US 20180140149A1

(19) **United States**

(12) **Patent Application Publication**

VAN DER KOOI et al.

(10) **Pub. No.: US 2018/0140149 A1**

(43) **Pub. Date: May 24, 2018**

(54) **BAGLESS VACUUM CLEANER**

(71) Applicant: **KONINKLIJKE PHILIPS N.V.**, EINDHOVEN (NL)

(72) Inventors: **JOHANNES TSEARD VAN DER KOOI**, EINDHOVEN (NL); **RALPH PIERRE KREBBERS**, EINDHOVEN (NL)

(73) Assignee: **Koninklijke Philips N.V.**, Eindhoven (NL)

(21) Appl. No.: **15/564,340**

(22) PCT Filed: **Mar. 31, 2016**

(86) PCT No.: **PCT/EP2016/056989**

§ 371 (c)(1),
(2) Date: **Oct. 4, 2017**

(30) **Foreign Application Priority Data**

Apr. 13, 2015 (EP) 15163395.5

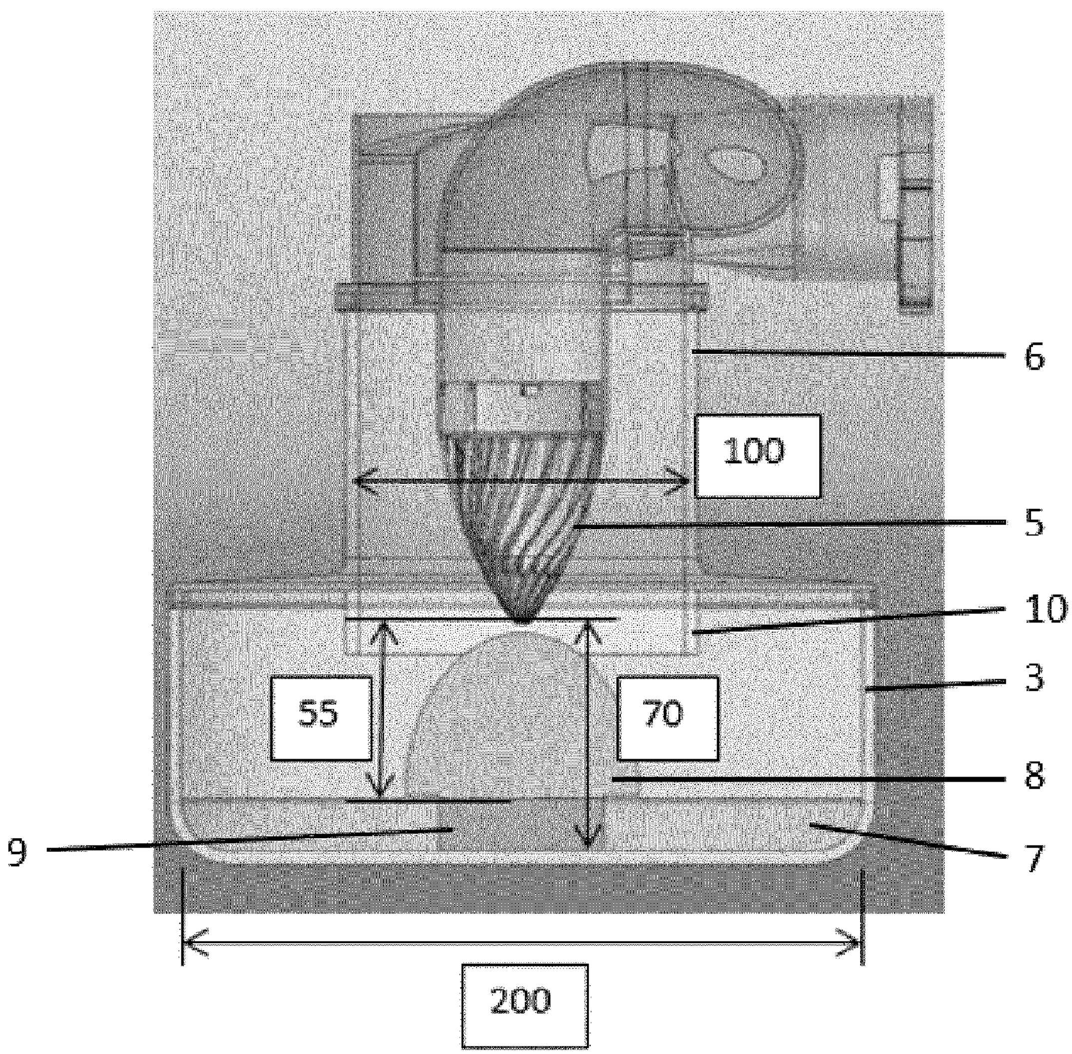
Publication Classification

(51) **Int. Cl.**
A47L 9/16 (2006.01)
A47L 9/18 (2006.01)

(52) **U.S. Cl.**
CPC ***A47L 9/1666*** (2013.01); ***A47L 9/182*** (2013.01); ***A47L 9/1683*** (2013.01)

(57) **ABSTRACT**

In a bagless vacuum cleaner, comprising a cyclonic separator having a cyclone tube (**6**), and a bucket (**3**) for containing a liquid, a diameter of the bucket (**3**) is at least 2 times a diameter of the cyclone tube (**6**). Preferably, in the bucket (**3**) there is a body (**8**) having a center in line with a center of the cyclone tube (**6**), a shape of the body (**8**) being or approximating a mushroom-shape.



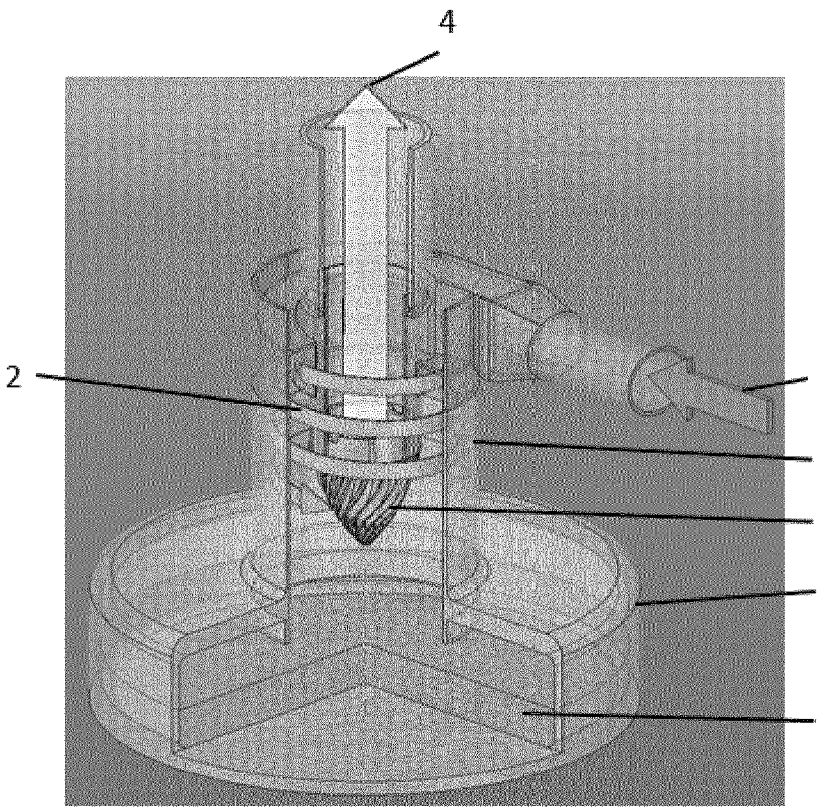


Fig. 1

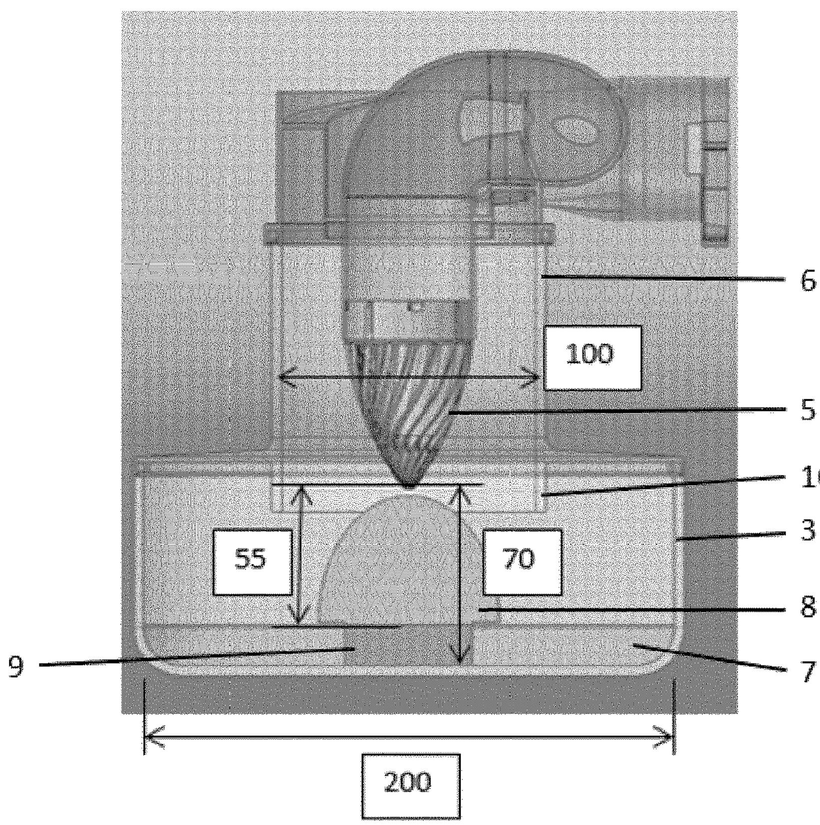


Fig. 2

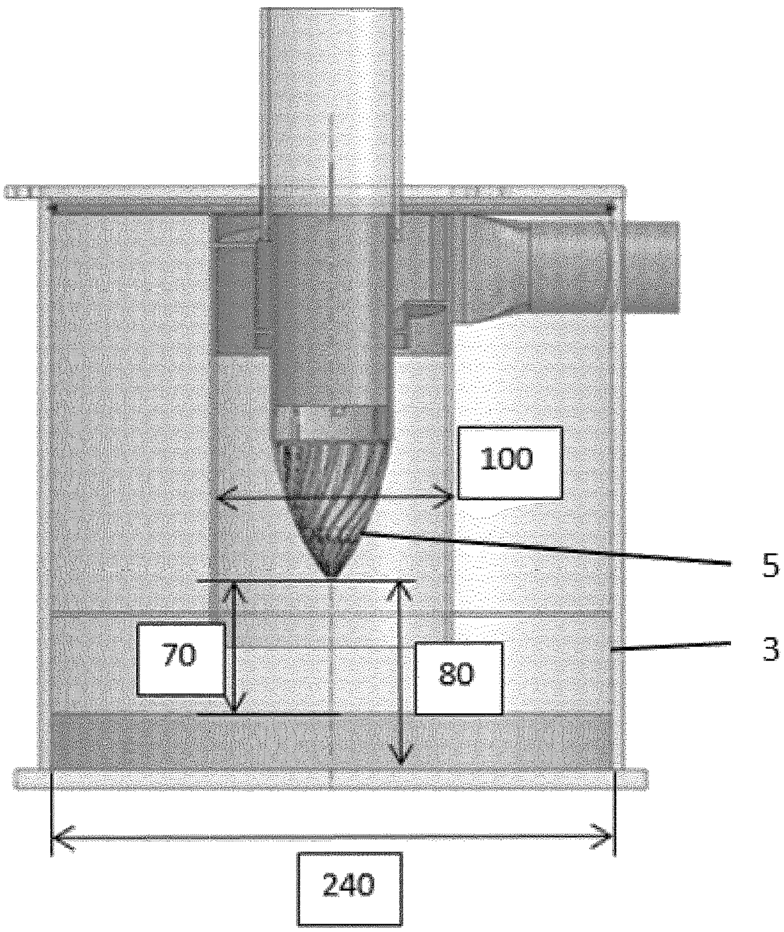


Fig. 3

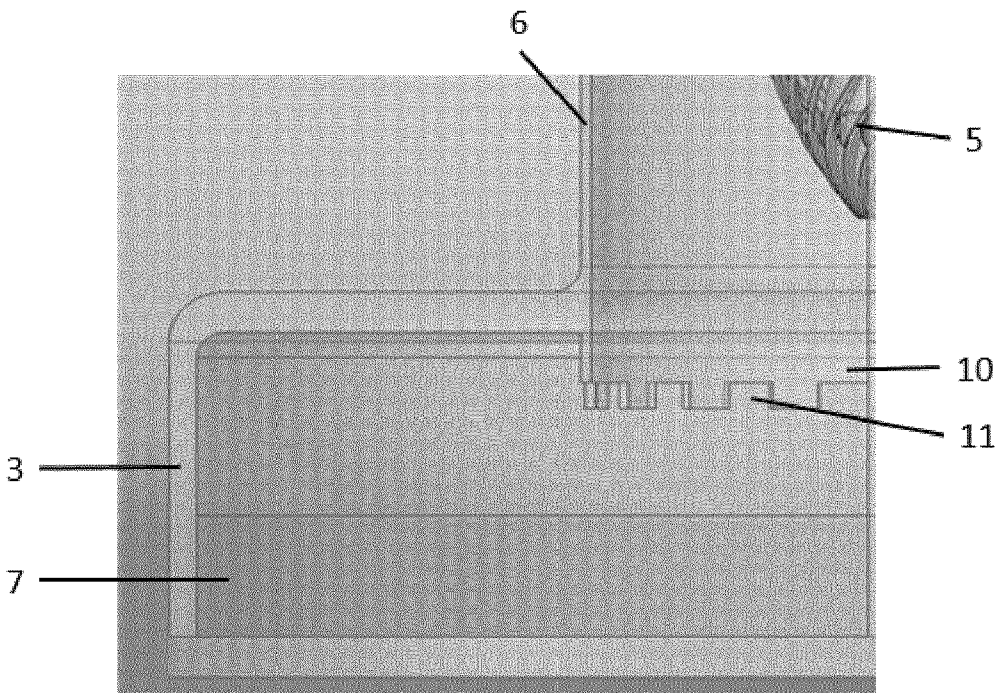


Fig. 4

BAGLESS VACUUM CLEANER

FIELD OF THE INVENTION

[0001] The invention relates to a bagless vacuum cleaner using a cyclone to separate dust from air.

BACKGROUND OF THE INVENTION

[0002] US 2012/0145009 discloses a wet type dust collecting apparatus of a vacuum cleaner, which includes a first separating unit configured to filter out and discharge dust by rotating air which is inlet via a first air inlet, and a plurality of a second centrifugal separating units configured to filter out dust from the air which is discharged from the first separating unit, and configured to eliminate dust from the inlet air via water which is filled inside of the second centrifugal separating units.

SUMMARY OF THE INVENTION

[0003] It is, inter alia, an object of the invention to provide an improved vacuum cleaner. The invention is defined by the independent claims. Advantageous embodiments are defined in the dependent claims.

[0004] In one aspect of the invention, in a bagless vacuum cleaner, which comprises a cyclonic separator having a cyclone tube, and a bucket for containing a liquid, a diameter of the bucket is at least 2 times a diameter of the cyclone tube. Preferably, in the bucket there is a body having a center in line with a center of the cyclone tube, a shape of the body being or approximating a mushroom-shape.

[0005] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** shows a first embodiment of the invention;

[0007] FIG. **2** shows a first set of dimensions of an embodiment of the invention;

[0008] FIG. **3** shows preferred dimensions of an embodiment of the invention; and

[0009] FIG. **4** shows a preferred embodiment of the invention having a rim shaped to regulate an amount of liquid entering into a cyclone tube.

DESCRIPTION OF EMBODIMENTS

[0010] Vacuum cleaners are available in two basic versions: bag and bagless. The bagless versions are based on dust separation by cyclonic action, filters, water filtration, and combinations of these systems.

[0011] Water filtration uses water as the main filter medium. Air is forced into the water where particles are captured in the water as the air moves through. Instead of water, another cleaning liquid could be used.

[0012] In cyclonic systems, centrifugal forces are created by rotating air inside a chamber. A high speed rotating (air)flow is established within a cylindrical or conical container called a cyclone. Air flows in a helical pattern, beginning at the top of the cyclone and ending at the bottom end before exiting the cyclone through the center of the cyclone and out the top. Particles in the rotating stream have too much inertia to follow the tight curve of the stream, and strike the outside wall, then fall to the bottom of the cyclone where they can be removed. The cyclone geometry, together with flow rate, defines the cut point of the cyclone, i.e. the size of particles that will be removed from the stream with a 50% efficiency.

[0013] In order to get the best performance out of the vacuum cleaner, the challenge is to attain the highest separation performance while having a pressure drop in the system which is as low as possible. Normally a higher separation performance comes with a higher pressure drop which results in a lower suction power and therefore less performance for the vacuum cleaner. Therefore this invention focuses on a better filter performance without compromising on suction power performance.

[0014] As described above the particles in the rotating stream which have too much inertia to follow the tight curve of the stream will strike the outside wall. Then they fall to the bottom of the cyclone where they are stored while the clean air leaves the cyclone in the middle section through a so-called vortex finder. However, some of the particles which strike the outside wall are dragged back from the wall into the center of the cyclone by small air movements (turbulences) which occur. Furthermore it is hard to keep the particles at the bottom of the cyclone in the dust collecting space as even very small flow velocities can pick them up and drag them to the cyclone again. These phenomena both decrease the separation performance of the cyclone.

[0015] FIG. **1** shows a first embodiment of the invention, in which water **7** is provided at the bottom of the cyclone, such that particles are trapped by the water are prevented from being introduced to the cyclone again. Furthermore a part of the cyclone wall is wetted in the process, causing particles to first stick to the wall and then being rinsed towards the bottom of the cyclone where the dirt collecting finds place.

[0016] A cyclone is placed such that a dirt bucket **3** is located at the bottom of the cyclone. When filled with water **7**, a vortex finder **5** is pointing towards the water. Dirty air **1** is sucked directly in the cyclone. Dust and air are separated in the cyclone. The dust particles flow with the air stream **2** downwards along the wall of a cyclone tube **6** and fall in the water at the bottom of the bucket **3**. Clean air **4** is sucked via the vortex finder towards a suction motor (not shown). The diameter of the bucket **3** is larger than the diameter of the cyclone tube **6**.

[0017] FIGS. **2** and **3** show relative dimensions of embodiments of the invention. When the diameter of the bucket is decreased, the water rotational speed increases and as a result the water gets more turbulent. Therefore the distance from the water to the top of the vortex finder **5** needs to be increased to avoid water being sucked into the vortex finder **5**. This results in an increase of the total height of the appliance. Put otherwise, an increased width of the bucket **3** allows for a reduction in its height with the same amount of water.

[0018] Preferably, there is at least 0.5 liter of water in the bucket. A smaller diameter combined with the requirement of 0.5 liter of water results in a higher bucket to allow the 0.5 liter water storage.

[0019] Taking into account an optimal height of a vacuum cleaner to guarantee a stable appliance (not tilting when being moved), the dimensioning shown in FIG. **2** appeared very beneficial, while that of FIG. **3** is even more preferred. The following table compares the relative dimensions of FIGS. **2** and **3** to those in of an actual embodiment of a Samsung vacuum cleaner as covered by US 2012/0145009.

	FIG. 2	FIG. 3	US 2012/0145009
Diameter of cyclone tube 6 in relation to diameter of bucket 3	100/200 = 0.5	100/240 = 0.4	100/172 = 0.58
Diameter of bucket 3 in relation to distance between bottom of bucket 3 to end of vortex finder 5	200/70 = 2.8	240/80 = 3.0	172/121 = 1.4
Diameter of cyclone tube 6 in relation to distance between water surface to end of vortex finder 5	100/55 = 1.8	100/70 = 1.4	unknown

[0020] The end of the vortex finder **5** is understood to be the lowest part where air can enter into the vortex finder **5**.

[0021] Challenge in a cyclonic system containing water (either that of the prior art or that of FIG. **1**) is to keep the water away from the suction motor. Normally the cyclonic action takes care of this by centrifuging water droplets to the outside walls in a way that air and water are separated before air enters the vortex finder. The force responsible for separating the water droplets from the air is the centrifugal force. The force is given by:

$Fc=m\omega^2 r$(ω=angular velocity, m=mass, r=distance relative to center of the cyclone)

[0022] From the formula it follows that when the distance to the center approaches zero, the resulting force also goes to zero. Therefore, droplets at the center do not experience centrifugal forces and are not separated from the air. This can result in water droplets being sucked from the center passing the vortex finder into the suction motor.

[0023] As soon as the system of FIG. **1** has been started up, no water exist at the center because of the rotation of the water in the dirt bucket **3** (comparable with a whirlpool). Water in the dirt bucket **3** rotates and a dry spot occurs at the middle. However, when starting the appliance the water is not rotating yet and therefore the dry spot is not yet created and water is sucked up through the vortex finder into the suction motor.

[0024] To that end, the embodiment of the invention as shown in FIG. **2** comprises a body **8** with a specific shape which prevents water from being present in the middle of the dirt bucket **3** at startup which is not interfering with the cyclone when the system is in steady state. It is noted that the advantages of this particular shape can be used both in the embodiment of the invention of FIG. **1** and in the prior art as shown in e.g. US 2012/0145009.

[0025] A preferred shape of the body **8** is the shape of a mushroom as shown in FIG. **2**. In this shape there is no 'flat spot' (such as when the body would have a flat upper surface) where water can accumulate and still the center of the space below the cyclone is 'filled' till such an extent that the water present will always experience centrifugal forces. A mushroom-like kind of shape as shown in FIG. **2** will not function as vortex stabilizer, which would happen if the body would have a triangular shape above the water surface).

[0026] The mushroom-shaped body **8** should not touch the vortex finder **5** or be too close to the vortex finder **5** as capillary forces between surface of the mushroom-shaped body **8** and the vortex finder **5** surfaces will 'catch' water. This will result in water being sucked up through the vortex finder **5**.

[0027] A pure triangular form would result in that water gets the opportunity to be sucked up along the slope of the triangular body entering the vortex finder **5**. Especially when the water is moving because of movement of the appliance, water will be present at the slopes and can thus easily be sucked up. However, it is possible for the body to have multiple slopes, e.g. a first slope at an angle of less than 45° (e.g. 20°) with the horizontal at an uppermost part of the body, followed by a second slope at an angle of more than 45% (e.g. 70°) with the horizontal: this would approximate the ideal mushroom shape.

[0028] Furthermore the body **8** preferably has a part **9** having a smaller diameter (as shown in FIG. **2**). This part (recess) **9** should have the same height as the height of the water. This feature prevents water from easily being forced towards the slope of the body when the appliance is moved/shaken.

[0029] Another challenge in a cyclonic system combined with water is to keep the system as clean as possible. The less parts that get dirty, the more convenient the appliance will be with regard to cleanability.

[0030] The amount of contamination of the cyclonic parts is highly dependent on the amount of water entering the cyclone from the dirt container **3**. If more water enters the cyclone tube **6**, more of it becomes wet and therefore dirty. A similar kind of relation can be found for the separation performance, which is also highly dependent on the amount of water in the cyclone. The wetter the cyclone gets, the better the separation performance will be.

[0031] From a consumer point of view the separation performance should be as good as possible while the appliance should stay as clean as possible. This results in a contradiction for the preferred amount of water entering the cyclone.

[0032] To set for the optimum one would like to be able to control the amount of water going to the cyclone.

[0033] In an embodiment without a rim **10** as shown in FIG. **2**, water will be blown towards the top of the dirt container **3** from which it will be sucked into the cyclone tube **6** by a secondary flow going from the middle of the cyclone via top of the bucket into the cyclone again. The amount of water going to the cyclone is not controllable in such an embodiment without a rim **10**.

[0034] As a result of the rim **10** in FIG. **2**, water travels from the top cover of the bucket **3** to the rim **10** where the steep corner combined with gravitational forces force the water to fall off the rim. The rotational air centrifuges the water then away from the cyclone. This solution gives a minimum amount of water entering the cyclone. As shown in FIG. **2**, the rim **10** is positioned at the end of the cyclone tube **6** at the transition of the cyclone tune **6** to the dirt container **3**.

[0035] The rim **10** is preferably higher than 1 mm and should have a sharp edged end. In an embodiment, the rim **10** has openings **11** to give part of the water the ability to enter the cyclone tube **6**. The number and shape of such openings **11** allow for regulating an amount of water that enters the cyclone tube **6**.

[0036] The invention may be used in an optimal setting containing water in the bucket **3**, as well as in a suboptimal setting where there is no water in the bucker **3**, depending on the preference of the consumer.

[0037] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

1. A bagless vacuum cleaner, comprising
a cyclonic separator having a cyclone tube, and
a bucket for containing a liquid,
wherein a diameter of the bucket is at least 2 times a diameter of the cyclone tube.

2. A bagless vacuum cleaner as claimed in claim **1**, wherein the diameter of the bucket is 2.5 times the diameter of the cyclone tube.

3. A bagless vacuum cleaner as claimed in claim **1**, wherein the diameter of the bucket is at least 2.8 times a distance between the bottom of the bucket to an end of a vortex finder of the cyclonic separator.

4. A bagless vacuum cleaner as claimed in claim **3**, wherein the diameter of the bucket is at least 3 times the distance between the bottom of the bucket to the end of a vortex finder of the cyclonic separator.

5. A bagless vacuum cleaner as claimed in claim **1**, wherein in the bucket there is a body having a center in line with a center of the cyclone tube, a shape of the body being or approximating a mushroom-shape.

6. A bagless vacuum cleaner as claimed in claim **5**, wherein the body has a part having a smaller diameter than a largest diameter of the body, a height of the part corresponding to an intended level of the liquid.

7. A bagless vacuum cleaner as claimed in claim **1**, wherein the cyclone tube extends into the bucket so as to form a rim having openings for regulating an amount of liquid entering into the cyclone tube.

8. A bagless vacuum cleaner, comprising
a cyclonic separator having a cyclone tube, and
a bucket for containing a liquid,
wherein in the bucket there is a body having a center in line with a center of the cyclone tube, a shape of the body being or approximating a mushroom-shape.

9. A bagless vacuum cleaner as claimed in claim **8**, wherein the body has a part having a smaller diameter than a largest diameter of the body, a height of the part corresponding to an intended level of the liquid.

10. A bagless vacuum cleaner as claimed in claim **8**, wherein a diameter of the bucket is at least 2 times a diameter of the cyclone tube.

11. A bagless vacuum cleaner as claimed in claim **8**, wherein the diameter of the bucket is 2.5 times the diameter of the cyclone tube.

12. A bagless vacuum cleaner as claimed in claim **8**, wherein the diameter of the bucket is at least 2.8 times a distance between the bottom of the bucket to an end of a vortex finder of the cyclonic separator.

13. A bagless vacuum cleaner as claimed in claim **8**, wherein the diameter of the bucket is at least 3 times the distance between the bottom of the bucket to the end of a vortex finder of the cyclonic separator.

14. A bagless vacuum cleaner as claimed in claim **8**, wherein the cyclone tube extends into the bucket so as to form a rim having openings for regulating an amount of liquid entering into the cyclone tube.

* * * * *