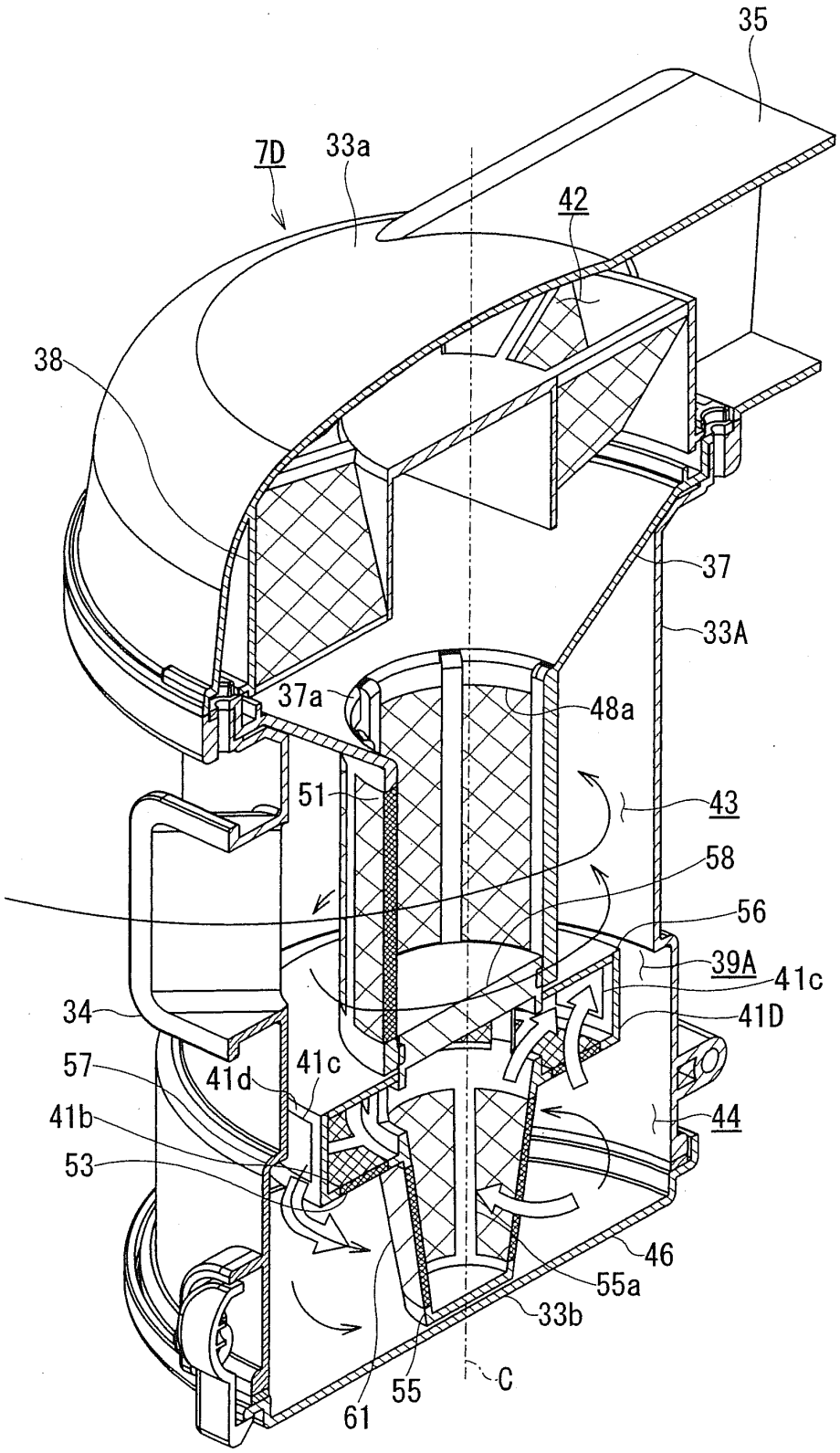
35
7D
33a
42
38
37
33A
37a
48a
51
43
58
56
39A
41c
34
41D
57
41d
41c
41b
44
53
46
55a
33b
C
55
61

FIG. 9

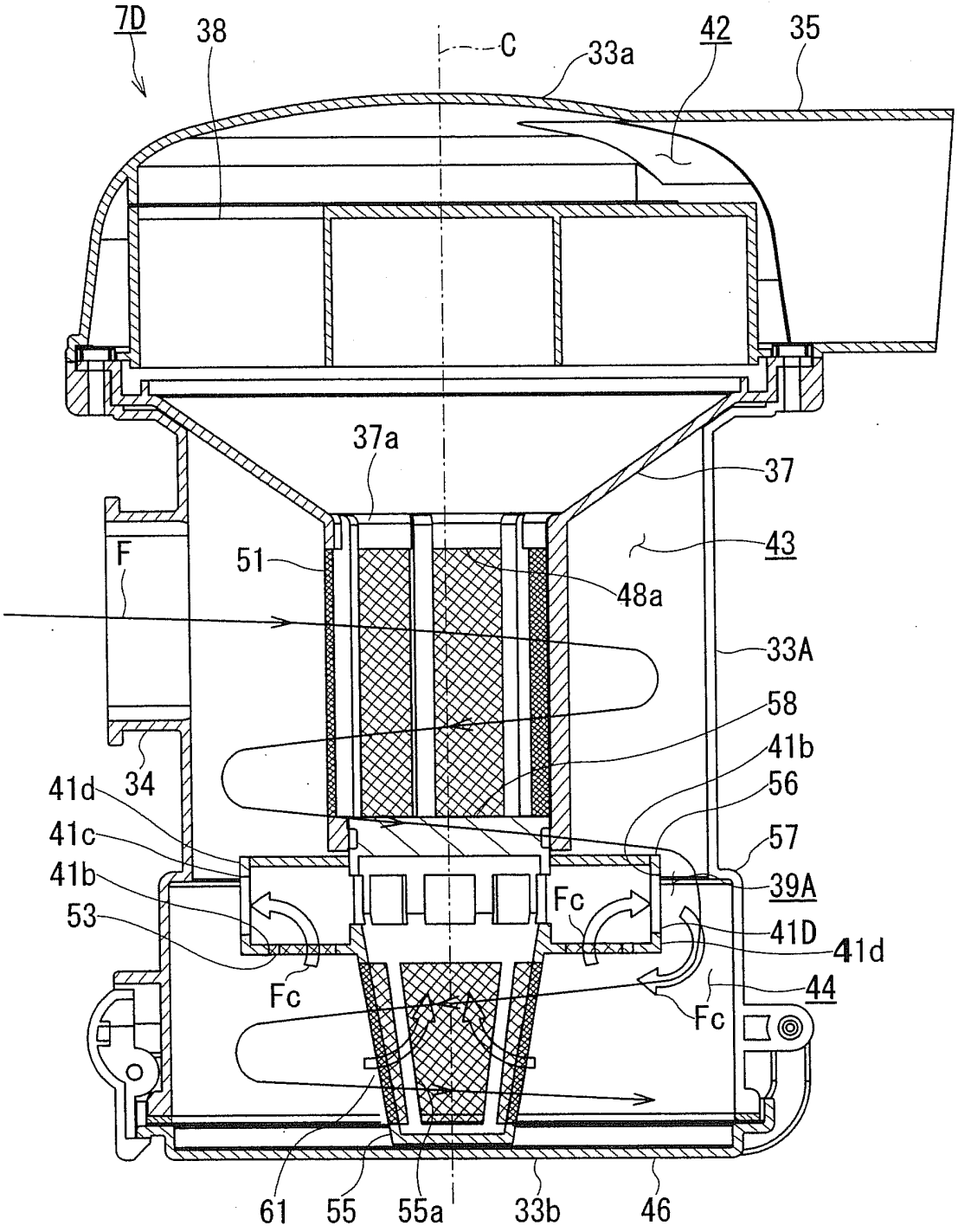
7D
38
C
33a
42
35
37a
37
F
51
43
48a
33A
58
41b
56
41d
34
41c
57
41b
39A
53
Fc
41D
41d
Fc
44
Fc
61
55
55a
33b
46

FIG. 10

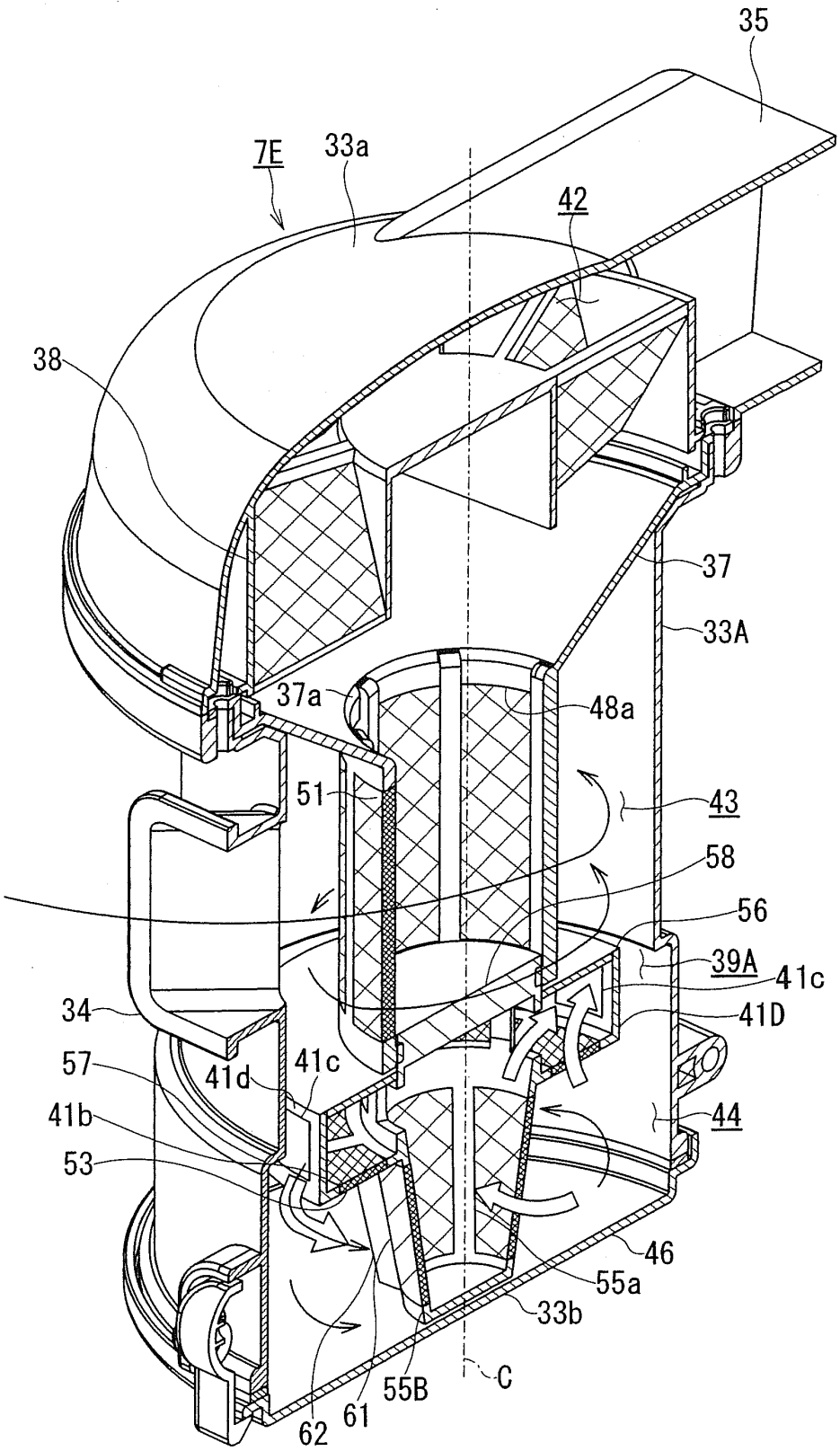
35
7E
33a
42
38
37
33A
37a
48a
51
43
58
56
39A
41c
34
41D
57
41d
41c
41b
44
53
46
55a
33b
C
55B
62
61

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/054334

A. CLASSIFICATION OF SUBJECT MATTER
A47L9/16(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, B04C1/00-11/00

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 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2006-346141 A (Matsushita Electric Industrial Co., Ltd.), 28 December 2006 (28.12.2006), entire text; all drawings (Family: none)	1,2,4-9, 13-16 3,10-12
Y A	JP 2000-317348 A (Mitsuhiro SEKINO), 21 November 2000 (21.11.2000), entire text; all drawings (Family: none)	1,2,4-9, 13-16 3,10-12
Y A	JP 2006-346140 A (Matsushita Electric Industrial Co., Ltd.), 28 December 2006 (28.12.2006), entire text; all drawings (Family: none)	9,13-16 1-8,10-12

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
20 May, 2011 (20.05.11)	31 May, 2011 (31.05.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/054334

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-102121 A (Sharp Corp.), 09 April 2002 (09.04.2002), entire text; all drawings (Family: none)	13-16
Y	JP 2003-88485 A (Sharp Corp.), 25 March 2003 (25.03.2003), entire text; all drawings (Family: none)	13-16
Y	JP 9-155239 A (Tsutomu NOZAKI), 17 June 1997 (17.06.1997), entire text; all drawings (Family: none)	14-16

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 9155239 A **[0003]**