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(54) CYCLONE SEPARATION APPARATUS

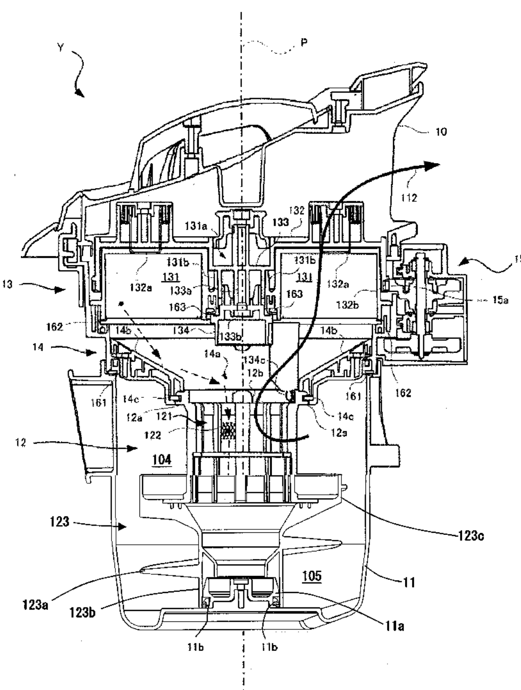
(57) **Problem to be Solved**

Disclosed is a cyclone dust collection apparatus that can maintain the material targeted for collection in a firmly compressed state even when the compression force is released.

Means of Solving the Problem

Disclosed is a cyclone separation apparatus that is equipped with a collection container with a roughly cylindrical interior surface, wherein, by causing air drawn in from an air inlet disposed in the circumferential direction in the periphery of the collection container to spiral along the roughly cylindrical interior surface, and then discharging the air from the center of the collection container through a filter means, the relatively large material targeted for collection and contained in the air is collected at the bottom of the collection container and the relatively small material targeted for collection is collected in the filter means, and wherein the cyclone separation apparatus is equipped with a spiral curved surface inside the collection container centered around the vertical central shaft of the collection container, and is equipped with a compression member that can rotate around the vertical central shaft.

Fig.2



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Description

Field of the Invention

[0001] The present invention generally relates to a cyclone separation apparatus that centrifuges the material targeted for collection and specifically to a cyclone separation apparatus that can increase the collected amount of the relatively large material targeted for collection and collected.

Description of the Related Art

[0002] A cyclone dust collection apparatus has been reported in Patent Literature 1 as an example of the cyclone separation apparatus that is equipped with a collection container with a roughly cylindrical interior surface, wherein by discharging air within the collection container from an air outlet disposed in the center of the collection container, causing air drawn in from an air inlet disposed in the periphery of the collection container to spiral along the interior periphery surface of the collection container, and then discharging the air from the air outlet through a filter means, relatively large dust contained in the air is collected at the bottom of the collection container and relatively small dust is collected in the filter means.

This cyclone dust collection apparatus is designed to swirl relatively large dust for collecting by centrifugal force and collect relatively small dust that flies by flowing air by a filter means disposed in the flow of air, thereby resulting in less noise and attaining an improvement of dust collection efficiency.

[0003] When the aforementioned cyclone dust collection apparatus is used in general household, cotton dust from blankets and clothes accounts for much of dust volume collected. As fiber or the like consisting of this cotton dust in itself is elastic, the density of dust is small, so that it's necessary to frequently remove (discard) the cotton dust from a dust collection portion. Furthermore such dust is light and easy to fly apart, thereby causing a problem that the user feels uncomfortable with the fluttering and re-entrainment of dust when discarding it in an outside garbage bucket or the like.

[0004] As the cyclone dust collection apparatus described in the aforementioned Patent Literature 1 is designed to collect dust relying absolutely on the flow of air, however, it cannot compress dust with low density such as the collected fiber to more than a certain volume and increase so much dust accumulation degree in a limited dust collection space. Therefore, such problems cannot be solved that dust collection efficiency decrease unless the collected dust is frequently discarded so that it takes a lot of trouble with discarding dust, or dust is likely to disperse in air so that the user feels uncomfortable with the fluttering and re-entrainment of dust when discarding it in a garbage bucket or the like.

[0005] In order to solve such problems, it's necessary to compress the collected dust as hard as possible. As an existing dust collection apparatus equipped with such a compression means of dust, there is provided a dust collection apparatus equipped with a mechanical compression means as described in the Patent Literature 2.

The dust collection apparatus equipped with such a mechanical compression means can compress and harden the collected dust, and thereby results in little decline in dust collection efficiency even after continuous use for a long time.

Patent Literature 1: Japanese Unexamined Patent Application Publication No.2006-75584
Patent Literature 1: Japanese Unexamined Patent Application Publication No.2005-13312

Disclosure of the Invention

Problems to be Solved by the Invention

[0006] In the case of the dust collection apparatus described in the aforementioned Patent Literature 2, however, it is designed to compress dust by holding a doughnut-shaped compression circular plate down from up above the dust collection portion through a handle operated manually so that it creates another problem for fundamentally wasting user's time.

Furthermore, the dust collection apparatus described in the Patent Literature 2 compresses dust or the like simply in a linear manner (without rotation) by pushing down the compression circular plate, so that this causes such a problem that, when the doughnut-shaped compression disk is raised at the time of start of operation next time, dust including cotton dust or the like, which is likely to restore to the original shape, recovers back to almost the same volume as that before compression, and thereby results in the loss of effect of compression behavior.

[0007] The aforementioned problems equally occur with not only a dust collection apparatus like an electric vacuum cleaner but also a cyclone separation apparatus that separates materials including powder and fiber or various materials with different particle size contained in air from the air by particle size. The present invention is directed to solve the above problems occurred in the cyclone separation apparatus that separates widely various materials as well as the aforementioned typical dust collection apparatus.

[0008] Accordingly, the present invention has been devised in view of such circumstances as mentioned above, and the object of the present invention is to provide an excellent cyclone dust collection apparatus that can maintain the material targeted for collection in a firmly compressed state by compressing the material targeted for collection by the rotation of a compression portion even when the compression force for the material targeted for collection is released in order to discharge the material targeted for collection, whereby a high suction force can be maintained even if a large amount of the material targeted for collection is stored in the collection container, high collection efficiency can be maintained for a long time, and such a problem does not exist as the material targeted for collection flying apart again in air when the compression force is released at the time of discharging the material targeted for collection by maintaining the material targeted for collection in a firmly compressed state as mentioned above.

Furthermore, another object is to provide a cyclone dust collection apparatus that takes into account a decrease in driving load of the compression portion and a downsizing of the whole apparatus by downsizing the compression portion.

Means of Solving the Problems

[0009] In order to achieve the aforementioned objects, according to the present invention, there is provided a cyclone separation apparatus that is equipped with a collection container with a roughly cylindrical interior surface, wherein, by causing air drawn in from an air inlet disposed in the circumferential direction in the periphery of the collection container to spiral along the roughly cylindrical interior surface, and then discharging the air from the center of the collection container through a filter means, the relatively large material targeted for collection and contained in the air is collected at the bottom of the collection container and the relatively small material targeted for collection is collected in the filter means, and wherein the cyclone separation apparatus is equipped with a spiral curved surface inside the collection container centered around the vertical central shaft of the collection container, and is equipped with a compression member that can rotate around the vertical central shaft.

More particularly, a conceivable configuration is that the collection container, in an upper portion thereof, is equipped with a separation apparatus body having an air outlet through which air is discharged via the filter means.

An embodiment of the compression of the material targeted for collection by the compression member is conceivable in which the spiral curved surface of the compression member is rotated around the vertical central shaft by the rotation of the compression member, whereby the material targeted for collection accumulated in the collection container is pushed out toward the bottom surface of the collection container by the spiral curved surface and compressed.

The shape of the spiral curved surface of the compression member is conceivable in which assuming the spiral curved surface as a screw, the spiral curved surface of the compression member is formed so as to have the screw go backward by the rotation of the compression member. As a typical example of what transfers the material targeted for collection by the rotation of a spiral curved surface on the assumption that the spiral curved surface is a screw, Archimedes' screw as a screw pump can be mentioned.

While, when seeing the shape of the spiral curved surface in relation to the direction of airflow descending along the interior periphery surface of the collection container, as another example embodiment, a configuration is conceivable in which the spiral curved surface of the compression member is formed in the same direction as that of rotation of airflow descending in a whirl along the interior periphery surface of the collection container.

Conversely, a possible configuration of the present invention may include the spiral curved surface of the compression member being formed in the opposite direction from the direction of rotation of airflow descending in a whirl along the interior periphery surface of the collection container.

Furthermore, a configuration is conceivable in which the collection container is further equipped with a driving means for providing a rotary drive of the compression member.

In this case, for example, the compression member can be controlled to be automatically rotary driven after the completion of the process of collecting the material targeted for collection or to be rotary driven during the same process, thereby attaining an enhancement of laborsaving.

In the latter case, it is also possible to control the compression member to be intermittently rotary driven during the process of collecting the material targeted for collection.

In any of these cases as described above, it is preferable to provide a cyclone separation apparatus with the compression member that is stored in the collection container with a roughly cylindrical space between the collection container and the interior periphery surface of the collection container. In this case, the width in the direction of the radius of the roughly cylindrical space surrounded by the interior periphery surface of the collection container may be configured to become reduced in size downward.

[0010] In any of these cases as described above, a configuration is conceivable in which the spiral curved surface of the compression member is formed so as to twist along the interior periphery surface of the collection container with at least more than one complete circle thereof.

Conversely, the spiral curved surface of the compression member may be formed so as to twist along the interior

periphery surface of the collection container with less than one complete circle thereof, thereby attaining a downsizing of the compression member.
Furthermore, in this case, a configuration is conceivable in which the compression member is configured to comprise the rotation shaft portion disposed at the vertical center thereof, the spiral curved surface formed around the rotation shaft portion and the disk-shaped shielding member disposed above the spiral curved surface, with a clearance being vertically interposed between the spiral curved surface and the disk-shaped shielding member.
In this case, the spiral curved surface is formed from the start end on the side of the upper portion opening of the collection container through the termination end on the side of the lower bottom surface of the collection container, so that if the outer edge of the start end s formed in a curved line so as to have the radius from the center to the outer periphery of the compression member gradually enlarge, it may prevents waste textile or the like from catching in the start end.
The above-mentioned cyclone separation apparatus is usable as a cyclone dust collection apparatus when the material targeted for collection is dust.

Advantageous Effect of the Invention

[0011] As described above, according to the present invention, there is provided a cyclone separation apparatus that is equipped with a collection container with a roughly cylindrical interior surface, wherein, by causing air drawn in from an air inlet disposed in the circumferential direction in the periphery of the collection container to spiral along the roughly cylindrical interior surface, and then discharging the air from the center of the collection container through a filter means, the relatively large material targeted for collection and contained in the air is collected at the bottom of the collection container and the relatively small material targeted for collection is collected in the filter means, and wherein the cyclone separation apparatus is equipped with a spiral curved surface inside the collection container centered around the vertical central shaft of the collection container, and is equipped with a compression member that can rotate around the vertical central shaft. Thus, it is possible to compress the relatively large material targeted for collection and collected by the rotation of the compression member.
According, the compression force to the material targeted for collection like dust can be maintained, and at the same time, the upper side of the spiral curved surface can be secured as the space of the dust collection container, so that even if a large amount of material targeted for collection is accumulated in the collection container, as the performance of the cyclone separation apparatus can be maintained, the suction force doesn’t decrease, thereby maintaining a high collection efficiency for a long time..
Furthermore, in accordance with the present invention, there is provided an excellent cyclone separation apparatus that can maintain the material targeted for collection in a firmly compressed state as mentioned above, and when the compression force is released, without causing any issue such as the material targeted for collection flying apart again in the air, can pass it to the post-processing or discarded it.
In addition, in accordance with the present invention, the compression member to be rotary driven can be downsized, thereby attaining a decrease in driving load of the compression member and a downsizing of the apparatus.

Brief Description of the Drawings

[0012]

FIG.1 is an appearance diagram of an electric vacuum cleaner X in accordance with an embodiment of the present invention.

FIG.2 is a cross-sectional view depicting the internal structure of a cyclone dust collection apparatus Y in accordance with the embodiment of the present invention.

FIG.3 is a cross-sectional view depicting the internal structure of the cyclone dust collection apparatus Y in accordance with the embodiment of the present invention.

[FIG.4 shows perspective views depicting a spirally rotating compression portion disposed in the cyclone dust collection apparatus Y in accordance with the embodiment of the present invention. FIG. (a) is a perspective view from downward and FIG. (b) from upward.

FIG.5 shows drawings depicting an upper portion filter unit 13 disposed in the cyclone dust collection apparatus Y in accordance with the embodiment of the present invention.

FIG.6 is a cross-sectional view depicting the internal structure of the cyclone dust collection apparatus Y centered on a spirally rotating compression portion in accordance with the embodiment of the present invention.

FIG.7 shows exploded perspective views depicting the internal structure of the cyclone dust collection apparatus Y in accordance with the embodiment of the present invention.

FIG.8 is a cross-sectional view depicting a rotating force transfer path to the spirally rotating compression portion of the cyclone dust collection apparatus Y in accordance with the embodiment of the present invention.

FIG.9 shows cross-sectional views of the cyclone dust collection apparatus Y depicting the situation when dust is compressed and laminated by the rotation of the spirally rotating compression portion.

FIG.10 shows cross-sectional views of the cyclone dust collection apparatus Y depicting how dust is stored in the spirally rotating compression portion.

FIG.11 is a cross-sectional view of the cyclone dust collection apparatus Y when a right cylindrical dust collection container is used.

FIG.12 is a cross-sectional view of the cyclone dust collection apparatus Y depicting the place where a spiral portion is set.

FIG.13 is a perspective view of the cyclone dust collection apparatus Y depicting the place where the spiral portion is set.

FIG.14 is a sectional side elevation of the cyclone dust collection apparatus Y depicting a rib formed in the dust collection container.

FIG.15 is a horizontal sectional view of the cyclone dust collection apparatus Y depicting the rib formed in the dust collection container.

FIG.16 is a drawing equivalent to FIG.6 in accordance with an embodiment where the spiral portion is less than one complete circle around a rotation shaft portion.

FIG.17 shows drawings equivalent to FIG.7 in accordance with the embodiment where the spiral portion is less than one complete circle around the rotation shaft portion.

FIG.18 is a drawing equivalent to FIG.8 in accordance with the embodiment where the spiral portion is less than one complete circle around the rotation shaft portion.

FIG.19 shows perspective views of the spiral portion in accordance with the embodiment where the spiral portion is less than one complete circle around the rotation shaft portion.

FIG.20 (a) and (b) are perspective views, and FIG.(c) is a plan view of the spiral portion with the start end being in a circular form in accordance with the embodiment where the spiral portion is less than one complete circle around the rotation shaft portion.

Description of the Preferred Embodiment

[0013] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings for a sufficient understanding of the present invention. It is to be noted that the following embodiments of the present invention are presented by way of example only, and are no way intended to limit the technical scope of the present invention.
First of all, referring to Fig.1, the schematic configuration of an electric vacuum cleaner X in accordance with an embodiment of the present invention will be described.
As shown in FIG.1, the electric vacuum cleaner X is schematically configured to comprise a cleaner body 1, an intake port 2, a connector 3, a connecting hose 4 and an operating handle 5. The cleaner body 1 is embedded with an electric blower (not shown), a cyclone dust collection apparatus Y, a control apparatus (not shown) or the like. It is to be noted that the cyclone dust collection apparatus Y will be described in detail in the latter clause.
The electric blower comprises a blower fan for intaking air and a blower drive motor for driving the blower fan to rotate.

The control apparatus comprises CPU, RAM, ROM or the like for integrally controlling the electric vacuum cleaner X. More specifically, in the control apparatus, the CPU performs various processing tasks in accordance with the control program(s) stored in the ROM.
It is to be noted that the operating handle 5 is equipped with an operating switch (not shown) in order for the user to start and stop the operation, and selectively operate a plurality of operation modes of the electric vacuum cleaner X. In addition, a display portion (not shown) such as LED for displaying the current status of the electric vacuum cleaner X is also disposed adjacent to the operating switch.

[0014] The cleaner body 1 is connected to the intake port 2 via the connecting hose 4 connected to the front end of the cleaner body 1 and the connector 3 connected to the connecting hose 4.
Therefore, in the electric vacuum cleaner X, the operation of the electric blower (not shown) embedded in the cleaner body 1 allows the intake port 2 to intake air. Then the air drawn in from the intake port 2 flows into the cyclone dust collection apparatus Y through the connector 3 and the connecting hose 4. In the cyclone dust collection apparatus Y, dust is centrifuged from the air drawn in. It is to be noted that the air after dust removal in the cyclone dust collection apparatus Y is discharged from an exhaust port (not shown) disposed to the rear end of the cleaner body 1.

[0015] Hereinafter, with reference to FIG. 2~6, the cyclone dust collection apparatus Y will de described in details as an example of the cyclone dust collection apparatus in accordance with the present invention.
As shown in FIG. 2 and 3, the cyclone dust collection apparatus Y is schematically configured to comprise a housing 10, a dust collection container 11 (one example of collection containers) having roughly cylindrical interior surface and being detachably connected to the housing 10, an interior cylinder 12, an upper portion filter 13, a dust receiving portion 14, a dust removal drive mechanism 15 or the like.
In the cyclone dust collection apparatus Y, the dust collection container 11, the interior cylinder 12, the upper portion filter unit 13 and the dust receiving portion 14 are coaxially arranged centered around a vertical central shaft P. Furthermore, the cyclone dust collection apparatus Y is configured to be detachably connected to the cleaner body 1.
The housing 10 comprises the interior cylinder 12 with a filter 122.
This cyclone dust collection apparatus Y is configured to be equipped with the collection container 11 with a roughly cylindrical interior surface, wherein by discharging air within the collection container 11 from the interior cylinder 12 disposed in the center thereof, causing air drawn in from an air inlet 111a (Refer to FIG.7) disposed in the periphery of the collection container 11 to spiral along the interior periphery surface of the collection container 11, and then discharging the air from the interior cylinder 12 through the upper portion filter unit 13 that is one example of a filter means, the relatively large dust targeted for collection and contained in the air is collected at the bottom of the collection container 11 and the relatively small dust targeted for collection is collected by the upper portion filter unit 13 or the like.

[0016] The dust collection container 11 is a container with the interior periphery surface as well as the external form being cylindrical for holding dust separated from the air drawn in. The dust collection container 11 is configured to be detachably connected to the housing 10 of the cyclone dust collection apparatus Y. After removing the cyclone dust collection apparatus Y from the cleaner body 1, the user removes the dust collection container 11 from the cyclone dust collection apparatus Y and discards dust in the dust collection container 11. It is to be noted that a circular seal member 161 is disposed between the housing 10 of the cyclone dust collection apparatus Y and the dust collection container 11. This seal member 161 prevents leak of air between the housing 10 and the dust collection container 11.
In addition, a fitting portion 11a that is fitted to a rotating shaft portion 123b disposed in the interior cylinder 12 to be described later is disposed at the bottom of the dust collection container 11. A circular seal member 11b is disposed in the outer periphery of the fitting section 11a to fill a clearance between the fitting section 11a and the rotating shaft portion 123b of the interior cylinder 12. This seal member 11b prevents leak of air between the rotating shaft portion 123b and the dust collection container11.

[0017] Furthermore, the dust collection container 11 is equipped with a connecting portion 111 to which the connecting hose 4 (Refer to FIG. 1) is connected. The air drawn in through the connector 3 and the connecting hose from the intake port 2 flows into the dust collection container 11 through the connecting portion 111.
An air inlet111a (Fig.7) of the connecting portion 111 directed to the dust collection container 11 is formed so as to allow the air from the connecting hose 4 to spiral within the dust collection container 11. More specifically, the air inlet 111a (Fig.7) is formed so as to have the outlet at the side of the dust collection container 11 being directed to the circumferential direction of the dust collection container 11. Therefore, in the dust collection container 11, by whirling the air drawn in, dust contained in the air is separated by centrifugal force (centrifugal separation). Then the dust centrifugally separated by the dust collection container 11 will be held at the bottom of the dust collection container 11 (Dust shown in FIG. 9 and 10).
Meanwhile, the air after dust removal passes along an exhaust path 112 as indicated by arrow (FIG.2) and is discharged outward from the dust collection container 11 through an exhaust port (not shown) disposed to the cleaner body 1. Here, the exhaust path 112 from the dust collection container 11 through the exhaust port (not shown) is arranged with the interior cylinder 12, the dust receiving portion 14 and the upper portion filter unit 13 in order.

[0018] The interior cylinder 12 is a cylindrical member arranged in the dust collection container 11. Here, the interior cylinder 12 is rotatably supported by the dust receiving portion 14. More specifically, a circular recess 12a disposed at the upper end of the interior cylinder 12 is supported by a circular support 14c disposed at the lower end of the dust receiving portion 14, allowing the interior cylinder 12 to be rotatably hung from the dust receiving portion 14. It is to be noted that the configuration for rotatably supporting the interior cylinder 12 is not limited to this. As an example, it may be conceivable to pivotably support, for example, the upper and lower ends of the interior cylinder 12.

In addition, a plurality of connections 12b, 12b,...are disposed on the upper end of the interior cylinder 12 so as to be engaged in an engaging portion 134c disposed to an inclined dust removable member 134 to be described later. The connection 12b is a rib that is disposed on an open edge portion of the interior cylinder 12 so as to protrude upward.

The interior cylinder 12 is connected to the inclined dust removal member 134 so as to be rotatable together with each other by having the connection 12b to be engaged in the engaging portion 134c. This enables the interior cylinder 12 to rotate in conjunction with the inclined dust removal member 134. It is to be noted that the connection structure of the interior cylinder 12 and the inclined dust removal member 134 is not limited to this. For example, such a configuration may be provided where the interior cylinder 12 is connected to the inclined dust removal member 134 so as to rotate together with each other by fitting the fitting portions attached to the interior cylinder 12 and the inclined dust removal member 134 respectively.

[0019] Furthermore, on the upper portion of the interior cylinder 12, an interior cylinder exhaust port 121 is formed for discharging the air after the separation of dust in the dust collection container 11 to the upper portion filter unit 13. Then, the interior cylinder exhaust port 121 is equipped with a cylindrical interior cylinder filter 122 covering the whole interior cylinder exhaust port 121. The interior cylinder filter 122 filters the air that passes through the interior cylinder exhaust port 121.

For example, the interior cylinder filter 122 is an air filter or the like made in a mesh form. It is to be noted that the interior cylinder filter 122 may be equipped either the inside or the outside of the interior cylinder exhaust port 121. Instead of the exhaust port 121 and the interior cylinder filter 122, a porosity in a mesh form may be configured to be formed in the interior cylinder 12. In this case, the porosity in a mesh form functions as the interior cylinder exhaust port 121 and the interior cylinder filter 122.

[0020] While, the lower portion of the interior cylinder 12 is equipped with a spirally rotating compression portion 123 for compressing dust within the dust collection container 11.

Here, in addition to FIG.2 and 3, with reference to FIG.4, a perspective view of the spirally rotating compression portion 123, the spirally rotating compression portion 123 will be described.

As shown in FIG. 2 ~ 4, the spirally rotating compression portion 123 comprises at least the rotation shaft portion 123b that is the center of rotation, a spiral portion 123a with a spiral curved surface formed around the rotation shaft portion 123b and a disk-shaped shielding member 123c disposed on the upper part of the spiral portion 123a.

The rotation shaft portion 123b is a hollow circular cylinder fitted to the fitting portion 11a disposed at the bottom of the dust collection container 11. As described above, a seal member 11b is interposed between the rotation shaft portion 123b and the fitting portion 11a (Refer to FIG. 2 and 3).

[0021] In the dust collection container 11, the disk-shaped shielding member 123c serves as a divider between an upper space portion (a dust separation portion 104) where dust is separated by centrifugal force of spiral flow to be described below and a lower space portion (a dust collection portion 105). This prevents the collected dust from rolling and clogging the interior cylinder filter 122. Furthermore, the disk-shape prevents dust contained in cyclone air flow from getting stuck therewith and can efficiently introduce dust to the bottom surface of the dust collection container 11.

[0022] Furthermore, the rotating shaft portion 123b is equipped with a plate-like spiral portion 123a (an example of compression member) that extends spirally centered around the rotating shaft portion 123b toward the bottom surface of the dust collection portion 105 with the upper and under surface thereof being curved with a spiral curved surface centered around the vertical central shaft P. In accordance with this embodiment of the present invention, as shown in FIG.4, the spiral portion 123a is formed from a start end 123s at the side of upper portion opening of the dust collection container 11 to a terminating end 123e at the side of the lower portion bottom surface of the dust collection container 11. The start end 123s is connected to the under surface of the disk-shaped shielding member 123c, but the terminating end 123e is free. However, the spiral portion 123a in accordance with the present invention is not limited to this shape. The start end 123s of the spiral portion 123a may be separated from the disk-shaped shielding member 123c and a clearance may be interposed between the spiral portion 123a and the disk-shaped shielding member 123c. Such an embodiment will be described below.

The spiral portion 123a moves dust accumulated within the dust collection container 11 to the bottom portion of the dust collection container 11 when the interior cylinder 12 is rotated as described below. At this time, assuming the spiral curved surface of the compression member as a screw, the spiral curved surface is formed so as to have the screw go backward by the rotation of the compression member, thereby enabling the dust to be compressed on this spiral curved surface.

Preferably, at this time, the spiral curved surface of the spiral portion 123a is formed to have the same direction of inclination as that of the swirling airflow as indicated by arrow A in FIG.6. By rotating the spiral portion 123a in the

opposite direction from the rotation of arrow A in FIG.6, the dust within the dust collection container 11 is moved to the bottom surface of the dust collection container 11 due to the friction against the interior surface of the dust collection container 11.
However, the spiral curved surface of the spiral portion 123a may be inclined to the opposite direction from the direction of inclination of the swirling airflow swirling along the interior periphery surface of the dust collection container 11. At this time, the direction of rotation of the spiral portion 123a is the same as that of the swirling airflow of arrow A in FIG. 6. More specifically, assuming the spiral portion 123a as a screw, the direction of rotation of the spiral portion 123a is the direction for the screw to go backward by the rotation of the spiral portion 123a.
Furthermore, when the interior cylinder 12 is rotated, the spiral portion 123a pushes, between the bottom surface of the dust collection container 11 and thereof, the dust that has moved to the bottom surface of the dust collection container 11 outward from the center of rotation shaft and compresses it by the rotation of the interior cylinder 12 and the friction with the bottom surface of the dust collection container 11. By this configuration, the dust is firmly compressed by rotation so that the possible amount of accumulation of dust of the dust collection container 11 can be increased. Therefore, for example, it may be possible to realize a downsizing of the dust collection container 11. In addition, the dust firmly compressed does not easily come loose, thereby not causing a problem of fling apart when it is taken out and allowing it to be discarded as it is as dust.

[0023] Meanwhile, the air after filtration by the interior cylinder filter 122 of the interior cylinder 12 is introduced to the upper portion filter unit 13 through the inside of the interior cylinder 12.
Here, with reference to FIG. 5 in addition to FG.2 and 3, the upper portion filter unit 13 will be described. FIG.5 (a) is a perspective view of the upper portion filter unit 13 as viewed from up above and FIG.5 (b) is a perspective view of the upper portion filter unit 13 as viewed from underneath.
The upper portion filter unit 13 includes a HEPA filter (High Efficiency Particulate Air Filter) 131, a filter dust removal member 132, the inclined dust removable member 134, or the like.

[0024] The HEPA filter 131 is a kind of air filters that further filters the air flowing on the exhaust path 112 after being discharged from the interior cylinder 12.
The HEPA filter 131 comprises an aggregate of a plurality of filters circularly disposed and fixed around the vertical central shaft P. It is to be noted that each of a plurality of filters, for example, is fixed to the framework shown in FIG.5 (b). In addition, a plurality of filters included in the HEPA filter 131 are arranged in a pleated shape with a repeated concavo-convex pattern in a roughly horizontal direction, thereby securing enough filter area of the HEP filter 131. It should be noted that a circular seal member 162 is disposed between the lower end of the HEPA filter 131 and the housing 10, thereby preventing the leak of air therebetween.
Furthermore, as shown in FIG. 2 and 3, at the center of the HEPA filter 131, a hollow portion 131a is formed, into which a coupling portion 133 disposed in a filter dust removal member 132 is fit to be described below. Also the hollow portion 131a is equipped with a supporting portion 131b that rotatably supports the coupling member 133.

[0025] As described above, the cyclone dust collection apparatus Y attains an enhancement of the power of dust collection by filtering air in two stages such as the interior cylinder filter 122 and the HEPA filter 131.
However, when the HEPA filter 131 is clogged with the accumulation of dust, the air passing resistance increases. As a result, the load of the electric blower (not shown) increases, possibly resulting in a decrease in the power of dust attraction. Therefore, the upper portion filter unit 13 is equipped with the filter dust removal member 132 that removes dust attached to the HEPA filter 131.

[0026] The filter dust removal member 132 is rotatably supported by the supporting portion 131b disposed at the center of the HEPA filter 131. More specifically, the filter dust removal member 132 is equipped with the coupling member 133 rotatably supported by the supporting portion 131b.
In addition, the coupling portion 133 is equipped with the inclined dust removable member 134 that is screwed by a screw 133b into a screw hole 133a disposed to the coupling portion 133, thereby allowing the filter dust removal member 132 and the inclined dust removable member 134 to be coupled so as to rotate together. It is to be noted that a seal member 163 that fills a clearance between the inclined dust removable member 134 and the HEPA filter 131 is disposed therebetween. Thus it helps preventing the leak of air between the inclined dust removable member 134 and the HEPA filter 131.

[0027] As shown in FIG. 2 and 5 (a), the filter dust removable member 132 comprises two contact portions (132a) that are arranged at a predetermined interval along the HEPA filter 131 so as to contact the upper end portion of the HEPA filter 131. The contact portion 132a is a plate spring-form elastic member. It is to be noted that the contact portion 132a is not limited to the plate spring-form elastic member. Also, with regards to the contact portion 132a, either one or a plurality thereof may be disposed.
Furthermore, the filter dust removable member 132 is equipped with a gear 132b around the outer perphery thereof. As shown in FIG. 2 and 3, this gear 132b is meshed with a gear 15a attached to a dust removal drive mechanism 15 disposed in the cyclone dust collection apparatus Y.

[0028] As clearly shown in FIG.2, the dust removal drive mechanism 15 comprises a decelerator coupled to a driving

motor (not shown, but a driving means as an example and hereinafter called "a dust removal driving motor") disposed on the side of the cleaner body 1 and a gear 15a coupled the driving motor. The dust removal drive mechanism 15 allows the rotating force of the dust removal driving motor to be transmitted to the gear 15a via the decelerator. And the rotating force of the gear 15 of the dust removal drive mechanism 15 is transmitted to the gear 132b, thereby enabling the filter dust removal member 132 to rotate.
Then, as described above, the rotation of the filter dust removal member 132 is transmitted to the inclined dust removable member 134, thereby allowing the interior cylinder 12 that rotates together with the inclined dust removable member 134 and the spirally rotating compression portion 123 that rotates together with the interior cylinder 12 to rotate around the vertical central shaft P.
It is to be noted that, in accordance with the embodiment of the present invention, the invention is described as embodied in such an example that the filter dust removal member 132 is rotated by the dust removal driving motor. As another embodiment, however, there may be provided a mechanism in which the filter dust removal member 132 can be rotated manually instead of by the dust removal driving motor.
Furthermore, it is also proper to have the spirally rotating compression portion 123 rotate by other motors than the dust removal driving motor. In order to perform the removal of dust by the upper portion filter unit 13 and the rotation of the spirally rotating compression portion 123 separately, such a method as using other motors mentioned above may be adopted.

[0029] When the filter dust removal member 132 is rotated, two of the contact portions (132a) attached thereto intermittently hit and provide vibration to the HEPA filter 131 formed in a pleated shape, thereby knocking off dust attached to the HEPA filter 131 by the vibration provided by the filter dust removal member 132. It is to be noted that, to put into operation of the dust removal driving motor (not shown), it is preferable, before the start or after the ending of the dust collection behavior by the electric vacuum cleaner X for example. Thus it enables the dust to be removed from the HEPA filter 131 effectively without airflow into downstream in the HEPA filter 131 due to the air intake by the electric blower.

[0030] Furthermore, as described above, the dust receiving portion 14 rotatably supports the interior cylinder 12. More specifically, the circular support 14c that is fit to the circular recess 12a disposed at the upper end of the interior cylinder 12 is arranged at the lower end of the open edge portion 14a of the dust receiving portion 14, thereby enabling the interior cylinder 12 to be rotatably hung up by the dust receiving portion 14.

[0031] Then, the structure of the spirally rotating compression portion 123 will be described in more detail.
As described above, the cyclone dust collection apparatus Y is formed to be roughly cylindrical in shape, and configured to comprise the upper portion filter unit 13 arranged at the upper portion thereof and the dust collection container 11 arranged at the lower portion thereof.
The disk-shaped shielding member 123c that serves as a boundary division between the dust separation portion 104 and the dust collection portion 105 is integrally joined to the lower end of the interior cylinder 12 housed in the dust collection container 11. The external diameter of the disk-shaped shielding member 123c is almost the same as that of the spiral portion 123a thereunder, and smaller than the internal diameter of the dust separation portion 104. And a clearance 106 (FIG.6) is interposed between the periphery of disk-shaped shielding member 123c and the interior wall of the dust collection container 11. The clearance 106 is suitable in size to such a situation that when transferring the dust separated at the dust separation portion 104 to the dust collection portion 105, even the dust at a certain volume can be smoothly transferred, and the dust once transferred and accumulated at the dust collection portion 105 can be rolled up without clogging the interior cylinder filter 122. It was confirmed that about 13mm is preferable by experiment.

[0032] In addition, a clearance 107 (equivalent to the roughly cylindrical space in accordance with the present invention) between the spiral portion 123a and the interior surface of the dust collection container 11 is configured to become smaller toward the bottom surface of the dust collection container 11 as the diameter of the dust collection container 11 is designed to become smaller toward the bottom surface thereof. Thus the friction between dust and the interior wall surface of the dust collection container 11 gets bigger and the force to transfer the dust in the direction of the vertical central shaft P by the spirally rotating compression portion 123 also gets bigger, resulting in compression further efficiently.

[0033] Moreover, the disk-shaped shielding member 123c has a predetermined thickness in the direction of height. The thickness of the disk-shaped shielding member 123c in the direction of height affects the performance of centrifugal separation in the dust separation portion 104, and in this embodiment, about 13 mm is employed as the thickness, which was experimentally determined.

[0034] Furthermore, as described above, the spiral portion 123a of the spirally rotating compression portion 123 is formed in a plate-like shape that is curved by being sandwiched between spirally curved surfaces thereabove and therebelow. It is also formed so as to twist around the rotating shaft portion 123b that extends almost vertically downward from the disk-shaped shielding member 123c to the bottom surface of the dust collection container 11 with more than one complete circle from the start end 123s (the connection portion to the disk-shaped shielding member 123c) to the termination end 123e (the lower end). The preferable value of the twist angle as described above is equivalent to 1.6 circles. In this way, the spiral portion 123a is formed to have a spirally turning plane that is inclined downward along the direction of rotation of cyclone swirling airflow (indicated by arrow A in FIG.6) along the interior periphery surface of the

dust collection container 11.
However, the twist angle whereby the aforementioned portion 123a twists around the rotating shaft portion 123b is not limited to the above figure. For example, it should be reduced to less than one complete circle for downsizing the spiral portion 123a if desired. Such a compact spiral portion 123a will be described below.

[0035] Furthermore, a clearance 108 (Refer to FIG.6) is interposed between the termination end (lower end) of the spiral portion 123a of the spirally rotating compression portion 123 and the bottom surface of the dust collection portion 105, thereby attaining a major increase of the amount of dust that can be pushed from the center of the rotating shaft outwardly and compressed.
Also, the width of the clearance 108 is large enough to prevent the cyclone dust collection apparatus Y from being damaged by clogging of the dust that is pushed and compressed to the bottom surface of the dust collection portion 105 and foreign materials or the like between the termination end of the spiral portion and the bottom surface of the dust collection portion 105. In this embodiment, about 6 ~ 13mm is employed as the width of the aforementioned clearance 108 that was determined as by experiment using 10kg of DMT standard waste TYPE8 based on the IEC Standard as a test waste.

[0036] The behavior of the electric vacuum cleaner configured as described above will be described below.
As shown in FIG. 3 and 6, airflow that comes into the dust separation portion 104 of the dust collection container 11 through the air inlet 111a of the connection portion 111 that is formed in the circumferential direction of the dust separation portion 104 swirls along the interior periphery surface of the dust separation portion 104 at a high speed as indicated by arrow A in FIG.6. Relatively large dust in the swirling airflow is separated therefrom by centrifugal force and pushed to the interior wall of the dust collection container 11. As shown in FIG.2, the exhaust port 121 is disposed down below so that the airflow, thereafter, spirally comes into the dust collection port 105. As indicated by the two dot chain line arrow A in FIG.6, the swirling airflow (main airflow) turns to climb upward after arriving at the bottom surface of the dust collection portion 105. In the case of FIG.6, the rotation direction of airflow swirling in the clearance 107 surrounding the spirally rotating compression portion 123 matches the inclination direction of the spiral portion 123a of the spirally rotating compression portion 123 so that the cyclone swirling airflow is not prevented, thereby enabling efficient centrifugal separation with less pressure loss and achieving high suction power.

[0037] Furthermore, the dust transferred by the airflow indicated by the two dot chain line arrow A in FIG.6 gets lodged in (trapped in) and accumulated in the space 112a between the termination end (lower end portion) of the spiral portion 123a and the bottom surface of the dust collection container 11, wherein the dust is laminated from the underside but along the spiral curved surface of the spiral portion 123a, thereby preventing further pressure loss from increasing.

[0038] In addition, the rotation direction of the airflow swirling in the clearance 107 surrounding the spirally rotating compression portion 123 matches the inclination direction of the spiral portion 123a thereof, so that the dust accumulated and laminated is slightly compressed by the airflow as well, thereby decreasing the volume of dust accumulated / laminated and attaining more efficient dust collection.

[0039] Next, the action of accumulation and lamination by the airflow of dust will be described in detail below.
As described above, the dust suck in is separated in the dust separation portion 104, passes through the clearance 106 (FIG.6), and is introduced to the dust collection portion 105. In the dust collection portion 105, the dust is blocked (trapped) by the clearance 108 after passing through the clearance 107, and then is accumulated. This accumulation of dust is laminated on the dust already accumulated by every rotation of spirally rotating compression portion 123. Thus, as the laminate grows along the spiral portion 123a without being disproportionately placed in this dust collection apparatus, there is no way that dust is accumulated disproportionately within the dust collection portion 105, thereby attaining a dramatic increase in the dust collectable capacity in comparison with other dust collection portions with the same volume.
Furthermore, the spiral portion 123a may be formed in a spiral shape having a direction of inclination toward downward along the direction of rotation of cyclone swirling airflow. In this case, compression effect by the cyclone airflow is also obtained, thereby attaining a further increase in dust collectable capacity.

[0040] Then, the more specific explanation is to follow about the action of rotary compression.
For example, when the blower drive motor stops driving, the airflow stops swirling. When the dust removal drive mechanism 15 is driven after confirming the halt of driving of the blower drive motor, as described above, the interior cylinder 12, the exhaust port 121, the disk-shaped shielding member 123c, the spirally rotating compression portion 123 and the rotating shaft portion 123b, all together rotate as one in the direction of arrow D indicated in FIG. 8 (in a counterclockwise direction, viewed from the upper surface) around the vertical central shaft P. In this way, the rotation by the dust removal drive mechanism 15 is transmitted to the rotating shaft portion 123b via the 1st rotation shaft line 152 and 2nd rotation shaft line 153 shown in FIG.8.
Thus, when the spirally rotating compression portion 123 rotates, according to the principle of screw, the thrust force is produced in the direction of the rotation shaft (in the downward vertical direction indicated by arrow E in FIG.10). By this thrust force, the dust 200 accumulated in the dust collection portion 105 as shown in FIG. 9 is pushed out to the direction of the rotation shaft, pushed to the bottom surface of the dust collection container 11 and compressed to the direction of the rotation shaft.

[0041] Meanwhile, in the case of conventional cyclone dust collection apparatuses, in which the spiral portion 123a doesn't rotate, when dust is laminated up to the upper portion above 300 (roughly the position of the start end of the spiral portion 123a) shown in FIG. 10, even if a new dust 201(Refer to FIG. 9) is sucked in from the upper side, the dust 201 cannot be laminated/collected since there is no place where dust gets lodged, thereby resulting in continuous rotation around the interior cylinder 12. By continuous rotation, a large amount of dust is adhered to the interior cylinder filter 122, thereby leading to a sudden decrease in suction power and decrease of a product life-cycle due to the major load resting on the blower drive motor.

[0042] However, in this dust collection apparatus Y, the dust accumulated between the spiral portion 123a and the bottom surface of the dust collection container 11 is applied with the rotating force by the rotation of the spiral portion 123a. Thus, the dust is compressed by being pushed out outwardly from the center shaft, so that the dust 200 between the spirally rotating compression portion 123 and the bottom surface of dust collection container 11 maintains itself in a firmly compressed state once it is compressed after the rotation stops or even after the dust collection container 11 is released and the compression force is released.

[0043] By maintaining the compressed state in this way, the dust can be held in the lower portion under the height 300 so that the dust is collected even when the new dust 201 is suck in from up above, and the new dust can be further compressed by the rotation of the spirally rotating compression portion 123, thereby attaining continuous compression efficiently. As a result, according to experiment, such effect was confirmed that for the dust collection portion with the same volume, the dust collectable capacity increased about threefold.

[0044] In addition, in this dust collection apparatus Y, even if a great deal of dust is collected by just one-time suction and the height of the dust reaches 300 shown in FIG. 10, it comes together with the old one already contacted to the spiral portion 123a, and can be pushed out in the direction of the rotation shaft for compression.

[0045] Furthermore, as a compression action is performed by the rotation of the spirally rotating compression portion 123, dust is applied with the force outwardly from the center of shaft rotation by the rotation of the spirally rotating compression portion 123. Thus, the dust tends not to really adhere to the cylindrical rotation shaft portion 123b, thereby attaining a significant enhancement of maintenanceability. In addition, even if the dust is adhered to the spirally rotating compression portion 123, it is cleaned off by the dust that has been pushed out downwardly and compressed by the rotation of the spirally rotating compression portion 123. In this way, the maintenanceability of the spirally rotating compression portion 123 is very high.

[0046] Also, as described above, the dust after compression is integrated so as to be solidified in a doughnut shape, thereby preventing waste from flying apart and dropping out when discarding waste, and attaining efficient waste discarding.

[0047] By rotating the spirally rotating compression portion 123 by a driving means such as a motor, it is possible to automatically rotate the spirally rotating compression portion 123 during the driving of the blower drive motor (during suction), thereby enabling dust to be compressed as well as caught/collected simultaneously. It also can achieve further compression efficiently, attaining further enhancement of the effect as mentioned above. In addition, even if a large amount of dust is sucked in at one time, it is possible to compress it, enabling continuous cleaning for a long time.

[0048] And further, with the intermittent rotation of the spirally rotating compression portion 123 during the driving (suction) of blower drive motor, it becomes possible to collect and compress dust simultaneously, and prevent power consumption from increasing and increase a product life-cycle in terms of the life-cycle of drive mechanism as it is unnecessary to continue driving the spirally rotating compression portion 123 for a long time. In addition, it is possible to decrease the noise when the driving of compression portion drive mechanism, thereby attaining a cyclone dust collection apparatus that is quiet and easy to use.

[0049] Furthermore, by disposing a rib 400 longitudinally to the interior wall surface of the dust collection container 11 as shown in FIG.14, it becomes possible to make the clearance partially smaller between the spirally rotating compression portion 123 and the dust collection container 11. Such configuration increases thrust force in the direction of the rotation shaft by the spirally rotating compression portion 123, thereby achieving more efficient compression. In addition, the lib 400 is disposed to the interior wall surface of the dust collection container 11 so as to have the clearance between the spirally rotating compression portion 123 and the dust collection container 11 become smaller toward the bottom surface of the dust collection container 11, thereby achieving more efficient compression of dust.
One rib is effective, but it is preferable to have a plurality of ribs evenly distributed from the view point of balance.
With regards to the configuration for generating a resistance to generate a friction in order to push out dust between the spiral portion 123a and the dust collection container 11, it is not limited to the rib 400 disposed to the interior wall surface of the dust collection container 11, but the interior wall surface thereof may be formed so as to be concavoconvex or be provided with surface treatment that becomes resistance.

[0050] The spirally rotating compression portion 123 shown in FIG.11 comprises the clearance 107 between the outer circumferential end of the spiral portion 123a and the interior wall surface of the dust collection portion 105 with the diameter of the internal periphery of the dust collection container 11 being constant whereby there is no space that becomes smaller toward the bottom surface of the dust collection container 11. More specifically, the clearance 107 is constant toward the bottom surface of the dust collection container 11. Other configurations are the same as the 1st embodiment of the present invention. In the case of the dust collection container 11, as the internal diameter does never become smaller toward the bottom surface of the dust collection container 11, the volume of the dust collection portion 105 increases and it is possible to compress dust by constant thrust force in the direction of rotation shaft, thereby achieving the accumulation and lamination of much mote dust. Furthermore, as the clearance 107 is constant toward the bottom surface of the dust collection container 11, the friction between dust and the interior wall surface of the dust collection container 11 doesn't change, so that compression can be performed by constant thrust force in the direction of rotation shaft, thereby attaining the effect of preventing the spirally rotating compression portion 123 from being immobilized and locked by clogging of dust.

[0051] When the spirally rotating compression portion 123 continues rotating without being locked, the amount of dust collected per unit volume of the dust collection portion 105 increases. Thus, in the case of collecting the same volume of dust, a more compact and lighter electric vacuum cleaner can be provided, thereby attaining an easiness in handling thereof, leading to a reduction of burden on the part of the user and a dramatic increase of cleaning efficiency for the user.

[0052] As is appreciated from the dust compression by the spirally rotating compression portion 123 mentioned above, dust compression is conducted adjacent to the termination end 123e of the spiral portion 123a, but not so positively done adjacent to the start end 123s. From this point of view, it is considered not necessarily urgent need that the spiral portion 123a as discussed previously is formed so as to twist along the interior periphery surface of the dust collection container 11 with at least more than one complete circle of the interior periphery surface. Therefore, it may be preferable to consider the downsizing of the whole spirally rotating compression portion 123 of by cutting off the portion adjacent to the start end 123s of the spiral portion 123a that doesn't contribute to compression. In that case, it may be considered to have the twist angle of the spiral portion 123a less than one complete circle along the interior periphery of the dust collection container 11. It becomes possible to downsize the spiral portion 123a or the whole spirally rotating compression portion 123 including the spiral portion 123a by reducing the twist angle of the spiral portion 123a in this way. By so downsizing the spirally rotating compression portion 123, it is expected that rotation load is mitigated on the part of the spirally rotating compression portion 123, and the reduction in size and weight of the whole apparatus is realized.

FIG.19 shows the spirally rotating compression portion 123 with the twist angle of the spiral portion 123a being less than one complete circle as mentioned above. A view of the spirally rotating compression portion 123 viewed from obliquely upward from a lower position is shown in (b) of the same figure is, and that viewed from obliquely downward from an upper position is shown in (a) thereof.

[0053] With regards to the spirally rotating compression portion 123 shown in FIG. 19, the spiral portion 123a formed around the spiral portion 123b disposed vertically at the center thereof is separated from the disk-shaped shielding member 123c disposed above the spiral portion 123a, and a clearance W is interposed vertically between the spiral portion 123a and the disk-shaped shielding member 123c. The clearance W is shown in FIG. 16 corresponding to FIG. 6 and FIG. 18 corresponding to FIG.8, and should be clearly understood with reference thereto.

[0054] Meanwhile, when the clearance W is formed by cutting off the portion adjacent to the start end 123s of the spiral portion 123a as shown in FIG. 16 or 18 as described above, it is considered that dust like waste textile or the like is likely to adhere to a start end 123s' that has been newly formed by cutting off the portion adjacent to the start end 123s. Particularly when the spirally rotating compression portion 123 rotates in the direction of the spiral screw of the spiral portion 123 going backward as indicated by arrow D in FIG.18, dust like waste textile or the like is likely to adhere to the start end 123s'. Such a problem that waste textile is likely to screw with the start end appears prominently when the start end 123s' that has been formed after the portion adjacent to start end 123s is cut off is formed in the direction of radius of the rotating shaft portion 123b as shown in FIG.19.

In order to solve such a problem, as shown in FIG.20, the start end 123s' that has been formed after cutting off the portion adjacent to the start end 123s may be formed in a circular arc shape. In a precise sense, it is necessary for the radius of the outer edge portion of the start end 123s from the center of the spiral portion 123a to be arranged in a curved line so as to gradually enlarge from the start end 123s' in the direction toward the terminal end. More specifically, as shown in FIG.20 (c), when the outer edge portion of the start end 123s' of the spiral portion 123a having the radius of r0 is formed in a curved line so as to have the radius r from the center point O of the spiral portion 123a enlarge gradually from the start end 123s' (gradually enlarge from r1, r2, ...rn to r0) in the direction toward the termination end (in the direction indicated by arrow Yx), waste textile or the like easily moves along the outer edge of the curved line and falls off the start end 123s', preventing dust from adhering thereto and resulting in such a situation that it is unnecessary to clean the portion for a long time or permanently.

It is to be noted that the embodiment as mentioned above explained the case when as a result of cutting off a portion of the spiral portion 123a, the spiral portion 123a and the disk-shaped shielding member 123c were arranged discrete, resulting in the formation of the clearance W therebetween, but this is merely exemplary in nature. The configuration is allowable in which without cutting off the portion of the spiral portion 123a, the start end 123s of the spiral portion 123a is formed so as to be continuously connected to the disk-shaped shielding member 123c, resulting in no clearance therebetween.

Industrial Applicability

[0055] The present invention is applicable to cyclone separation apparatuses including a dust collector such as an electric vacuum cleaner.

Description of Drawing Reference Numerals

[0056]

1 0 ...	housing (separation apparatus body)
1 1 ...	dust collection container
1 2 ...	interior cylinder
1 3 ...	upper portion filter unit
1 4 ...	dust receiving portion
1 5 ...	dust removal drive mechanism
1 0 4 ...	dust separation portion
1 0 5 ...	dust collection portion
1 2 3 ...	spirally rotating compression portion
1 2 3 a ...	spiral portion (compression portion)
1 2 3 b ...	rotating shaft portion
1 2 3 c ...	disk-shaped shielding member
1 2 3 s , 1 2 3 s '...	start end
1 2 3 e ...	termination end
2 0 0 , 2 0 1 ...	dust
4 0 0 ...	rib

Claims

1. A cyclone separation apparatus that is equipped with a collection container with a roughly cylindrical interior surface, wherein, by causing air drawn in from an air inlet disposed in the circumferential direction in the periphery of the collection container to spiral along the roughly cylindrical interior surface, and then discharging the air from the center of the collection container through a filter means, the relatively large material targeted for collection and contained in the air is collected at the bottom of the collection container and the relatively small material targeted for collection is collected in the filter means, and wherein the cyclone separation apparatus is equipped with a spiral curved surface inside the collection container centered around the vertical central shaft of the collection container, and is equipped with a compression member that can rotate around the vertical central shaft.

2. The cyclone separation apparatus according to claim 1, wherein a separation apparatus body is disposed in the upper portion of the collection container, having an air outlet through which air is discharged via the filter means.

3. The cyclone separation apparatus according to any of the preceding claims, wherein the spiral curved surface of the compression member is rotated around the vertical central shaft by the rotation of the compression member, whereby the material targeted for collection accumulated in the collection container is compressed by the spiral curved surface.

4. The cyclone separation apparatus according to any of the preceding claims, wherein assuming the spiral curved surface as a screw, the spiral curved surface of the compression member is formed so as to have the screw go backward by the rotation of the compression member.

5. The cyclone separation apparatus according to any of the preceding claims, wherein the spiral curved surface of the compression member is formed in the direction roughly corresponding to the direction of rotation of airflow descending in a whirl along the interior periphery surface of the collection container

6. The cyclone separation apparatus according to any of the preceding claims, wherein a driving means is further disposed for rotary driving the compression member.

7. The cyclone separation apparatus according to claim 6, wherein the compression member is controlled to be rotary

driven after the completion of the process of collecting the material targeted for collection.

8. The cyclone separation apparatus according to claim 6, wherein the compression member is controlled to be rotary driven during the process of collecting the material targeted for collection.

9. The cyclone separation apparatus according to claim 8, wherein the compression member is controlled to be intermittently rotary driven during the process of collecting the material targeted for collection

10. The cyclone separation apparatus according to any of the preceding claims, wherein the compression member is stored in the collection container with a roughly cylindrical space between the compression member and the interior periphery surface of the collection container.

11. The cyclone separation apparatus according to any of the preceding claims, wherein the spiral curved surface of the compression member is formed so as to twist along the interior periphery surface of the collection container with more than or less than one complete circle of the interior periphery surface.

12. The cyclone separation apparatus according to claim 11, wherein the collection container is equipped with a separation member having the spiral curved surface formed around the vertical central shaft of the collection container with more than one complete circle and a disk-shaped shielding member arranged above the separation member for separating the upper space portion of the collection container from the lower space portion thereof.

13. The cyclone separation apparatus according to claim 12, wherein a clearance is vertically interposed between the spiral curved surface and the disk-shaped shielding member.

14. The cyclone separation apparatus according to any of the preceding claims, wherein the spiral curved surface is formed from a start end on the side of the upper portion opening of the collection container through a termination end on the side of the lower bottom surface of the collection container, and the outer edge of the start end is formed in a curved line so as to have the radius from the center of the compression member to the outer periphery thereof gradually enlarge.

15. The cyclone separation apparatus according to any of the preceding claims, which is applicable to a cyclone dust collection apparatus with dust as the material targeted for collection.

Fig.1

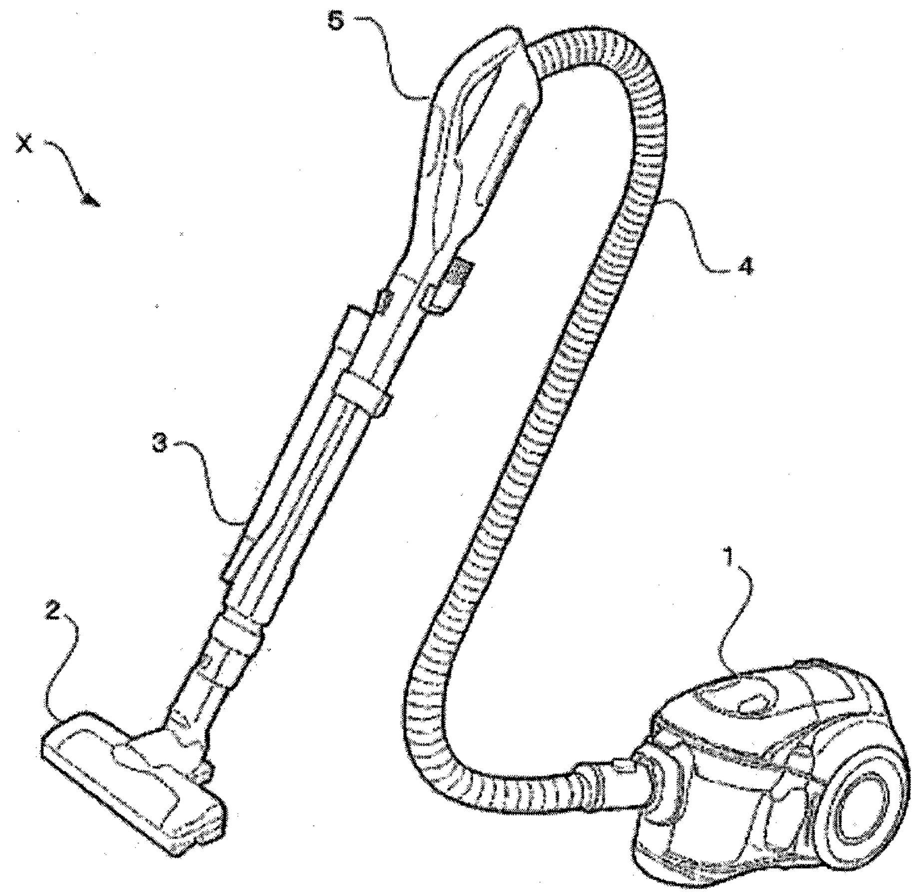
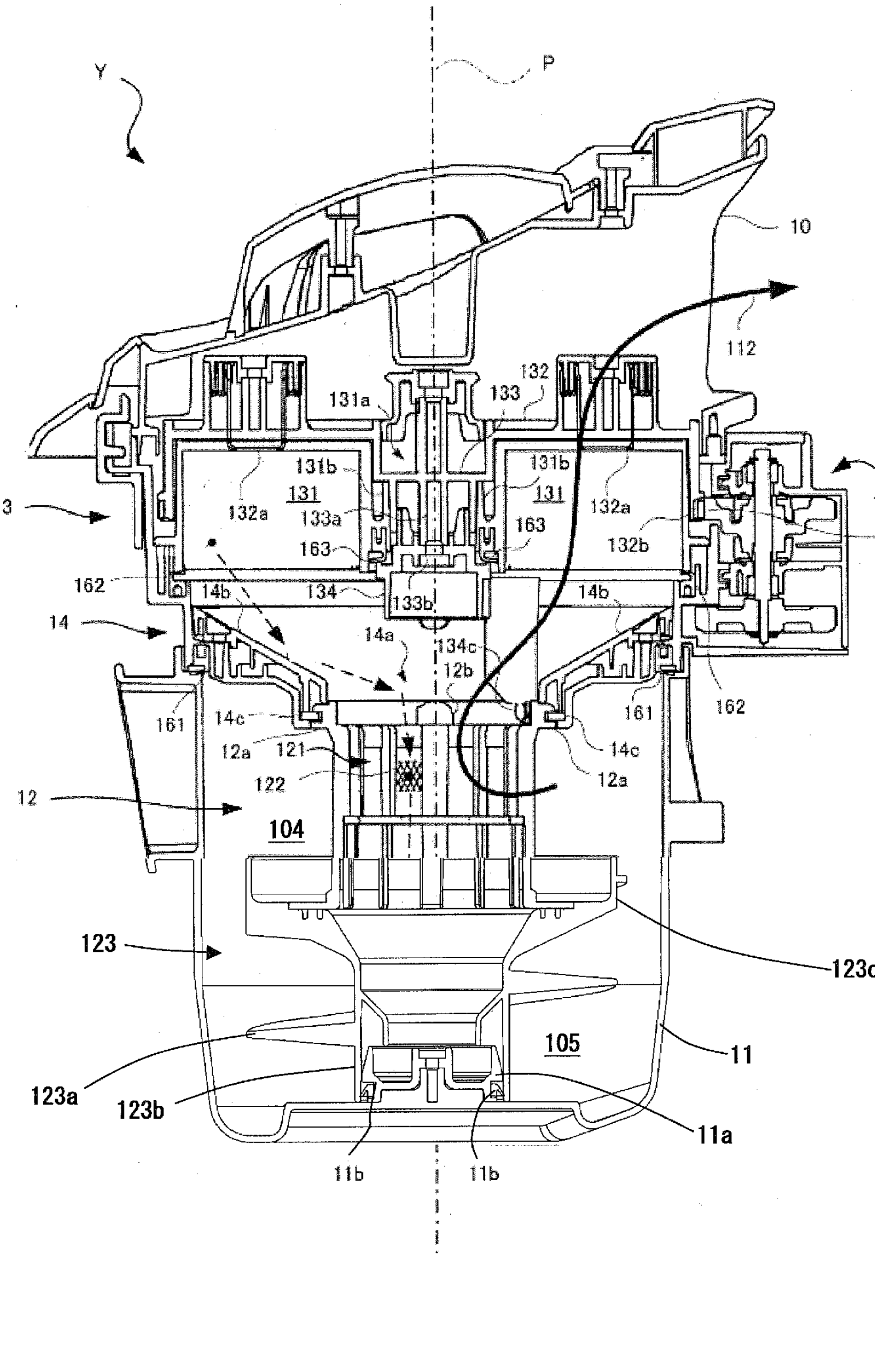


Fig.2


Y
P
10
112
132
133
131a
131b
131
132a
133a
163
162
134
133b
14b
14
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134c
12b
161
14c
12a
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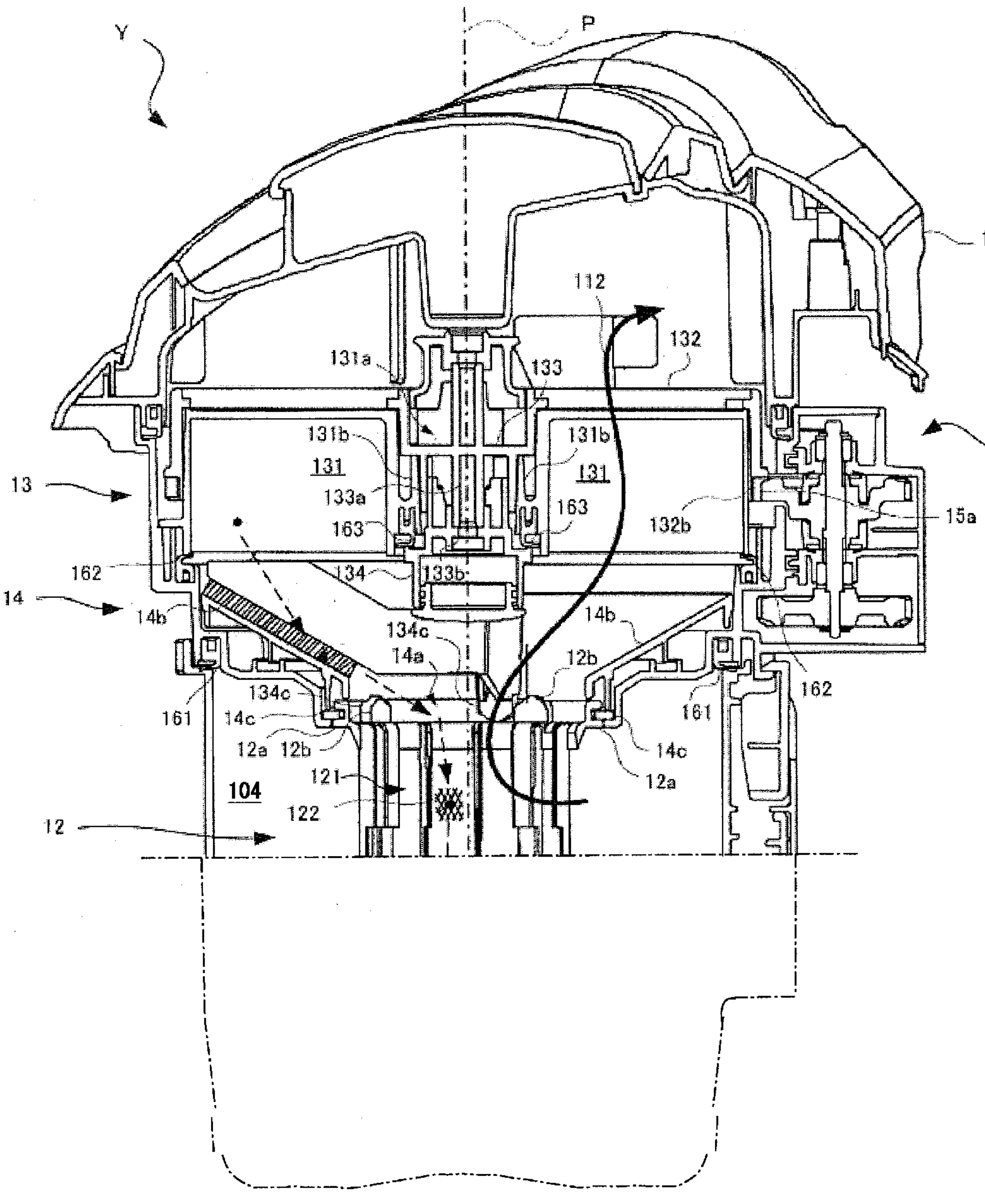
15
15a
132b

Fig.3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162
134
133b
14
14b
134c
14b
14a
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134c
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161
12a
12b
14c
12a
121
104
122
12

Fig.4

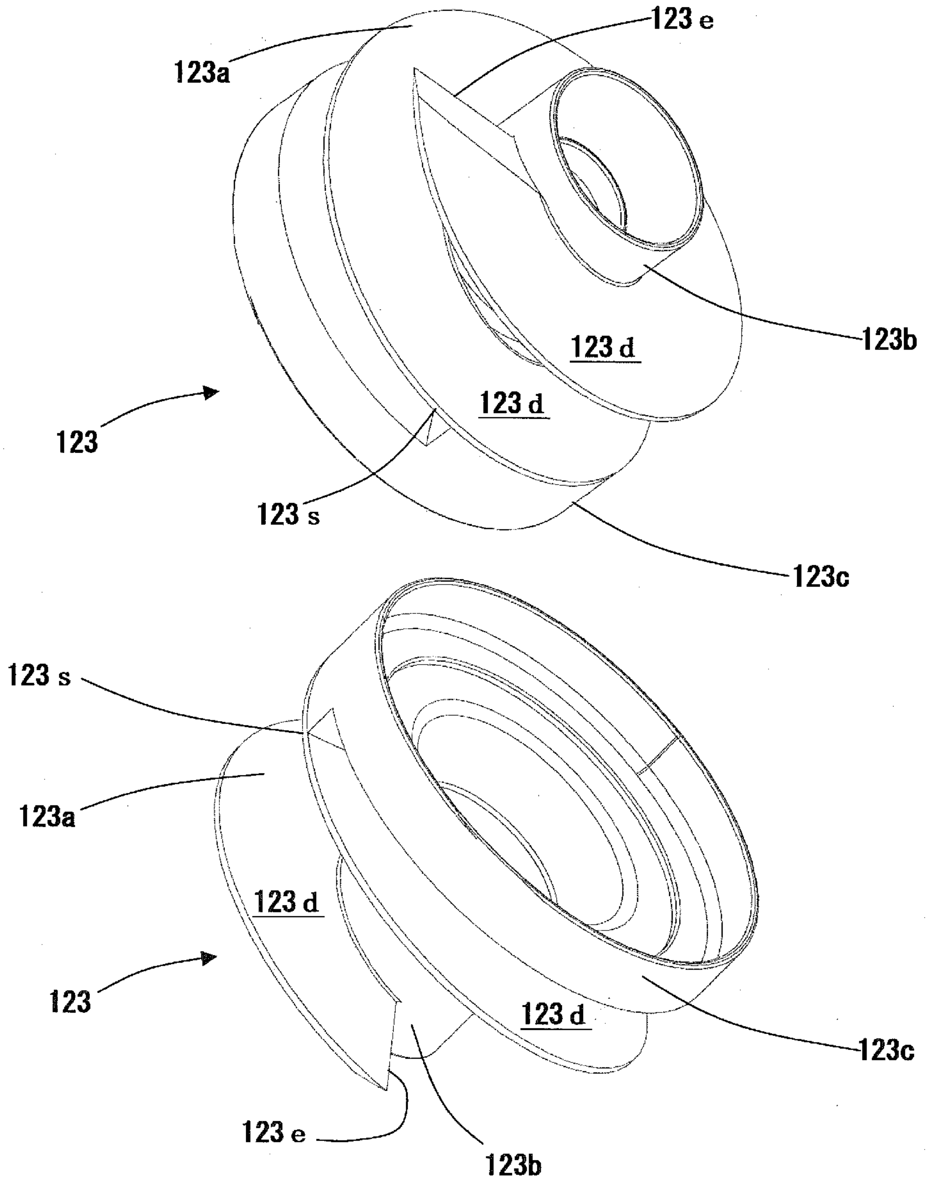
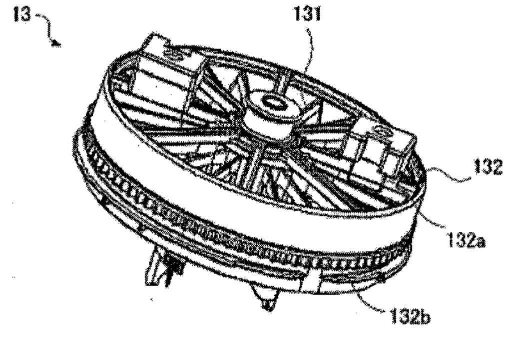
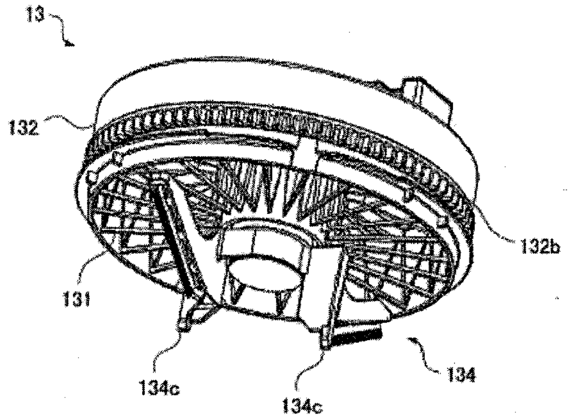

123 e
123a
123b
123 d
123 d
123
123 s
123c
123 s
123a
123 d
123
123 d
123c
123 e
123b

Fig.5



(a)



(b)

Fig.6

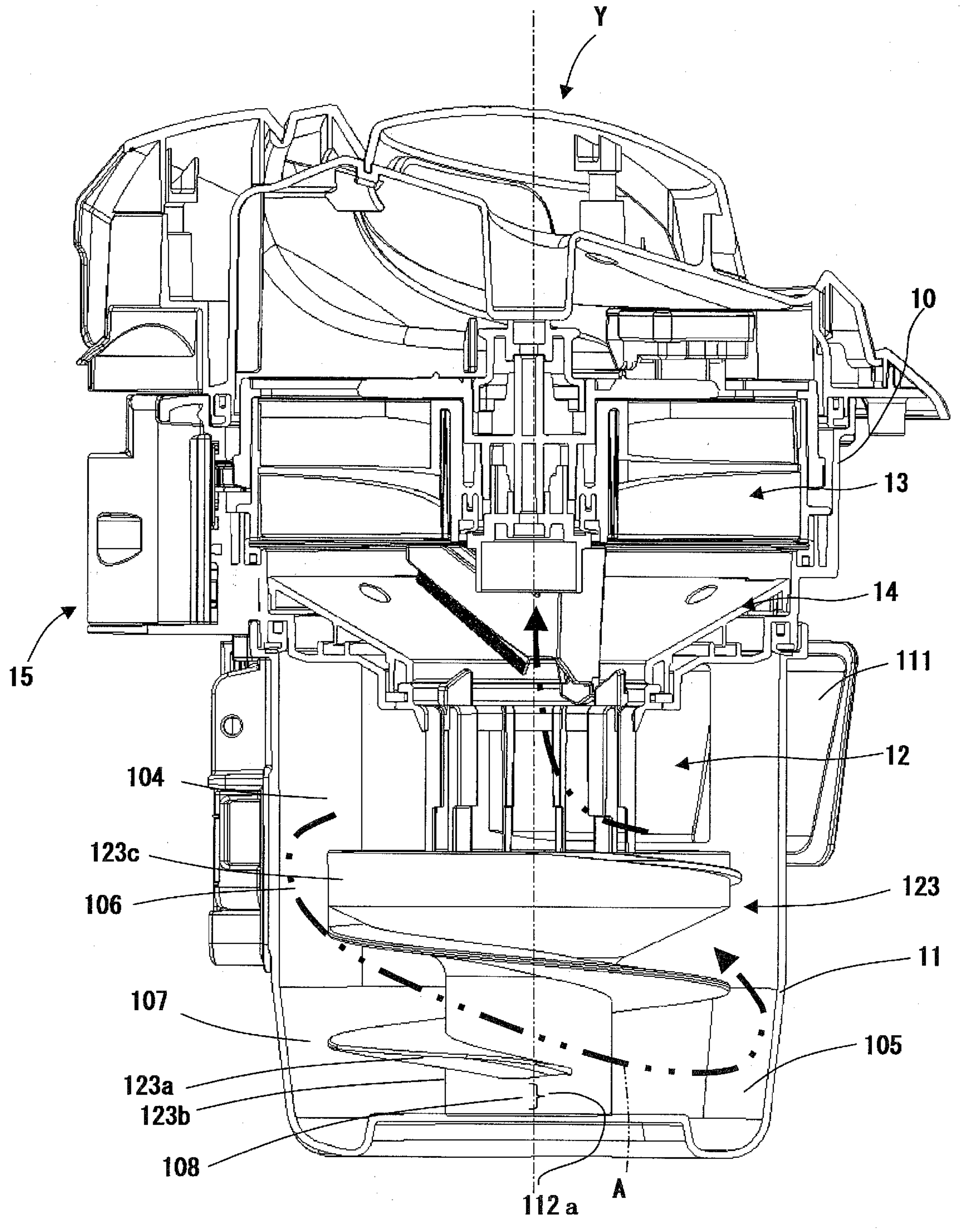

Y
10
13
14
15
111
12
104
123c
106
123
11
107
105
123a
123b
108
112 a
A

Fig.7

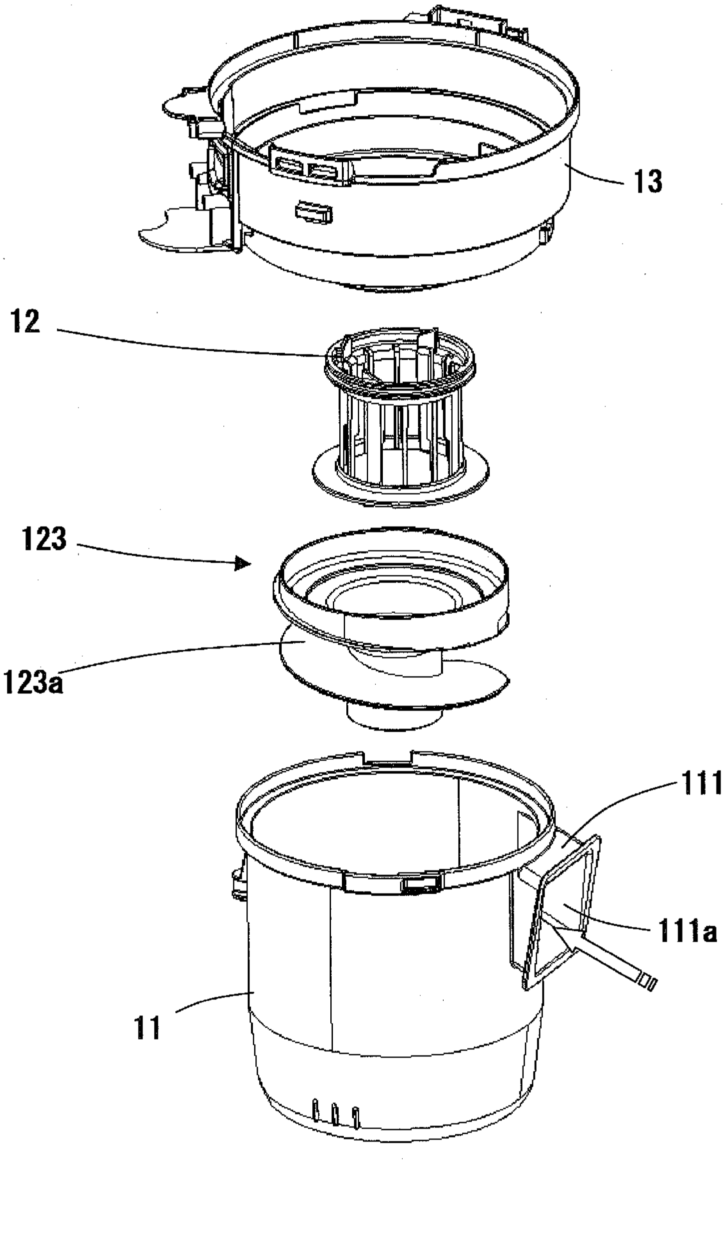


Fig.8

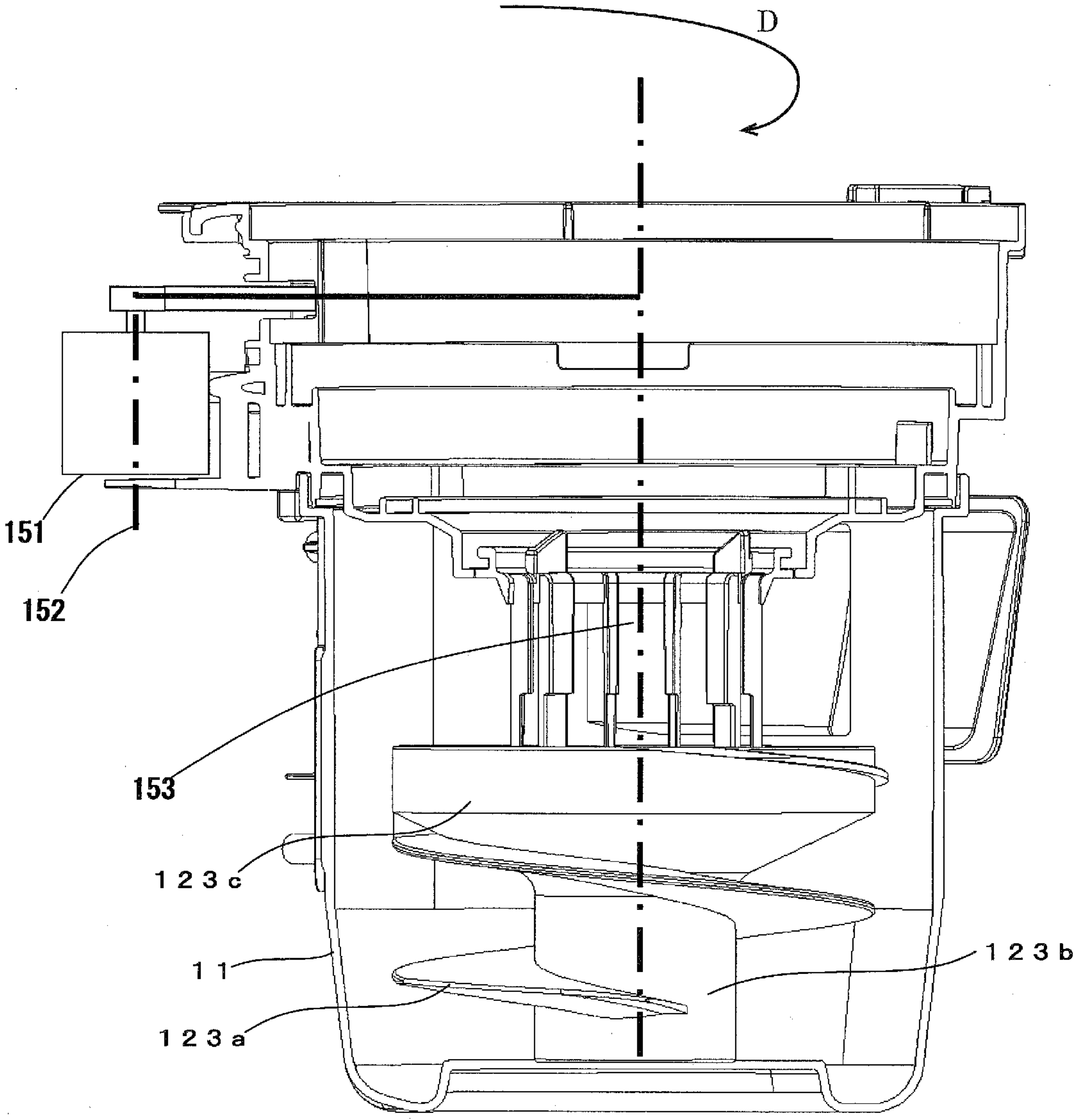


Fig.9

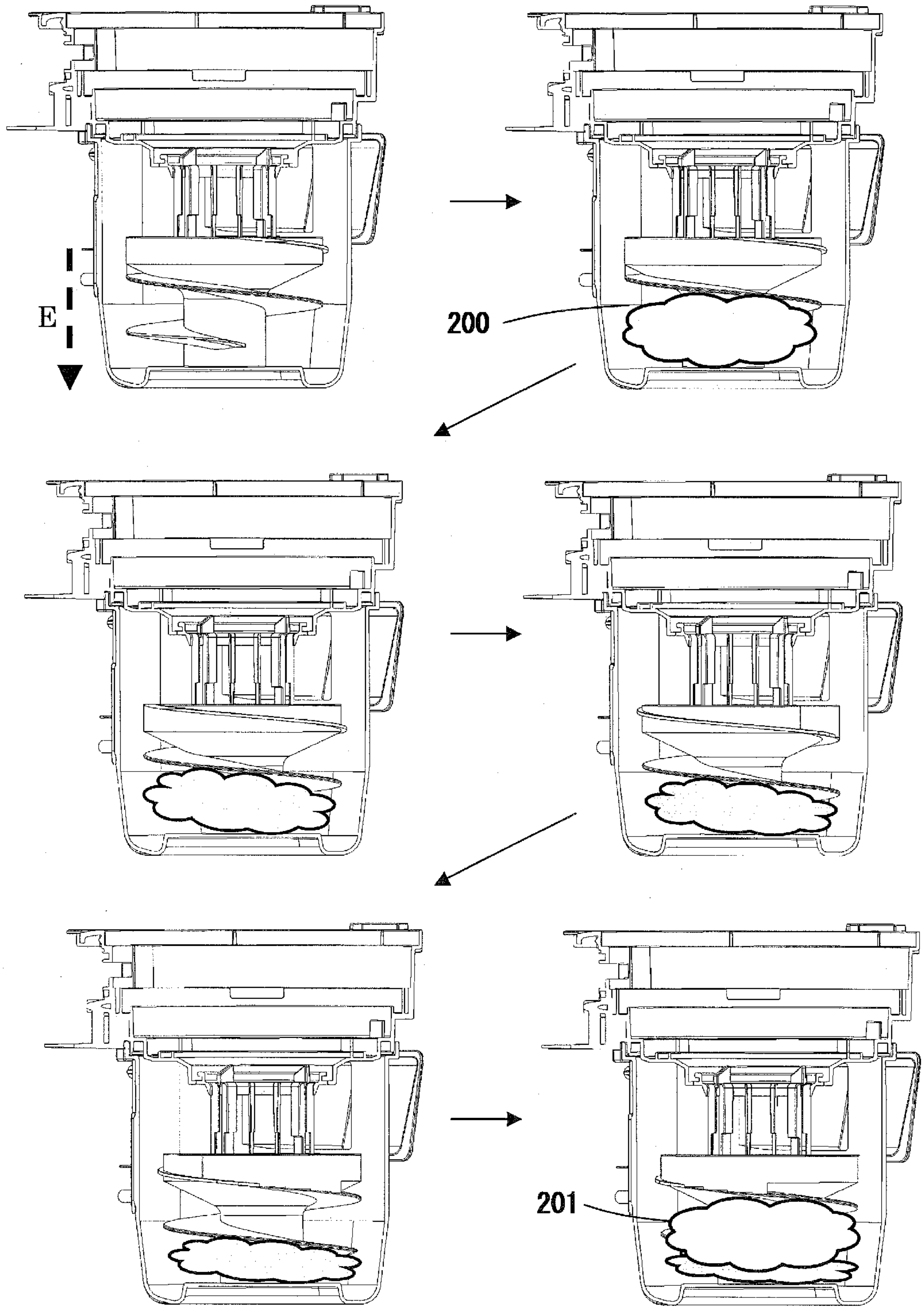


Fig.10

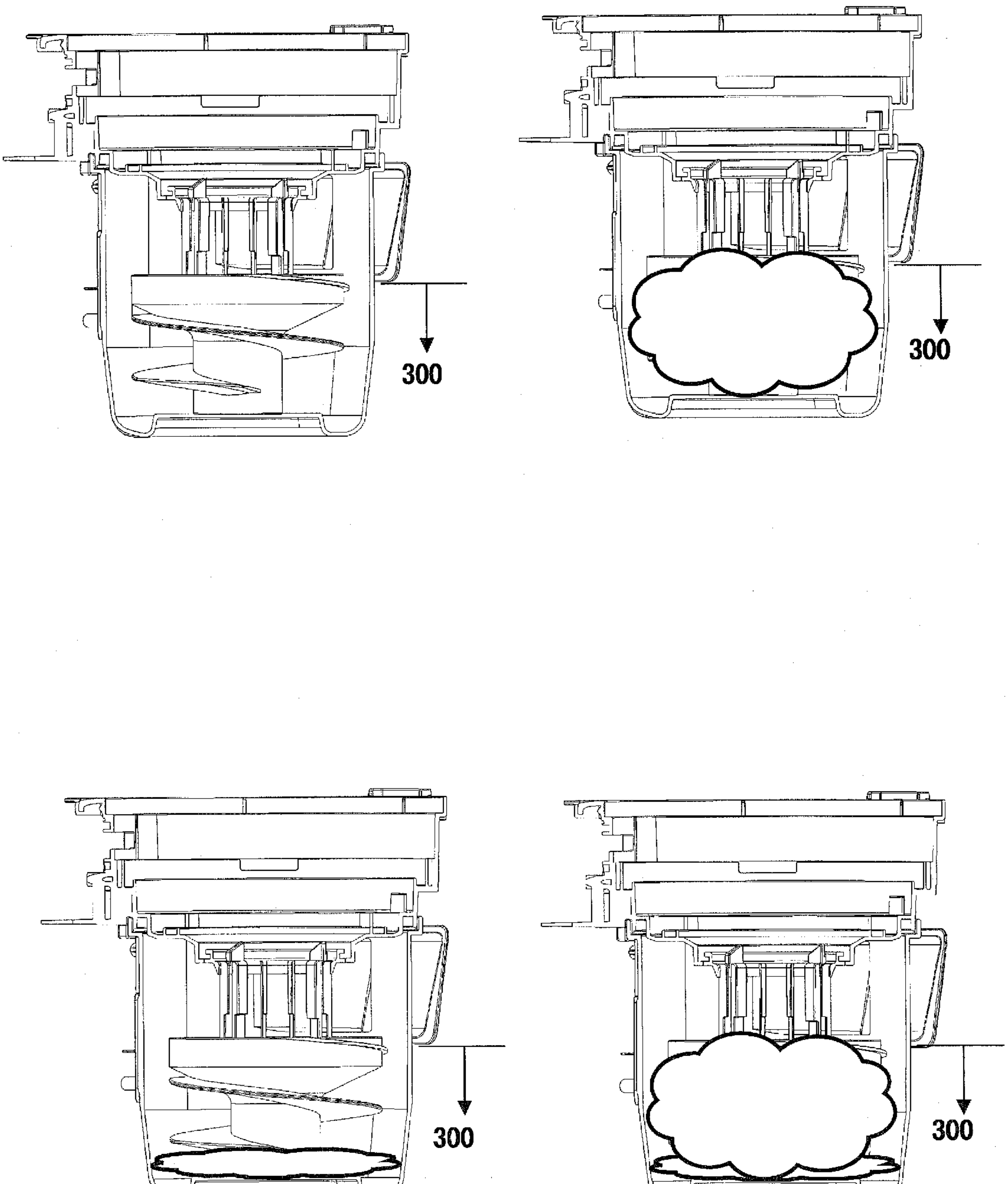


Fig.11

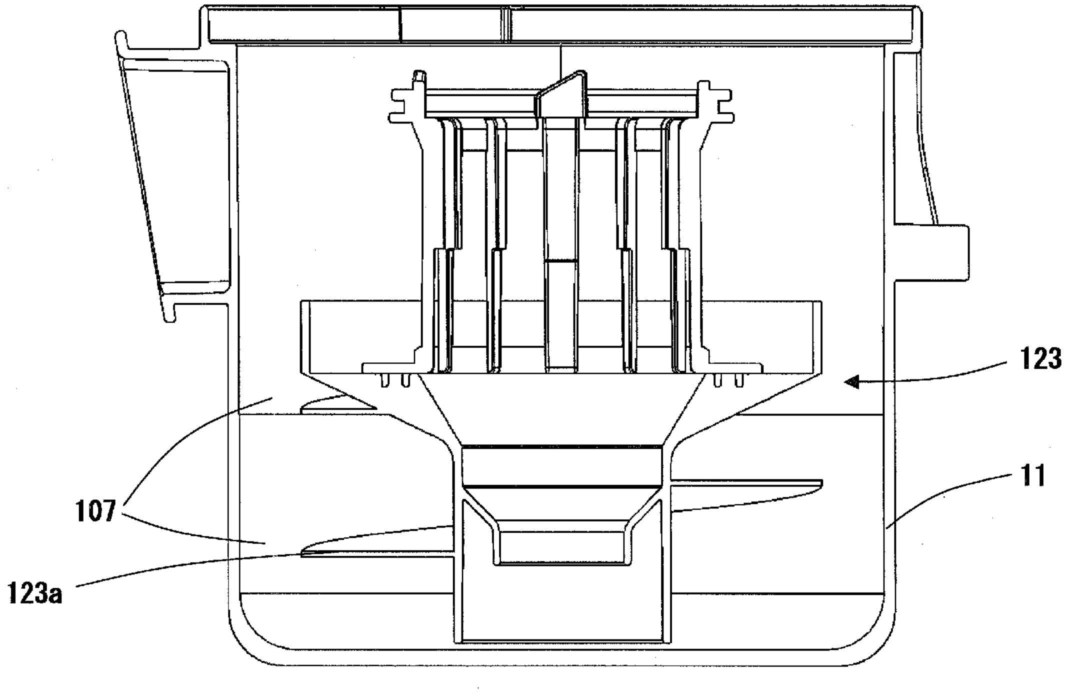


Fig.12

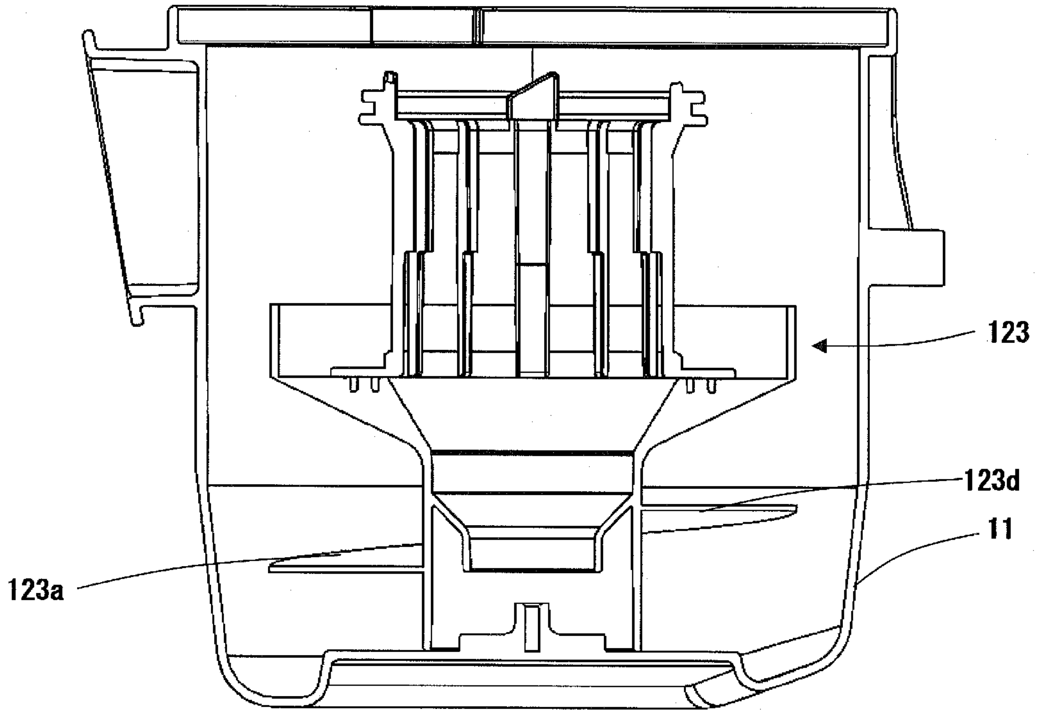


Fig.13

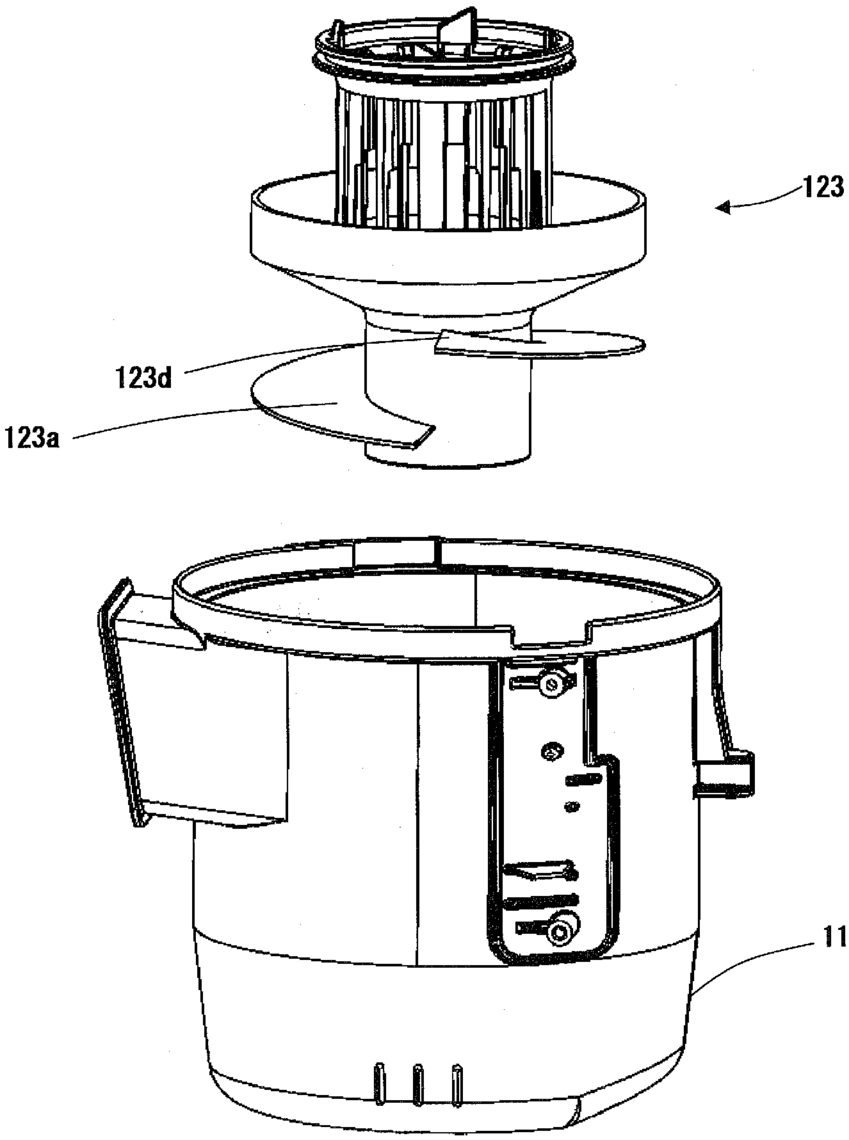


Fig.14

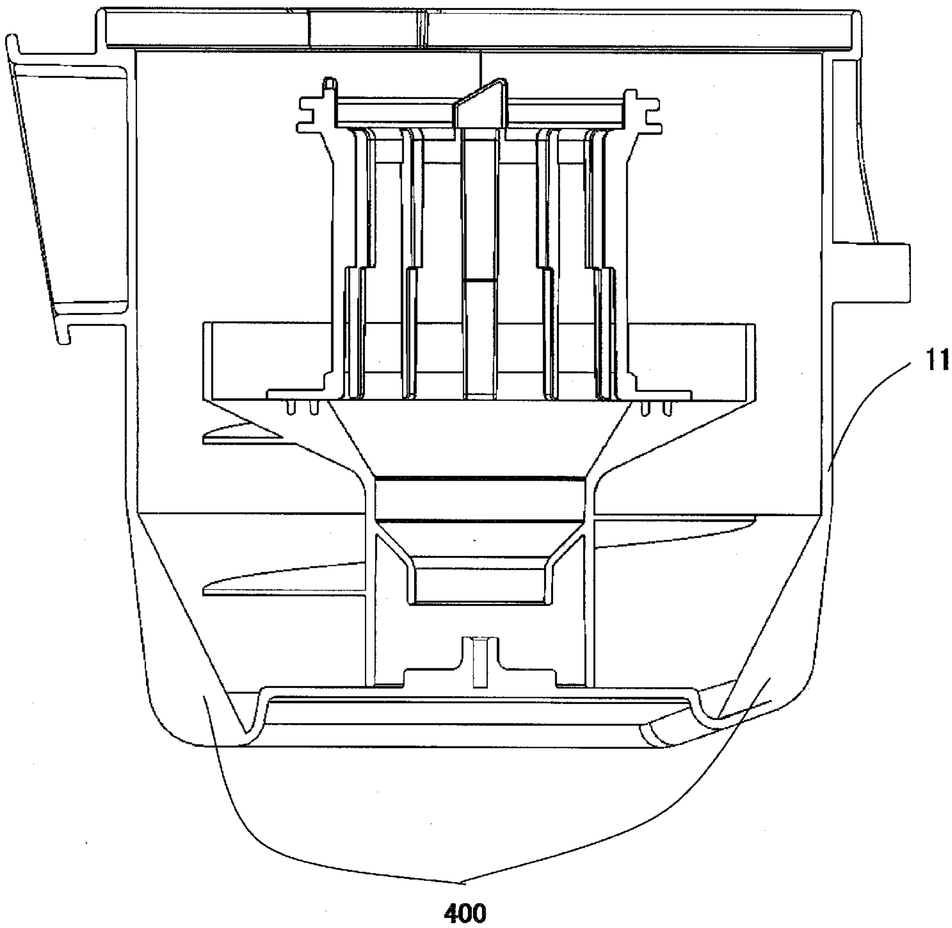


Fig.15

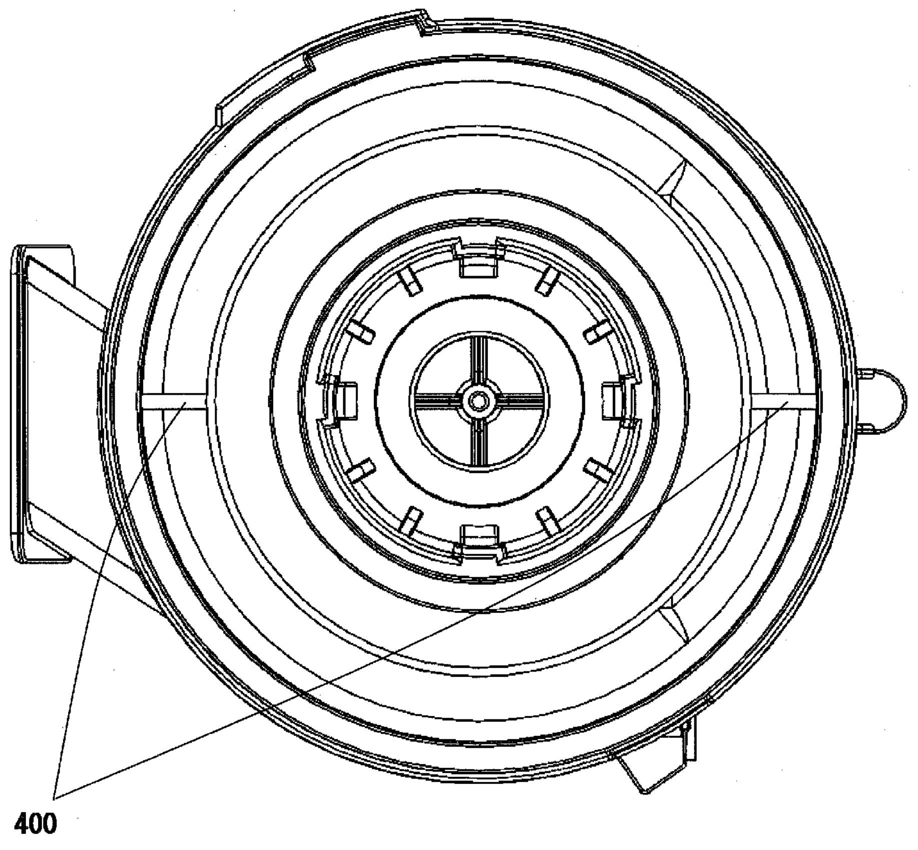
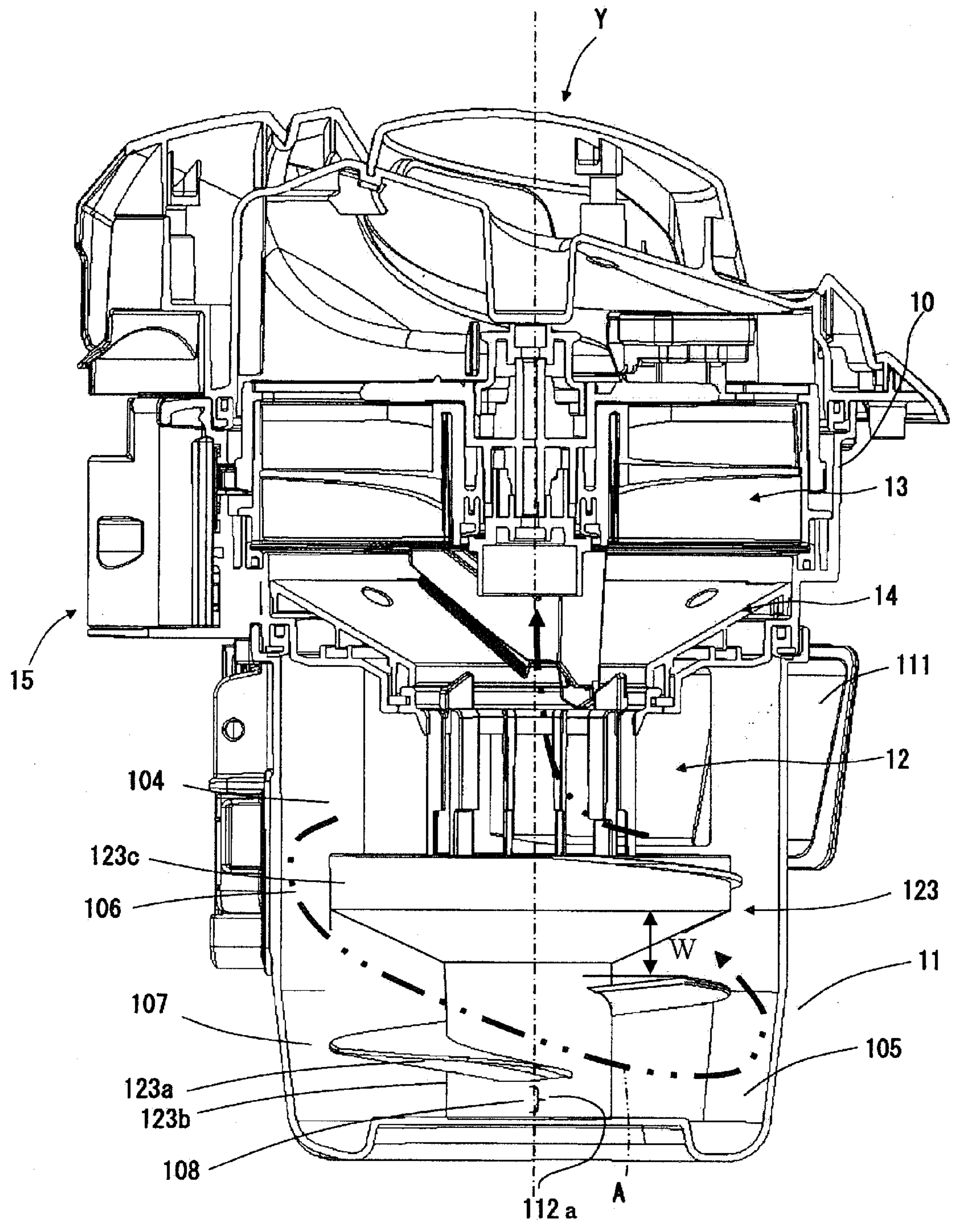


Fig.16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111
12
104
123c
106
123
W
11
107
105
123a
123b
108
112 a
A

Fig.17

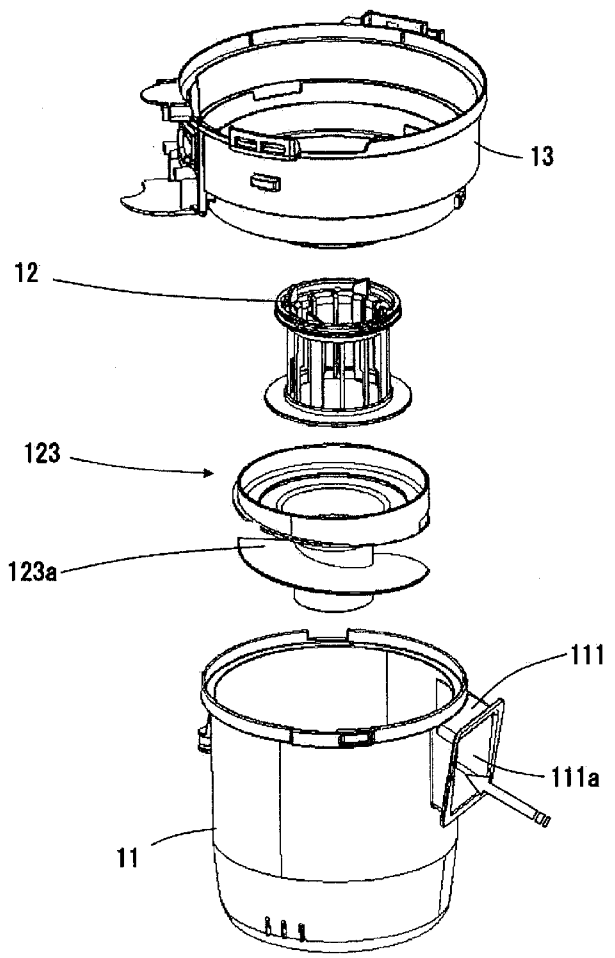


Fig.18

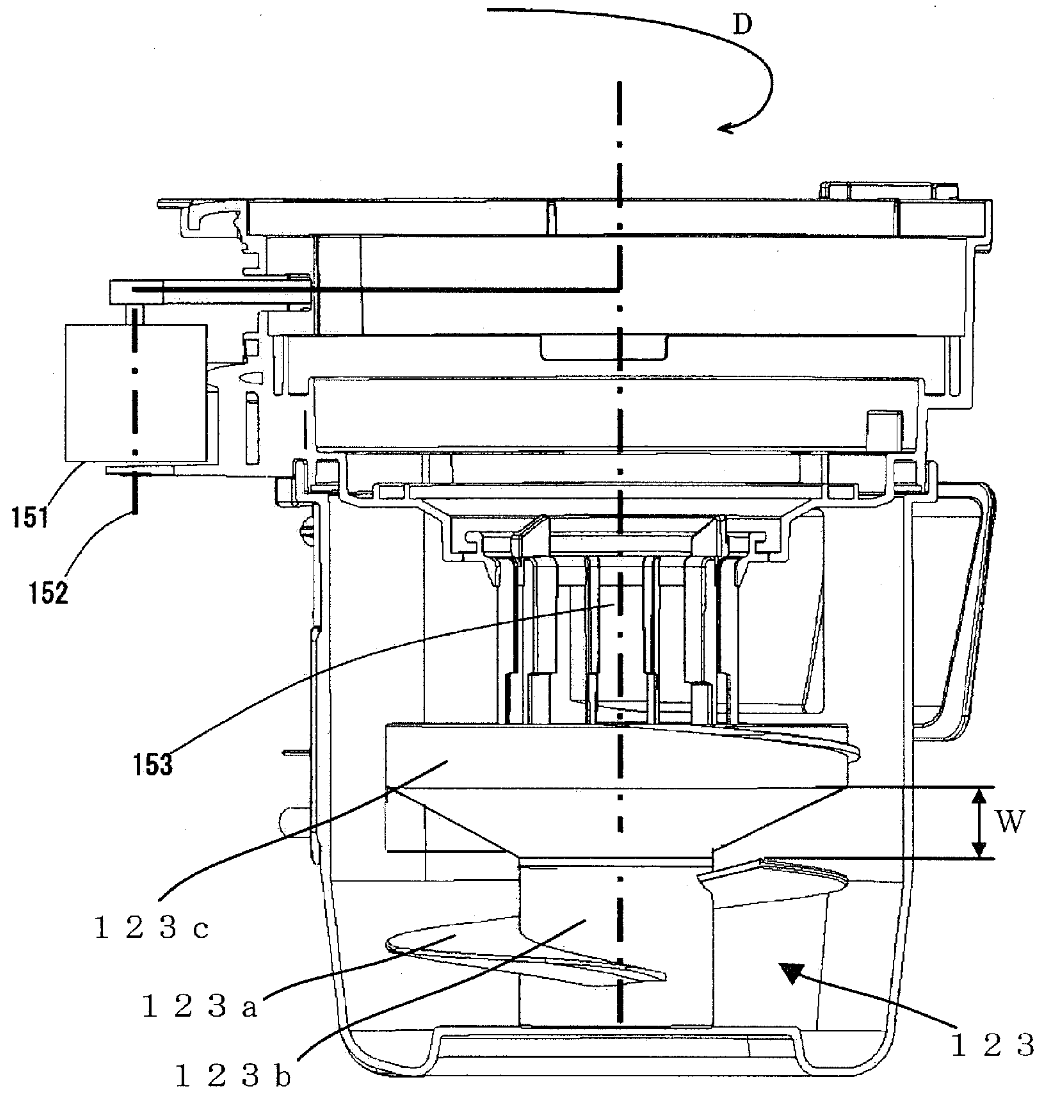
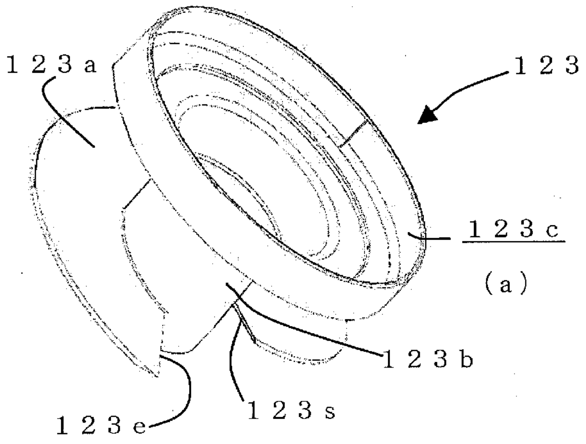


Fig.19



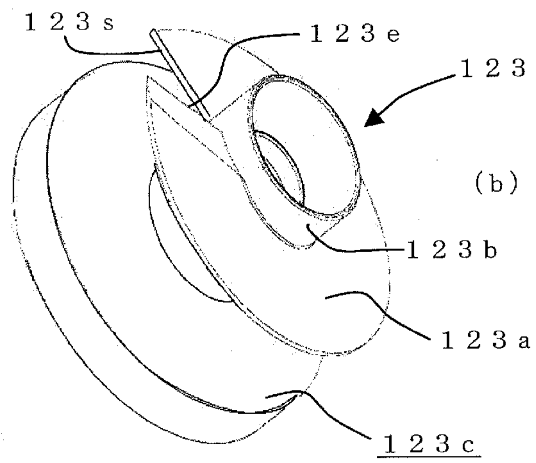
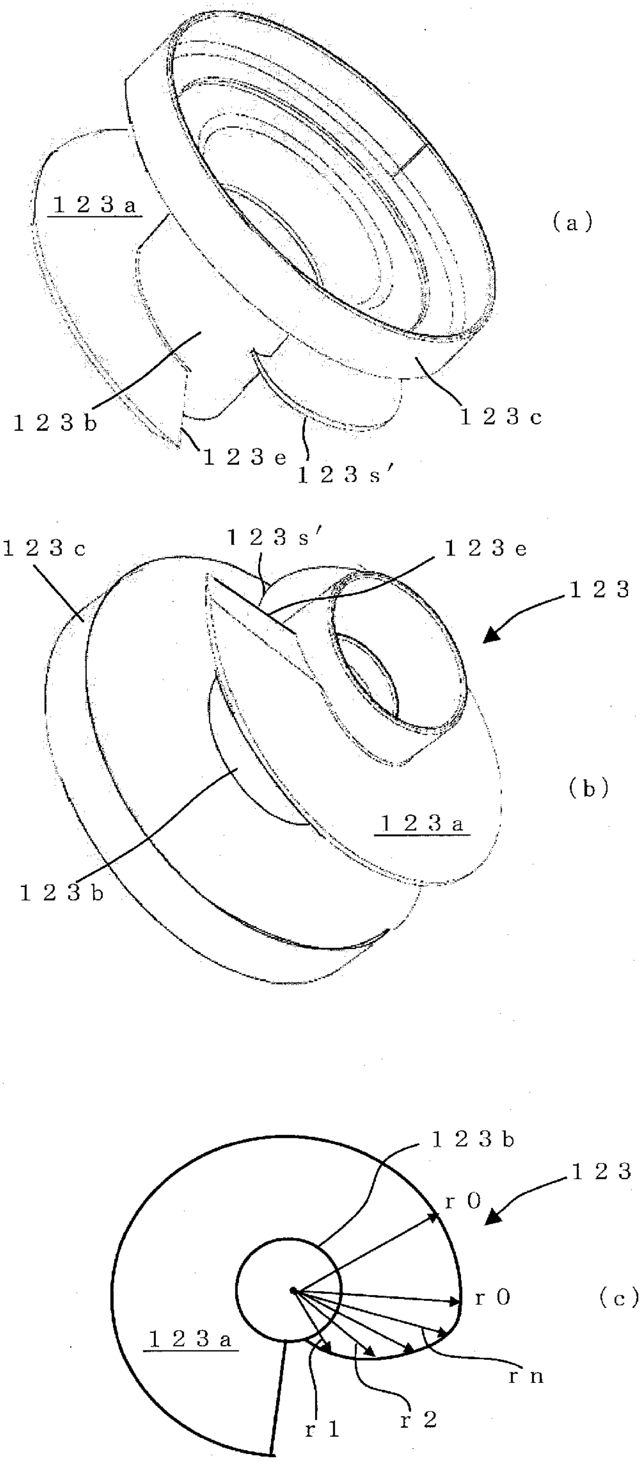


Fig.20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1 2 3 b
1 2 3 e
1 2 3 s'
1 2 3 c
1 2 3 c
1 2 3 s'
1 2 3 e
1 2 3
(b)
1 2 3 a
1 2 3 b
1 2 3 b
1 2 3
r 0
r 0
(c)
1 2 3 a
r n
r 1
r 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/055394

A. CLASSIFICATION OF SUBJECT MATTER
A47L9/10(2006.01)i, *A47L9/16*(2006.01)i, *A47L9/20*(2006.01)i, *B04C5/04*(2006.01)i, *B04C5/103*(2006.01)i, *B04C5/12*(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)
A47L9/10, A47L9/16, A47L9/20, B04C5/04, B04C5/103, B04C5/12

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	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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 A	JP 47-37655 B1 (Maschinenfaberik Leetel AG.), 22 September, 1972 (22.09.72), Full text; all drawings (Family: none)	1-9,11,15 10,12-14

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

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Date of the actual completion of the international search 15 June, 2009 (15.06.09)	Date of mailing of the international search report 23 June, 2009 (23.06.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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Patent documents cited in the description

- JP 2006075584 A **[0005]**
- JP 2005013312 A **[0005]**