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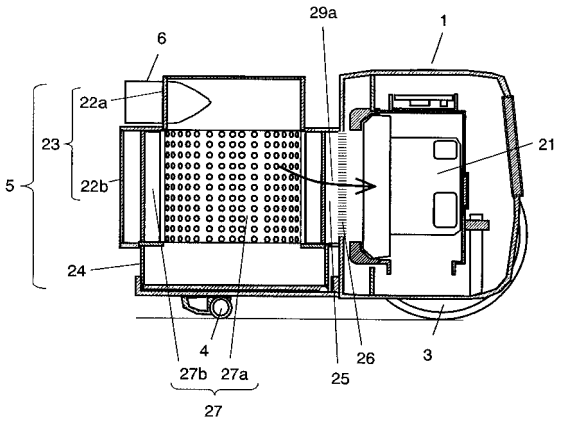
(54) ELECTRIC CLEANER

(57) A vacuum cleaner is disclosed, and this cleaner maintains sucking power at a high level while it resists lowering the suction force although it sucks dust. The vacuum cleaner includes a cylindrical dust collecting case which takes air in sucked by an electric air blower and including dust. The case includes a suction port through which the air including dust flows into the case along a tangent line, and a dust collector communicates with the port. A dust filter in the case is placed in an air-duct through which the case communicates with the electric air blower. This structure allows whirling airflow in the case to whirl continuously in the case, so that dust can be removed from the filter even if the dust attaches to the filter. As a result, sucking airflow can be always secured.

FIG. 2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a vacuum cleaner that employs a reusable dust collecting case.

BACKGROUND ART

[0002] A conventional vacuum cleaner has generated cyclone air current in its dust collecting case for separating dust from the sucked air current with centrifugal force, thereby accumulating the dust in the dust collecting case. This is disclosed in patent document 1*. However, this conventional structure cannot separate the dust sufficiently because of the restriction that sucking power should be kept at a high level, so that the dust accumulated in the dust collecting case works as a filter and thus fine dust attaches to accumulated rough dust, thereby resisting to the airflow. As a result, sucking power is lowered in a short time. Production of the cyclone air current requires a sucking air duct to be bent greatly, and whirling airflow is also generated in sucking the air, so that a pressure loss becomes greater in the sucking air duct starting from sucking and ending at discharging. As a result, the sucking power is obliged to lower. *Patent Document 1: Unexamined Japanese Patent Publication No. 2000 - 342492.

DISCLOSURE OF INVENTION

[0003] The present invention addresses the foregoing problems, and aims to provide a vacuum cleaner that sucks dust with the sucking power maintained at a high level, and the suction force is difficult to lower while the vacuum cleaner works.

[0004] A vacuum cleaner of the present invention comprises the following elements in order to solve the foregoing problems:

an electric air blower;
a dust separator, for taking air in sucked by the electric air blower and including dust, placed on the upper stream of the blower; and
a dust collector for accommodating the dust separated by the dust separator,

wherein the dust separator includes an air duct for whirling airflow, which air duct runs the air taken from a suction port and containing the dust, and the dust separator also includes a dust filter which forms at least a part of the air duct, and the dust filter is surrounded by space on which the suction force of the electric air blower acts.

[0005] The foregoing structure of the present invention allows the dust separator to generate the whirling airflow therein when the air including the dust flows into the dust separator. The dust having the whirling component whirls also in a hollow cylinder of the dust separator, so that rough dust such as lint and hair whirls and lowers in the hollow cylinder to the dust collector.

[0006] The whirling airflow removes dust attaching to the inner wall of the hollow cylinder in the dust filter, so that no dust accumulates in the filter and thus the air-permeability of the filter can be maintained. The sucked dust accumulates in the dust collector, and the sucking air-duct running from a suction port to the electric air blower is secured around the dust filter. As a result, this structure does not cause to lower an air volume, but is excellent in maintaining the air volume, so that the vacuum cleaner of the present invention can be a product of maintenance free for a long period.

[0007] The air duct running from the suction port to the electric air blower can separate the dust from the duct without repeating sharp bends, expansions or shrinkages of the airflow, so that a sucking power at a high level can be maintained for a long period. The vacuum cleaner of the present invention thus can be free from maintenance works for a long period while it maintains sucking power at a high level, and its suction force is difficult to lower although it sucks dust.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 shows an entire view of a vacuum cleaner in accordance with a first embodiment of the present invention.
Fig. 2 shows a sectional view illustrating a structure of an essential part of the vacuum cleaner shown in Fig. 1.
Fig. 3A shows a front sectional view of a dust collecting case of the vacuum cleaner shown in Fig. 1.
Fig. 3B shows a lateral sectional view of the dust collecting case shown in Fig. 3A.
Fig. 3C shows a sectional view taken along line A - A in Fig. 3B.
Fig. 3D shows a sectional view taken along line B - B in Fig. 3B.
Fig. 4 shows a sectional view of an essential part of a second dust filter of the vacuum cleaner shown in Fig. 1.
Fig. 5A shows a plan sectional view illustrating a direction of airflow near to a suction port of the dust collecting case of the vacuum cleaner shown in Fig. 1.
Fig. 5B shows a plan sectional view illustrating a direction of airflow near to a dust filter of the dust collecting case.
Fig. 5C shows a vertical sectional view illustrating airflow running in a vertical direction in the dust collecting case.
Fig. 6 shows a graph illustrating a relation between an amount of collected house dust and changes in sucking airflow; the relation is measured both in the vacuum cleaner shown in Fig. 1 and another vacuum

cleaner for comparison purpose.

Fig. 7 shows a perspective view of a dust collecting case of another vacuum cleaner in accordance with the embodiment of the present invention.

Fig. 8A shows a lateral sectional view of the dust collecting case of this another vacuum cleaner in accordance with the embodiment.

Fig. 8B shows a sectional view taken along line B - B in Fig. 8A.

Fig. 9A shows a front sectional view of the dust collecting case of this another vacuum cleaner in accordance with the embodiment.

Fig. 9B shows a sectional view taken along line B - B in Fig. 9A.

Fig. 10 shows a sectional view of an essential part of a vacuum cleaner in accordance with a second embodiment of the present invention.

Fig. 11A shows a front sectional view of a dust collecting case of the vacuum cleaner shown in Fig. 10.

Fig. 11B shows a lateral sectional view of the dust collecting case shown in Fig. 10.

Fig. 11C shows a sectional view taken along line A - A in Fig. 11B.

Fig. 11D shows a sectional view taken along line B - B in Fig. 11B.

Fig. 12A shows a plan sectional view illustrating a direction of airflow near to a suction port of the dust collecting case of the vacuum cleaner shown in Fig. 10.

Fig. 12B shows a plan sectional view illustrating a direction of airflow near to a dust filter of the dust collecting case.

Fig. 12C shows a vertical sectional view illustrating airflow running in a vertical direction in the dust collecting case.

Fig. 13 shows a graph illustrating a relation between an amount of collected house dust and changes in sucking airflow; the relation is measured both in the vacuum cleaner shown in Fig. 10 and another vacuum cleaner for comparison purpose.

Fig. 14 shows a sectional view illustrating a structure of an essential part of a driving gear of a vacuum cleaner in accordance with a third embodiment of the present invention.

Fig. 15 shows a graph illustrating a relation between an amount of collected house dust and changes in sucking airflow of the vacuum cleaner shown in Fig. 14.

Fig. 16A is a lateral sectional view of a dust collecting case in accordance with a fourth embodiment of the present invention.

Fig. 16B shows a sectional view taken along line B - B in Fig. 16A.

Fig. 17 shows a sectional view of the operation of an essential part of a first dust removing means of the vacuum cleaner.

Fig. 18 shows a perspective view of a dust collecting case of another vacuum cleaner in accordance with the fourth embodiment.

Fig. 19A shows a lateral sectional view of a dust collecting case in accordance with a fifth embodiment of the present invention.

Fig. 19B shows a sectional view taken along line B - B in Fig. 19A.

Fig. 20 shows a sectional view of the operation of an essential part illustrating an action of a second dust removing means of the vacuum cleaner.

Fig. 21 shows a graph illustrating a relation between an amount of collected house dust and changes in sucking airflow of the vacuum cleaner; the relation is measured both in the vacuum cleaner in accordance with the fifth embodiment and the vacuum cleaner in accordance with the second embodiment for comparison purpose.

Fig. 22 shows a perspective view of a dust collecting case of a vacuum cleaner in accordance with a sixth embodiment of the present invention.

Fig. 23 shows a sectional view of the operation of an essential part illustrating an action of a third dust removing means of the vacuum cleaner.

Fig. 24 shows a perspective view of a dust collecting case including a third dust removing means of another vacuum cleaner in accordance with the sixth embodiment.

Fig. 25 shows a perspective view of a dust collecting case of a vacuum cleaner in accordance with a seventh embodiment of the present invention.

Fig. 26 shows a sectional view of the operation of an essential part illustrating an action of a fourth dust removing means of the vacuum cleaner.

Fig. 27 shows a graph illustrating a relation between an amount of collected house dust and changes in sucking airflow of the vacuum cleaner; the relation is measured both in the vacuum cleaner in accordance with the seventh embodiment and the vacuum cleaner in accordance with the second embodiment for comparison purpose.

Fig. 28 shows a perspective view of a dust collecting case of a vacuum cleaner in accordance with an eighth embodiment of the present invention.

Fig. 29A shows a lateral sectional view illustrating a status where dust accumulates in the dust collecting case of the vacuum cleaner in accordance with the eighth embodiment.

Fig. 29B shows a lateral sectional view illustrating a status where a door of the dust collecting case opens for discharging the accumulated dust.

Fig. 30 shows a perspective view of a dust collecting case of a vacuum cleaner in accordance with a ninth embodiment of the present invention.

Fig. 31A shows a lateral sectional view illustrating a status where dust accumulates in the dust collecting case of the vacuum cleaner in accordance with the ninth embodiment.

Fig. 31B shows a lateral sectional view illustrating a status where a door of the dust collecting case opens

for discharging the accumulated dust.

Fig. 32A shows a lateral sectional view of a dust collecting case in accordance with a tenth embodiment of the present invention.

Fig. 32B shows a sectional view taken along line B - B in Fig. 32A.

Fig. 33 shows a perspective view of a dust collecting case of the vacuum cleaner in accordance with the tenth embodiment.

DESCRIPTION OF REFERENCE MARKS

[0009]

1	cleaner unit
5	dust collecting case
6	suction port
21	electric air blower
22a	upper section of the dust collecting case
22b	middle section of the dust collecting case
23	dust separator
24	dust collector
27	dust filter
27a	first dust filter
27b	second dust filter
28	third dust filter
29a	first air duct (main air duct)
29b	second air duct (sub air duct)
31	door
33	space
41	pleated filter
42	dint
43	sealed section
51	fine dust
52	rough dust
161	first dust removing means
191	second dust removing means
221	third dust removing means
251	cylindrical basket (fourth dust removing means)
324	fourth dust filter

DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] A vacuum cleaner of the present invention comprises the following elements:

an electric air blower;

a dust separator, for introducing air sucked by the air blower and including dust, disposed on the upper stream of the blower; and

a dust collector for accommodating the dust separated by the dust separator,

wherein the dust separator includes a whirling airflow air-duct, which runs the air taken from a suction port and containing the dust as the whirling airflow, and the dust separator also includes a dust filter which forms at least a part of the foregoing air-duct, and the dust filter is surrounded by space on which the suction force of the air blower acts.

[0011] The foregoing structure of the present invention allows the dust separator to generate the whirling airflow therein when the air including the dust flows into the dust separator. The dust having the whirling component whirls also in a hollow cylinder of the dust separator, so that rough dust such as lint and hair whirl and lower in the hollow cylinder and enters in the dust collector.

[0012] The whirling airflow removes dust attaching to the inner wall of the hollow cylinder in the dust filter, so that no dust accumulates in the filter and thus the air-permeability of the filter can be maintained. The sucked dust accumulates in the dust collector, and the suction path running from the suction port to the air blower is secured around the dust filter. As a result, this structure does not cause to lower an air volume, but is excellent in maintaining the air volume, so that the vacuum cleaner of the present invention can be free from maintenance works for a long period.

[0013] The air duct running from the suction port to the air blower can separate the dust from the air-duct without repeating sharp bends, expansions or shrinkages of the airflow, so that a sucking power at a high level can be maintained for a long period. The vacuum cleaner of the present invention thus can be free from maintenance work for a long period while it maintains sucking power at a high level, and its suction force is difficult to lower although it sucks dust.

[0014] The present invention places dust filters along the entire air-duct of the whirling airflow. This structure allows securing a suction path running from the suction port to the air blower along the entire dust filter, so that air volume does not decrease any more, and the vacuum cleaner can be excellent in maintaining the air volume and free from maintenance work for a long period.

[0015] The present invention places the dust collector under the dust filter, so that rough dust such as lint and hair whirl in a hollow cylinder of the dust filter and lowers to the dust collector more efficiently.

[0016] The present invention forms the air duct of the whirling airflow into an approx. cylindrical shape, and places a suction port along the tangent line of this air duct. This structure allows the air containing dust to enter into the dust separator along the tangent line, so that more powerful whirling airflow can be generated in the dust separator.

[0017] The present invention forms a main air duct in the space provided to the outer circumference of the dust filters so that the suction force of the air blower can act on the outer circumference. This structure allows securing the suction path running from the suction port to the air blower in a more effective manner along the dust filters, so that the air flow does not decrease any more, and the vacuum cleaner can be excellent in maintaining the air volume and free from maintenance work for a long time.

[0018] The present invention provides the dust collec-

tor with a sub air duct on which the suction force of the air blower acts. This structure allows rough dust, which has whirled and lowered in the hollow cylinder of the dust filter and enters in the dust collector, to be sucked by the sub air-duct so that the rough dust is caught and accumulated in the dust collector more positively. On top of that, this structure can prevent the dust from reattaching to the dust filter due to raising of dust during the operation, so that this structure can suppress a decrease in the air volume. As a result, a vacuum cleaner excellent in maintaining the air volume is obtainable.

[0019] The present invention places the sub air-duct running from the dust collector and communicating with the outside of the dust filter via the dust filter. This structure allows the rough dust, which whirls and lowers in the hollow cylinder of the dust filter and enters in the dust collector, to be sucked by the sub air-duct and to be screened out by the dust filter, so that the rough dust can be caught by the dust collector in a more positive way before accumulating in the dust collector. The vacuum cleaner thus can maintain its air volume and can be free from maintenance work for a long period.

[0020] The present invention provides the vacuum cleaner with a third dust filter in the sub air duct. This structure allows the rough dust, which whirls and lowers in the hollow cylinder within the dust filter and enters in the dust collector, to be sucked toward the third dust filter which screens out the rough dust. The dust is thus caught in the dust collector in a more positive way before accumulating in the dust collector. Fine dust passing through the third filter is also screened out by the filter so that the fine dust can be removed in the air duct on the way to the air blower.

[0021] This structure allows separating the rough dust from the fine dust more positively, and the rough dust can be positively caught and accumulated in the dust collector. The vacuum cleaner thus can maintain the air volume more positively and needs no maintenance work for a long period.

[0022] The dust filter of the vacuum cleaner of the present invention is formed of at least a first dust filter for collecting rough dust on the upper stream side of the sucking airflow, and a second dust filter placed on the outer circumference of the first dust filter and on the down stream side for collecting fine dust. This structure allows the first dust filter placed on the upper stream side to collect rough dust such as lint, hair, and food grounds, and allows the second dust filter placed on the down stream side to collect fine dust such as grains of sand. Lint tending to block the air duct can be thus caught on the upper stream side and whirled in the dust collector. A decrease in suction force can be thus prevented more effectively.

[0023] The present invention provides the dust collector with the sub air duct on which the suction force of the air blower acts. This structure allows the rough dust arrived at the dust collector to be sucked by the sub air duct and screened out by the dust filter, so that the rough dust can be caught and accumulated in the dust collector more positively. The vacuum cleaner thus can maintain the air volume and needs no maintenance work for a long period. On top of that, this structure can prevent the dust from reattaching to the dust filter due to raising of dust during the operation, so that this structure can suppress the decrease in the air volume. As a result, a vacuum cleaner excellent in maintaining the air volume is obtainable.

[0024] The present invention provides the vacuum cleaner with a main air duct running from the air duct of the whirling airflow to the outer circumference of the dust separator via the first and the second dust filters, and a sub air duct running from the dust collector to the outer circumference of the dust separator via the third and the second dust filters. This structure allows the rough dust such as lint and hair to whirl and lower in the hollow cylinder within the first dust filter before arriving at the dust collector, and then allows the rough dust to be sucked from the dust collector toward the third filter which screens out the rough dust. The rough dust is thus caught and accumulated in the dust collector more positively. Fine dust passing through the third filter flows into the second filter at its lower end, and screened out by the second filter and runs through the air duct and removed on the way to the air blower.

[0025] This structure allows separating the rough dust from the fine dust more positively, and the rough dust can be caught and accumulated in the dust collector. The vacuum cleaner thus can maintain the air volume more positively and needs no maintenance work for a long period.

[0026] The present invention provides the vacuum cleaner with the third dust filter for collecting rough dust. This structure allows the rough dust entered in the dust collector to be sucked toward the second filter through the third filter; however, the third filter blocks the rough dust such as lint and hair to pass, so that the rough dust is separated from fine dust. The rough dust such as lint and hair blocking the air duct can be thus positively caught in the dust collector, so that the decrease in the air volume can be prevented more positively.

[0027] The present invention provides the first dust filter is made of the material including at least one of punching metal, metal mesh and resin mesh. This structure allows fiber-oriented dust such as lint to resist tangling with the first filter because the first filter has no fine peaks and valleys on the surface so that its surface is more flat than that of a net-like dust filter, and allows the fiber-oriented dust to whirl continuously with ease for being caught and accumulated in the dust collector.

[0028] The present invention provides the second dust filter is formed into a cylindrical shape formed by rounding a pleated member. Use of the pleated member allows increasing an area of the filter, so that resistance against air permeability can be lowered and sucking power can be maintained at a high level for a long period.

[0029] The present invention provides the second dust

filter is formed of the pleated member of which inner wall shapes like a letter U rounded and forming dints at the outer circumference of the cylindrical shape of the second filter. The rounded dints prevent fine dust from attaching to and accumulating on the second dust filter. The fine dust attaching to the filter can be removed with ease, so that the decrease in the air volume can be prevented.

[0030] The present invention provides the vacuum cleaner with a rotary dust filter. This structure allows preventing the dust from attaching to the filter in somewhat unbalanced manner, so that the dust can be attached to the filter evenly in amount. As a result, the decrease in the air volume due to clogging of the filter can be effectively prevented.

[0031] The present invention provides the vacuum cleaner with the first and the second dust filters at least one of which can rotate. This structure allows preventing the dust from attaching to the first or the second filter in somewhat unbalanced manner, so that the dust can be attached to the filters evenly in amount. As a result, the decrease in the air volume due to clogging of one of the filters can be more effectively prevented.

[0032] The present invention provides the vacuum cleaner with the first and the second dust filter both of which rotate together. This structure allows preventing the dust from attaching to the first and the second filters in somewhat unbalanced manner, so that the dust can be attached to the filters evenly in amount. As a result, the decrease in the air volume due to clogging of the filters can be more effectively prevented with a simple structure.

[0033] The present invention provides the vacuum cleaner with a dust removing means for removing the dust attaching to the dust filter. This structure allows removing fine dust such as grains of sand attaching to the filter, so that the clogging of the filter can be more positively prevented, and the decrease in the air volume can be prevented.

[0034] The present invention prepares a dust removing means contacting with the rotary dust filter. This structure allows removing the dust attaching to the inner wall of the dust filter along the entire circumference. This removing means can be manually rotated with a simple structure, or the removing means includes a rotary driving means and a control means for rotating the dust removing means in step with the timing of the air blower. As a result, the air permeability of the dust filter can be maintained more effectively, so that the decrease in the air volume can be prevented.

[0035] The present invention provides at least one of the first or the second rotary dust filter with a dust removing means contacting thereto for vibrating the filter contacting to the removing means, so that the dust attaching to the filter can be removed. This structure allows removing the dust attaching to the inner wall of the first or the second dust filter more effectively. As a result, the decrease in the air volume can be prevented more effectively.

[0036] The present invention provides at least one of the first or the second rotary dust filter with a dust removing means contacting thereto for scraping or rubbing off the dust attaching to the dust filter. This structure allows removing the dust attaching to the inner wall of the first or the second dust filter more effectively, which dust is lint or hair tangling with the filter or causes clogging.

[0037] The present invention provides the vacuum cleaner with a dust removing means that moves along the dust filter while it contacts with the filter, thereby vibrating the filter for removing the dust or scraping or rubbing off the dust attaching to the filter. This structure allows removing the dust attaching to the inner wall of the filter with ease along the entire circumference. This removing means can be manually rotated with a simple structure, or the removing means includes a rotary driving means and a control means for rotating the dust removing means in step with the timing of the air blower. As a result, the air permeability of the dust filter can be maintained more effectively, so that the decrease in the air volume can be prevented.

[0038] The third dust filter of the present invention shapes like a truncated cone, i.e. the lower diameter is greater than the upper diameter, and both of the upper and lower ends open. This structure allows the fine dust removed from the third dust filter to drop into the dust collector under the third filter along the slanting face formed of bus lines. The fine dust can be prevented from reattaching to the third filter, so that the decrease in the air volume can be prevented more effectively.

[0039] The dust filter of the present invention shapes like a truncated cone, i.e. the lower diameter is greater than the upper diameter. This structure allows sucking the dust of a greater amount than a capacity of the dust collector. If the dust of a greater amount than a capacity of the dust collector is sucked and the dust clogs in the hollow cylinder within the dust filter, the dust can be removed from the filter with ease because the lower section is greater than the upper section. The vacuum cleaner excellent in throwing the dust away and convenience is thus obtainable.

[0040] The present invention provides the third dust filter with an opening and places a dust removing means near to this opening. A dust chamber communicating with this opening is provided in the dust collector. The dust removed by the dust removing means runs through this opening and is accommodated in this chamber. This structure can prevent the dust from reattaching to the dust filter due to raising of dust during the operation, so that this structure can further suppress the decrease of the air volume. As a result, a vacuum cleaner excellent in maintaining the air volume is obtainable.

[0041] The present invention prepares vent holes on a lateral wall of the dust chamber for communicating with the dust collector, and a fourth dust filter is placed on the vent holes. This structure secure the air duct running from the dust collector to the outer circumference of the dust

filter via the fourth filter and the dust chamber, so that a sucking air volume is difficult to lower even the vacuum cleaner sucks dust, and the sucking power can be kept at a high level for a long period.

[0042] The present invention discharges the dust by opening the bottom of the dust collector. This structure allows the fine and rough dust accumulated in the dust collector to drop by means of gravity, so that the dust in the collector can be discharged with ease. The vacuum cleaner excellent in throwing the dust away and convenience is thus obtainable.

[0043] The present invention forms at least one of the dust separator or the dust collector at least in part by using see-through material. This structure allows the user to see the dust whirling or recognize an amount of the dust collected, so that the users can determine the timing of throwing the dust away from the dust collector or find abnormality in the dust collector sooner.

[0044] The present invention forms the dust filter at least in part by using see-through material. This structure allows the users to see the content of the dust, so that the users can find some thing other than dust with ease.

[0045] The structure of the vacuum cleaner of the present invention is described more specifically hereinafter. The vacuum cleaner comprises the following elements:

a sucking tool for sucking dust scattered on the floor;
an electric air blower for sucking the air transferred from the sucking tool and containing the dust;
a cleaner unit accommodating the air blower;
a dust separator for taking the air in sucked by the air blower and containing the dust, and separating the dust from the air; and
a dust collector for collecting the dust separated from the air.

[0046] The dust separator includes a suction port for taking the air in transferred from the sucking tool and containing the dust, an air duct for running the air containing the dust as whirling airflow, and a dust filter for separating the dust from the air and forming at least a part of the air duct. A main air duct covers the outer circumference of the dust filter and is coupled to the suction side of the air blower so that the suction force of the air blower can act on the outer circumference of the dust filter.

[0047] Generation of the whirling airflow needs the following structure: the air duct for the whirling airflow shapes like an approx. cylinder, more preferably, it forms a cylinder, and a suction port is formed such that the whirling airflow is generated along the inner wall of the air duct and the air flow whirls along the circumference direction. To be more specific, the sucking direction of the suction port crosses the axial direction of the cylinder at right angles so that it can run along the circumferential direction of the inner wall, and the sucking direction runs along the tangent line of the cylinder. The approx. cylindrical shape includes a sectional view of an oval or polygon such as an octagon. Any shape is acceptable as far as it allows generating the whirling airflow along the circumferential direction of the inner wall of the air duct.

[0048] The generation of the whirling airflow in the air duct naturally needs a negative pressure status produced by the suction force of the air blower acting on the inside of the air duct. For that purpose, a first end having the suction port of the air duct is covered with the top face of the dust collector and a second end thereof is air-tightly coupled to the dust collector, so that the suction force of the air blower acts on the dust filter formed in the air duct.

[0049] More preferably, a sub air duct is placed to the coupling section between the air duct and the dust collector or to the dust collector per se, so that the suction force of the air blower acts on the sub air duct. This structure allows obtaining not only the suction force acting on the dust filter but also the suction force acting on somewhere near the dust collector, so that the dust passing through the dust filter moves to the dust collector with more ease.

[0050] A first end of the sub air duct is coupled to a part of the dust collector, and a second end thereof is coupled to the suction side of the air blower or to a part of the main air duct already formed. This structure produces a similar advantage to what is discussed previously. Preferably the third dust filter is mounted to the first end of the sub air duct for preventing the dust accumulated in the dust collector from flowing to the air blower. It is preferable to prepare the third dust collector not ready to be clogged, particularly when the suction force of the air blower desirably acts on the dust collector via the sub air duct.

[0051] Therefore, the third dust filter is used for collecting rough dust, so that it is difficult to be clogged and it can be used for a long period. Use of the third filter for collecting the rough dust possibly prompts fine dust to flow into the sub air duct. If the fine dust flows into the air blower directly, the air blower lowers its durability. When the third filter is used for collecting the rough dust, a fine-dust filter should be placed on the upper stream of the suction side of the air blower.

[0052] If the dust filter placed in the main air duct is used for collecting the fine dust, the sub air duct can be coupled to the main air duct placed on the upper stream of the fine dust filter. This coupling method allows the fine dust filter to collect the fine dust from the sub air duct, and this method also can eliminate a fine dust filter exclusively used in the sub air duct, so that the maintenance work of the fine dust filter can be improved.

[0053] The foregoing vacuum cleaner invites self-cleansing effect at the dust filter placed in the dust separator due to the whirling airflow; however, since the dust filter is sucked from its outer circumference, the clogging with the dust cannot be eliminated 100%. The dust removing means is thus prepared for removing the dust clogged in the filter. This dust removing means is operated at, e.g. starting or ending the operation of the vac-

uum cleaner for removing the dust clogged in the filter. This operation allows the vacuum cleaner to be used for a long period free from lowering the suction force and sucking power.

[0054] The timing of working the dust removing means is preferably set in accordance with the structure of the dust separator, a type of dust filters to be used after studying how much clogging is generated in the dust filter during actual cleaning operations. To be more specific, the dust removing means is operated for a given time when the vacuum cleaner starts working, or when the vacuum cleaner ends working, or operated for a given time both at the start and the end of the work of the cleaner. It is preferable to use a motor to drive the dust removing means at the foregoing timing.

[0055] For instance, on-off control over a motor can be done with ease by a microprocessor, and this control can be incorporated easily into the control program (carried out in general by a microprocessor) over the vacuum cleaner as a part of sequential actions. Use of a cord take-up mechanism built in the vacuum cleaner for controlling the dust removing means is another way than the use of the motor as discussed above. To be more specific, a user pulls the cord wound on the take-up mechanism for starting the cleaning, then the cord wound section of the mechanism is rotated by the pulling force. If this rotating force is transferred to the dust removing means, the removing means works when the cleaner starts working. In general, the take-up mechanism includes a built-in spring, which is wound by the rotation of the take-up mechanism when the cord is pulled. At the end of cleaning, a button (in general, the button is placed at a part of the cleaner unit to be depressed) is pushed for taking up the cord on the mechanism, and then the wound spring rotates the take-up section along the take-up direction. If this rotating force is transferred to the dust removing means, the removing means can work at the end of cleaning.

[0056] As discussed above, a method of working the dust removing means can be selected appropriately; however, the operation of the dust removing means at least every time when the cleaning starts and ends allows removing the clogging in the dust filter whenever the cleaner starts working. The vacuum cleaner thus can maintain and exert the original suction force and sucking power whenever it works. The vacuum cleaner of the present invention has a structure where the suction force acts on the outer circumference of the dust filter, namely, self cleansing action can suppress the clogging in the dust filter, and yet, the dust removing means is employed in the foregoing structure, so that no clogging occurs over a long time-span, and this structure allows the vacuum cleaner to be free from maintenance work over a long time-span. The operation time of the dust removing means can be shortened because the foregoing clog-resistant structure. In the case of driving the dust removing means by a motor, this structure does not take a time for a user to start cleaning or to restore the tools and parts to the original places, so that the user can simply use the cleaner in an efficient manner.

[0057] Exemplary embodiments of the present invention are described hereinafter.

Embodiment 1

[0058] Fig. 1 and Fig. 2 show a vacuum cleaner in accordance with the first exemplary embodiment. As shown in Fig. 2, cleaner unit 1 includes electric air blower 21, and both of wheels 3 and casters 4 are mounted to the outside of cleaner unit 1 for moving freely on the floor. Dust collecting case 5 is mounted to cleaner unit 1 in a detachable manner on the upper stream side of electric air blower 21 via air-permeable partition wall 26. Dust collecting case 5 takes the air in sucked by electric air blower 21 and including dust.

[0059] Dust collecting case 5 is formed by piling up a plurality of hollow cylinders having different diameters from each other. In this first embodiment, three cylinders are piled up from the top in this order; upper section 22a of case 5, middle section 22b of case 5, and dust collector 24. Upper section 22a and middle section 22b of case 5 work as dust separator 23. Upper section 22a includes suction port 6 which takes the air in including dust along the tangent line.

[0060] Dust collecting case 5 communicates from suction port 6 to dust collector 24 on the bottom where dust accumulates, and the air duct running from suction port 6 to electric air blower 21 communicates with partition wall 26 of cleaner unit 1 at opening 25 placed at dust separator 23 in dust collecting case 5. Cylindrical dust filter 27 is placed in dust separator 23.

[0061] As shown in Fig. 1, suction port 6 is coupled to suction hose 7 and extension tube 8 in this order, and sucking tool 9 is mounted to the tip of extension tube 8. Driving electric air blower 21 will suck the dust on the floor.

[0062] Cylindrical dust filter 27 is formed of two layers, namely, cylindrical first dust filter 27a placed on the upper stream side and forming a rough-dust filter, and cylindrical second dust filter 27b placed on the down stream side of the first dust filter 27a at the outer circumference and forming a fine dust filter. Air vents of first dust filter 27a and second dust filter 27b are placed in the middle of main air duct 29a, i.e. a first air duct, through which suction port 6 communicates with electric air blower 21.

[0063] Main air duct 29a running from suction port 6 to electric air blower 21 is placed along the entire circumference of the air space stretching from the inside of first dust filter 27a to the outer circumference of second dust filter 27b.

[0064] Dust collecting case 5 and cylindrical dust filter 27 are detailed hereinafter with reference to Figs. 3A, 3B, 3C and 3D. As shown in Fig. 3A, case 5 is formed by piling up three vertical and hollow cylinders. Suction port 6 is placed as shown in Fig. 3C at an off-center place such that the airflow flows thereto along the tangent line on the sectional view of circle of upper section 22a of

case 5. In this first embodiment, dust collecting case 5 shapes like a hollow cylinder; however, the cross section of the cylinder is not necessarily a true round, but it can be an oval, or a polygon such as an octagon or a decagon. Any shape can be acceptable as far as it allows the airflow, which enters along the tangent line of suction port 6, to whirl along the inner wall of case 5. Cylindrical dust filter 27 is also not necessarily a true round, but it can be an oval, or a polygon such as an octagon or a decagon. Any shape can be accepted as far as it allows the whirling airflow generated along the inner wall of case 5 to be generated also in the hollow cylinder of first dust filter 27a.

[0065] The path, which forms the whirling airflow generated along the inner wall of upper section 22a of case 5 as well as forms the whirling airflow generated in the hollow cylinder of first dust filter 27a, is thus referred to as a whirling airflow air-duct.

[0066] Suction port 6 is placed at upper section 22a of case 5 such that the whirling airflow can be generated along the direction toward dust collector 24, to be more specific, the lower end of suction port 6 is placed over the upper end of opening 25 provided to dust separator 23. This structure allows the air taken into suction port 6 along the tangent direction of upper section 22a to be whirled toward dust collector 24, i.e. along the downward direction, due to suction force acting on opening 25. The whirling airflow lowering and whirling involves rough dust 52 such as lint in whirling and lowering to dust collector 24 because rough dust 52 receives wind pressure of the whirling airflow.

[0067] Dust collecting case 5 has dust collector 24 at its bottom for accumulating the dust, and the bottom face of case 5 works as door 31, so that door 31 is opened via hinge 32 for discharging the dust accumulated in dust collector 24.

[0068] Dust collecting case 5 is made of acrylic resin in this first embodiment, and at least a part of case 5 is preferably made of see-through material so that an amount of dust can be recognized by human eyes with ease. The see-through material is preferably ABS, polypropylene, or acrylic resin because they are obtainable with ease and excellent in being processed.

[0069] As shown in Fig. 3B, on the inner wall between suction port 6 and dust collector 24, space 33 is formed over the entire outer circumference between case 5 and cylindrical dust filter 27, so that the interior of case 5 communicates with suction port 6 of electric air blower 21 via this space 33.

[0070] The inner wall of upper section 22a of case 5 and the inner wall of first dust filter 27a form one wall as a whole, in other words, nothing protrudes on the inner wall of case 5. First dust filter 27a is one of the elements of cylindrical filter 27 and placed inside of filter 27. As shown in Fig. 3D, cylindrical dust filter 27 rounds itself in cylindrical case 5 so that filter 27 forms a cylindrical shape. First dust filter 27a, i.e. a rough dust filter, placed on the upper stream side of sucking airflow screens out larger dust such as lint and hair from the sucking airflow. Second dust filter 27b, i.e. a fine dust filter, placed on the down stream side of the sucking airflow screens out smaller dust (small particles) such as grains of sand, pollens and tick-droppings from the airflow.

[0071] As discussed above, use of multi-layer cylindrical dust filters in response to sizes of dusts to be screened out will decrease the frequency of clogging in the dust filter, so that the performance of maintaining the air volume can be extended. The multi-layer structure can be replaced with a single-layer structure.

[0072] First dust filter 27a is preferably made of metal mesh, punching metal or resin mesh having a rather larger hole diameter so that fine dust such as grains of sand can pass through. In this first embodiment, metal mesh having vent holes of which diameter is 250 micron is used so that fine projections on the inner wall of first dust filter 27a can be minimized.

[0073] Second dust filter 27b can be made of non-woven fabric, pulp, glass fiber, or HEPA filter. The non-woven fabric is pleated and then formed into a cylindrical shape because this material can screen out rather smaller particles efficiently. The filter thus made can reduce the vent resistance while it maintains dust removing performance. Porous member made of PTFE excellent in removing dust, is preferably coated on the filter face, to which dust attaches, because use of this filter as second dust filter 27b can suppress the clogging in the filter.

[0074] Fig. 4 shows a sectional view of an enlarged essential part of second dust filter 27b shown in Fig. 3D. In this first embodiment, as shown in Fig. 3D and Fig. 4, a sheet of filter made of PTFE film, having vent holes of which diameter is approx. 0.5 micron, and reinforced by PET resin for increasing rigidity, is used. This sheet filter is pleated to form pleated filter 41, and both of the ends are coupled together to form a cylindrical shape.

[0075] At the circumference of pleated filter 41, dints 42 are formed on the inner wall of the pleated member which is located on the upper stream side of the sucking airflow, and dints 42 shape like letter U and are rounded with R (radius) = 2 - 5 mm. Some part of pleated filter 41 closer to first dust filter 27a has no dints 42.

[0076] Exterior of pleated filter 41, i.e. second dust filter 27b, is sealed with resin or sealing agent at the upper and lower ends in the range of several millimeters to form sealed section 43, which blocks both of upward and downward air-permeability.

[0077] Operation of the foregoing vacuum cleaner in accordance with the first embodiment is demonstrated hereinafter with reference to Figs. 5A - 5C. Upon turning on electric air blower 21, sucking airflow is generated, and air including dust scattered on the floor is sucked into dust collecting case 5 via sucking tool 9, extension tube 8, and sucking hose 7. Since suction port 6 of case 5 is placed off-center toward the tangent direction on the cross section of the cylinder, the airflow flowing into suction port 6 as shown in Fig. 5A enters into case 5 along the tangent direction of the cross section of the cylindrical case 5, and then changes into the whirling airflow.

[0078] The whirling airflow generated at upper section 22a of case 5 whirls and lowers to the vicinity of cylindrical dust filter 27. Since first dust filter 27a placed on the upper stream side has no projections toward the interior of dust collecting case 5, nothing blocks the flow of the whirling airflow, so that the airflow still whirls and passes through first dust filter 27a, second dust filter 27b, and space 33 sequentially as shown in Fig. 5B, and is sucked into electric air blower 21.

[0079] The dust sucked together with the sucking airflow whirls with the airflow and arrives at cylindrical dust filter 27, and fine dust 51 such as grains of sand passes through first dust filter 27a and is filtered out by second dust filter 27b placed outside the first one.

[0080] Rough dust 52 such as lint having a small specific gravity and subject to wind pressure is easily removed from the surface of first dust filter 27a, and as shown in Fig. 5B and Fig. 5C, rough dust 52 still whirls in first dust filter 27a at the hollow cylinder. This operation proves that first dust filter 27a exerts self-cleansing function by using the airflow, so that no clogging is invited and a decrease in the suction force can be suppressed.

[0081] As an amount of dust sucked increases, rough dust 52 such as lint whirls in first dust filter 27a and lowers to dust collector 24. To summarize what is discussed above, rough dust 52 such as lint receives wind pressure from the whirling airflow, and then whirls and lowers to dust collector 24, and fine dust 51 such as grains of sand passes through mesh holes of first dust filter 27a, so that no dust accumulates in first dust filter 27a, which can be thus free from clogging and maintain its air permeability.

[0082] To be more specific, dust sucked is positively separated into fine dust 51 and rough dust 52, and fine dust 51 is filtered out by second dust filter 27b, and rough dust 52 is caught by dust collector 24. Suction path running from suction port 6 to electric air blower 21 is secured along the circumference of first and second dust filters 27a and 27b, so that a decrease in air volume can be suppressed.

[0083] On top of that, second dust filter 27b includes dints 42 at its pleated section located on the upper stream side of the sucking airflow, and each one of the dints 42 shapes like letter U and is rounded with 2R - 5R. This rounded dint prevents fine dust 51 from attaching to and accumulating on second dust filter 27b. Even if fine dust 51 accumulates, this structure allows removing fine dust 51 with ease, so that the decrease in air volume due to clogging in the filter can be prevented.

[0084] Although an amount of dust accumulated in dust collecting case 5 increases, door 31 is opened for discharging the dust smoothly because no projections exist in the interior of case 5, which can be thus taken care very easily.

[0085] Performance of maintaining the air volume is evaluated on the vacuum cleaner in accordance with the first embodiment. House dust is separated into lint and fine dust by using a sieve, and 4g of lint and 3g of fine dust are mixed together, so that total 7g is sucked per operation for evaluating a change in the air volume. Fig. 6 shows the evaluation result. A cyclone vacuum cleaner commercially available is also evaluated for comparison purpose.

[0086] As shown in Fig. 6, the vacuum cleaner of the first embodiment maintains an air volume at a high level from the start, and it maintains over 90% of the initial air volume after sucking 80g of dust; however, the cyclone vacuum cleaner shows a low air volume at the start, and decreases the air volume at a high speed, then it only keeps not more than 80% of the initial air volume after sucking 60g of dust. On top of that, sucking power of the two cleaners are measured, and the cleaner of the first embodiment shows the sucking power higher than the cyclone cleaner by over 100W.

[0087] This evaluation proves that the vacuum cleaner in accordance with the first embodiment maintains the sucking power at a high level, and resists against the decrease in suction force while it sucks dust.

[0088] In this first embodiment, second dust filter 27b is placed along the entire outer circumference of first dust filter 27a; however, as shown in Figs. 7, 8A and 8B, second dust filter 27b is not necessarily placed along the entire circumference, and it can be placed simply on the suction side of the air blower. This simple structure produces an advantage similar to what is discussed above.

[0089] As shown in Fig. 9A with broken lines and in Fig. 9B, cylindrical dust filter 27 is notched, and see-through and arc-shaped material is fit into this notch to form see-through window 91, which allows a user to monitor accumulated dust vertically in a sectional view. The user thus can easily find some item erroneously sucked out of the dust.

Embodiment 2

[0090] In this second embodiment, differences in structure and operation from those of the first embodiment are discussed, and elements similar to those used in the first embodiment have the same reference marks and the descriptions thereof are omitted here. Figs. 10, 11A, 11B, 11C and 11D show a vacuum cleaner in accordance with the second embodiment and sectional views of dust collecting case 5.

[0091] As shown in these Figs., the vacuum cleaner in accordance with the second embodiment differs from that of the first embodiment in third dust filter 28 shaped like a cylinder placed beneath cylindrical dust filter 27. This third dust filter 28 is formed of a rough dust filter which is made of metal mesh of which vent hole is 250 micron across. This structure is similar to first dust filter 27a. An inner end of third dust filter 28 solidly contacts (without any gaps) with the rim end of first dust filter 27a, and an outer end of third dust filter 28 solidly contacts with sealed section 43 and dust collector 24 such that third dust filter 28 can cover over sealed section 43 at the lower end of the outer circumference of second dust filter 27b.

[0092] Third dust filter 28 is placed at some place in

sub air-duct 29b, i.e. a second air-duct, running from suction port 6 to the lower end of second dust filter 27b via the hollow cylinder of first dust filter 27a, dust collector 24 and this third dust filter 28. First dust filter 27a, second dust filter 27b and third dust filter 28 are thus placed in main air-duct 29a, through which suction port 6 communicates with electric air blower 21, or sub air-duct 29b. Operation of the foregoing vacuum cleaner is demonstrated hereinafter with reference to Figs. 12A - 12C.

[0093] Upon starting the operation of electric air blower 21, sucking airflow is generated, and dust scattered on the floor is sucked into dust collecting case 5 via sucking tool 9, extension tube 8, and sucking hose 7. Since suction port 6 of case 5 is placed off-center toward the tangent direction on the cross section of the cylinder, as shown in Fig. 12A, the airflow flowing in suction port 6 enters in case 5 along the tangent direction of the cross section of the cylinder, and changes to the whirling airflow.

[0094] The whirling airflow generated at upper section 22a of case 5 whirls and lowers to the vicinity of cylindrical dust filter 27. Since first dust filter 27a placed on the upper stream side has no projections toward the interior of dust collecting case 5, nothing blocks the flow of the whirling airflow, so that the airflow still whirls and passes through first dust filter 27a, second dust filter 27b, and space 33 sequentially as shown in Fig. 12B, and is sucked into electric air blower 21.

[0095] The dust sucked together with the sucking airflow whirls with the airflow and arrives at cylindrical dust filter 27, and fine dust 51 such as grains of sand passes through first dust filter 27a and is filtered out by second dust filter 27b placed outside the first dust filter 27a.

[0096] Rough dust 52 such as lint having a small specific gravity and subject to wind pressure is easily removed from the surface of first dust filter 27a, and as shown in Fig. 12B and Fig. 12C, rough dust 52 still whirls in first dust filter 27a at the hollow cylinder. This operation proves that first dust filter 27a exerts self-cleansing function by using the airflow, so that no clogging is invited and a decrease in the suction force can be suppressed.

[0097] As an amount of dust sucked increases, rough dust 52 such as lint whirls in first dust filter 27a and lowers to dust collector 24. Rough dust 52 arrived at dust collector 24 is sucked toward dints 42 of pleated section at the end of second dust filter 27b via third dust filter 28 placed over dust collector 24, so that rough dust 52 can be caught and accumulated positively in dust collector 24. On top of that, compression acts on rough dust 52, so that shrinkage in a volume of rough dust 52 can be expected.

[0098] Without sub air-duct 29b, when the suction path is blocked on the upper stream side of dust collecting case 5, almost all the dust in dust collector 24 is raised cloudily and reattaches to the inner wall of first dust filter 27a. Sub air-duct 29b communicates with main air-duct 29a via dust collector 24 when the sucking path is blocked on the upper stream side, and sub air-duct 29b thus becomes a bypath which can prevent, in advance, the dust from being raised cloudily.

[0099] In first dust filter 27a, rough dust 52 such as lint receives wind pressure from the whirling airflow, and then whirls and lowers, and fine dust 51 such as grains of sand passes through mesh holes of first dust filter 27a, so that no dust accumulates in first dust filter 27a, which can be thus free from accumulation of dust, and maintain its air permeability.

[0100] Third dust filter 28 is made of metal mesh, and placed such that its inner end solidly contact (without any gaps) with the rim end of first dust filter 27a, and its outer end solidly contacts with sealed section 43 provided to the outer circumference on the lower end of second dust filter 27b. This structure allows fine dust 51 mixed with rough dust 52 in dust collector 24 to pass through third dust filter 28, and then rough dust 52 is filtered out by second dust filter 27b.

[0101] To be more specific, dust sucked is positively separated into fine dust 51 and rough dust 52, and fine dust 51 is filtered out by second dust filter 27b, and rough dust 52 is caught in dust collector 24. The suction path running from suction port 6 to electric air blower 21 is secured along the circumference of first and second dust filters 27a and 27b, so that a decrease in air volume can be suppressed.

[0102] In this second embodiment, an evaluation test is carried out on the performance of maintaining the air volume as it is done in the first embodiment. Fig. 13 shows the test result, which tells that the second embodiment shows better performance than the first embodiment.

[0103] Use of third dust filter 28 placed in dust collecting case 5 in addition to the structure of the first embodiment allows dust collector 24 to catch and accumulate the rough dust therein positively, so that the decrease in air volume can be more positively suppressed. As a result, a useful vacuum cleaner is obtainable.

[0104] In this second embodiment, second dust filter 27b and third dust filter 28 are placed along the entire circumference of first dust filter 27a; however, similar to the first embodiment, they can be placed simply on the suction side of the air blower (not shown). This simple structure produces a similar advantage to what is discussed above.

Embodiment 3

[0105] In this third embodiment, differences in structure and operation from those of the first and second embodiments are discussed, and elements similar to those used in the first and second embodiments have the same reference marks and the descriptions thereof are omitted here.

[0106] Fig. 14 shows a sectional plan view of an essential part of cylindrical dust filter 27. Other structures remain as they are in the second embodiment. As shown in Fig. 14, driving gear 141 is placed to sealed section 43 at the upper end of outer circumference of second

dust filter 27b. Second dust filter 27b and first dust filter 27a are rotated together by this driving gear 141 and another driving gear 142 engaging with driving gear 141, and motor 143 which drives gear 142.

[0107] Both of first and second dust filters 27a, 27b can be rotated as discussed above; however, only second dust filter 27b can be rotated, or first dust filter 27a is provided with driving gear 141, and then first dust filter 27a can be driven alone by driving gear 142 and motor 143.

[0108] Rotation of first and second dust filters 27a, 27b driven by motor 143 allows preventing dust from attaching to the filters at some parts in unbalanced manner, because the dust tends to attach to around partition wall 26 on which suction force of air blower 2 acts more strongly. The foregoing structure thus can prevent this problem, and make an amount of dust attaching to the first and second dust filters 27a, 27b uniform quantity-wise, so that a decrease in air volume due to clogging in the filter can be prevented more positively.

[0109] Performance of maintaining the air volume is evaluated on the vacuum cleaner in accordance with the third embodiment. House dust is separated into lint and fine dust by using a sieve, and 4g of lint and 3g of fine dust are mixed together, so that total 7g is sucked per operation for evaluating a change in the air volume. Fig. 15 shows the evaluation result, which tells that this third embodiment is more excellent in the performance of maintaining air volume than the second embodiment.

[0110] This evaluation proves that the vacuum cleaner in accordance with the third embodiment maintains the sucking power at a high level, and resists against the decrease in suction force while it sucks dust. In this third embodiment, second dust filter 27b and third dust filter 28 are placed along the entire circumference of first dust filter 27a; however, similar to the previous embodiments, they can be placed simply on the suction side of the air blower (not shown). This simple structure produces a similar advantage to what is discussed previously.

Embodiment 4

[0111] In this fourth embodiment, differences in structure and operation from those of embodiments 1 - 3 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0112] Figs. 16A, 16B and 17 show sectional views of dust collecting case 5 in accordance with the fourth embodiment and essential parts of dust collecting case 5. In Figs. 16A and 16B, first dust removing means 161 is rigidly mounted to at least one of an upper section or a lower section of dust collecting case 5. As shown in Fig. 17, first dust removing means 161 shapes like a spatula, of which both ends are sharpened, and is urged against the inner wall of first dust filter 27a.

[0113] As already described in embodiment 3, motor 143 and driving gear 142 rotate driving gear 141 placed on second dust filter 27b, so that first dust filter 27a and second dust filter 27b are rotated together, then first dust removing means 161 slides on the inner wall of first dust filter 27a while it is urged against the inner wall. First dust removing means 161 thus cleans the inner wall of first dust filter 27a by removing the dust such as lint attaching to or accumulating on the inner wall of first dust filter 27a, thereby maintaining the air permeability of first dust filter 27a and preventing a decrease in air volume.

[0114] First dust filter 27a is set such that it rotates one turn for 5 seconds, and motor 143 is powered for 5 seconds by a controller (not shown) just after electric air blower 21 is stopped, so that both of second and first dust filters 27b, 27a rotate together. In this instance, only one dust removing means 161 is employed; however, a plurality of the dust removing means will produce the greater advantage.

[0115] First dust removing means 161 shaping like a spatula is employed in this fourth embodiment; however, the shape can be changed to a brush-like or raising-like shape depending on types of the dust for obtaining proper effect to the shape.

[0116] In this embodiment, as shown in Fig. 16A, a bar-like member is mounted vertically to an upper section of dust collecting case 5 as first dust removing means 161; however, as shown in Fig. 18, first dust removing means 161 can be mounted spirally with an angle while it is urged against the inner wall of first dust filter 27a. This structure increases shearing effect when first filter 27a is rotated, so that hair or lint tangled is sheared during the cleaning, and the better cleaning effect can be expected.

Embodiment 5

[0117] In this fifth embodiment, differences in structure and operation from those of embodiments 1 - 4 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0118] Figs. 19A and 19B show sectional views of a vacuum cleaner in accordance with the fifth embodiment. Fig. 19A shows a vertical sectional view of the vacuum cleaner. In Fig. 19A, second dust removing means 191 is placed around the outside of second dust filter 27b. Fig. 20 shows an enlarged essential part of second dust removing means 191, which includes a spring formed by bending metal foil. The spring works as beater 201.

[0119] Driving gear 141 is coupled to second dust filter 27b, and first filter 27a moves together with second dust filter 27b. Driving gear 141 is driven by motor 143 and driving gear 142, thereby driving first and second dust filters 27a, 27b.

[0120] As shown in Figs. 19B and 20, rotation of first and second dust filters 27a, 27b will prompt beater 201 to beat second dust filter 27b from the outside, thereby dropping the dust attaching to or accumulating on the inside of pleated filter 41, which shapes like letter U, of

second dust filter 27b, so that second dust filter 27b can be cleaned. Continuous rotation of filters 27a and 27b will clean the entire circumference of filter 27b.

[0121] In this embodiment, second dust filter 27b is set such that it rotates one turn in 5 seconds, and motor 143 is powered for 5 seconds by a controller (not shown) just after electric air blower 21 is stopped, so that second and first dust filters 27b, 27a rotate together. After electric air blower 21 is halted, second dust filter 27b can be thus cleaned for 5 seconds, thereby dropping the dust attaching to the entire circumference of second dust filter 27b.

[0122] The same evaluation test as the first embodiment is done on the performance of maintaining the air volume, and the result is shown in Fig. 21, which tells that the fifth embodiment is more excellent in this performance than the second embodiment.

[0123] As discussed above, the rotation of first and second dust filters 27a, 27b prompts second dust removing means 191 to remove the dust attaching to second dust filter 27b for cleaning. As a result, the decrease in air volume can be prevented more positively.

[0124] Beater 201 formed by bending metal foil is used as second dust removing means 191 in this fifth embodiment; however, beater 201 can be a plate-like member or an elastic member such as rubber.

Embodiment 6

[0125] In this sixth embodiment, differences in structure and operation from those of embodiments 1 - 5 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0126] Fig. 22 shows a perspective view of dust collecting case 5 of the vacuum cleaner in accordance with the sixth embodiment. In Fig. 22, third dust removing means 221 is rigidly mounted to upper section 22a of case 5, and upper section 22a rotates together with middle section 22b while they maintain air-tightness in between.

[0127] Third dust removing means 221 shapes like a spatula, of which both ends are sharpened, and is urged against the inner wall of first dust filter 27a, as shown in Fig. 23.

[0128] Rotation of upper section 22a will prompt third dust removing means 221 to slide on the inner wall of first dust filter 27a while third dust removing means 221 is urged against the inner wall, thereby cleaning the inner wall of filter 27a. The dust such as lint tangling in and attaching to the inner wall of first filter 27a thus can be removed. This structure allows maintaining the air permeability of filter 27a and preventing a decrease in air volume. In this instance, only one third dust removing means 221 is employed; however, a plurality of third dust removing means 221 will produce the greater advantage.

[0129] Third dust removing means 221 shaping like a spatula is employed in this sixth embodiment; however, the shape can be changed to a brush-like or raising-like shape depending on types of the dust for obtaining proper effect to the shape.

[0130] Third dust removing means 221 is mounted vertically; however, as shown in Fig. 24, it can be mounted spirally with an angle. This structure increases shearing effect when third dust removing means 221 is rotated, so that hair or lint tangled is sheared during the cleaning, and the better cleaning effect can be expected.

[0131] Third dust removing means 221 fixed to upper section 22a of case 5 can be rotated manually along either direction, and this method makes the structure simple, or it can be rotated by a driver and a controller (neither one not shown) such that it rotates in step with the timing when electric air blower 21 starts or stops.

Embodiment 7

[0132] In this seventh embodiment, differences in structure and operation from those of embodiments 1 - 6 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0133] Fig. 25 shows a perspective view of dust collecting case 5 of the vacuum cleaner in accordance with the seventh embodiment. Fig. 26 shows a sectional view of an essential part of a fourth dust removing means (cylindrical basket 251) of the vacuum cleaner. Fig. 25 illustrates that the fourth dust removing means, i.e. cylindrical basket 251, is placed in space 33 outside the second dust filter 27b. Cylindrical basket 251 is formed by coupling upper and lower circular gears 252 together by means of a plurality of connectors 253, and beater 254 is mounted to connectors 253. Beater 254 is formed by bending metal foil as shown in Fig. 26.

[0134] Circular gears 252 are rotated by driving gear 256 equipped to motor 255, thereby rotating cylindrical basket 251. Beaters 254 thus vibrate or beat the outer wall of second dust filter 27b. Rotation of cylindrical basket 251 working as the fourth dust removing means prompts beaters 254 to vibrate or beat the outer wall of second dust filter 27b, thereby dropping fine dust 51 attaching to or accumulating on second dust filter 27b at the pleated section, in particular, at dints 42. Second dust filter 27b thus can be cleaned. Continuous rotation cleans the entire outer wall of second dust filter 27b.

[0135] Cylindrical basket 251 is set such that it rotates one turn in 5 seconds, and motor 255 is powered for 5 seconds by a controller (not shown) just after electric air blower 21 is stopped for rotating cylindrical basket 251 one turn, so that the entire outer wall of second dust filter 27b can be cleaned.

[0136] The same evaluation test as other embodiments is done on the performance of maintaining the air volume, and the result is shown in Fig. 27, which tells that the seventh embodiment is more excellent in this performance than the second embodiment.

[0137] The rotation of cylindrical basket 251 working as the fourth dust removing means allows removing the

dust attaching to second dust filter 27b, and preventing a decrease in air volume more positively.

[0138] Beater 254 formed by bending metal foil is used in this seventh embodiment; however, it can be a plate-like member or an elastic member such as rubber.

[0139] The fourth dust removing means, i.e. cylindrical basket 254 alone is rotated by a controller (not shown) in this instance; however, this controller can be used for rotating third dust removing means 221 demonstrated in embodiment 6, or both of these dust removing means can be rotated simultaneously or with a time lag in between.

Embodiment 8

[0140] In this eighth embodiment, differences in structure and operation from those of embodiments 1 - 7 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0141] Fig. 28 shows a perspective view of dust collecting case 5 of the vacuum cleaner in accordance with the eighth embodiment. Fig. 29A shows a lateral sectional view illustrating the dust accumulated in dust collecting case 5, and Fig. 29B shows a lateral sectional view of door 31 left open.

[0142] As shown in Fig. 28, third dust filter 28 shapes like a truncated cone of which upper and lower ends open, and the upper end has the same diameter as that of the lower end of first filter 27a, so that the upper end of third dust filter 28 contacts with the lower end of first filter 27a. The lower end of third dust filter 28 has a smaller diameter than the inner diameter of the bottom of dust collector 24, and the lower end solidly contacts with the bottom of dust collector 24. Other structures remain unchanged from the first embodiment. Third dust filter 28 is made of metal mesh of which vent holes are 250 micron across.

[0143] The structure employing the truncated cone shape, of which both ends are open, maintains the airflow similar to that in the first embodiment, and fine dust 51 is filtered out by second dust filter 27b, and rough dust 52 is caught and accumulated in dust collector 24.

[0144] Fine dust 51 is removed and dropped from second dust filter 27b with the fourth dust removing means demonstrated in embodiment 7, and as shown in Fig. 29A, such fine dust 51 travels along the slope formed of the bus lines of the truncated cone and positively arrives at the bottom of dust collector 24. This structure allows fine dust 51 dropped to the bottom to be distanced from second filter 27b, so that the suction force less acts on dropped fine dust 51. This structure thus allows preventing fine dust 51 from reattaching to filter 27b, and preventing a decrease in air volume due to clogging in filter 27b.

[0145] The truncated cone shape of third dust filter 28 makes rough dust 52 resist urging against third dust filter 28 even if the space within third dust filter 28 is filled up with rough dust 52, because the lower space is greater than the upper space. As shown in Fig. 29B, when door 31 opens via hinge 32 mounted on the bottom of dust collector 24, the dust can be discharged from third dust filter 28 smoothly and easily by means of gravity. As a result, a vacuum cleaner excellent in throwing dust away is obtainable.

Embodiment 9

[0146] In this ninth embodiment, differences in structure and operation from those of embodiments 1 - 8 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0147] Fig. 30 shows a perspective view of dust collecting case 5 of the vacuum cleaner in accordance with the ninth embodiment. Fig. 31A shows a lateral sectional view illustrating the dust accumulated in case 5, and Fig. 31B shows a lateral sectional view of door 31 left open.

[0148] As shown in Fig. 30, in this ninth embodiment, first dust filter 27a shapes like a truncated cone of which lower end has a larger diameter than the upper end. The truncated cone-shaped first dust filter 27a makes rough dust 52 resist urging against first dust filter 27a even if greater amount of dust than the capacity of dust collector 24 is sucked, whereby the space within first dust filter 27a is filled up with rough dust 52, because the lower space is greater than the upper space. As shown in Fig. 31B, when door 31 opens via hinge 32 mounted on the bottom of dust collector 24, the dust can be discharged from first dust filter 27a smoothly and easily by means of gravity. As a result, a vacuum cleaner excellent in throwing dust away is obtainable.

Embodiment 10

[0149] In this tenth embodiment, differences in structure and operation from those of embodiments 1 - 9 are discussed, and elements similar to those used in the previous embodiments have the same reference marks and the descriptions thereof are omitted here.

[0150] Figs. 32A, 32B and 33 show the structure of dust collecting case 5 of the vacuum cleaner in accordance with the tenth embodiment. Third dust filter 28 has opening 321, and dust chamber 322 placed beneath opening 321 and partitioned off in dust collector 24. The dust removed by second dust removing means 191 is accommodated in this partitioned chamber 322.

[0151] As shown in Figs. 32A, 32B, 33, dust chamber 322 communicates with opening 321 prepared just under second dust removing means 191 for the dust to fall through opening 321 and to be accommodated positively into dust chamber 322. A shape of the inlet of chamber 322 agrees with that of opening 321 so that the dust falling through opening 321 can be accommodated in chamber 322 positively.

[0152] Placement of dust chamber 322 within dust col-

lector 24 allows a user to throw the dust in dust collector 24 away together with the dust in chamber 322.

[0153] Vent holes 323 are prepared in dust chamber 322, and fourth dust filter 324 is placed in order to stop up vent holes 323. Fourth dust filter 324 is made of metal mesh of which air permeable apertures are 250 micron across, which is the same as that of third dust filter 28.

[0154] Placement of fourth dust filter 324 in the sucking air duct is similar to that of third dust filter 28, i.e. fourth dust filter 324 is placed at some point in sub air-duct 29b, i.e. a second air-duct, running from suction port 6 to the lower end of second dust filter 27b via the hollow cylinder of first dust filter 27a, dust collector 24, and vent holes 323 of dust chamber 322.

[0155] Operation of the vacuum cleaner in accordance with the tenth embodiment is demonstrated hereinafter. Fine dust 51 removed by second dust removing means 191 falls through opening 321 prepared in third dust filter 28, so that dust 51 is accommodated into dust chamber 322, which is placed within dust collector 24. This structure allows reducing an amount of dust re-raised in cleaning, and preventing a decrease in the air volume traveling through the first air-duct, i.e. main air-duct 29a and the second air-duct, i.e. sub air-duct 29b.

[0156] Vent holes 323 are prepared in dust chamber 322, and vent holes 323 are stopped up with fourth dust filter 324 made of metal mesh, thereby securing sub air-duct 29b. In sucking the dust, as described in embodiment 2, since rough dust 52 is caught in dust collector 24, the air-duct can be secured along the circumference of first dust filter 27a and second dust filter 27b, so that the decrease in air volume can be prevented.

[0157] Fine dust 51 removed is accommodated in dust chamber 322 and separated from rough dust 52, so that fine dust 51 is prevented from being re-raised or attaching to second dust filter 27b. As a result, the decrease in the air volume traveling through main air-duct 29a and sub air-duct 29b can be prevented more effectively.

INDUSTRIAL APPLICABILITY

[0158] A vacuum cleaner of the present invention maintains sucking power at a high level, while its suction force resists lowering although it sucks dust. This vacuum cleaner thus can substantially lessen cumbersome take-care jobs such as cleaning of the filters, throwing the dust away, so that this vacuum cleaner is useful for various jobs such as a home-use cleaner and a professional-use cleaner.

Claims

1. A vacuum cleaner comprising:

an electric air blower;
a dust separator disposed on an upper stream side of the electric air blower for taking air in, which air is sucked by the electric air blower and includes dust; and
a dust collector for accommodating the dust separated by the dust separator,

wherein the dust separator includes a whirling airflow air-duct for running the air, which is taken in through a suction port and includes the dust, as whirling airflow, and a dust filter forming at least a part of the whirling airflow air-duct, and
wherein the dust filter is surrounded by a space, on which suction force of the electric air blower acts.

2. The vacuum cleaner of claim 1, wherein the whirling airflow air-duct is provided with the dust filter at an entire circumference.

3. The vacuum cleaner of claim 1, wherein the dust collector is disposed below the dust filter.

4. The vacuum cleaner of claim 1, wherein the whirling airflow air-duct forms an approximately cylindrical shape, and the suction port is disposed along a tangent line of the approximately cylindrical shape.

5. The vacuum cleaner of any one of claims 1 - 4, wherein a main air-duct is formed in the space surrounding the circumference of the dust filter, and the suction force of the electric air blower acts on the circumference of the dust filter through the main air-duct.

6. The vacuum cleaner of claim 5, wherein the dust collector includes a sub air-duct on which the suction force of the air blower acts.

7. The vacuum cleaner of claim 6, wherein the sub air-duct runs from the dust collector through the dust filter and reaches an exterior of the dust filter.

8. The vacuum cleaner of claim 6, wherein a third dust filter is disposed in the sub air-duct.

9. The vacuum cleaner of claim 5, wherein the dust filter includes at least a first dust filter for catching rough dust on an upper stream side of sucking airflow, and a second dust filter disposed outer circumference of the first dust filter and on a downstream side of the sucking airflow for catching fine dust.

10. The vacuum cleaner of claim 9, wherein the dust collector includes a sub air-duct on which the suction force of the electric air blower acts.

11. The vacuum cleaner of claim 10, wherein the main air-duct runs from the whirling airflow air-duct to circumference of the dust separator via the first dust filter and the second dust filter, and the sub air-duct

runs from the dust collector to the circumference of the dust separator via a third dust filter and the second dust filter.

12. The vacuum cleaner of claim 11, wherein the third dust filter catches rough dust.

13. The vacuum cleaner of claim 9, wherein the first dust filter includes at least one of punching metal, metal mesh, and resin mesh.

14. The vacuum cleaner of claim 9, wherein the second dust filter shapes like a cylinder formed by rounding a pleated member.

15. The vacuum cleaner of claim 14, wherein the pleated member shapes like letter U and rounded inward at outside of the cylindrical second dust filter.

16. The vacuum cleaner of claim 1, wherein the dust filter rotates.

17. The vacuum cleaner of claim 9, wherein at least one of the first dust filter and the second dust filter rotates.

18. The vacuum cleaner of claim 17, wherein the first dust filter rotates in step with the second dust filter.

19. The vacuum cleaner of claim 1 further comprising a dust removing means for removing dust attaching to the dust filter.

20. The vacuum cleaner of claim 16 further comprising a dust removing means brought into contact with the dust filter rotating.

21. The vacuum cleaner of claim 17 further comprising a dust removing means which is brought into contact with at least one of the first dust filter and the second dust filter rotating, wherein the dust removing means vibrates the contacted dust filter for removing dust attaching to the contacted dust filter.

22. The vacuum cleaner of claim 17 further comprising a dust removing means which is brought into contact with at least one of the first dust filter and the second dust filter rotating, wherein the dust removing means removes dust attaching to the contacted dust filter by scraping or rubbing off the dust from the contacted dust filter.

23. The vacuum cleaner of claim 19, wherein the dust removing means moves while it contacts the dust filter for removing dust attaching to the filter by vibrating the filter, or scraping or rubbing off the dust from the filter.

24. The vacuum cleaner of claim 8, wherein the third dust filter shapes like a truncated cone having a lower diameter greater than an upper diameter, and the truncated cone opens at its upper end and lower end.

25. The vacuum cleaner of claim 1, wherein the dust filter shapes like a truncated cone having a lower diameter greater than an upper diameter.

26. The vacuum cleaner of claim 11, wherein an opening is disposed at a part of the third dust filter, and a dust removing means is disposed near the opening, a dust chamber communicating with the opening is disposed in the dust collector, and dust removed by the dust removing means passes through the opening before it is accommodated in the dust chamber.

27. The vacuum cleaner of claim 26, wherein the dust chamber has a vent hole communicating with the dust collector, and a fourth dust filter is disposed to the vent hole.

28. The vacuum cleaner of claim 1, wherein the dust collector opens its bottom for discharging the dust.

29. The vacuum cleaner of claim 1, wherein at least one of the dust separator and the dust collector at least in part is formed of see-through material.

30. The vacuum cleaner of claim 1, wherein at least a part of the dust filter is formed of see-through material.

Amended claims under Art. 19.1 PCT

1. (Amended)
A vacuum cleaner comprising:

an electric air blower;
a dust separator disposed on an upper stream side of the electric air blower for taking air in, which air is sucked by the electric air blower and includes dust; and
a dust collector for accommodating the dust separated by the dust separator,

wherein the dust separator includes a whirling airflow air-duct for running the air, which is taken in through a suction port and includes the dust, as whirling airflow, and a dust filter forming at least a part of the whirling airflow air-duct, and
wherein the dust filter is surrounded by a space on which suction force of the electric air blower acts, and an air vent of the dust filter is disposed nearer to the dust collector than to the suction port so that the whirling airflow can be generated toward the dust collector.

FIG. 1

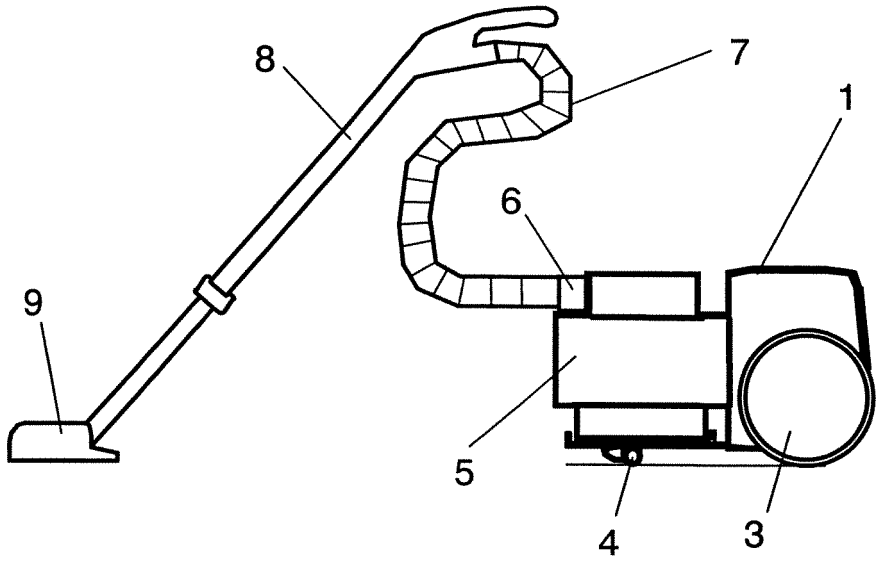


FIG. 2

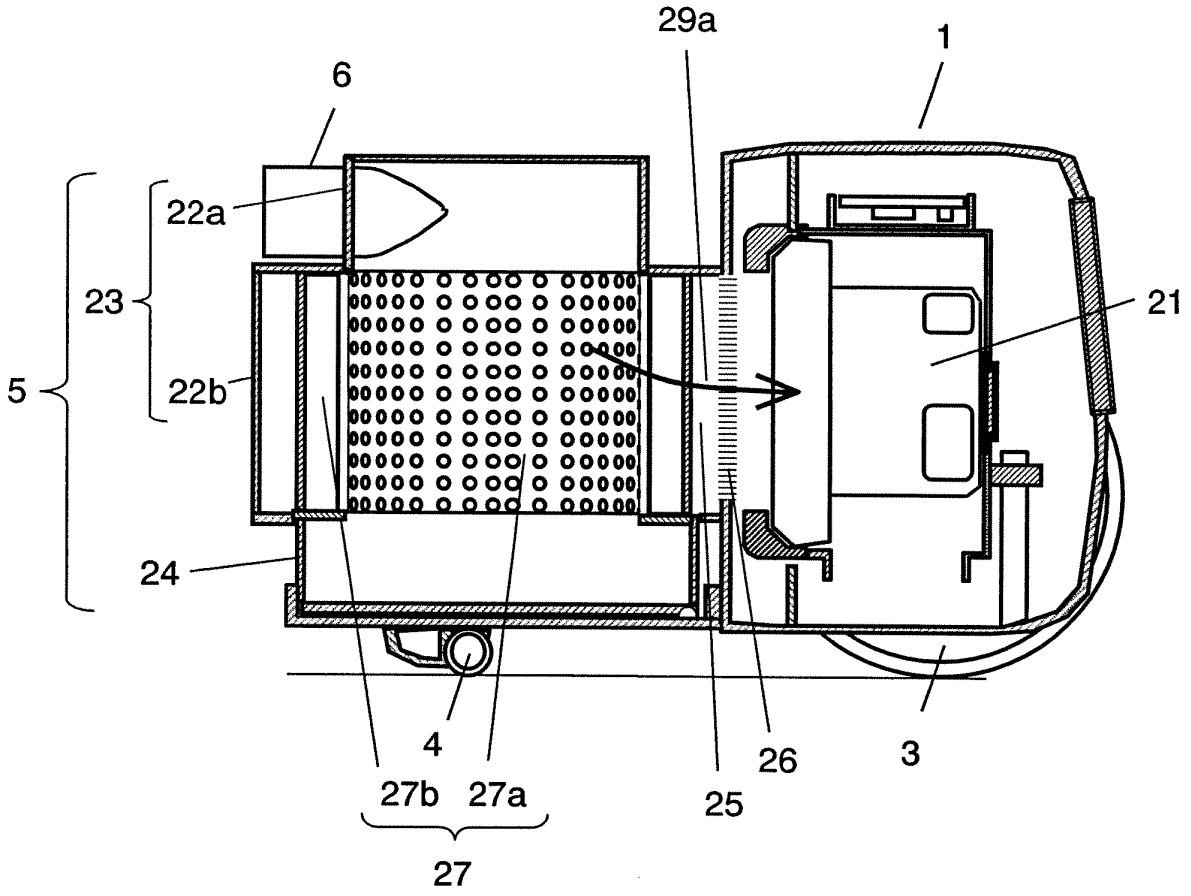


FIG. 3A

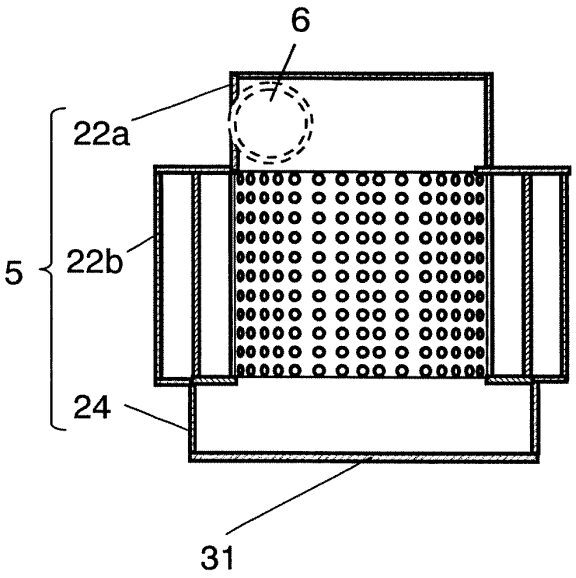


FIG. 3B

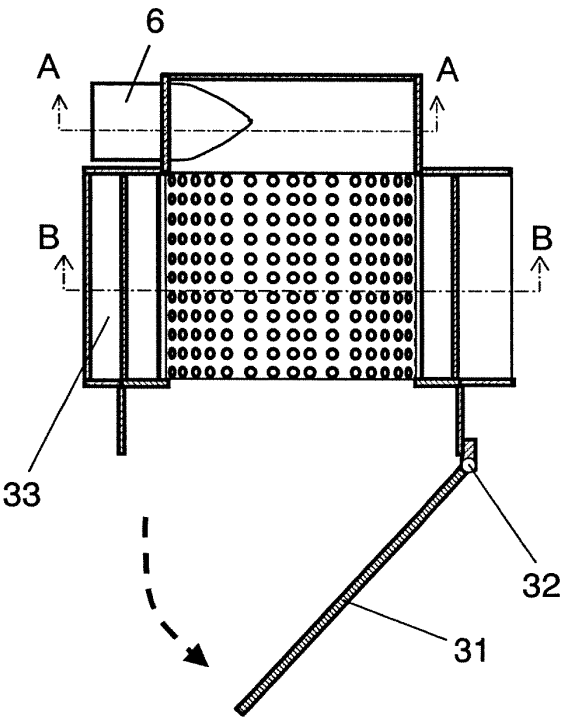


FIG. 3C

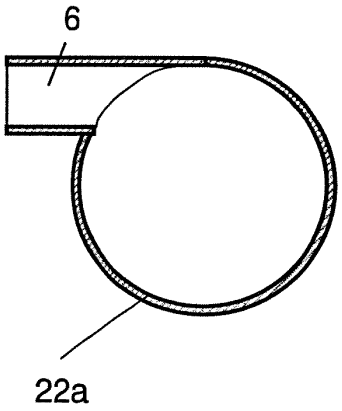


FIG. 3D

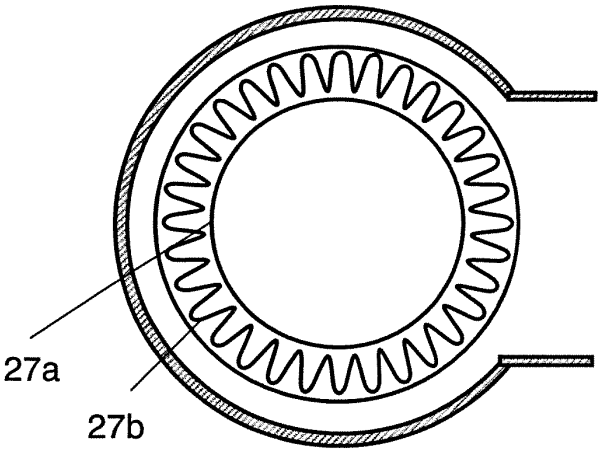


FIG. 4

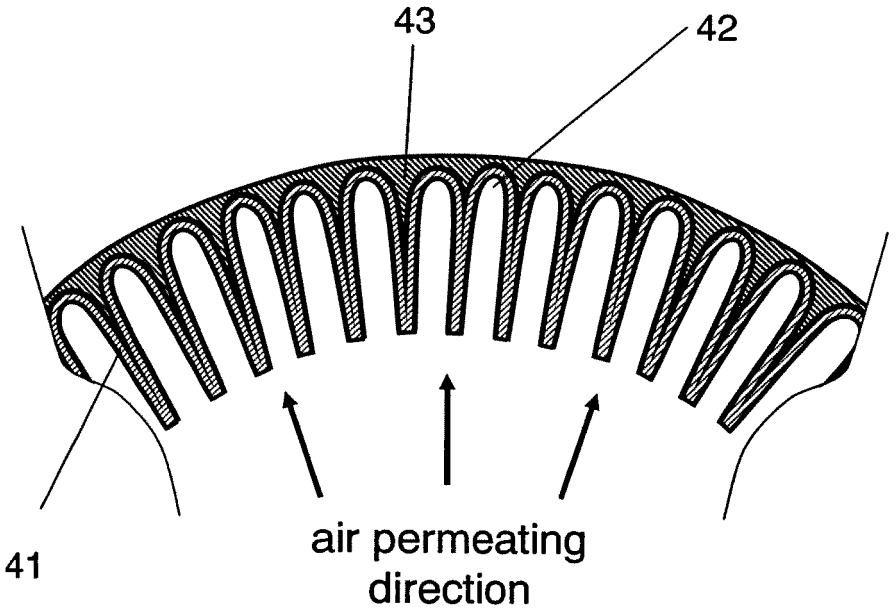


FIG. 5A

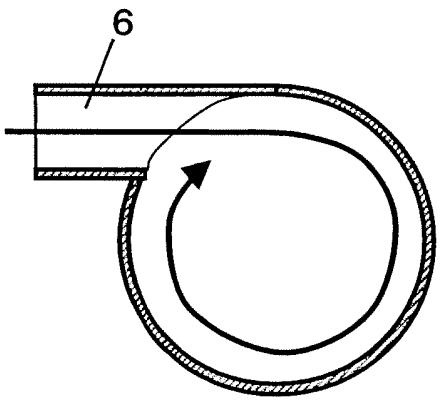


FIG. 5B

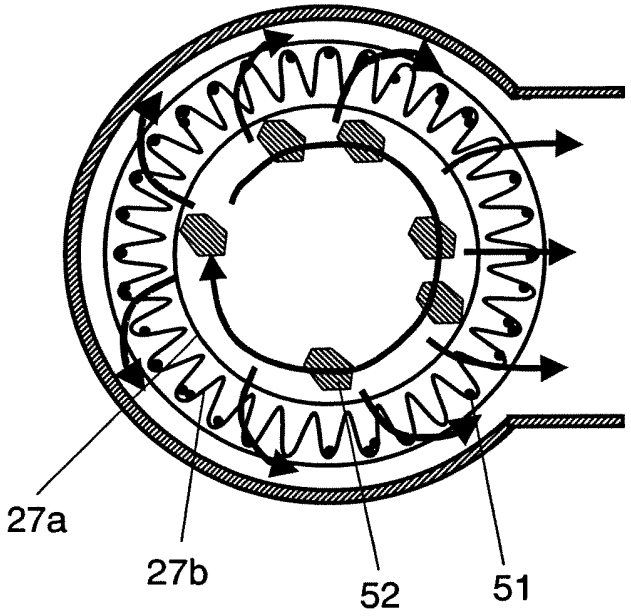


FIG. 5C

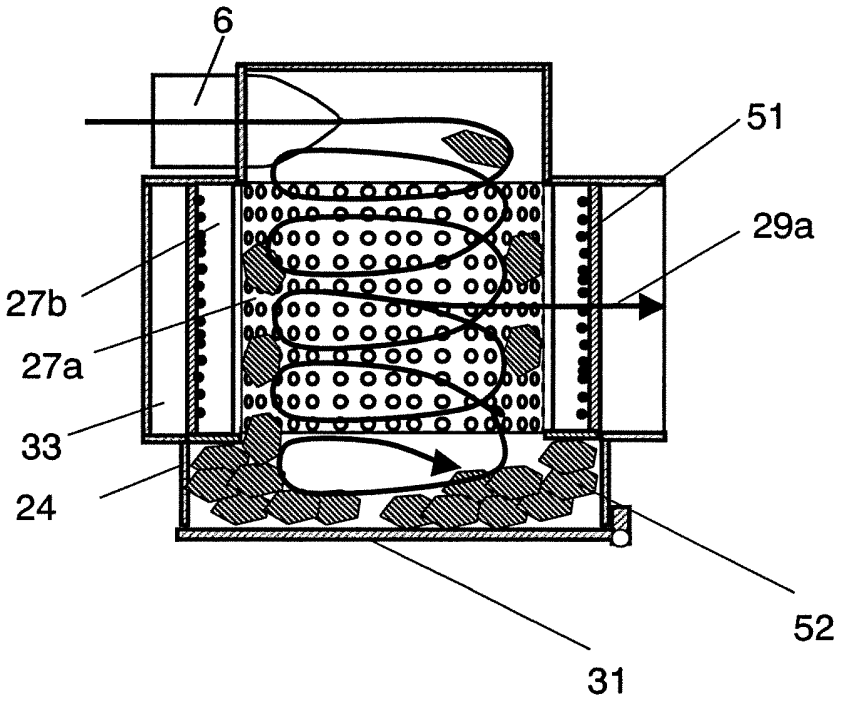


FIG. 6

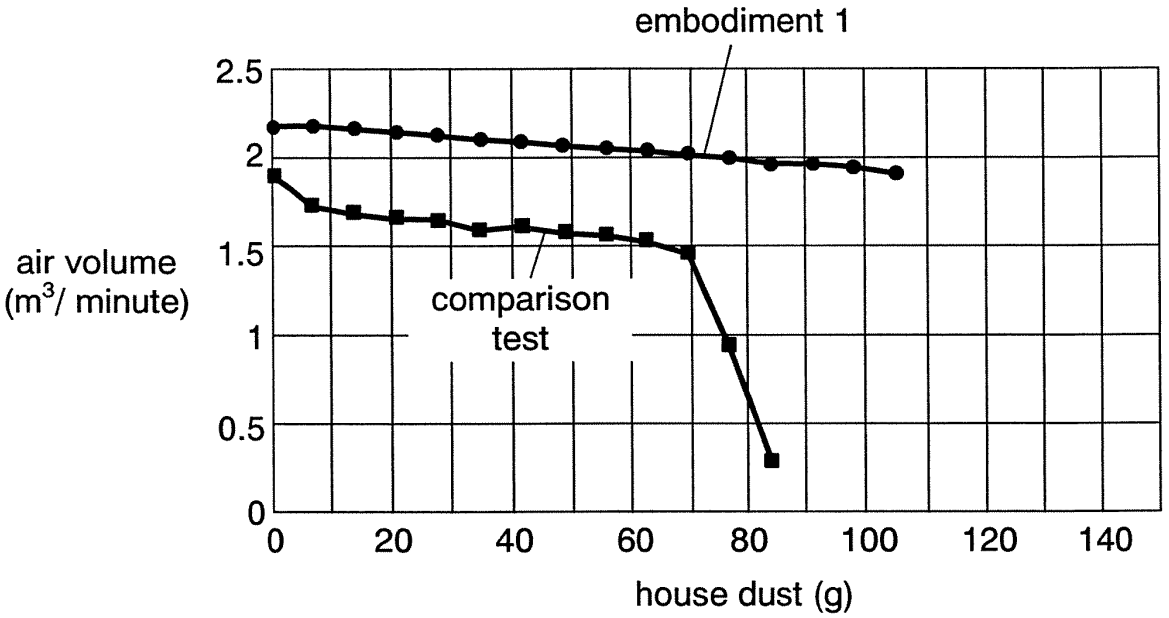

embodiment 1
2.5
2
1.5
1
0.5
0
air volume
(m3/ minute)
comparison
test
0
20
40
60
80
100
120
140
house dust (g)

FIG. 7

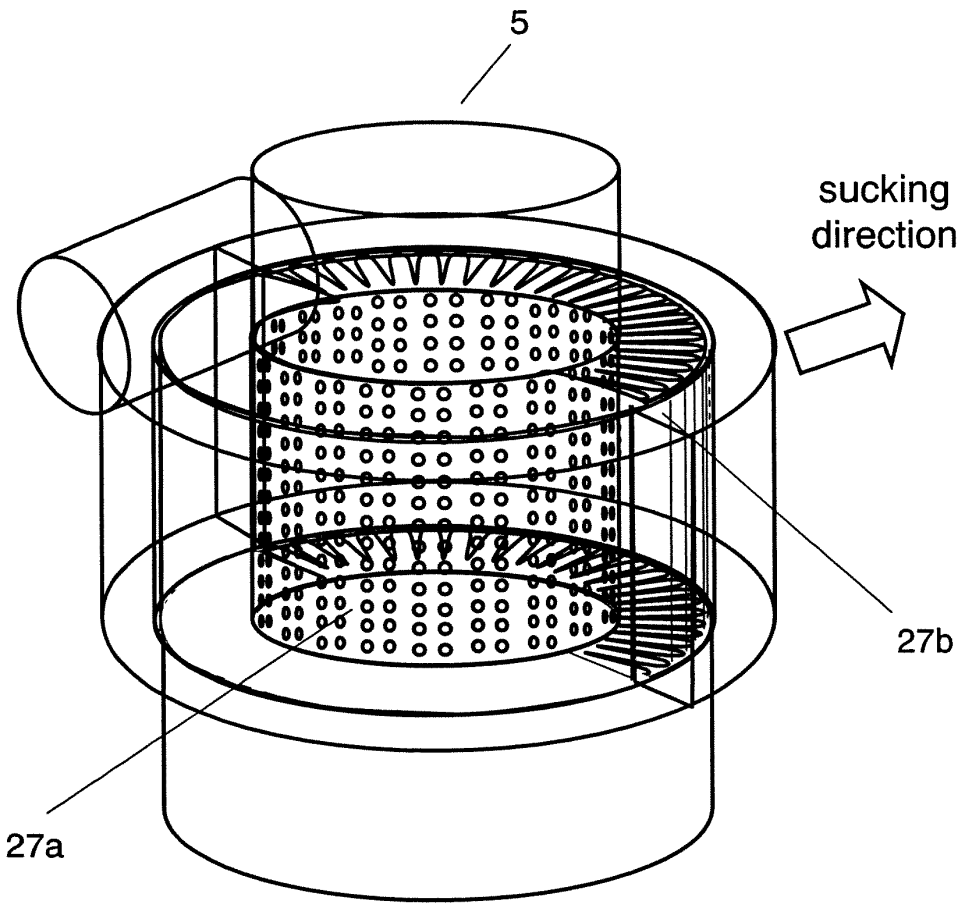


FIG. 8A

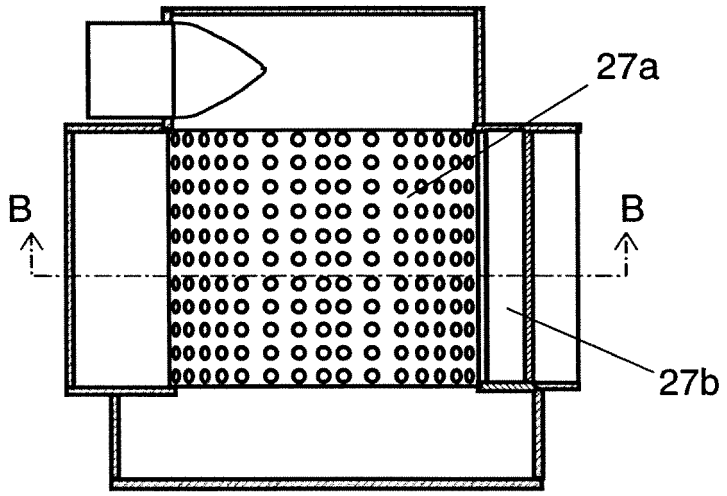


FIG. 8B

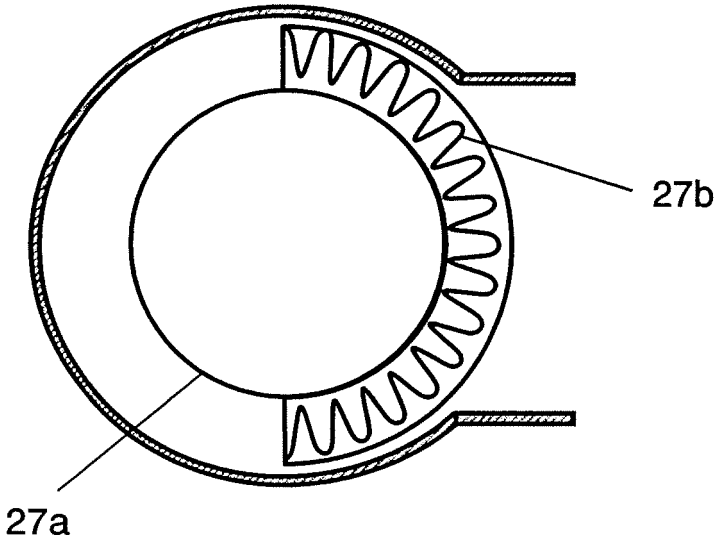


FIG. 9A

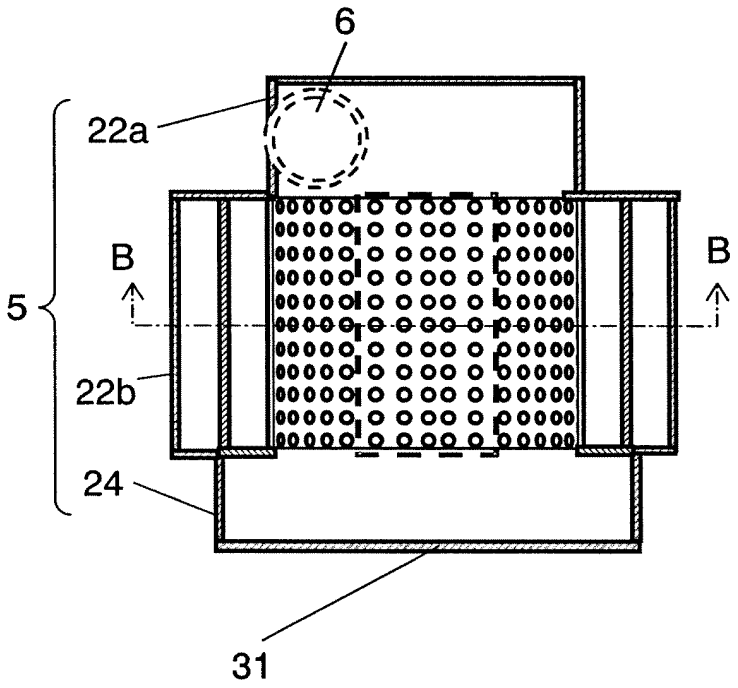


FIG. 9B

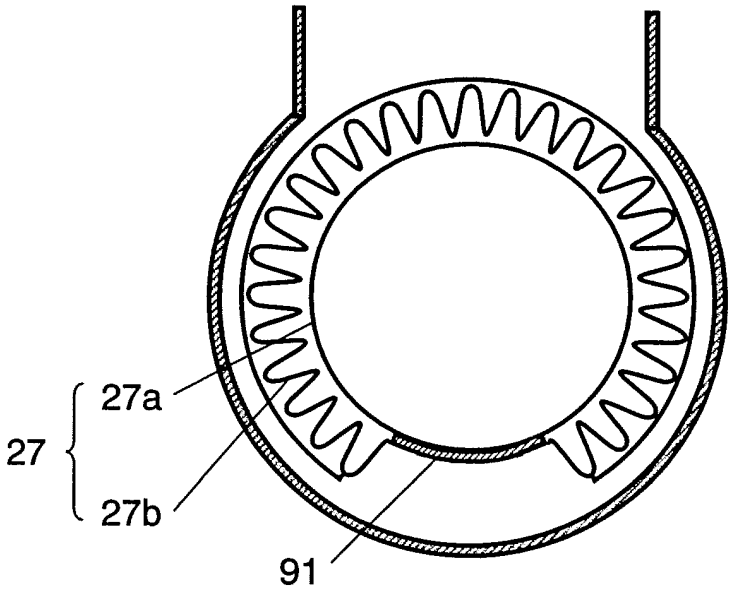


FIG. 10

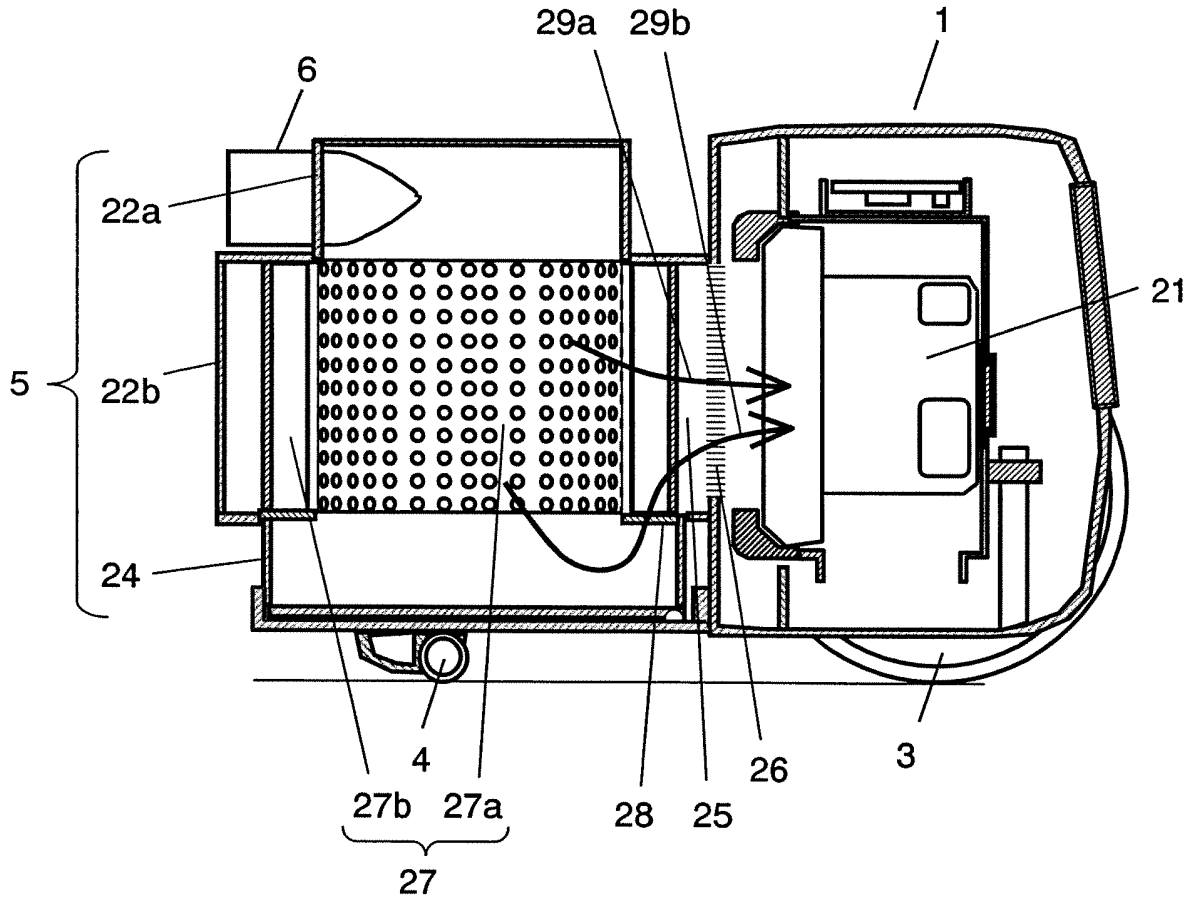


FIG. 11A

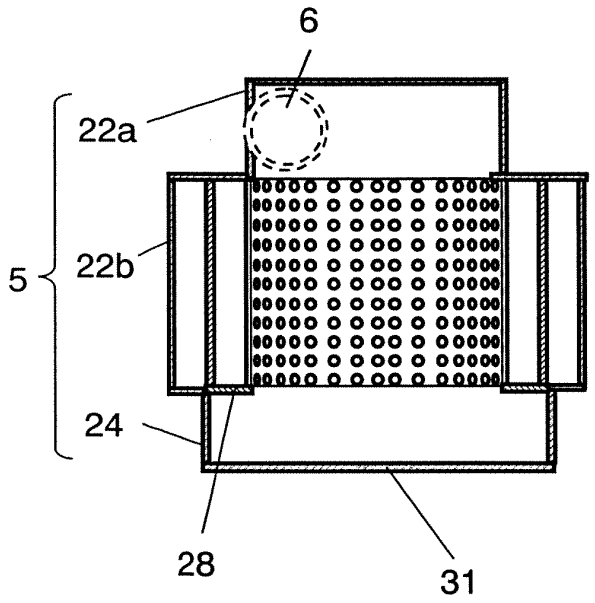


FIG. 11B

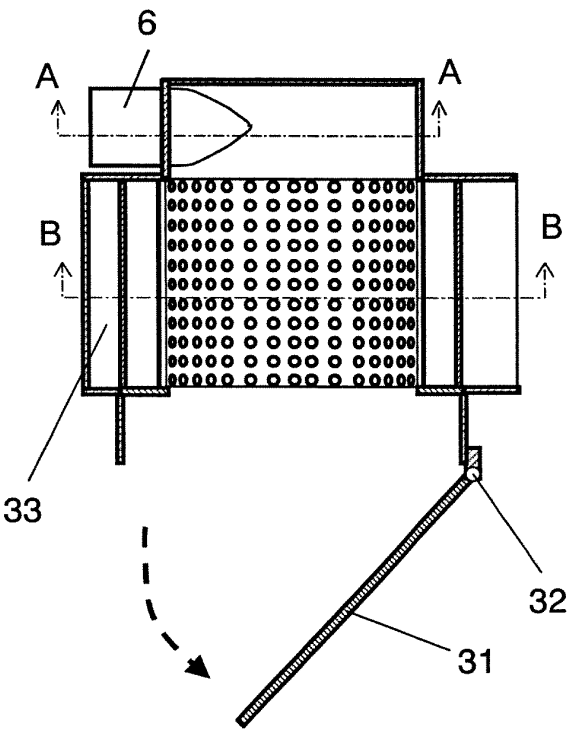


FIG. 11C

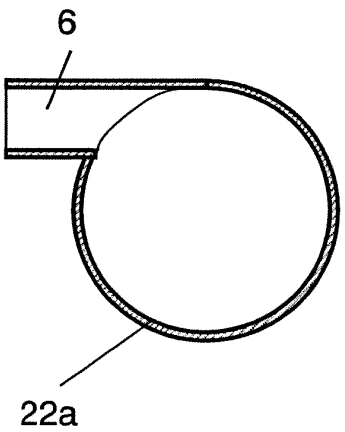


FIG. 11D

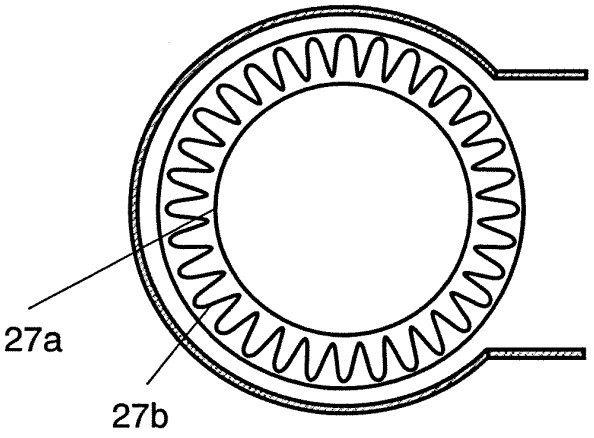


FIG. 12A

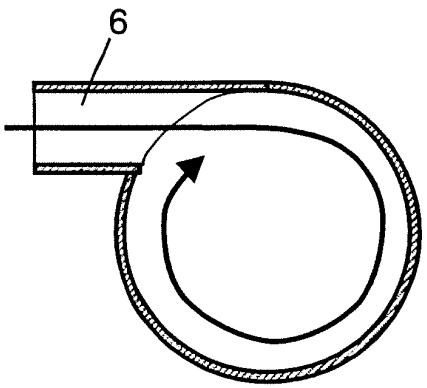


FIG. 12B

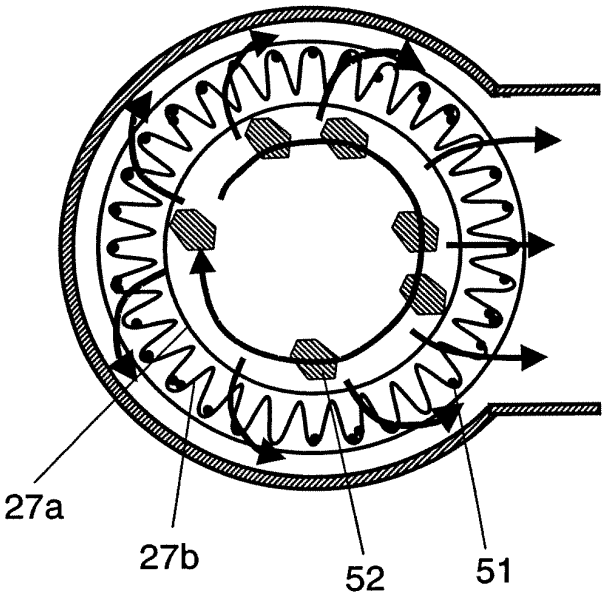


FIG. 12C

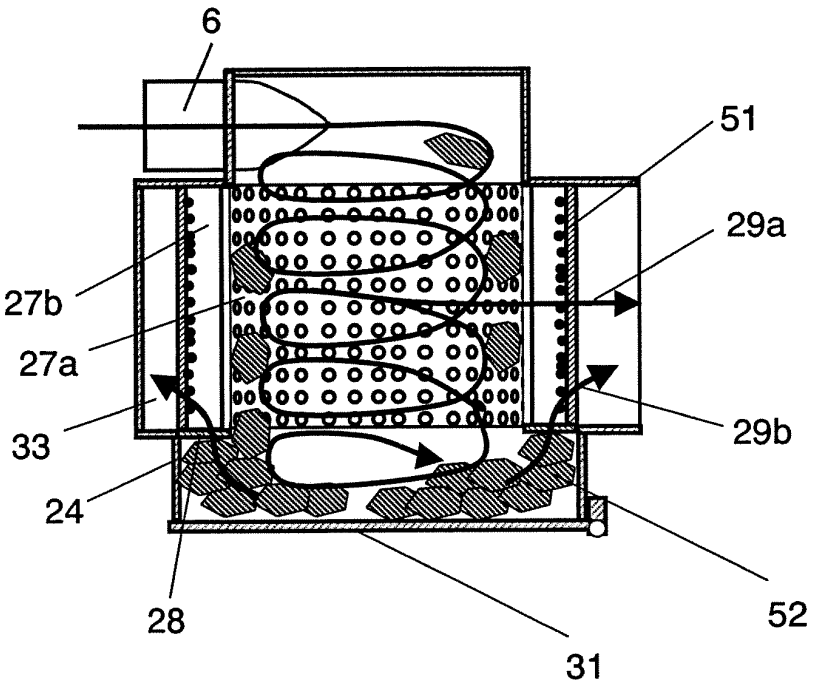


FIG. 13

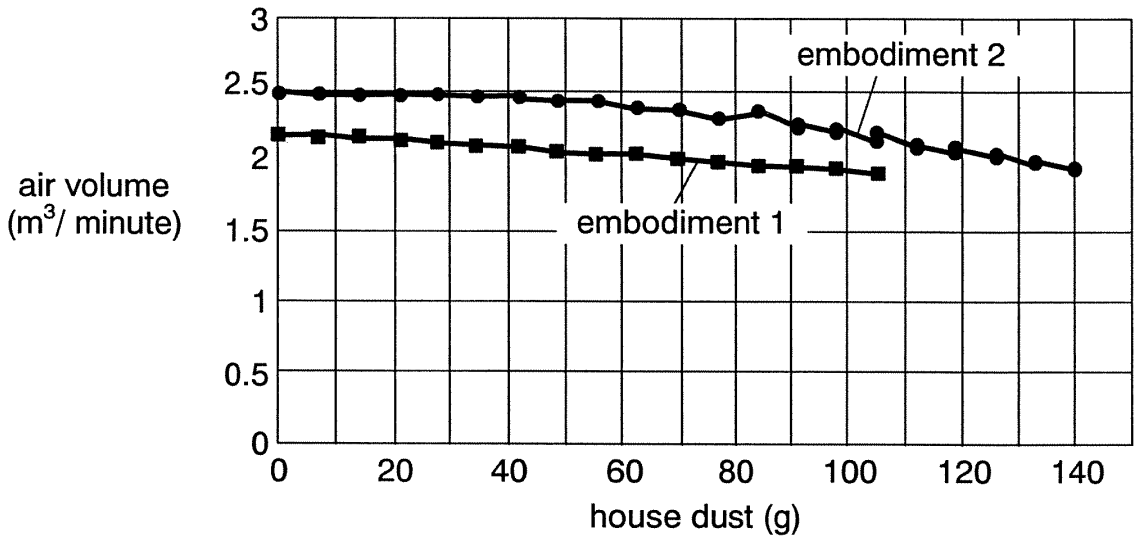

air volume
(m3/ minute)
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
house dust (g)
embodiment 2
embodiment 1

FIG. 14

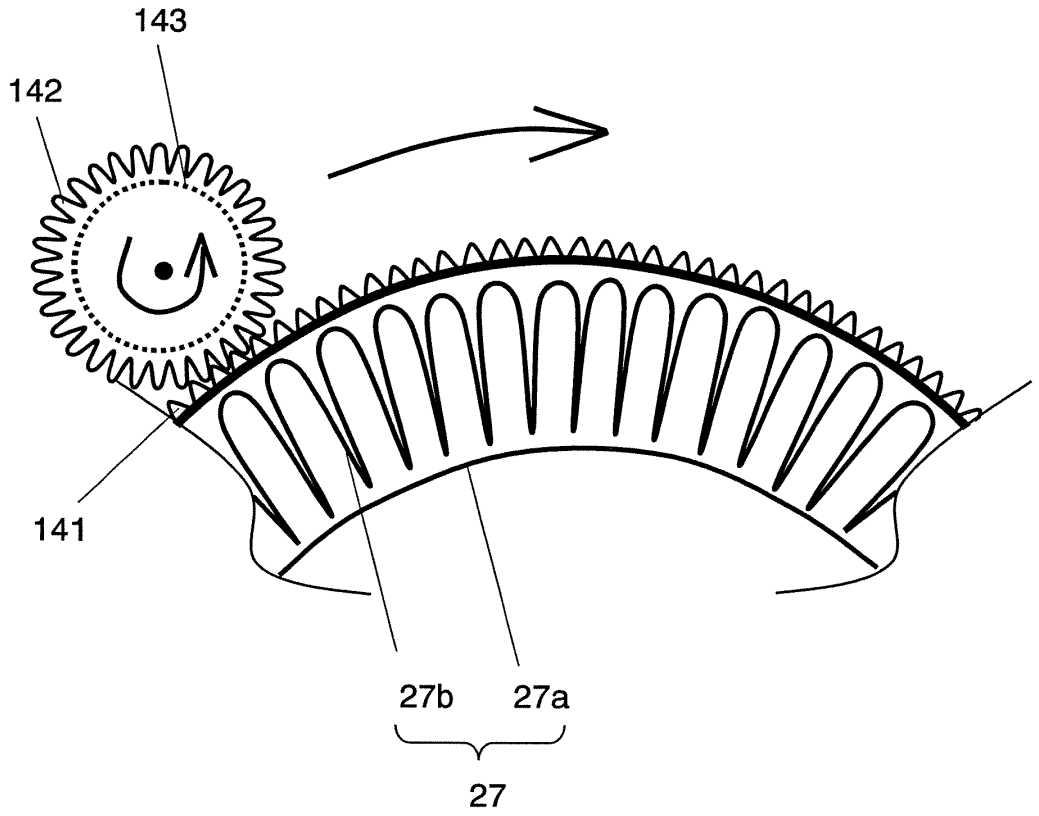

143
142
141
27b
27a
27

FIG. 15

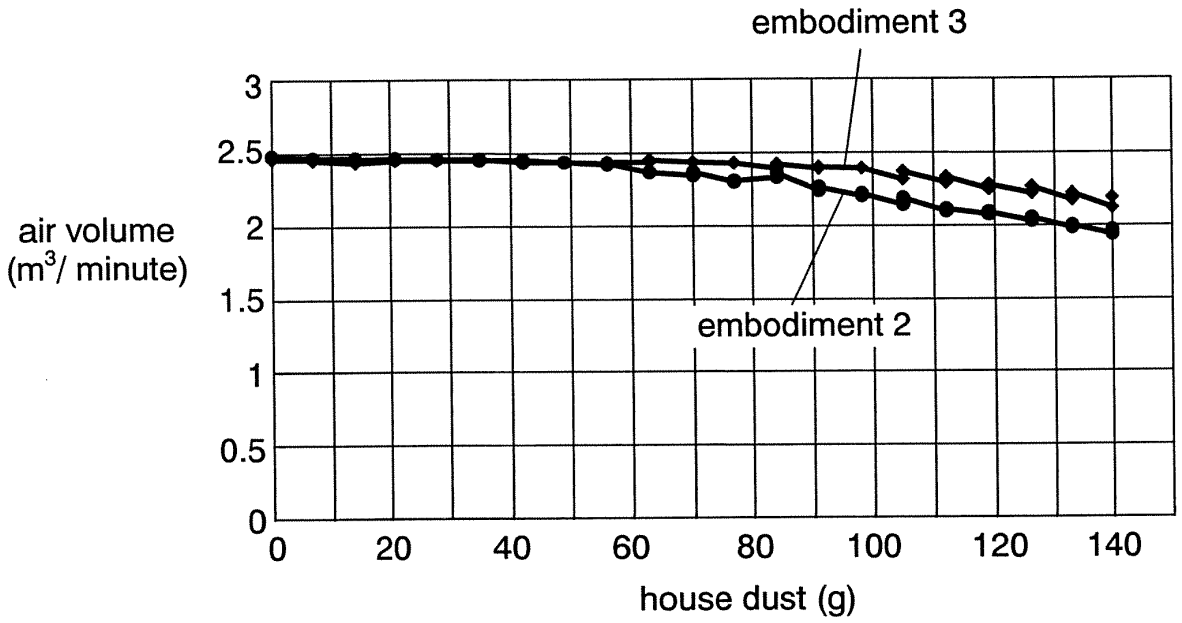

embodiment 3
embodiment 2
air volume
(m3/ minute)
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
house dust (g)

FIG. 16A

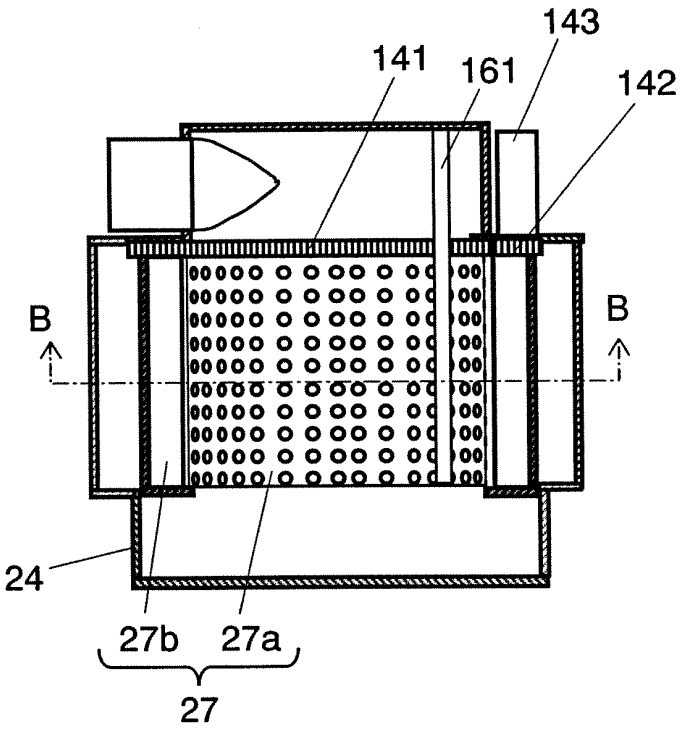


FIG. 16B

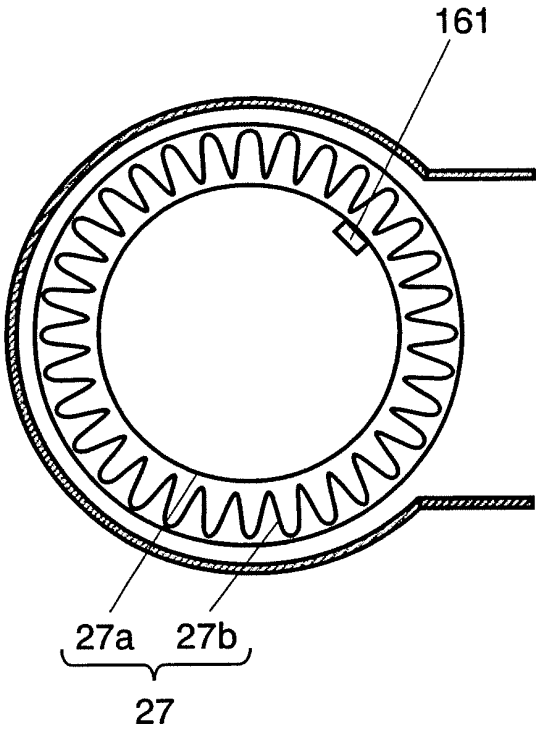


FIG. 17

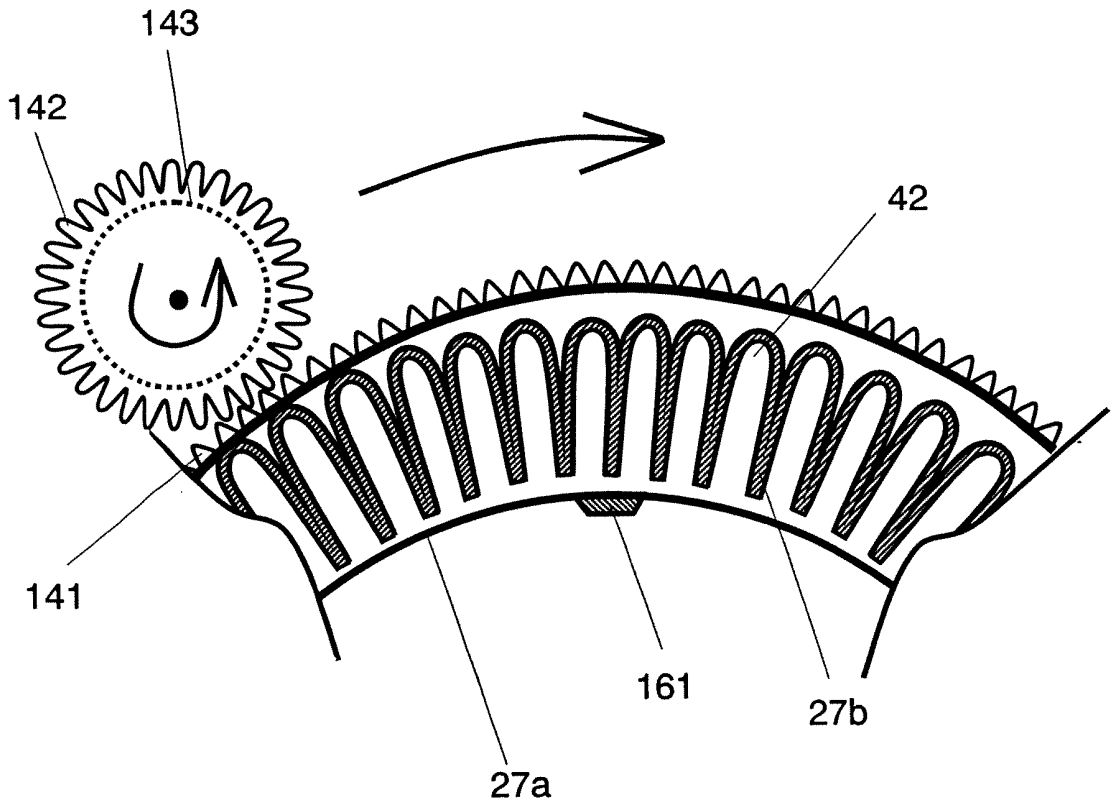


FIG. 18

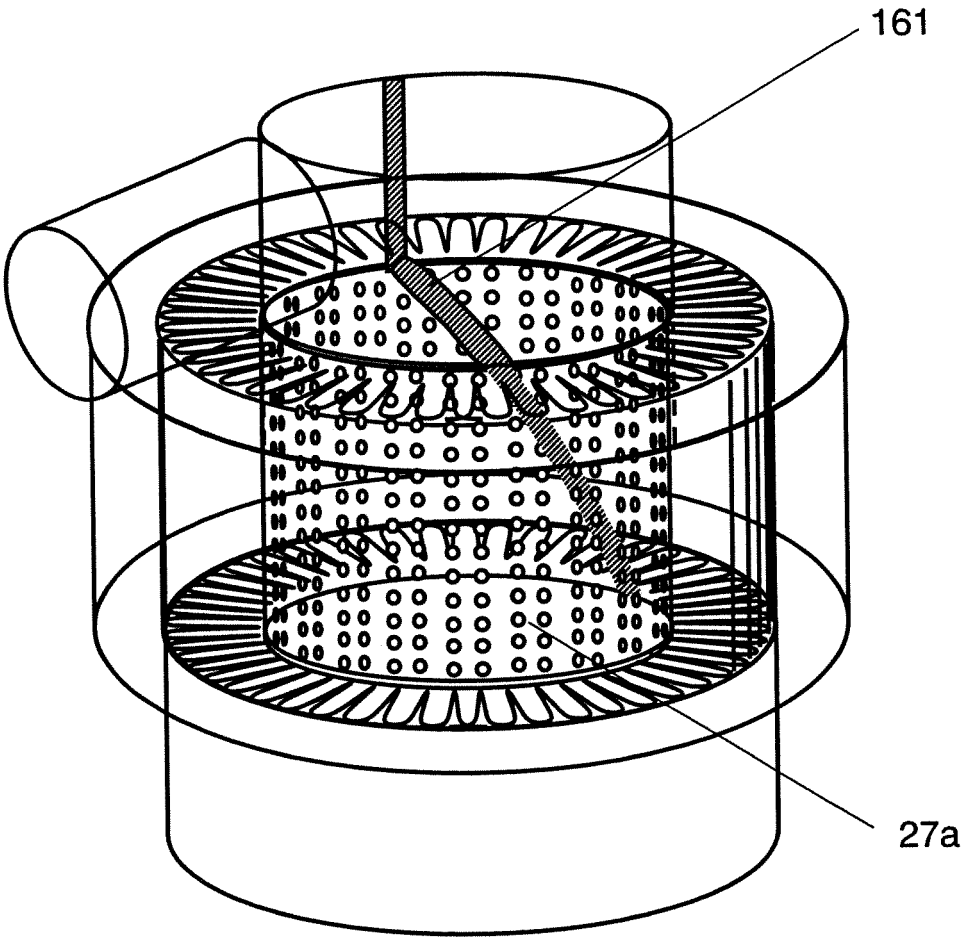


FIG. 19A

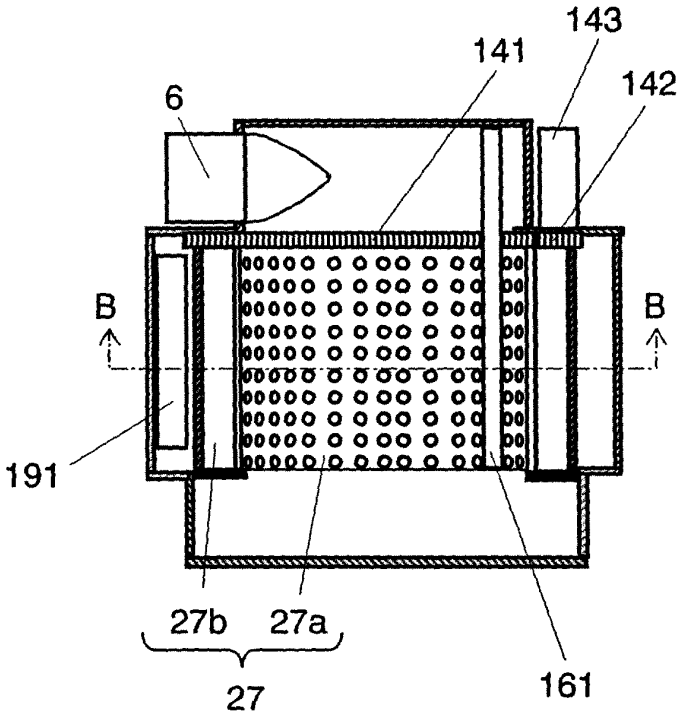


FIG. 19B

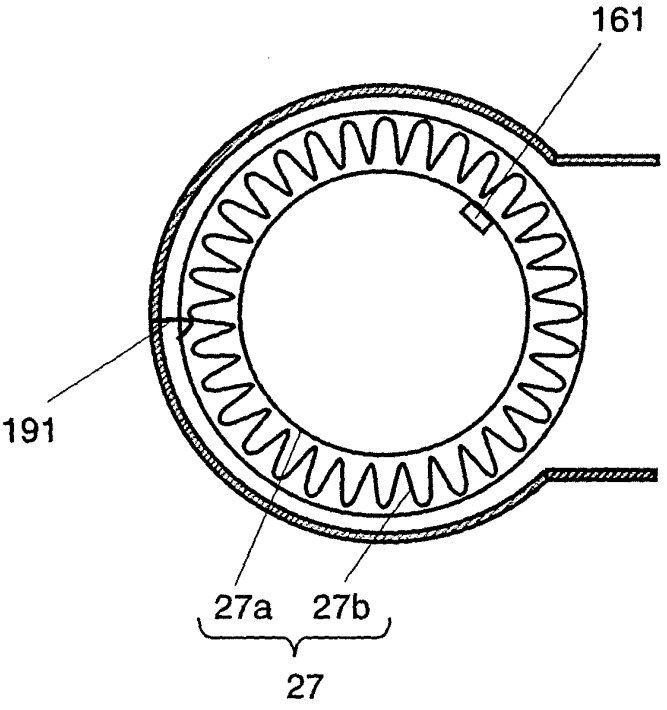


FIG. 20

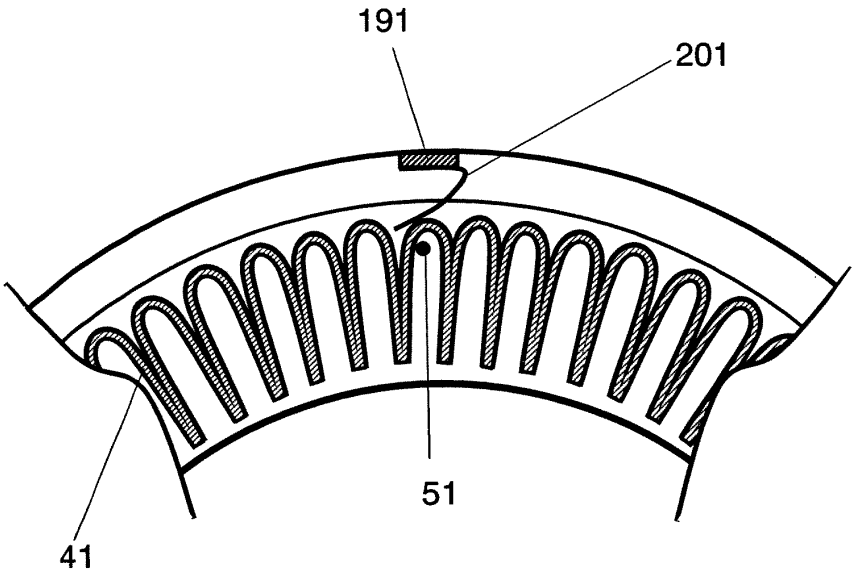

191
201
51
41

FIG. 21

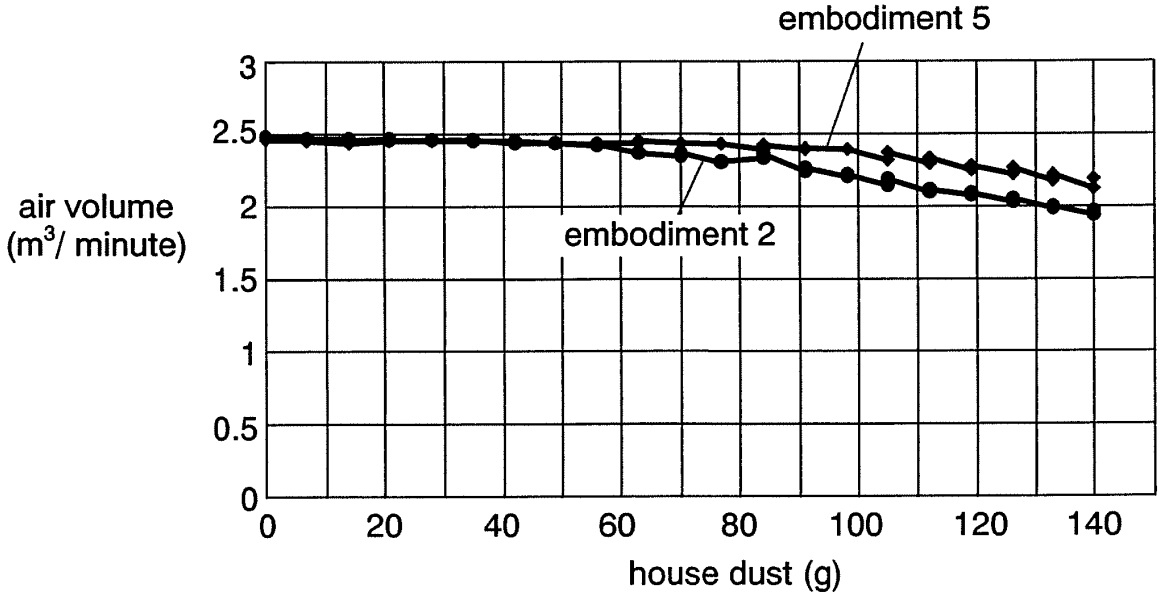

embodiment 5
embodiment 2
air volume
(m3/ minute)
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
house dust (g)

FIG. 22

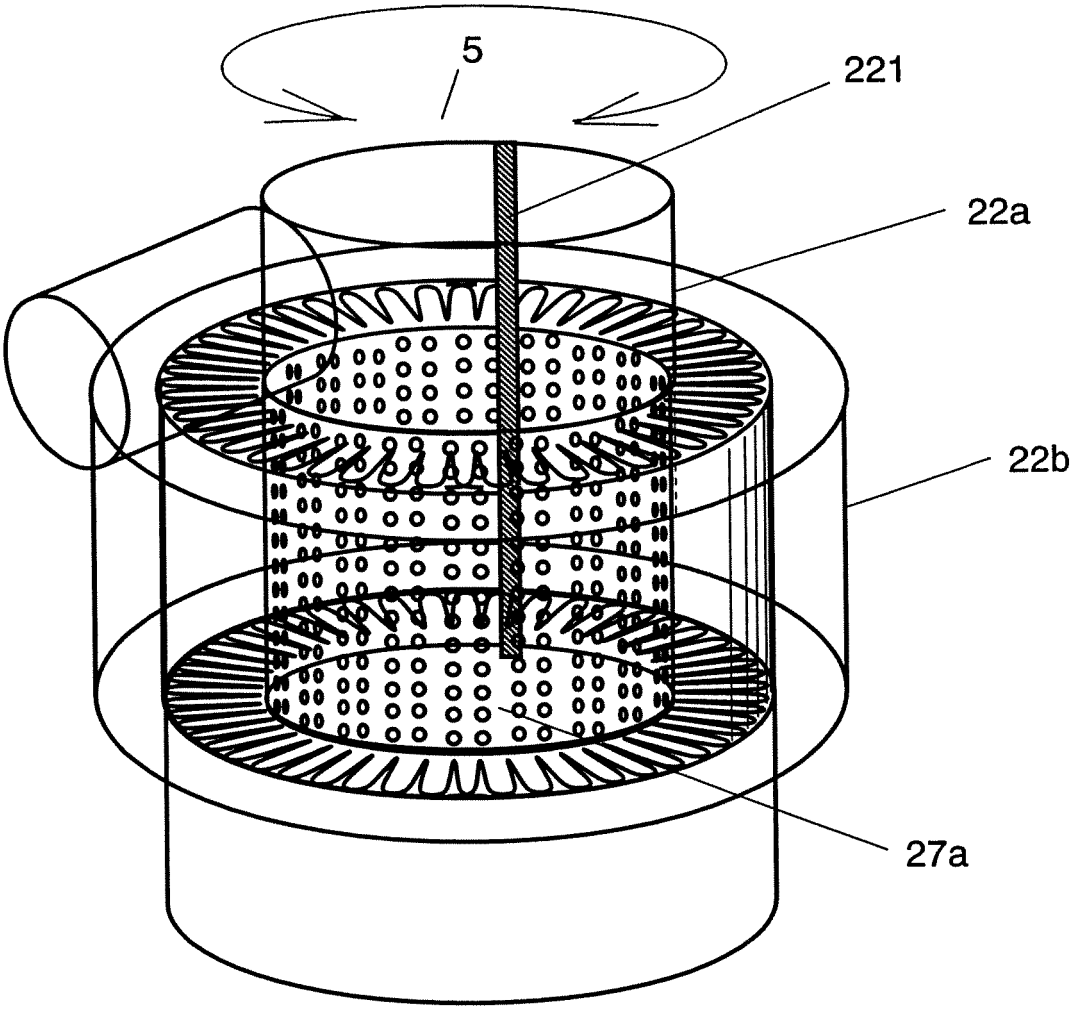


FIG. 23

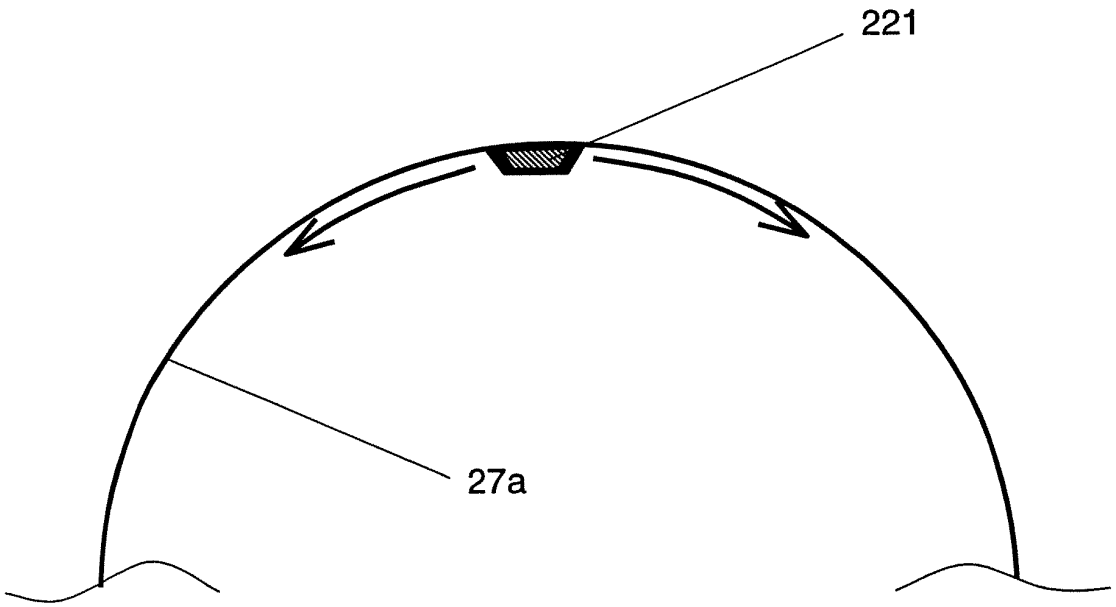


FIG. 24

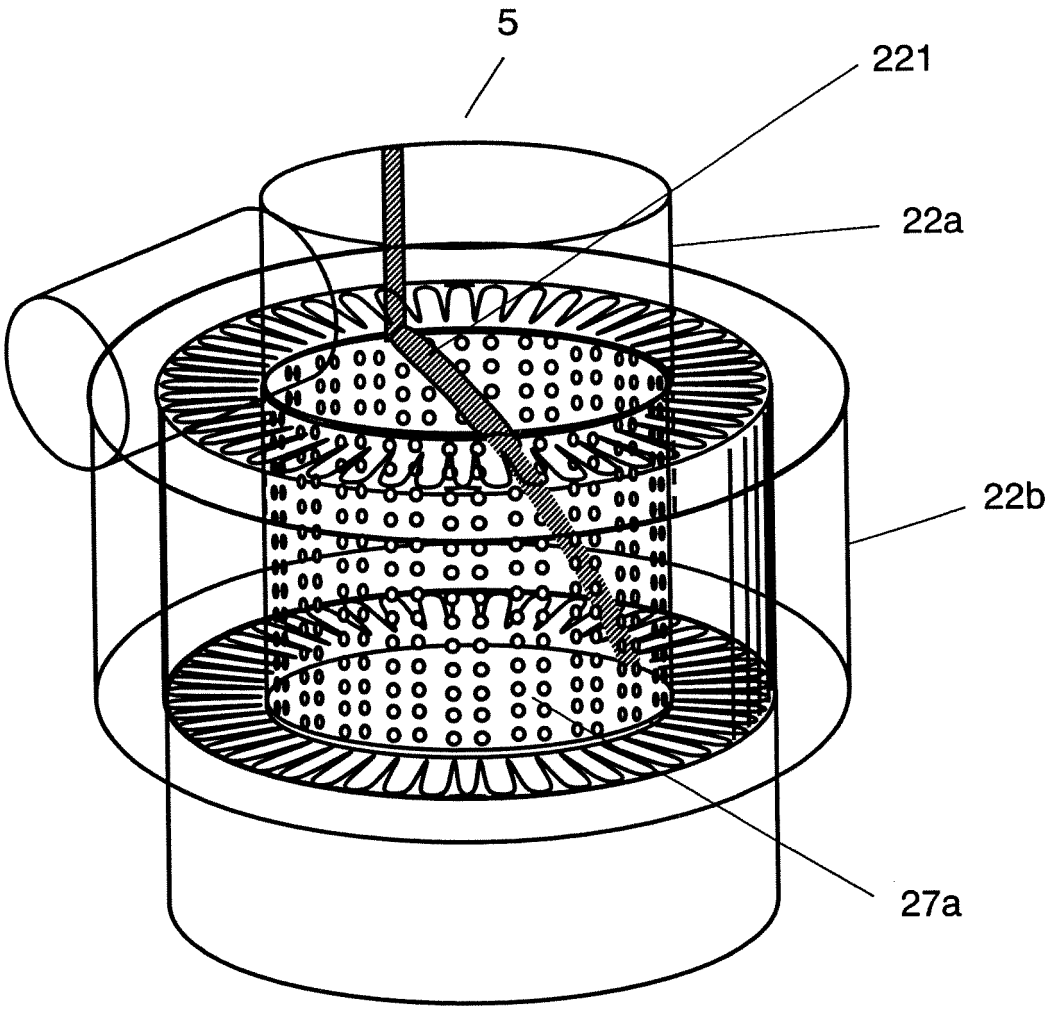


FIG. 25

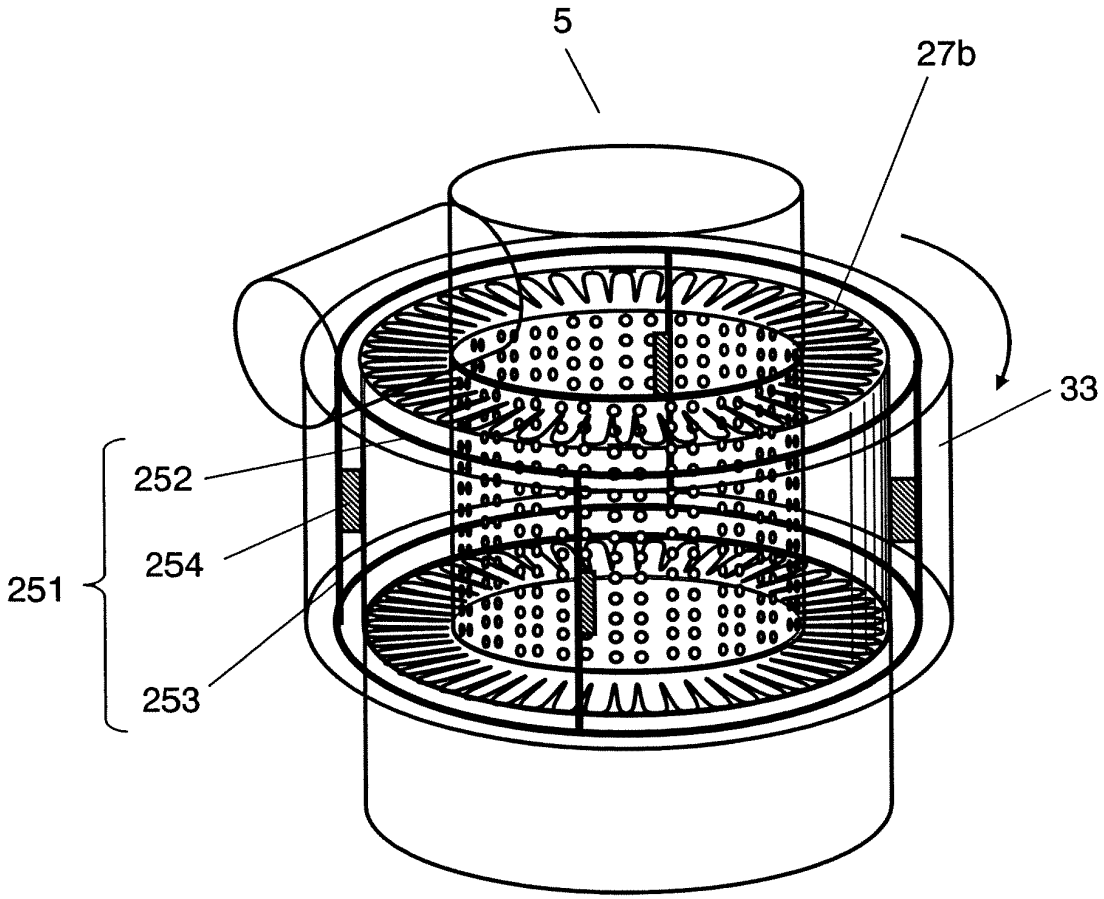


FIG. 26

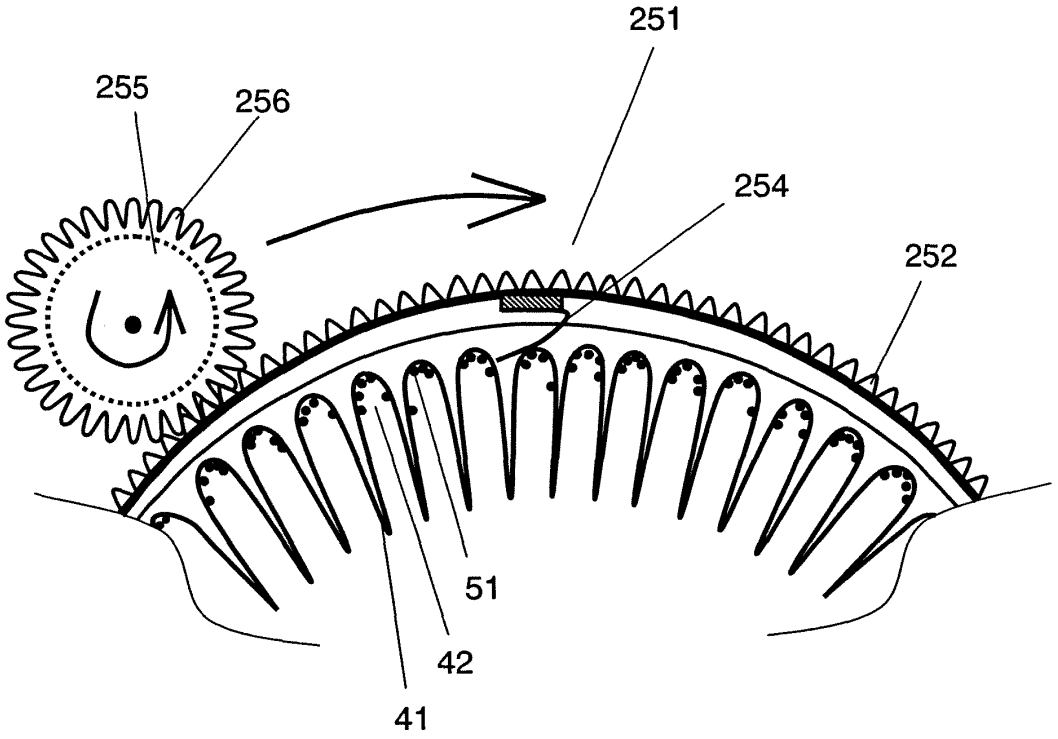

251
255
256
254
252
51
42
41

FIG. 27

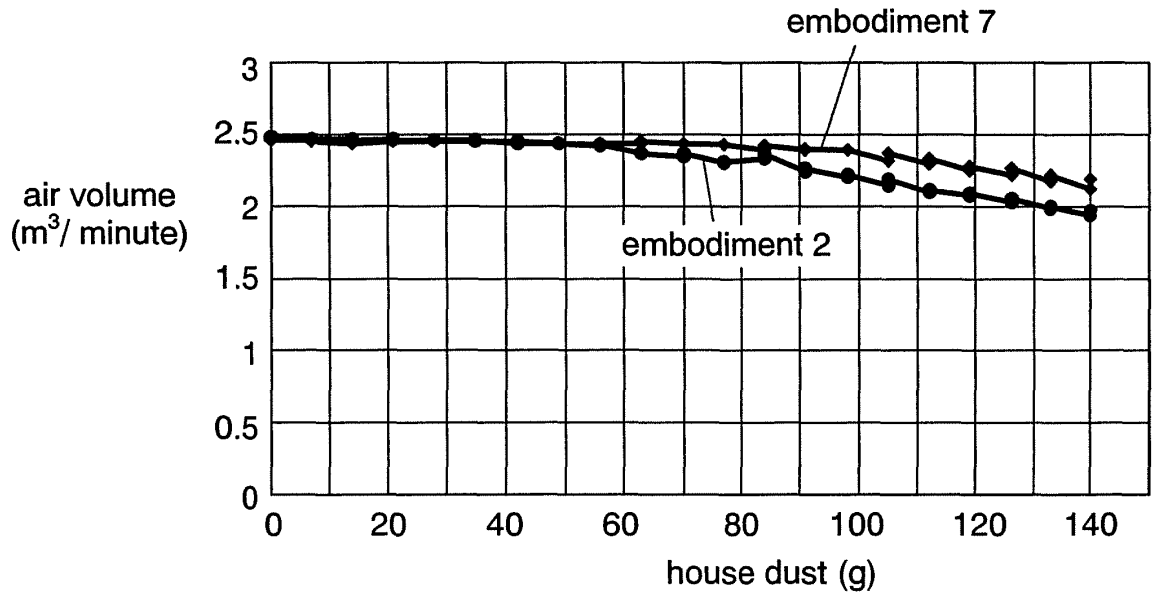

embodiment 7
embodiment 2
air volume
(m3/ minute)
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
house dust (g)

FIG. 28

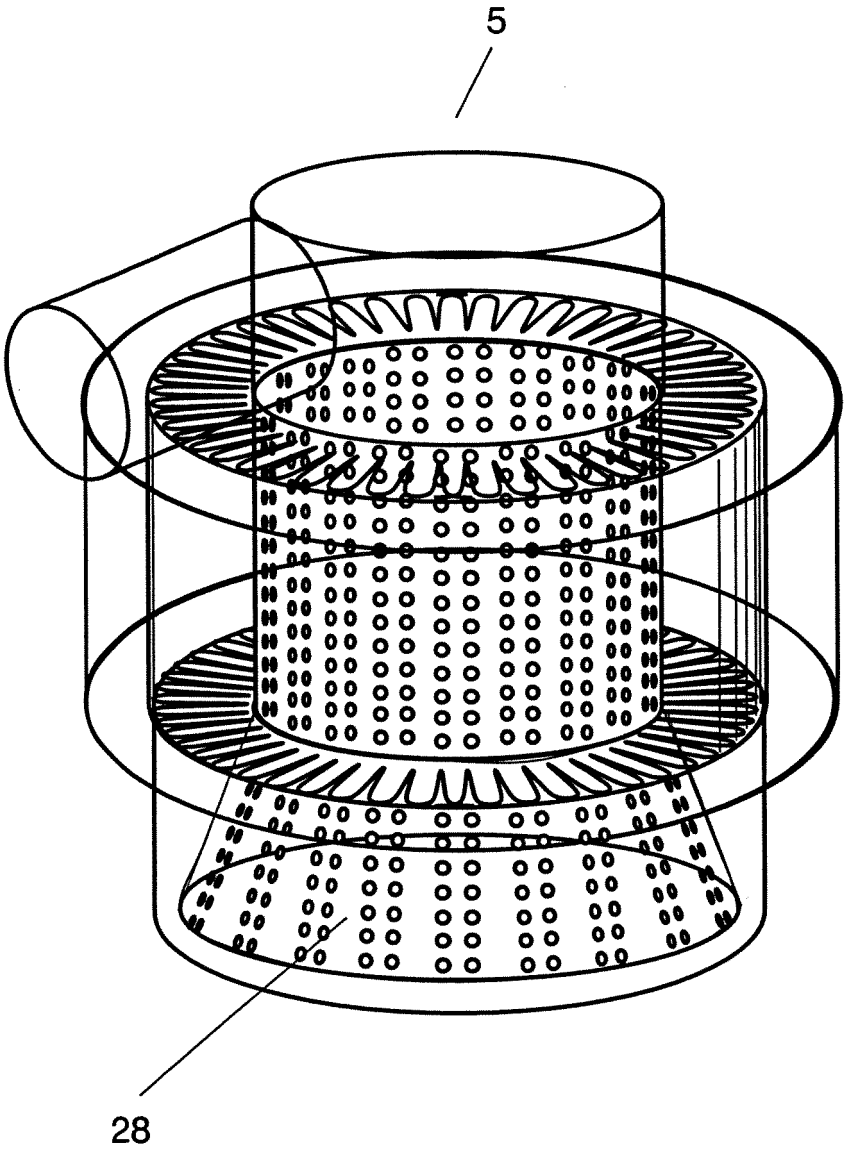


FIG. 29A

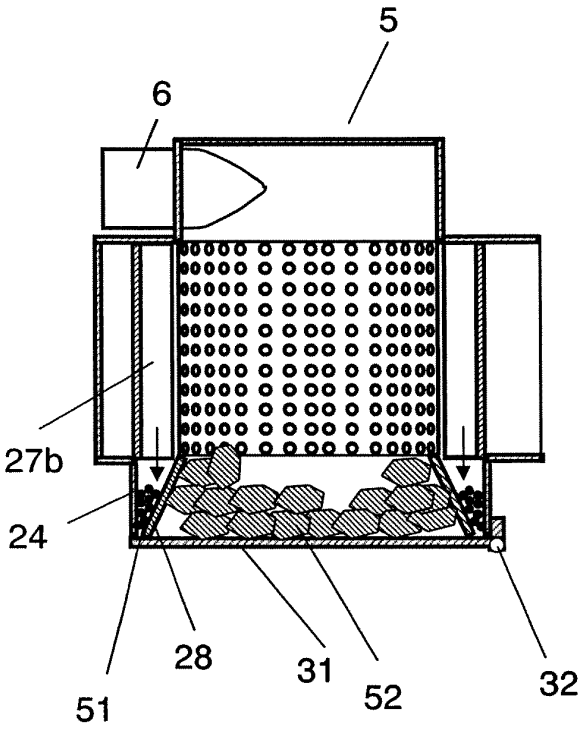


FIG. 29B

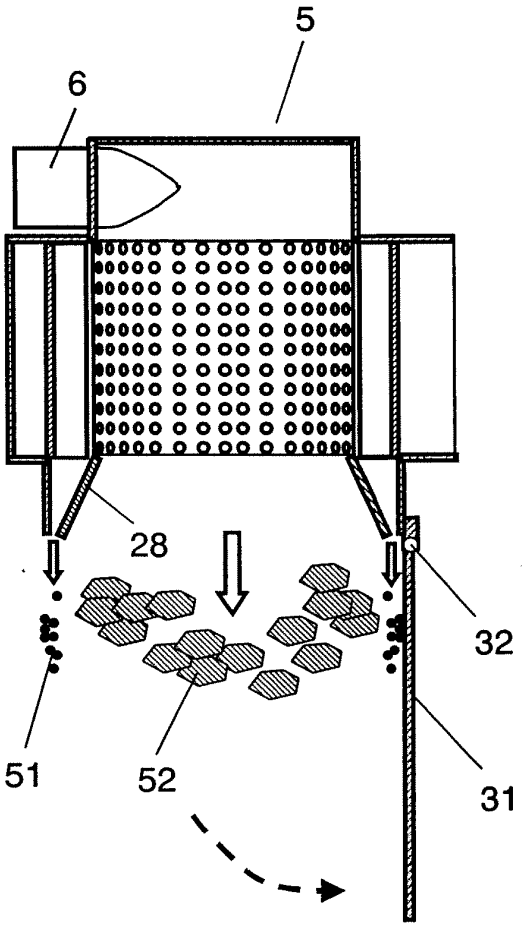


FIG. 30

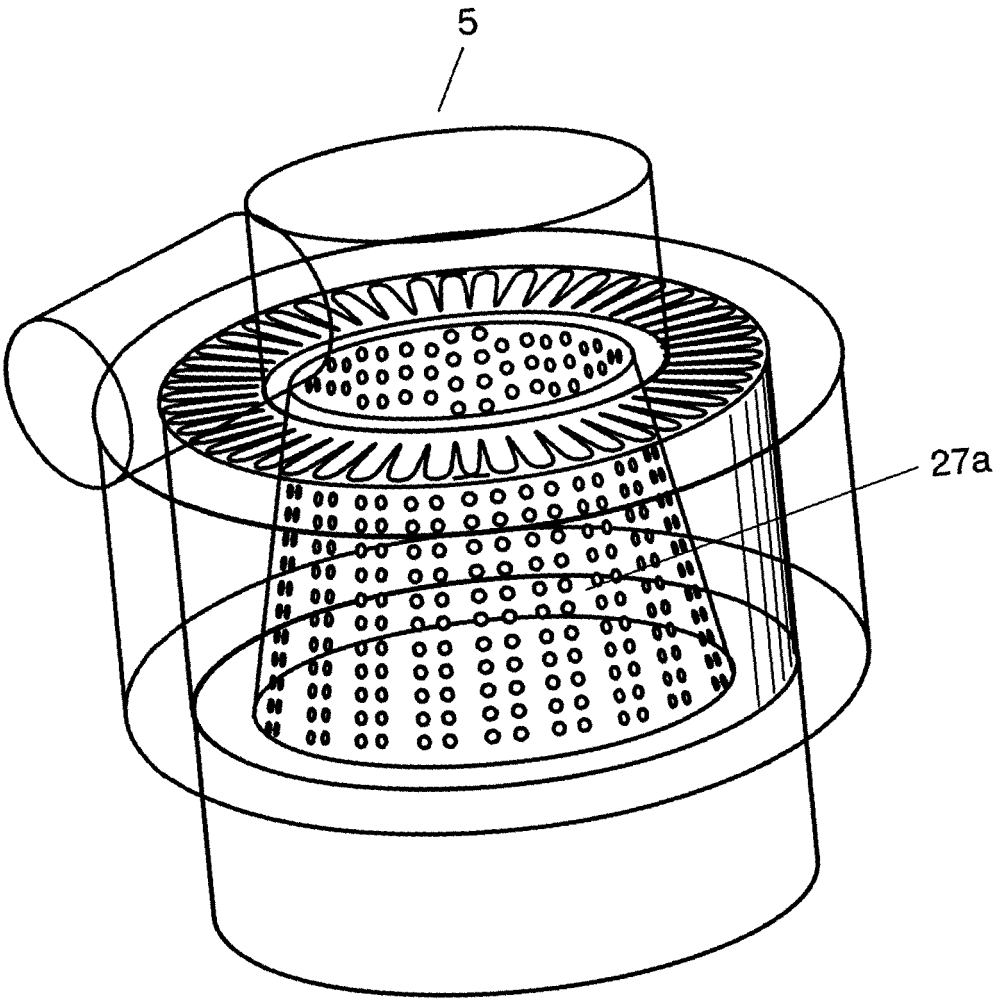


FIG. 31A

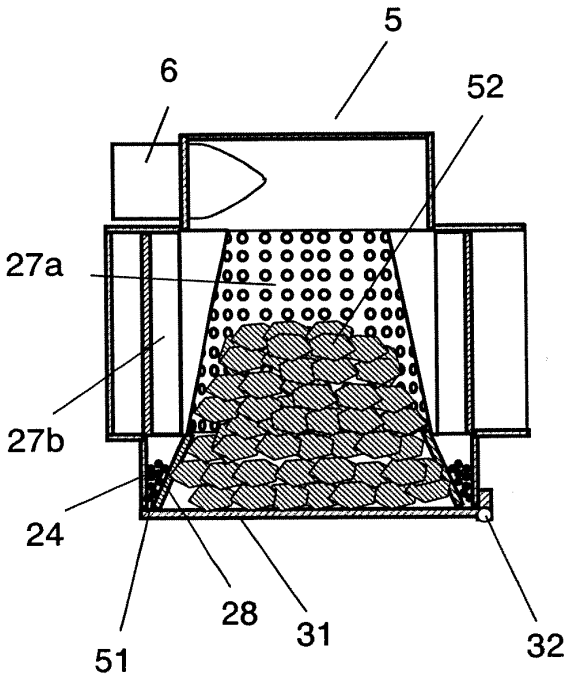


FIG. 31B

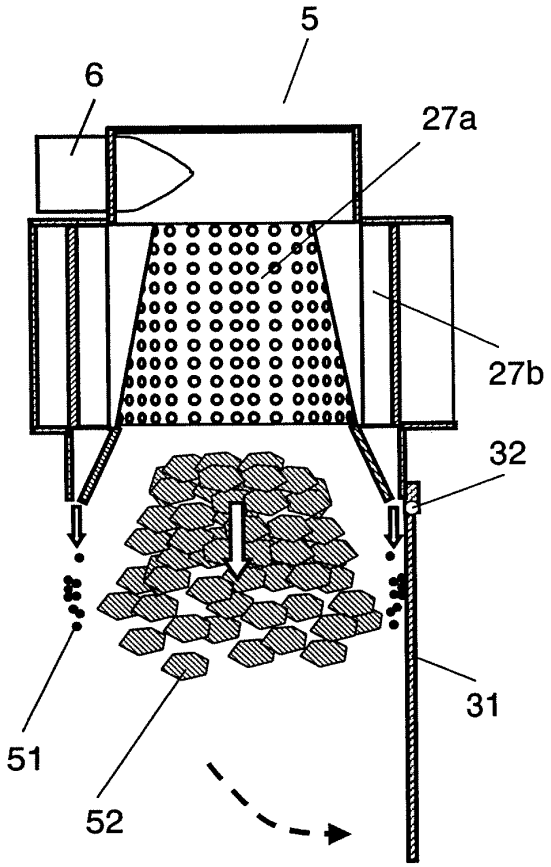


FIG. 32A

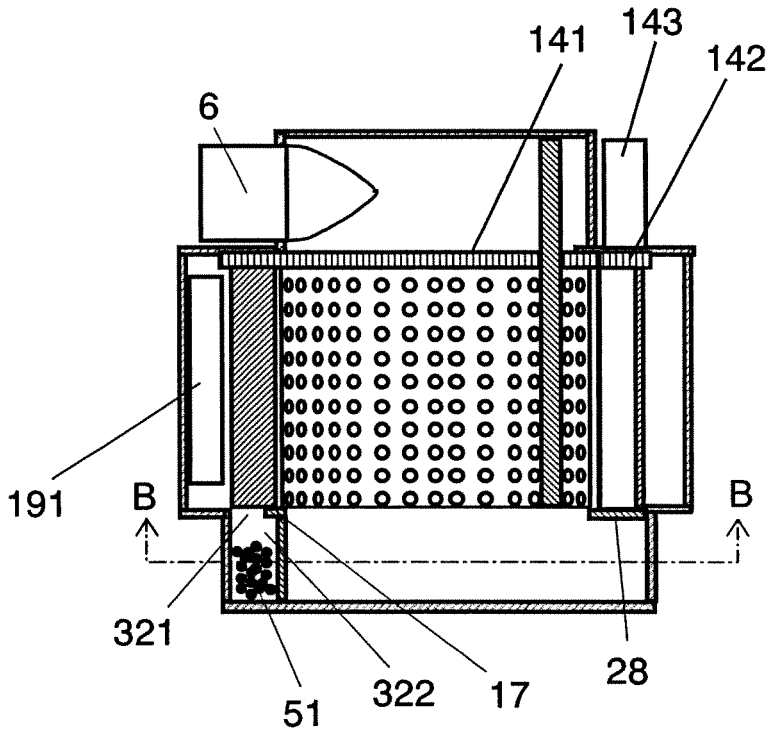


FIG. 32B

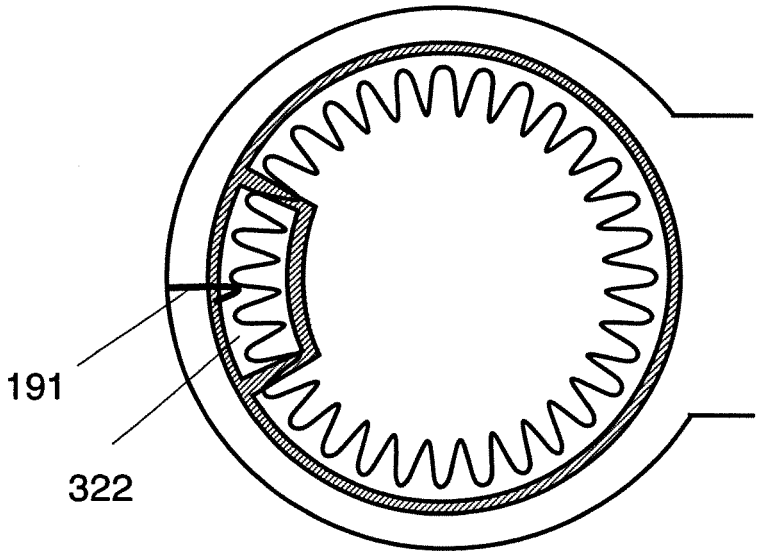
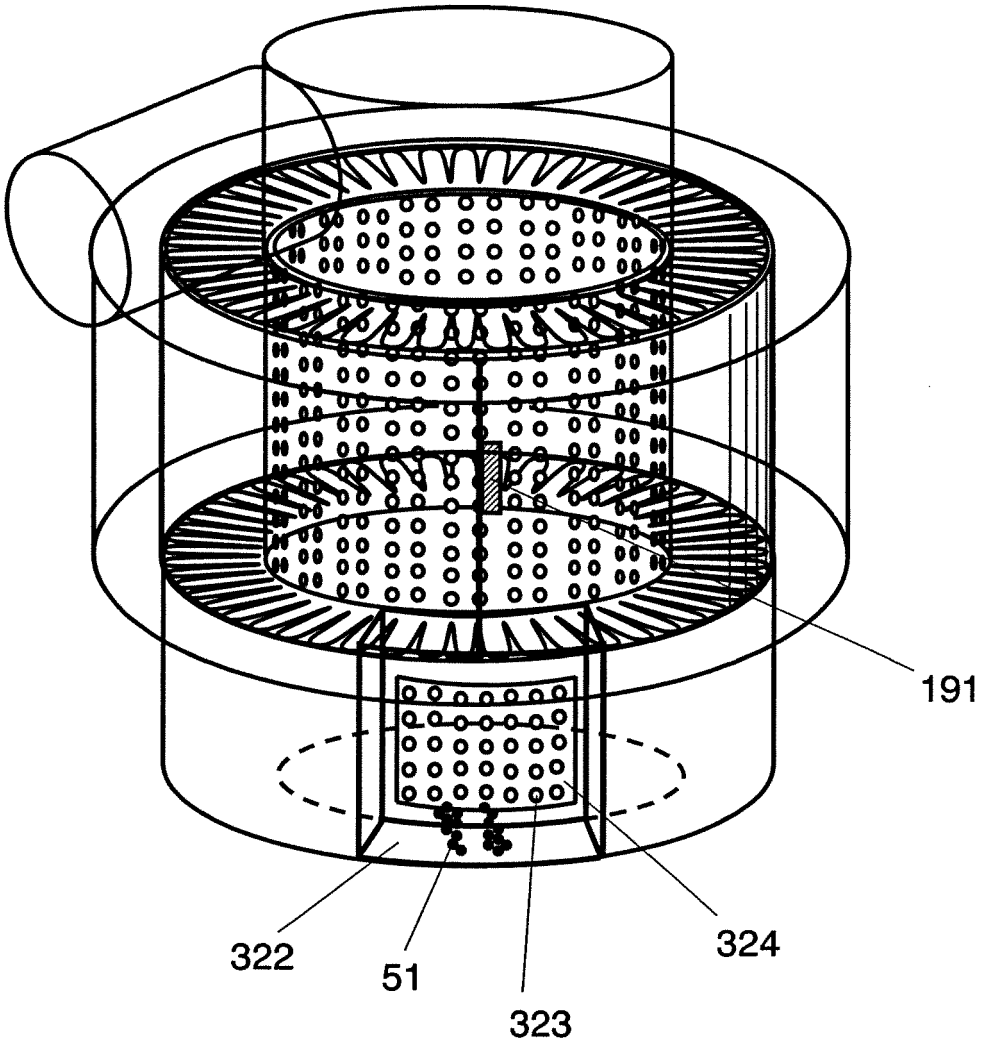


FIG. 33



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/056920

A. CLASSIFICATION OF SUBJECT MATTER
A47L9/16(2006.01)i, *A47L9/10*(2006.01)i, *A47L9/12*(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, A47L9/10, A47L9/12

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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 11337/1980(Laid-open No. 114755/1981) (Matsushita Electric Industrial Co., Ltd.), 03 September, 1981 (03.09.81), Full text; all drawings Full text; all drawings (Family: none)	1-5,9,13,19, 23 6-8,10-12, 14-18,20-22, 24-30
Y	JP 2005-52394 A (Mitsubishi Electric Corp.), 03 March, 2005 (03.03.05), Full text; all drawings (Family: none)	6-8,10-12, 24,26,27

☒ 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
31 May, 2007 (31.05.07)	12 June, 2007 (12.06.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/056920

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 2005-237470 A (Toshiba Tec Corp.), 08 September, 2005 (08.09.05), Par. No. [0007]; Fig. 1 (Family: none)	14,15
Y	JP 54-98053 A (Matsushita Electric Industrial Co., Ltd.), 02 August, 1979 (02.08.79), Full text; all drawings (Family: none)	16-18,20-22
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 116322/1979(Laid-open No. 32645/1981) (Matsushita Electric Industrial Co., Ltd.), 31 March, 1981 (31.03.81), Full text; all drawings (Family: none)	16-18,20-22
Y	JP 2001-54496 A (Makita Corp.), 27 February, 2001 (27.02.01), Full text; all drawings (Family: none)	24,25
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 8468/1975(Laid-open No. 90558/1976) (Matsushita Electric Industrial Co., Ltd.), 20 July, 1976 (20.07.76), Full text; all drawings (Family: none)	26,27
Y	JP 2004-33241 A (Sanyo Electric Co., Ltd.), 05 February, 2004 (05.02.04), Par. Nos. [0020], [0033] to [0034] (Family: none)	28,29
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 35001/1984(Laid-open No. 147350/1985) (Mitsubishi Electric Corp.), 30 September, 1985 (30.09.85), Full text; all drawings (Family: none)	30
Y	JP 11-155784 A (Namura Denki Kogyo Kabushiki Kaisha), 15 June, 1999 (15.06.99), Full text; all drawings (Family: none)	30

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INTERNATIONAL SEARCH REPORT

International application No.
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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
the

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee..

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/056920

Continuation of Box No.III of continuation of first sheet(2)

It is apparent that the invention of claim 1 is not novel, since it was disclosed in document: Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 011337/1980 (Laid-open No. 114755/1981) (Matsushita Electric Industrial Co., Ltd.), 31 January, 1980 (31.01.80), the whole specification and all the drawings. As a result, the invention of claim 1 does not have the special technical features within the meaning of PCT Rule 13.2, second sentence, since it does not explicitly specify any contribution over the prior art. Therefore, the invention of claim 1 and the individual inventions of claims 2 - 30 are not so related as to involve one or more of the same or corresponding "special technical features".

Moreover, it is also apparent that the inventions of claims 2 - 5, 9, 13, 19 and 23 are not novel, since they were also disclosed in the aforementioned document. As a result, the inventions of claims 2 - 5, 9, 19 and 23 do not have the special technical features within the meaning of PCT Rule 13.2, second sentence, since they do not explicitly specify any contribution over the prior art. (The invention described in the aforementioned document is different from the invention of claims 2 and 9, respectively, in that the dust eliminating film is disposed all over the circumference of the swirling air flow passage, and in that the second dust eliminating film is disposed on the downstream side at the outer circumference of the first dust eliminating film". However, this difference is nothing but a mere matter of design variation.)

Thus, in the claims referring to claim 1, there are a group of claim 2 and claims referring to claim 2, a group of claim 3 and claims referring to claim 3, a group of claim 4 and claims referring to claim 4, a group of claim 5 and claims referring to claim 5, a group of claims 16 and 20, a group of claims 19 and 23, a group of claim 25, a group of claim 28, a group of claim 29, and a group of claim 30. As described above, however, those invention groups are not so related as to involve one or more of the same or corresponding "special technical features", since the invention itself of claim 1 does not have the special technical features. Since the invention itself of claims 2 - 5 and 9 does not have the special technical features, moreover, there is no technical relation to involve one or more of the same or corresponding "special technical features" among the group of claim 5, the group of claims 6 - 8 and 24, the group of claim 9, the group of claims 10 - 12, 26 and 27, the group of claim 13, the group of claims 14 and 15, and the group of claims 17, 18, 21 and 22.

Thus, it is apparent that those inventions of the following 38 groups do not comply with the requirement of invention, since the technical feature within the meaning of PCT Rule 13.2 cannot be found inbetween.

(continued to the next page)

INTERNATIONAL SEARCH REPORT

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1. Group of claim 1
2. Group of claim 2
3. Group of claim 5 referring to claim 2
4. Group of claims 6 - 8 and 24 referring to the group of the aforementioned No.3
5. Group of claim 9 referring to the group of the aforementioned No.3
6. Group of claims 10 - 12, 26 and 27 referring to the group of the aforementioned No.5
7. Group of claim 13 referring to the group of the aforementioned No.5
8. Group of claims 14 and 15 referring to the group of the aforementioned No.5
9. Group of claims 17, 18, 21 and 22 referring to the group of the aforementioned No.5
10. Group of claim 3
11. Group of claim 5 referring to claim 3
12. Group of claims 6 - 8 and 24 referring to the group of the aforementioned No.11
13. Group of claim 9 referring to the group of the aforementioned No.11
14. Group of claims 10 - 12, 26 and 27 referring to the group of the aforementioned No.13
15. Group of claim 13 referring to the group of the aforementioned No.13
16. Group of claims 14 and 15 referring to the group of the aforementioned No.13
17. Group of claims 17, 18, 21 and 22 referring to the group of the aforementioned No.13
18. Group of claim 4
19. Group of claim 5 referring to claim 4
20. Group of claims 6 - 8 and 24 referring to the group of the aforementioned No.19
21. Group of claim 9 referring to the group of the aforementioned No.19
22. Group of claims 10 - 12, 26 and 27 referring to the group of the aforementioned No.21
23. Group of claim 13 referring to the group of the aforementioned No.21
24. Group of claims 14 and 15 referring to the group of the aforementioned No.21
25. Group of claims 17, 18, 21 and 22 referring to the group of the aforementioned No.21
26. Group of claim 5 referring to claim 1
27. Group of claims 6 - 8 and 24 referring to the group of the aforementioned No.26
28. Group of claim 9 referring to the group of the aforementioned No.26
29. Group of claims 10 - 12, 26 and 27 referring to the group of the aforementioned No.28
30. Group of claim 13 referring to the group of the aforementioned No.28
31. Group of claims 14 and 15 referring to the group of the aforementioned No.28
32. Group of claims 17, 18, 21 and 22 referring to the group of the aforementioned No.28
33. Group of claims 16 and 20
34. Group of claims 19 and 23
35. Group of claim 25
36. Group of claim 28
37. Group of claim 29
38. Group of claim 30

(continued to the next page)

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Here, the inventions of the groups of the aforementioned No.2, No.3, No.5, No.7, No.10, No.11, No.13, No.15, No.18, No.19, No.21, No.23, No.26, No.28, No.30 and No.34 require no endeavor for additional investigation, when the main invention or the group of claim 1 (i.e., the group of the aforementioned No.1) is to be investigated.

If the invention of the group of the aforementioned No.4 is investigated, moreover, no endeavor for the additional investigations is needed when the inventions of the groups of the aforementioned No.12, No.20 and No.27 are to be investigated. This discussion can be likewise applied to the inventions of the groups of the aforementioned No.6, No.8 and No.9.".

Hence, the number of the inventions of the international application described in the claims is 10, as described in the following.

1: Group of claims 1 - 5, 9, 13, 19 and 23
2: Group of claims 6 - 8 and 24
3: Group of claims 10 - 12, 26 and 27
4: Group of claims 14 and 15
5: Group of claims 17, 18, 21 and 22
6: Group of claims 16 and 20
7: Group of claim 25
8: Group of claim 28
9: Group of claim 29
10: Group of claim 30

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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 2000342492 A **[0002]**