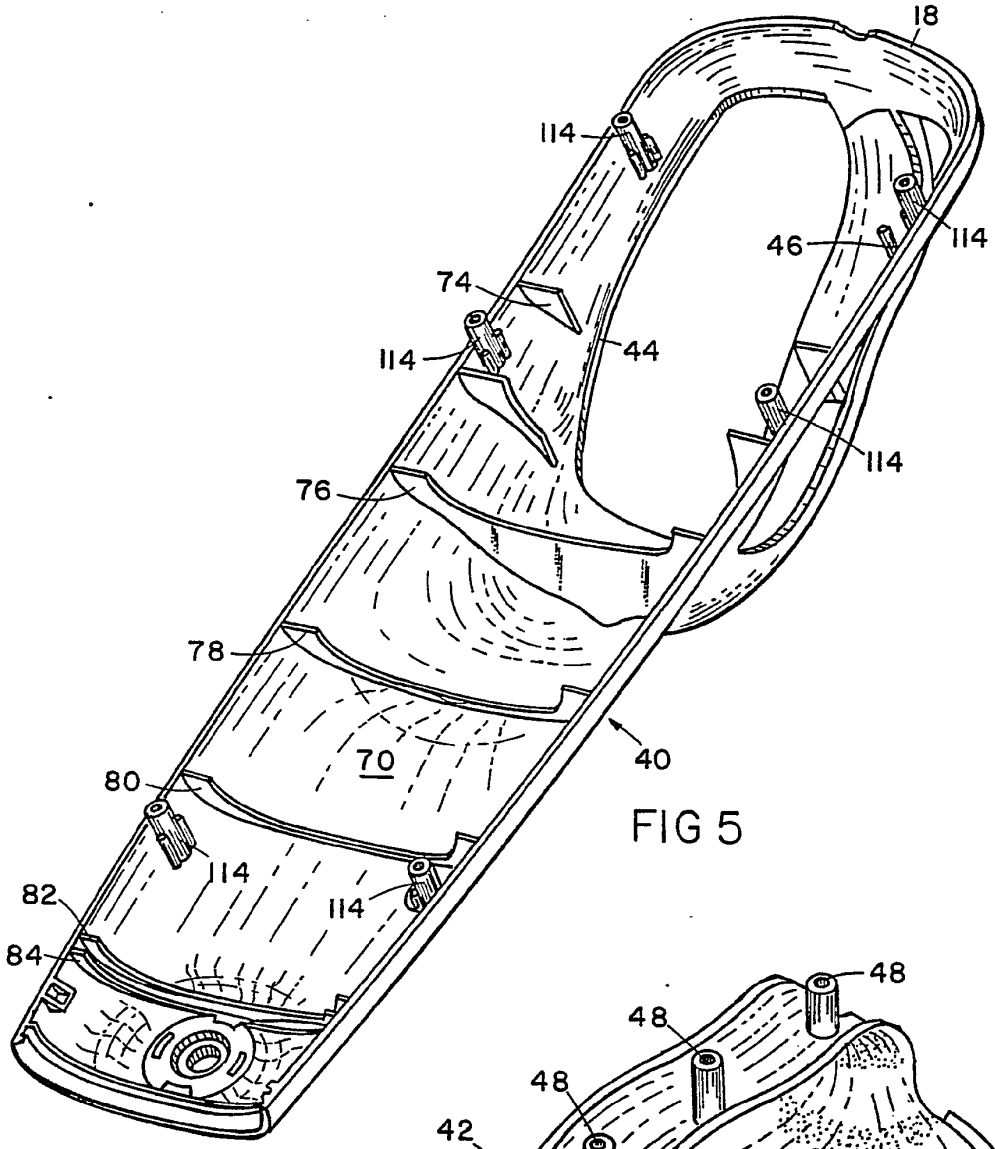

18
114
46
114
74
44
114
114
76
78
70
40
80
114
114
82
84

FIG 5

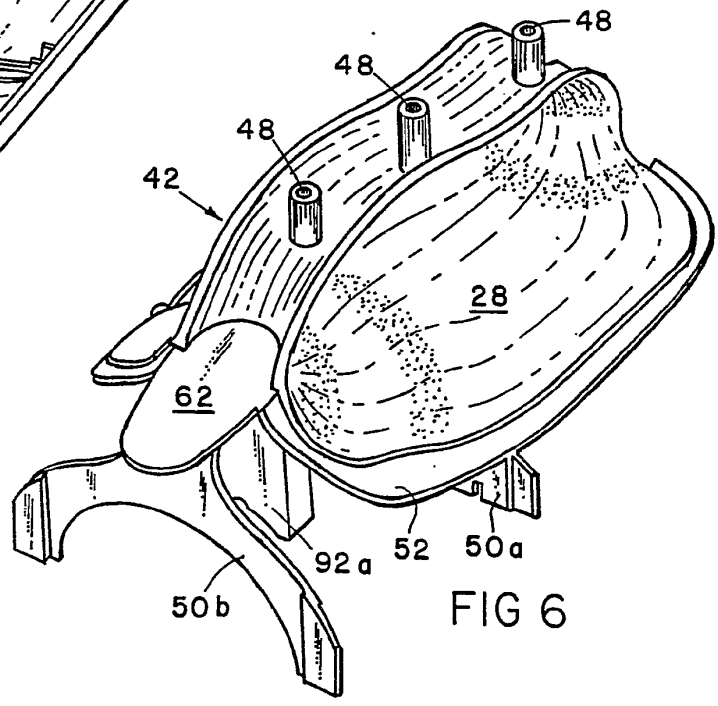

48
48
48
42
28
62
52
50a
92a
50b

FIG 6

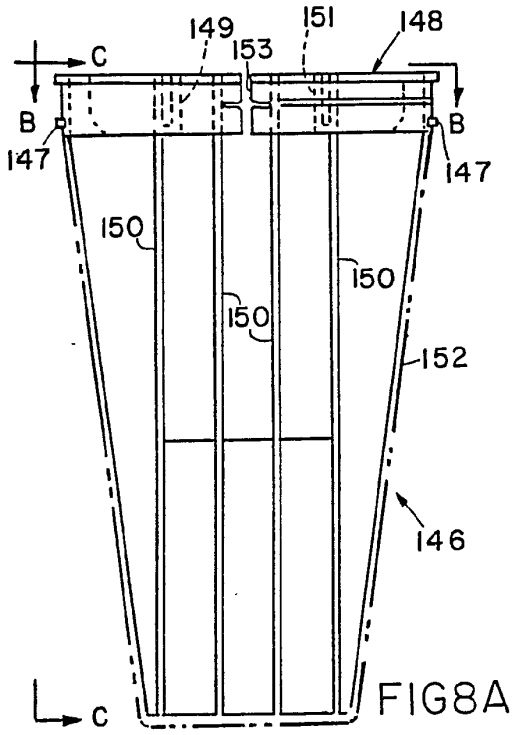


FIG8A

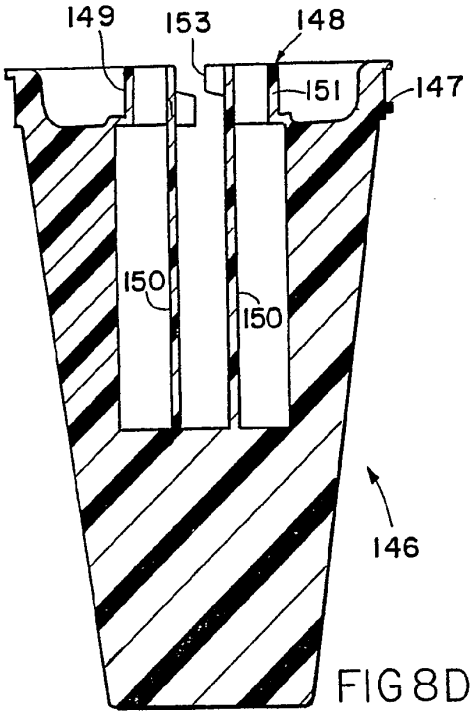


FIG8D

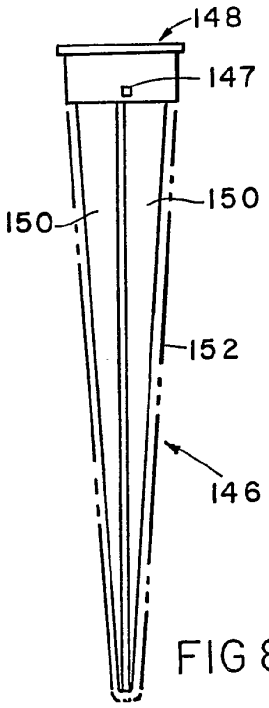


FIG8C

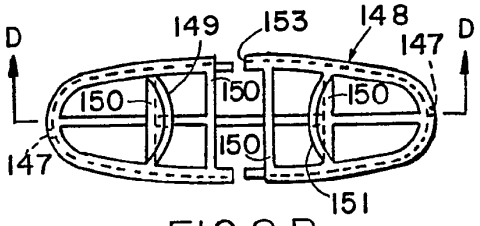


FIG8B

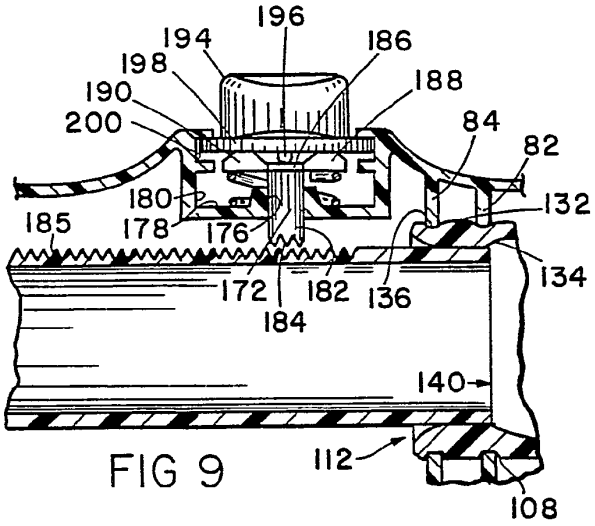


FIG 9

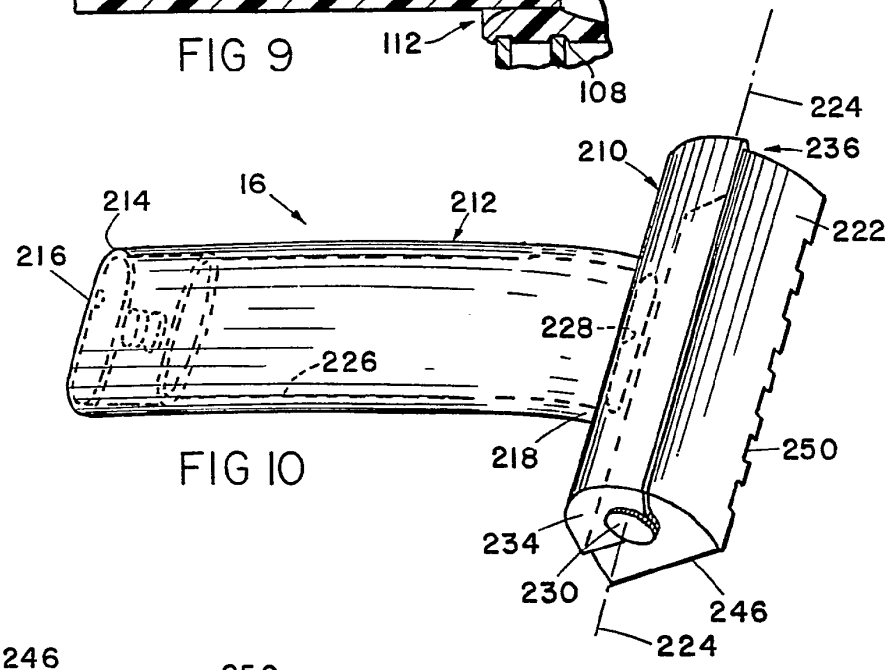


FIG 10

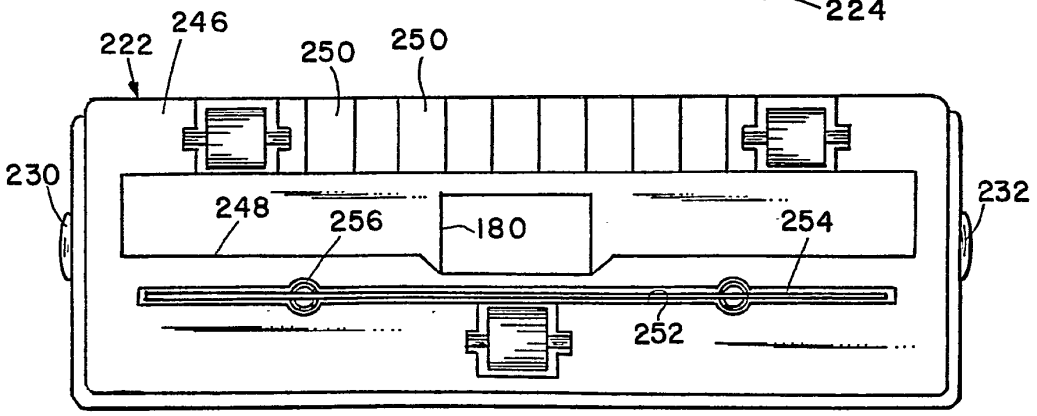


FIG 11

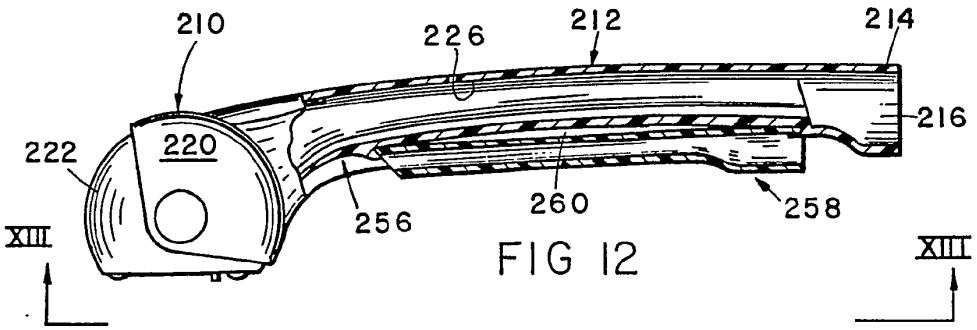


FIG 12

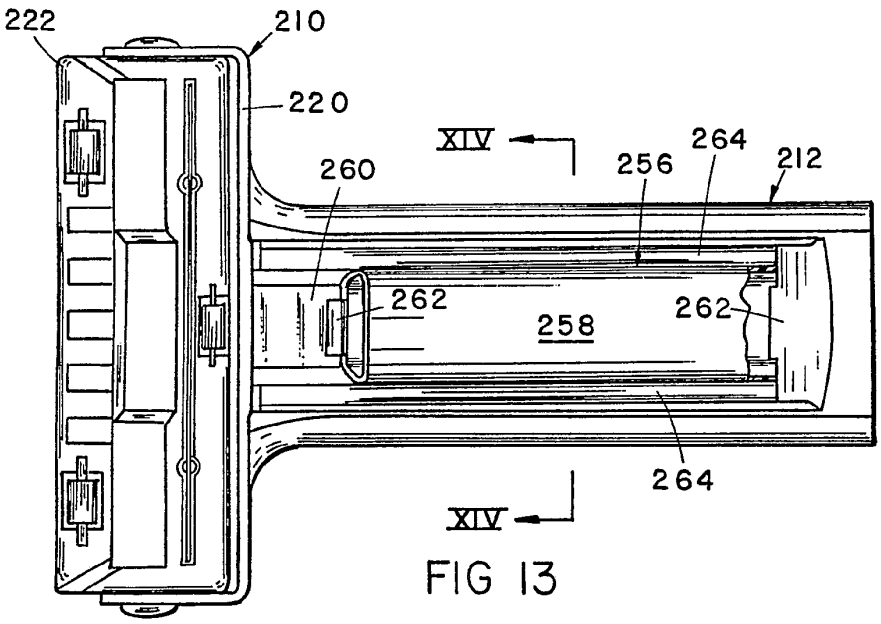


FIG 13

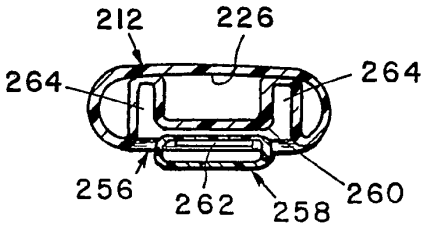


FIG 14

VACUUM CLEANER

This invention relates generally to vacuum cleaners, and particularly to vacuum cleaners convertible from a hand-held vacuum to a stick-type vacuum cleaner.

A variety of different dry-type vacuum cleaners are available for a variety of uses ranging from heavy duty rug and carpet cleaners, light duty rug and carpet cleaners for cleaning small spills and crumbs, and compact hand-held cleaners for cleaning cushions, pillows, stair treads and the like. There have also been developed cleaners particularly designed or equipped with conversion tools to be used for special purposes such as removal of spider webs near the ceiling, drapery valences, and other hard to reach areas.

In recent years, due to the introduction of plastics and substantial improvements in the design of electric motors for this type of equipment, the bulk and weight of these machines have been reduced substantially. Also, the development of compact rechargeable, heavy duty batteries has made possible the so-called "cordless vacuum cleaner". However, there remains the problem that the machines are limited to one or two functions. For other functions, it has been necessary to have a second tool or a bulky and clumsy conversion kit. Such tools and conversion kits are necessary because the vacuums are too large or bulky to life above the head to clean out of reach areas or tight areas.

Stick vacuums, that is hand-held vacuums attached to the end of a rod, were designed to be used to clean carpets or floors from a standing position, or to clean hard to reach areas such as ceilings, drapery valences, and the like. However, a majority of the stick-vacs

proved awkward to handle since substantially all of the weight of the vacuum was disposed at the far end of the wand. When used above or off the floor, the mass of the vacuum at the end of the wand requires the operator to exert a great deal of energy in suspending the vacuum at the end of the wand. Moreover, accessory cleaning tools were stored separate from the portion of the vacuum being held by the user, making them rather awkward to access.

The instant invention provides a vacuum cleaner convertible from a lightweight and manoeuvrable hand-held vacuum to an extended stick-like vacuum to clean floors from a standing position and otherwise inaccessible areas. In the extended position, the nozzle is sufficiently strong to support the weight of the vacuum. Moreover, the vacuum cleaner is adapted to receive a floor cleaning tool or head which may be used in either the extended or retracted position, depending upon the desired cleaning task to be performed. The floor cleaning tool conveniently carries at least one accessory cleaning tool thereon.

The vacuum cleaner includes a low profile, oblate housing having an opening in a first end which extends substantially the length of the housing, and having a shape substantially identical to the exterior shape of the housing. The housing is enlarged toward the second end to contain a motor driven fan for drawing air into the first end and out the second end of the vacuum housing. Telescopically received within the first end of the housing is an elongate tubular dirt cup adapted to slide therein between a first retracted position and a second extended position. The tubular dirt cup may be locked into any one of a number of positions between and including the fully retracted and extended positions. The dirt cup includes a removable filter at one end and

a flapper valve at an opposite end adapted to prevent the debris from falling back out the dirt cup once captured. A handle extending from the top of the vacuum cleaner housing provides a compound grip to optimally position the centre of gravity of the vacuum when used as a hand-held vacuum or in the extended position as a stick-like vacuum. The angles of the two grip positions and handle contours are ergonomically designed so the operator may comfortably use the vacuum.

The vacuum cleaner also includes a detachable floor cleaning tool having a pivotal cleaning head designed to engage the surface to be cleaned. An accessory such as a crevice tool is detachably coupled, and nested in a neck portion of the floor cleaning tool, for easy access by the user. The accessory is designed to be attached to the end of the elongate dirt cup and fully movable therewith.

The instant invention provides numerous advantages over prior hand-held and stick-like vacuum cleaners, including the ergonomic design for the wide range of readily convertible operating positions, as well as the low profile nozzle to access tight or otherwise inaccessible areas. The extensible dirt cup offers the advantage of a stick vacuum without the stick, and always provides the same travel distance for debris entering the vacuum before it is captured by the filter regardless of whether in the retracted or extended position, making for a more efficient vacuum. Moreover, the short distance to the dirt cup reduces the risk that debris may clog or block the intake.

Additional advantages include a convertible hand vacuum/stick vacuum having a floor cleaning tool which carries accessories for special cleaning applications. The accessories are easily accessed by the user and are

aesthetically incorporated in the overall function and design. The improved filter design also improves operational and cleaning functions. The combination of the dirt cup/extension into the extensible dirt cup reduces the need for parts in assembly as well as reduce replacement part inventory, while also providing an attractive, versatile and easily manoeuvrable design. The low profile and linear alignment of the components may be formed from inexpensive materials and easily assembled, thus providing an inexpensive yet efficient and versatile vacuum cleaner.

A better understanding of the objects, benefits and advantages of our invention may be obtained from the appended detailed description and drawings, wherein:

Figure 1 is an oblique view of one embodiment of the invention;

Figure 2 is a side, cross-sectional view taken along lines II-II in Figure 1;

Figure 3 is a cross-sectional view taken along lines III-III in Figure 2;

Figure 4 is an oblique view of the lower one-half of the housing;

Figure 5 is an oblique view of the upper one-half of the housing;

Figures 6 and 7 are oblique views of an insert for the upper one-half of the housing;

Figures 8A-8D illustrate one embodiment of a filter assembly for use in this invention;

Figure 9 is an enlarged, fragmentary side cross-sectional view of one embodiment of a locking mechanism; and

Figures 10 to 14 generally illustrate one embodiment of a floor cleaning and accessory tool.

For purposes of the following description, the terms

"upper", "lower", "right", "left", "rear", "front", "vertical", "horizontal" and derivatives thereof shall relate to the invention as oriented in Figure 1. However, it is to be understood that the invention may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the inventive concepts defined in the appended claims. Specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

Throughout the following description referring to the many drawing figures, like reference numerals will be used to indicate like components, wherein Figure 1 illustrates one embodiment of a vacuum cleaner 10 of this invention including an elongate, low profile, oblate housing 12, a variably extensible dirt cup 14 and a detachable floor cleaning tool 16. Housing 12 has a rear and front end 18 and 20, respectively defining a longitudinal axis A-A extending therebetween. Proximate first end 18 and located approximately one-quarter of the length of housing 12 is an enlarged, rondure, or bulbous portion 22 adapted to accommodate a centrifugal fan 24 (Figures 2 and 3) and an air-cooled electric motor 26 therein. From rondure or enlarged portion 22 to front end 20, the size of housing 12 is reduced forming a low profile, elongate nose portion 23 having a substantially oblate or elliptical cross-section perpendicular to longitudinal axis A-A of housing 12. The low profile, oblate portion or nose 23 and dirt cup 14 provides sufficient cross-sectional area for good air flow while

simultaneously allowing access of dirt cup 14 and nose portion 23 to otherwise inaccessible areas.

Integral with housing 12 and extending from an upper surface 28 of rondure portion 22 is a handle 30 rejoining housing 12 near back end 18. Handle 30 includes a switch 32 for turning the motor 26 on and off, and a compound angle forming two ergonomically designed grip positions 34 and 36. The angular orientations of the two grip positions 34, 36 are adapted to position the vacuum's centre of gravity either below or ahead of the user's hand while the vacuum is used as a hand-held vacuum or as stick-like vacuum. For example, grip position 34 may be inclined between 5 degrees and 15 degrees from longitudinal axis A-A to provide a grip position suitable for use as a stick vacuum. Grip position 36 may be inclined between 10 degrees and 25 degrees with respect to longitudinal axis A-A to provide an ergonomic grip when used as a hand-held vacuum.

Housing 12 is preferably formed from a high impact polystyrene plastic (HIPP) or ABS plastic in three separate pieces: one forming lower half 38 and two parts, upper housing 40 and handle insert 42, forming the upper half. Handle insert 42 is adapted to fit within opening 44 of upper housing 40 to complete the lower side of handle 30 and the upper surface of bulbous portion 22 for the fan and motor 24, 26 (Figures 6 and 7). Handle insert 42 and upper housing 40 may be held together by post and socket fasteners 46, 48, respectively, extending from the respective portions comprising handle 30. Ribs 50 extending from lower surface 52 of handle insert 42 extend laterally beyond the portion comprising outer surface 28 of rondure housing 22, thus preventing it from extending beyond the remainder of outer surface 28 of housing 40. Each piece is preferably formed using well-

known injection moulding techniques.

An electric cord 54 exiting back 18 of housing 12 is used to supply AC current to motor 24. A first end of cord 54 is secured within housing 12 by anchor 56a-56b (Figures 4 and 7) such that any tensional force applied to cord 54 will not break the electrical coupling to motor 24. Because of the compact nature of housing 12, it is preferred that cord 54 be stowed on the exterior of housing 12.

Back 18 of lower housing 38 is adapted to receive a plate 57 (Figures 1 and 2) at the base of rondure portion 22, disposed parallel to the longitudinal axis A-A of housing 12. Cord 54 is also wrapped about a hook 58 extending from a disc 60 rotatably coupled with lower housing 38 proximate front 20. Disc 60 includes a shaft 62 journalled within a hole in lower housing 38 adapting disc 60 to rotate about the shaft. Cord 54 may be wrapped around plate 56 and hook 58 and retained in place using a conventional catch (not shown) formed in the plug and adapted to pinch an adjacent portion of the cord. Cord 54 may be quickly released by rotating disc 60 such that hook 58 is positioned toward the back end of housing 12 and allowing cord 54 to fall free.

Although this invention has been described with an electric cord stowed on the exterior of the vacuum housing, it is contemplated that back 18 of housing 12 may be slightly modified to accommodate a cord reel well-known in the art. It is further contemplated by the invention that AC power may be substituted by a DC power supply consisting of rechargeable batteries. Such a DC power supply may be easily accommodated within housing 12 as well as the appropriate circuitry used to recharge the cells. Each of the above modifications may be made using conventional and readily available materials.

The interior surfaces 70 and 72 (Figures 4 and 5) of upper and lower housings 38 and 40, respectively, generally conform to the external shape, periodically reinforced and strengthened by ribs or bulkheads 74-84 (Figures 2 to 5). Each rib extends substantially perpendicular to the longitudinal axis of housing 12. Ribs 50a and 50b, together with tongue 62 extending from insert 42, cooperate with ribs 74, 76 extending from lower housing 38 to form a chamber 86 enclosing fan 24. Motor 26 is supported within housing 12 by ribs and/or mounts such as 50a, 74, 90a-90b and 92a-92b so that fan 24 is unencumbered and free to rotate within chamber 86.

Centrifugal fan 24 located within chamber 86 is oriented to draw air in through extensible dirt cup 14 and out through perforations 100 in back 18 of lower housing 38. Fan 24 is preferably powered by an electric motor 26, such as made by Ametek's, Lamb Electric Division of Ohio. Motor and fan 24, 26 are supported within chamber 86 such that an air inlet 102 of fan impeller 24 is concentrically received within one end 104 of casing 53. Casing 53 extends from end 104 immediately adjacent impeller 24, terminating at its opposite end 106 just inside end 20 of housing 12.

Casing 53 is centred within housing 12 and retained therein by ribs 76-84 defined in each half 38, 40 of housing 12. Ribs 82 and 84 (Figure 9) are specifically adapted to engage grooves 108 extending around outer surface 110 of casing 53 near end 112. Ribs 76-84 and upper and lower housing 38 and 40 are specially designed to be clamped together about fan 24, motor 26 and casing 53 in registered alignment by bosses 114 receiving threaded fasteners extending through sockets 120 in lower housing 38 (Figures 4 and 5).

The geometry of casing 53 changes from end-to-end

(Figure 3). At end 104, opening 126 is generally circular, having an inside diameter slightly larger than the outside diameter of air inlet 102 of impeller 24. It is preferred that substantially close tolerances be maintained between the outside diameter of impeller air inlet 102 and the inside diameter of impeller air inlet 102 and the inside diameter of opening 126 to assure efficient air flow. Casing 53 tapers rapidly outward from end 104 in a horizontal direction to obtain a maximum cross-sectional area within the oblate shape of housing 12 toward end 20. Slidably received in end 106 is the extensible dirt cup 14 adapted to extend from and retract within the casing. End 106 has an opening 128 shaped substantially identical to the outer surface 130 of dirt cup 14 with at least a portion of end 106 (Figure 9) having ramping surfaces 134, 136, each adapted to glide up and over dirt cup end 140.

The inner surface 112 of casing opening 128 fits closely with outer surface 130 of dirt cup 14 to provide a substantially airtight seal. However, if desired, a gasket or sealing material (not shown) may be fixed along either ramp surface 134 or 136, or along any other portion of casing 53 or housing 12 in contact with outer surface 130 of dirt cup 14 to form the seal. The gasket or seal may also act as a bearing surface to reduce the friction associated with the sliding motion of dirt cup 14 within casing 53. Both casing 53 and dirt cup 14 may be formed from a polymeric material using well-known moulding techniques to produce the inner passages and openings.

Dirt cup 14 has a tubular inner wall 142 forming a passage extending the length of the dirt cup and concentric with the longitudinal axis A-A of vacuum 10. One end 140 of dirt cup passages 142 is adapted to

receive a filter assembly 146 (Figures 8A-8D) including a split-oval frame 148 having a plurality of tapered ribs 150 extending perpendicular therefrom. Frame 148 is fitted with a spun-bonded polypropylene filter 152 which may be pleated or sewn together to form a pocket for each rib 150, effectively increasing the surface area of filter 152 to trap dirt and debris. Filter assembly 146 is disposed within passage 142 such that the ribs 150 are oriented toward the opposite end 154 of dirt cup 14. Filter assembly 146 may be retained within end 140 by locking tabs 147 extending from each apex of the generally elliptical frame adapted to engage complimentary slots or notches formed on the inside of dirt cup end 140. Filter assembly 146 may be disengaged from end 140 by pinching ribs 149 and 151 together, closing gap 153 and withdrawing locking tabs 147 from dirt cup end 140.

End 154 of dirt cup 14 is fitted with an insert 156 having an external shape substantially similar to the oblate or elliptical transverse section exhibited by dirt cup 14 and front end 20 of housing 12. However, with respect to insert 156, the external dimensions preferably do not exceed the internal dimensions of passage 142 in order to be telescopically received by floor cleaning tool 16 described in greater detail below. Insert 156 includes a passage 158 extending therethrough parallel to and preferably concentric with longitudinal axis A-A of vacuum 10. End 160 disposed within passage 142 is adapted to retain a flapper valve 164 adapted to seat passage 158 with flow in a single direction. The nozzle end 166 of insert 156 includes an end face 168 and contains opening or orifice 170 to passage 158. Nozzle end face 168 is angled between 35 degrees and 55 degrees with respect to longitudinal axis A-A, generally placing

it parallel to the surface to be cleaned with the operator holding either one of the two grip positions 34, 36 on handle 30.

Dirt cup 14 is adapted to slidably extend from and retract within casing 53. To maintain any one position, a locking mechanism 172, as shown in Figure 9, extends through housing 12 proximate front end 20 and includes a plunger 174 extending through a hole 176 defined in the bottom 178 of a cylindrical recess or cavity 180 formed within housing 12. Tip 182 of plunger 174 includes serrations 184 adapted to engage serrated grooves 185 formed along the outer surface 130 of dirt cup 14. An opposite end 186 of plunger 174 has a flange or plate 188 containing a cam 190 along an upper surface. Disposed above flange 188 and cam surface 190 is a knob 194 having a lower cam surface 196 adapted to engage cam 190. Knob 194 also includes a flange 198 extending around its perimeter adapted to engage a retaining channel 200 which holds knob 194 against cam surface 190 of plunger 174. Rotation of knob 194 engages cam surfaces 190 and 196, forcing plunger 174 downwardly against spring 208 and forcing tip 182 against serrated grooves 185 in dirt cup outer surface 130. Friction between tip 182 and serrated grooves 185 in outer surface 130 is sufficiently strong to retain dirt cup 14 in position while vacuum 10 is in use. Rotating knob 194 in an opposite direction disengages cam surfaces 190 and 196 and allows spring 208 to bias plunger 174 upwardly to disengage tip 182 from dirt cup 14.

In one embodiment, vacuum 10 includes a detachable floor cleaning tool 16 (Figures 1 and 10 to 14) having a foot 210 disposed at one end of an elongate neck 212. The exterior of neck 212 is substantially identical in shape to the exterior shape of dirt cup 14. At an upper

end 214, neck 212 has a cavity 216 adapted to firmly receive nozzle 166 of insert 156 and retain tool 16 thereon. The opposite end 218 of neck 212 comprises a shroud 220 about a floor engaging head 222 pivotal about an axis 224. A passage 226 within neck 212 extends the entire length thereof from the bottom of cavity 216 to an opening 228 within shroud 220. Tool 16 may be formed from the same material as casing 53 using the same moulding technique.

Floor engaging head 222 within shroud 220 is substantially a cylinder having outside dimensions substantially identical to the inside dimensions of shroud 220 and is pivotally coupled at its ends 230 and 232 to shroud ends 234 and 236 (Figure 11). Head 222 is preferably formed as two pieces adapted to snap-fit together. Each half of head 222 may be made from injection moulded ABS or high impact, high heat polystyrene plastic. Head 222 has a flat 246 parallel to axis 224 and adapted to engage the floor (Figure 11). At least one channel 248 is formed therein, extending along the length and increasing in depth from its outer ends 230 and 232 toward a centreline. Channel 248 converges to a throat 180 extending perpendicular to axis 224 and in fluid communication with passage 226 extending from shroud 220. Additional channels 250 may be formed within flat 246 extending from the external surface of head 222 and connected to channel 248. Channels 248 and 250 within floor engaging head 222 provide a means for causing a high velocity stream of air to pass through or close to the surface to be cleaned to entrain dirt and other materials on or in that surface. In addition, flat 246 includes a recess 252 adjacent and parallel to the rear edge of channel 248 adapted to retain a flexible and resilient strip brush 254. Brush 254 is biased outwardly

in a direction perpendicular to flat 246 by springs 256 disposed between the head interior and strip brush 254. To facilitate easy movement of head 222 along the surface to be cleaned, flat 246 includes a plurality of wheels 258, proportionally spaced about in flat 246.

Nested in lower surface 256 of neck 212 is at least one accessory cleaning tool such as crevice tool 258. In a preferred embodiment, crevice tool 258 is retained within recess 260 in surface 256 by detents 262 which engage each end of crevice tool 258. As shown in Figures 12 and 13, recess 260 is preferably located along a longitudinal centreline extending the length of tool 16, to partially conceal accessory tool 258 and not interfere with the blow moulding technique and design of tool 16. In transverse section (Figure 13), recess 260 is bordered by channels 264 actually formed by the compression of the plastic tube used to form tool 16. Channels 264 also make tool 16 more rigid and also define the dimensions of passage 226 which runs from cavity 216 at the rear to opening 228 in shroud 220.

In operation, the desired configuration is selected by the operator to suit the cleaning task to be performed. For example, if vacuum 10 is desired to be used in a hand vacuum configuration, knob 194 is rotated to release dirt cup 14 such that it may be retracted a predetermined distance within housing 12. If a small area is to be cleaned, foot 16 may be removed from the end of dirt cup 14 by simply pulling on the pressure connection. With dirt cup 14 in a retracted position within housing 12, the operator holds vacuum 10 by grasping grip position 34 of handle 30 locating the centre of gravity below the operator's hand and slightly forward, such that end face 168 of dirt cup 14 may be naturally placed substantially parallel to the surface to

be cleaned. With the operator gripping position 34, the vacuum may be easily actuated sliding to and aft switch 32.

For areas out of reach of the user, dirt cup 14 may be extended by rotating knob 194 to disengage dirt cup 14. The dirt cup may then be extended to the desired length and locked into position by rotating knob 194. The operator may then actuate vacuum 10 and perform the cleaning task.

For cleaning large surface areas such as a floor, the operator moves dirt cup 14 to its fullest extension and locks it in place. The operator may also attach cleaning foot 16. Foot 16 is retained on the end of dirt cup 14 by a friction coupling between cavity 216 and insert 156. The operator may stand upright, grasping vacuum 10 at grip position 36, thus locating the centre of gravity substantially below and forward of the grip position to aid in moving the vacuum along the surface to be cleaned. Because the dirt cup extends, a substantial portion of the vacuum weight is retained near the compound handle, making for easy manipulation of the vacuum. Because the dirt cup extends instead of moving the vacuum body further from the user, this invention provides all the advantages of a stick-like vacuum, but without the stick and associated weight shift.

In order to vacuum areas too narrow for cleaning tool 16, or even nozzle insert 156, accessory cleaning tool 258 is used. Floor cleaning tool 16 is removed from insert 156. Accessory cleaning tool 258 is detached from surface 256 and inserted into orifice 170. Accessory cleaning tools offer a wide variety of cleaning characteristics and are well known. In this particular embodiment, accessory tool 258 is a crevice tool having a long, thin, rectangular tube. The end received within

orifice 170 forms a substantially tight seal, causing the suction created by the vacuum to be concentrated at the open end of crevice tool 258. When not in use, crevice tool 258 or other accessory is removed from orifice 170 and relocated in recess 260 and retained therein by detents 262 snapped into opposite ends of tool 258.

To evacuate dirt and debris contained in vacuum 10, foot 210 may be removed and dirt cup 14 completely withdrawn from housing 12. Dirt cup 14 is released from housing 12 by disengaging plunger 174 and pulling dirt cup 14 from end 112 of casing 53. With dirt cup 14 remove, filter assembly 146 may be withdrawn from first end 144 by pinching ribs 149, 151. Spun-bonded, polypropylene filter 152 may be removed from frame 148 and washed or otherwise cleaned to remove dirt and debris. Filter 152 may be replaced on frame 148 such that ribs 150 extend into filter 152. With filter assembly 146 withdrawn from dirt cup 14, dirt and debris not entrained in filter 152 may be emptied into another container. Filter assembly 146 is then reinserted into first end 144 such that locking tabs 147 engage recesses in the first end 140 of dirt cup 142 and dirt cup 14 is then reinserted into housing 12. Operation resumes as outlined above.

Although the invention has been described with respect to specific preferred embodiments thereof, many variations and modifications will be apparent to those skilled in the art.

CLAIMS

1. A vacuum cleaner, comprising:

a housing;

a tubular dirt cup slidably disposed within said housing and adapted to move between a first position within said housing and a second position extending from said housing; and

suction means disposed within said housing for creating a vacuum in said tubular dirt cup.

2. The vacuum cleaner of Claim 1, further including:

means for fixing the position of said tubular dirt cup between and including said first and last positions; and

means within said tubular dirt cup for trapping dirt and debris therein.

3. The vacuum cleaner of Claim 2, wherein said housing includes a handle extending from an upper portion of said enlarged portion and defining at least two grip positions at different angles with respect to a longitudinal axis of said housing.

4. The vacuum cleaner of Claim 3, further including a floor cleaning tool detachably coupled to an end of said tubular dirt cup extending from said nozzle, said floor cleaning tool having a pivotal floor engaging head.

5. The vacuum cleaner of Claim 4, further

including:

a casing within said housing and having a first end concentric with said suction means and a second end slidably receiving said tubular dirt cup; and

means for restraining withdrawal of said tubular dirt cup from said casing.

6. The vacuum cleaner of Claim 5, wherein said means for fixing the position of said tubular dirt cup includes:

a biased plunger having a tip adapted to engage said tubular dirt cup;

a knob disposed above said plunger; and

cam means between said knob and said plunger for engaging and disengaging said plunger with respect to said tubular dirt cup.

7. The vacuum cleaner of Claim 6, further including at least one accessory tool detachably coupled to said floor cleaning tool for attachment to said end of said tubular dirt cup in place of said floor cleaning tool.

8. The vacuum cleaner of Claim 7, wherein said suction means includes:

a centrifugal fan having a central air inlet;

a motor driving said centrifugal fan; and

said centrifugal fan having said central air inlet disposed within and concentric within said first end of said casing and enclosed within a chamber within said housing.

9. A vacuum cleaner convertible between a hand-held vacuum to a stick-type vacuum, comprising:

a housing having a rondure portion near a first end and an oblate, low profile portion at a second end;

an elongate dirt cup slidably disposed within said low profile portion and adapted to move between a first and a second position;

a handle extending from an upper surface of said rondure portion defining a first and a second grip position, each disposed at a different angle with respect to said longitudinal axis of said housing.

10. The vacuum cleaner as recited in Claim 9, further including means extending through a wall of said housing for releasably fixing a position of said elongate dirt cup between, and including, said first and last positions.

11. The vacuum cleaner as recited in Claim 9, including a floor cleaning tool detachably coupled to one end of said elongate dirt cup, said floor cleaning tool having a cleaning head pivotally coupled within a shroud disposed perpendicular to said longitudinal axis of said housing.

12. The vacuum as recited in Claim 9, further including a casing coaxially disposed within said low profile portion and adapted to slidably receive said elongate dirt cup.

13. The vacuum cleaner as recited in Claim 9, wherein said vacuum creating means includes:

a motor;

a centrifugal fan coupled to said motor and having a central air intake coaxial with a shaft from said motor;

a casing having a first end concentrically disposed about said air intake of said centrifugal fan and a second end slidably receiving said elongate dirt cup; and

a chamber formed by said housing about said first end of said casing and said centrifugal fan having an outlet through said motor and said first ends of said housing.

14. The vacuum cleaner as recited in Claim 10, wherein said fixing means includes:

a plunger having an axis substantially perpendicular to the longitudinal axis of said housing and a tip adapted to releasably engage said elongate tubular dirt cup to hold said dirt cup in fixed relation to said housing; and

means for releasably urging said plunger against said elongate tubular dirt cup.

15. The vacuum cleaner as recited in Claim 11, wherein said cleaning head of said floor cleaning tool includes a flat adapted to engage the surface to be cleaned and having a channel extending substantially perpendicular to the longitudinal axis of said housing, said channel in fluid communication with a leading edge of said cleaning head by at least one passage formed therein to generate a high velocity stream of air to pass through or over the surface to be cleaned to entrain dirt and other debris on or in that surface.

16. The vacuum cleaner of Claim 11, further including at least one accessory tool detachably coupled to said one end of said elongate dirt cup in place of said floor cleaning tool and detachably stored on said floor cleaning tool.

17. A vacuum cleaner, comprising:

an elongate housing having an enlarged portion near first end and a generally oblate portion integral with and extending from said second end of said housing to define a longitudinal axis, said oblate portion having an opening at its free end in fluid communication with an interior of said housing;

a handle integral with and extending from an upper portion of said housing defining at least two grip orientations with respect to said longitudinal axis of said housing;

an elongate dirt cup concentric with said nozzle and slidably received within said opening, said dirt cup having a passage extending from an inlet at a first end to an opening at a second end, said dirt cup adapted to move between a first retracted position within said oblate portion of said housing to a second extended position;

a motor driven fan disposed within said rondure portion of said housing and adapted to draw air through said inlet and into said dirt cup;

a floor cleaning tool detachably coupled to said first end of said elongate dirt cup; and

at least one accessory tool detachably stored on said floor cleaning tool and detachably coupled to said first end of said elongate dirt cup in place of said floor cleaning tool.

18. The vacuum cleaner of Claim 17, including means for releasably fixing a portion of said elongate dirt cup slidably disposed in and extending from said housing.

19. The vacuum cleaner of Claim 18, including a casing disposed within said housing and slidably

receiving said elongate dirt cup, said casing forming a generally tight seal between said motor driven fan and said elongate dirt cup.

20. A vacuum cleaner, comprising:

a housing having an elongate and oblate first end having an opening defined therein concentrically extending the length of said housing;

fan means disposed within said housing distant from said first end for creating a vacuum therein causing air to flow through said opening in said first end and out a second end of said housing;

an elongate tubular dirt cup concentric with and slidably disposed within said opening in said first end and adapted to move between a retracted position within said housing to an extended position from said opening in said first end;

means extending through said housing and engaging said dirt cup to adjust the position of said dirt cup within said first end;

flapper means disposed within a first end of said dirt cup for providing a single flow direction through said dirt cup;

means disposed within a second end of said dirt cup for filtering the flow of air through said dirt cup;

a floor engaging tool detachably received over said first end of said dirt cup; and

an integral handle extending from an upper surface of said housing, said handle having at least two grip positions defined by an obtuse angle; and

at least one accessory cleaning tool detachably coupled to said floor engaging tool for storage and detachably coupled to said first end of said dirt cup in place of said floor engaging tool.

21. A vacuum cleaner, comprising:

an elongate, generally low profile housing having a first and second end defining a longitudinal axis and having a generally oblate transverse cross-section, at least a portion of said housing between said first and second end enlarged, adapted to accommodate means for creating a vacuum within said housing; and

a handle extending from and integral with said enlarged portion and said first end of said housing and defining at least two grip positions disposed along dissimilar angular orientations with respect to said longitudinal axis; and

an opening defined in said second end of said housing for receiving an extensible container generally along the longitudinal axis, said container adapted to receive and retain debris drawn therein by said vacuum creating means.

22. The vacuum cleaner of Claim 21, further including:

means for adjustably fixing the extensible position of said container with respect to said second end; and

a floor cleaning tool detachably coupled to a free end of said extensible container extending from said second end of said housing; and

an accessory cleaning tool detachably stored on said floor cleaning tool and detachably coupled to said free end of said extensible container in place of said floor cleaning tool.

23. The vacuum cleaner of Claim 22, wherein said at least two grip positions provides a first grip position generally above said enlarged portion of said housing and a second grip position generally toward said first end of

said housing.

24. The vacuum cleaner of Claim 23, wherein said handle is curved defining said first and second grip position so that a hand gripping said first and second grip position changes an angle of said hand in relationship to said horizontal axis and the surface being cleaned.

25. The vacuum cleaner of Claim 24, wherein said enlarged portion of said housing includes:

a centrifugal fan having an air inlet adapted to draw air in from said second end of said housing and said container; and

means for driving said centrifugal fan to create said vacuum.

26. The vacuum cleaner of Claim 25, wherein said container includes:

a tubular, generally oblate dirt cup adapted to retract within and extend from said opening in said second end of said housing and having an opening at a first and second end, said first end disposed within said housing;

filter means releasably fixed in said opening in said first end; and

a flapper valve disposed within said opening on said second end, adapted to permit air and debris to flow in a single direction in said tubular dirt cup.

27. The vacuum cleaner of Claim 26, further including a casing disposed within said second end of said housing and adapted to slidably receive said tubular dirt cup therein in substantially airtight engagement,

said casing also adapted to provide fluid communication between said inlet of said centrifugal fan and said openings of said tubular dirt cup so as to entrain debris within a high velocity air stream and capture said debris within said dirt cup.

28. A vacuum cleaner, comprising:

an elongate, generally low profile housing having a first and a second end, said second end having an opening therein in fluid communication with an interior of said housing;

a compound handle extending from said housing and integral therewith, interconnecting said first end with a point between said first and second end of said housing and defining at least two grip positions linearly along said handle, each having a predetermined angular orientation with respect to the longitudinal axis of said housing; and

means disposed within said housing for creating a high velocity of air flow into said second end into said interior.

29. The vacuum cleaner of Claim 28, wherein said means for creating a high velocity air flow includes:

an extensible container slidably disposed within said opening in said second end of said housing and adapted to be releasably fixed between and including a first retracted position within said housing and a second extended position from said second end;

a casing concentrically received about one end of said extensible container and disposed within said second end of said housing for receiving said container in sliding engagement therein in a first end; and

means partially received within a second end of said

casing and disposed within said housing for creating a vacuum in said casing and drawing debris entrained therein into said container.

30. The vacuum cleaner of Claim 29, wherein said extensible container includes:

filter means detachably fixed within a first end of said container received within said casing; and

valve means disposed within an opposite end of said container for retaining debris within said container.

31. The vacuum cleaner of Claim 30, wherein said container is releasably fixed with respect to said housing by cam operated means extending through said housing for releasably engaging an exterior surface of said container.

32. The vacuum cleaner of Claim 31, further including a detachable floor cleaning tool received about said opposite end of said container.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number: GB 9311978.2

Relevant Technical fields

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(ii) Int Cl (Edition 5) A47L 5/24

Search Examiner: A C HOWARD

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search: 5 JULY 1993

Documents considered relevant following a search in respect of claims 1-8

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	EP 0307240 A1 (BILOU) whole specification relevant	1
X	US 4610048 (ISHIHARA ET AL) whole specification relevant	1, 5, 8
X	US 3966444 (CLOWERS) whole specification relevant	1, 3, 4

		to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

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Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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GB A 2080727 GB 1507851 GB 1149716
GB A 2032877 GB 1388293

(58) Field of search
B5K

(54) Method and device for heat sealing thermoplastic materials

(57) A pair of flat resistance wires 11 are encased within a plastic sheath 12 and are spaced in a manner designed for maximum thermal emission. To weld together two thermoplastic materials, the sheathed wires are held between and in firm contact with the materials to be joined. A predetermined electric current is passed through the wires until enough heat has been generated to weld the materials together. The invention may be applied to a process for heat sealing a plastic lid 22 to a plastic drum 14. The sheathed wires are fastened to the lower surface of the thermoplastic drum lid 22, which together with the resistance wires is clamped to the thermoplastic drum 14 with a standard drum clamp 42. An electric current is passed through the wires for a period of time sufficient to heat up the wires and weld the lid 22 to the drum 14.

FIG. 3

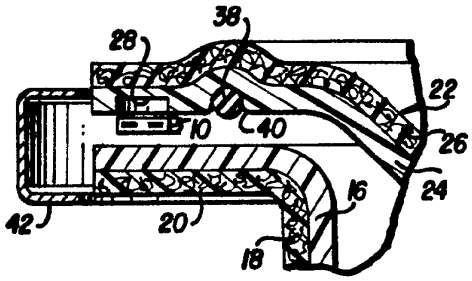
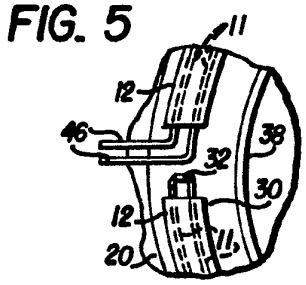


FIG. 5



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

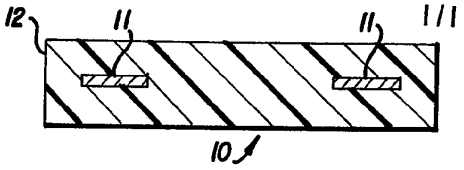


FIG. 1

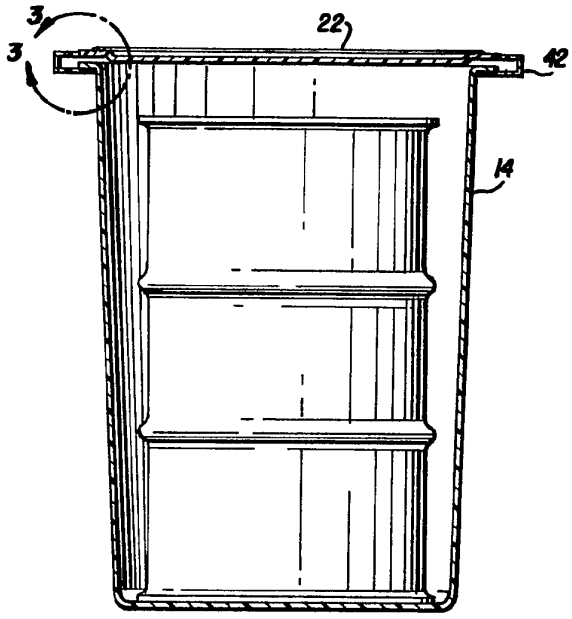


FIG. 2

FIG. 3

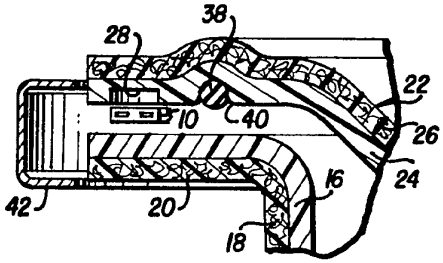
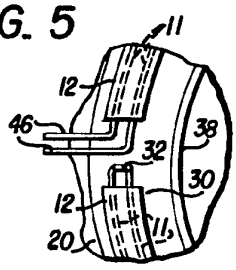


FIG. 5



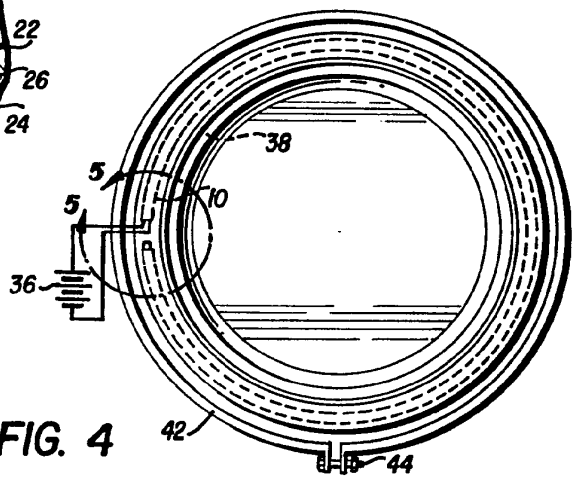


FIG. 4

SPECIFICATION

Method and device for heat sealing thermoplastic materials

The present invention relates to a method of and a device for heat sealing thermoplastic materials together, and in particular a method and device for heat sealing a thermoplastic lid to a thermoplastic drum designed for the disposal of hazardous wastes.

A search of the prior art failed to uncover any prior art references which disclose the method or device of the present invention. A number of patents were uncovered which disclose methods or devices for heat sealing or bonding methods in general.

U.S Patent No. 4, 349, 219 discloses a welding muff of thermoplastic material which forms a sleeve around two pipe parts that are to be joined. A resistance wire within the muff welds the interior surface of the muff to the exterior surfaces of the pipe parts.

U.S Patent No. 4, 029, 837 discloses a composite plastic-metallic bonding means and method comprising a metallic mesh interposed between first and second layers which are inserted between first and second bodies. The metal mesh is heated by exposing it to an alternating magnetic field. The heated mesh melts layers and forms a seal between the first and second bodies.

U.S Patent No. 2, 961, 363 discloses a method for coupling thermoplastic components comprising a hollow ring of an exothermic autocombustible substance which is placed between the two thermoplastic components to be coupled. Ignition of the exothermic autocombustible substance heats the thermoplastic components and welds them together.

U.S Patent No. 4, 106, 969 discloses a method of joining a thermoplastic material to an inorganic material comprising heating a helical coil and partially embedding it in the thermoplastic material and then gluing the inorganic material to the thermoplastic material using the helical coil as an anchor for the adhesive.

Because of inherent structural limitations or flammability problems, the above methods and devices are not suitable for welding thermoplastic materials or for sealing and storing hazardous waste materials.

In recent times, the disposal of hazardous waste material has become a significant problem. Nearly 270 million tons of hazardous waste material is generated each year. Presently, the waste material is typically disposed of by placing it in either a metallic or plastic container. The metallic containers are unsuitable because they are subject to corrosion and leakage when exposed to the elements for a period of time.

To avoid the corrosion problems associated with metal containers, hazardous waste materials, such a solid hazardous wastes in bulk or particulate form, dewatered hazardous sludges, or hazardous wastes that have been stabilized through solidification/cementation processes, are frequently stored in plastic containers. The presently used plastic containers are closed by a conventional metal clamp holding the lid to the drum. It has been suggested that waste material originally placed in a metal container may then be placed in a plastic container.

It has also been suggested to heat seal plastic drums by suspending a heating plate between the plastic drum and a plastic lid that is suspended above the heating plate. When the top of the drum and the bottom of the lid reach a predetermined temperature, the plate is removed and the lid is pressed onto the drum to complete the seal.

Both methods for sealing the plastic containers are disadvantageous. The metal clamp is prone to corrosion or rusting and the heating plate method is awkward to use and requires expensive capital equipment.

In view of the foregoing limitations and shortcomings of the prior art, as well as other disadvantages not specifically mentioned above, it should be apparent that there still exists a need in the art for an efficient and effective means of heat sealing thermoplastic materials, and in particular for heat sealing thermoplastic lids onto drums.

According to a first aspect of the present invention there is provided a method of welding two thermoplastic elements together, comprising:.

positioning the two thermoplastic elements together with a surface of each element in confronting relation;

inserting a resistance wire encapsulated in a thermoplastic sheath between the confronting surfaces of the two elements;

passing an electrical current through the resistance wire to heat the wire and weld the elements to each other at the confronting surfaces thereof.

According to a second aspect of the present invention there is provided a sealable drum kit, comprising:

a drum having a thermoplastic wall and an open end;

a lid of thermoplastic material adapted to close the open end of the drum;

a first resistance wire adapted and arranged to be isposed between the lid and the open end of the drum all;

Such that by passing an electrical current through the wire, the wire can be heated so as to weld the lid to the drum wall at the open end thereof.

According to a third aspect of the present invention there is provided a device for welding two thermoplastic materials together, comprising at least one flat ribbon resistance wire encapsulated in a thermoplastic sheath.

It is believed possible by means of the present invention to provide an economical device for heat sealing thermoplastic materials together with maximum efficiency.

It is further believed possible by means of the present invention to provide a resistance wire device for heat sealing two thermoplastic materials together using a minimal amount of capital equipment.

It is still further believed possible by means of the present invention to provide a means for heat sealing materials together with a resistance wire, wherein shifting of the wire during the heating process is prevented.

It is still further believed possible by means of the present invention to provide a system for heat sealing plastic drums that would result in a weld of consistent quality.

It is still further believed possible by means of the present invention to provide a low cost method of converting a salvage drum to an encapsulated drum.

It is still further believed possible by means of the present invention to encapsulate a pair of flat ribbon resistance wires in a thermoplastic sheath in such a manner that the wires remain positioned in fixed relation to each other so that they heat the surrounding sheath with maximum thermal efficiency.

It is still further believed possible by means of the present invention to provide a means for heat sealing a lid to a drum wherein the heat sealing means is attached to the drum lid and remains in situ after sealing.

It is still further believed possible by means of the present invention to provide a means for heat sealing a lid to a drum wherein the heating means is sealingly isolated from the contents of the drum.

In a preferred mode of practising the present invention, a pair of flat ribbon resistance wires are encapsulated within a thermoplastic sheath. The flat wires have a width substantially greater than the thickness thereof. The wires are arranged in side-by-side substantially coplanar relation to each other in a manner designed to emit heat to the surrounding thermoplastic sheath with maximum thermal efficiency.

To weld together two thermoplastic elements, the sheathed wires are disposed between and in firm contact with the two elements to be joined. A predetermined electric current is passed through the wires until enough heat has been generated to weld or thermally bond the thermoplastic elements together.

A preferred application of the present invention involves the application of the sheathed resistances wires to a process for heat sealing plastic lids to plastic drums. In particular, the sheathed wires are fastened to the lower surface of a thermoplastic drum lid adjacent the outer perimeter thereof. A groove is formed in the lid in an annular path radially within, yet adjacent to, the sheathed wire. An annular seal, such an an o-ring is placed in the grove to prevent flammable gases or materials within the drum from contacting the welding area.

The lid, together with the resistance wires and the o-ring, is clamped to the upper lip or flange of a thermoplastic drum with a standard drum clamp. An electric current is passed through the wires for a period of time sufficient to heat up the wires, melt the thermoplastic sheath and weld the lid to the drum. The wires are then disconnected from the electric current and the sealed drum is ready for disposal.

The invention will be described by way of example with reference to the accompanying drawings, in which like references refer to like parts unless stated otherwise, and in which:

Figure 1 is a cross-sectional view of a heat sealing device with resistance wires encased in a plastic sheath;

Figure 2 is a cross-sectional view of a plastic drum and lid with a metal drum therein;

Figure 3 is a detailed cross-sectional view of the circled portion of Figure 2;

Figure 4 is a top plan view of the lid clamped to a drum; and

Figure 5 is a detailed view of the circled portion of Figure 4 as viewed from the underside of the lid.

Referring now in detail to the drawings wherein like parts are designated by like reference numerals throughout, there is illustrated in Fig. 1 a cross-sectional view of a heat sealing device which is designated by reference numeral 10. The device 10 comprises a pair of flat resistance wires 11 encased in a thermoplastic sheath 12.

The wires 11 have a width substantially greater than the thickness thereof. In one preferred form, the wires are about .0625 inch (.15875cm) wide and .0045 inch (.01143cm) thick. The wires are preferably made from nickel-chromium and have a resistance of approximately 2 ohms per linear foot (30.48 cms).

The sheath 12 may be made of any suitable thermoplastic material, preferably polyethylene, and may be formed by drawing the wires 11 in spaced, parallel relation through a specially designed extruder die wherein molten polyethylene is extruded around the wires to form the sheath. For some applications, such as sealing plastic drums, it may be advantageous to draw the sheath and wires so that the heat sealing device 10 is arcuate or cicular in shape, as is shown in Fig. 4

The heat sealing device 10 may also be fabricated by rolling a pair of flat resistance wires 11 between a pair of thin strips of polyethylene which have been heated sufficiently to weld the strips of polyethylene together around the wires and thereby encapsulate the wires. Whether the heat sealing device is fabricated by extrusion, rolling or any other pro-

cess, the wires are preferably arranged in side by side, substantially coplanar relation to one another, as can be seen in Fig. 1, and are preferably spaced apart 2 to 3 times the width of the wire for maximum thermal efficiency. It is also possible to form the heat sealing device with only one flat resistance wire in the sheath instead of two.

To weld two thermoplastic elements together, the elements are clamped or held together with the heat sealing device 10 interposed between them such that the wider, flat surfaces of the wires confront the surfaces of the elements to be welded together. Electric leads are clipped to the wire ends and a predetermined electric current is passed through the resistance wires to generate heat therein. Connecting 120 volts AC across a fourteen foot length of 2 ohm (30.48cms) wire for three or four minutes will raise the sheath temperature to about 300-400°F (149-204°C), which is sufficiently hot to melt the polyethylene and weld or thermally bond the two thermoplastic elements together. The current source is then disconnected and the welded materials are allowed to cool. Because the wires 10 are in a sheath 12, they are not likely to shift due to expansion during the welding process.

The above-described device and method for welding plastic materials together is especially suitable for plastic encapsulation drums for hazardous waste disposal. In Figs. 2 and 3, there is shown such an encapsulation drum 14, which comprises an inner layer 16 of polyethylene of about .125 inch (.3175cm) thick, and an outer layer 18 of fiberglass, also about .125 inch (.3175cm) thick. The means for bonding the polyethylene to the fiberglass are well known and are not considered a part of the invention. The drum has a flange or lip 20 extending horizontally from the top thereof. The drum walls are tapered to allow a plurality of drums to be stacked within one another. Preferably, the drum is a 95 gallon size so that a 55 gallon metal drum is easily contained therein.

A lid 22 designed to fit on the drum 14 is also shown in Figs. 2 and 3. In a manner similar to the drum, the lid 22 is made from a .125 inch (.3175cm) layer 24 of polyethylene bonded to a .125 inch (.3175cm) layer 26 of fiberglass. The lid 22 is recessed in its center so that it fits within and is located by the drum flange 20. The heat sealing device 10 is attached to the underside of the outer peripheral edge of the lid 22 by welding the device to the lid surface, for instance, with a hand welded tool, or by any other suitable method. A groove 28 may be formed in the lid to facilitate the placement of the device 10.

As best seen in Fig. 5, at one end 30 of the plastic sheath 12, the wires 11 are electrically interconnected by a short piece of flat wire 32 or by any other electrically conductive means, such as a shorting bar or by folding or twisting the wires 11 together. At the other end 34 of the sheath 12, the ends of the wires 10 are connected to a source 36 of electricity by connecting conventional leads (not shown in detail) to the ends 46 of the wires 11. Preferably, the electric source provides 120 volt AC current, although alternative embodiments may be designed to run from other sources of electricity, such as a 12 volt DC car battery 36 (Fig. 4) or generator. The current is controlled to flow with a predetermined amplitude for a predetermined duration, depending upon when enough heat has been generated to weld the lid and the drum together.

A circular o-ring 38, preferably of silicone rubber, is located in an annular groove 40 formed in the lower surface of the lid adjacent, but interior to, the heat sealing device 10. The purpose of the o-ring is to enhance the seal between the drum 14 and lid 22. This is particularly important if there are flammable materials being sealed within the drum, in that the o-ring 38 will prevent the flammable material from coming into contact with the weld area. A standard drum clamp 42 is fitted over the drum flange 20 and lid 22 and holds them together when tightened by bolt 44 (Fig. 4).

Hazardous waste materials that are not reactive with polyethylene can be placed directly within the drum 14. However, if the waste materials will react with or corrode polyethylene, they can be first sealed within a conventional metal drum 46, which can be placed within the polyethylene/fiberglass drum 14.

After the waste materials have been placed in the drum 14, lid 22 is clamped in place by clamp 42 with the ends 46 of wires 10 extending outside the drum. An electric current is applied to the wire ends 46, as shown in Fig. 4. It has been found tha satisfactory results are achieved when using a fourteen foot length of 2 ohm/foot (30.48cms) with the wires spaced .125 -.1875 inch (.3175—.47625cm) apart and a 120 volt source is applied for about three minutes. Fourteen feet (426.72cms) is the total length of the resistance wire 11, which is actually twice the length of the sheath 12, since the two wires in the sheath are interconnected at one end and thus form a single circuit that doubles back on itself.

Although only preferred embodiments are specifically illustrated and described herein, it will be appreciated that many modifications and variations of the present invention are possible in light of the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

CLAIMS

1. A method of welding two thermoplastic

elements together, comprising:

positioning the two thermoplastic elements together with a surface of each element in confronting relation;

inserting a resistance wire encapsulated in a thermoplastic sheath between the confronting surfaces of the two elements;

passing an electrical current through the resistance wire to heat the wire and weld the elements to each other at the confronting surfaces thereof.

2. A sealable drum kit, comprising:

a drum having a thermoplastic wall and an open end;

a lid of thermoplastic material adapted to close the open end of the drum;

a first resistance wire adapted and arranged to be disposed between the lid and the open end of the drum wall;

such that by passing an electrical current through the wire, the wire can be heated so as to weld the lid to the drum wall at the open end thereof.

3. A sealable drum kit according to claim 2, and further comprising an annular flange extending from the open end of the drum wall, such that when the drum is closed by the lid, the wire is located between the lid and the flange.

4. A sealable drum kit according to claim 2 or 3, said lid having an annular groove in the underside thereof, said wire being located within the groove.

5. A sealable drum kit according to claim 2, 3 or 4, and further comprising a thermoplastic sheath in which the first resistance wire is encapsulated.

6. A sealable drum kit according to claim 5, further comprising a second resistance wire encapsulated within the thermoplastic sheath, the second wire being arranged in side-by-side, substantially coplanar relationship within the first wire.

7. A sealable drum kit according to claim 6, wherein the resistance wires are flat ribbon wires.

8. A sealable drum kit according to claim 6 or 7, wherein one end of the first wire is electrically connected to one end of the second wire, and the other ends of the first and second wires are adapted to be connected to a source of electrical current.

9. A sealable drum kit according to claim 3 or to any one of claims 4 to 8 appended to at least claim 3, and further comprising an o-ring located between the lid and drum flange, said o-ring being adjacent and interior to the resistance wire.

10. A device for welding two thermoplastic materials together, comprising at least one flat ribbon resistance wire encapsulated in a thermoplastic sheath.

11. A device according to claim 10, wherein said device comprises two flat ribbon resistance wires encapsulated in said thermoplastic sheath in side-by-side, substantially coplanar relation.

12. A device according to claim 11, wherein the wires have a width to thickness ratio of about 14.

13. A device of claim 12, wherein the wires are spaced from each other a distance equal to at least twice their width.

14. A device of claim 10, 11, 12 or 13 wherein one end of one wire is electrically interconnected with one end of the other wire and the remaining ends of the wires are adapted to be connected to an electric power source.

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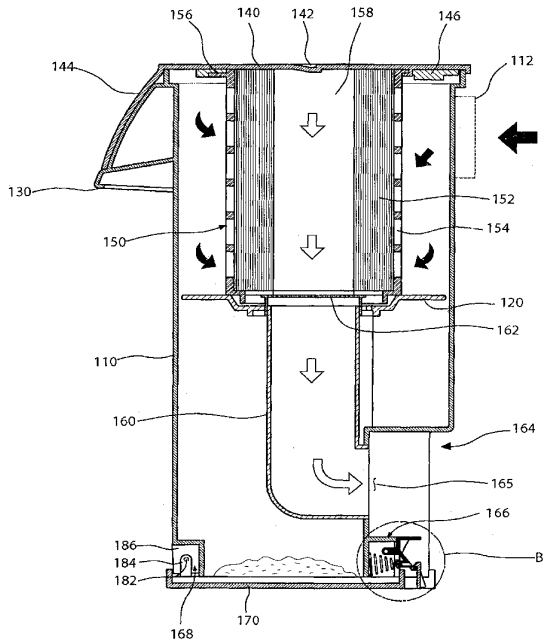
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(54) Dust collection unit for vacuum cleaner

(57) Provided is a dust collection unit (100) for a vacuum cleaner (1), including a dust collection container (110) and a coupling portion (166) formed at a concaved inside of the dust collection container (110), for allowing a lower cover (170) to be selectively coupled to the dust collection container (110). The dust collection unit (100) is firmly supported against an external impact, thereby enhancing the reliability of the vacuum cleaner (1) and preventing the vacuum cleaner (1) from being damaged.

FIG. 6



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EP 1 629 758 A3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 2125

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	FR 2 812 531 A (SAMSUNG KWANGJU ELECTRONICS CO [KR]) 8 February 2002 (2002-02-08) * page 9, line 25 - page 10, line 13; figures 1,3 *	1-13	INV. A47L9/16
A	US 2001/018865 A1 (WEGELIN JACKSON W [US] ET AL) 6 September 2001 (2001-09-06) * paragraph [0073]; figures 17-19 *	1,5,9,10	
A	WO 02/067753 A (DYSON LTD [GB]; VUIJK REMCO DOUWINUS [GB]) 6 September 2002 (2002-09-06) * page 7, line 25 - page 8, line 20; figures 3-5 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			A47L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 December 2009	Clarke, Alister

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 25 2125

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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28-12-2009

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Dyson Ex1020
Page 863

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(19) (CA) **CANADIAN PATENT** (12)

(54) Arrangement of Multiple Fluid Cyclones

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Canada

(73) Granted to Queen's University at Kingston
Canada

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Canada

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This invention relates to a special form of fluid cyclone in which the velocity energy in the exit fluid is converted into exit pressure thus permitting the device to discharge to atmospheric pressure or a higher pressure while a vacuum may exist in the central core of the vortex.

This invention also relates to a special arrangement for multiple fluid cyclones which operate with less energy due to recovery of the energy in the fluid as it leaves the device.

The principles of the invention may be applicable, where the fluid is a liquid or a gas and permits removal of solid or liquid particles of higher density than the main fluid.

Fluid cyclones and Hydroclones have been in use for some time by the paper industry and metallurgical industry. These devices are described in the textbook "Hydroclones" written by D. Bradley and published by the Pergamon Press.

The most common form of Hydroclone is the straight conical design. Fluid enters by a tangential inlet into a short cylindrical section. A vortex is created in the cylindrical section and a conical section below the cylindrical section as fluid spirals in a path moving downward and inward, then upward in a helical path to an exit pipe co-axial with the cylindrical section. The centrifugal acceleration, due to rapid rotation of the fluid, causes dense particles to be forced outward to the wall of the cylinder and cone.

The dense particles are transported in the slower moving boundary layer downward towards the apex of the cone where they leave as a hollow cone spray. The high centrifugal force near the centre opens up a liquid free space which is referred to as a



vortex core. In the conical cylone, with free discharge of rejects to the atmosphere, this core is filled with air and a back pressure at the exit of the hydroclone is required to prevent air insuction.

In some designs the cylindrical section is much longer than in others. One design having a longer cylindrical section is sold under the trade name "Vorvac" which was designed to remove both dirt and gas simultaneously. The general flow pattern is similar to that described for conical designs, but there is an additional downward moving helical flow next to the core carrying froth or light material. This extra flow is obtained because of the use of a device at the exit which will be discussed later and referred to as a core trap. The reject flow from the Vorvac is usually to a vacuum tank and the entire fluid in the device is below atmospheric pressure in order to expand gas bubbles so they can be taken out more readily.

Another known device sold under the trade name "Vorject" has a conventional type of fluid flow pattern, but the conical reduction at the bottom is used to turn back the main downward flow towards the main fluid exit, but not to limit discharge of reject flow. The boundary layer fluid containing the reject material is separated from the rest of the fluid nearer the centre by use of a core trap and it issues forth from a tangential exit under pressure. The rejection of material and prevention of air insuction in this type of design is not affected by outlet pressure. Rejection of material may be controlled by throttling of the reject stream and may also be limited by injection of water to carry back fine material while removing coarser material.

Various designs of fluid cyclones and other vortex separators are disclosed in the following United States Patents:

2,982,409	2,835,387	3,421,622
2,849,930	3,785,489	3,543,932
2,816,490	3,734,288	3,861,532
2,757,581	~~3,716,139~~ 3,761,137	3,057,476
~~2,920,701~~ 2,920,761	3,696,927	3,353,673
2,757,582	3,612,276	3,288,286
2,927,693	3,101,313	

The fluid leaving a fluid cyclone has a very high tangential velocity about the central axis and quite a high axial velocity. In most designs this velocity energy becomes dissipated as turbulence in the exit piping.

A principal object of the present invention is to provide a modified design for the recovery of energy in the fluid which in previous designs was lost.

Where multiple small units are used they are usually assembled into some form of bank. The past method used headers with individual connectors and more recent arrangements involve placing multiple units in tank like systems. In both these systems nozzles or slots provide a throttling means to ensure distribution of the flow and a tangential entry velocity to the individual units.

A further object of the present invention is to provide a special arrangement for multiple cyclones which operate with less energy due to recovery of the energy in fluid as it leaves the device.

A further object of the present invention is to provide

Dyson Ex1020
Page 867

a special arrangement for multiple cyclones which leads to reduced energy loss in creating the tangential velocity upon entering the fluid cyclones, thereby leaving more energy to be recovered on exit from each individual cyclone. In addition, the same special arrangement at the exit leads to more complete recovery of velocity energy in fluid leaving the individual cyclones.

In keeping with the foregoing there is provided in accordance with one aspect of the present invention a fluid cyclone having an upper cylindrical end portion with inlet and outlet passages tangential thereto, said outlet passage having an annular inlet in the cylindrical portion and coaxial therewith followed by an inner passage that gradually increases in area and diameter to the tangential outlet passage and a lower portion with a reject outlet in the lower end thereof.

In accordance with a further aspect of the present invention there is provided a header for a plurality of cyclones, said header having a passageway with a first inlet thereto and a plurality of outlets therefrom, said outlets being spaced apart from one another downstream from said first inlet and providing inlets to respective ones of the plurality of cyclones; and deflector means in said passageway to create vortices of flowing fluid at each of said plurality of outlets.

In accordance with a further aspect of the present invention, where a plurality of cylones are to be supplied with fluid, their tangential velocity may be provided by a multiple vortex pattern established between two plates with the centre of the multiple vortices centered on the axis of the

Dyson Ex1020
Page 868

cyclones. In a similar manner a reverse flow of vortices may be obtained in a separate space between two plates. This is best done with an equal number of fluid cyclones half of which rotate clockwise and with inflow to the vortices between the parallel plates, and exit from the parallel plate on one side of the bank of cyclones whereas the other half of the fluid cyclones rotate in a counterclockwise direction and receive and discharge their flows to vortices between the plates from and to a channel on the other side of the bank of cyclones. A set of deflector plates may be used on the inlet channels to the vortex space to insure proper formation of the vortex pattern by directing flow at the proper orientation towards the vortex about each cyclone.

The invention is illustrated by way of example in the accompanying drawings wherein:

Figure 1 is an elevational view of a typical cone type fluid cyclone;

Figure 2 is a similar view of a fluid cyclone provided in accordance with the present invention for recovery of velocity energy;

Figure 3 is a cross-sectional view taken along line 3-3 of Figure 2;

Figure 4 is a partial elevational sectional view illustrating an alternate reject system;

Figure 5 is a horizontal sectional view taken along essentially 5-5 of Figure 6 of fluid cyclones of conventional type mounted in a special arrangement in accordance with the present invention;

Dyson Ex1020
Page 869

Figure 6 is a vertical sectional view of the multiple cyclone of Figure 5 taken along line 6-6 of Figure 5;

Figure 7 is a view similar to Figure 6 illustrating a reject system with cyclones of the type illustrated in Figure 2;

Figure 8 is an elevational view of a multi-cyclone provided in accordance with the present invention;

Figure 9 is an elevational view of the upper header for the multi-cyclone of Figure 8;

Figure 10 is a sectional view taken along a stepped sectional line 10-10 of Figure 11;

Figure 11 is a cross-sectional view taken along stepped sectional line 11-11 in Figure 9;

Figure 12 is a cross-sectional view taken along stepped sectional line 12-12 in Figure 9;

Figure 13 is a cross-sectional view taken along sectional lines 13-13 in Figures 9 and 11; and

Figure 14 is an enlarged cross-sectional view showing in detail one of the cyclones of the multi-cyclone unit.

Referring now in detail to the drawings, there is illustrated in Figure 1 the most common form of hydrocyclone which is a straight conical design. Fluid enters by a tangential inlet 1, into a short cyclindrical section 2. A vortex is created in the cylindrical section and a conical section 3 below the cylindrical section as fluid spirals in a path moving downward and inward, then upward in a helical path to an exit pipe 4 co-axial with the cylindrical section. The centrifugal acceleration due to rapid rotation of the fluid causes dense particles to be forced outward to the wall of the cylinder and

Dyson Ex1020
Page 870

cone. The dense particles are transported in a slower moving boundary layer downward toward the apex 5 of the cone where they leave as a hollow cone spray. The high centrifugal force near the center opens up a fluid free space which is referred to as the vortex core when the fluid is a liquid. In the conical cyclone, with free discharge of rejects to atmosphere, this cone is filled with air and a back pressure at the exit of the hydrocyclone is required to prevent air insuction.

The present invention is directed to reducing energy losses caused by friction in fluid cyclones. In considering energy states in a fluid cyclone, at the inlet to the fluid cyclone the hydraulic energy in the fluid is mostly pressure with some as velocity.

In the descending path, as the fluid spirals inward towards the smaller radius of exit, velocity increases roughly according to the relationship $V_e = kr^n$. If there were no friction n would have a value of -1, but because of friction n lies somewhere between -0.4 and -0.9 depending on design. In this region pressure energy goes down as velocity energy rises so that near the exit a major form of the energy is as velocity. In a normal fluid cyclone this velocity energy is lost and the outlet pressure is almost entirely from the mean pressure energy in the outlet area.

If the velocity energy were to be completely converted into pressure energy at the exit and friction losses were zero in the cyclone it could operate at any flow theoretically with no pressure drop. The velocity possible would be limited by the fact that the pressure could not fall below a vacuum of

about 25 inches of mercury without having the space filled with water vapor. In practice, there are however losses of hydraulic energy by fluid friction which means less recovery of energy than that applied.

The tangential velocity and hence centrifuge force in the vortex of a cyclone is related to the pressure differential between the inlet pressure and the average pressure s the fluid leaves the central exit from the separating region. In the case of the conventional centrifuge with an air core, this average pressure on exit of accepted fluid is somewhere between the core pressure and the exit pressure which hs to be above atmospheric pressure, whereas with a pressure recovery design, which has a vacuum at the core, the average pressure will again be somewhere between the core pressure and that of the outlet, but much nearer the core pressure. Thus, the operation of the conventional and velocity recovery units shown in the table below will have the same separation performance with inlet and outlet pressure shown compared in the table below.

PRESSURE DIFFERENCE	PRESSURE P.S.I.					
	CONVENTIONAL			VELOCITY RECOVERY		
	INLET	OUTLET	CORE	INLET	OUTLET	CORE
High	50	5	0	40	10	-15
Low	50	5	0	40	10	-15

A fluid cyclone with recovery of velocity energy is illustrated in Figure 2 wherein fluid to be treated enters by a tangential nozzle inlet 10 into a cyclindrical section 11. Here it mixes with fluid which has come up from below, but not

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left the central exit opening 12. The mixture then follows a helical form of path downward to the cone 13 which is shown as a preferred curved form although a straight form would also function.

Any dense material is deposited by centrifugal force in the slower moving outer boundary layer. This layer travels quickly down the cone due to the differential pressure between differing radii resulting from centrifugal forces on the high speed fluid in the interior. The boundary layer material can be allowed to leave without the inner fluid by blocking the vortex with a blunt cone plate 14 while permitting the boundary layer fluid with its content of heavy material to leak away through a gap between the end 15 of the cone 13 and the blunt cone plate 14.

The main flow inside the boundary layer is turned back upward by the restriction of cone 13 and may either rejoin the downward stream in the cylindrical section 11 or leave by the central exit 12. The exit channel is an annular passage 16 between an inner cone 17 and an outer cone 17A providing a space which leads gently outward and expands in area. In the design shown this passage curves outward however, although this is the preferred design as the expansion of the path is gentlest where velocity is highest, straight cones would also serve some useful purpose. The fluid leaves by tangential outlet 18.

The gradual expansion in the exit passage and gradual increase in its radius leads to a conversion of both the axial and tangential velocity into pressure energy. Thus the unit can discharge to a much higher pressure than either at the core of

Dyson Ex1020
Page 873

the vortex or the mean pressure in the exit stream. With discharge to atmospheric pressure there will be a partial vacuum at the core yet the design shown will permit the flow out of the reject end to occur to atmospheric pressure.

The blunt cone plate 14 blocks the vortex at the bottom and a central depression 14A in the blunt cone plate 14 stabilizes the core. The rejected fluid escaping from the gap 19 between cones 13 and 14 enters a cylindrical space 20 then passes downward past the edge of the blunt cone plate 14 and spaced apart support rods 21 into a space 22 between the bottom of the blunt cone plate 14 and a bottom plate 23. At this point the reject fluid will have considerable tangential velocity and pressure. As it passes the smaller radius towards a central exit 24 in plate 23, the tangential velocity will increase such that a vortex will exist between plate 23 and the underside of the cone plate 14. The reject fluid will emerge finally through the central hole 24 as a hollow cone spray. The pressure drop across the vortex on plate 23 will limit the rejection rate in selective fashion.

The pressure drop across a vortex occurs because of the centrifugal acceleration which acts on the mass of the fluid. The tangential velocity which causes this is dependent upon the initial tangential velocity of fluid entering the periphery of the vortex. If this fluid is a boundary layer fluid only, the velocity and hence throttling effect of the vortex will be low. If this fluid contains higher velocity liquid from the inner portion in cone 13, then the velocity and throttling effect of the reject vortex will be high.

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The design is hence selective in rejecting the boundary layer fluid only. The depth of the boundary layer will depend upon its viscosity and will increase it it contains a high content of dense solids. The pressure differential in the exit vortex is due to centrifugal forces from the tangential velocity. Thus an increase in viscosity which will cause reduction in tangential velocity due to friction will thereby reduce the throttling effect of the vortex permitting a larger flow. This furthers the action of the reject system making it react automatically to varying loads of undesirable material in the fluid being treated.

Other arrangements may be made for removal of reject material. An extension of the cone, such as shown in Figure 4 as 25, will throttle reject material and limit discharge. if this is left open to the atmosphere the pressure at the core of the cyclone must be also at atmospheric pressure. This may permit the fluid cyclone with velocity energy recovery to discharge to a pressure which may be useful in certain installations. Where this is not the case it may be preferable for this type of reject control to discharge rejects to a vacuum receiver 26.

In instances where the quantity of undesirable solids is extremely low they may be collected in a closed receiver. Thus the space between the orifice plate 23 (Figure 2) and the bottom of the cone plate 14 may be replaced with a receiving chamber having a suitable mechanism for dumping the collected solids.

It is a known fact that smaller cyclones can remove finer particles than larger units. Experiments conducted by the applicant have also revealed that a smaller unit for the

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Dyson Ex1020
Page 875

same design capacity has less loss of hydraulic energy by friction and hence more recoverable hydraulic energy. The applicant has also established through experiments that the simple tangential entry into a cylinder results in a great deal of loss of hydraulic energy and generation of turbulence. These studies have resulted in multiple arrangements of cyclone units by the applicant and which are illustrated in Figures 5 to 14. In the multiple units, multiple vortices are created directly in a header system in a stable arrangement. The arrangement may be considered identical to that of the stable pattern of vortex eddies which are created when a stream of fluid passes a fixed object and is known as a vortex trail. Vortices of opposite rotational sense progress in two lines. The spacing of the two lines normally would be 0.2806 times the spacing of individual vortices at each trail.

Referring to Figures 5 and 6 there is illustrated six cyclone units 40A, 40B, 40C, 40D, 40E and 40F (only three appear in Figure 6) that are of conventional design but provided with a novel inlet and outlet means. The inflow fluid to the cyclone units is from a common chamber 42 and the outflow into a common chamber 44. Chambers 42 and 44 are separate from one another and provided by spaced apart flat parallel plates 45, 46 and 47 interconnected by side walls and end walls. The chambers have respective opposite end walls 48 and 49, each of which have curved wall portions 50 and 51 interiorly of the chambers, such portions being preferably of spiral shape.

Cyclone units 40A, 40C and 40G are spaced apart from one another in a first row and cyclone units 40B, 40D and 40F are

Dyson Ex1020
Page 876

spaced apart from one another in the second row. The first and second rows are spaced apart from another and the cyclone units are staggered as best seen from Figure 5. Cyclone units 40A, 40C and 40G have fluid rotation which appear from top view to rotate clockwise as indicated by arrows 53, 54 and 55 whereas units 40B, 40D and 40F have fluid rotation which appears from the top view to rotate counterclockwise as indicated by arrows 56, 57 and 58. The row of counter-rotating units is displaced by half the distance between units in the row direction and by approximately .28 times the distance between units sideways, thus placing the units in the pattern normally observed in a vortex trail. In this pattern, counter-rotating vortices are closest to each other and there is no frictional shear between them. The individual cyclone units acquire their fluid flow, not from individual tangential inlets, but by a general pattern of multiple vortices which is established in the space 42 between the parallel plates 45 and 46. The pattern of flow is established by two streams of constant velocity admitted by two channels 59, one to feed fluid into clockwise vortices 53, 54 and 55 and the other into counterclockwise vortices 56, 57 and 58. Fluid is diverted from the channels 59 at the appropriate angle and position to form the proper spiral vortex pattern by deflection plates 60 and the spiral containment end walls 50 and 51. The two feed channels 59 are joined by a passage 61 having an inlet 62 thereto through which the entering fluid is fed.

Fluid which enters the barrel of the cyclones leaves the cyclones by respective exit pipes 63 with a high rotational

Dyson Ex1020
Page 877

velocity into the space 44 between the plates 46 and 47. Although much of the rotational velocity is lost with the abrupt corner as shown, there will be reverse vortex flow in the space 44 in the tangential matrix in a similar sense to that in space 42 but with outward fluid flow movement. The fluid from the space 44 flows by way of two channels 64 interconnected by a passage 65 and is discharged through a common outlet similar to inlet 62 illustrated in Figure 5.

The heavy material rejected at the bottom exit of the fluid cyclones is shown as being collected in a pan 66 and discharged through an exit passage 67.

The embodiment illustrated in Figure 7 is similar to that illustrated in Figures 5 and 6 and consists of a plurality of cyclone units 70 which are of the energy recovery type of Figure 2. The energy recovery cyclones are arranged in the type of arrangement of Figure 5 with the pattern of spiral vortices of a similar type created in the space between flat plates defining the chambers. The cyclones have conical and bottom end design 71 which is similar to that shown in Figure 2 and an annular opening 72 for outflow of material from the cyclone. The annular outlet 72 leads to an expanding annular space 73 which in turn leads to space between the plates defining chamber 74. In this latter space the reverse spiral flow pattern described above with reference to Figures 5 and 6 occurs with fluid being collected by a pair of channels 75, only one of which is shown and which are interconnected by a passage 76 having an outlet therefrom (not shown) similar to inlet 62 illustrated and described with reference to Figure 5.

Dyson Ex1020
Page 878

Reject materials are collected in a pan 77 and taken away by a pipe or other passage means 78.

Material to the respective cyclone units 70 is from a chamber 79 common to all of the units and having a pair of inlet passage means 80 (only one of which is shown) similar to the passages 59 described and illustrated with reference to Figure 5. The pair of passages 80 are interconnected by a passage 81 having an inlet thereto (not shown) corresponding to inlet 62 illustrated and described with reference to Figure 5.

Referring to Figures 8 to 14 inclusive, there is illustrated in more detail a practical embodiment of a multi-cyclone unit consisting of a plurality of individual cyclone units 100 having an inlet and outlet header system 200 on the upper end and a reject box 300 on the lower end, all of which are mounted on a supporting structure 400. The supporting frame consists of four vertical posts 401 rigidly connected by way of coupling members 402 to a horizontally disposed support plate 403. The reject box 300 is also rigidly connected to the legs 401 by way of bracket members 301, further rigidifying the entire structure.

The header 200 has an inlet 201 for fluids to be treated and an outlet 202. Details of the header 200 are illustrated in Figures 9 to 13 inclusive and reference will now be made thereto. The header 200 is a rigid assembly having four sockets 203 for receiving the upper ends of the frame posts 401, thereby mounting the header on the frame. Suitable locking means, for example set screws or the like, may be utilized in

Dyson Ex1020
Page 879

anchoring the header to the posts. The header 200 has a chamber 204 in which there is established a pattern of vortex flow such that the chamber serves as a common inlet for all of the cyclone units. Similarly there is a chamber 205 common to all of the individual cyclone units for the outflow of fluid from the cyclones. The inlet chamber 204 is defined by a central plate 206 and a lower plate 207 together with side plates 208 and 209. The outlet chamber is defined by the central plate 206 and upper plate 210 spaced therefrom and the side plates 208 and 209.

In referring to Figure 11 there is located in the inlet chamber 204, a partition wall 212 that divides the inflowing fluid into two passages designated respectively 213 and 214. In the respective passages are diverter plates 215 and 216 secured to the central plate 206 and projecting downwardly therefrom toward the lower wall of the inlet manifold but spaced therefrom. The diverter plates 215 and 216 direct the inflowing fluid to form spiral vortices about the inlets of respective individual cyclone units 100A and 100B. Fluid flowing below the diverter plates 215 and 216 is directed to form spiral vortices about the respective individual cyclone units 100C and 100D. The curved end wall portions 221, 222, 223 and 224 serve as containment walls for the vortices at respective cyclone units 100A, 100B, 100C and 100D and as previously mentioned are preferably spirally shaped. The passages in outlet chamber 205 are shown in Figure 12 which is a section taken along stepped line 12-12 in Figure 9. The outlet from the individual cyclone units 100A, 100B, 100C and 100D is into chamber 205 and fluid flow therefrom is

Dyson Ex1020
Page 880

divided by partition wall 217 into passages 218 and 219 connected by way of passage 220 to the outlet 202.

A cross-section of an individual cyclone unit is illustrated in Figure 14 and includes an upper cylindrical portion 101 followed by a lower tapered conical section 102. Inflow of fluid to be treated through chamber 204 enters the cyclone from the centre of the spiral vortex in said manifold by annular inlet passage 103. Outflow from the cyclone is through an annular passage 104, gradually increasing in size to the outlet chamber 205 where it spirals outward. The passage 104 is provided by truncated conical member 105 mounted on the intermediate plate 206 and a further conical member 106 projecting thereinto and mounted on the upper plate 210 by a plurality of bolts 107. The cylindrical portion 101 and tapered lower end portion 102 may be a single unit or, alternatively, separate units as illustrated, the cylindrical portion being provided by a short length of sleeve abutting at one end the lower manifold plate 207 and at the other end a flange on the tapered cone 102. A plurality of screws 108, threaded in the frame plate 403, press against an annular bearing ring 109 abutting the flange on member 102 and presses the cylindrical sleeve 101 against the manifold. O-ring seals 110 are provided to seal the joints.

The reject box 300 is mounted on the frame posts 401 at the lower reject outlet end of the cyclone. Between the reject box and mounted on the lower end of the conical portion are upper and lower plates 120 and 121 interconnected by a plurality of bolt and nut units 122 and held in spaced apart

Dyson Ex1020
Page 881

relation by a short sleeve 123. The lower end of the cone 102 is open as indicated at 112 and spaced therebelow is a cone plate 125. The cone plate 125 is mounted on the plate 120 by a plurality of machine screws 126 spaced apart from one another circumferentially around the cone plate. The cone plate is held in suitable spaced relation from plate 120 by spacers 127. Rejects from the cyclone follow the path indicated by the arrow A and discharge into the reject header box 300 by way of an aperture 128 in the lower plate 121.

Cyclones of the foregoing design are basically intended for use with water as the working fluid. The present design, however, is also deemed applicable when using gas as the working fluid; for example, treating gases from furnaces to remove fly ash and smoke.

There would, of course, be no phase discontinuity with gas in the cyclone, but the core pressure could also become subatmospheric with a design with pressure recovery. If the core pressure was low enough the gas near the core would expand thus increasing the velocity and become cold because of adiabatic expansion. The velocity of gases and hence the centrifugal force will be very much higher due to its lower density with an upper limit at the velocity of sound or approximately 1000 ft/second. This compares to a maximum theoretical possible velocity with water as the fluid, with 10 p.s.i. inlet and vacuum core of 60 ft. per second. The centrifugal accelerations at a radius of 1/2 inch with these tangential velocities would be 2683 times that of gravity for the water and 745,341 times that of gravity for the gas at the velocity of sound.

Dyson Ex1020
Page 882

In practice neither of these maximum velocities will be achieved because of friction in both devices. Gas cyclones are usually employed with only a few inches water gauge as a pressure differential. The velocity of sound can be achieved with 10 p.s.i. of air pressure. Atmospheric pressure is in excess of this so that very low friction loss and complete pressure recovery could achieve close to the velocity of sound in the gas near the core with a very low pressure differential across the unit.

A small multi-cyclone unit as described in the foregoing has been tested by the applicant for comparison in operability with air as opposed to water as the working fluid. In testing the unit to treat air, a fan was used to suck the air through the unit. The comparison makes the assumption that friction losses are proportional to velocity head whether one is dealing with air or water which is approximately true at very high Reynolds number. The following table shows comparative operation of the system on water and air:

COMPARISON 3" MULTICYLONE 4 UNITS

	Water	Air
Inlet Pressure	10 p.s.i.	Atmospheric
Outlet Pressure	0 p.s.i.	-1" Water Gauge
Flow	150 US gallon/min	62 cubic ft/min
Mean Gravities	315	975
Mean Pressure at Outlet	6" Hg Vacuum	-1.2" Water gauge
Core Pressure	28" High Vacuum	10" Hg Vacuum?

In practice one would use much larger and more numerous cyclones to handle air at the low fan pressures used

Dyson Ex1020
Page 883

in the test. Hydraulic capacities are roughly proportional to the square root of the applied pressure differential. Mean gravities will be roughly proportional to the pressure differential. The mean pressure shown is in the fluid leaving the interior of the unit. The very center of the vortex will have a much lower pressure which in the case of water is filled with water vapour. The core condition with air is difficult to estimate due to expansion of the gas resulting in reduced density and temperature. The tests conducted, however, do establish applicability in the use of the multiple arrangement for not only liquids but gases.

Dyson Ex1020
Page 884

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

A fluid cyclone having an upper circular end with tangential inlet and outlet passages adjacent thereto, and a lower portion with a reject outlet in the lower end thereof; said outlet passage comprising an uninterrupted curved passage that gradually increases in size from an inlet thereto, which is coaxial with said circular portion, to said tangential outlet.

2. A fluid cyclone having an upper cylindrical end portion with respective inlet and outlet passages tangential thereto, and a lower portion with a reject outlet in the lower end thereof, said outlet passage having an annular inlet in the cylindrical portion and coaxial therewith followed by an uninterrupted curved passage that gradually increases in size to the tangential outlet passage.

3. A fluid cyclone as defined in claim 1 or 2 wherein said lower portion tapers inwardly decreasing gradually in size from the upper end thereof to said reject outlet.

4. A fluid cyclone as defined in claim 1 or 2 wherein said lower portion is conical having a curved side wall.

5. A fluid cyclone as defined in claim 1 or 2 including a cone plate underlying said reject outlet and spaced therefrom.

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6. A fluid cyclone as defined in claim 1 or 2 including a cone plate underlying said reject outlet and spaced therefrom and located in a chamber having a discharge orifice therefrom below the cone plate.

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ABSTRACT

A special form of fluid cyclone in which the velocity energy in the exit fluid is converted into exit pressure thus permitting the device to discharge to atmospheric pressure or a higher pressure while a vacuum may exit in the central core of the vortex. The result is achieved by use of a curved passage at the exit which starts as a coaxial space and gradually expands and turns outward to become a circular space between two disks. The removal of reject material to atmospheric pressure with a vacuum at the core may be achieved by limiting the restriction in cross-section of the bottom core such that the pressure is atmospheric and allow it to leave through a space between the end of the cone and a blunt shaped surface. The above special form of fluid cyclone operates particularly well, because of reduced energy losses, when employed in a multiple arrangement in which the tangential velocity energy of fluid entering the barrel of the individual cyclone units is created by fluid flowing at larger radius such as to create a pattern of multiple vortex flow. The vortices are in a chamber providing a common inlet to a plurality of cyclone units with the vortices centering on the individual units. The special arrangement of fluid cyclones is in a geometry similar to that of a vortex trail with an even number of units of opposing vortex direction. The same type of arrangement; i.e. having all of the units discharge into a common chamber, leads to further energy recovery in fluid leaving the fluid cyclones.

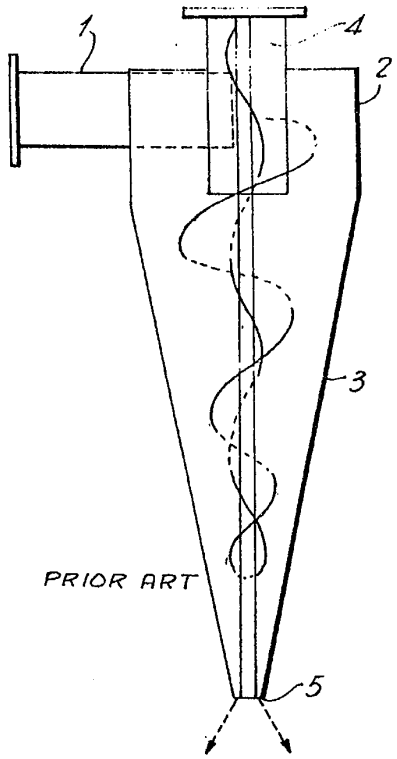


Fig-1

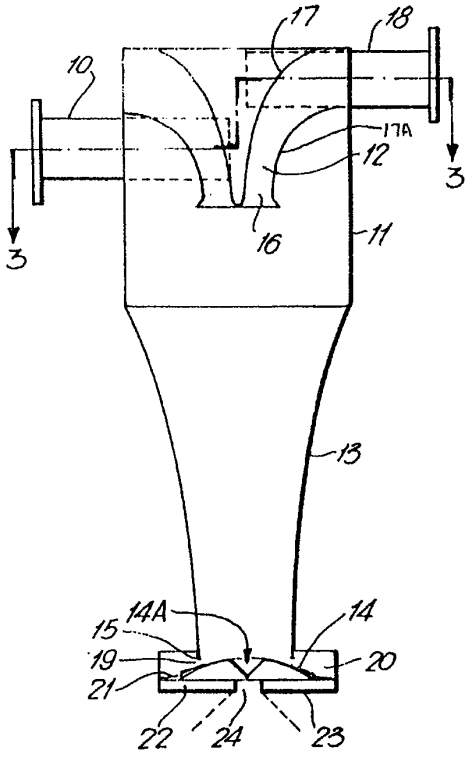


Fig-2

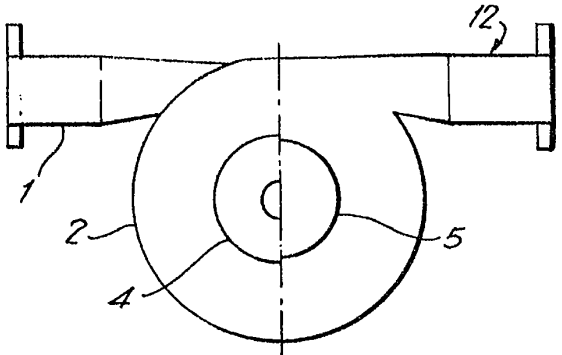


Fig-3

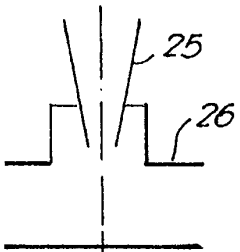


Fig-4

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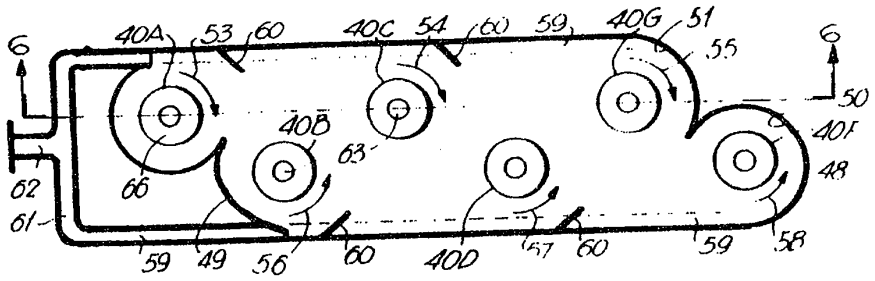


Fig-5

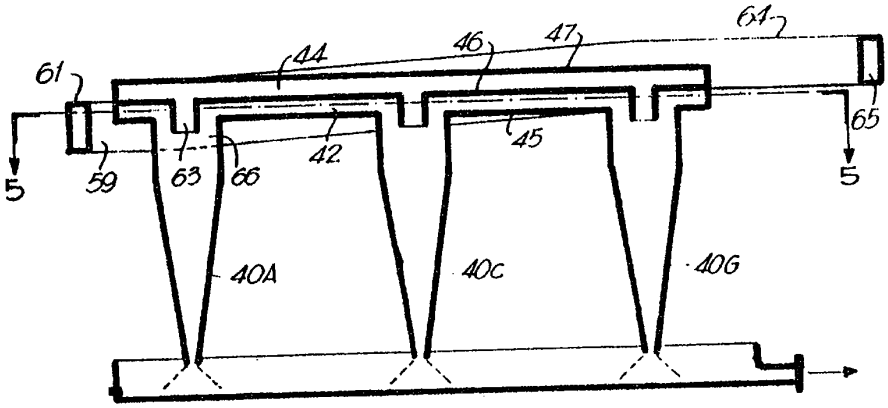


Fig-6

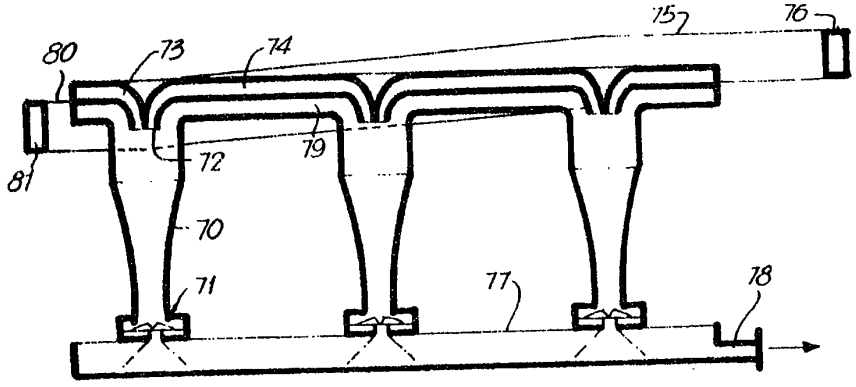


Fig-7

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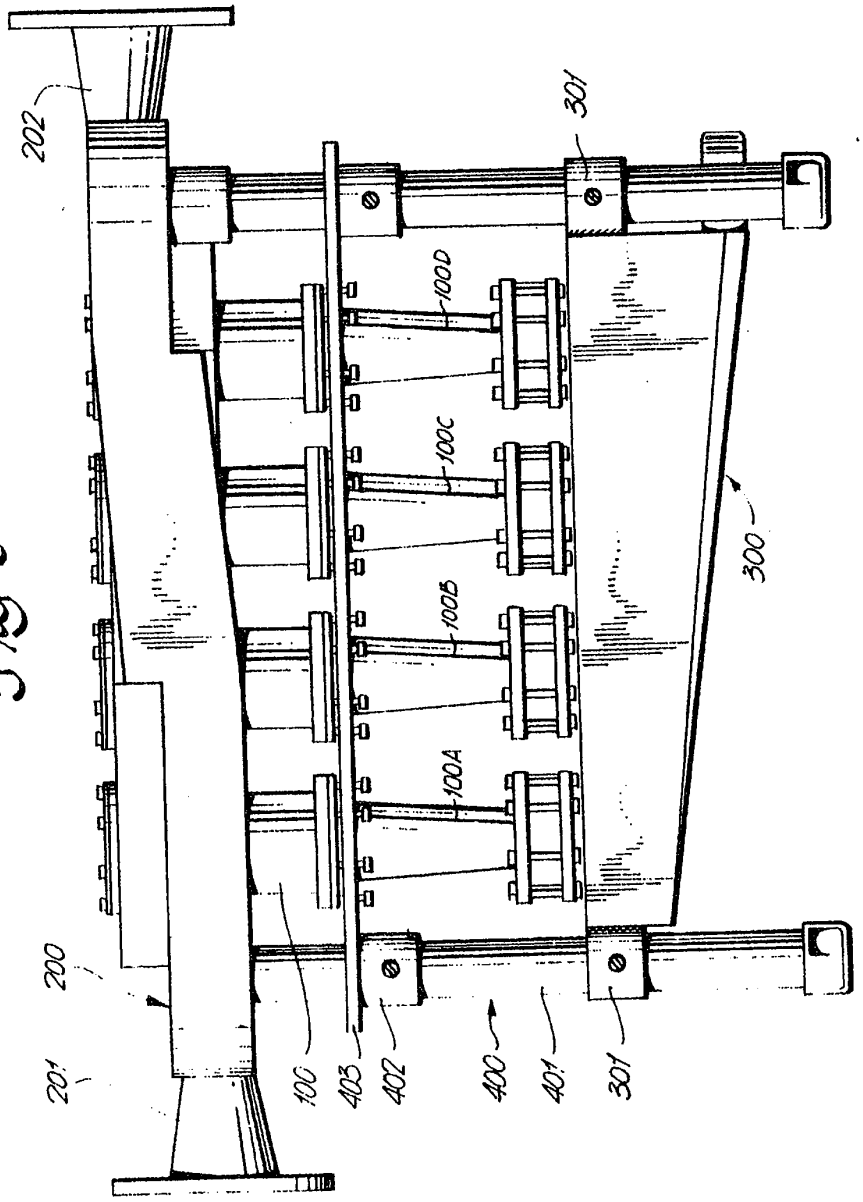


Fig. 8.

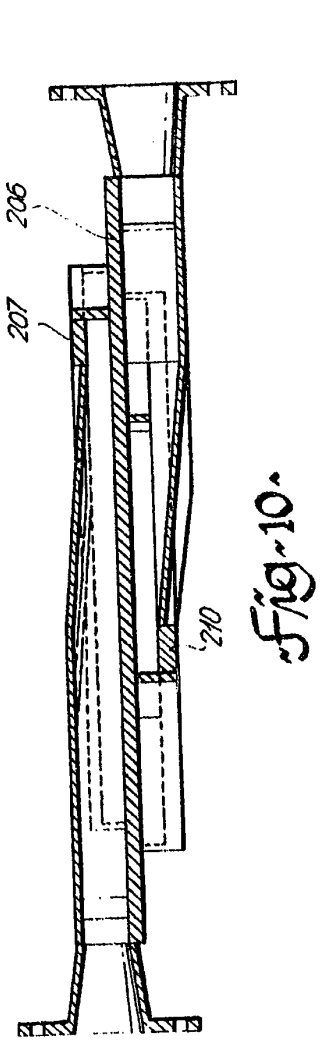


Fig. 10.

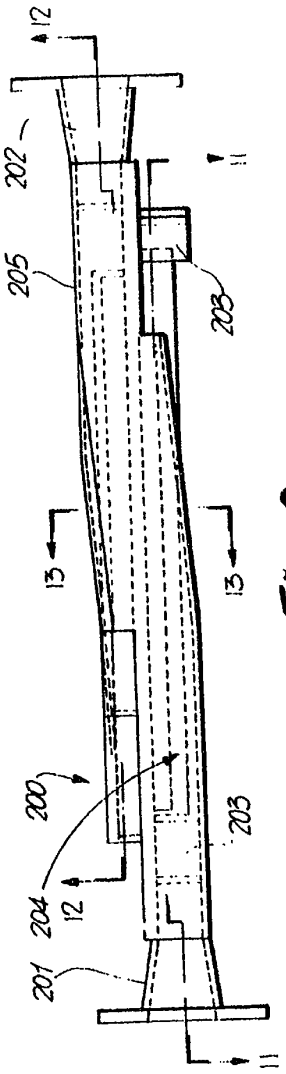


Fig. 9.

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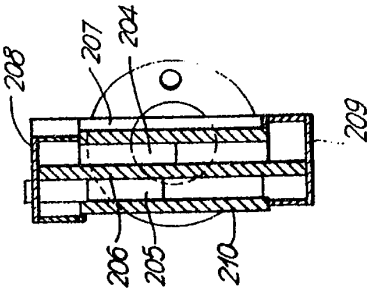


Fig. 13.

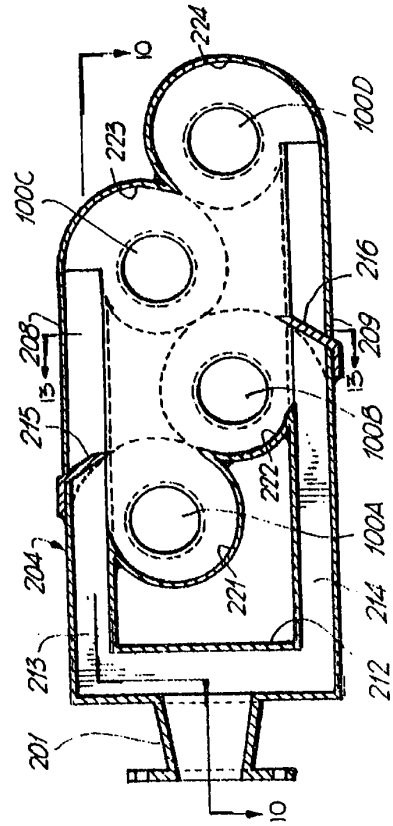


Fig. 11.

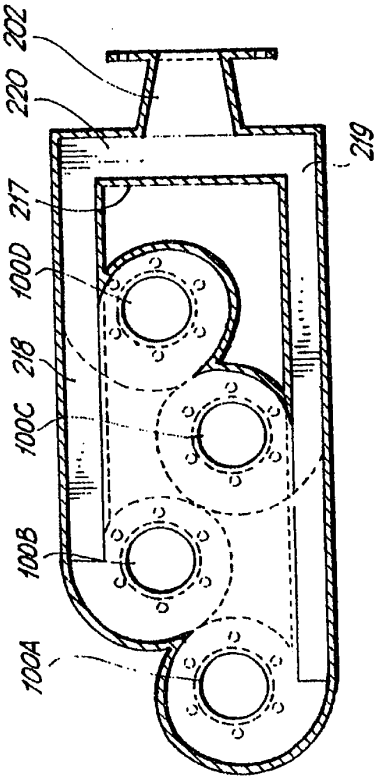


Fig. 12.

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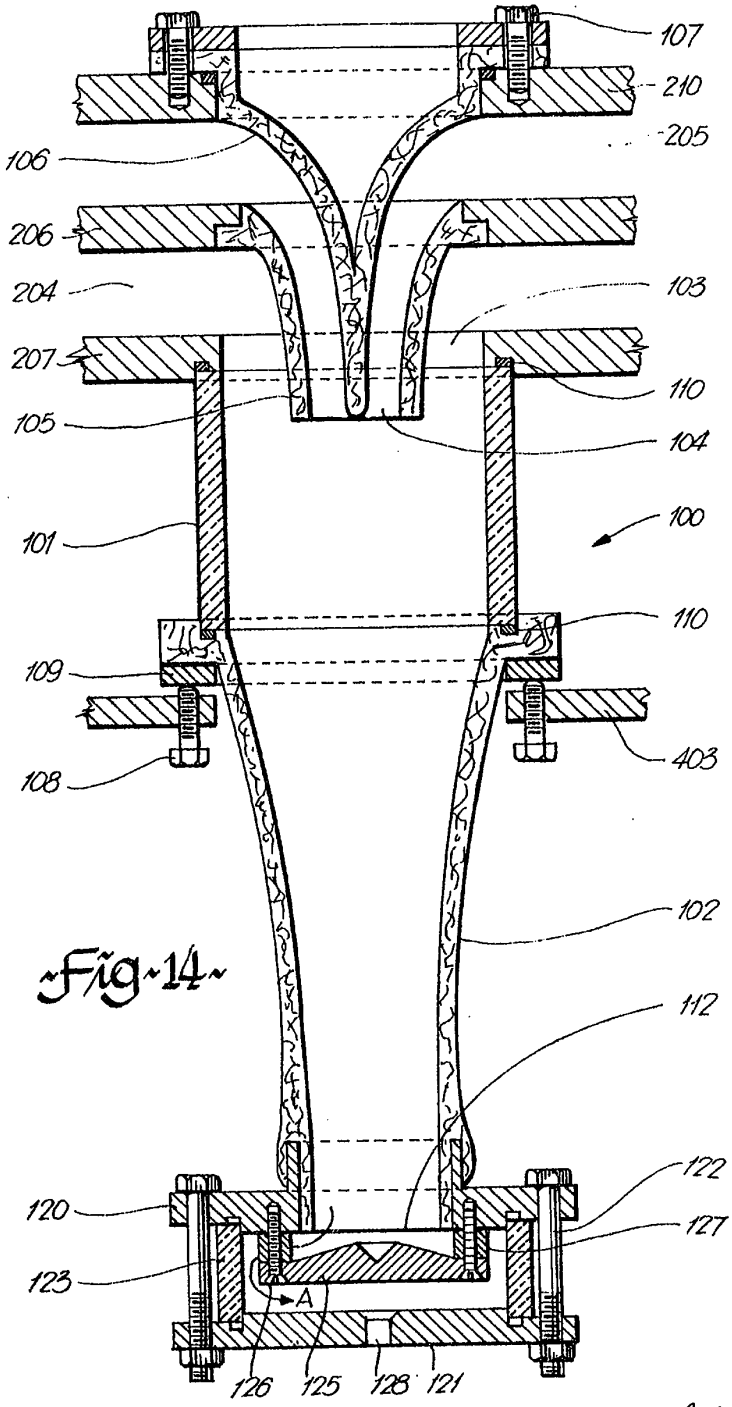


Fig-14

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Erteilt auf Grund des Ersten Überleitungsgesetzes vom 8. Juli 1949
(WiGBl. S. 175)

BUNDESREPUBLIK DEUTSCHLAND

AUSGEGEBEN AM
30. APRIL 1953

DEUTSCHES PATENTAMT

PATENTSCHRIFT

№ 875 134

KLASSE 50e GRUPPE 310

M 11571 III/50e

Max Strupp, Frankfurt/M.
ist als Erfinder genannt worden

Metallgesellschaft Aktiengesellschaft, Frankfurt/M.

Fliehkraft-Staubabscheider

Patentiert im Gebiet der Bundesrepublik Deutschland vom 4. November 1951 an
Patentanmeldung bekanntgemacht am 4. September 1952
Patenterteilung bekanntgemacht am 19. März 1953

Die Erfindung betrifft einen Fliehkraft-Staubabscheider, insbesondere in der Ausbildung als Mehrfach-Fliehkraft-Staubabscheider mit axialem Reingasauslaß im Rohgaseinlaß und einer an den Rohgaseinlaß anschließenden, gegebenenfalls von inneren Einbauten freien Rohrverlängerung, dem sogenannten Abscheiderrohr, dessen Länge unterhalb des Reingaseinlasses gemessen ein Mehrfaches, und zwar mindestens, wie bekannt, das Dreifache seines Durchmessers beträgt.

Nach der Erfindung ist an Stelle des bisher üblichen, an das Abscheiderrohr anschließenden verjüngten Staubauslasses (Konus) das Abscheiderrohr ohne Verjüngung mit gleichem Durchmesser und etwa in gleicher Länge des sonst üblichen konischen Staubauslasses ausgebildet, so daß die Gesamtlänge des Abscheiderrohres unterhalb des Reingaseinlasses beginnend (sog. nutzbare Länge) etwa das Fünffache und mehr des Durchmessers des Abscheiderrohres beträgt. Kurz vor dem Ende dieses derart verlängerten zylindrischen Abscheiderrohres ist im Innern des Abscheiderrohres ein den Rückstrom des Gases aus dem anschließenden Staubbunker drosselndes und den Staub leitendes Organ mit Saubdurchtrittsöffnungen am Umfang desselben angeordnet. Der Abstand dieses Leit- und Drosselorgans vom unteren Ende des Abscheiderrohres ist dabei so groß gewählt, daß der an seinem Umfang nach dem Staubbunker durchtretende, durch die Zentrifugalwirkung ausgeschleuderte Staub bei etwa schraubenförmig bis geradliniger Bewegung noch eine axiale Führung in Verlängerung des Abscheiderrohres erfährt und nicht sofort seitlich, wie bisher bekannt, über den unteren Rand des Abscheiderrohres hinaus in den Staubbunker ausgeschleudert wird. Der nach der Erfindung eingebaute Leitkörper soll also einen mehrfachen Zweck erfüllen, einmal eine Drosselung der Gas-

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geschwindigkeit und dadurch die Verhinderung, zumindest Dämpfung von Druckschwankungen zwischen dem Abscheiderrohr bzw. den Abscheiderrohren bei Mehrfach-Fliehkraft-Staubabscheidern und dem gemeinsamen Staubbunker und zum anderen eine Art Durchschleusung des Staubes in wesentlich axialer Richtung in den Staubbunker. Die geradlinige Führung des Staubes nach Durchtritt desselben durch die äußeren Leitöffnungen verhindert die Bildung von Staubwirbeln im anschließenden Bunker, und die inneren Drosselöffnungen des Organs verhindern bzw. dämpfen den Rückstrom des mit dem Staub eingeführten Gases aus dem Staubbunker in die Abscheiderrohre und damit in den Reingasstrom.

Vorteilhaft schließen sich in bekannter Weise an das untere Ende des Reingasrohres und gleichachsig mit dem Reingasrohr und dem Abscheiderrohr Leitkörper an, die bis zur Umkehrzone des Gaswirbels nach unten in das Abscheiderrohr hineinragen, mindestens aber in der Ausdehnung des dreifachen Abscheiderrohrdurchmessers und gegebenenfalls bis an das oder die Drossel- und Leitorgane nach der Erfindung, die gegebenenfalls auch in mehrfacher Ausführung übereinander im Abscheiderrohr angeordnet sein können. Dabei können die äußere Formgebung des Leit- und Drosselorgans, die Anordnung und Anzahl der äußeren Staubdurchtrittsöffnungen mannigfaltig variiert werden, indem nicht nur ebene, sondern auch schraubenförmig, gegebenenfalls mehrgängig ausgebildete Drallkörper als Organ gemäß der Erfindung Verwendung finden können.

Die Anordnung von Anschlußstellen oder -ringen mit zentraler Gasdurchtrittsöffnung am Ende dieser zylindrischen Abscheiderrohre ohne konischen Staubaustritt ist bekannt. Bei dieser Anordnung tritt aber der Staub seitlich aus dem Ende des Abscheiderrohres aus.

An Hand der Zeichnung sei der Gegenstand der Erfindung in der Anwendung bei Mehrfach-Fliehkraft-Staubabscheidern bekannter Bauart des näheren erläutert.

Die Abb. 1 zeigt schematisch einen senkrechten Schnitt durch einen Mehrfach-Fliehkraft-Staubabscheider mit der Ausbildung der Abscheiderrohre und den ausgesetzten Leit- und Drosselorganen nach der Erfindung. Die Abb. 2a bis 2i stellen verschiedene Ausführungsformen der Einbaukörper dar.

In sämtlichen Abbildungen sind für gleiche Teile gleiche Bezugszeichen gewählt, und zwar sind mit 5 das oder die Abscheiderrohre des Mehrfach-Fliehkraft-Staubabscheiders bezeichnet, die in dem gemeinsamen Gehäuse 1 in an sich bekannter Weise angeordnet sind und in den gemeinsamen Staubbunker 2 münden. Das Rohgas tritt beispielsweise seitlich durch den Stutzen 3 über die einen Drall des Gasstromes bewirkenden Wirbler 6 in die Abscheiderrohre 5 ein und nimmt seinen Richtungswechsel im wesentlichen unterhalb der bekannten, der Gleichrichtung der Strömung dienenden Leitbleche 8 nach dem Reingasrohr 7 (Einlaß) vor, um durch die Auslässe 4 den Mehrfach-Fliehkraft-Staubabscheider als Reingas zu verlassen.

Die nach der Erfindung eingebauten Leit- und Drosselkörper mit dem Bezugszeichen 9 sind in den Abb. 2c bis 2i in mehreren Ausführungsbeispielen dargestellt. Wie aus diesen Abbildungen ersichtlich, kann entweder eine einwandfreie Schlitzung des unteren Endes der Abscheiderrohre 5 mit einwärts gebogenen Flanken (Abb. 2c) in Frage kommen oder eine schraubenlinienförmige Ausbildung gemäß Abb. 2d, dic, wie der Grundriß zeigt, eine Öffnung 10 für den Durchtritt des Staubes und gegebenenfalls eine Öffnung 11 für den Rückstrom des Reingases frei läßt. Die letztere ist größer als bei der früher üblichen Staubauslaßöffnung bei konischer Ausbildung des Endes des Abscheiderrohres, also etwa $\frac{D}{2}$.

Nach der Ausführungsform Abb. 2e besteht der Leit- und Drosselkörper 9 aus einem an sich bekannten Drallkörper, ähnlich dem am Eintritt der Abscheiderrohre. Nach Abb. 2f und 2g können kegelstumpfförmige Einsatzkörper 9 mit nach oben oder nach unten gekehrter kleinerer Grundfläche, gegebenenfalls in einer der Wirbelausbildung angepaßten schlanken Form, wie in Abb. 1 und 2f mit 9' bezeichnet, angewendet werden. In diesem Falle können weitere Gaseintrittsschlitze 12 vorgesehen werden. Auch eine schräg eingesetzte Blende nach Abb. 2h mit nur einem Staubdurchtrittsschlitz 10 kann den erfindungsgemäß angestrebten Zweck erfüllen. Die allgemeinere Form dieses Einsatzringes 9 ist in Abb. 2i mit mehreren Staubdurchtrittsöffnungen 10 und einer Gasdurchtrittsöffnung 11 gezeichnet. Der Einsatzring ist durch Stege 13 (vgl. auch Abb. 2g) an der Rohrwandung angeheftet. Wesentlich ist, daß diese Einsatzkörper 9 mit einem Abstand B (Abb. 1) vom Ende der Abscheiderrohre 5 in denselben angeordnet sind. Dieser Abstand beträgt mindestens die Hälfte des Rohrdurchmessers und richtet sich im wesentlichen nach der Staubart und der Geschwindigkeit, mit der der Staub am Ende der Abscheiderrohre 5 anlangt. Die Länge B soll so groß gewählt werden, daß der Staub in geschlossener Form in den Staubbunker 2 geleitet wird, damit sich die Staubwirbel der Abscheiderrohre untereinander beim Austritt nicht beeinflussen und derart ein Rückstrom staubfreien Gases bzw. ein Ausgleich der Gasdrücke in den einzelnen Abscheiderrohren über dem Staubbunker ohne Staubaufwirbelung ermöglicht wird.

Durch Einbau mehrerer Drosselscheiben oder Blenden 9 im Abstand übereinander kann die Loslösung von Staub und Reingas noch verbessert werden, beispielsweise mit 14 in Abb. 2i dargestellt, wobei die Ringfläche 9 kleiner gewählt wird. Dabei kann ein düsenartig im Innern sich verengender, nach außen sich kegelig erweiternder Hohlkörper 15 (Abb. 2i) an Stelle mehrerer Ringflächen 9 ausgebildet werden.

Nach einem Merkmal der Erfindung beträgt die Gesamtlänge L (Abb. 1) vorteilhaft das mindestens

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Fünffache, beispielsweise Sechsfache des Durchmessers D des Reingasrohres 5, wobei die Länge der Gleichrichterflächen 8, in Abb. 1 mit A bezeichnet, in an sich bekannter Weise etwa das Dreifache des Durchmessers D des Abscheiderrohres beträgt. Durch diese große nutzbare Rohrlänge L (am Einlaß des Reingasrohres 7 beginnend gemessen) wird erreicht, daß die durch den Drall ausgeschiedenen Staubwirbel genügend Zeit haben, sich von dem in umgekehrter Richtung abgeführten Reingasstrom in Verbindung mit dem Gleichrichterkörper 8 zu trennen, so daß der Entstaubungswirkungsgrad, wie Versuche gezeigt haben, von bisher 90 auf 92% und mehr verbessert wird. Dabei kann das in den Staubbunker 2 hineinragende Ende der Abscheiderrohre 5 gegebenenfalls, wie in Abb. 2b dargestellt, abgeschrägt sein.

Bei der in der Zeichnung dargestellten Stellung der Wirbler 6 ist ein Anstellwinkel von 30° der Leitschaufeln gegen die Waagerechte angenommen. Um die Bauhöhe der Abscheiderrohre möglichst niedrig zu halten, kann der Anstellwinkel beispielsweise auf 10° und gleichzeitig auch der Durchmesser der Abscheiderrohre auf 30 mm und darunter verringert werden.

Patentansprüche:

1. Fliehkraft-Staubabscheider, insbesondere in der Ausbildung als Mehrfach-Fliehkraft-Staubabscheider mit in einen Staubbunker mündenden zylindrischen Staubabscheiderrohren mit axialem oder tangentialem Rohgaseintritt und axialem Reingasaustritt im Rohgaseinlaß, dadurch gekennzeichnet, daß ein, gegebenenfalls mehrere Leitorgane (9, 14, 15) mit Abstand voneinander bzw. vom Staubaustrittsende im Abscheiderrohr (5) angeordnet sind.

2. Fliehkraft-Staubabscheider, insbesondere nach Anspruch 1, bei dem die Länge des Abscheiderrohres, unterhalb des Reingaseintritts beginnend, mindestens das Dreifache seines Durchmessers beträgt, dadurch gekennzeichnet, daß die Länge des zylindrischen Abscheiderrohres (5) mindestens das Fünffache seines Durchmessers (D) beträgt und gegebenenfalls im Innern desselben Leitorgane (9, 14, 15) mit Durchtrittsöffnungen (10) am äußeren Umfang für den Staub und zweckmäßig einem zentralen Gasdurchlaß (11) angeordnet sind.

3. Ausbildung der Leitorgane nach den Ansprüchen 1 und 2, dadurch gekennzeichnet, daß dieselben die Gestalt einer ein- oder mehrgängigen Schraubenfläche aufweisen (nach Abb. 2c, 2d, 2e).

4. Ausbildung der Leitorgane nach den Ansprüchen 1 und 2, gekennzeichnet durch einen kegelstumpfförmigen, gegebenenfalls düsenförmig verlängerten Einsatzkörper (nach Abb. 2g und 2i).

Hierzu 1 Blatt Zeichnungen

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Page 896

Zu der Patentschrift 875 134
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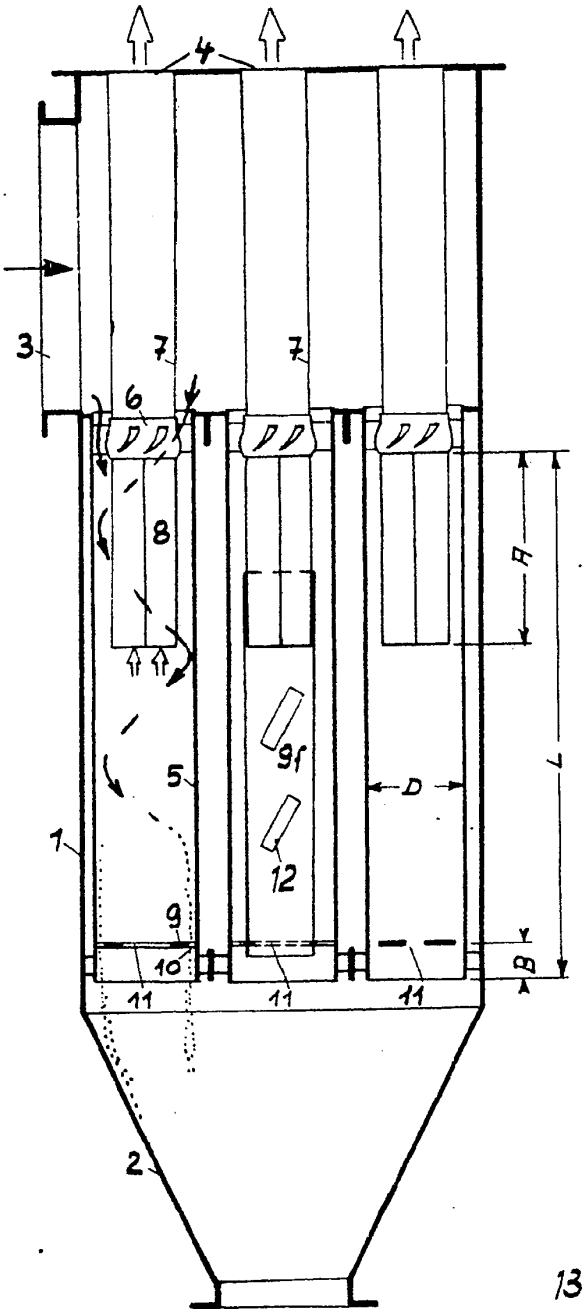


Abb. 1

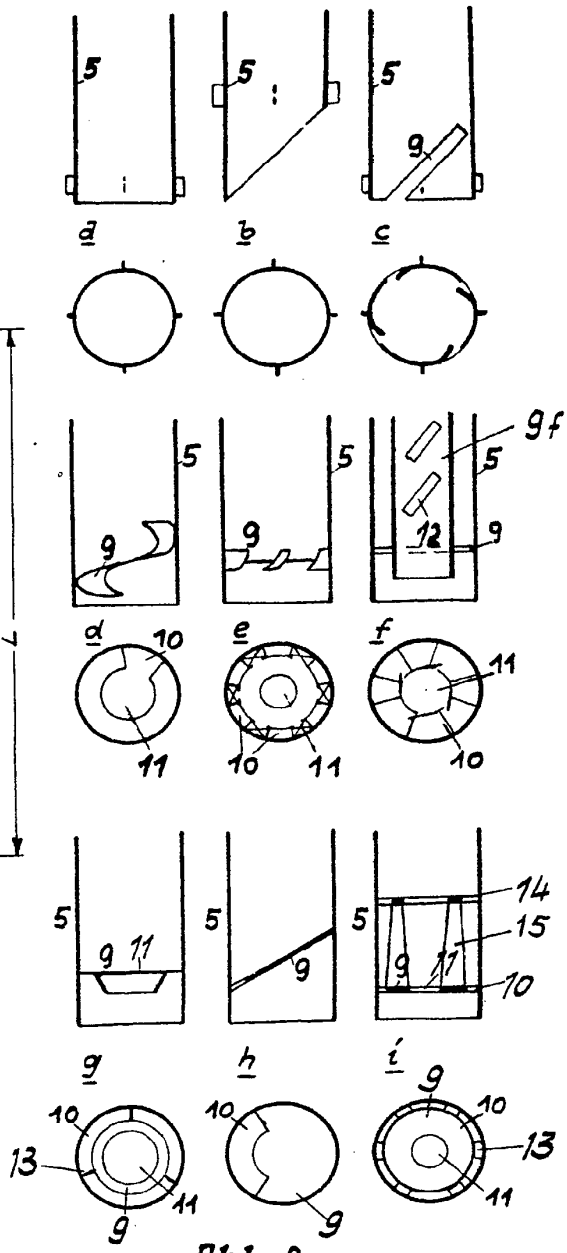


Abb. 2

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PATENT SPECIFICATION

700,791

Inventor :—GEORGE WILLIAM COX.

Date of filing Complete Specification : July 11, 1952.

Application Date : Aug. 3, 1951. No. 18429/51.

Complete Specification Published : Dec. 9, 1953.

Index at Acceptance :—**Class 23**, A1A.

COMPLETE SPECIFICATION.

Improvements in and relating to Dust Separators.

We, THE ENGLISH ELECTRIC COMPANY LIMITED, of Queens House, 28 Kingsway, London, W.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

The invention relates to dust separators of the cyclone type which, by centrifugal action, separate dust particles out of a stream of gas laden with the same.

In such dust separators the gas laden with dust particles is introduced with a swirl for example through vanes or tangential slots, into an outer tube leading into a dust discharge chamber from which the dust is withdrawn tangentially while the purified gas reverses its axial direction and leaves through a central outlet tube arranged concentrically to and within the said outer tube. A division plate having a central aperture (so called " iris " plate) and flaps slightly turned up out of its plane towards the swirling gas stream (so called " razor blades ") are sometimes used in such separators between the outer tube and the dust discharge chamber. The invention is concerned with this particular kind of cyclone type dust separators.

According to a main feature of the invention a louvred separator tube is arranged within the dust discharge chamber which tube is fitted at one end around the central aperture of the said " iris " plate and closed by a blanking plate at the opposite end.

Preferably these louvres open inward in a direction opposite to the axial direction of the dust laden gas, i.e. in the direction towards the central outlet tube for the purified gas.

Preferably these louvres are also arranged helically on the said separator tube, their helix being of the opposite hand to the swirl of the dust laden gas.

In order that the invention may be better understood and readily carried into effect, an embodiment of it will now be described by way of example with reference to the drawing accompanying the Provisional Specification, in which :—

Fig. 1 is a longitudinal section of the outer tube, central tube and discharge chamber with the louvred tube shown in elevation.

Fig. 2 is a longitudinal part view showing a section of the louvred tube and " iris " plate only.

Fig. 3 is a perspective view of the " iris " plate on a larger scale.

Dust laden gases enter an outer tube 1 through swirl vanes 2*a* which impart to them a rotary motion as they pass along the outer tube 1. Centrifugal action consequently throws the dust particles which are much heavier than the gas against the wall of the outer tube 1. When meeting an " iris " division plate 10 the swirling dust particles and the part of the gas heavily concentrated with them passes through the flaps or " razor blades " 12 slightly turned up towards the swirling gas stream into a dust discharge chamber 4, whereas the purified inner gas stream while maintaining its swirl reverses its axial direction and leaves the separator through a central outlet tube 3.

The gas having entered the dust discharge chamber 4 meets the louvres 13 in a louvred inner tube 9 transversely, and changes its axial direction by being deflected by these louvres as indicated in Fig. 2. This gas flows through a central aperture 11 of the " iris " plate 10 and joins the main purified gas stream leaving through the central outlet tube 3.

The dust particles, however, being much

[*Price 2s. 8d.*]

Price 3s. 6d. Price 4s 6d.

Dyson Ex1020
Page 898

heavier than the gas, are unable to execute the turn through the louvres 13 of the tube 9 and are confined to the space between the discharge chamber 4 and the louvred tube 9.

The dust is eventually discharged tangentially from the chamber 4 through a tube 7. The louvred inner tube 9 is closed at its end opposite the aperture 11 by a blanking plate 8, to prevent re-circulation of the dust particles.

It will be seen that in the present embodiment both the discharge chamber 4 and the louvred tube 9 are of frusto-conical shape with approximately the same virtual apex. This arrangement causes the vortex movement of the gas to be maintained towards the narrow end of the louvred tube 9, whereby the separating effect of the louvres 13 is maintained substantially over the full length thereof.

Instead of using a discharge chamber 4 and louvred tube 9 having the same virtual apex, these two components may be constructed to have, e.g. the same aperture angle.

What we claim is :—

1. A dust separator wherein gas laden with dust particles is introduced with a swirl for example through vanes or tangential slots, into an outer tube into a dust discharge chamber from which the dust is withdrawn tangentially while the purified gas reverses its axial direction and leaves through a central outlet tube arranged concentrically to and within the said outer tube, a division plate having a central aperture and flaps slightly turned up out of its plane towards the swirling gas stream being arranged between the said outer tube and the said dust discharge chamber, and a louvred separator tube being arranged within the said dust discharge chamber, fitted at one end around the said central aperture and closed at the opposite end.

2. A dust separator according to Claim 1, wherein both the said dust discharge chamber and said louvred separator tube are of frusto-conical shape, tapering in the same direction.

3. A dust separator according to Claim 2, wherein the said dust discharge chamber and louvred separator tube have substantially the same virtual apex.

4. A dust separator according to Claim 2, wherein the said dust discharge chamber and louvred separator tube have substantially the same aperture angle.

5. A dust separator according to any one of the preceding claims wherein the said louvres open inward in a direction opposite to the axial direction of the dust laden gas, i.e. in a direction towards the central outlet tube for the purified gas.

6. A dust separator according to any one of the preceding claims wherein the said louvres are arranged helically on the said separator tube, their helix being of the opposite hand to the swirl of the dust laden gas.

7. A dust separator as claimed in Claim 1, substantially as described with reference to the drawing accompanying the Provisional Specification.

L. B. SHUFFREY,
Agent for the Applicants.

PROVISIONAL SPECIFICATION.

Improvements in and relating to Dust Separators.

We, THE ENGLISH ELECTRIC COMPANY LIMITED, of Queens House, 28 Kingsway, London, W.C.2, a British Company, do hereby declare this invention to be described in the following statement :—

The invention relates to dust separators of the cyclone type which, by centrifugal action, separate dust particles out of a stream of gas laden with the same.

In such dust separators the gas laden with dust particles is introduced through swirl vanes, tangential slots or the like into an outer tube leading into a dust discharge chamber from which the dust is withdrawn tangentially while purified gas reverses its axial direction and leaves through a central outlet tube arranged concentrically to and within the said outer tube. A division plate having a central aperture (so called " iris " plate) and flaps slightly turned up out of its plane towards the swirling gas stream (so called " razor blades ") are sometimes used in such separators between the outer tube and the dust discharge chamber. The invention is concerned with this particular kind of cyclone type dust separators.

According to a main feature of the invention a louvred separator tube is arranged within the dust discharge chamber which tube is fitted at one end around the aperture of the said " iris " plate and closed by a blanking plate at the opposite end.

Preferably these louvres open inward in a direction opposite to the axial direction of the dust laden gas, i.e. in the direction towards the central outlet tube for the purified gas.

Preferably these louvres are also arranged

Dyson Ex1020
Page 899

helically on their tube, their helix being of the opposite hand to the swirl of the dust laden gas.

In order that the invention may be better understood, an embodiment of it will now be described by way of example with reference to the accompanying drawing, in which :—

Fig. 1 is a longitudinal section of the outer tube, central tube and discharge chamber with the louvred tube shown in elevation.

Fig. 2 is a longitudinal part view showing a section of the louvred tube and " iris " plate only.

Fig. 3 is a perspective view of the " iris " plate on a larger scale.

Dust laden gases enter the outer tube 1 through swirl vanes 2*a* which impart to them a rotary motion as they pass along the outer tube 1. Centrifugal action consequently throws the dust particles which are much heavier than the gas against the wall of the outer tube 1. When meeting the " iris " plate 10 the swirling dust particles and the part of the gas heavily concentrated with them passes through the slightly upturned flaps or " razor blades " 12 into the dust discharge chamber 4, whereas the purified inner gas stream while maintaining its swirl reverses its axial direction and leaves the separator through the central outlet tube 3.

The gas having entered the dust discharge chamber 4 meets the louvres 13 in the louvred inner tube 9 transversely, and changes its axial direction by being deflected by these louvres as indicated in Fig. 2. This gas flows through the central aperture 11 of the " iris " plate 10 and joins the main purified gas stream leaving through the central outlet tube 3.

The dust particles, however, being much heavier than the gas, are unable to execute the turn through the louvres 13 of the tube 9 and are confined to the space between the discharge chamber 4 and the louvred tube 9.

The dust is eventually discharged tangentially from the chamber 4 through a tube 7. The louvred inner tube 9 is closed at its end opposite the aperture 11 by a blanking plate 8, to prevent recirculation of the dust particles.

It will be seen that in the present embodiment both the discharge chamber 4 and the louvred tube 9 are of frusto-conical shape with approximately the same virtual apex. This arrangement causes the vortex movement of the gas to be maintained towards the narrow end of the louvred tube 9, whereby the separating effect of the louvres 13 is maintained substantially over the full length thereof.

Instead of using a discharge chamber 4 and louvred tube 9 having the same virtual apex, these two components may be constructed to have, e.g. the same aperture angle.

L. B. SHUFFREY,
Agent for the Applicants.

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Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.

Dyson Ex1020
Page 900

700,791 PROVISIONAL SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

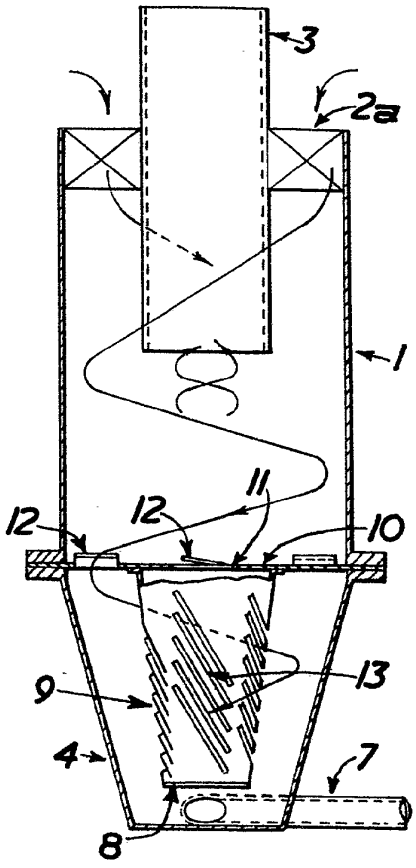


FIG. 1.

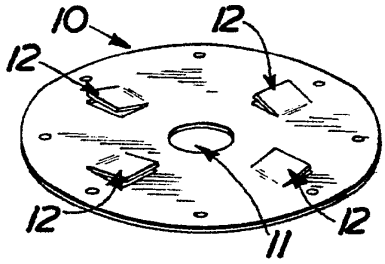


FIG. 3.

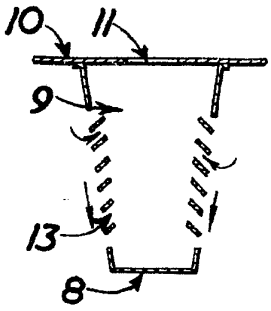


FIG. 2.

D1

(19) BUNDESREPUBLIK DEUTSCHLAND

DEUTSCHES PATENTAMT

(12) Gebrauchsmuster U1

(11) Rollennummer G 92 16 071.9

(51) Hauptklasse A47L 9/10

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(54) Bezeichnung des Gegenstandes
Staubsauger mit kegelstumpfförmigem Einsatzring

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19 679 S/rbi

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Staubsauger mit kegelstumpfförmigem Einsatzring

Die Erfindung betrifft einen Staubsauger mit einem kegelstumpfförmigen Einsatzring, der sich in der Gebrauchslage des Staubsaugers von oben nach unten verjüngt und zum Führen von Staub oder anderen angesaugten Stoffen nach unten in einen Staubbehälter dient.

Ein derartiger Einsatzring ist bei herkömmlichen Staubsaugern oberhalb eines zum Staubsaugergehäuse gehörenden und von diesem lösbar angeordneten Staubbehälters angeordnet. Der Einsatzring dient dazu, Staub nach unten zu leiten und auch dazu, das Aufwirbeln von Staub im Staubbehälter zu verhindern oder zu reduzieren. Vor allem bei Zyklonstaubsaugern wird durch den Einsatzring ein Mitwirbeln des Staubes nach oben an den Filter vermieden. Durch die Turbulenzen bei derartigen Staubsaugertypen würde nämlich sonst die Gefahr bestehen, daß der Filter zugemacht wird. Sofern der Staubbehälter vom übrigen Gehäuse gelöst wird, um den Inhalt

durch Umkippen z.B. in einen Müllsack oder einen anderen Abfallbehälter zu entleeren, bleibt ein Großteil des Staubes in dem im Querschnitt dreieckigen Ringraum zwischen den Einsatzring und der Wandung des Staubbehälters zurück, so daß also eine vollständige Entleerung nicht möglich ist.

Der Erfindung liegt die Aufgabe zugrunde, einen Staubsauger der genannten Art so auszubilden, daß ein möglichst vollständiges Entleeren des Staubbehälters möglich und dies auch erleichtert wird.

Diese Aufgabe wird gemäß der Erfindung durch einen im Bereich zwischen seinen Enden wenigstens teilweise derart flexiblen Einsatzring dadurch erfüllt, daß er umstülpbar ist. Man kann diesen Einsatzring entweder von Hand umstülpen oder ihn so gestalten, daß er sich beim Drehen um 180° um eine Horizontalachse ausgehend von der Gebrauchslage selbsttätig umstülpt, wobei der verjüngte Teil wieder nach unten gelangt.

Wird der Staubbehälter vom übrigen Gehäuse gelöst und umgestülpt, um den Inhalt zu entleeren, so stülpt sich der Einsatzring ebenfalls um und bildet dadurch für den Ausschüttvorgang einen Trichter, der es in vorteilhafter Weise erlaubt, den Staubbehälter restlos zu entleeren und dabei seinen Inhalt sogar in Aufnahmebehälter einzufüllen, deren oberer Rand einen geringeren Durchmesser aufweist als der obere Rand des Staubbehälters. Wird nach dem Entleeren der Staubbehälter wieder in seine Gebrauchslage, in der sein offenes Ende nach oben zeigt, gebracht, so stülpt sich der

Einsatzring wieder in seine ursprüngliche Form um, in der das verjüngte Ende wiederum nach unten weist.

Um den Umstülpvorgang besonders sicher zu gestalten, kann es zweckmäßig sein, gemäß einer Ausführungsform das verjüngte Ende des Einsatzrings zu beschweren. Dies kann gemäß einer Ausführungsform der Erfindung dadurch geschehen, daß das verjüngte Ende ringförmig versteift ist. Dadurch bildet sich auch eine in ihrer Form nahezu unveränderliche Schüttkante. Die Beschwerung kann auch unabhängig von dem Versteifungsring vorgesehen sein. Bei einer weiteren zweckmäßigen Ausführungsform können mehrere Zentrierringe kaskadenförmig angeordnet sein.

Die einzige Figur zeigt einen oben abgebrochenen Längsschnitt durch einen Staubsauger mit unten angeordnetem Staubbehälter.

Der Staubsauger 1 weist ein nicht dargestelltes Motorgehäuseteil auf, in dem ein Antriebsmotor und ein Gebläse untergebracht sind. An einem Sauganschluß 5 kann ein Saugschlauch angeschlossen werden. Die angesaugten Stoffe fallen nach unten in einen lösbar verbundenen Staubbehälter 10, der nicht vom Saugluftstrom durchsetzt wird. Der Staubsauger arbeitet nach dem Zyklonprinzip.

Im oberen Endbereich des im wesentlichen kreiszylindrisch ausgebildeten Staubbehälters 10 ist ein Einsatzring 12 lösbar befestigt. Der Einsatzring 12 ist im wesentlichen kegelstumpfförmig mit einem in der Zeichnung oberen weiten Ende und einem unteren engeren Ende und besteht im Beispiel aus einem sehr flexiblen

Elastomer. Das untere Ende ist durch eine ringförmige Verdickung oder Verstärkung 14, die einstückig mit dem übrigen Einsatzring 12 im Spritzgieß-Verfahren hergestellt ist, versteift und beschwert, so daß diese ringförmige Verstärkung 14 durch Schwerkraftwirkung bestrebt ist, immer die tiefstmögliche Lage einzunehmen. Das obere weite Ende des Einsatzrings 12 ist ebenfalls in seinem Randbereich durch einen Ring 16, der angespritzt ist, verdickt, und in diesen ringförmigen Bereich 16 ist ein ringförmiger Metallring 18 eingespritzt, der das lösbare Befestigen des Einsatzrings 12 im oberen Teil des Staubbehälters 10 erlaubt, wobei der ringförmige Bereich 16 durch den Metallring 18 nach außen gedrückt wird und somit eine kräftige reibungsschlüssige Anlage an der Innenseite des Staubbehälters 10 bewirkt wird. Beim Einsetzen des Einsatzrings 12 sorgt eine an der Innenseite des Staubbehälters 10 vorhandene Ringschulter 20 dafür, daß der Einsatzring 12 eine definierte Lage einnimmt und nicht zu weit nach unten ins Innere des Staubbehälters 10 hineingedrückt werden kann.

Zum Entleeren des Staubbehälters 10 wird das Motorgehäuse nach Lösen von entsprechenden Verbindungselementen vom Staubbehälters 10 abgehoben, und der Staubbehälter 10 wird umgestülpt. Dabei gelangt die ringförmige Verstärkung 14 wegen der leichten Verformbarkeit des Bereichs zwischen den Verstärkungsringen 14 wiederum nach unten und bildet dabei einen Ausschüttrichter, der es gestattet, den Inhalt des Staubbehälters 10 restlos zu entleeren. Wird der Staubbehälter wieder in die in der Figur gezeigte Lage zurückgebracht, so nimmt auch der Einsatzring 12 wieder die in der Figur gezeigte Lage ein.

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Schutzansprüche

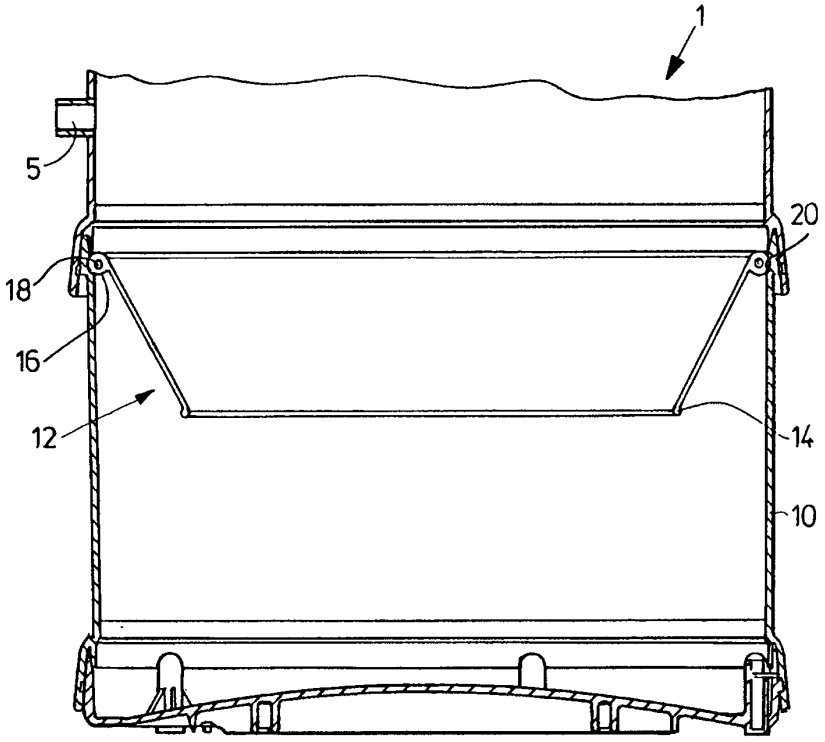
1. Staubsauger mit einem Staubbehälter, der vom übrigen Staubsauger lösbar ist, und mit einem im Staubbehälter angeordneten, kegelstumpfförmigen Einsatzring, der sich in der Gebrauchslage des Staubsaugers von oben nach unten verjüngt und zum Führen von Staub oder anderen angesaugten Stoffen nach unten in einen Staubbehälter dient, gekennzeichnet durch einen mindestens im Bereich zwischen seinen Enden wenigstens teilweise derart flexiblen Einsatzring (12), daß er umstülpbar ist.

2. Staubsauger nach Anspruch 1, dadurch gekennzeichnet, daß sich der Einsatzring (12) beim Drehen um 180° um eine Horizontalachse ausgehend von der Gebrauchslage selbsttätig umstülpt, wobei der verjüngte Teil wieder nach unten gelangt.

3. Staubsauger nach einem oder beiden der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das verjüngte Ende des Einsatzrings (12) beschwert (14) ist.

4. Staubsauger nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das verjüngte Ende des Einsatzrings (12) ringförmig versteift (14) ist.

5. Staubsauger nach einem oder mehreren der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß mehrere Einsatzringe kaskadenförmig angeordnet sind.



19679

19 FEDERAL REPUBLIC OF GERMANY
GERMAN PATENT OFFICE

12 Utility Model U1

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(54) Description of the subject
Vacuum cleaner with truncated cone-shaped insert ring

(71) Name and residence of holder
Electrostar Schöttle GmbH & Co., 7313 Reichenbach, DE

(74) Name and residence of representative
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19 679 S/rbi

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Vacuum Cleaner with Truncated Cone-Shaped Insert Ring

The invention relates to a vacuum cleaner with a truncated cone-shaped insert ring, which in the position of use of the vacuum cleaner tapers from the top toward the bottom and guides the dust or other suctioned substances downwards into a dust container.

In conventional vacuum cleaners, such an insert ring is arranged above a dust container of the vacuum cleaner casing and detachably arranged therefrom. The insert ring conducts dust downwards and also prevents or reduces the dust from whirling up in the dust container. In cyclone vacuum cleaners, in particular, the dust is prevented by the insert ring from being whirled along upwards toward the filter. Due to the turbulence in such types of vacuum cleaners, the filter could shut. If the dust container is released from the remaining casing in order to empty the contents by tipping it over a garbage bag or another waste container, much of the

Dyson Ex1020
Page 911

dust remains in the annulus, which is triangular in cross-section, between the insert ring and the wall of the dust container, thereby making it impossible to empty [it] completely.

The task of the present invention is to design a vacuum cleaner of the type mentioned, in such a way that the dust container is emptied as completely as possible and that it is easy to do so.

This task is at least partially fulfilled according to the present invention by an insert ring, in the region between its ends, which is flexible such that it can be turned inside out. This insert ring may be turned inside out manually or it can be created such that it automatically turns inside out when turned 180 degrees around a horizontal axis radiant from the position of use, whereby the tapered part again reaches downwards.

If the dust container is detached from the remaining casing and turned inside out in order to empty the contents, the insert ring likewise turns inside out and, as a result, forms a funnel for the emptying process, which advantageously allows it to empty the dust container without any remainder, and in the process, even pour its contents into a receptacle whose upper edge exhibits a diameter smaller than the upper edge of the dust container. If after being emptied, the dust container is brought back to its position of use, in which its open end is upwards, the insert

Dyson Ex1020
Page 912

ring inverts back to its original shape in which the tapered end again points downwards.

In order to make the process of turning it inside out particularly secure, it may be expedient, in accordance with an embodiment, to weigh down the tapered end of the insert ring. In accordance with an embodiment of the present invention, this may be done by stiffening the tapered end in a ring-shaped manner. This forms a hopper almost unalterable in its shape. The weighing down may also be provided irrespective of the stiffening ring. In another expedient form of embodiment, several eccentric rings may be arranged in cascade.

The only figure shows a longitudinal section, broken off above, through a vacuum cleaner with a dust container arranged below.

Vacuum cleaner 1 exhibits a motor casing part, not illustrated, in which a drive motor and a blower are arranged. A suction hose may be connected to a suction connection 5. The suctioned substances fall downward into a detachably attached dust container 10, which is not permeated with the stream of suction air. The vacuum cleaner works according to the cyclone principle.

An insert ring 12 is detachable fastened in the upper end region of the essentially circular-cylindrical dust container 10. The insert ring 12 is essentially truncated

Dyson Ex1020
Page 913

cone-shaped with an upper wide end and a lower, narrower end in the drawing, and in the example, is made from a very flexible elastomer. The lower end is stiffened and weighted by a ring-shaped thickening or reinforcement 14, which is manufactured in one piece with the remaining insert ring 12 in a die-cast process, such that this ring-shaped reinforcement 14 strives, due to the force of gravity, to always occupy the lowest possible position. The upper wide end of the insert ring 12 is likewise thickened at its edge by a ring 16, which is injection-moulded, and injected into this ring-shaped region 16 is a ring-shaped metal ring 18, which allows the detachable fastening of the insert ring 12 in the upper part of the dust container 10, whereby the ring-shaped region 16 is pressed outward by the metal ring 18 and consequently causes a powerful frictional system on the interior of the dust container 10. When applying the insert ring 12, an annular shoulder 20 on the interior of the dust container 10 ensures that the insert ring 12 occupies a defined position and cannot be inserted too far downward into the interior of the dust container 10.

To empty the dust container 10, the motor casing is lifted from the dust container 10 after being detached from the corresponding connecting elements, and the dust container 10 is turned inside out. In the process, because the region between the stiffening rings 14 is easily deformed, the ring-shaped stiffening 14 again goes downwards and in the process forms an emptying funnel that allows it to empty the contents of the dust container 10 without any remainder. If the dust container

Dyson Ex1020
Page 914

is once again brought back into the position shown in the figure, the insert ring 12 again also takes up the position shown in the figure.

Dyson Ex1020
Page 915

Protective Claims

1. A vacuum cleaner having a dust container, which is detachable from the remaining vacuum cleaner, and having a truncated, cone-shaped insert ring arranged in the dust container, which in the position of use of the vacuum cleaner tapers from the top toward the bottom and guides the dust or other suctioned substances downwards into a dust container, characterized by an insert ring (12) at least partially flexible at least in the region between its ends, such that it can be turned inside out.

2. The vacuum cleaner as recited in Claim 1, characterized in that the insert ring (12), when turned by 180 degrees around a horizontal axis radiant from the position of use, automatically turns inside out, whereby the tapered part again reaches downwards.

3. The vacuum cleaner as recited in one or both of the preceding claims, characterized in that the tapered end of the insert ring (12) is weighted (14).

Dyson Ex1020
Page 916

4. The vacuum cleaner as recited in one of the preceding claims, characterized in that the tapered end of the insert ring (12) is stiffened in a ring-shaped manner.

5. The vacuum cleaner as recited in one or several of the preceding claims, characterized in that several insert rings are arranged in cascade.

Dyson Ex1020
Page 917

1,111,074

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,111,074

Date of Application and filing Complete Specification: 29 April, 1966.
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Application made in Germany (No. S96824 Ic/34c) on 29 April, 1965.
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Complete Specification Published: 24 April, 1968.
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Index at acceptance: —A4 F(11A3A3, 12D, 12J)
Int. Cl.: —A 47 l 5/00

COMPLETE SPECIFICATION

Improvements in or relating to a Vacuum Cleaner

We, SIEMENS-ELECTROGERÄTE GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, formerly Siemens-Electrogerate Aktiengesellschaft, a German Company of Berlin and Munich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to vacuum cleaners.

According to the present invention there is provided a vacuum cleaner having a cylindrical flow chamber provided with opposed end walls, one of these end walls being closed apart from an air intake pipe that opens into the chamber through this end wall and the other of these end walls being closed apart from a suction duct that passes therethrough, said pipe being directed at an acute angle relative to the longitudinal axis of the chamber and tangentially relative to the curved wall of the chamber, and said suction duct being disposed coaxially in the flow chamber and surrounding a suction fan.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawing, in which:

Figure 1 is a diagrammatical side view, taken in section, of a first form of vacuum cleaner, and

Figure 2 is a similar view of a second form of vacuum cleaner,

The vacuum cleaner shown in Figure 1 has a cylindrical flow chamber 1 which has end walls 2 and 3. The end wall 2 is closed apart from an intake or inlet duct 4 that opens into the wall 2. This duct 4 is inclined at an acute angle to the longitudinal axis of the chamber 1, and is directed tangentially relatively to the curved wall of the chamber. The end wall 3 is also closed apart from a suction duct 5 that is disposed centrally in the flow chamber 1, and which is formed by a hollow cylinder that passes through the wall 3. The duct 5 contains a fan 6. At its end projecting into the flow chamber 1, the suction duct 5 has a tubular extension 7 whose internal diameter is smaller than that of the suction duct 5 and whose external surface is shaped in the manner of an annular ring or swelling 8. Opposite the free end of the extension 7 there is secured, on the internal side of the end wall 2, a hollow stub cylinder 9 into which the free end of the extension 7 is entered, said end being closed by a replaceable filter 10, preferably a fine filter. Disposed at the place where the suction duct 5 is connected to the extension 7, is a disc-shaped baffle 11 which sub-divides the flow chamber 1 into two compartments 13 and 14 communicating with one another through an annular gap 12.

The end of the suction duct 5 which passes through the wall 3 of the flow chamber 1, is secured on a base plate 15 in such a manner that there is formed between the end wall 3 and the base plate 15, a gap 16 into which apertures 17, formed in the suction duct 5 open. To facilitate the movement of the vacuum cleaner, the base plate 15 is provided with rollers or wheels 18.

In operation, the air flow, mixed with dust, which is drawn in by the fan 6 through the intake duct 4 into the flow chamber 1 forms, owing to the positioning of the intake duct 4, a helical flow or vortex which progresses, *via* the annular gap 12, towards the lower end wall 3 and, in the region of the wall 3, reverses and forms an upwardly directed helical flow concentric with the descending flow.

In the mixing zone between the descend-

[*Price 4s. 6d.*]

Dyson Ex1020
Page 918

ing flow system and the ascending flow system moving concentrically therewith, the dust carried by the in-drawn air is separated-out and descends into the lower region of the chamber compartment 13. The baffle 11 deflects the ascending helical flow outwardly so that in the region of the annular gap 12 the two flows which are moving in opposite directions to one another, but rotating in the same sense, are brought into intensive contact. In this region of the flow chamber, dust residues which have not been separated-out in the mixed flow system in the region of the chamber compartment 13 are taken-up by the descending flow and re-introduced into the separating process. Besides the helical flow entering the lower chamber compartment 13, which flow includes the main proportion of the indrawn air, there forms in the upper compartment 14 a further helical flow which is formed by air quantities which fan out from the general flow direction as "stray" flow veins on entering the flow chamber. This is so because the external surface shape of the swelling 8 produces a vortex, downstream of the main helical flow, in which the residual dust is separated-out. This vortex also takes-up the flow components which divide from the helical flow on entry into the flow chamber and whose dust content would escape without the provision of the downstream vortex. The effect of this annular swelling is augmented by the hollow cylinder 9. The dust contained in this flow is separated-out in the region of the annular swelling 8 so that the filter 10 closing the extension 7 is merely used to provide complete reliability, since the air drawn from the flow chamber 1 by the fan 6 is already substantially free of dust before the filter 10. The purified discharge air is blown out through apertures 17 into the gap 16 between the end wall 3 and the base plate 15. Since the blown-out air is distributed over the entire cross-section of the gap 16, its flow speed at the gap outlet is very low.

The second form shown in Figure 2 has similarities with the first embodiment and corresponding parts are designated by the same reference numerals. However, the second embodiment differs from the first embodiment described in that the flow chamber 1 is secured releasably to the base plate 15. For this purpose, annular grooves 19 and 20 are provided on a fan casing 6A and the suction duct 5, and a sealing ring 21 is inserted in these grooves. The fan casing 6A contains a fan (not shown) corresponding to the fan 6 described above. By means of a handle 22 the flow chamber 1 can be removed, from the base plate 15 and the fan casing 6A which is connected rigidly thereto, by overcoming the retaining action of the sealing ring 21. When the flow chamber 1 has been lifted-off, it can be carried as a closed dust container to a suitable place of emptying, such as a dustbin. The end wall or bottom 3 is mounted on the side wall so as to be pivotable about a hinge 23, in order to empty the flow chamber 1. At the opposite side from the hinge 23 there is provided at the other side of the flow chamber 1 a locking rod 24 with which a guide 25 and an operating handle 26 are coupled. By means of the locking rod 24, the bottom 3 of the flow chamber 1 can be opened and closed again by operating the handle 26. The flow chamber 1 is replaced on the base plate 15 after emptying, the sealing 21 locking into the annular grooves 19 and 20 and thus fixing the flow chamber 1 in position. The vacuum cleaner is then ready for operation again.

In a modification of the above the bottom 3 can be of multi-part construction, in which case only some, or all of the parts may be hinged.

WHAT WE CLAIM IS:—

1. A vacuum cleaner having a cylindrical flow chamber provided with opposed end walls, one of these end walls being closed apart from an air intake pipe that opens into the chamber through this end wall and the other of these end walls being closed apart from a suction duct that passes therethrough; said pipe being directed at an acute angle relative to the longitudinal axis of the chamber and tangentially relative to the curved wall of the chamber, and said suction duct being disposed coaxially in the flow chamber and surrounding a suction fan.

2. A vacuum cleaner as claimed in claim 1, wherein in the flow chamber, at an end of the suction duct remote from said other end wall of the flow chamber, a disc-shaped baffle is arranged extending transversely of the longitudinal axis of the chamber and sub-dividing the flow chamber into two compartments communicating with one another through an annular gap.

3. A vacuum cleaner as claimed in claim 1 or 2, wherein an end of the suction duct which projects beyond said other end wall of the flow chamber is so connected to a base plate that a gap is formed between this wall and the base plate.

4. A vacuum cleaner as claimed in claim 3, wherein the suction duct is closed by the base plate and apertures are formed in a wall of the duct, which apertures are arranged in the gap between the base plate and the flow chamber.

5. A vacuum cleaner as claimed in claim 3 or 4, wherein the base plate is movable over the ground on runners or rollers mounted on the base plate.

6. A vacuum cleaner as claimed in claim 1 or 2, wherein the flow chamber is con-

Dyson Ex1020
Page 919

nected releasably to a base plate and a casing of the suction fan.

7. A vacuum cleaner as claimed in claim 6 when appendant to claim 2, wherein between the fan casing and the wall of the suction duct a sealing ring is arranged.

8. A vacuum cleaner as claimed in claim 7, wherein the sealing ring engages in annular grooves in the fan casing and in the wall of the suction duct.

9. A vacuum cleaner as claimed in claim 2 or any one of claims 3 to 5 when appendant to claim 2, wherein a replaceable protective filter is arranged in the region of the baffle.

10. A vacuum cleaner as claimed in any one of claims 6 to 8, wherein said other end wall is hingedly mounted and is adapted to be locked in a position to close the flow chamber.

11. A vacuum cleaner as claimed in claim 10, wherein said other end wall is of multi-part construction, at least one of these parts being hinged and being adapted to be locked in said position to close the flow chamber.

12. A vacuum cleaner substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1

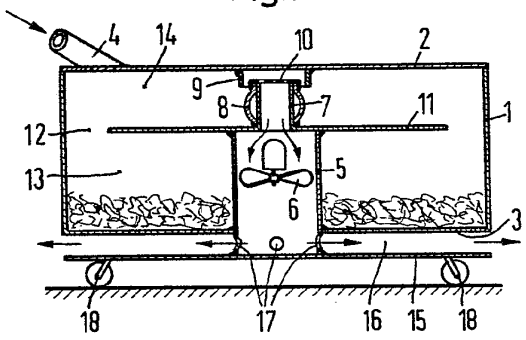
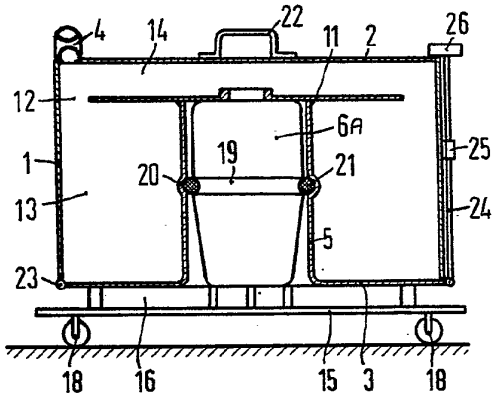


Fig.2



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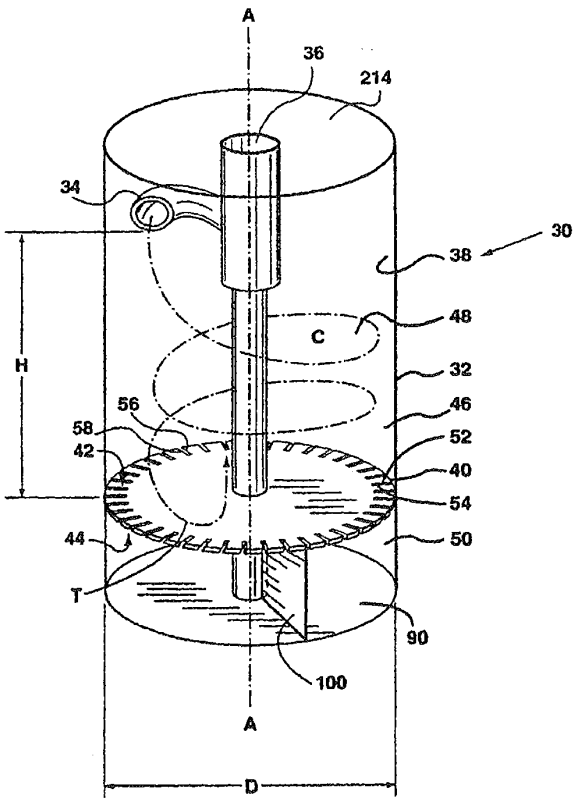
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(54) Title: APPARATUS AND METHOD FOR SEPARATING PARTICLES FROM A CYCLONIC FLUID FLOW



(57) Abstract: A particle separation member (40) is provided for use with a cyclone separator (30). The particle separation member (40) divides the separator (30) into a cyclone chamber (46) and a particle receiving chamber (50). The cyclone chamber (46) and the particle receiving chamber (50) communicating via a plurality of apertures (52) in the particle separation member (40).

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Title: APPARATUS AND METHOD FOR SEPARATING PARTICLES FROM A CYCLONIC FLUID FLOW

FIELD OF THE INVENTION

The present invention relates generally to cyclonic separators. In one particular application, the invention relates to the cyclonic separation of particulate material from an air flow. In a preferred embodiment, the cyclonic separator is used in a vacuum cleaner to remove entrained particulate matter from an air stream.

BACKGROUND OF THE INVENTION

The use of a cyclone, or multiple cyclones connected in parallel or series, has long been known to be advantageous in the separation of particulate matter from a fluid stream. Typically, a relatively high speed fluid stream is introduced tangentially to a generally cylindrical or frusto-conical container, wherein the dirty air stream is accelerated around the inner periphery of the container. The centrifugal acceleration caused by the travel of the fluid in a cyclonic stream through the cyclone causes the particulate matter to be disentrained from the fluid flow and, eg., to collect at the bottom of the container. A fluid outlet is provided for the extraction of the fluid from the centre of the top of the cyclone container, as is well known in the art.

A typical flow path in a cyclone separator is as follows. Fluid to be treated is introduced tangentially at a fluid inlet located at an upper end of the cyclone container. The fluid stream rotates around the inner surface of the cyclone container, and spirals generally downwardly around the inner surface of the container (if the cyclone container is vertically disposed). At a bottom end of the cyclone container the fluid stream travels radially inwardly, generally along the bottom of the container and then turns upwardly and proceeds vertically up and out of the cyclone container. The particulate matter separating action of the cyclonic flow occurs substantially around the inner surface of the container. Once the fluid moves inwardly to the centre of the container, and upwardly there through, there is little or no dirt separation achieved.

The difficulty experienced with prior art cyclonic separators is the reentrainment of the deposited particles back into the outgoing fluid flow. Deposited particles exposed to a high speed cyclonic flow thereover have a tendency to be reentrained. This is particularly problematic when the container has a solid bottom portion in which the dirt collects. However, there is a potential reentrainment problem even if the bottom of the container has a passageway provided in the bottom thereof to convey the separated particulate material away from the container.

If a high degree of separation is required, it is known to connect a plurality of cyclones in series. While using several cyclones in series can provide the required separation efficiency, it has several problems. First, if the separators are to be used in industry, they generally need to accommodate a high flow rate (eg. if they are to be used to treat flue gas). The use of a plurality of cyclones increases the capital cost and the time required to manufacture and install the separators. Further, the use of a plurality of cyclones increases the space requirements to house the cyclones as well as the back pressure caused by the air flow through the cyclones. These latter issues are particularly acute for cyclone separators which are to be contained in a small housing, such as a vacuum cleaner. Accordingly, there is a need for an improved anti-reentrainment means for cyclonic separators.

SUMMARY OF THE INVENTION

In has now been discovered that a single cyclone having improved efficiency (eg. up to 99.9% efficiency) may be manufactured by positioning in the cyclone chamber a particle separation member for creating a dead air space beneath the cyclonic flow region of the cyclone chamber wherein the dead air space is in communication with the cyclonic flow region by a plurality of openings or apertures in the member. This construction effectively traps separated material beneath the cyclonic flow region and inhibits the reentrainment of the separated material. Thus, a single cyclone may be used in place of a plurality of cyclones to achieve the same separation efficiency.

As the fluid flow travels through the cyclone chamber, a boundary layer forms. Generally, the interior surface of a cyclonic chamber is smooth so as to provide for an uninterrupted cyclonic flow in the chamber. However, in the chamber, a boundary layer is still formed on all surfaces over which the fluid passes. According to the instant invention, the system (i.e. the motor means to move the fluid through the chamber, the fluid inlet to the chamber, the fluid outlet to the chamber and/or the construction of the separation member) is designed to minimize the thickness of the boundary layer in the vicinity of the apertures in the separation member.

In particular, as the fluid travels over the upper surface of the particle separation member, a boundary flow layer will form. The boundary layer will thicken until a thickness is reached at which the boundary layer has sufficient energy to break off and travel away from the upper surface. Generally at this point, the fluid travels upwardly to the fluid outlet from the cyclone. When the boundary layer breaks off from the upper surface, vortices are formed in the fluid stream adjacent the apertures in the separation member causing localized turbulence. The turbulent flow reentrains particles that had been separated from the fluid flow and may even pull some of the separated particles out of the dead air space beneath the cyclonic flow region of the cyclone chamber.

In accordance with the instant invention, there is provided a separator for separating entrained particles from a fluid flow, the separator comprising a cyclone chamber an outer wall and a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion, a fluid inlet for introducing a cyclonic fluid flow to the cyclonic flow region, a fluid outlet for removing the fluid flow from the cyclone chamber, a particle separating member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separating member having a plurality of apertures, and a particle receiving chamber disposed beneath the particle separating member for receiving particles passing into the particle receiving chamber through the

apertures wherein the apertures are disposed on the particle separating member such that the medial portion of the cyclonic flow region is substantially free from said apertures.

The separator may be used in an upright vacuum cleaner. Accordingly, the separator may further comprise a cleaner head adapted for movement over a floor and having a fluid nozzle positionable adjacent the floor, the nozzle in fluid flow communication via a passageway with the separator fluid inlet, a handle for moving the cleaner head over the floor, and a casing for housing the cyclone chamber. The casing is preferably pivotally mounted to the cleaner head. The separator may be used in a canister or a central vacuum cleaner. Accordingly, the passageway may further comprise a flexible portion that is positioned external of the cleaner head and the casing and the handle is affixed to the cleaner head.

In one embodiment, the apertures are sized to inhibit elongate particles from passing there through, whereby elongate particles collect on top of the particle separating member.

In another embodiment, the apertures are shaped to aerodynamically direct particles from the cyclonic flow region into the particle receiving chamber.

The particle separating member may extend under all of the cyclonic flow region to define bottom surface of the cyclonic flow region. Alternately, it may extend only under that portion of the cyclonic flow region in which the apertures are to be provided. For example, the particle separating member may extend essentially under only the outer peripheral portion, the inner portion or both the peripheral and inner portions of the cyclonic flow region.

In accordance with the instant invention, there is also provided a separator for separating entrained particles from a fluid flow, the separator comprising a cyclone chamber for containing a cyclonic flow in a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion, means for introducing a

fluid flow to the cyclone flow region for cyclonic rotation therein, means for removing the fluid flow from the cyclone chamber, particle receiving means disposed beneath the cyclone flow region for receiving particles separated from the fluid flow, separation means for dividing the particle receiving means from the cyclone chamber, and transporting means associated with the separation means for connecting the particle receiving means in flow communication with the cyclonic flow region such that, in operation, particles pass through the transporting means to the particle receiving means wherein said transporting means are positioned outside the medial portion of the cyclonic flow region.

In one embodiment, the particle receiving means comprises a sealed chamber except for the transporting means and the separator further comprises emptying means for emptying the particle receiving means.

In another embodiment, the separator further comprises means for connecting the particle receiving means in flow communication with a conduit for transporting separated particles downstream from the particle receiving means.

In another embodiment, the separator further comprises aerodynamic means associated with the transporting means for directing particles from the cyclonic flow region into the particle receiving means.

In another embodiment, the particle separating means extends under all of the cyclonic flow region to define bottom surface of the cyclonic flow region.

In another embodiment, the transporting means are positioned beneath only one or both of the peripheral and inner portions of the cyclonic flow region.

In another embodiment, the transporting means are distributed regularly around the separating means.

In another embodiment, the fluid contacts only a portion of the separating means and the transporting means are positioned only in said portion.

In another embodiment, the transporting means comprise openings in the separation means.

In accordance with the instant invention, there is also provided a method for separating entrained particles from a fluid flow, the method comprising the steps of introducing a fluid to flow cyclonically in a chamber having a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion, removing particles from the fluid flow in the cyclone chamber via passages provided beneath one or both of the peripheral and inner portions, and removing the fluid flow from the chamber.

In one embodiment, the method further comprises the steps of storing the particles removed from the fluid flow and inverting the chamber to remove the separated particles.

In another embodiment, the method further comprises the step of transporting separated particles downstream from the chamber.

In another embodiment, the separator comprises the dirt separation mechanism for a vacuum cleaner and the method further comprises passing a cleaning head over a surface to clean the surface.

In another embodiment, the method further comprises directing particles to pass into the passages.

In another embodiment of the instant invention, the cyclonic separator is constructed to minimize the thickness of the boundary layer when it breaks off thereby reducing turbulent flow in the vicinity of the apertures. This may be achieved by varying one or more of the number of apertures in the particle separation member, the length of the apertures, the width of the apertures, the included angle between the upstream edge of the apertures and the upper surface of the particle separation member, the included angle between the downstream edge of the apertures and the upper surface of the particle separation member, and the position of a baffle beneath the particle separation member with respect to the point at which the cyclonic air flow changes direction at the bottom of the cyclone chamber. The

actual design of the system will changes in the size of the cyclone chamber, the velocity of the fluid flow in the cyclone chamber and the viscosity of the fluid flow in the cyclone chamber.

In another embodiment, the flow of the fluid itself may be modified to minimize the thickness of the boundary layer when it breaks off. For example, the fluid flow may be pulsed with the frequency of the pulses set to reduce the maximum thickness of the boundary layer. By pulsing the fluid flow, the fluid flow is cyclically accelerated and decelerated. This cycling is set to encourage the boundary layer to break off when it is thinner than when the fluid flow is not pulsed. The acceleration after the deceleration provides sufficient energy to cause the boundary layer to delaminate sooner than it would in a constant flow regime thereby reducing turbulent flow in the vicinity of the apertures. This pulsed flow may be achieved in several ways such as by sending a pulsed electrical signal to the fluid pump which produces the fluid flow through the cyclone chamber, by pulsing the fluid as it passes through the cyclone air inlet (eg. the inlet may have an aperture that may be cyclically opened and closed at produce the pulsed flow), by pulsing the fluid as it passes through the cyclone air outlet (eg. the outlet may have an aperture that may be cyclically opened and closed at produce the pulsed flow), or by rotating the particle separation member in its plane (eg. by mounting the particle separation member with a spring biasing means so that the particle separation member will cyclically rotate clockwise and then counter clockwise).

The prior art teaches the need for a plurality of cyclones in order achieve ultra-high particle separation efficiencies. However, it has been found that ultra-high efficiencies can be obtained in a single stage cyclone incorporating the particle separation member of the present invention. Accordingly, cleaning efficiencies in excess of 99% may be obtained with a single stage separator utilizing a separator according to the present invention, thereby negating the need for second stage cyclonic separation altogether. Cleaning efficiencies of over 99.5% have also been achieved for particle laden air streams.

In accordance with this aspect of the instant invention, there is provided a separator for separating entrained particles from a fluid flow, the separator comprising a separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a fluid inlet for introducing a cyclonic fluid flow to the cyclonic flow region;

(c) a fluid outlet for removing the fluid flow from the cyclone chamber;

(d) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures; and,

(e) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures

wherein the separator is constructed to reduce turbulent fluid flow in the vicinity of the apertures.

In accordance with the instant invention, there is also provided a separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber for containing a cyclonic flow in a cyclonic flow region;

(b) fluid entry means for introducing a fluid flow to the cyclone flow region for cyclonic rotation therein;

(c) fluid exit means for removing the fluid flow from the cyclone chamber;

(d) fluid pump means for causing fluid flow through the cyclone chamber;

(e) particle receiving means disposed beneath the cyclone flow region for receiving particles separated from the fluid flow;

(f) separation means for dividing the particle receiving means from the cyclone chamber;

(g) transporting means associated with the separation means for connecting the particle receiving means in flow communication with the cyclonic flow region such that, in operation, a boundary layer flow of fluid develops over the separation means and the particles disentrained from the fluid flow pass through the transporting means to the particle receiving means; and,

(h) means for reducing the thickness of the boundary layer of fluid as it travels over the separation means.

In one embodiment, the means for reducing the thickness of the boundary layer comprises means for pulsing the fluid flow through the cyclone chamber. The means for pulsing the fluid flow through the cyclone chamber may comprise means for pulsing an electrical signal to the fluid pump means. Alternately, or in addition, the means for pulsing the fluid flow through the cyclone chamber may comprise means pulsing for cyclically opening and closing one of the fluid entry means and the fluid exit means.

In another embodiment, the means for reducing the thickness of the boundary layer comprises constructing and positioning the transporting means to reduce turbulent fluid flow over the separation means.

In another embodiment, the means for reducing the thickness of the boundary layer comprises constructing and positioning flow disruption means beneath the separating means for disrupting cyclonic fluid flow in the particle receiving means.

In another embodiment, the particle receiving means comprises a sealed chamber except for the transporting means and the separator further comprises emptying means for emptying the particle receiving means.

In accordance with the instant invention, there is also provided a method for separating entrained particles from a fluid flow, the method comprising the steps of:

(a) introducing a fluid to flow cyclonically in a chamber having a cyclonic flow region and a particle separation member positioned in the cyclone chamber to define a particle receiving chamber;

(b) adjusting the back pressure in the chamber to promote the formation of a laminar boundary layer adjacent the particle separation member;

(c) removing particles from the fluid flow in the cyclone chamber via passages provided in the particle separation member; and,

(d) removing the fluid flow from the chamber.

In one embodiment, the method further comprises the steps of storing the particles removed from the fluid flow and inverting the chamber to remove the separated particles.

In another embodiment, the particle separation member is constructed and positioned to reduce turbulent fluid flow over the particle separation member in the vicinity of the passages and the method further comprises passing the fluid flow over the particle separation member during operation of the chamber.

In another embodiment, the chamber further comprises further comprising flow disruption means which is constructed and positioned beneath the separating means for disrupting cyclonic fluid flow in the particle receiving chamber to reduce turbulent fluid flow over the particle separation member in the vicinity of the passages and the method further comprises passing the fluid flow over the particle separation member during operation of the chamber.

In accordance with the instant invention, there is also provided a vacuum cleaner comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a fluid inlet for introducing a cyclonic fluid flow to the cyclonic flow region;

(c) a cleaner head adapted for movement over a surface and having a fluid nozzle positionable adjacent the surface, the nozzle in fluid flow communication via a passageway with the fluid inlet;

(d) a fluid outlet for removing the fluid flow from the cyclone chamber;

(e) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures; and,

(f) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures,

wherein the separator is constructed to reduce turbulent fluid flow in the vicinity of the apertures.

In accordance with the instant invention, there is also provided a vacuum cleaner comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a air inlet for introducing a cyclonic air flow to the cyclonic flow region;

(c) a cleaner head adapted for movement over a surface and having a air nozzle positionable adjacent the surface, the nozzle in air flow communication via a passageway with the air inlet;

(d) a air outlet for removing the air flow from the cyclone chamber;

(e) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures;

(f) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures; and,

(g) a motor for causing the air to flow through the vacuum cleaner

wherein the air flow through the cyclone chamber is pulsed.

In one embodiment, the vacuum cleaner further comprises a moveable closure member on one of the air inlet and the air outlet for causing a pulsed air flow through the cyclone chamber.

In another embodiment, the motor receives an electrical signal and the electrical signal is pulsed to produce the pulsed air flow.

In accordance with the instant invention, there is also provided a vacuum cleaner comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a air inlet for introducing a cyclonic air flow to the cyclonic flow region;

(c) a cleaner head adapted for movement over a surface and having a air nozzle positionable adjacent the surface, the nozzle in air flow communication via a passageway with the air inlet;

(d) a air outlet for removing the air flow from the cyclone chamber;

(e) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures;

(f) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures; and,

(g) a handle for moving the cleaner head over the floor; and,

(h) a motor for causing the air to flow through the vacuum cleaner

wherein the particle separation member is constructed and adapted to increase the particle separation efficiency of the cyclone chamber.

In one embodiment, the particle separation member has from 5 to 35 apertures.

In another embodiment, the number of apertures in the particle separation member is calculated by the formula:

$$\text{number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of the cyclonic flow region

D= the diameter of the cyclone chamber

In another embodiment, the cyclone chamber has a diameter and each aperture has a longitudinally extending upstream edge and a longitudinally extending downstream edges, relative to the air flow, and transverse sides extending between the edges, the edges have a length which is less than 10% of the diameter of the cyclone chamber and the sides have a length which is 25 - 35% of the length of the edges.

In another embodiment, the edges are substantially radially aligned with the cyclone chamber.

In another embodiment, each aperture has an upstream edge and a downstream edge, relative to the air flow, and the upstream edge is angled towards the particle receiving chamber, the included angle between the upstream edge and the upper surface of the particle separation member is from 15 to 90°.

In another embodiment, each aperture has an upstream edge and a downstream edge, relative to the air flow, and the downstream edge is angled towards the particle receiving chamber, the included angle between the downstream edge and the upper surface of the particle separation member is from 15 to 90°.

In another embodiment, the air flow changes direction and travels to the air outlet at a position as it travels over the particle separation member and the vacuum cleaner further comprising a baffle positioned beneath the particle separation member at a position 10 to 20° downstream of the position at which the air flow changes direction.

In another embodiment, the particle receiving chamber has a bottom to comprise a sealed chamber except for the apertures and the baffle extends between the particle separation member and the bottom of the particle receiving chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made by way of example to the accompanying drawings of a preferred embodiment of the present invention, in which:

Figure 1 is a perspective view of a household vacuum cleaner incorporating a cyclone separator according to the present invention;

Figure 2 is a front elevational view of the vacuum cleaner of Figure 1;

Figure 3 is a side elevational view of the vacuum cleaner of Figure 1;

Figure 4 is a cross-sectional view along the line 4-4 in Figure 1;

Figure 5 is a cut away perspective view of the cyclonic separation member of Figure 1 when removed from the vacuum cleaner;

Figure 6 is a cross-sectional view along the line 6-6 in Figure 2 with the bin removed;

Figure 7 is a cut away perspective view of an alternate embodiment of the cyclonic separation member of Figure 5;

Figures 8 and 9 are cross-sectional views along the line 6-6 in Figure 2 showing alternate configurations of the particle separation member of the present invention;

Figure 10 is an enlarged cross-section view of the particle separator member of the present invention, showing aperture detail;

Figure 11 is a sectional perspective view of the particle separator member having baffle members according to the present invention;

Figure 12 is an enlarged bottom plan view in the direction of arrow 12 of the baffles of Figure 11;

Figures 13 -15 are top plan views of various alternate configurations of the particle separation member of the present invention;

Figure 16 is a sectional side view of an alternate embodiment of the particle separator member of the present invention;

Figure 17 is an isometric view of a further alternate embodiment of the particle separator member of the present invention;

Figure 18 is an isometric view of a further alternate embodiment of the particle separator member of the present invention;

Figure 19 is a sectional perspective view of and alternate embodiment of the baffle members according to the present invention;

Figure 20 is a bottom plan view of the baffle members of Figure 19;

Figure 21 is an enlarged perspective view of the bin of Figure 1 when removed from the vacuum cleaner; and,

Figure 22 is an enlarged perspective view of the access member of Figure 21.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The improvements in cyclonic separators described herein may be used with or in place of cyclonic separation devices of any sort which are used to separate particulate material from a fluid stream. For example, they may be used with a fluid stream consisting of one or more gasses such as industrial dust collection systems (eg. flue gas scrubbing), they may be used to classify particles according to their size or they may be used with a fluid stream consisting of one or more liquids (eg. a hydrocyclone) or with fluid streams comprising a gas/liquid mixture. It will be appreciated that they these cyclone separators may be used in any manner known in the particle separation art.

For example, the separation member according to the present invention may also be employed in the classification and/or sorting of particles by size. Particles to be sorted are entrained in a fluid flow and introduced to a cyclonic separator having a separation member according to the present invention, the separation member having a first aperture size. Particles smaller than the first aperture size are permitted to pass through the separation member and into a hopper for transfer to a subsequent cyclonic separator while larger particles are collected on top of the particle separator.

The particle passing through the separation member are introduced cyclonically to a second cyclone having a separation member with apertures of a second, smaller size, relative to the first cyclone. As in the first cyclone, particles smaller than the second aperture size are permitted to pass through the separation member and into a hopper for transfer to a third cyclonic separator, while larger particle remain on the separation member in the second cyclone chamber. This process is repeated, as required, until the particles are classified as needed.

In one preferred embodiment, the cyclonic separator is used as a dirt separation means of a vacuum cleaner. As shown in Figure 1, as the cyclonic separator of this invention may have a dirt separation efficiency of 99.95% or higher, the vacuum cleaner may use only a single cyclonic separator and, in fact, the single cyclonic separator of this invention may be the only dirt separation means used in the vacuum cleaner. As is known in the art after filters (i.e. a filter positioned downstream from the motor of the vacuum cleaner) may optionally be provided, eg. a HEPA filter to remove very small quantities of particulate matter such as the carbon dust which is produced by the motor.

In the application as exemplified in Figures 1 and 5, particle separation member 30 is shown as the cyclone separator for vacuum cleaner 200. While separator 30 may be used in any vacuum cleaner (eg. an upright, a canister, a backpack cleaner or a central vacuum cleaning system), the following discussion describes the use of particle separation member 30 in an upright vacuum cleaner.

As exemplified in Figures 1 and 5, vacuum cleaner 200 has a floor cleaning head 202, means for moving cleaning head 202 across a floor (eg. wheels 204), main casing 206 rotatably attached to cleaner head 202, and a handle 208 for moving cleaner 200 across the floor. Main casing 206 houses separator 30. In this embodiment, a single separator 30 is used and comprises a central air feed conduit 210 in air flow communication with dirty air inlet 220 adjacent the floor in cleaner head 202 (see Figures 4 and 5) at one end and in

air flow communication with curved air inlet 34 at the other end. Rotatably mounted brush 222 may be positioned in dirty air inlet 220.

Bin 32 may be removable from main casing 206 by any means known in the art (see Figure 21), such as by the application of pressure by the hand of a user to handle 212, so that collected dirt may be removed from bin 32.

Cyclonic separator 30 comprises a bin 32 having an open end 214, an inlet 34 for delivering a cyclonic fluid flow to separator 30 and an outlet 36 for removing fluid from the separator. Inlet 34 need not be tangential but may be of any configuration which is capable of providing a cyclonic fluid flow to bin 32, such as an axial or screw cyclone inlet. Disposed in a lower portion of bin 32 is a separation member 40 which comprises a flat, disc-like member, having an upper face 42 and a lower face 44, and which substantially divides bin 32 into a cyclone chamber 46, having a cyclonic flow region 48 defined therein, and a particle receiving chamber 50. Separation member 40 may be made of plastic plate having a thickness of, eg. 1/40 of the diameter of bin 32. Cyclone chamber 46 and particle receiving chamber 50 communicate only via a plurality of apertures 52 in separation member 40. Apertures 52 comprise a plurality of openings or slits 54, each having an upstream edge 56 and a downstream edge 58 relative to the direction of cyclonic fluid flow in cyclone chamber 46 (arrow C), longer than the transverse width and oriented generally radially with respect to bin 32 (see Figure 5). Particle receiving chamber 50 comprises a chamber extending between lower face 44 and bottom face 90 of bin 32. Particle receiving chamber 50 preferably comprises about 10% of the volume of bin 32.

In use, a particle-laden fluid stream is introduced to cyclone chamber 46 via inlet 34 to flow cyclonically therein. The cyclonic flow proceeds rotationally around and downwardly through bin 32. The fluid stream is accelerated as it comes into the region of influence of particle separation member 40 which causes the fluid to change direction towards the central portion of cyclonic flow region 48 in cyclone chamber 46 (eg. around central air feed conduit 210) and is ultimately removed from cyclone chamber

46 via outlet 36. As the cyclonic fluid flow moves cyclonically down along inner wall 38 of cyclone chamber 46, it encounters separation member 40 and travels across separation member 40. The change in speed and direction of the fluid stream as it flows through cyclone chamber 46 causes particles entrained in the fluid stream to become disentrained. These separated particles have a greater mass and continue to accelerate towards separation member 40 where (depending on particle size) they pass through apertures 52 into particle receiving chamber 50. The separated particulate matter collects in particle receiving chamber 50. Larger particles separated from the fluid flow by the cyclonic action and incapable of passing through apertures 52 accumulate on upper surface 42 of separation member 40.

The reentrainment of deposited particles into the cyclonic flow is related to the speed and degree of cyclonic flow of fluid passing over deposited particles. Accordingly, any reduction in the cyclonic flow of the fluid within the particle receiving chamber will beneficially enhance the anti-reentrainment properties of the separator. To that end, referring to Figure 11 particle receiving chamber 50 may be provided with one or more baffles 100. The baffles operate to reduce and preferably stop the cyclonic flow of air beneath particle separation member 40. Thus particle receiving chamber 50 forms a dead air space beneath cyclonic flow region 48.

It will thus be appreciated that separation member 40 assists in particle separation in several ways. First, by providing a discontinuous surface, it disrupts the cyclonic flow thus assisting in separating entrained particulate matter from the fluid stream. Secondly, if provides an area (particle receiving chamber 50) which is separate from cyclone chamber 46. If a portion of the fluid stream enters particle receiving chamber 50, the cyclonic flow may be slowed or terminated thus allowing entrained particulate matter to separate out without the potential for reentrainment.

In use, an air flow is created by a motor 224 (eg. the fluid pump means) in vacuum cleaner 200 to draw air from, eg., from dirty air inlet 220, through passageway 226 in cleaner head 202, through centre air feed conduit 210 and into cyclone chamber 46 via inlet 34. Cyclonic flow is maintained in

cyclone chamber 46 thereby causing particles entrained in the cyclonic flow to be deposited, with smaller particles passing through apertures 52 into particle receiving chamber 50, while larger particles (eg. elongate particles such as hair, carpet fibres and the like) are deposited on upper surface 42 of separation member 40. Air then exits cyclone chamber via air outlet 36, though motor 224 and then exits the cleaner via outlet 228. The finer dirt tends to be separated and deposited in particle receiving chamber 50. Therefore, after operation of vacuum cleaner 200, particles of varying size may have collected in bin 32 both above and below separation member 40.

In the embodiment of Figure 7, cyclonic separator 30 is used to separate material entrained in an industrial fluid stream. In order to allow the separated material to be collected without interrupting the flow of fluid through cyclonic separator 30, particle receiving chamber 50 is provided with a hopper 60 having a sloping wall 62 leading to a hopper exit 64. Hopper exit 64 communicates with a particle transport conduit 66 for transporting received particles away from receiving chamber 50. Hopper 60 collects separated particles for removal by transport conduit 66 (such as due to gravity flow).

It will be appreciated that cyclone chamber 46 may be of any design known in the art. Inner wall need not be cylindrical as shown in Figure 1 but may be of any shape known in the art. Further, inlet 34 and outlet 36 may be positioned at any location and more than one inlet and outlet may be used.

The location of apertures 52 have been found to affect the particle separation characteristics of separation member 40 for a given cyclone configuration and application. It has been found that the anti-reentrainment characteristics of separation member 40 are enhanced if apertures 52 are concentrated beneath peripheral portion 70 of cyclonic flow region 48 (see Figure 6), inner portion 72 of cyclonic flow region 48 (see Figure 8), or both peripheral portion 70 and inner portion 72 (see Figure 9) thereby leaving medial portion 74 substantially free from apertures 52. If apertures 52 are provided beneath medial portion 74 without any means

provided in particle receiving chamber 50 for preventing any substantial (and preferably all) cyclonic flow in particle separating chamber 50, then some of the particulate material in particle separation chamber 50 will be reentrained into the air flow in cyclone chamber 46. Accordingly, it is preferred that there are no apertures 52 beneath medial portion 74 when there are no means (eg. baffles) to prevent cyclonic flow in particle separation chamber 50. It will be appreciated that a few apertures 52 may be provided in medial portion 74 without creating substantial reentrainment.

Preferably, peripheral portion 70 comprises approximately the outermost one quarter of the radial width 76 of cyclonic flow region 48, and inner portion 72 comprises approximately the innermost one quarter of the radial width 76 of cyclonic flow region 48. Medial portion 74 therefore comprises half of the radial width 76.

If a cyclone separator configuration is varied, the shape and size of cyclonic flow region 48 will vary. For example, referring to Figure 6, cyclone bin 32 having central air feed conduit 210 results in an annular-shaped cyclonic flow region 48. As a result, cyclonic flow region 48 has a radial width 76 between central air feed conduit 210 and inner wall 38. However, if there is no member positioned in bin 32 (as shown in Figures 8 and 9), then cyclonic flow region 48 has a radial width 76 which extends from central axis A to inner wall 38. Bin 32 may have a non-circular cross-section (eg. elliptical) or any non-curvilinear cross-section which permits a substantially cyclonic flow therein. Also, the radial width of cyclone chamber 46 may vary along its longitudinal length (i.e. in the direction of axis A), and may be, eg., cylindrical, frusto-conical or any other shape having beneficial cyclonic particle separation characteristics.

Apertures 52 may be of any particular shape. For example, they may be circular (see Figure 14), rectangular (see Figure 19), triangular, or other regular or irregular shape. Preferably, if apertures 52 are located against the inner or outer edge of separation member 40, then they have only one wall 57. For example, as shown in Figure 5, apertures 52 extend all the way to inner wall 38 of bin 32 while in Figure 9 they terminate inwardly of

inner wall 38. While apertures 52 may be any shape, in a preferred embodiment, they have a length greater than their width. In particular, as shown in Figure 11, upstream and downstream edges 56, 58 are preferably longer than the spaced opposed sides 57 extending between edges 56, 58 (eg. edges 56, 58 are preferably at least twice the length of sides 57) so that apertures 52 define slits.

As shown in Figure 11, slits 54 may extend generally radially (i.e. edges 56, 58 may extend generally radially). However, as shown in Figure 13, slits 54 may be angled slightly, relative to radial width 76, so that the outer edge 82 of an aperture 52 is upstream of the inner edge 84, relative to the cyclonic air flow (indicated by arrow C). The angle α of slits 54 relative to radial width 76 may be up to 45°.

Preferably apertures 52 extend radially and edges 56, 58 have a length L which is about 10% or less of diameter D of bin 32 and sides 57 have a length W (i.e. the width of the apertures) which is about 5% or less of diameter D of bin 32 (see Figure 11). More preferably, length W is about 25 to 35% of length L.

Apertures 52 may be equidistantly spaced apart around separation member 40 (see Figures 6 - 9) or they may be positioned with different spacings between adjacent apertures 52. Further, apertures 52 may be continuously positioned around all of separation member 40 (see Figures 6 - 9) or apertures 52 may be positioned around only a portion of separation member 40 (see Figure 15). Distributing apertures 52 over only a region may be beneficial where only a portion of dirt separation member 40 is contacted by the cyclonic flow in bin 32. This may be used, for example, if bin 32 has a single inlet 34. In such a case, the sector of separation member 40 which will be contacted by the cyclonic flow may be predetermined and apertures 52 provided only in that sector.

Preferably, particle separation member 40 will have from about 5 to about 35 apertures 52. The number of apertures 52 which may be required for a particular system may be determined by the formula:

$$\text{Number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of cyclonic flow region 48
D= the diameter of bin 32 (see Figure 5)

The formula provides a rough approximation of the ideal number of apertures 52 for a particular system (i.e. within 20%). The actual number of apertures which are required for maximum separation efficiency for a particular system may vary slightly from the formula.

It should be noted that dust separation member 40 need not be positioned perpendicular to the cyclonic (ie. longitudinal) axis of cyclonic flow region 48 in cyclone chamber 46. In particular separation member 40 may be at an angle to the axis.

Referring now to Figure 16, separation member 40 need not extend across the entirety of cyclonic flow region 48, but rather may be disposed in only the portion of cyclonic flow region 48 beneath which apertures 52 are to be provided. By way of example only, Figure 16 shows a separation member 40 which comprises an annular ring 86 disposed beneath peripheral portion 70 of cyclonic flow region 48. Particle receiving chamber 50 is disposed thereunder, between bin 32 and an inner wall 88. It will be understood by one skilled in the art that separation member 40 may equally have any other configuration suitable for a given separator application without departing from the scope of the present invention. It will be appreciated, for example, that separator 40 may comprise an annular ring positioned beneath inner portion 72 of cyclonic flow region 48.

Referring to Figures 17 and 18, respectively, separation member 40 need not be disc-shaped, but may also be conical or trumpet-shaped. It may be convex (i.e. it may project into particle receiving chamber 50 as shown in Figure 17) or it may be concave (i.e. it may project away from particle receiving chamber 50 as shown in Figure 18). It will be appreciated that separation member 40 need not define a continuous surface. For example, as shown in Figure 18, it may have a curved surface in which apertures 52 are provided and a flat central top portion 78.

Referring to Figure 10, edges 56 and 58 may be aerodynamically shaped to enhance the performance of separation member 40. For example, the thickness of particle separation member 40 is preferably reduced adjacent the upstream edge 56. Referring to Figure 10, aperture 52 has a sloped upstream edge 56 to assist in directing air and particles from cyclone chamber 46 to particle receiving chamber 50. Upstream edge 56 is preferably sloped with respect to upper surface 42 such that the included angle α' is from 15 to 90° and an included angle less than 30° is more preferred. The thickness of downstream edge 58 of particle separation member 40 may be substantially unchanged. Alternately, aperture 52 is preferably shaped such that downstream edge 58 is sloped with respect to upper surface 42 to assist in directing air and particles from cyclone chamber 46 to particle receiving chamber 50. Preferably, the included angle α'' is from 15 to 90° and an included angle less than 30° is more preferred.

Preferably, baffles 100 are provided on lower surface 44 and extend away from particle separation member 40. If separator 30 has a bottom 90, then preferably, baffles 100 extend from lower surface 44 towards bottom 90 but do not touch bottom 90. Baffles 100 preferably extend approximately three-quarters of the distance from lower surface 44 of separation member 40 to the bottom 90 of particle receiving chamber 50, but may be longer or shorter if desired. Preferably baffles 100 are parallel to the longitudinal axis of cyclone bin 32.

As shown in Figures 19 and 20, a baffle 100 is preferably disposed adjacent each aperture 52 on the downstream side, relative to cyclonic flow in cyclonic chamber 46 (arrow C). For example, a baffle 100 may be offset 15° downstream from its associated aperture 52. It will be appreciated that a baffle 100 need not be associated with each aperture 52. Preferably the baffles are immediately downstream of each aperture 52.

Baffles 100 comprises a wall 102 which may extend radially inwardly or which may be curved. Preferably wall 102 is substantially parallel to aperture 52 along its length. Wall 102 extends at least coterminously with

the length of edges 56, 58 apertures 52. Preferably, wall extends at least three times the length of edges 56, 58.

As shown in Figures 11 and 12, baffle 100 may also have a lateral wall 104 disposed adjacent outer and/or inner edges 82 and 84 of aperture 52. Wall 104 preferably extends from wall 102 in the upstream direction. If an aperture 52 is disposed in peripheral portion 70, baffle 100 preferable has one lateral wall 104 only, disposed adjacent inner edge 84. Wall 102 is positioned inward of edge 84 so as to define a dead air space beneath aperture 52. If an aperture 52 is located in inner portion 72, baffle 100 preferably has a lateral wall 104 disposed adjacent inner edge 84 and outer edge 82 of aperture 52 (not shown). Walls 104 may thus effectively define an open central area in particle receiving chamber 50.

Baffles 100, configured as a wall 102 alone or in conjunction with a lateral wall 104, reduce and preferably stop the cyclonic nature of the fluid flowing beneath separation member 40. Referring to Figures 19 and 20, baffles 100 may extend from the wall of bin 32 to its centre to effectively divide particle receiving chamber 50 into a plurality of pie-shaped compartments 106 within particle receiving chamber 50. This configuration substantially inhibits any fluid flow, cyclonic or otherwise, within compartments 106, thereby beneficially enhancing the anti-reentrainment of characteristics of separation member 40.

Preferably, as shown in the embodiment of Figures 2, 4, 5 and 7, a single baffle 100 is provided beneath particle separation member 40. As shown in these embodiments, baffle 100 extends vertically between bottom 90 and lower face 44 and radially outwardly from central air feed conduit 210 to inner wall 38. In this embodiment, baffle 100 is preferably positioned about 10 to 20° downstream from the point T where the cyclonic flow changes direction to flow upwardly through cyclonic flow region 48 (see figures 5 and 6).

Although as described above, it is desirable to position apertures 52 in peripheral portion 70 and/or inner portion 72 of cyclonic flow region 48, when baffles 100 are used in conjunction with apertures 52 the

positioning of apertures 52 is less critical. In such a case, apertures 52 with baffles 100 may be positioned at any location along the radial width of particle separation member 40 and may be disposed in any one or more of inner portion 72, medial portion 74 and peripheral portion 70 of cyclonic flow region 48.

After operation of vacuum cleaner 200, particles of varying size may have collected in bin 32 both above and below separation member 40. To empty such collected contents, bin 32 is preferably removable from main casing 206, via, eg., handle 212, and inverted (typically over a refuse collector of the like) to cause the collected particles on upper face 42 to fall from bin 32 under the influence of gravity.

If cyclone separator has a closed bottom 90, then a door or the like is preferably provided to assist in emptying chamber 50. The door may be provided on the outer wall of bin 32. Preferably, particle separation member 40 is constructed to assist in emptying the contents of particle receiving chamber 50 when bin 32 is inverted. To this end, particle separation member 40 may be constructed to provide an opening when bin 32 is inverted (see for example Figures 21 and 22) or a door may be provided in bin 32 prior to inverting bin 32 .

Pursuant to the first alternative, separation member 40 may comprise a main body 110 and an access member 112, as shown in Figure 22. Access member 112 comprises a chord section of separation member 40 pivotally connected to main body 110 by a hinge member 114 to swing between a closed position, substantially planar with main body 110 (as represented by the solid lines in Figures 21 and 22) and an open position, wherein access member 112 swings upwardly relative to main body 110 (as represented by the broken lines in Figures 21 and 22).

Referring again to Figure 21, when bin 32 is removed from vacuum cleaner 200 and inverted, access member 112, by virtue of its pivoting connection to main body 110, is permitted to freely swings to its "open" position under the influence of gravity, thereby permitting the contents of particle receiving chamber 50 to fall from particle receiving

chamber 50 and out of bin 32. When bin 32 is returned to its upright position, the access member 112 falls to its closed position under the influence of gravity. To bias access member 112 towards its closed positioned when bin 32 is upright, access member 112 may optionally be provided with a weight 116, or a suitable spring means (not shown) or other biasing means known to those skilled in the art. Hole 118 is provided to permit centre air feed conduit 210 to pass there through.

The direction of the pivot axis 218 of hinge member 114 is preferably selected to assist access member 112 to remain closed while the vacuum cleaner is in use. If the vacuum cleaner is an upright vacuum cleaner in which particle separation member 40 is generally horizontally disposed position when main casing 206 is in the upright storage position (eg. separation member 40 is perpendicular to inner wall 38), then particle separation member 40 will be at an inclined position when main casing 206 is pivoted to the in use position. Access member 112 has a pivot axis 218 which is preferably not parallel to pivot axis 216 of the upper casing 206 of the vacuum cleaner. In such a case, no weight may be required. Preferably, pivot axis 218 of access member 112 is at an angle β of 10 - 50°, preferably 20° to 40°, and more preferably about 30° to the pivot axis 216 of upper casing 206 (see Figure 21).

Access member 112 is preferably provided in the rear portion of the cyclone bin 32 to prevent access member 112 from opening during use. In particular, all or a major portion of access member 122 is preferably positioned rearward of centre air feed 210 (i.e. towards handle 208). In such a case, no weight may be required.

As the fluid flow travels through bin 32, a boundary layer forms. A boundary layer is formed on top of particle separation member 40 as the fluid travels over upper surface 42 of particle separation member 40. The boundary layer will thicken until a thickness is reached at which the boundary layer has sufficient energy to break off and travel away from upper surface 42 (i.e. point T). When this occurs, vortices are formed in the fluid stream adjacent apertures 52 causing localized turbulence. The turbulent

flow reentrains particles that had been separated from the fluid flow and may even pull some of the separated particles out of particle receiving chamber 50. According to the instant invention, separator 30 is preferably constructed to minimize the thickness of the boundary layer when it breaks off thereby reducing turbulent flow in the vicinity of apertures 52. The introduction of the separation member according to the present invention to a cyclonic separator dramatically increases the overall efficiency of the separator. The prior art teaches the need for a plurality of cyclones in order achieve ultra-high particle separation efficiencies. However, it has been found that ultra-high efficiencies can be obtained in a single stage cyclone incorporating the particle separation member of the present invention. Accordingly, cleaning efficiencies in excess of 99% may be obtained with a single stage separator utilizing the separator 30 according to the present invention, thereby negating the need for second stage cyclonic separation altogether. Cleaning efficiencies of over 99.5% have also been achieved for particle laden air streams.

Therefore, the present invention permits ultra-high efficiencies to be attained with relatively simple separator configurations compared to the prior art. The reduction of separator structure, in turn, beneficially reduces the fluid pressure losses across the separator, thereby permits a deeper vacuum (increased fluid flow rate) to be drawn for a given motor size. For household vacuum cleaner applications, back pressures of only 4 - 8 kpa may be obtained allowing the motor size to be reduced without sacrificing the vacuum strength of the device. The reduced structure and motor size also beneficially result in a cost and size savings to the overall separator unit.

The baffle members according to the present invention greatly enhance the performance of the separation member and greatly assist in obtaining ultra-high efficiencies. The projection of baffle members into the particle receiving chamber beneficially disrupts and, depending on the baffle configuration, substantially inhibits cyclonic flow in the particle receiving chamber, thereby reducing the reentrainment of deposited particles.

In another preferred embodiment, the separation efficiency of particle separation member 40 may be increased by pulsing the electrical

signal to motor 224. The timing of the pulses is determined to reduce and preferably minimize the maximum thickness of the boundary layer of fluid as it travels over upper surface 42 in the vicinity of point T. This produces a pulsed fluid flow through bin 32. Alternately, such a pulsed flow may be mechanically produced such as by providing inlet 34 with an moveable closure member such as plate 120 to which a means is attached to cause the plate to cyclically open and close inlet 34, eg. a spring, a solenoid 122 having an arm 124 attached to plate 120, or the like. Alternately, the aperture closure member may be provided on outlet 36. These mechanical devices effect the back pressure in bin 32 so as to favour smooth (laminar) boundary layer flow as opposed to turbulent flow in the vicinity of apertures 52.

The separation member access means according to the present invention provides a simple and convenient method of emptying collected particles from two chambers simultaneously, namely larger particles deposited in the cyclone chamber (i.e. on top of the particle separation member) and finer particles deposited in the particle receiving chamber. This provides a simple and convenient automatic method of emptying dual chambers.

The superimposed particle separation member according to the present invention also provides a convenient method for emptying collected particles from two chambers simultaneously. To enhance the convenience, the movement of the superimposed members may be linked to open when the bin is removed from the main casing.

While the above description constitutes the preferred embodiments, it will be appreciated that the present invention is susceptible to modification and change without departing from the fair meaning of the proper scope of the accompanying claims.

WE CLAIM:

1. A separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber an outer wall and a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion;

(b) a fluid inlet for introducing a cyclonic fluid flow to the cyclonic flow region;

(c) a fluid outlet for removing the fluid flow from the cyclone chamber;

(d) a particle separating member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separating member having a plurality of apertures; and,

(e) a particle receiving chamber disposed beneath the particle separating member for receiving particles passing into the particle receiving chamber through the apertures

wherein the apertures are disposed on the particle separating member such that the medial portion of the cyclonic flow region is substantially free from said apertures.

2. The separator of claim 1 wherein the peripheral portion of the cyclonic flow region comprises one quarter of the radial width of the cyclonic flow portion.

3. The separator of claim 2 wherein the medial portion of the cyclonic flow region comprises one half of the radial width of the cyclonic flow portion.

4. The separator of claim 1 wherein the particle receiving chamber comprises a sealed chamber except for the apertures.

5. The separator of claim 1 wherein the particle receiving chamber is in communication with a conduit for transporting separated particles downstream from the particle receiving chamber.

6. The separator of claim 1 further comprising:

(a) a cleaner head adapted for movement over a floor and having a fluid nozzle positionable adjacent the floor, the nozzle in fluid flow communication via a passageway with the separator fluid inlet;

(b) a handle for moving the cleaner head over the floor; and,

(c) a casing for housing the cyclone chamber.

7. The separator of claim 6 wherein the casing is pivotally mounted to the cleaner head.

8. The separator of claim 6 wherein the passageway comprises a flexible portion that is positioned external of the cleaner head and the casing and the handle is affixed to the cleaner head.

9. The separator of claim 1 wherein the apertures are sized to inhibit elongate particles from passing there through, whereby elongate particles collect on top of the particle separating member.

10. The separator of claim 1 wherein the apertures are shaped to aerodynamically direct particles from the cyclonic flow region into the particle receiving chamber.

11. The separator of claim 1 wherein the apertures comprise slits having longitudinally extending upstream and downstream edges relative to the fluid flow and transversely extending sides and the edges are longer than the sides.

12. The separator of claim 11 wherein the length of the edges are substantially aligned with the radial width of the cyclone chamber.

13. The separator of claim 11 wherein the length of the edges define a longitudinally extending axis which are at an angle of up to 45° to the radius of the cyclonic flow region.

14. The separator of claim 1 wherein the apertures have an radial outer end and a radial inner end and the radial outer end is positioned adjacent the outer wall of the cyclone chamber.

15. The separator of claim 1 wherein the apertures have an upstream edge and downstream edge, relative to the fluid flow and the thickness of the particle separating member is reduced adjacent the upstream edge of the apertures.

16. The separator of claim 15 wherein the particle separating member has an upper surface and a lower surface and the upper surface is angled towards the particle receiving chamber adjacent the upstream edge and the lower surface is angled away from the aperture adjacent the downstream edge.

17. The separator of claim 1 wherein the particle separating member is disposed substantially perpendicularly to a longitudinal axis of the cyclonic flow region.

18. The separator of claim 1 wherein the particle separating member is disposed at an angle to a longitudinal axis of the cyclonic flow region.

19. The separator of claim 1 wherein the particle separating member is convex or concave.

20. The separator of claim 1 wherein the particle separating member extends under all of the cyclonic flow region to define bottom surface of the cyclonic flow region.

21. The separator of claim 1 wherein the particle separating member extends essentially under only the outer peripheral portion.

22. The separator of claim 1 wherein the apertures are positioned essentially only beneath the peripheral portion of the cyclonic flow region.

23. The separator of claim 1 wherein the apertures are positioned essentially only beneath the inner portion of the cyclonic flow region.

24. The separator of claim 1 wherein the apertures are positioned beneath only the peripheral and inner portions of the cyclonic flow region.

25. The separator of claim 1 wherein the apertures are distributed regularly around the particle separating member.

26. The separator of claim 1 wherein the fluid contacts only a portion of the particle separating member and the apertures are positioned only in said portion.

27. A separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber for containing a cyclonic flow in a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion;

(b) means for introducing a fluid flow to the cyclone flow region for cyclonic rotation therein;

(c) means for removing the fluid flow from the cyclone chamber;

(d) particle receiving means disposed beneath the cyclone flow region for receiving particles separated from the fluid flow;

(e) separation means for dividing the particle receiving means from the cyclone chamber; and

(f) transporting means associated with the separation means for connecting the particle receiving means in flow communication with the cyclonic flow region such that, in operation, particles pass through the transporting means to the particle receiving means

wherein said transporting means are positioned outside the medial portion of the cyclonic flow region.

28. The separator of claim 27 wherein the particle receiving means comprises a sealed chamber except for the transporting means and the separator further comprises emptying means for emptying the particle receiving means.

29. The separator of claim 27 further comprising means for connecting the particle receiving means in flow communication with a conduit for transporting separated particles downstream from the particle receiving means.

30. The separator of claim 27 further comprising aerodynamic means associated with the transporting means for directing particles from the cyclonic flow region into the particle receiving means.

31. The separator of claim 27 wherein the particle separating means extends under all of the cyclonic flow region to define bottom surface of the cyclonic flow region.

32. The separator of claim 27 wherein the transporting means are positioned beneath only one or both of the peripheral and inner portions of the cyclonic flow region.

33. The separator of claim 27 wherein the transporting means are distributed regularly around the separating means.

34. The separator of claim 27 wherein the fluid contacts only a portion of the separating means and the transporting means are positioned only in said portion.

35. The separator of claim 27 wherein the transporting means comprise openings in the separation means.

36. A method for separating entrained particles from a fluid flow, the method comprising the steps of:

(a) introducing a fluid to flow cyclonically in a chamber having a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion;

(b) removing particles from the fluid flow in the cyclone chamber via passages provided beneath one or both of the peripheral and inner portions; and,

(c) removing the fluid flow from the chamber.

37. The method of claim 36 further comprising the steps of storing the particles removed from the fluid flow and inverting the chamber to remove the separated particles.

38. The method of claim 36 further comprising the step of transporting separated particles downstream from the chamber.

39. The method of claim 36 wherein the separator comprises the dirt separation mechanism for a vacuum cleaner and the method further comprises passing a cleaning head over a surface to clean the surface.

40. The method of claim 36 further comprising directing particles to pass into the passages.

41. A separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a fluid inlet for introducing a cyclonic fluid flow to the cyclonic flow region;

(c) a fluid outlet for removing the fluid flow from the cyclone chamber;

(d) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures; and,

(e) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures

wherein the separator is constructed to reduce turbulent fluid flow in the vicinity of the apertures.

42. The separator of claim 41 further comprising a fluid pump for causing the fluid to flow through the separator wherein the fluid flow through the cyclone chamber is pulsed.

43. The separator of claim 41 further comprising a moveable closure member on one of the fluid inlet and the fluid outlet for causing a pulsed fluid flow through the cyclone chamber.

44. The separator of claim 41 wherein the particle separation member has from 5 to 35 apertures.

45. The separator of claim 41 wherein the number of apertures in the particle separation member is calculated by the formula:

$$\text{number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of the cyclonic flow region

D= the diameter of the cyclone chamber

46. The separator of claim 41 wherein the cyclone chamber has a diameter and each aperture has a longitudinally extending upstream edge and a longitudinally extending downstream edges, relative to the fluid flow, and transverse sides extending between the edges, the edges have a length which is less than 10% of the diameter of the cyclone chamber and the sides have a length which is 25 - 35% of the length of the edges.

47. The separator of claim 46 wherein the edges are substantially radially aligned with the cyclone chamber.

48. The separator of claim 41 wherein each aperture has an upstream edge and a downstream edge, relative to the fluid flow, and the upstream edge is angled towards the particle receiving chamber, the included angle between the upstream edge and the upper surface of the particle separation member is from 15 to 90°.

49. The separator of claim 41 wherein each aperture has an upstream edge and a downstream edge, relative to the fluid flow, and the downstream edge is angled towards the particle receiving chamber, the included angle between the downstream edge and the upper surface of the particle separation member is from 15 to 90°.

50. The separator of claim 41 wherein the fluid flow changes direction and travels to the fluid outlet at a position as it travels over the particle separation member and the separator further comprising a baffle positioned beneath the particle separation member at a position 10 to 20° downstream of the position at which the fluid flow changes direction.

51. The separator of claim 50 wherein the particle receiving chamber has a bottom to comprise a sealed chamber except for the apertures and the baffle extends between the particle separation member and the bottom of the particle receiving chamber.

52. The separator of claim 41 wherein the particle receiving chamber is in communication with a conduit for transporting separated particles downstream from the particle receiving chamber.

53. The separator of claim 41 further comprising:

(a) a cleaner head adapted for movement over a floor and having a fluid nozzle positionable adjacent the floor, the nozzle in fluid flow communication via a passageway with the separator fluid inlet;

(b) a handle for moving the cleaner head over the floor; and,

(c) a casing for housing the cyclone chamber.

54. The separator of claim 41 wherein the particle separation member extends under all of the cyclonic flow region to define bottom surface of the cyclonic flow region.

55. A separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber for containing a cyclonic flow in a cyclonic flow region;

(b) fluid entry means for introducing a fluid flow to the cyclone flow region for cyclonic rotation therein;

(c) fluid exit means for removing the fluid flow from the cyclone chamber;

(d) fluid pump means for causing fluid flow through the cyclone chamber;

(e) particle receiving means disposed beneath the cyclone flow region for receiving particles separated from the fluid flow;

(f) separation means for dividing the particle receiving means from the cyclone chamber;

(g) transporting means associated with the separation means for connecting the particle receiving means in flow communication with the cyclonic flow region such that, in operation, a boundary layer flow of fluid develops over the separation means and the particles disentrained from the fluid flow pass through the transporting means to the particle receiving means; and,

(h) means for reducing the thickness of the boundary layer of fluid as it travels over the separation means.

56. The separator of claim 55 wherein the means for reducing the thickness of the boundary layer comprises means for pulsing the fluid flow through the cyclone chamber.

57. The separator of claim 56 wherein the means for pulsing the fluid flow through the cyclone chamber comprises means for pulsing an electrical signal to the fluid pump means.

58. The separator of claim 56 wherein the means for pulsing the fluid flow through the cyclone chamber comprises means pulsing for cyclically opening and closing one of the fluid entry means and the fluid exit means.

59. The separator of claim 55 wherein the means for reducing the thickness of the boundary layer comprises constructing and positioning the transporting means to reduce turbulent fluid flow over the separation means.

60. The separator of claim 55 wherein the means for reducing the thickness of the boundary layer comprises constructing and positioning flow

disruption means beneath the separating means for disrupting cyclonic fluid flow in the particle receiving means.

61. The separator of claim 55 wherein the particle receiving means comprises a sealed chamber except for the transporting means and the separator further comprises emptying means for emptying the particle receiving means.

62. The separator of claim 55 wherein the transporting means are aerodynamically shaped to directing particles from the cyclonic flow region into the particle receiving means.

63. A method for separating entrained particles from a fluid flow, the method comprising the steps of:

(a) introducing a fluid to flow cyclonically in a chamber having a cyclonic flow region and a particle separation member positioned in the cyclone chamber to define a particle receiving chamber;

(b) adjusting the back pressure in the chamber to promote the formation of a laminar boundary layer adjacent the particle separation member;

(c) removing particles from the fluid flow in the cyclone chamber via passages provided in the particle separation member; and,

(d) removing the fluid flow from the chamber.

64. The method of claim 63 further comprising the steps of storing the particles removed from the fluid flow and inverting the chamber to remove the separated particles.

65. The method of claim 63 wherein the separator comprises the dirt separation mechanism for a vacuum cleaner and the method further comprises passing a cleaning head over a surface to clean the surface.

66. The method of claim 63 wherein the particle separation member is constructed and positioned to reduce turbulent fluid flow over the particle separation member in the vicinity of the passages and the method further comprises passing the fluid flow over the particle separation member during operation of the chamber.

67. The method of claim 63 wherein the chamber further comprises flow disruption means which is constructed and positioned beneath the separating means for disrupting cyclonic fluid flow in the particle receiving chamber to reduce turbulent fluid flow over the particle separation member in the vicinity of the passages and the method further comprises passing the fluid flow over the particle separation member during operation of the chamber.

68. A vacuum cleaner comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a fluid inlet for introducing a cyclonic fluid flow to the cyclonic flow region;

(c) a cleaner head adapted for movement over a surface and having a fluid nozzle positionable adjacent the surface, the nozzle in fluid flow communication via a passageway with the fluid inlet;

(d) a fluid outlet for removing the fluid flow from the cyclone chamber;

(e) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures; and,

(f) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures;

wherein the separator is constructed to reduce turbulent fluid flow in the vicinity of the apertures.

69. A vacuum cleaner comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a air inlet for introducing a cyclonic air flow to the cyclonic flow region;

(c) a cleaner head adapted for movement over a surface and having a air nozzle positionable adjacent the surface, the nozzle in air flow communication via a passageway with the air inlet;

(d) a air outlet for removing the air flow from the cyclone chamber;

(e) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures;

(f) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures; and,

(g) a motor for causing the air to flow through the vacuum cleaner wherein the air flow through the cyclone chamber is pulsed.

70. The vacuum cleaner of claim 69 further comprising a moveable closure member on one of the air inlet and the air outlet for causing a pulsed air flow through the cyclone chamber.

71. The vacuum cleaner of claim 69 wherein the motor receives an electrical signal and the electrical signal is pulsed to produce the pulsed air flow.

72. A vacuum cleaner comprising:

(a) a cyclone chamber having an outer wall and a cyclonic flow region;

(b) a air inlet for introducing a cyclonic air flow to the cyclonic flow region;

(c) a cleaner head adapted for movement over a surface and having a air nozzle positionable adjacent the surface, the nozzle in air flow communication via a passageway with the air inlet;

(d) a air outlet for removing the air flow from the cyclone chamber;

(e) a particle separation member positioned in the cyclone chamber beneath at least a portion of the cyclonic flow region, the particle separation member having an upper surface and plurality of apertures;

(f) a particle receiving chamber disposed beneath the particle separation member for receiving particles passing into the particle receiving chamber through the apertures; and,

(g) a motor for causing the air to flow through the vacuum cleaner wherein the particle separation member is constructed and adapted to increase the particle separation efficiency of the cyclone chamber.

73. The vacuum cleaner of claim 72 wherein the particle separation member has from 5 to 35 apertures.

74. The vacuum cleaner of claim 72 wherein the number of apertures in the particle separation member is calculated by the formula:

$$\text{number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of the cyclonic flow region

D= the diameter of the cyclone chamber

75. The vacuum cleaner of claim 72 wherein the cyclone chamber has a diameter and each aperture has a longitudinally extending upstream edge and a longitudinally extending downstream edges, relative to the air flow, and transverse sides extending between the edges, the edges have a length which is less than 10% of the diameter of the cyclone chamber and the sides have a length which is 25 - 35% of the length of the edges.

76. The vacuum cleaner of claim 75 wherein the edges are substantially radially aligned with the cyclone chamber.

77. The vacuum cleaner of claim 72 wherein each aperture has an upstream edge and a downstream edge, relative to the air flow, and the

upstream edge is angled towards the particle receiving chamber, the included angle between the upstream edge and the upper surface of the particle separation member is from 15 to 90°.

78. The vacuum cleaner of claim 72 wherein each aperture has an upstream edge and a downstream edge, relative to the air flow, and the downstream edge is angled towards the particle receiving chamber, the included angle between the downstream edge and the upper surface of the particle separation member is from 15 to 90°.

79. The vacuum cleaner of claim 72 wherein the air flow changes direction and travels to the air outlet at a position as it travels over the particle separation member and the vacuum cleaner further comprising a baffle positioned beneath the particle separation member at a position 10 to 20° downstream of the position at which the air flow changes direction.

80. The vacuum cleaner of claim 79 wherein the particle receiving chamber has a bottom to comprise a sealed chamber except for the apertures and the baffle extends between the particle separation member and the bottom of the particle receiving chamber.

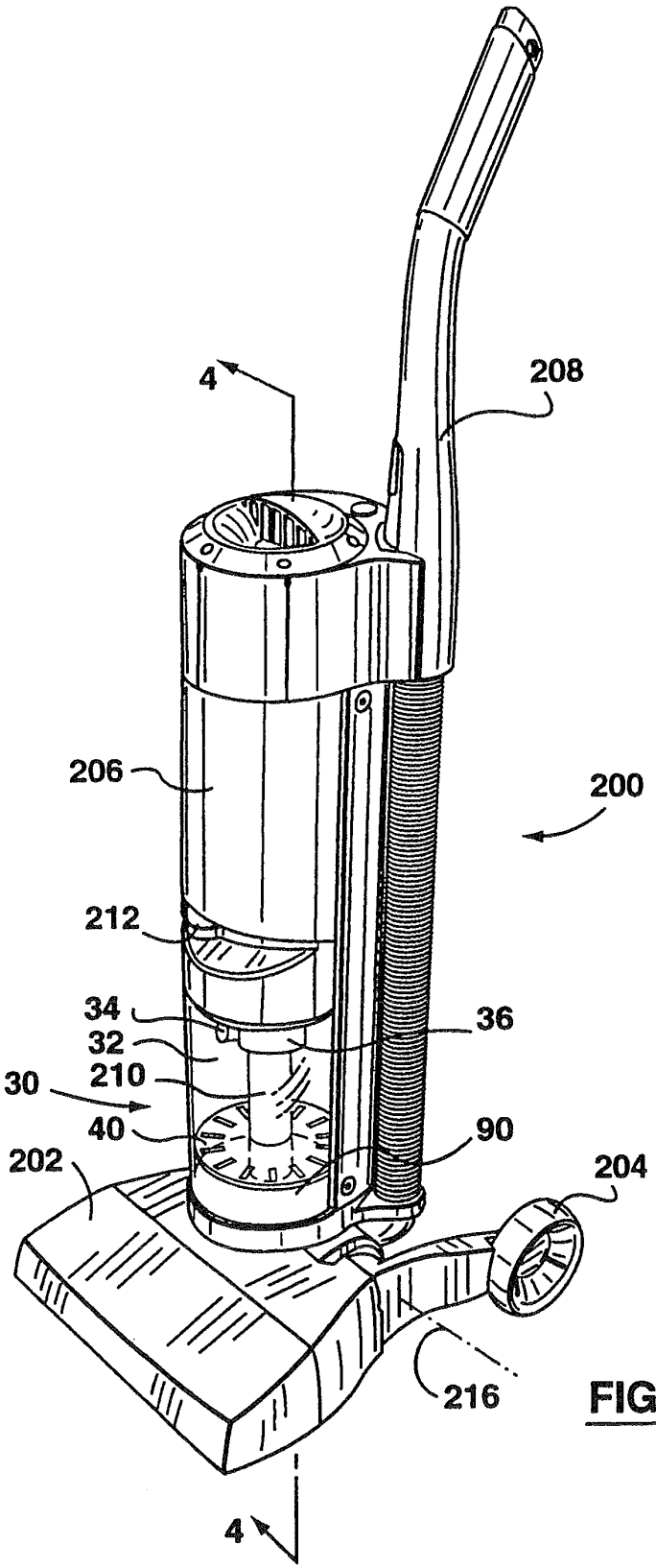


FIG. 1

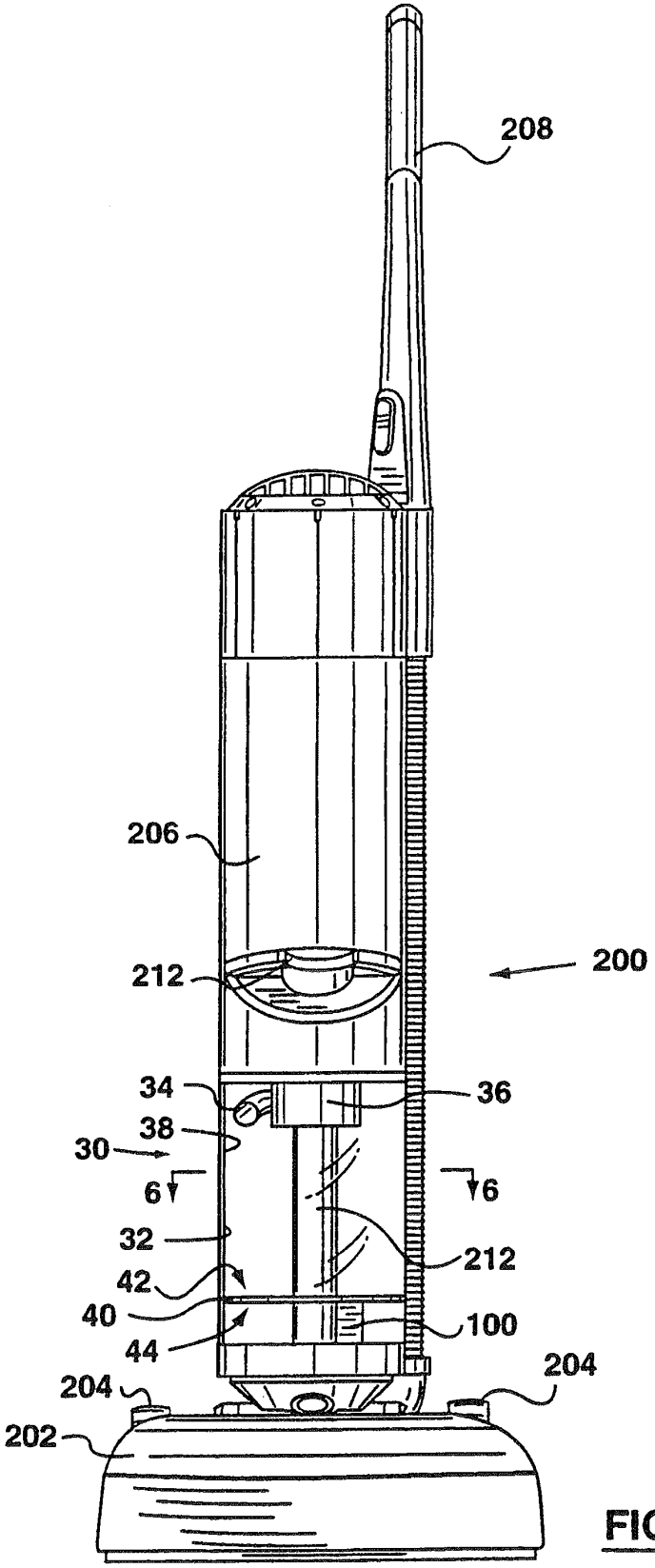


FIG. 2

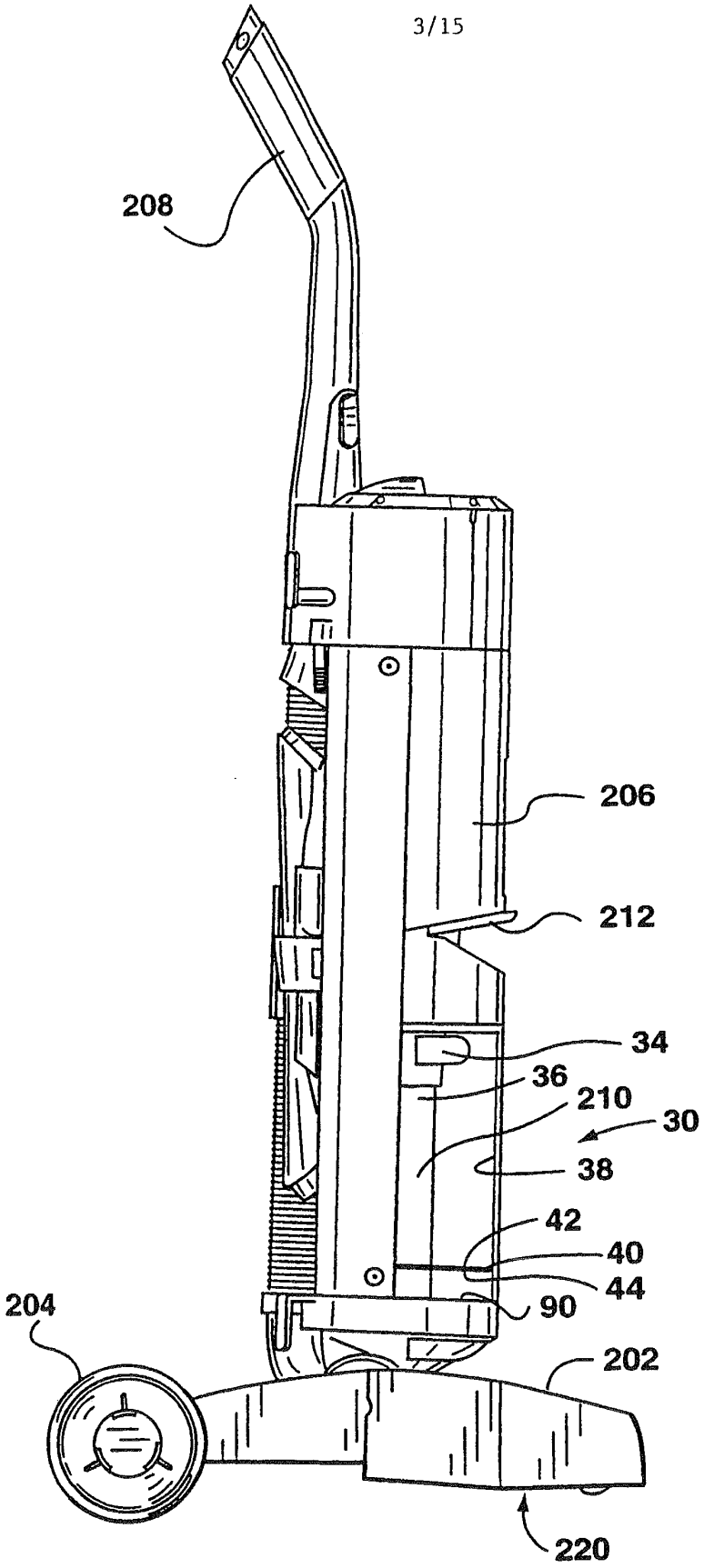


FIG. 3

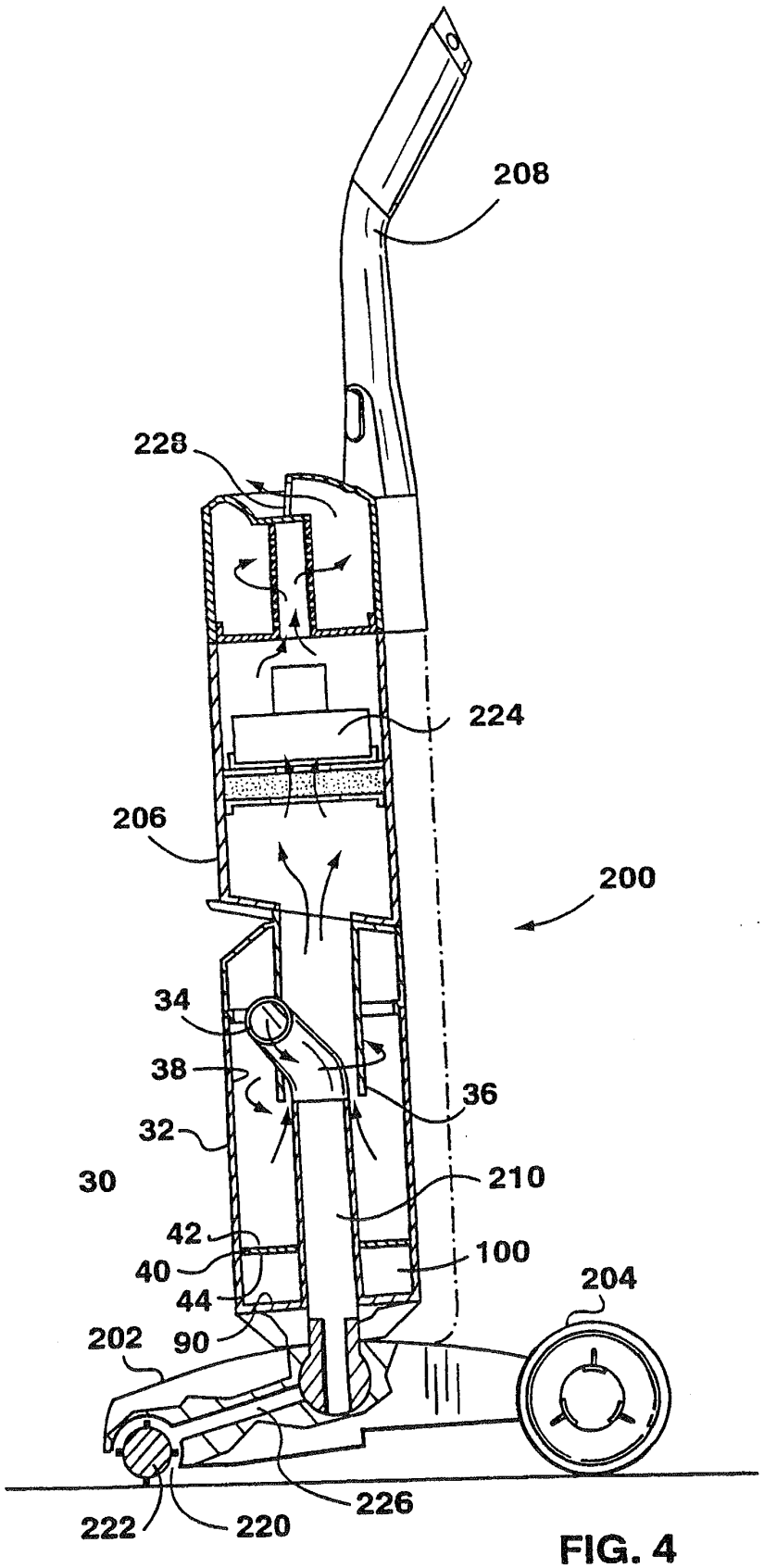

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FIG. 4

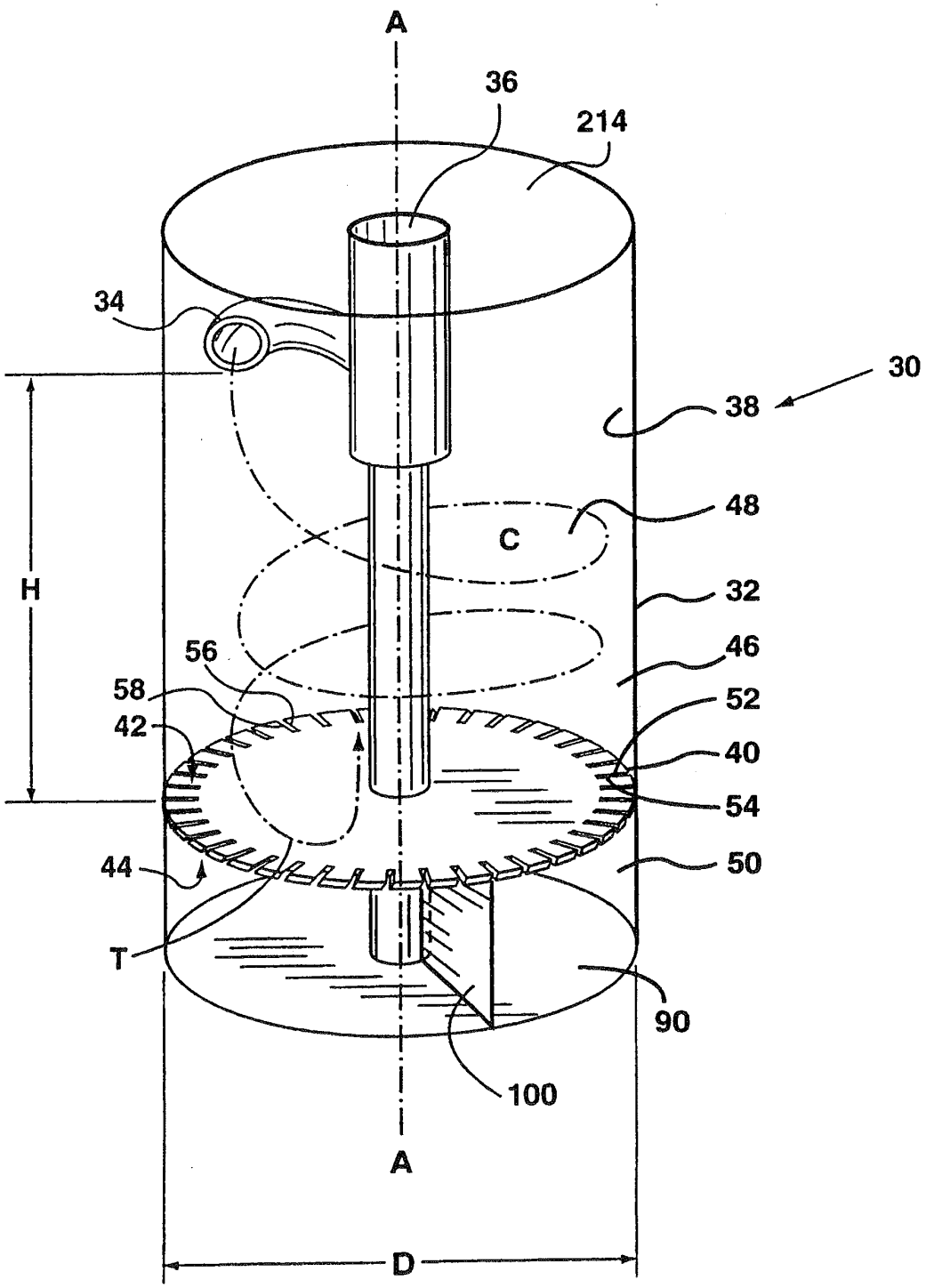


FIG. 5

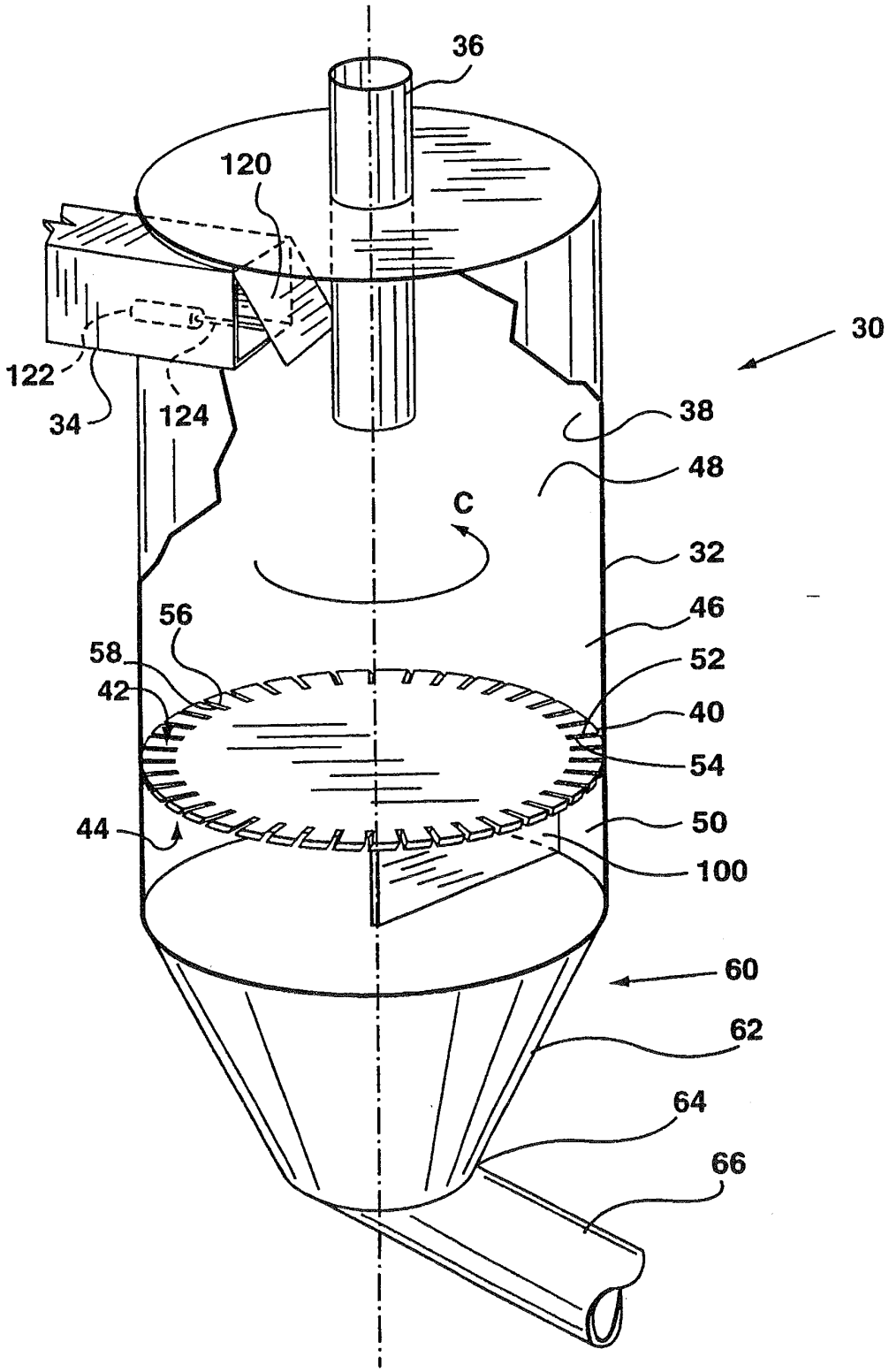

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FIG. 7

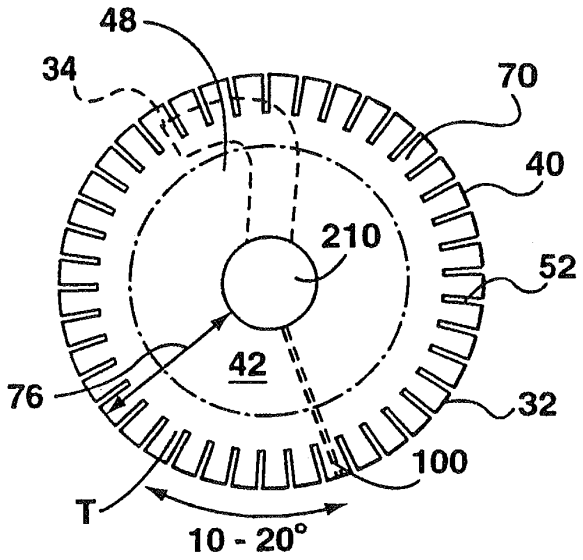


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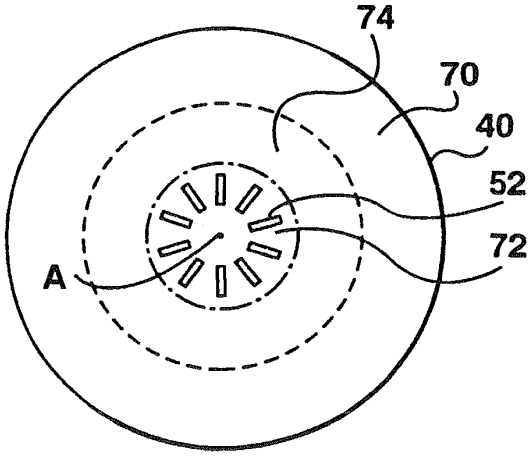


FIG. 8

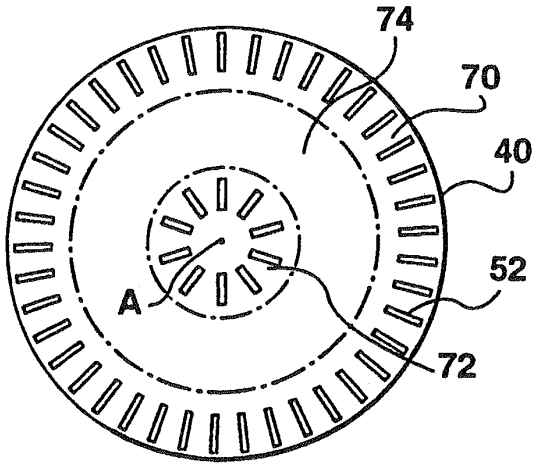


FIG. 9

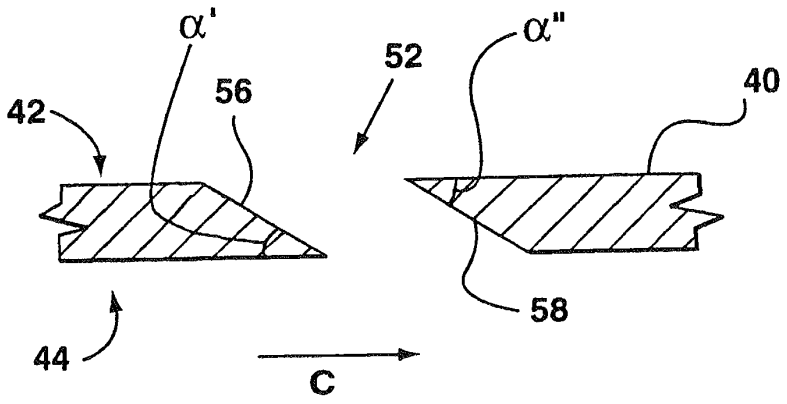


FIG. 10

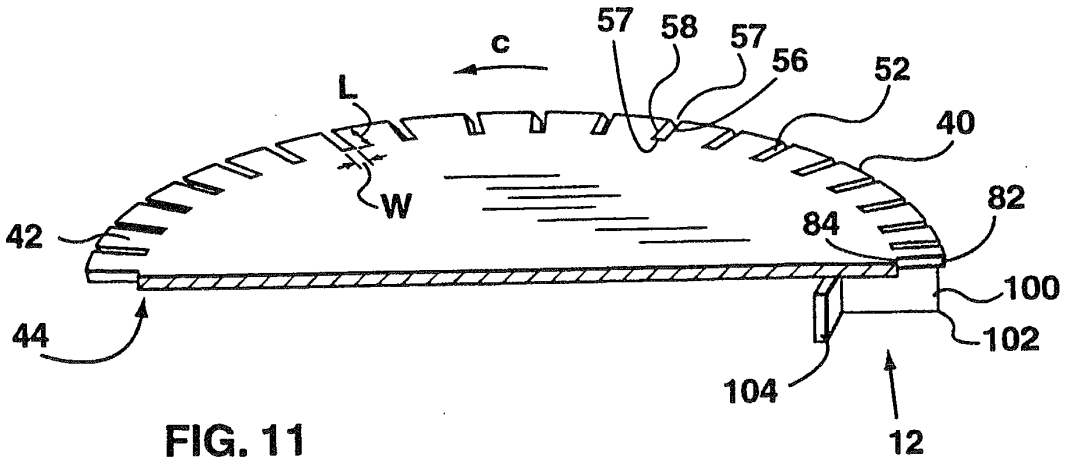


FIG. 11

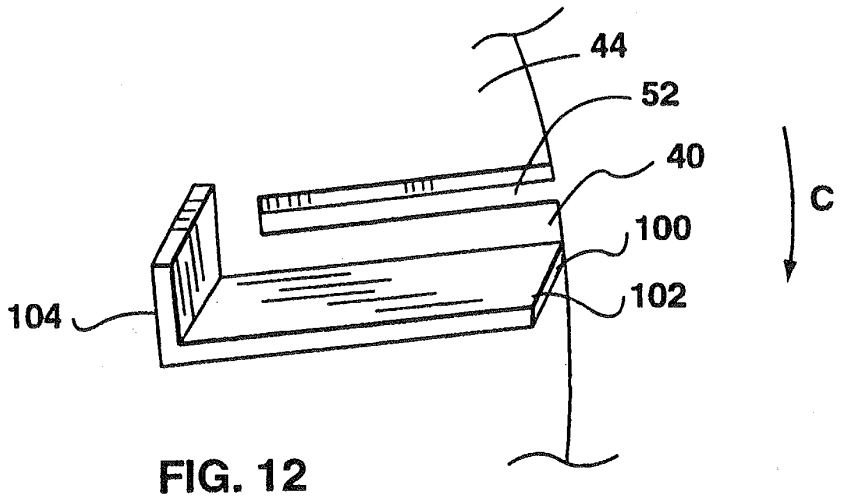


FIG. 12

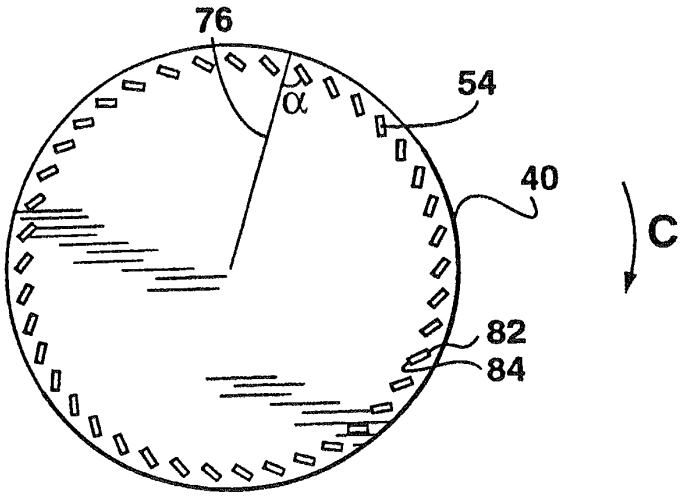


FIG. 13

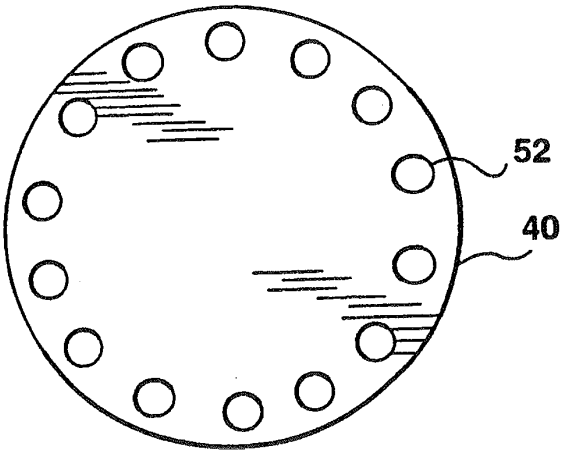


FIG. 14

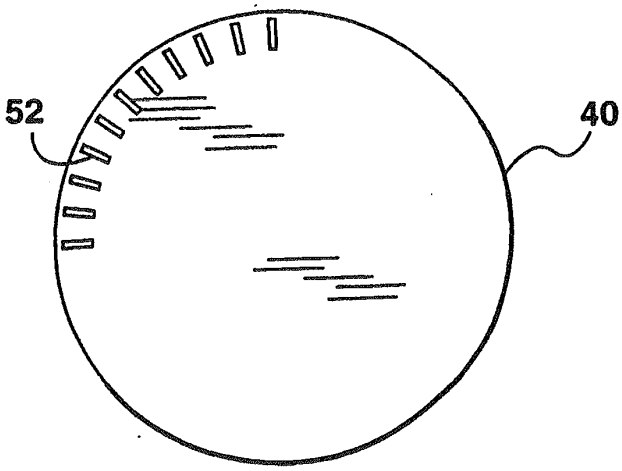


FIG. 15

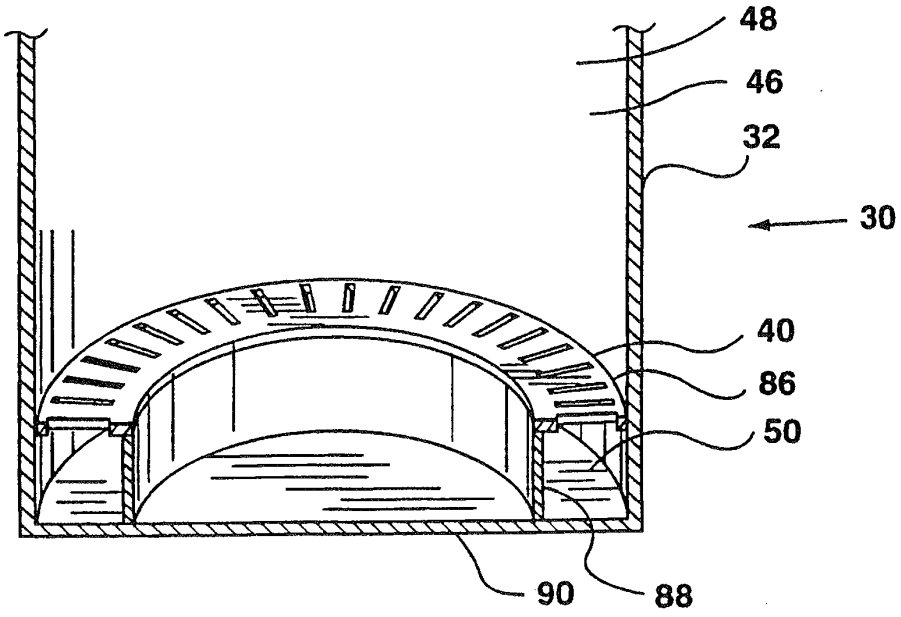


FIG. 16

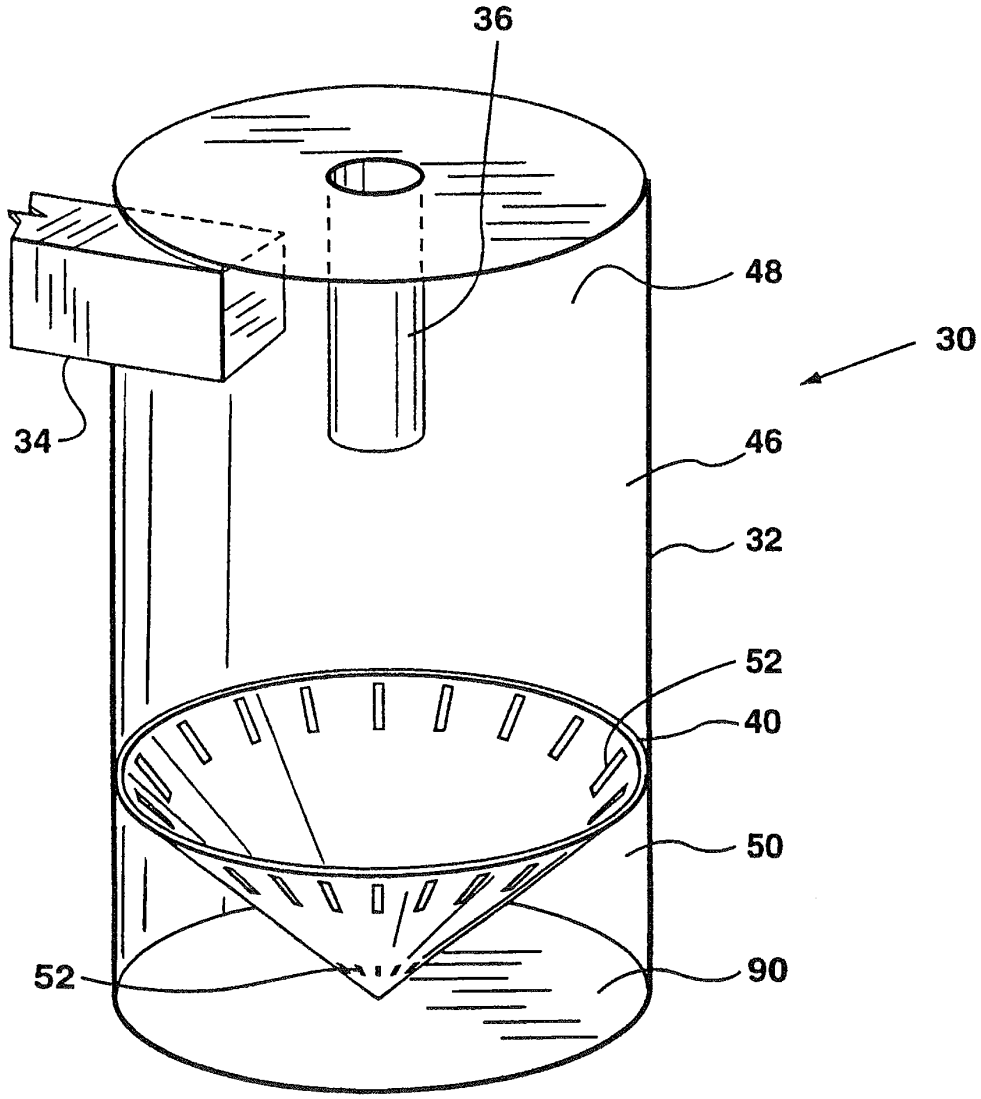


FIG. 17

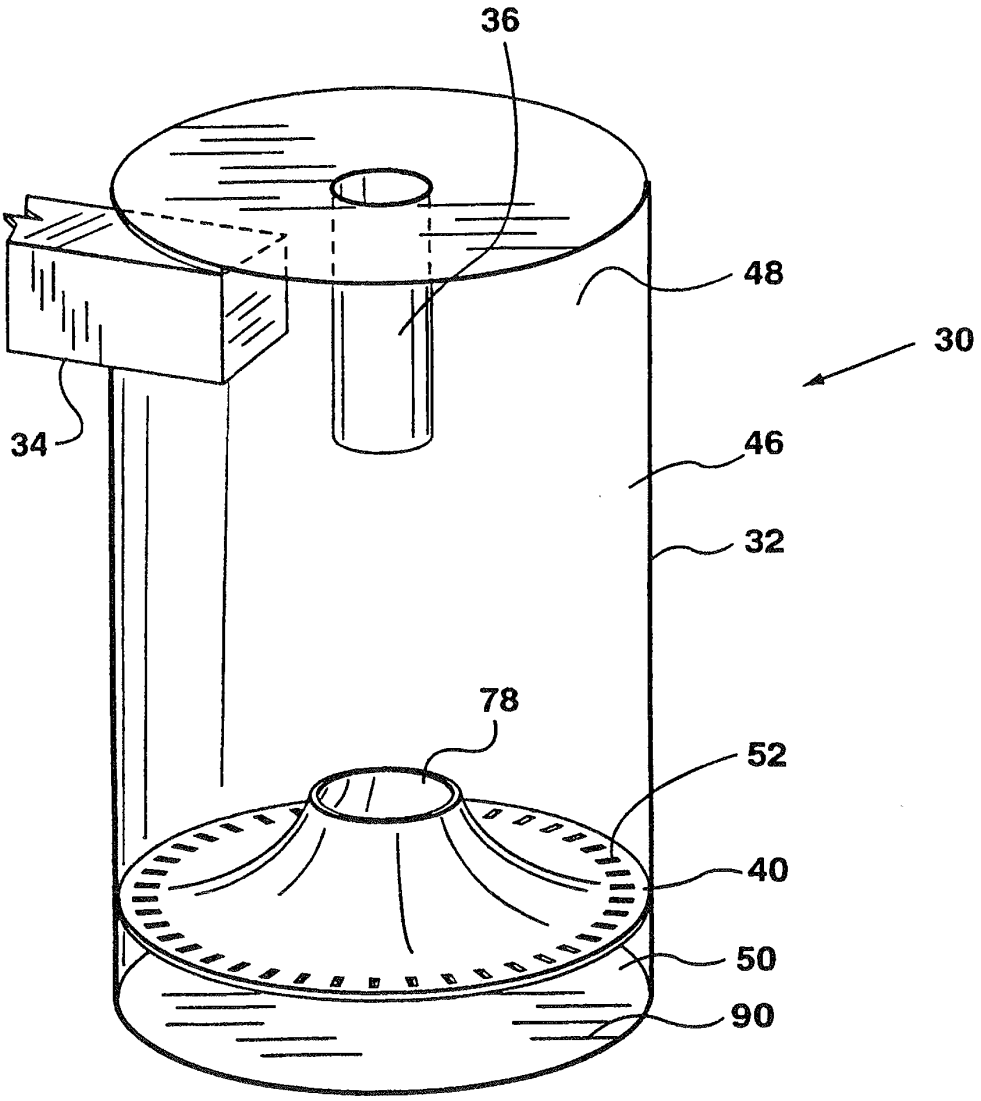


FIG. 18

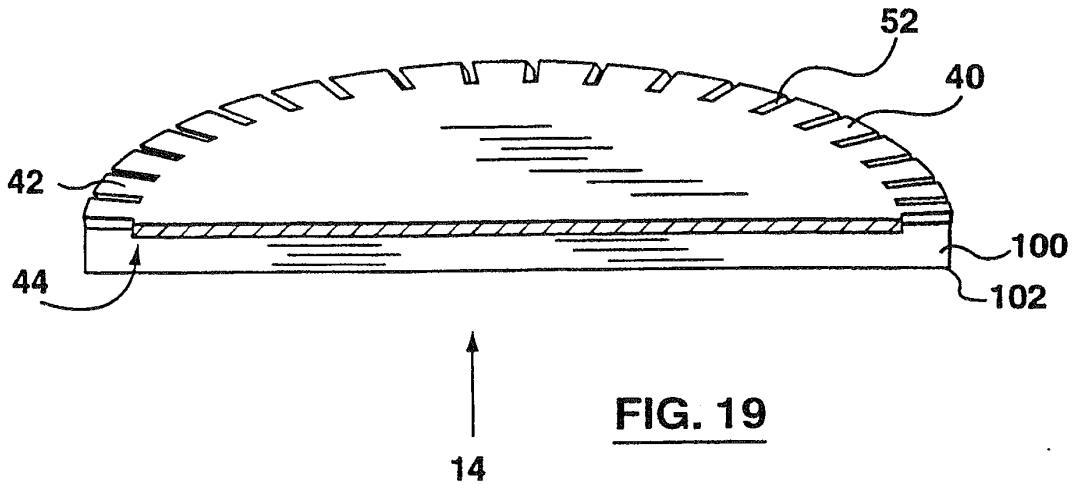


FIG. 19

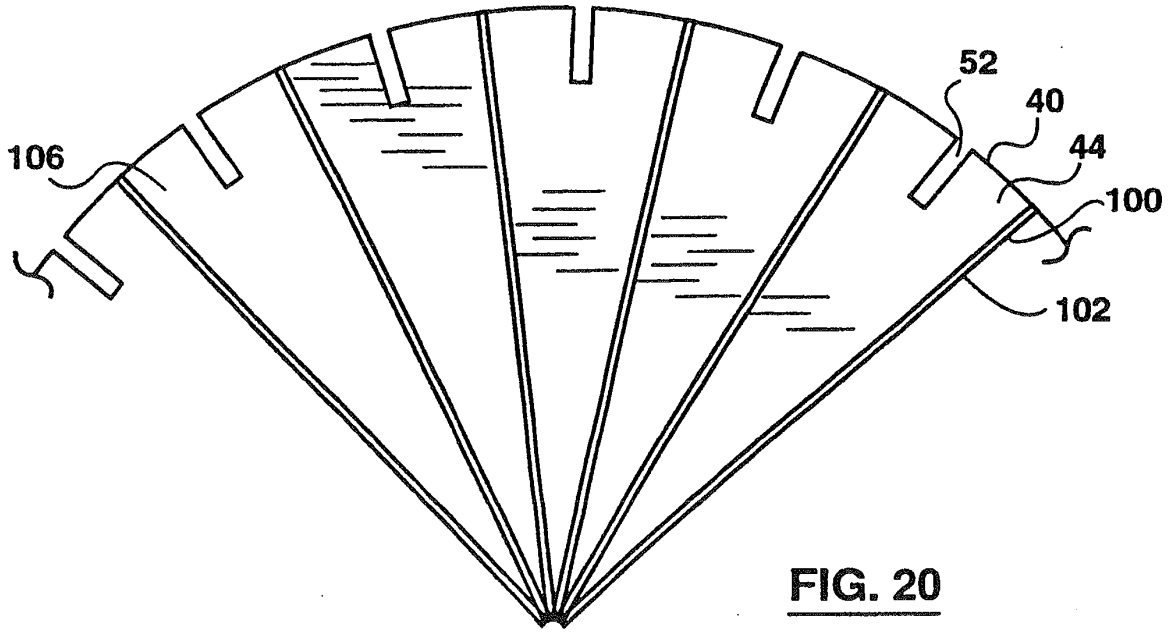


FIG. 20

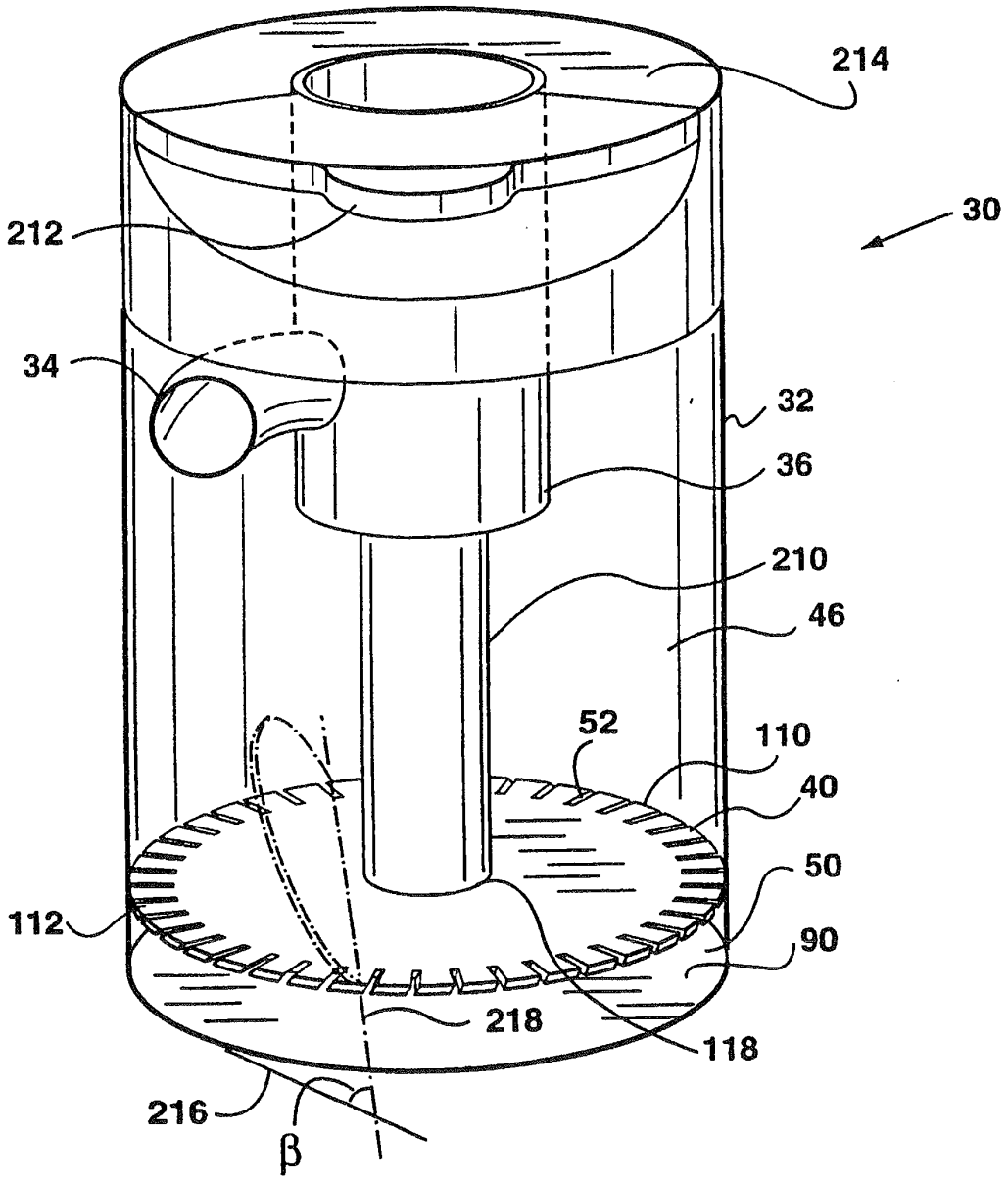


FIG. 21

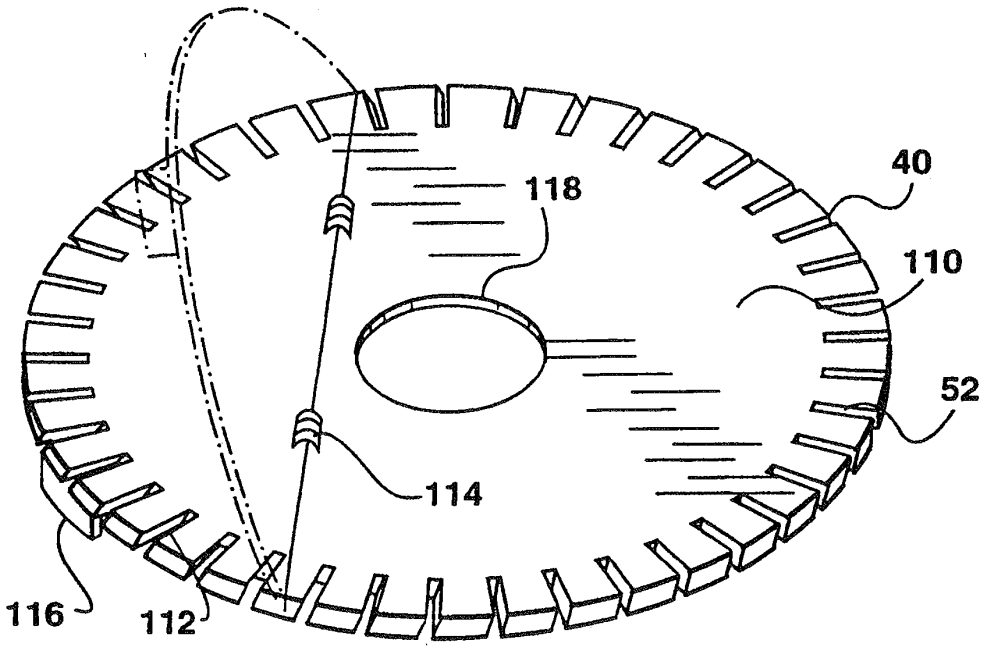


FIG. 22

(19) Europäisches Patentamt
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(11) EP 1 200 196 B1

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(86) International application number:
PCT/CA2000/000873

(87) International publication number:
WO 2001/007168 (01.02.2001 Gazette 2001/05)

(54) **APPARATUS AND METHOD FOR SEPARATING PARTICLES FROM A CYCLONIC FLUID FLOW**

VORRICHTUNG UND VERFAHREN ZUM ABTRENNEN VON TEILCHEN AUS EINEM ZYKLONARTIGEN FLUIDSTROM

APPAREIL ET PROCEDE POUR LA SEPARATION DE PARTICULES DANS UN ECOULEMENT DE FLUIDE CYCLONIQUE

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

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(60) Divisional application:
04078261.7 / 1 512 362

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GB-A- 2 282 979
US-A- 1 937 765
US-A- 2 981 369
US-A- 3 988 132
US-A- 4 486 207

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EP 1 200 196 B1

Description

[0001] The present invention relates generally to cyclonic separators. In one particular application, the invention relates to the cyclonic separation of particulate material from an air flow. In a preferred embodiment, the cyclonic separator is used in a vacuum cleaner to remove entrained particulate matter from an air stream.

BACKGROUND OF THE INVENTION

[0002] The use of a cyclone, or multiple cyclones connected in parallel or series, has long been known to be advantageous in the separation of particulate matter from a fluid stream. Typically, a relatively high speed fluid stream is introduced tangentially to a generally cylindrical or frusto-conical container, wherein the dirty air stream is accelerated around the inner periphery of the container. The centrifugal acceleration caused by the travel of the fluid in a cyclonic stream through the cyclone causes the particulate matter to be disentrained from the fluid flow and, eg., to collect at the bottom of the container. A fluid outlet is provided for the extraction of the fluid from the centre of the top of the cyclone container, as is well known in the art.

[0003] A typical flow path in a cyclone separator is as follows. Fluid to be treated is introduced tangentially at a fluid inlet located at an upper end of the cyclone container. The fluid stream rotates around the inner surface of the cyclone container, and spirals generally downwardly around the inner surface of the container (if the cyclone container is vertically disposed). At a bottom end of the cyclone container the fluid stream travels radially inwardly, generally along the bottom of the container and then turns upwardly and proceeds vertically up and out of the cyclone container. The particulate matter separating action of the cyclonic flow occurs substantially around the inner surface of the container. Once the fluid moves inwardly to the centre of the container, and upwardly there through, there is little or no dirt separation achieved.

[0004] The difficulty experienced with prior art cyclonic separators is the reentrainment of the deposited particles back into the outgoing fluid flow. Deposited particles exposed to a high speed cyclonic flow thereover have a tendency to be reentrained. This is particularly problematic when the container has a solid bottom portion in which the dirt collects. However, there is a potential reentrainment problem even if the bottom of the container has a passageway provided in the bottom thereof to convey the separated particulate material away from the container.

[0005] If a high degree of separation is required, it is known to connect a plurality of cyclones in series. While using several cyclones in series can provide the required separation efficiency, it has several problems. First, if the separators are to be used in industry, they generally need to accommodate a high flow rate (eg. if they are to be used to treat flue gas). The use of a plurality of cyclones increases the capital cost and the time required to manufacture and install the separators. Further, the use of a plurality of cyclones increases the space requirements to house the cyclones as well as the back pressure caused by the air flow through the cyclones. These latter issues are particularly acute for cyclone separators which are to be contained in a small housing, such as a vacuum cleaner. Accordingly, there is a need for an improved anti-reentrainment means for cyclonic separators.

SUMMARY OF THE INVENTION

[0006] In has now been discovered that a single cyclone having improved efficiency (eg. up to 99.9% efficiency) may be manufactured by positioning in the cyclone chamber a particle separation member for creating a dead air space beneath the cyclonic flow region of the cyclone chamber wherein the dead air space is in communication with the cyclonic flow region by a plurality of openings or apertures in the member. This construction effectively traps separated material beneath the cyclonic flow region and inhibits the reentrainment of the separated material. Thus, a single cyclone may be used in place of a plurality of cyclones to achieve the same separation efficiency.

[0007] As the fluid flow travels through the cyclone chamber, a boundary layer forms. Generally, the interior surface of a cyclonic chamber is smooth so as to provide for an uninterrupted cyclonic flow in the chamber. However, in the chamber, a boundary layer is still formed on all surfaces over which the fluid passes. According to the instant invention, the system (i.e. the motor means to move the fluid through the chamber, the fluid inlet to the chamber, the fluid outlet to the chamber and/or the construction of the separation member) is designed to minimize the thickness of the boundary layer in the vicinity of the apertures in the separation member.

[0008] In particular, as the fluid travels over the upper surface of the particle separation member, a boundary flow layer will form. The boundary layer will thicken until a thickness is reached at which the boundary layer has sufficient energy to break off and travel away from the upper surface. Generally at this point, the fluid travels upwardly to the fluid outlet from the cyclone. When the boundary layer breaks off from the upper surface, vortices are formed in the fluid stream adjacent the apertures in the separation member causing localized turbulence. The turbulent flow reentrains particles that had been separated from the fluid flow and may even pull some of the separated particles out of the dead air space beneath the cyclonic flow region of the cyclone chamber.

[0009] Examples of prior art cyclonic separators are disclosed in, for example, US-A-4486207, WO-A-98/43721, DE-C-875134, US-A-2981369, DE-C-4232382 and US-A-3988132. However, in these prior art arrangements it is possible for particles which have

Dyson Ex1020
Page 983

been separated into a retaining volume to be re-entrained into the cyclonic flow region.

[0010] In accordance with the instant invention, there is provided a separator for separating entrained particles from a fluid flow, the separator comprising:

(a) a cyclone chamber for containing a cyclonic flow in a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion;
(b) means for introducing a fluid flow to the cyclone flow region for cyclonic rotation therein; and
(c) means for removing the fluid flow from the cyclone chamber;
characterized by
(d) particle receiving means disposed beneath the cyclone flow region for receiving particles separated from the fluid flow; and
(e) separation means disposed beneath at least a portion of the cyclone flow region and positioned to be contacted by the cyclonic flow in the cyclonic flow region and configured to inhibit re-entrainment of particles from the particle receiving means to the cyclonic flow region, the separation means having apertures and being positioned to connect the particle receiving means in flow communication with the cyclonic flow region such that, in operation, particles pass through the apertures to the particle receiving means.

[0011] In one embodiment, the particle receiving means comprises a sealed chamber except for the apertures and the separator further comprises emptying means for emptying the particle receiving means.

[0012] The particle receiving means may comprise a sealed chamber except for the apertures and the separator may further comprise emptying means for emptying the particle receiving means.

[0013] In another embodiment, the separator further comprises means for connecting the particle receiving means in flow communication with a conduit for transporting separated particles downstream from the particle receiving means.

[0014] In another embodiment, the separator further comprises aerodynamic means associated with the apertures for directing particles from the cyclonic flow region into the particle receiving means.

[0015] In another embodiment, the particle separating means extends under all of the cyclonic flow region to define a bottom surface of the cyclonic flow region.

[0016] In another embodiment, the apertures are positioned beneath only one or both of the peripheral and inner portions of the cyclonic flow region.

[0017] In another embodiment, the apertures are distributed regularly around the separating means.

[0018] In another embodiment, the fluid contacts only a portion of the separating means and the apertures are positioned only in said portion.

[0019] In another embodiment, the apertures comprise openings in the separation means.

[0020] The separator may be used in an upright vacuum cleaner. Accordingly, the separator may further comprise a cleaner head adapted for movement over a floor and having a fluid nozzle positionable adjacent the floor, the nozzle in fluid flow communication via a passageway with the separator fluid inlet, a handle for moving the cleaner head over the floor, and a casing for housing the cyclone chamber. The casing is preferably pivotally mounted to the cleaner head. The separator may be used in a canister or a central vacuum cleaner. Accordingly, the passageway may further comprise a flexible portion that is positioned external of the cleaner head and the casing and the handle is affixed to the cleaner head.

[0021] In one embodiment, the apertures are sized to inhibit elongate particles from passing there through, whereby elongate particles collect on top of the particle separating member.

[0022] The apertures may comprise slits having longitudinally extending upstream and downstream edges relative to the fluid flow and transversely extending sides and the edges may be longer than the sides.

[0023] The length of the edges may be substantially aligned with the radial width of the cyclone chamber.

[0024] The length of the edges may define a longitudinally extending axis which are at an angle of up to 45° to the radius of the cyclonic flow region.

[0025] The apertures may have a radial outer end and a radial inner end and the radial outer end may be positioned adjacent the outer wall of the cyclone chamber.

[0026] The apertures may have an upstream edge and downstream edge, relative to the fluid flow and the thickness of the particle separating member may be reduced adjacent the upstream edge of the apertures.

[0027] The separation means may have an upper surface and a lower surface and the upper surface may be angled towards the particle receiving means adjacent the upstream edge and the lower surface may be angled away from the aperture adjacent the downstream edge.

[0028] The separation means may be disposed substantially perpendicularly to a longitudinal axis of the cyclonic flow region.

[0029] The separator may be constructed to reduce turbulent fluid flow in the vicinity of the apertures.

[0030] The separator may further comprise a fluid pump for causing the fluid to flow through the separator, wherein the fluid flow through the cyclone chamber is pulsed.

[0031] The separator may further comprise a moveable closure member on one of means for introducing a fluid flow to the cyclone flow region and means for removing the fluid flow from the cyclone flow region for causing a pulsed fluid flow through the cyclone chamber.

Dyson Ex1020
Page 984

[0032] in one embodiment, the separation means has from 5 to 35 apertures.

[0033] In another embodiment, the number of apertures in the separation means is calculated by the formula:

$$\text{number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of the cyclonic flow region

D= the Diameter of the cyclone chamber

[0034] In another embodiment, the cyclone chamber has a diameter and each aperture has a longitudinally extending upstream edge and a longitudinally extending downstream edge, relative to the fluid flow, and transverse sides extending between the edges, the edges have a length which is less than 10% of the diameter of the cyclone chamber and the sides have a length which is 25 - 35% of the length of the edges.

[0035] In another embodiment, the edges are substantially radially aligned with the cyclone chamber.

[0036] In another embodiment, each aperture has an upstream edge and a downstream edge, relative to the fluid flow, and the upstream edge is angled towards the particle receiving means, the included angle between the upstream edge and the upper surface of the separation means is from 15 to 90°.

[0037] In another embodiment, each aperture has an upstream edge and a downstream edge, relative to the fluid flow, and the downstream edge is angled towards the particle receiving means, the included angle between the downstream edge and the upper surface of the separation means is from 15 to 90°.

[0038] In another embodiment, the fluid flow changes direction and travels to means for removing the fluid flow from the cyclone chamber at a position as it travels over the separation means and the separator further comprising a baffle positioned beneath the separation means at a position 10 to 20° downstream of the position at which the fluid flow changes direction.

[0039] In another embodiment, the separation receiving means has a bottom to comprise a sealed chamber except for the apertures and the baffle extends between the separation means and the bottom of the separation receiving means.

[0040] The separator may include means for reducing the thickness of the boundary layer of fluid as it travels over the separation means.

[0041] In one embodiment, the means for reducing the thickness of the boundary layer comprises means for pulsing the fluid flow through the cyclone chamber. The means for pulsing the fluid flow through the cyclone chamber may comprise means for pulsing an electrical signal to the fluid pump means. Alternately, or in addition, the means for pulsing the fluid flow through the cyclone chamber may comprise means for cyclically opening and closing one of the means for introducing a fluid flow to the cyclone flow region and the means for removing the fluid flow from the cyclone chamber.

[0042] In another embodiment, the means for reducing the thickness of the boundary layer comprises constructing and positioning the apertures means to reduce turbulent fluid flow over the separation means.

[0043] In another embodiment, the means for reducing the thickness of the boundary layer comprises constructing and positioning flow disruption means beneath the separating means for disrupting cyclonic fluid flow in the particle receiving means.

[0044] The apertures may be aerodynamically shaped to direct particles from the cyclonic flow region into the particle receiving means.

[0045] The separator may further compris a plurality of baffle means positioned in the particle receiving means.

[0046] The baffle means may depend downwardly from the separation means.

[0047] The particle receiving means may have a bottom surface and the baffle means may be spaced from said bottom surface to define an open area between the baffle means and the bottom surface.

[0048] The baffle means may extend to a position adjacent said bottom surface.

[0049] A baffle means may be disposed adjacent each aperture.

[0050] The baffle means may be disposed downstream of said apertures.

[0051] The apertures may have a longitudinal length and the baffle means may comprise a main body and a second portion, the main body portion having at least the same longitudinal length as said apertures and extending in a direction transverse to air flow along the upper surface of the separation means and the second portion may extend at an angle to the main body portion at a position that does not underlie the aperture.

[0052] The second portion may be disposed substantially perpendicularly to the main body portion.

[0053] The second portion may extend upstream from the main body portion.

[0054] The apertures may have longitudinally extending upstream and downstream edges and the baffle means may have a portion that is at least the same length as the edges.

[0055] The apertures may comprise slits having longitudinally extending upstream and downstream edges relative to the fluid flow and transversely extending sides and the edges may be longer than the sides.

[0056] The length of the edges may be substantially aligned with the radial width of the cyclone chamber.

[0057] The length of the edges may define a longitudinally extending axis which are at an angle of up to 45° to a radial line extending outwardly from the centre of the cyclone chamber.

[0058] The separator may further comprise access means for selectively providing access to the particle receiving means via the separation means.

Dyson Ex1020
Page 985

[0059] The access means may form part of the separation means and, when in the open position, may provide an opening between the particle receiving means and the cyclone chamber.

[0060] The access means may be freely moveable between its open and closed positions whereby the access means moves to its open position when the chamber is inverted.

[0061] The access means may have a connecting portion which is pivotally connected to the separation means.

[0062] The separator may further comprise a weighted member connected to the access means at a position spaced from the connecting portion.

[0063] The access means and the separation means may form a surface that underlies all of the cyclonic flow region.

[0064] The access means may comprise a chord section of the separation means.

[0065] The prior art teaches the need for a plurality of cyclones in order achieve ultra-high particle separation efficiencies. However, it has been found that ultra-high efficiencies can be obtained in a single stage cyclone incorporating the particle separation member of the present invention. Accordingly, cleaning efficiencies in excess of 99% may be obtained with a single stage separator utilizing a separator according to the present invention, thereby negating the need for second stage cyclonic separation altogether. Cleaning efficiencies of over 99.5% have also been achieved for particle laden air streams.

[0066] Also disclosed herein is a method for separating entrained particles from a fluid flow, the method comprising the steps of introducing a fluid to flow cyclonically in a chamber having a cyclonic flow region, the cyclonic flow region having a radial width, an outer peripheral portion, a medial portion disposed interior of the peripheral portion and an inner portion disposed interior of the medial portion, removing particles from the fluid flow in the cyclone chamber via passages provided beneath one or both of the peripheral and inner portions, and removing the fluid flow from the chamber.

[0067] In one embodiment, the method further comprises the steps of storing the particles removed from the fluid flow and inverting the chamber to remove the separated particles.

[0068] In another embodiment, the method further comprises the step of transporting separated particles downstream from the chamber.

[0069] In another embodiment, the separator comprises the dirt separation mechanism for a vacuum cleaner and the method further comprises passing a cleaning head over a surface to clean the surface.

[0070] In another embodiment, the method further comprises directing particles to pass into the passages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0071] For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made by way of example to the accompanying drawings of a preferred embodiment of the present invention, in which:

Figure 1 is a perspective view of a household vacuum cleaner incorporating a cyclone separator according to the present invention;

Figure 2 is a front elevational view of the vacuum cleaner of Figure 1;

Figure 3 is a side elevational view of the vacuum cleaner of Figure 1;

Figure 4 is a cross-sectional view along the line 4-4 in Figure 1;

Figure 5 is a cut away perspective view of the cyclonic separation member of Figure 1 when removed from the vacuum cleaner;

Figure 6 is a cross-sectional view along the line 6-6 in Figure 2 with the bin removed;

Figure 7 is a cut away perspective view of an alternate embodiment of the cyclonic separation member of Figure 5;

Figures 8 and 9 are cross-sectional views along the line 6-6 in Figure 2 showing alternate configurations of the particle separation member of the present invention;

Figure 10 is an enlarged cross-section view of the particle separator member of the present invention, showing aperture detail;

Figure 11 is a sectional perspective view of the particle separator member having baffle members according to the present invention;

Figure 12 is an enlarged bottom plan view in the direction of arrow 12 of the baffles of Figure 11;

Figures 13 -15 are top plan views of various alternate configurations of the particle separation member of the present invention;

Figure 16 is a sectional side view of an alternate embodiment of the particle separator member of the present invention;

Figure 17 is an isometric view of a further alternate embodiment of the particle separator member of the present invention;

Figure 18 is an isometric view of a further alternate embodiment of the particle separator member of the present invention;

Figure 19 is a sectional perspective view of and alternate embodiment of the baffle members according to the present invention;

Figure 20 is a bottom plan view of the baffle members of Figure 19;

Figure 21 is an enlarged perspective view of the bin of Figure 1 when removed from the vacuum cleaner; and,

Figure 22 is an enlarged perspective view of the ac-

Dyson Ex1020
Page 986

cess member of Figure 21.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0072] The improvements in cyclonic separators described herein may be used with or in place of cyclonic separation devices of any sort which are used to separate particulate material from a fluid stream. For example, they may be used with a fluid stream consisting of one or more gasses such as industrial dust collection systems (eg. flue gas scrubbing), they may be used to classify particles according to their size or they may be used with a fluid stream consisting of one or more liquids (eg. a hydrocyclone) or with fluid streams comprising a gas/liquid mixture. It will be appreciated that they these cyclone separators may be used in any manner known in the particle separation art.

[0073] For example, the separation member according to the present invention may also be employed in the classification and/or sorting of particles by size. Particles to be sorted are entrained in a fluid flow and introduced to a cyclonic separator having a separation member according to the present invention, the separation member having a first aperture size. Particles smaller than the first aperture size are permitted to pass through the separation member and into a hopper for transfer to a subsequent cyclonic separator while larger particles are collected on top of the particle separator. The particles passing through the separation member are introduced cyclonically to a second cyclone having a separation member with apertures of a second, smaller size, relative to the first cyclone. As in the first cyclone, particles smaller than the second aperture size are permitted to pass through the separation member and into a hopper for transfer to a third cyclonic separator, while larger particle remain on the separation member in the second cyclone chamber. This process is repeated, as required, until the particles are classified as needed.

[0074] In one preferred embodiment, the cyclonic separator is used as a dirt separation means of a vacuum cleaner. As shown in Figure 1, as the cyclonic separator of this invention may have a dirt separation efficiency of 99.95% or higher, the vacuum cleaner may use only a single cyclonic separator and, in fact, the single cyclonic separator of this invention may be the only dirt separation means used in the vacuum cleaner. As is known in the art after filters (i.e. a filter positioned downstream from the motor of the vacuum cleaner) may optionally be provided, eg. a HEPA filter to remove very small quantities of particulate matter such as the carbon dust which is produced by the motor.

[0075] In the application as exemplified in Figures 1 to 5, particle separation member 30 is shown as the cyclone separator for vacuum cleaner 200. While separator 30 may be used in any vacuum cleaner (eg. an upright, a canister, a backpack cleaner or a central vacuum cleaning system), the following discussion describes the use of particle separation member 30 in an upright vacuum cleaner.

[0076] As exemplified in Figures 1 and 5, vacuum cleaner 200 has a floor cleaning head 202, means for moving cleaning head 202 across a floor (eg. wheels 204), main casing 206 rotatably attached to cleaner head 202, and a handle 208 for moving cleaner 200 across the floor. Main casing 206 houses separator 30. In this embodiment, a single separator 30 is used and comprises a central air feed conduit 210 in air flow communication with dirty air inlet 220 adjacent the floor in cleaner head 202 (see Figures 4 and 5) at one end and in air flow communication with curved air inlet 34 at the other end. Rotatably mounted brush 222 may be positioned in dirty air inlet 220.

[0077] Bin 32 may be removable from main casing 206 by any means known in the art (see Figure 21), such as by the application of pressure by the hand of a user to handle 212, so that collected dirt may be removed from bin 32.

[0078] Cyclonic separator 30 comprises a bin 32 having an open end 214, an inlet 34 for delivering a cyclonic fluid flow to separator 30 and an outlet 36 for removing fluid from the separator. Inlet 34 need not be tangential but may be of any configuration which is capable of providing a cyclonic fluid flow to bin 32, such as an axial or screw cyclone inlet. Disposed in a lower portion of bin 32 is a separation member 40 which comprises a flat, disc-like member, having an upper face 42 and a lower face 44, and which substantially divides bin 32 into a cyclone chamber 46, having a cyclonic flow region 48 defined therein, and a particle receiving chamber 50. Separation member 40 may be made of plastic plate having a thickness of, eg. 1/40 of the diameter of bin 32. Cyclone chamber 46 and particle receiving chamber 50 communicate only via a plurality of apertures 52 in separation member 40. Apertures 52 comprise a plurality of openings or slits 54, each having an upstream edge 56 and a downstream edge 58 relative to the direction of cyclonic fluid flow in cyclone chamber 46 (arrow C), longer than the transverse width and oriented generally radially with respect to bin 32 (see Figure 5). Particle receiving chamber 50 comprises a chamber extending between lower face 44 and bottom face 90 of bin 32. Particle receiving chamber 50 preferably comprises about 10% of the volume of bin 32.

[0079] In use, a particle-laden fluid stream is introduced to cyclone chamber 46 via inlet 34 to flow cyclonically therein. The cyclonic flow proceeds rotationally around and downwardly through bin 32. The fluid stream is accelerated as it comes into the region of influence of particle separation member 40 which causes the fluid to change direction towards the central portion of cyclonic flow region 48 in cyclone chamber 46 (eg. around central air feed conduit 210) and is ultimately removed from cyclone chamber 46 via outlet 36. As the cyclonic fluid flow moves cyclonically down along inner wall 38 of cyclone chamber 46, it encounters separation member 40

Dyson Ex1020
Page 987

and travels across separation member 40. The change in speed and direction of the fluid stream as it flows through cyclone chamber 46 causes particles entrained in the fluid stream to become disentrained. These separated particles have a greater mass and continue to accelerate towards separation member 40 where (depending on particle size) they pass through apertures 52 into particle receiving chamber 50. The separated particulate matter collects in particle receiving chamber 50. Larger particles separated from the fluid flow by the cyclonic action and incapable of passing through apertures 52 accumulate on upper surface 42 of separation member 40.

[0080] The reentrainment of deposited particles into the cyclonic flow is related to the speed and degree of cyclonic flow of fluid passing over deposited particles. Accordingly, any reduction in the cyclonic flow of the fluid within the particle receiving chamber will beneficially enhance the anti-reentrainment properties of the separator. To that end, referring to Figure 11 particle receiving chamber 50 may be provided with one or more baffles 100. The baffles operate to reduce and preferably stop the cyclonic flow of air beneath particle separation member 40. Thus particle receiving chamber 50 forms a dead air space beneath cyclonic flow region 48.

[0081] It will thus be appreciated that separation member 40 assists in particle separation in several ways. First, by providing a discontinuous surface, it disrupts the cyclonic flow thus assisting in separating entrained particulate matter from the fluid stream. Secondly, if provides an area (particle receiving chamber 50) which is separate from cyclone chamber 46. If a portion of the fluid stream enters particle receiving chamber 50, the cyclonic flow may be slowed or terminated thus allowing entrained particulate matter to separate out without the potential for reentrainment.

[0082] In use, an air flow is created by a motor 224 (eg. the fluid pump means) in vacuum cleaner 200 to draw air from, eg., from dirty air inlet 220, through passageway 226 in cleaner head 202, through centre air feed conduit 210 and into cyclone chamber 46 via inlet 34. Cyclonic flow is maintained in cyclone chamber 46 thereby causing particles entrained in the cyclonic flow to be deposited, with smaller particles passing through apertures 52 into particle receiving chamber 50, while larger particles (eg. elongate particles such as hair, carpet fibres and the like) are deposited on upper surface 42 of separation member 40. Air then exits cyclone chamber via air outlet 36, through motor 224 and then exits the cleaner via outlet 228. the finer dirt tends to be separated and deposited in particle receiving chamber 50. Therefore, after operation of vacuum cleaner 200, particles of varying size may have collected in bin 32 both above and below separation member 40.

[0083] In the embodiment of Figure 7, cyclonic separator 30 is used to separate material entrained in an industrial fluid stream. In order to allow the separated material to be collected without interrupting the flow of fluid through cyclonic separator 30, particle receiving chamber 50 is provided with a hopper 60 having a sloping wall 62 leading to a hopper exit 64. Hopper exit 64 communicates with a particle transport conduit 66 for transporting received particles away from receiving chamber 50. Hopper 60 collects separated particles for removal by transport conduit 66 (such as due to gravity flow).

[0084] It will be appreciated that cyclone chamber 46 may be of any design known in the art. Inner wall need not be cylindrical as shown in Figure 1 but may be of any shape known in the art. Further, inlet 34 and outlet 36 may be positioned at any location and more than one inlet and outlet may be used.

[0085] The location of apertures 52 have been found to affect the particle separation characteristics of separation member 40 for a given cyclone configuration and application. It has been found that the anti-reentrainment characteristics of separation member 40 are enhanced if apertures 52 are concentrated beneath peripheral portion 70 of cyclonic flow region 48 (see Figure 6), inner portion 72 of cyclonic flow region 48 (see Figure 8), or both peripheral portion 70 and inner portion 72 (see Figure 9) thereby leaving medial portion 74 substantially free from apertures 52. If apertures 52 are provided beneath medial portion 74 without any means provided in particle receiving chamber 50 for preventing any substantial (and preferably all) cyclonic flow in particle separating chamber 50, then some of the particulate material in particle separation chamber 50 will be reentrained into the air flow in cyclone chamber 46. Accordingly, it is preferred that there are no apertures 52 beneath medial portion 74 when there are no means (eg. baffles) to prevent cyclonic flow in particle separation chamber 50. It will be appreciated that a few apertures 52 may be provided in medial portion 74 without creating substantial reentrainment.

[0086] Preferably, peripheral portion 70 comprises approximately the outermost one quarter of the radial width 76 of cyclonic flow region 48, and inner portion 72 comprises approximately the innermost one quarter of the radial width 76 of cyclonic flow region 48. Medial portion 74 therefore comprises half of the radial width 76.

[0087] If a cyclone separator configuration is varied, the shape and size of cyclonic flow region 48 will vary. For example, referring to Figure 6, cyclone bin 32 having central air feed conduit 210 results in an annular-shaped cyclonic flow region 48. As a result, cyclonic flow region 48 has a radial width 76 between central air feed conduit 210 and inner wall 38. However, if there is no member positioned in bin 32 (as shown in Figures 8 and 9), then cyclonic flow region 48 has a radial width 76 which extends from central axis A to inner wall 38. Bin 32 may have a non-circular cross-section (eg. elliptical) or any non-curvilinear cross-section which permits a substantially cyclonic flow therein. Also, the radial width of cyclone chamber 46 may vary along its longitudinal length (i.e. in the direction of axis A), and may be, eg., cylindrical, frusto-conical or any other shape having beneficial

Dyson Ex1020
Page 988

cyclonic particle separation characteristics.

[0088] Apertures 52 may be of any particular shape. For example, they may be circular (see Figure 14), rectangular (see Figure 19), triangular, or other regular or irregular shape. Preferably, if apertures 52 are located against the inner or outer edge of separation member 40, then they have only one wall 57. For example, as shown in Figure 5, apertures 52 extend all the way to inner wall 38 of bin 32 while in Figure 9 they terminate inwardly of inner wall 38. While apertures 52 may be any shape, in a preferred embodiment, they have a length greater than their width. In particular, as shown in Figure 11, upstream and downstream edges 56, 58 are preferably longer than the spaced opposed sides 57 extending between edges 56, 58 (eg. edges 56, 58 are preferably at least twice the length of sides 57) so that apertures 52 define slits.

[0089] As shown in Figure 11, slits 54 may extend generally radially (i.e. edges 56, 58 may extend generally radially). However, as shown in Figure 13, slits 54 may be angled slightly, relative to radial width 76, so that the outer edge 82 of an aperture 52 is upstream of the inner edge 84, relative to the cyclonic air flow (indicated by arrow C). The angle α of slits 54 relative to radial width 76 may be up to 45°.

[0090] Preferably apertures 52 extend radially and edges 56, 58 have a length L which is about 10% or less of diameter D of bin 32 and sides 57 have a length W (i.e. the width of the apertures) which is about 5% or less of diameter D of bin 32 (see Figure 11). More preferably, length W is about 25 to 35% of length L.

[0091] Apertures 52 may be equidistantly spaced apart around separation member 40 (see Figures 6 - 9) or they may be positioned with different spacings between adjacent apertures 52. Further, apertures 52 may be continuously positioned around all of separation member 40 (see Figures 6 - 9) or apertures 52 may be positioned around only a portion of separation member 40 (see Figure 15). Distributing apertures 52 over only a region may be beneficial where only a portion of dirt separation member 40 is contacted by the cyclonic flow in bin 32. This may be used, for example, if bin 32 has a single inlet 34. In such a case, the sector of separation member 40 which will be contacted by the cyclonic flow may be predetermined and apertures 52 provided only in that sector.

[0092] Preferably, particle separation member 40 will have from about 5 to about 35 apertures 52. The number of apertures 52 which may be required for a particular system may be determined by the formula:

$$\text{Number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of cyclonic flow region 48

D= the diameter of bin 32 (see Figure 5)

The formula provides a rough approximation of the ideal number of apertures 52 for a particular system (i.e. within 20%). The actual number of apertures which are required for maximum separation efficiency for a particular system may vary slightly from the formula.

[0093] It should be noted that dust separation member 40 need not be positioned perpendicular to the cyclonic (ie. longitudinal) axis of cyclonic flow region 48 in cyclone chamber 46. In particular separation member 40 may be at an angle to the axis.

[0094] Referring now to Figure 16, separation member 40 need not extend across the entirety of cyclonic flow region 48, but rather may be disposed in only the portion of cyclonic flow region 48 beneath which apertures 52 are to be provided. By way of example only, Figure 16 shows a separation member 40 which comprises an annular ring 86 disposed beneath peripheral portion 70 of cyclonic flow region 48. Particle receiving chamber 50 is disposed thereunder, between bin 32 and an inner wall 88. It will be understood by one skilled in the art that separation member 40 may equally have any other configuration suitable for a given separator application without departing from the scope of the present invention. It will be appreciated, for example, that separator 40 may comprise an annular ring positioned beneath inner portion 72 of cyclonic flow region 48.

[0095] Referring to Figures 17 and 18, respectively, separation member 40 need not be disc-shaped, but may also be conical or trumpet-shaped. It may be convex (i.e. it may project into particle receiving chamber 50 as shown in Figure 17) or it may be concave (i.e. it may project away from particle receiving chamber 50 as shown in Figure 18). It will be appreciated that separation member 40 need not define a continuous surface. For example, as shown in Figure 18, it may have a curved surface in which apertures 52 are provided and a flat central top portion 78.

[0096] Referring to Figure 10, edges 56 and 58 may be aerodynamically shaped to enhance the performance of separation member 40. For example, the thickness of particle separation member 40 is preferably reduced adjacent the upstream edge 56. Referring to Figure 10, aperture 52 has a sloped upstream edge 56 to assist in directing air and particles from cyclone chamber 46 to particle receiving chamber 50. Upstream edge 56 is preferably sloped with respect to upper surface 42 such that the included angle α' is from 15 to 90° and an included angle less than 30° is more preferred. The thickness of downstream edge 58 of particle separation member 40 may be substantially unchanged. Alternately, aperture 52 is preferably shaped such that downstream edge 58 is sloped with respect to upper surface 42 to assist in directing air and particles from cyclone chamber 46 to particle receiving chamber 50. Preferably, the included angle α'' is from 15 to 90° and an included angle less than 30° is more preferred.

[0097] Preferably, baffles 100 are provided on lower surface 44 and extend away from particle separation member 40. If separator 30 has a bottom 90, then pref-

Dyson Ex1020
Page 989

erably, baffles 100 extend from lower surface 44 towards bottom 90 but do not touch bottom 90. Baffles 100 preferably extend approximately three-quarters of the distance from lower surface 44 of separation member 40 to the bottom 90 of particle receiving chamber 50, but may be longer or shorter if desired. Preferably baffles 100 are parallel to the longitudinal axis of cyclone bin 32.

[0098] As shown in Figures 19 and 20, a baffle 100 is preferably disposed adjacent each aperture 52 on the downstream side, relative to cyclonic flow in cyclonic chamber 46 (arrow C). For example, a baffle 100 may be offset 15° downstream from its associated aperture 52. It will be appreciated that a baffle 100 need not be associated with each aperture 52. Preferably the baffles are immediately downstream of each aperture 52.

[0099] Baffles 100 comprise a wall 102 which may extend radially inwardly or which may be curved. Preferably wall 102 is substantially parallel to aperture 52 along its length. Wall 102 extends at least coterminously with the length of edges 56, 58 apertures 52. Preferably, wall extends at least three times the length of edges 56, 58.

[0100] As shown in Figures 11 and 12, baffle 100 may also have a lateral wall 104 disposed adjacent outer and/or inner edges 82 and 84 of aperture 52. Wall 104 preferably extends from wall 102 in the upstream direction. If an aperture 52 is disposed in peripheral portion 70, baffle 100 preferable has one lateral wall 104 only, disposed adjacent inner edge 84. Wall 102 is positioned inward of edge 84 so as to define a dead air space beneath aperture 52. If an aperture 52 is located in inner portion 72, baffle 100 preferably has a lateral wall 104 disposed adjacent inner edge 84 and outer edge 82 of aperture 52 (not shown). Walls 104 may thus effectively define an open central area in particle receiving chamber 50.

[0101] Baffles 100, configured as a wall 102 alone or in conjunction with a lateral wall 104, reduce and preferably stop the cyclonic nature of the fluid flowing beneath separation member 40. Referring to Figures 19 and 20, baffles 100 may extend from the wall of bin 32 to its centre to effectively divide particle receiving chamber 50 into a plurality of pie-shaped compartments 106 within particle receiving chamber 50. This configuration substantially inhibits any fluid flow, cyclonic or otherwise, within compartments 106, thereby beneficially enhancing the anti-reentrainment of characteristics of separation member 40.

[0102] Preferably, as shown in the embodiment of Figures 2, 4, 5 and 7, a single baffle 100 is provided beneath particle separation member 40. As shown in these embodiments, baffle 100 extends vertically between bottom 90 and lower face 44 and radially outwardly from central air feed conduit 210 to inner wall 38. In this embodiment, baffle 100 is preferably positioned about 10 to 20° downstream from the point T where the cyclonic flow changes direction to flow upwardly through cyclonic flow region 48 (see figures 5 and 6).

[0103] Although as described above, it is desirable to position apertures 52 in peripheral portion 70 and/or inner portion 72 of cyclonic flow region 48, when baffles 100 are used in conjunction with apertures 52 the positioning of apertures 52 is less critical. In such a case, apertures 52 with baffles 100 may be positioned at any location along the radial width of particle separation member 40 and may be disposed in any one or more of inner portion 72, medial portion 74 and peripheral portion 70 of cyclonic flow region 48.

[0104] After operation of vacuum cleaner 200, particles of varying size may have collected in bin 32 both above and below separation member 40. To empty such collected contents, bin 32 is preferably removable from main casing 206, via, eg., handle 212, and inverted (typically over a refuse collector of the like) to cause the collected particles on upper face 42 to fall from bin 32 under the influence of gravity.

[0105] If cyclone separator has a closed bottom 90, then a door or the like is preferably provided to assist in emptying chamber 50. The door may be provided on the outer wall of bin 32. Preferably, particle separation member 40 is constructed to assist in emptying the contents of particle receiving chamber 50 when bin 32 is inverted. To this end, particle separation member 40 may be constructed to provide an opening when bin 32 is inverted (see for example Figures 21 and 22) or a door may be provided in bin 32 prior to inverting bin 32.

[0106] Pursuant to the first alternative, separation member 40 may comprise a main body 110 and an access member 112, as shown in Figure 22. Access member 112 comprises a chord section of separation member 40 pivotally connected to main body 110 by a hinge member 114 to swing between a closed position, substantially planar with main body 110 (as represented by the solid lines in Figures 21 and 22) and an open position, wherein access member 112 swings upwardly relative to main body 110 (as represented by the broken lines in Figures 21 and 22).

[0107] Referring again to Figure 21, when bin 32 is removed from vacuum cleaner 200 and inverted, access member 112, by virtue of its pivoting connection to main body 110, is permitted to freely swings to its "open" position under the influence of gravity, thereby permitting the contents of particle receiving chamber 50 to fall from particle receiving chamber 50 and out of bin 32. When bin 32 is returned to its upright position, the access member 112 falls to its closed position under the influence of gravity. To bias access member 112 towards its closed positioned when bin 32 is upright, access member 112 may optionally be provided with a weight 116, or a suitable spring means (not shown) or other biasing means known to those skilled in the art. Hole 118 is provided to permit centre air feed conduit 210 to pass there through.

[0108] The direction of the pivot axis 218 of hinge member 114 is preferably selected to assist access member 112 to remain closed while the vacuum cleaner is in use. If the vacuum cleaner is an upright vacuum

Dyson Ex1020
Page 990

cleaner in which particle separation member 40 is generally horizontally disposed position when main casing 206 is in the upright storage position (eg. separation member 40 is perpendicular to inner wall 38), then particle separation member 40 will be at an inclined position when main casing 206 is pivoted to the in use position. Access member 112 has a pivot axis 218 which is preferably not parallel to pivot axis 216 of the upper casing 206 of the vacuum cleaner. In such a case, no weight may be required. Preferably, pivot axis 218 of access member 112 is at an angle β of 10 - 50°, preferably 20° to 40°, and more preferably about 30° to the pivot axis 216 of upper casing 206 (see Figure 21).

[0109] Access member 112 is preferably provided in the rear portion of the cyclone bin 32 to prevent access member 112 from opening during use. In particular, all or a major portion of access member 122 is preferably positioned rearward of centre air feed 210 (i.e. towards handle 208). In such a case, no weight may be required.

[0110] As the fluid flow travels through bin 32, a boundary layer forms. A boundary layer is formed on top of particle separation member 40 as the fluid travels over upper surface 42 of particle separation member 40. The boundary layer will thicken until a thickness is reached at which the boundary layer has sufficient energy to break off and travel away from upper surface 42 (i.e. point T). When this occurs, vortices are formed in the fluid stream adjacent apertures 52 causing localized turbulence. The turbulent flow reentrains particles that had been separated from the fluid flow and may even pull some of the separated particles out of particle receiving chamber 50. According to the instant invention, separator 30 is preferably constructed to minimize the thickness of the boundary layer when it breaks off thereby reducing turbulent flow in the vicinity of apertures 52. The introduction of the separation member according to the present invention to a cyclonic separator dramatically increases the overall efficiency of the separator. The prior art teaches the need for a plurality of cyclones in order achieve ultra-high particle separation efficiencies. However, it has been found that ultra-high efficiencies can be obtained in a single stage cyclone incorporating the particle separation member of the present invention. Accordingly, cleaning efficiencies in excess of 99% may be obtained with a single stage separator utilizing the separator 30 according to the present invention, thereby negating the need for second stage cyclonic separation altogether. Cleaning efficiencies of over 99.5% have also been achieved for particle laden air streams.

[0111] Therefore, the present invention permits ultra-high efficiencies to be attained with relatively simple separator configurations compared to the prior art. The reduction of separator structure, in turn, beneficially reduces the fluid pressure losses across the separator, thereby permits a deeper vacuum (increased fluid flow rate) to be drawn for a given motor size. For household vacuum cleaner applications, back pressures of only 4 - 8 kpa may be obtained allowing the motor size to be reduced without sacrificing the vacuum strength of the device. The reduced structure and motor size also beneficially result in a cost and size savings to the overall separator unit.

[0112] The baffle members according to the present invention greatly enhance the performance of the separation member and greatly assist in obtaining ultra-high efficiencies. The projection of baffle members into the particle receiving chamber beneficially disrupts and, depending on the baffle configuration, substantially inhibits cyclonic flow in the particle receiving chamber, thereby reducing the reentrainment of deposited particles.

[0113] In another preferred embodiment, the separation efficiency of particle separation member 40 may be increased by pulsing the electrical signal to motor 224. The timing of the pulses is determined to reduce and preferably minimize the maximum thickness of the boundary layer of fluid as it travels over upper surface 42 in the vicinity of point T. This produces a pulsed fluid flow through bin 32. Alternately, such a pulsed flow may be mechanically produced such as by providing inlet 34 with an moveable closure member such as plate 120 to which a means is attached to cause the plate to cyclically open and close inlet 34, eg. a spring, a solenoid 122 having an arm 124 attached to plate 120, or the like. Alternately, the aperture closure member may be provided on outlet 36. These mechanical devices effect the back pressure in bin 32 so as to favour smooth (laminar) boundary layer flow as opposed to turbulent flow in the vicinity of apertures 52.

[0114] The separation member access means according to the present invention provides a simple and convenient method of emptying collected particles from two chambers simultaneously, namely larger particles deposited in the cyclone chamber (i.e. on top of the particle separation member) and finer particles deposited in the particle receiving chamber. This provides a simple and convenient automatic method of emptying dual chambers.

[0115] The superimposed particle separation member according to the present invention also provides a convenient method for emptying collected particles from two chambers simultaneously. To enhance the convenience, the movement of the superimposed members may be linked to open when the bin is removed from the main casing.

[0116] While the above description constitutes the preferred embodiments, it will be appreciated that the present invention is susceptible to modification and change without departing from the fair meaning of the proper scope of the accompanying claims.

Claims

1. A separator for separating entrained particles from a fluid flow, the separator comprising:

Dyson Ex1020
Page 991

(a) a cyclone chamber (46) for containing a cyclonic flow in a cyclonic flow region (48), the cyclonic flow region (48) having an inner wall (38), a radial width (76), an outer peripheral portion (70), a medial portion (74) disposed interior of the peripheral portion (70) and an inner portion (72) disposed interior of the medial portion (74);
(b) means (34) for introducing a fluid flow to the cyclone flow region (48) for cyclonic rotation therein; and
(c) means (36) for removing the fluid flow from the cyclone chamber (46);
characterised by:
(d) particle receiving means (50) disposed beneath the cyclone flow region (48) for receiving particles separated from the fluid flow; and
(e) separation means (40) disposed beneath at least a portion of the cyclone flow region (48) and positioned to be contacted by the cyclonic flow in the cyclonic flow region (48) and configured to inhibit re-entrainment of particles from the particle receiving means (50) to the cyclonic flow region (48), the separation means (40) having apertures (52) and being positioned to connect the particle receiving means (50) in flow communication with the cyclonic flow region (48) such that, in operation, particles pass through the apertures (52) to the particle receiving means (50).

2. The separator of claim 1, wherein the apertures (52) have a perimeter defined by the separation means (40).

3. The separator of claim 1 or claim 2, wherein the separation means (40) essentially isolates the particle receiving means (50) from the cyclone chamber (46) except for the apertures (52) associated with the separation means (40).

4. The separator of any of claims 1 to 3, wherein the particle receiving means (50) comprises a sealed chamber except for the apertures (52) and the separator further comprises emptying means (112) for emptying the particle receiving means.

5. The separator of any of claims 1 to 4, further comprising means (66) for connecting the particle receiving means (50) in flow communication with a conduit for transporting separated particles downstream from the particle receiving means (50).

6. The separator of any of claims 1 to 5, further comprising aerodynamic means (56, 58) associated with the apertures (52) for directing particles from the cyclonic flow region (48) into the particle receiving means (50).

7. The separator of any of claims 1 to 6, wherein the particle separating means (40) extends under all of the cyclonic flow region (48) to define a bottom surface of the cyclonic flow region (48).

8. The separator of any of claims 1 to 7, wherein the apertures (52) are positioned beneath only one or both of the peripheral (70) and inner portions (72) of the cyclonic flow region (48).

9. The separator of any of claims 1 to 8, wherein the apertures (52) are distributed regularly around the separating means (40).

10. The separator of any of claims 1 to 8, wherein the fluid contacts only a portion of the separating means (40) and the apertures (52) are positioned only in said portion.

11. The separator of any of claims 1 to 10, wherein the apertures (52) comprise openings in the separation means (40).

12. The separator of any of claims 1 to 11, further comprising:

(a) a cleaner head (202) adapted for movement over a floor and having a fluid nozzle (220) positionable adjacent the floor, the nozzle (220) in fluid flow communication via a passageway (226) with the means (34) for introducing a fluid flow to the cyclone flow region (48);
(b) a handle (208) for moving the cleaner head over the floor; and,
(c) a casing (206) for housing the cyclone chamber whereby the separator forms a dirt filter for a vacuum cleaner (200).

13. The separator of claim 12, wherein the casing (206) is pivotally mounted to the cleaner head (202) and the vacuum cleaner (200) is an upright vacuum cleaner.

14. The separator of any of claims 1 to 13, wherein the apertures (52) are sized to inhibit elongate particles from passing therethrough, whereby elongate particles collect on top of the separation means (40).

15. The separator of claim 14, wherein the apertures (52) comprise slits having longitudinally extending upstream and downstream edges (56, 58) relative to the fluid flow and transversely extending sides (57) and the edges (56, 58) are longer than the sides (57).

16. The separator of claim 15, wherein the length of the edges (56, 58) are substantially aligned with the radial width (76) of the cyclone chamber (46).

Dyson Ex1020
Page 992

17. The separator of claim 15, wherein the length of the edges (57) define a longitudinally extending axis which are at an angle of up to 45° to the radius of the cyclonic flow region (48).

18. The separator of any of claims 14 to 17, wherein the apertures (52) have a radial outer end (82) and a radial inner end (84) and the radial outer end (82) is positioned adjacent the outer wall of the cyclone chamber (46).

19. The separator of any of claims 14 to 17, wherein the apertures (52) have an upstream edge (56) and downstream edge (58), relative to the fluid flow and the thickness of the particle separating member is reduced adjacent the upstream edge (56) of the apertures (52).

20. The separator of claim 19, wherein the separation means (40) has an upper surface (42) and a lower surface (44) and the upper surface (42) is angled towards the particle receiving means (50) adjacent the upstream edge (56) and the lower surface (44) is angled away from the aperture (52) adjacent the downstream edge (58).

21. The separator of any of claims 1 to 20, wherein the separation means (40) is disposed substantially perpendicularly to a longitudinal axis of the cyclonic flow region (48).

22. The separator of any of claims 1 to 21, wherein the separator is constructed to reduce turbulent fluid flow in the vicinity of the apertures (52).

23. The separator of claim 22, further comprising a fluid pump (224) for causing the fluid to flow through the separator wherein the fluid flow through the cyclone chamber (46) is pulsed.

24. The separator of claim 22, further comprising a moveable closure member (120) on one of means (34) for introducing a fluid flow to the cyclone flow region (48) and means (36) for removing the fluid flow from the cyclone flow region (48) for causing a pulsed fluid flow through the cyclone chamber (46).

25. The separator of any of claims 1 to 24, wherein the separation means (40) has from 5 to 35 apertures (52).

26. The separator of any of claims 14 to 20 or 25 or any of claims 21 to 24 when appendant to claim 14, wherein the number of apertures (52) in the separation means (40) is calculated by the formula:

$$\text{number of apertures} = \frac{H}{D} \times 4 \pm 20\%$$

where H= the vertical height of the cyclonic flow region (48)

D= the diameter of the cyclone chamber (46)

27. The separator of any of claims 14 to 20, 25 or 26 or any of claims 21 to 24 when appendant to claim 14, wherein the cyclone chamber (46) has a diameter and each aperture (52) has a longitudinally extending upstream edge (56) and a longitudinally extending downstream edge (58), relative to the fluid flow, and transverse sides (57) extending between the edges (56, 58), the edges (56, 58) have a length which is less than 10% of the diameter of the cyclone chamber (46) and the sides (57) have a length which is 25 - 35% of the length of the edges (56, 58).

28. The separator of claim 27, wherein the edges (57) are substantially radially aligned with the cyclone chamber (46).

29. The separator of any of claims 14 to 20, 25 to 28 or any of claims 21 to 24 when appendant to claim 14, wherein each aperture (52) has an upstream edge (56) and a downstream edge (57), relative to the fluid flow, and the upstream edge (56) is angled towards the particle receiving means (50), the included angle between the upstream edge (56) and the upper surface (42) of the separation means (40) is from 15 to 90°.

30. The separator of any of claims 14 to 20, 25 to 29 or any of claims 21 to 24 when appendant to claim 14, wherein each aperture (52) has an upstream edge (56) and a downstream edge (58), relative to the fluid flow, and the downstream edge (58) is angled towards the particle receiving means (50), the included angle between the downstream edge (58) and the upper surface (42) of the separation means (40) is from 15 to 90°.

31. The separator of any of claims 1 to 30, wherein the fluid flow changes direction and travels to means (36) for removing the fluid flow from the cyclone chamber (46) at a position as it travels over the separation means (40) and the separator further comprising a baffle (100) positioned beneath the separation means (40) at a position 10 to 20° downstream of the position at which the fluid flow changes direction.

32. The separator of claim 31, wherein the separation receiving means (50) has a bottom to comprise a sealed chamber except for the apertures and the baffle extends between the separation means (40) and the bottom of the separation receiving means (50).

33. The separator of any of claims 1 to 32, including

Dyson Ex1020
Page 993

means for reducing the thickness of the boundary layer of fluid as it travels over the separation means.

34. The separator of claim 33, wherein the means for reducing the thickness of the boundary layer comprises means (224, 120) for pulsing the fluid flow through the cyclone chamber (46).

35. The separator of claim 34, wherein the means for pulsing the fluid flow through the cyclone chamber (46) comprises means for pulsing an electrical signal to the fluid pump means (224).

36. The separator of claim 34, wherein the means for pulsing the fluid flow through the cyclone chamber (46) comprises means for cyclically opening and closing one of the means (34) for introducing a fluid flow to the cyclone flow region (48) and the means (36) for removing the fluid flow from the cyclone chamber (46).

37. The separator of claim 33, wherein the means for reducing the thickness of the boundary layer comprises constructing and positioning the apertures (52) to reduce turbulent fluid flow over the separation means (40).

38. The separator of claim 33, wherein the means for reducing the thickness of the boundary layer comprises constructing and positioning flow disruption means (100) beneath the separation means (40) for disrupting cyclonic fluid flow in the particle receiving means.

39. The separator of claim 33, wherein the apertures (52) are aerodynamically shaped for directing particles from the cyclonic flow region (48) into the particle receiving means (50).

40. The separator of any of the preceding claims, further comprising at least one baffle means (100) positioned beneath the separation means (40).

41. The separator of claim 40, comprising a plurality of baffle means (100) positioned beneath the separation means (40).

42. The separator of claim 41, comprising a plurality of baffle means (100) positioned in the particle receiving means (50).

43. The separator of any of claims 40 to 42, wherein the baffle means (100) depend downwardly from the separation means (40).

44. The separator of claim 43, wherein the particle receiving means (50) has a bottom surface (90) and the baffle means (100) are spaced from said bottom surface (90) to define an open area between the baffle means (100) and the bottom surface (90).

45. The separator of claim 44, wherein the baffle means (100) extend to a position adjacent said bottom surface (90).

46. The separator of any of claims 40 to 45, wherein a baffle means (100) is disposed adjacent each aperture (52).

47. The separator of any of claims 40 to 46, wherein the baffle means (100) are disposed downstream of said apertures (52).

48. The separator of any of claims 40 to 47, wherein the apertures (52) have a longitudinal length and the baffle means (100) comprise a main body (102) and a second portion (104), the main body portion (102) has at least the same longitudinal length as said apertures (52) and extends in a direction transverse to air flow along the upper surface (42) of the separation means (40) and the second portion (104) extends at an angle to the main body portion (102) at a position that does not underlie the aperture (52).

49. The separator of claim 48, wherein the second portion (104) is disposed substantially perpendicularly to the main body portion (102).

50. The separator of claim 48 or claim 49, wherein the second portion (104) extends upstream from the main body portion (102).

51. The separator of claim 47, wherein the apertures (52) have longitudinally extending upstream and downstream edges (56, 58) and the baffle means (100) have a portion that is at least the same length as the edges (56, 58).

52. The separator of any of the preceding claims, wherein the apertures (52) comprise slits having longitudinally extending upstream and downstream edges (56, 58) relative to the fluid flow and transversely extending sides (57) and the edges (56, 58) are longer than the sides (57).

53. The separator of claim 52, wherein the length of the edges (57) are substantially aligned with the radial width (76) of the cyclone chamber (46).

54. The separator of claim 52, wherein the length of the edges (56, 58) define a longitudinally extending axis which are at an angle of up to 45° to a radial line extending outwardly from the centre of the cyclone chamber (46).

55. The separator of any of claims 1 to 54, further com-

Dyson Ex1020
Page 994

prising access means (112) for selectively providing access to the particle receiving means (50) via the separation means (40).

56. The separator of claim 55, wherein the access means (112) forms part of the separation means (40) and, when in the open position, provides an opening between the particle receiving means (50) and the cyclone chamber (46).

57. The separator of claim 55 or claim 56, wherein the access means (112) is freely moveable between its open and closed positions whereby the access means (112) moves to its open position when the chamber (46) is inverted.

58. The separator of claim 55, wherein the access means (112) has a connecting portion (114) which is pivotally connected to the separation means (40).

59. The separator of claim 58, further comprising a weighted member (116) connected to the access means (112) at a position spaced from the connecting portion (114).

60. The separator of claim 55, wherein the access means (112) and the separation means (40) form a surface that underlies all of the cyclonic flow region (48).

61. The separator of claim 55, wherein the access means (112) comprises a chord section of the separation means (40).

62. The separator of any of the preceding claims, wherein the apertures (52) are positioned at least beneath the inner portion (72) of the cyclonic flow region (48).

63. The separator of any of the preceding claims, wherein the apertures are positioned essentially only beneath the peripheral portion of the cyclonic flow region.

64. The separator of any of the preceding claims, wherein the apertures are positioned essentially only beneath the inner portion of the cyclonic flow region.

65. The separator of any of the preceding claims, wherein the apertures are positioned beneath only the peripheral and inner portions of the cyclonic flow region.

Patentansprüche

1. Trennvorrichtung zum Trennen mitgeführter Partikel aus einem Fluidstrom, wobei die Trennvorrichtung Folgendes umfasst:

(a) eine Zyklonkammer (46), um einen Zyklonstrom in einem Zyklonstrombereich (48) zu enthalten, wobei der Zyklonstrombereich (48) eine innere Wand (38), eine radiale Breite (76), einen äußeren Umfangsabschnitt (70), einen mittleren Abschnitt (74), der innenliegend zum Umfangsabschnitt (70) angeordnet ist, und einen inneren Abschnitt (72) aufweist, der innenliegend zum mittleren Abschnitt (74) angeordnet ist;

(b) ein Mittel (34) zum Einführen eines Fluidstroms in den Zyklonstrombereich (48) für eine Zyklonrotation in demselben; und

(c) ein Mittel (36) zum Entfernen des Fluidstroms aus der Zyklonkammer (46); **gekennzeichnet durch**:

(d) ein Partikelaufnahmemittel (50), das unterhalb des Zyklonstrombereiches (48) angeordnet ist, um Partikel aufzunehmen, die von dem Fluidstrom getrennt sind; und

(e) ein Trennmittel (40), das sich unterhalb von mindestens einem Abschnitt des Zyklonstrombereiches (48) befindet und so angeordnet ist, dass es von dem Zyklonstrom in dem Zyklonstrombereich (48) berührt wird, und das so konfiguriert ist, dass es das erneute Mitführen von Partikeln aus dem Partikelaufnahmemittel (50) in den Zyklonstrombereich (48) verhindert, wobei das Trennmittel (40) Öffnungen (52) aufweist und so angeordnet ist, dass es das Partikelaufnahmemittel (50) derart in Strömungskommunikation mit dem Zyklonstrombereich (48) verbindet, dass Partikel bei Betrieb **durch** die Öffnungen (52) zu dem Partikelaufnahmemittel (50) strömen.

2. Trennvorrichtung nach Anspruch 1, wobei die Öffnungen (52) einen Umfang aufweisen, der durch das Trennmittel (40) definiert wird.

3. Trennvorrichtung nach Anspruch 1 oder Anspruch 2, wobei das Trennmittel (40) im Wesentlichen das Partikelaufnahmemittel (50) von der Zyklonkammer (46) isoliert, abgesehen von den Öffnungen (52), die zu dem Trennmittel (40) gehören.

4. Trennvorrichtung nach einem der Ansprüche 1 bis 3, wobei das Partikelaufnahmemittel (50) eine bis auf die Öffnungen (52) abgedichtete Kammer umfasst und die Trennvorrichtung des Weiteren ein Entleerungsmittel (112) zum Entleeren des Partikel-

Dyson Ex1020
Page 995

aufnahmemittels umfasst.

5. Trennvorrichtung nach einem der Ansprüche 1 bis 4, die des Weiteren ein Mittel (66) zum Verbinden des Partikelaufnahmemittels (50) in Strömungskommunikation mit einer Leitung zur Beförderung von getrennten Partikeln stromabwärts aus dem Partikelaufnahmemittel (50) umfasst.

6. Trennvorrichtung nach einem der Ansprüche 1 bis 5, die des Weiteren ein zu den Öffnungen (52) gehörendes aerodynamisches Mittel (56, 58) umfasst, um Partikel aus dem Zyklonstrombereich (48) in das Partikelaufnahmemittel (50) zu leiten.

7. Trennvorrichtung nach einem der Ansprüche 1 bis 6, wobei sich das Partikeltrennmittel (40) unter den gesamten Zyklonstrombereich (48) erstreckt, um eine untere Fläche des Zyklonstrombereichs (48) abzugrenzen.

8. Trennvorrichtung nach einem der Ansprüche 1 bis 7, wobei die Öffnungen (52) unterhalb entweder nur des Umfangsabschnitts (70) oder des inneren Abschnitts (72) des Zyklonstrombereiches (48) oder unter diesen beiden Abschnitten angeordnet sind.

9. Trennvorrichtung nach einem der Ansprüche 1 bis 8, wobei die Öffnungen (52) regelmäßig um das Trennmittel (40) herum verteilt sind.

10. Trennvorrichtung nach einem der Ansprüche 1 bis 8, wobei das Fluid nur einen Abschnitt des Trennmittels (40) berührt und die Öffnungen (52) nur in diesem Abschnitt angeordnet sind.

11. Trennvorrichtung nach einem der Ansprüche 1 bis 10, wobei die Öffnungen (52) Löcher in dem Trennmittel (40) umfassen.

12. Trennvorrichtung nach einem der Ansprüche 1 bis 11, die des Weiteren Folgendes umfasst:

(a) einen Reinigungskopf (202), der zur Bewegung über einen Boden ausgelegt ist und eine Fluiddüse (220) aufweist, die benachbart zum Boden angeordnet werden kann, wobei die Düse (220) über einen Durchgang (226) in Fluidstromkommunikation mit dem Mittel (34) zum Einführen eines Fluidstroms in den Zyklonstrombereich (48) steht;

(b) einen Griff (208) zur Bewegung des Reinigungskopfes über den Boden; und

(c) ein Gehäuse (206) zur Aufnahme der Zyklonkammer, wobei die Trennvorrichtung einen Schmutzfilter für einen Staubsauger (200) bildet.

13. Trennvorrichtung nach Anspruch 12, wobei das Gehäuse (206) gelenkig am Reinigungskopf (202) befestigt ist und der Staubsauger (200) ein aufrechter Staubsauger ist.

14. Trennvorrichtung nach einem der Ansprüche 1 bis 13, wobei die Öffnungen (52) so bemessen sind, dass sie den Durchgang länglicher Partikel durch diese hindurch verhindern, wobei sich längliche Partikel oben auf dem Trennmittel (40) sammeln.

15. Trennvorrichtung nach Anspruch 14, wobei die Öffnungen (52) Schlitze umfassen, die eine sich längs erstreckende, im Verhältnis zum Fluidstrom stromaufwärts gerichtete und eine sich längs erstreckende, im Verhältnis zum Fluidstrom stromabwärts gerichtete Kante (56, 58) und sich quer erstreckende Seiten (57) aufweisen und die Kanten (56, 58) länger als die Seiten (57) sind.

16. Trennvorrichtung nach Anspruch 15, wobei die Länge der Kanten (56, 58) im Wesentlichen zu der radialen Breite (76) der Zyklonkammer (46) ausgerichtet ist.

17. Trennvorrichtung nach Anspruch 15, wobei die Länge der Kanten (57) sich längs erstreckende Achsen abgrenzt, die sich in einem Winkel von bis zu 45° zum Radius des Zyklonstrombereiches (48) befinden.

18. Trennvorrichtung nach einem der Ansprüche 14 bis 17, wobei die Öffnungen (52) ein radiales äußeres Ende (82) und ein radiales inneres Ende (84) aufweisen und das radiale äußere Ende (82) benachbart zur Außenwand der Zyklonkammer (46) angeordnet ist.

19. Trennvorrichtung nach einem der Ansprüche 14 bis 17, wobei die Öffnungen (52) eine im Verhältnis zum Fluidstrom stromaufwärts gerichtete Kante (56) und eine im Verhältnis zum Fluidstrom stromabwärts gerichtete Kante (58) aufweisen und die Stärke des Partikeltrennmittels benachbart zur stromaufwärts gerichteten Kante (56) der Öffnungen (52) verringert ist.

20. Trennvorrichtung nach Anspruch 19, wobei das Trennmittel (40) eine obere Fläche (42) und eine untere Fläche (44) aufweist und die obere Fläche (42) in Richtung des Partikelaufnahmemittels (50) benachbart zur stromaufwärts gerichteten Kante (56) abgewinkelt ist und die untere Fläche (44) benachbart zur stromabwärts gerichteten Kante (58) von der Öffnung (52) weg abgewinkelt ist.

Dyson Ex1020
Page 996

21. Trennvorrichtung nach einem der Ansprüche 1 bis 20, wobei das Trennmittel (40) im Wesentlichen senkrecht zu einer Längsachse des Zyklonstrombereichs (48) angeordnet ist.

22. Trennvorrichtung nach einem der Ansprüche 1 bis 21, wobei die Trennvorrichtung so konstruiert ist, dass die Fluidwirbelströmung in der Nähe der Öffnungen (52) verringert wird.

23. Trennvorrichtung nach Anspruch 22, die des Weiteren eine Fluidpumpe (224) umfasst, um zu verursachen, dass das Fluid durch die Trennvorrichtung strömt, wobei der Fluidstrom durch die Zyklonkammer (46) pulsiert.

24. Trennvorrichtung nach Anspruch 22, die des Weiteren ein bewegliches Verschlusselement (120) an einem des Mittels (34) zur Einführung eines Fluidstroms in den Zyklonstrombereich (48) und des Mittels (36) zum Entfernen des Fluidstroms aus dem Zyklonstrombereich (48) umfasst, um einen pulsierenden Fluidstrom durch die Zyklonkammer (46) zu verursachen.

25. Trennvorrichtung nach einem der Ansprüche 1 bis 24, wobei das Trennmittel (40) 5 bis 35 Öffnungen (52) aufweist.

26. Trennvorrichtung nach einem der Ansprüche 14 bis 20 oder 25 oder nach einem der Ansprüche 21 bis 24, wenn sie zu Anspruch 14 gehören, wobei die Anzahl der Öffnungen (52) im Trennmittel (40) mit folgender Formel berechnet wird:

$$\text{Anzahl der Öffnungen} = \frac{H}{D} \times 4 \pm 20\%$$

wobei H = vertikale Höhe des Zyklonstrombereiches (48)
D = Durchmesser der Zyklonkammer (46)

27. Trennvorrichtung nach einem der Ansprüche 14 bis 20, 25 oder 26 oder nach einem der Ansprüche 21 bis 24, wenn sie zu Anspruch 14 gehören, wobei die Zyklonkammer (46) einen Durchmesser aufweist und jede Öffnung (52) eine sich im Verhältnis zum Fluidstrom längs erstreckende stromaufwärts gerichtete Kante (56) und eine sich im Verhältnis zum Fluidstrom längs erstreckende stromabwärts gerichtete Kante (58) und sich zwischen den Kanten (56, 58) erstreckende quer verlaufende Seiten (57) aufweist, wobei die Kanten (56, 58) eine Länge aufweisen, die weniger als 10% des Durchmessers der Zyklonkammer (46) beträgt, und die Seiten (57) eine Länge aufweisen, die 25-35% der Länge der Kanten (56, 58) beträgt.

28. Trennvorrichtung nach Anspruch 27, wobei die Kanten (57) im Wesentlichen radial mit der Zyklonkammer (46) ausgerichtet sind.

29. Trennvorrichtung nach einem der Ansprüche 14 bis 20, 25 bis 28 oder nach einem der Ansprüche 21 bis 24, wenn sie zu Anspruch 14 gehören, wobei jede Öffnung (52) eine im Verhältnis zum Fluidstrom stromaufwärts gerichtete Kante (56) und eine im Verhältnis zum Fluidstrom stromabwärts gerichtete Kante (57) aufweist und die stromaufwärts gerichtete Kante (56) in Richtung des Partikelaufnahmemittels (50) abgewinkelt ist, wobei der eingeschlossene Winkel zwischen der stromaufwärts gerichteten Kante (56) und der oberen Fläche (42) des Trennmittels (40) 15 bis 90° beträgt.

30. Trennvorrichtung nach einem der Ansprüche 14 bis 20, 25 bis 29 oder nach einem der Ansprüche 21 bis 24, wenn sie zu Anspruch 14 gehören, wobei jede Öffnung (52) eine im Verhältnis zum Fluidstrom stromaufwärts gerichtete Kante (56) und eine im Verhältnis zum Fluidstrom stromabwärts gerichtete Kante (58) aufweist und die stromabwärts gerichtete Kante (58) in Richtung des Partikelaufnahmemittels (50) abgewinkelt ist, wobei der eingeschlossene Winkel zwischen der stromabwärts gerichteten Kante (58) und der oberen Fläche (42) des Trennmittels (40) 15 bis 90° beträgt.

31. Trennvorrichtung nach einem der Ansprüche 1 bis 30, wobei der Fluidstrom die Richtung wechselt und zum Mittel (36) zur Entfernung des Fluidstroms aus der Zyklonkammer (46) an einer Position strömt, während er über das Trennmittel (40) strömt, und die Trennvorrichtung des Weiteren eine Prallplatte (100) umfasst, die unterhalb des Trennmittels (40) in einer Position angeordnet ist, die sich 10° bis 20° stromabwärts von der Position befindet, in der der Fluidstrom die Richtung wechselt.

32. Trennvorrichtung nach Anspruch 31, wobei das Trennungsaufnahmemittel (50) einen Boden aufweist, um eine abgesehen von den Öffnungen abgedichtete Kammer zu umfassen, und sich die Prallplatte zwischen dem Trennmittel (40) und dem Boden des Trennungsaufnahmemittels erstreckt.

33. Trennvorrichtung nach einem der Ansprüche 1 bis 32, die ein Mittel zur Verringerung der Stärke der Grenzschicht von Fluid, während dieses über das Trennmittel strömt, umfasst.

34. Trennvorrichtung nach Anspruch 33, wobei das Mittel zur Verringerung der Stärke der Grenzschicht Mittel (224, 120) umfasst, um den Fluidstrom durch die Zyklonkammer (46) pulsieren zu lassen.

Dyson Ex1020
Page 997

35. Trennvorrichtung nach Anspruch 34, wobei das Mittel zum Pulsieren des Fluidstroms durch die Zyklonkammer (46) ein Mittel zum Pulsieren eines elektrischen Signals zum Fluidpumpenmittel (224) umfasst.

36. Trennvorrichtung nach Anspruch 34, wobei das Mittel zum Pulsieren des Fluidstroms durch die Zyklonkammer (46) ein Mittel zum zyklischen Öffnen und Schließen eines des Mittels (34) zum Einführen eines Fluidstroms in den Zyklonstrombereich (48) und des Mittels (36) zum Entfernen des Fluidstroms aus der Zyklonkammer (46) umfasst.

37. Trennvorrichtung nach Anspruch 33, wobei das Mittel zum Verringern der Stärke der Grenzschicht das Konstruieren und Anordnen der Öffnungen (52) umfasst, um die Fluidwirbelströmung über dem Trennmittel (40) zu verringern.

38. Trennvorrichtung nach Anspruch 33, wobei das Mittel zum Verringern der Stärke der Grenzschicht das Konstruieren und Anordnen des Stromunterbrechungsmittels (100) unterhalb des Trennmittels (40) umfasst, um den Zyklonfluidstrom in dem Partikelaufnahmemittel zu unterbrechen.

39. Trennvorrichtung nach Anspruch 33, wobei die Öffnungen (52) aerodynamisch geformt sind, um Partikel aus dem Zyklonstrombereich (48) in das Partikelaufnahmemittel (50) zu leiten.

40. Trennvorrichtung nach einem der vorhergehenden Ansprüche, die des Weiteren mindestens ein Prallplattenmittel (100) umfasst, das unterhalb des Trennmittels (40) angeordnet ist.

41. Trennvorrichtung nach Anspruch 40, die eine Vielzahl von Prallplattenmitteln (100) umfasst, die unterhalb des Trennmittels (40) angeordnet sind.

42. Trennvorrichtung nach Anspruch 41, die eine Vielzahl von Prallplattenmitteln (100) umfasst, die in dem Partikelaufnahmemittel (50) angeordnet sind.

43. Trennvorrichtung nach einem der Ansprüche 40 bis 42, wobei die Prallplattenmittel (100) von dem Trennmittel (40) herabhängen.

44. Trennvorrichtung nach Anspruch 43, wobei das Partikelaufnahmemittel (50) eine untere Fläche (90) aufweist und die Prallplattenmittel (100) von der unteren Fläche (90) beabstandet sind, um einen offenen Bereich zwischen den Prallplattenmitteln (100) und der unteren Fläche (90) abzugrenzen.

45. Trennvorrichtung nach Anspruch 44, wobei sich die Prallplattenmittel (100) zu einer Position benachbart zur unteren Fläche (90) erstrecken.

46. Trennvorrichtung nach einem der Ansprüche 40 bis 45, wobei ein Prallplattenmittel (100) benachbart zu jeder Öffnung (52) angeordnet ist.

47. Trennvorrichtung nach einem der Ansprüche 40 bis 46, wobei die Prallplattenmittel (100) stromabwärts von den Öffnungen (52) angeordnet sind.

48. Trennvorrichtung nach einem der Ansprüche 40 bis 47, wobei die Öffnungen (52) eine Länge in Längsrichtung aufweisen und die Prallplattenmittel (100) einen Hauptkörper (102) und einen zweiten Abschnitt (104) umfassen, wobei der Hauptkörperabschnitt (102) mindestens dieselbe längliche Länge aufweist wie die Öffnungen (52) und sich in einer Richtung erstreckt, die quer zum Luftstrom entlang der oberen Fläche (42) des Trennmittels (40) verläuft, und sich der zweite Abschnitt (104) in einem Winkel zum Hauptkörperabschnitt (102) in einer Position erstreckt, die nicht unter der Öffnung (52) liegt.

49. Trennvorrichtung nach Anspruch 48, wobei der zweite Abschnitt (104) im Wesentlichen senkrecht zum Hauptkörperabschnitt (102) angeordnet ist.

50. Trennvorrichtung nach Anspruch 48 oder Anspruch 49, wobei sich der zweite Abschnitt (104) stromaufwärts vom Hauptkörperabschnitt (102) erstreckt.

51. Trennvorrichtung nach Anspruch 47, wobei die Öffnungen (52) eine sich längs erstreckende stromaufwärts gerichtete und eine sich längs erstreckende stromabwärts gerichtete Kante (56, 58) aufweisen und die Prallplattenmittel (100) einen Abschnitt aufweisen, der mindestens dieselbe Länge wie die Kanten (56, 58) aufweist.

52. Trennvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Öffnungen (52) Schlitze umfassen, die eine sich im Verhältnis zum Fluidstrom längs erstreckende stromaufwärts gerichtete und eine sich im Verhältnis zum Fluidstrom stromabwärts gerichtete Kante (56, 58) und sich quer erstreckende Seiten (57) aufweisen und die Kanten (56, 58) länger als die Seiten (57) sind.

53. Trennvorrichtung nach Anspruch 52, wobei die Länge der Kanten (57) im Wesentlichen zu der radialen Breite (76) der Zyklonkammer (46) ausgerichtet ist.

54. Trennvorrichtung nach Anspruch 52, wobei die Länge der Kanten (56, 58) sich längs erstreckende Achsen abgrenzt, die in einem Winkel von bis zu 45° zu einer radialen Linie verlaufen, die sich von der Mitte der Zyklonkammer (46) auswärts erstreckt.

Dyson Ex1020
Page 998

55. Trennvorrichtung nach einem der Ansprüche 1 bis 54, die des Weiteren ein Zugriffsmittel (112) umfasst, um über das Trennmittel (40) selektiv Zugriff auf das Partikelaufnahmemittel (50) bereitzustellen.

56. Trennvorrichtung nach Anspruch 55, wobei das Zugriffsmittel (112) einen Teil des Trennmittels (40) bildet und, wenn es sich in der offenen Position befindet, eine Öffnung zwischen dem Partikelaufnahmemittel (50) und der Zyklonkammer (46) bereitstellt.

57. Trennvorrichtung nach Anspruch 55 oder Anspruch 56, wobei das Zugriffsmittel (112) zwischen seiner offenen und seiner geschlossenen Position frei beweglich ist und sich das Zugriffsmittel (112) in seine offene Position bewegt, wenn die Kammer (46) umgekehrt wird.

58. Trennvorrichtung nach Anspruch 55, wobei das Zugriffsmittel (112) einen Verbindungsabschnitt (114) aufweist, der gelenkig mit dem Trennmittel (40) verbunden ist.

59. Trennvorrichtung nach Anspruch 58, die des Weiteren ein Gewichtselement (116) umfasst, das mit dem Zugriffsmittel (112) in einer Position verbunden ist, die von dem Verbindungsabschnitt (114) beabstandet ist.

60. Trennvorrichtung nach Anspruch 55, wobei das Zugriffsmittel (112) und das Trennmittel (40) eine Fläche bilden, die unter dem gesamten Zyklonstrombereich (48) liegt.

61. Trennvorrichtung nach Anspruch 55, wobei das Zugriffsmittel (112) einen Sehnenabschnitt des Trennmittels (40) umfasst.

62. Trennvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Öffnungen (52) mindestens unterhalb des inneren Abschnitts (72) des Zyklonstrombereichs (48) angeordnet sind.

63. Trennvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Öffnungen im Wesentlichen nur unterhalb des Umfangsabschnitts des Zyklonstrombereichs angeordnet sind.

64. Trennvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Öffnungen im Wesentlichen nur unterhalb des inneren Abschnitts des Zyklonstrombereichs angeordnet sind.

65. Trennvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Öffnungen nur unterhalb des Umfangsabschnitts und des inneren Abschnitts des Zyklonstrombereiches angeordnet sind.

Revendications

1. Séparateur servant à séparer des particules entraînées à partir d'un flux de fluide, le séparateur comprenant :

   (a) une chambre à cyclone (46) servant à contenir un flux cyclonique dans une zone de flux cyclonique (48), la zone de flux cyclonique (48) possédant une paroi interne (38), une largeur radiale (76), une partie périphérique externe (70), une partie médiane (74) qui est disposée à l'intérieur de la partie périphérique (70) et une partie interne (72) qui est disposée à l'intérieur de la partie médiane (74) ;
   (b) un moyen (34) servant à amener un flux de fluide vers la zone de flux cyclonique (48) afin d'y assurer une rotation cyclonique ; et
   (c) un moyen (36) servant à éliminer le flux de fluide de la chambre à cyclone (46) ;
   caractérisé par :
   (d) un moyen de réception de particules (50) qui est disposé sous la zone de flux cyclonique (48) afin de recevoir les particules qui sont séparées du flux de fluide ; et
   (e) un moyen de séparation (40) qui est disposé sous une partie au moins de la zone de flux cyclonique (48), et est positionné de façon à ce que le flux cyclonique entre en contact avec lui dans la zone de flux cyclonique (48) et configuré pour empêcher tout ré-entraînement des particules à partir du moyen de réception de particules (50) vers la zone de flux cyclonique (48), le moyen de séparation (40) ayant des ouvertures (52) et étant positionné pour raccorder le moyen de réception de particules (50) selon une communication de flux avec la zone de flux cyclonique (48), de sorte que, lors du fonctionnement, des particules passent à travers les ouvertures (52) jusqu'au moyen de réception de particules (50).

2. Le séparateur de la revendication 1, dans lequel le périmètre des ouvertures (52) est défini par le moyen de séparation (40).

3. Le séparateur de la revendication 1 ou de la revendication 2, dans lequel le moyen de séparation (40) isole essentiellement le moyen de réception de particules (50) par rapport à la chambre à cyclone (46) à l'exception des ouvertures (52) qui sont associées au moyen de séparation (40).

4. Le séparateur de l'une quelconque des revendications 1 à 3, dans lequel le moyen de réception de particules (50) comporte une chambre hermétique exception faite des ouvertures (52) et le séparateur comporte en outre un moyen de vidage (112) ser-

Dyson Ex1020
Page 999

vant à vider le moyen de réception de particules.

5. Le séparateur de l'une quelconque des revendications 1 à 4, comprenant en outre un moyen (66) servant à raccorder le moyen de réception de particules (50) selon une communication de flux avec un conduit servant à transporter les particules séparées en aval à partir du moyen de réception de particules (50).

6. Le séparateur de l'une quelconque des revendications 1 à 5, comprenant en outre des moyens aérodynamiques (56, 58) associés aux ouvertures (52) afin de diriger les particules à partir de la zone de flux cyclonique (48) vers le moyen de réception de particules (50).

7. Le séparateur de l'une quelconque des revendications 1 à 6, dans lequel le moyen de séparation de particules (40) s'étend sous la totalité de la zone de flux cyclonique (48) afin de définir une surface inférieure de la zone de flux cyclonique (48).

8. Le séparateur de l'une quelconque des revendications 1 à 7, dans lequel les ouvertures (52) sont positionnées sous l'une seulement des parties périphérique (70) et interne (72), ou sous les deux, de la zone de flux cyclonique (48).

9. Le séparateur de l'une quelconque des revendications 1 à 8, dans lequel les ouvertures (52) sont réparties à des intervalles réguliers autour du moyen de séparation (40).

10. Le séparateur de l'une quelconque des revendications 1 à 8, dans lequel le fluide entre uniquement en contact avec une partie du moyen de séparation (40) et les ouvertures (52) sont uniquement positionnées dans ladite partie.

11. Le séparateur de l'une quelconque des revendications 1 à 10, dans lequel les ouvertures (52) comportent des ouvertures qui sont prévues dans le moyen de séparation (40).

12. Le séparateur de l'une quelconque des revendications 1 à 11, comprenant en outre :

(a) une tête de nettoyage (202) qui est adaptée en vue d'un mouvement au-dessus du sol et possédant une buse de fluide (220) qui peut être positionnée de façon adjacente au sol, la buse (220) étant en communication de flux de fluide, par l'intermédiaire d'un passage (226), avec le moyen (34) servant à amener un flux de fluide vers la zone de flux cyclonique (48) ;
(b) une poignée (208) servant à déplacer la tête de nettoyage au-dessus du sol ; et
(c) un carter (206) servant à abriter la chambre à cyclone, cas dans lequel le séparateur constitue un filtre à poussières pour un aspirateur (200).

13. Le séparateur de la revendication 12, dans lequel le carter (206) est monté de façon pivotante sur la tête de nettoyage (202) et l'aspirateur (200) est un aspirateur vertical.

14. Le séparateur de l'une quelconque des revendications 1 à 13, dans lequel les ouvertures (52) sont dimensionnées de façon à empêcher le passage de particules allongées à travers celles-ci, cas dans lequel les particules allongées s'accumulent sur le haut du moyen de séparation (40).

15. Le séparateur de la revendication 14, dans lequel les ouvertures (52) comprennent des fentes possédant des bords amont et aval (56, 58) qui s'étendent dans le plan longitudinal par rapport au flux de fluide, ainsi que des côtés (57) qui s'étendent dans le plan transversal, alors que les bords (56, 58) sont plus longs que les côtés (57).

16. Le séparateur de la revendication 15, dans lequel la longueur des bords (56, 58) est essentiellement alignée avec la largeur radiale (76) de la chambre à cyclone (46).

17. Le séparateur de la revendication 15, dans lequel la longueur des bords (57) définit un axe s'étendant dans le plan longitudinal et se trouvant à un angle pouvant atteindre 45° par rapport au rayon de la zone de flux cyclonique (48).

18. Le séparateur de l'une quelconque des revendications 14 à 17, dans lequel les ouvertures (52) possèdent une extrémité radiale externe (82) et une extrémité radiale interne (84), et l'extrémité radiale externe (82) est positionnée de façon adjacente à la paroi externe de la chambre à cyclone (46).

19. Le séparateur de l'une quelconque des revendications 14 à 17, dans lequel les ouvertures (52) possèdent un bord amont (56) et un bord aval (58) par rapport au flux de fluide et l'épaisseur de l'élément de séparation de particules est réduite à côté du bord amont (56) des ouvertures (52).

20. Le séparateur de la revendication 19, dans lequel le moyen de séparation (40) possède une surface supérieure (42) et une surface inférieure (44), alors que la surface supérieure (42) est inclinée en direction du moyen de réception de particules (50) à côté du bord amont (56) et la surface inférieure (44) est inclinée de façon à s'éloigner de l'ouverture (52) qui est adjacente au bord aval (58).

Dyson Ex1020
Page 1000

21. Le séparateur de l'une quelconque des revendications 1 à 20, dans lequel le moyen de séparation (40) est disposé dans un plan essentiellement perpendiculaire par rapport à un axe longitudinal de la zone de flux cyclonique (48).

22. Le séparateur de l'une quelconque des revendications 1 à 21, dans lequel le séparateur est construit de façon à réduire la turbulence du flux de fluide à proximité des ouvertures (52).

23. Le séparateur de la revendication 22, comprenant en outre une pompe à fluide (224) pour obliger le fluide à passer à travers le séparateur, cas dans lequel le flux de fluide traversant la chambre à cyclone (46) est pulsé.

24. Le séparateur de la revendication 22, comprenant en outre un élément de fermeture mobile (120) qui est prévu sur l'un des deux moyens, soit le moyen (34) servant à amener un flux de fluide vers la zone de flux cyclonique (48), soit le moyen (36) servant à éliminer le flux de fluide de la zone de flux cyclonique (48), afin d'obliger un flux de fluide pulsé de passer à travers la chambre à cyclone (46).

25. Le séparateur de l'une quelconque des revendications 1 à 24, dans lequel le moyen de séparation (40) est muni de 5 à 35 ouvertures (52).

26. Le séparateur de l'une quelconque des revendications 14 à 20 ou 25, ou l'une quelconque des revendications 21 à 24 lorsqu'elle est subordonnée à la revendication 14, dans lequel le nombre d'ouvertures (52) prévu dans le moyen de séparation (40) est calculé sur la base de la formule suivante :

$$\text{nombre d'ouvertures} = \frac{H}{D} \times 4 \pm 20\%$$

où
H = la hauteur verticale de la zone de flux cyclonique (48)
D = le diamètre de la chambre à cyclone (46)

27. Le séparateur de l'une quelconque des revendications 14 à 20, 25 ou 26, ou l'une quelconque des revendications 21 à 24 lorsqu'elle est subordonnée à la revendication 14, dans lequel la chambre à cyclone (46) a un certain diamètre et chaque ouverture (52) possède un bord amont (56) qui s'étend dans le plan longitudinal et un bord aval (58) qui s'étend dans le plan longitudinal par rapport au flux de fluide, et des côtés transversaux (57) qui s'étendent entre les bords (56, 58), alors que les bords (56, 58) ont une longueur qui est inférieure à 10% du diamètre de la chambre à cyclone (46) et les côtés (57) ont une longueur qui est égale à 25-35% de la longueur des bords (56, 58).

28. Le séparateur de la revendication 27, dans lequel les bords (57) sont essentiellement alignés dans le plan radial avec la chambre à cyclone (46).

29. Le séparateur de l'une quelconque des revendications 14 à 20, 25 à 28, ou l'une quelconque des revendications 21 à 24 lorsqu'elle est subordonnée à la revendication 14, dans lequel chaque ouverture (52) possède un bord amont (56) et un bord aval (57), par rapport au flux de fluide, et le bord amont (56) est incliné en direction du moyen de réception de particules (50), alors que l'angle aigu formé entre le bord amont (56) et la surface supérieure (42) du moyen de séparation (40) est de 15 à 90°.

30. Le séparateur de l'une quelconque des revendications 14 à 20, 25 à 29, ou l'une quelconque des revendications 21 à 24 lorsqu'elle est subordonnée à la revendication 14, dans lequel chaque ouverture (52) possède un bord amont (56) et un bord aval (58), par rapport au flux de fluide, et le bord aval (58) est incliné en direction du moyen de réception de particules (50), alors que l'angle aigu formé entre le bord aval (58) et la surface supérieure (42) du moyen de séparation (40) est de 15 à 90°.

31. Le séparateur de l'une quelconque des revendications 1 à 30, dans lequel le flux de fluide change de direction et se déplace vers le moyen (36) servant à éliminer le flux de fluide de la chambre à cyclone (46) au niveau d'une certaine position, au fur et à mesure qu'il passe au-dessus du moyen de séparation (40) et le séparateur comprend en outre un déflecteur (100) lequel est positionné sous le moyen de séparation (40) en un emplacement situé de 10 à 20° en aval de la position à laquelle le flux de fluide change de direction.

32. Le séparateur de la revendication 31, dans lequel le moyen de réception de séparation (50) possède un fond afin de comporter une chambre hermétique, à l'exception des ouvertures, et le déflecteur s'étend entre le moyen de séparation (40) et le fond du moyen de réception de séparation (50).

33. Le séparateur de l'une quelconque des revendications 1 à 32, comprenant un moyen destiné à réduire l'épaisseur de la couche-limite du fluide au fur et à mesure que celui-ci passe au-dessus du moyen de séparation.

34. Le séparateur de la revendication 33, dans lequel le moyen destiné à réduire l'épaisseur de la couche-limite comprend un moyen (224, 120) servant à pulser le flux de fluide à travers la chambre à cyclone (46).

Dyson Ex1020
Page 1001

35. Le séparateur de la revendication 34, dans lequel le moyen servant à pulser le flux de fluide à travers la chambre à cyclone (46) comprend un moyen servant à pulser un signal électrique vers le moyen de pompe à fluide (224).

36. Le séparateur de la revendication 34, dans lequel le moyen servant à pulser le flux de fluide à travers la chambre à cyclone (46) comprend un moyen servant à ouvrir et à fermer de façon cyclique l'un des deux moyens, soit le moyen (34) servant à amener un flux de fluide vers la zone de flux cyclonique (48), soit le moyen (36) servant à éliminer le flux de fluide de la chambre à cyclone (46).

37. Le séparateur de la revendication 33, dans lequel le moyen destiné à réduire l'épaisseur de la couche-limite comprend la construction et le positionnement des ouvertures (52) afin de réduire la turbulence du flux de fluide au-dessus du moyen de séparation (40).

38. Le séparateur de la revendication 33, dans lequel le moyen destiné à réduire l'épaisseur de la couche-limite comprend la construction et le positionnement d'un moyen de perturbation de flux (100) sous le moyen de séparation (40) afin de perturber le flux de fluide cyclonique dans le moyen de réception de particules.

39. Le séparateur de la revendication 33, dans lequel les ouvertures (52) ont une forme aérodynamique afin de diriger les particules à partir de la zone de flux cyclonique (48) vers le moyen de réception de particules (50).

40. Le séparateur de l'une quelconque des revendications précédentes, comprenant en outre au moins un moyen de déflecteur (100) lequel est positionné sous le moyen de séparation (40).

41. Le séparateur de la revendication 40, comprenant une pluralité de moyens de déflecteurs (100) lesquels sont positionnés sous le moyen de séparation (40).

42. Le séparateur de la revendication 41, comprenant une pluralité de moyens de déflecteurs (100) lesquels sont positionnés dans le moyen de réception de particules (50).

43. Le séparateur de l'une quelconque des revendications 40 à 42, dans lequel les moyens de déflecteurs (100) sont inclinés vers le bas à partir du moyen de séparation (40).

44. Le séparateur de la revendication 43, dans lequel le moyen de réception de particules (50) possède une surface inférieure (90) et le moyen de déflecteur (100) est espacé d'une certaine distance de ladite surface inférieure (90) afin de définir une zone ouverte entre le moyen de déflecteur (100) et la surface inférieure (90).

45. Le séparateur de la revendication 44, dans lequel le moyen de déflecteur (100) s'étend vers une position qui est adjacente à ladite surface inférieure (90).

46. Le séparateur de l'une quelconque des revendications 40 à 45, dans lequel un moyen de déflecteur (100) est disposé de façon adjacente à chaque ouverture (52).

47. Le séparateur de l'une quelconque des revendications 40 à 46, dans lequel les moyens de déflecteurs (100) sont disposés en aval desdites ouvertures (52).

48. Le séparateur de l'une quelconque des revendications 40 à 47, dans lequel les ouvertures (52) ont une longueur longitudinale et les moyens de déflecteurs (100) comprennent un corps principal (102) et une deuxième partie (104), alors que la partie de corps principal (102) possède au moins la même longueur longitudinale que lesdites ouvertures (52) et s'étend dans une direction qui est transversale au flux d'air le long de la surface supérieure (42) du moyen de séparation (40) et la deuxième partie (104) s'étend suivant un certain angle par rapport à la partie de corps principal (102) au niveau d'un emplacement qui n'est pas sous-jacent à l'ouverture (52).

49. Le séparateur de la revendication 48, dans lequel la deuxième partie (104) est disposée dans un plan essentiellement perpendiculaire par rapport à la partie de corps principal (102).

50. Le séparateur de la revendication 48 ou de la revendication 49, dans lequel la deuxième partie (104) s'étend en amont à partir de la partie de corps principal (102).

51. Le séparateur de la revendication 47, dans lequel les ouvertures (52) possèdent des bords amont et aval (56, 58) qui s'étendent dans le plan longitudinal, et les moyens de déflecteurs (100) comportent une partie qui a au moins la même longueur que les bords (56, 58).

52. Le séparateur de l'une quelconque des revendications précédentes, dans lequel les ouvertures (52) comprennent des fentes possédant des bords amont et aval (56, 58) qui s'étendent dans le plan longitudinal par rapport au flux de fluide, ainsi que

Dyson Ex1020
Page 1002

des côtés (57) qui s'étendent dans le plan transversal, alors que les bords (56, 58) sont plus longs que les côtés (57).

53. Le séparateur de la revendication 52, dans lequel la longueur des bords (57) est essentiellement alignée avec la largeur radiale (76) de la chambre à cyclone (46).

54. Le séparateur de la revendication 52, dans lequel la longueur des bords (56, 58) définit un axe s'étendant dans le plan longitudinal et se trouvant à un certain angle pouvant atteindre 45° par rapport à une ligne radiale qui s'étend vers l'extérieur à partir du centre de la chambre à cyclone (46).

55. Le séparateur de l'une quelconque des revendications 1 à 54, comprenant en outre un moyen d'accès (112) servant à procurer de façon sélective un accès au moyen de réception de particules (50) par l'intermédiaire du moyen de séparation (40).

56. Le séparateur de la revendication 55, dans lequel le moyen d'accès (112) fait partie du moyen de séparation (40), et lorsqu'il se trouve en position ouverte, il offre une ouverture entre le moyen de réception de particules (50) et la chambre à cyclone (46).

57. Le séparateur de la revendication 55 ou de la revendication 56, dans lequel le moyen d'accès (112) est capable de se déplacer librement entre sa position ouverte et sa position fermée, cas dans lequel le moyen d'accès (112) se déplace vers sa position ouverte lorsque la chambre (46) est inversée.

58. Le séparateur de la revendication 55, dans lequel le moyen d'accès (112) possède une partie de raccordement (114) laquelle est raccordée de façon pivotante au moyen de séparation (40).

59. Le séparateur de la revendication 58, comprenant en outre un élément lesté (116) lequel est raccordé au moyen d'accès (112) au niveau d'un emplacement qui est espacé de la partie de raccordement (114).

60. Le séparateur de la revendication 55, dans lequel le moyen d'accès (112) et le moyen de séparation (40) constituent une surface qui est sous-jacente à la totalité de la zone de flux cyclonique (48).

61. Le séparateur de la revendication 55, dans lequel le moyen d'accès (112) comprend une partie de corde d'arc du moyen de séparation (40).

62. Le séparateur de l'une quelconque des revendications précédentes, dans lequel les ouvertures (52) sont au moins positionnées sous la partie interne (72) de la zone de flux cyclonique (48).

63. Le séparateur de l'une quelconque des revendications précédentes, dans lequel les ouvertures sont essentiellement positionnées sous la partie périphérique uniquement de la zone de flux cyclonique.

64. Le séparateur de l'une quelconque des revendications précédentes, dans lequel les ouvertures sont essentiellement positionnées sous la partie interne uniquement de la zone de flux cyclonique.

65. Le séparateur de l'une quelconque des revendications précédentes, dans lequel les ouvertures sont essentiellement positionnées sous les parties périphérique et interne uniquement de la zone de flux cyclonique.

Dyson Ex1020
Page 1003

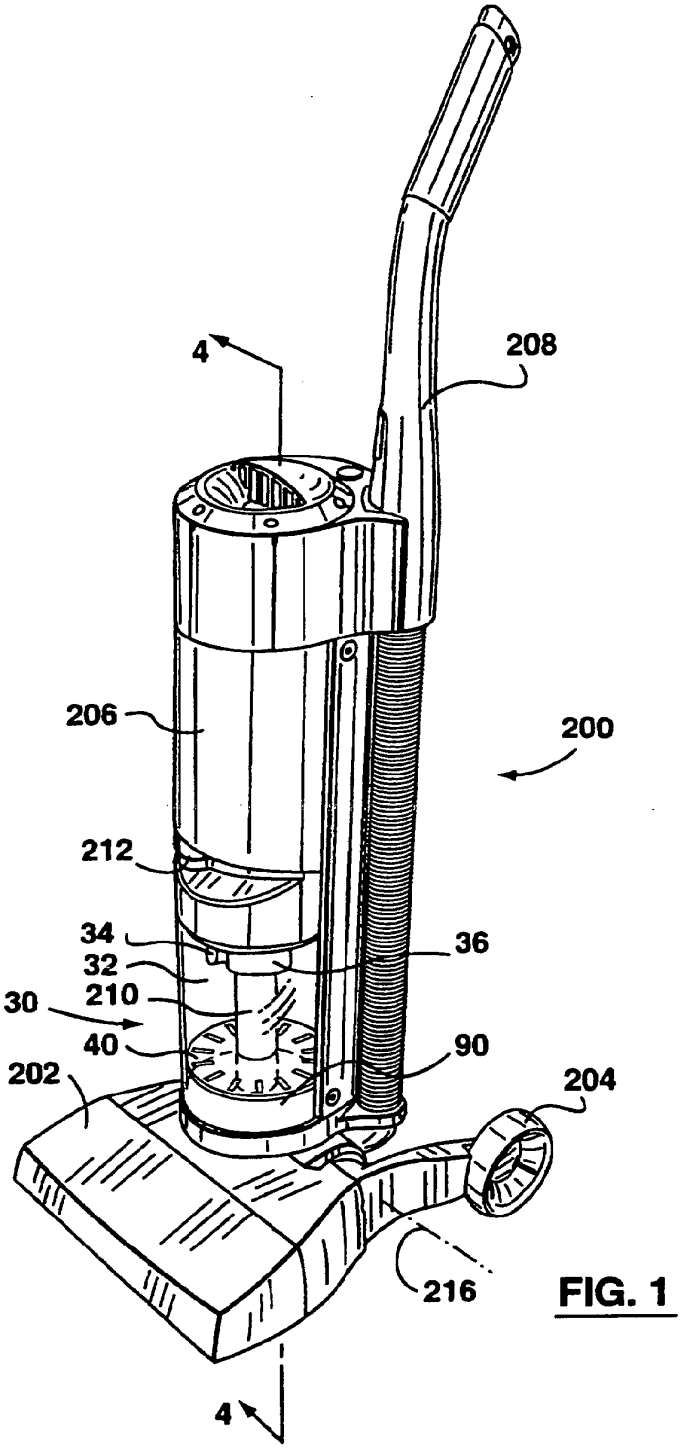


FIG. 1

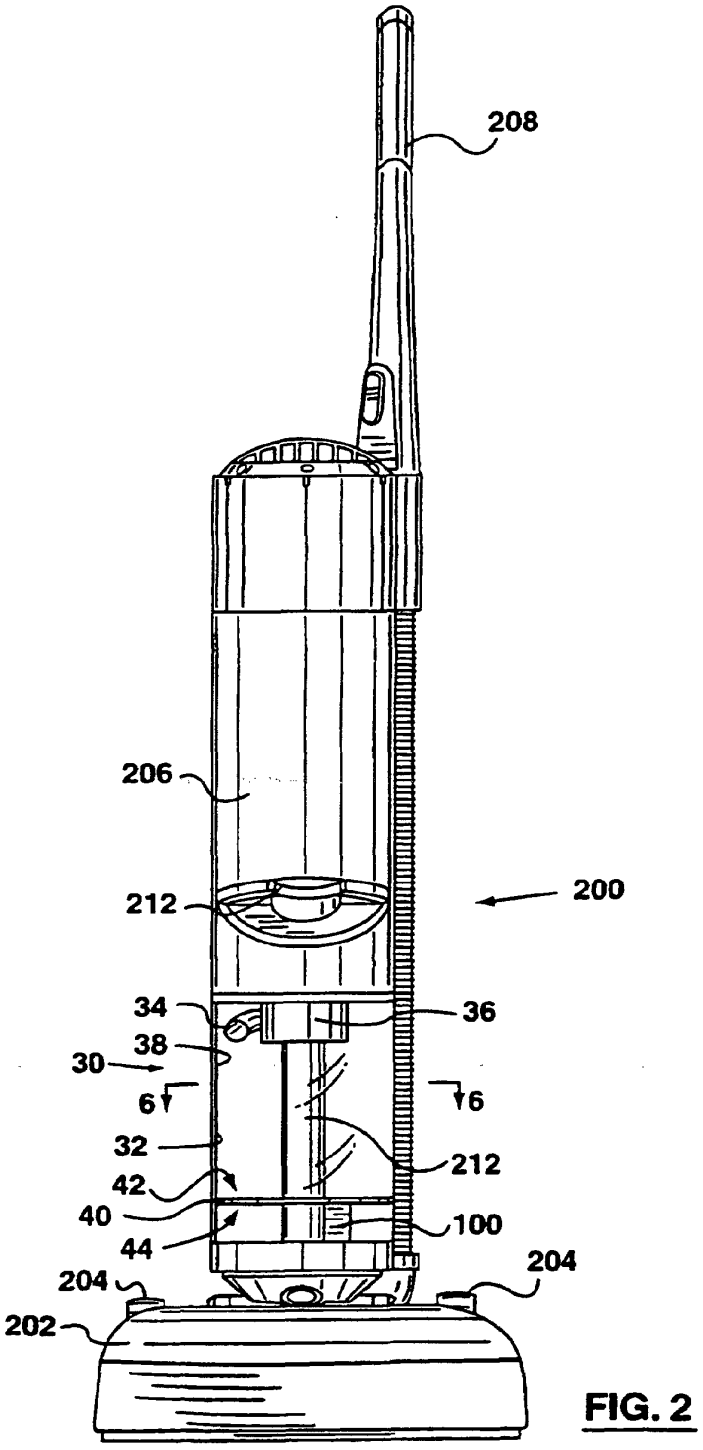


FIG. 2

Dyson Ex1020
Page 1005

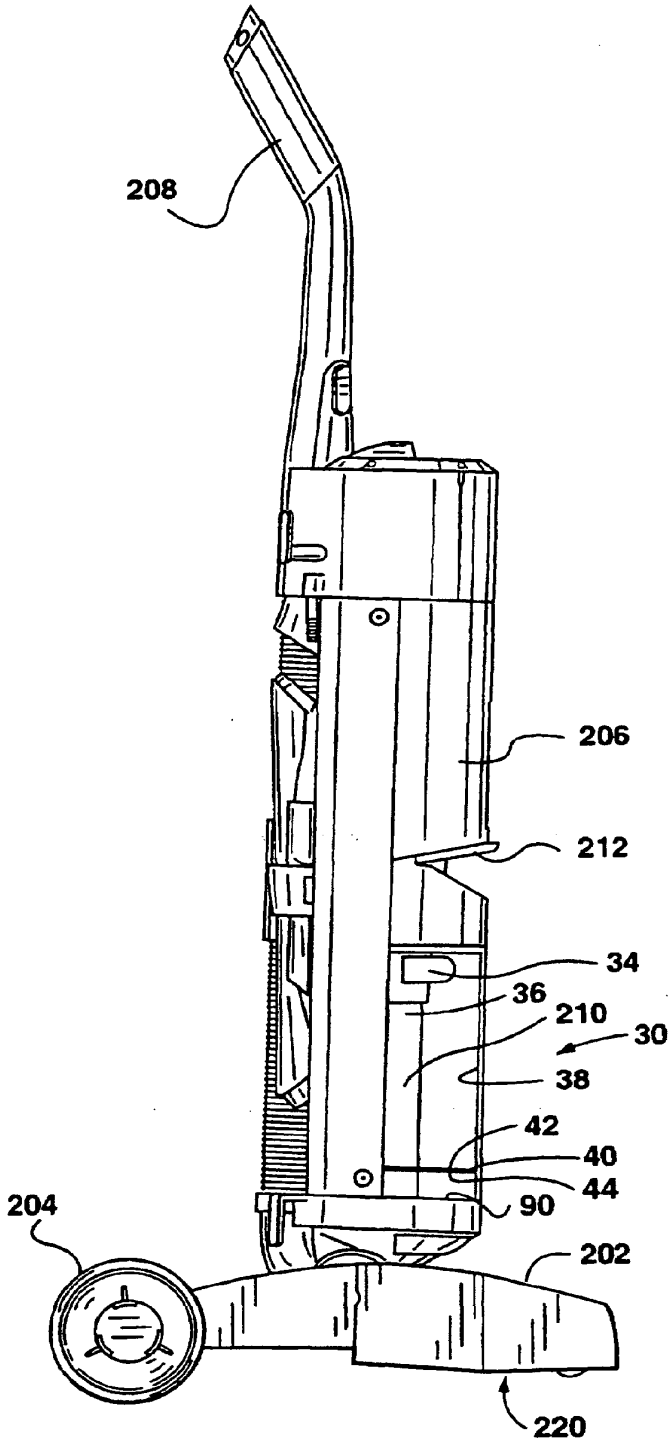


FIG. 3

Dyson Ex1020
Page 1006

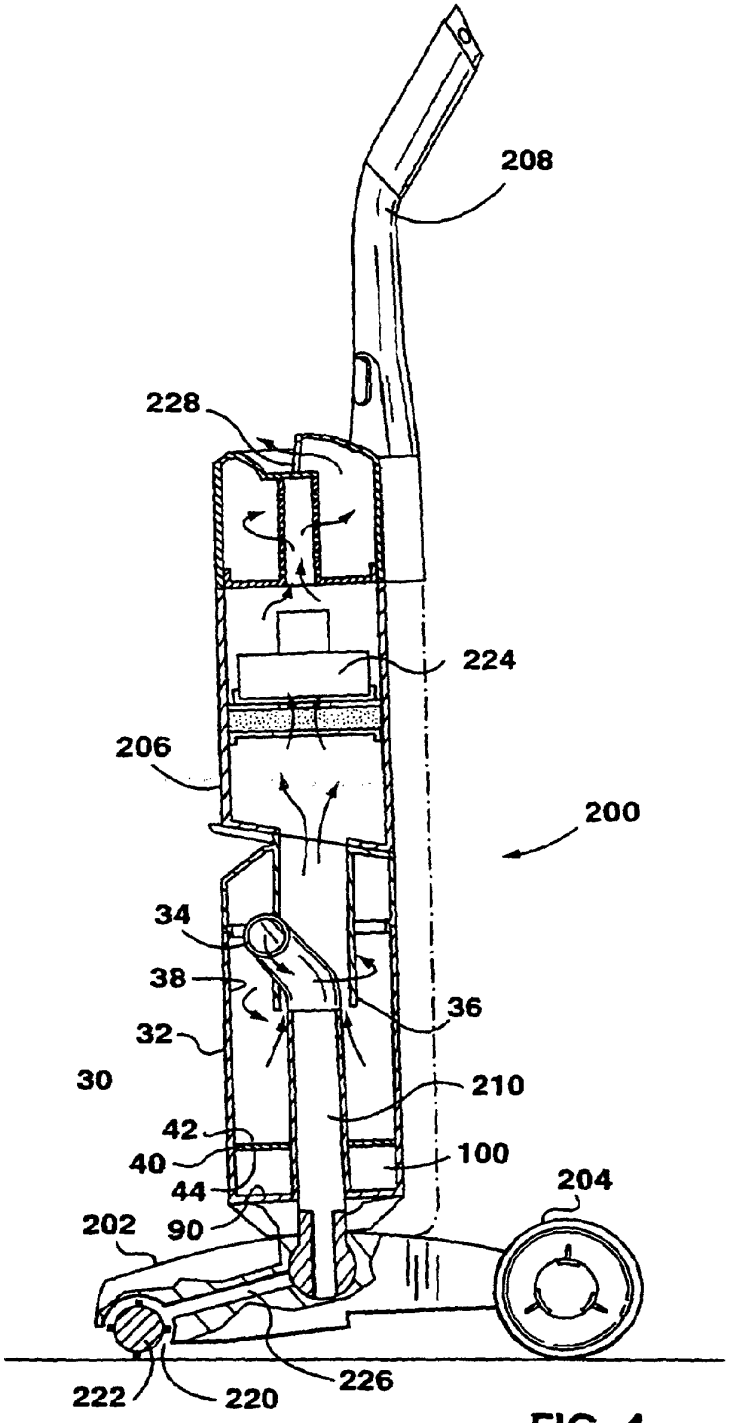


FIG. 4

Dyson Ex1020
Page 1007

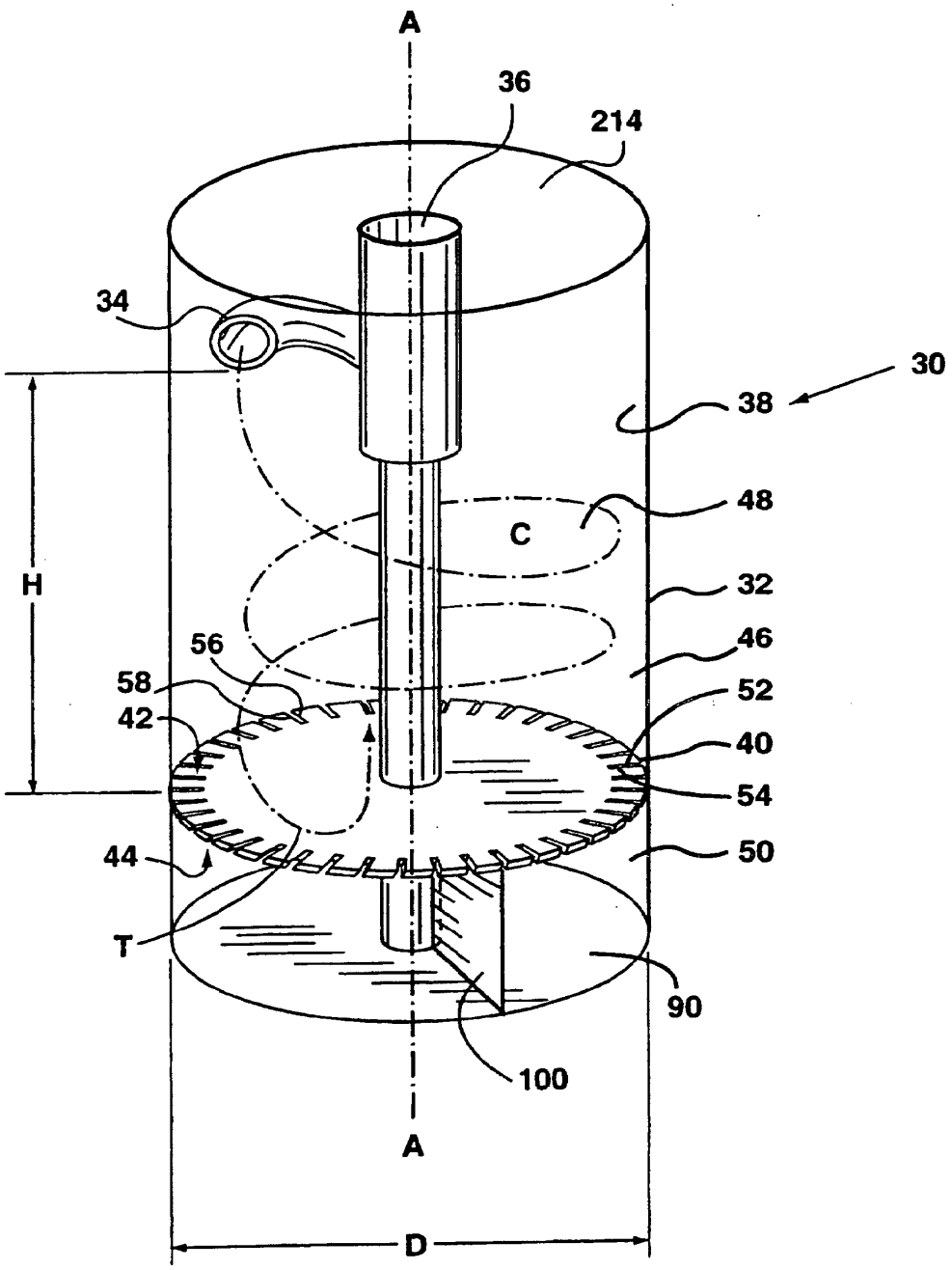


FIG. 5

Dyson Ex1020
Page 1008

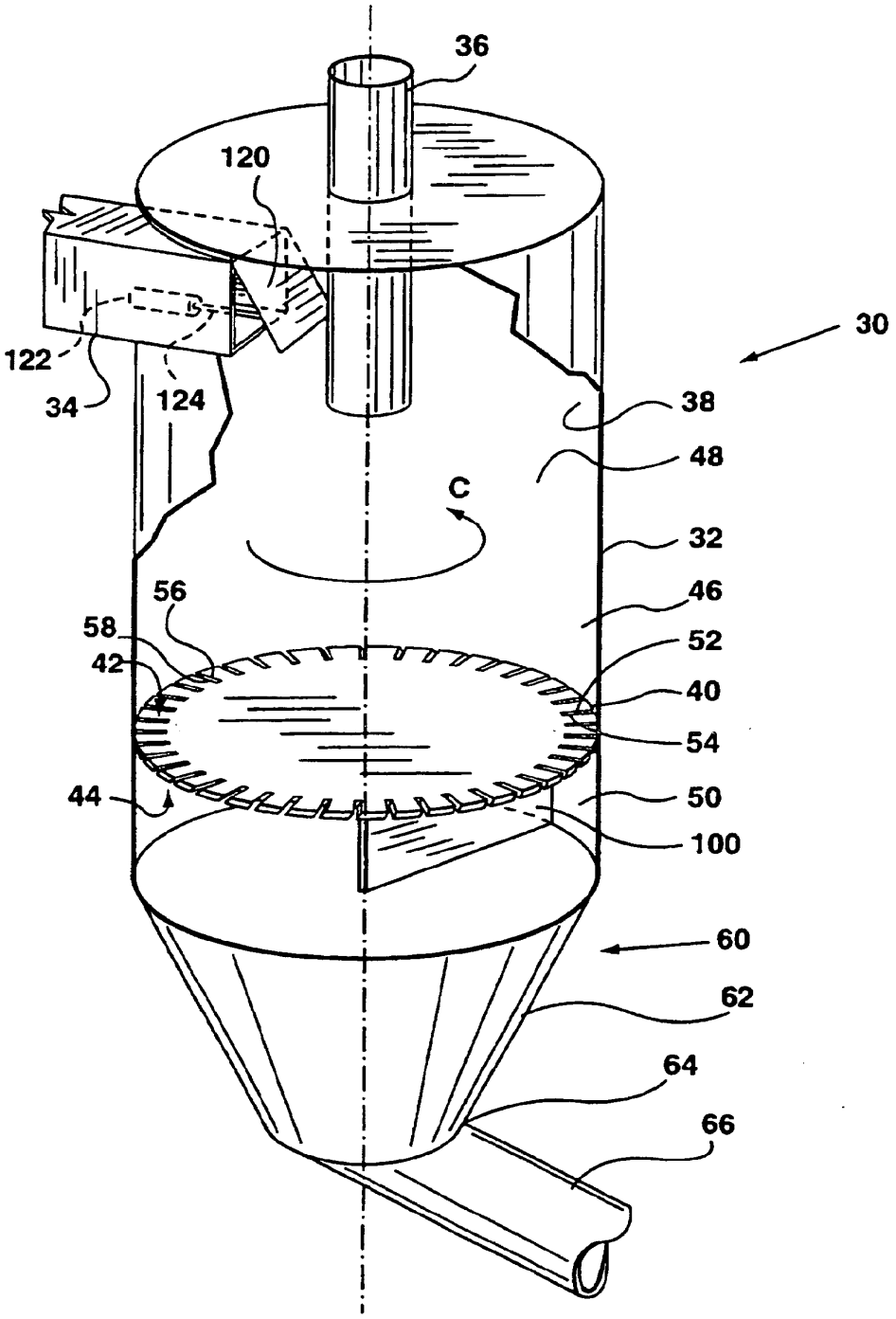


FIG. 7

Dyson Ex1020
Page 1009

FIG. 6

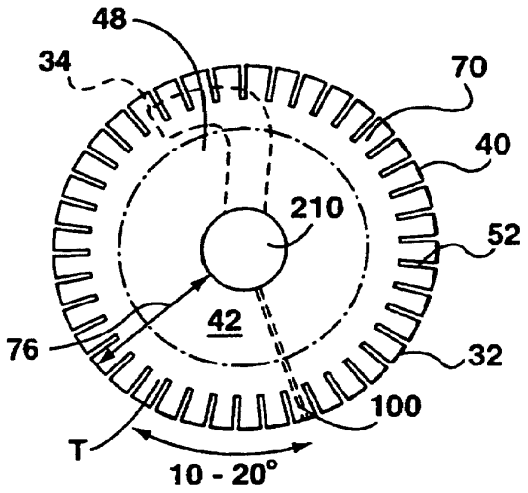


FIG. 8

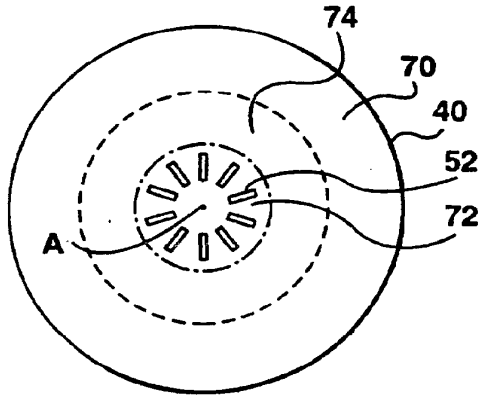
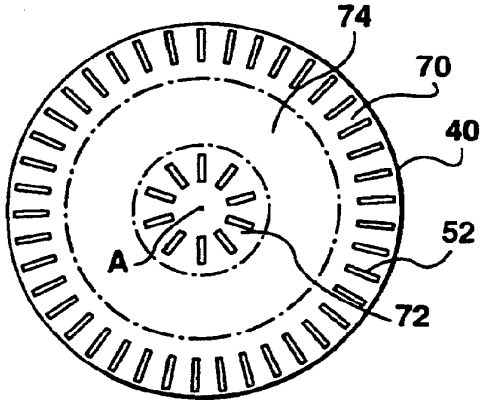


FIG. 9



Dyson Ex1020
Page 1010

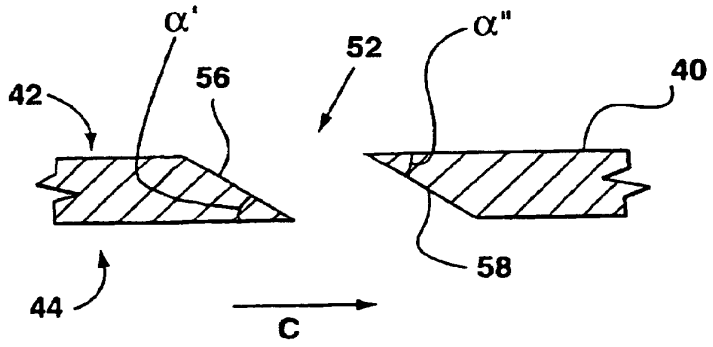


FIG. 10

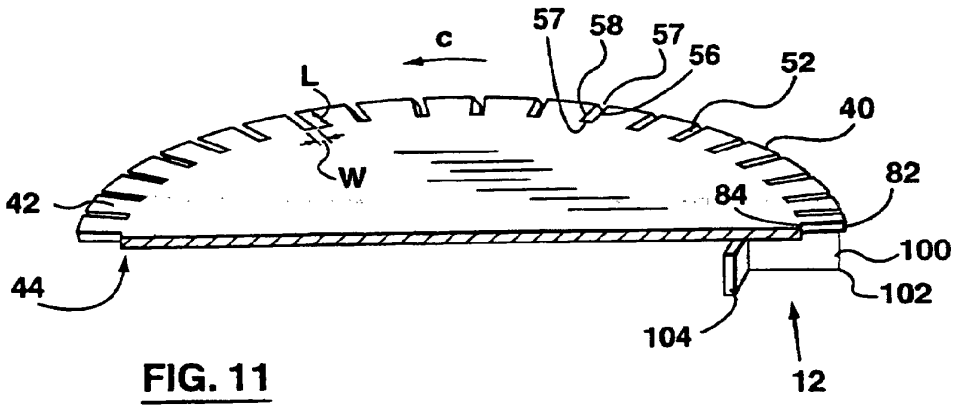


FIG. 11

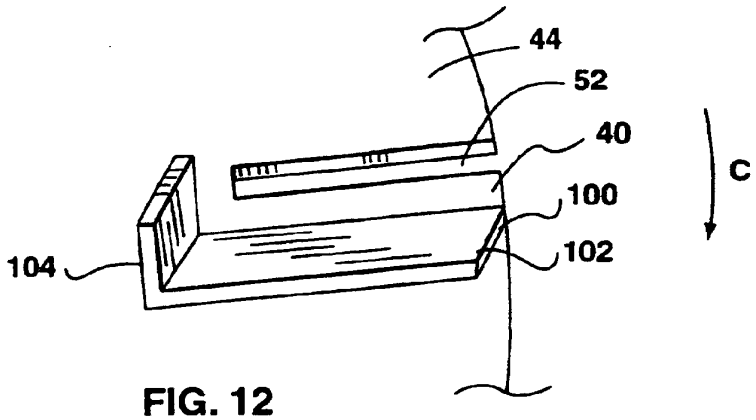


FIG. 12

Dyson Ex1020
Page 1011

FIG. 13

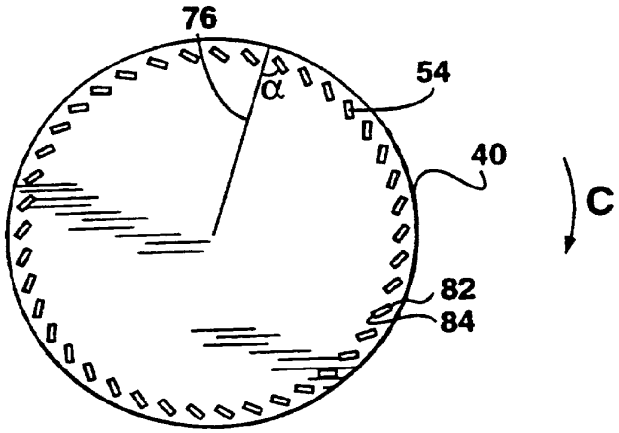


FIG. 14

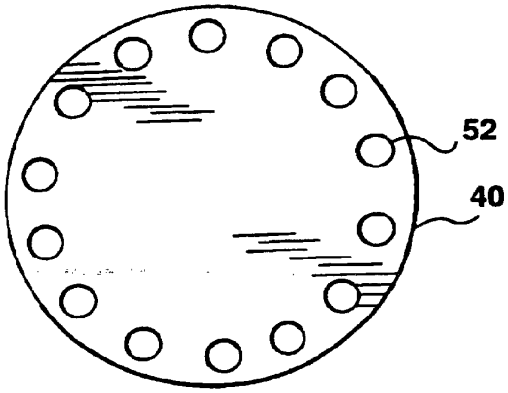
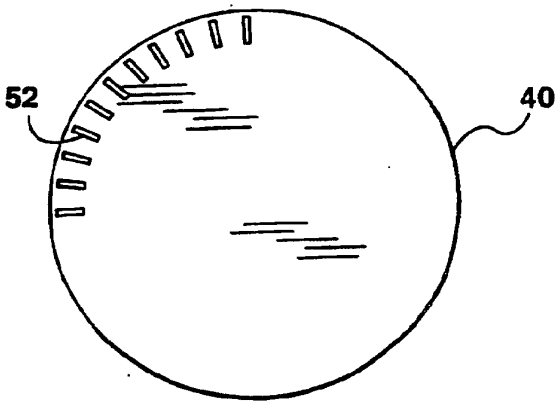


FIG. 15



Dyson Ex1020
Page 1012

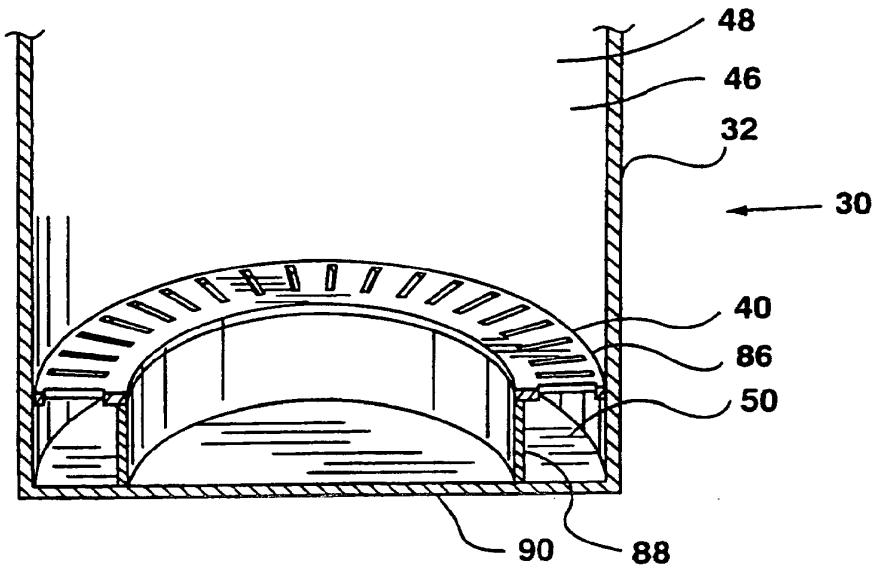


FIG. 16

Dyson Ex1020
Page 1013

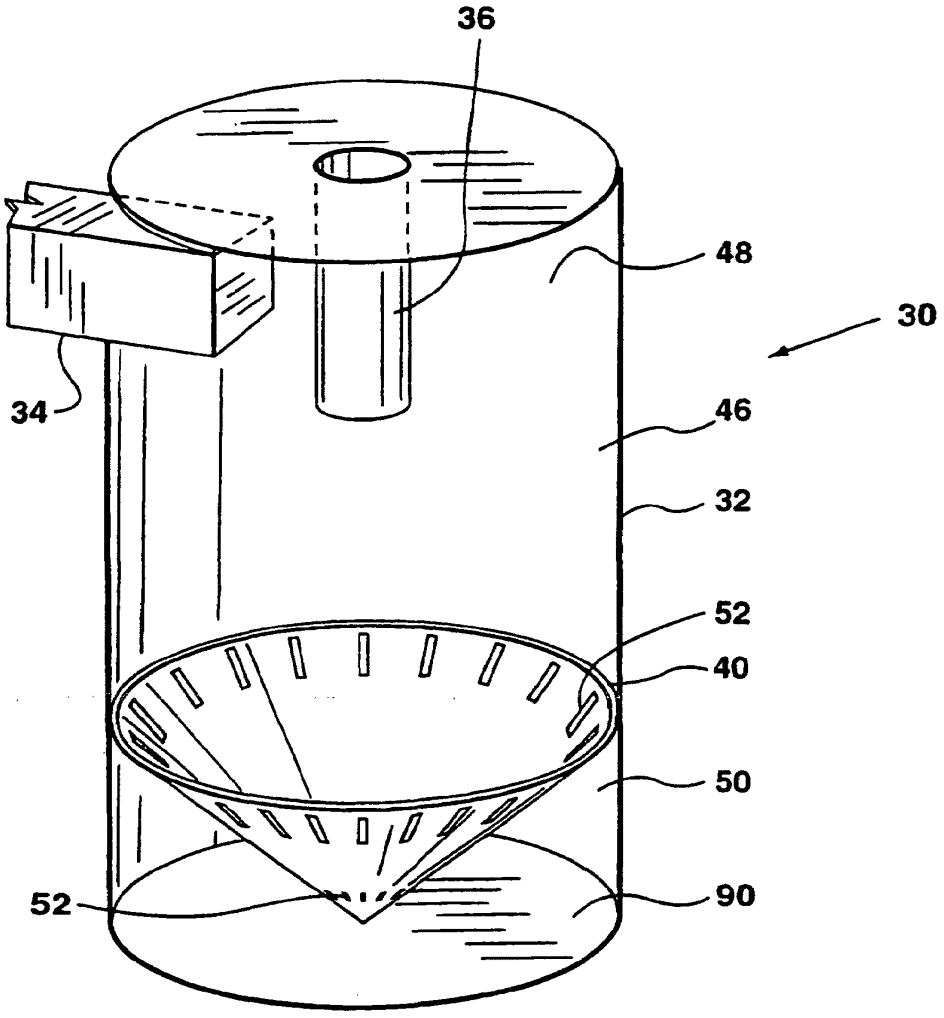


FIG. 17

Dyson Ex1020
Page 1014

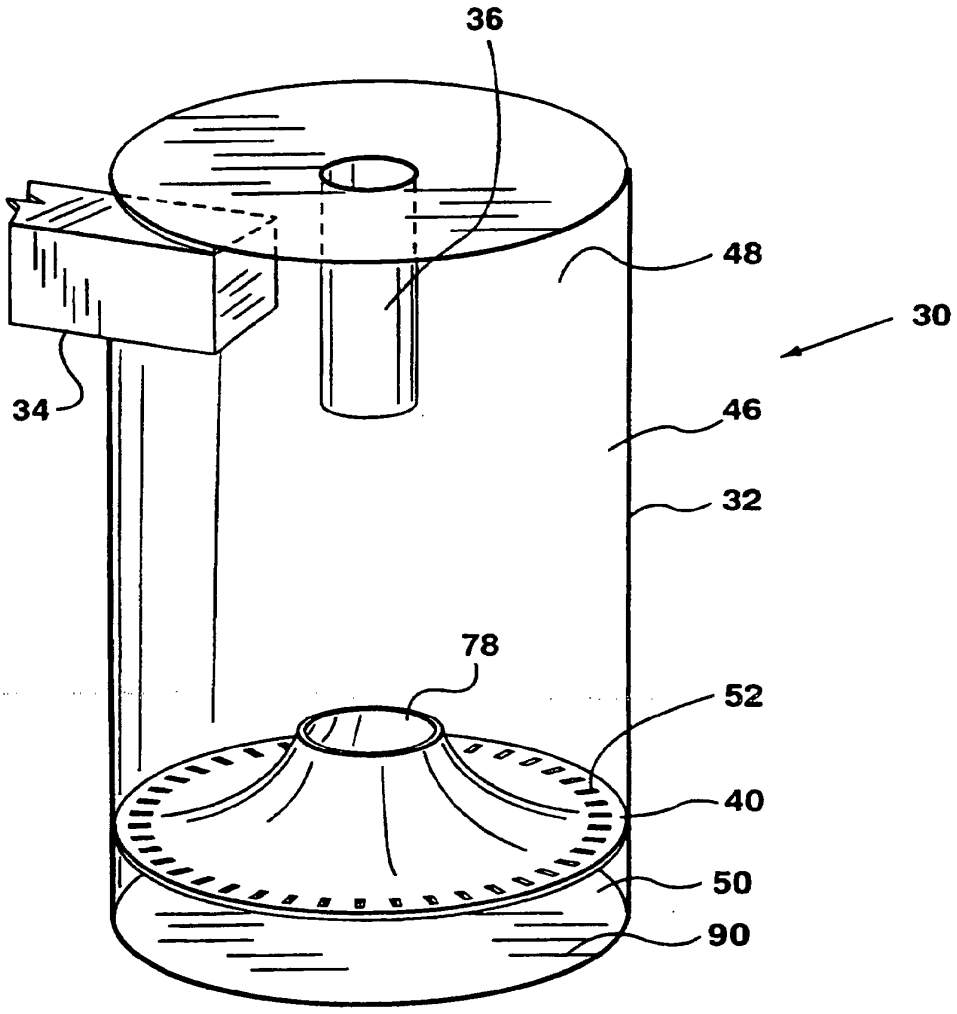


FIG. 18

Dyson Ex1020
Page 1015

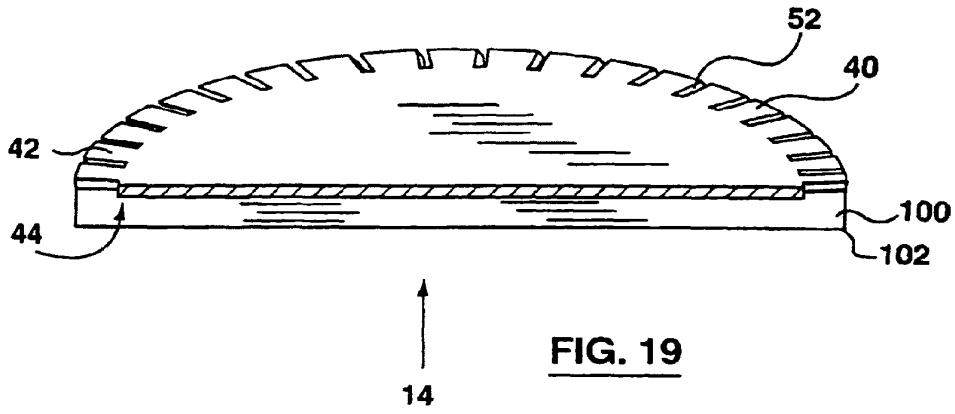


FIG. 19

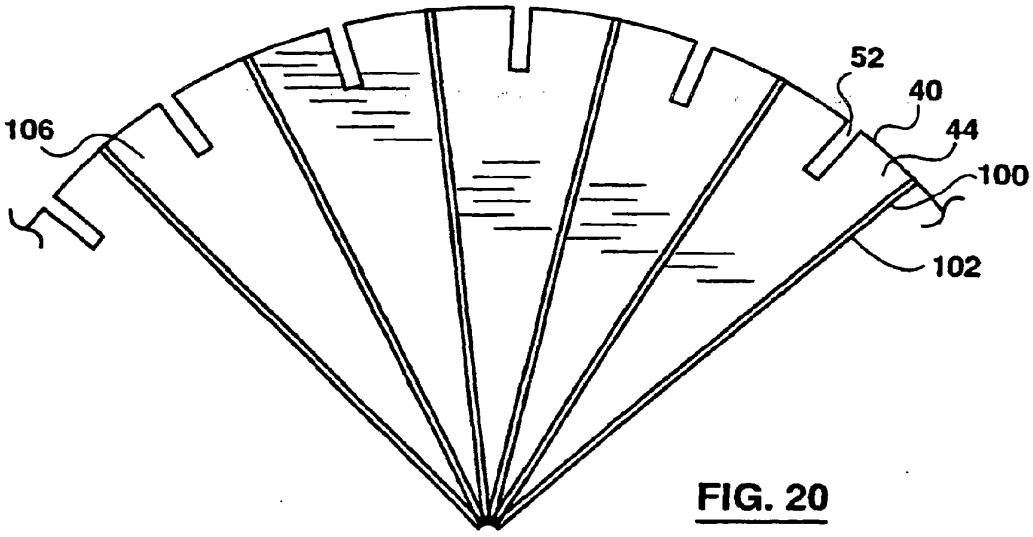


FIG. 20

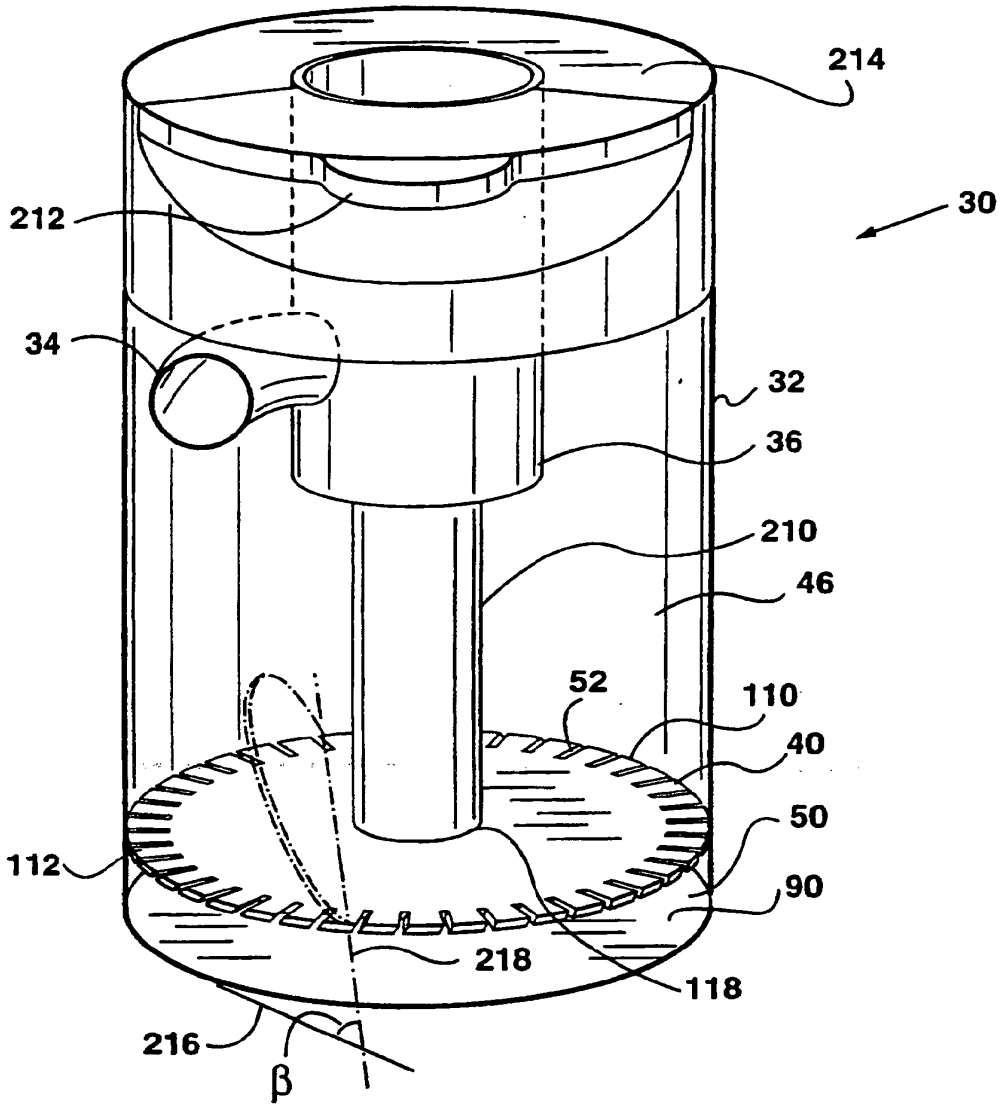


FIG. 21

Dyson Ex1020
Page 1017

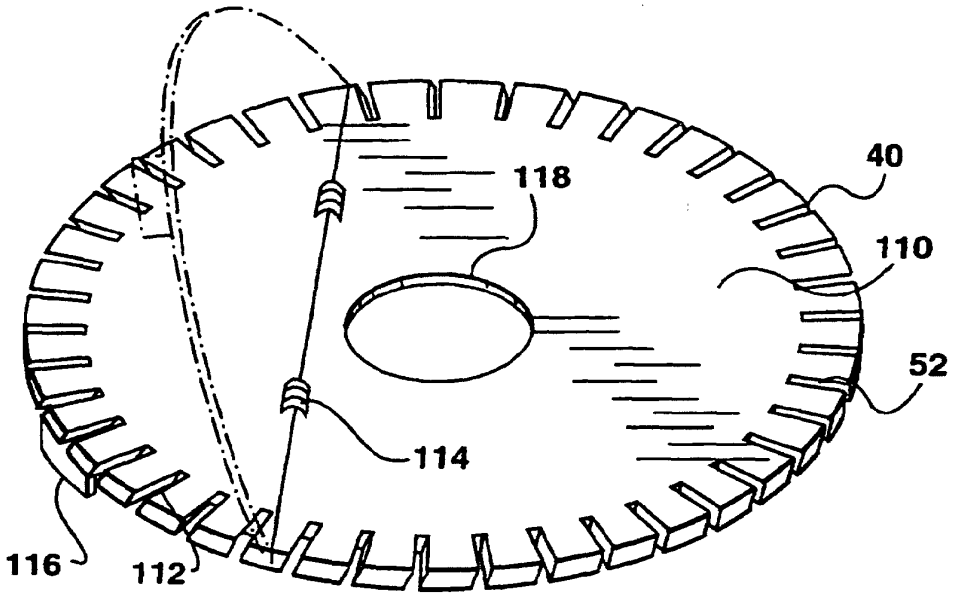


FIG. 22

Dyson Ex1020
Page 1018

Department of Patents. Patents Act 1903-1921 Commonwealth of Australia.

112,778

Application Date : 6th Apr., 1940. No. 1347/40.

Applicant (Actual Inventor) .. .. CLIFFORD VICTOR PEDERICK.
Application and Complete Specification .. Accepted, 21st March, 1941.
Acceptance Advertised (Sec. 50) .. 3rd April, 1941.

Classes 21.5 ; 66.5 ; 90.9 ; 17.4.

Drawing attached.

COMPLETE SPECIFICATION.

"An improved dry cleaner for gases."

I, CLIFFORD VICTOR PEDERICK of Tudhoe Street, Wagin, in the State of Western Australia, Commonwealth of Australia, Engineer, hereby declare this invention, and the manner in which it is to be performed, to be fully described and ascertained in and by the following statement:—

This invention relates to an improved dry cleaner for gases.

The cleaner is primarily intended for dealing with producer gas particularly such gas when generated for employment on mobile vehicles. The scope of the invention however is not so limited because the cleaner will have utility for the treatment of gases and the removal of solid particles contained therein.

Dry cleaners have frequently been employed in which the gases have been given a centrifugal motion for the purpose of separating the solid particles. I have found however that the effect of imparting a centrifugal motion in a dry cleaner in the ordinary way whilst it results in a separation of a certain amount of solid impurities has the effect of grinding many of the particles still finer, in fact to such a degree of fineness that they cannot be separated in such a cleaner and pass on to the next stage which is usually some form of scrubber.

The present invention relates to a dry cleaner in which the tendency to grind particles under the influence of centrifugal force is considerably reduced if not entirely eliminated. This is done by giving the gas a centrifugal motion limited as far as possible to the periphery of the container and in having a series of baffles and one or more associated openings through which the separated particles can continuously pass as separated. In consequence of such arrangement the grinding tendency previously referred to is largely reduced.

The invention will readily be understood by reference to the accompanying drawings showing a suitable form of apparatus which may be employed. In such drawings

1905.—17/4/41.—165.—Price, 1s. 6d. post free.

Dyson Ex1020
Page 1019

Fig. 1 is a sectional elevation of the cleaner constructed according to the invention and

Fig. 2 is a plan of a convenient form of baffle.

As shown in these drawings the container which is normally cylindrical is referenced **10**. The gas inlet is referenced **11** and obviously is near the top of the container. There is a cylindrical member **12** that is of such a diameter that its outer periphery approaches closely to the inner periphery of the container, there being a space of about ¼" between the two. Between the container and the cylindrical member **12** there will be a number of vanes, bars or the like **13** set at an angle so as to impart a swirling motion to the gas as it passes from above the cylindrical member **12** to the lower part of the container. This swirling motion however by reason of the small space between the members referred to is restricted as far as possible to an action around the periphery so as to leave a central portion of the container as quiet as possible from motion of the gas. In communication with the top of the cylinder **12** is the gas outlet **14**. At a lower level in the container **10** there will be a plate member **15** which near the edges is fashioned into the form of a number of up-turned fins **16**. Between each pair of fins there is a corresponding space that communicates with a lower portion of the container. The bottom of the container may have some readily removable cap **17** through which the accumulated solid particles can be withdrawn from time to time.

The gas enters the cleaner through the conduit **11**, then passes between the cylindrical member **12** and the container **10** and has a swirl imparted thereto. The solid particles tend to separate and as the motion is a circular one at the periphery the upturned fins **16** act as baffles and tend to stop the particles and they continually fall through the openings between these fins and collect

in a lower part of the container. In consequence of such continued and rapid removal of the solid particles the grinding action previously referred to is considerably reduced and the gas which leaves the cleaner through the outlet conduit **14** is sufficiently clean to require but little further cleaning action and that only to eliminate the very finest of particles which can only be collected in a wet cleaner.

Having now fully described and ascertained my said invention and the manner in which it is to be performed, I declare that what I claim is:—

1. In an improved dry cleaner for gases a container, a cylindrical member inside the container and having its outer periphery about one quarter inch from the inner periphery of the container, a plurality of directing vanes between the cylindrical member and the container so that the gases passing through the cleaner are given a centrifugal motion limited as far as possible to the periphery of the container.

2. In an improved dry cleaner for gases a container, a cylindrical member inside the container and having its outer periphery close to the inner periphery of the container, a plurality of directing vanes between the cylindrical member and the container so as to give the gas a centrifugal motion limited as far as possible to the periphery, and a series of baffles and associated openings at the periphery so that the separated particles are continuously removed.

3. An improved dry cleaner for gases substantially as herein described and as illustrated in the accompanying drawings.

Dated this tenth day of January, 1941.

CLIFFORD VICTOR PEDERICK,
By his Patent Attorney,
P. M. BONNERUP,
Fellow Institute of Patent Attorneys of Australia.

Witness—J. Dennis.

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Dyson Ex1020
Page 1020

Fig. 1.

Fig. 2.

(11) (A) No. 1077412

(45) ISSUED 800513

(52) CLASS 183-116
C.R. CL.

(51) INT. CL. [2] B04C 5/00

(19) (CA) CANADIAN PATENT (12)

(54) CYCLONE SEPARATOR FOR A STEAM/WATER MIXTURE

(70) Läubli, Fritz,
Switzerland

Granted to Sulzer Brothers Limited,
Switzerland

(21) APPLICATION No. 272,665

(22) FILED 770225

(30) PRIORITY DATE Switzerland (3802/76) 760326

No. OF CLAIMS 9

DISTRIBUTED BY THE PATENT OFFICE, OTTAWA.
CCA-274 (5-79)

ABSTRACT OF THE DISCLOSURE

A cyclone-type separator for separating water from a steam/water mixture. The separator is of the type of an upright, generally cylindric vessel whose upper portion defines a steam zone, the lower portion defining a water zone. A separation zone into which the steam/water mixture is normally introduced in tangential fashion, is located between the two former zones. A conduit communicates the interior of the separator at the steam zone with the interior of same slightly above the top level of the water zone, to return a film of water formed on the inside wall of the separator and rising towards the top thereof. Thus, the film of water is returned through said conduit back to the proximity of the water zone top level to increase the separation efficiency of the device.

The invention relates to a water separator of the cyclon type for a steam/water mixture with a vessel having a vertical axis. It encloses a steam space with its upper zone, a water space with its lower zone and a separator zone in between. The steam/water mixture enters tangenially into the separator zone. The vessel is provided with one outlet each, at least, in the zone of the steam space as well as the water space.

With a water separator of this kind the water injected against the wall of the vessel rushes along this wall downwards into the water space while the steam streams upwards into the steam space. Tests with such water separators have shown that a water film not visible under normal conditions can spread upwards along the vessel wall. This water film can be pushed to the steam outlet by the steam flow the pattern of which is not fully known yet. There it can be entrained by the strong stream forces of the steam along the wall of the pipe connected to the outlet or it can be carried away in droplet form by the steam. Thus the separating efficiency of these water separators is unsatisfactory for various applications.

It is an object of the invention to improve the separating efficiency of the above mentioned water separators in a simple and effective way.

According to the invention, the separator is provided with at least one channel for sucking off the water which spreads as a film over the vessel wall enclosing the steam space; its entrance is between the mixture inlet and steam outlet at the inner vessel wall and its exit is in the vessel in a zone below the mixture inlet and above the water outlet. Through this configuration of the water separator a bypass is created for the water where the water film rising along a helical path is sucked off by means of a part of the steam flow and is returned to a lower zone of the water separator. The water

Dyson Ex1020
Page 1024

entering into the suction channel thus flows into this channel not only under the influence of gravity but is also pulled into the suction channel by the forces of the streaming steam.

Two examples of the invention are explained in detail in the following description on hand of a drawing. It is shown:

Fig. 1 A water separator according to the invention partially in front view, partially in axial section.

Fig. 2 An axial section of the upper part of a modified water separator and

Fig. 3 A section of the separator according to Fig. 2 showing the zone of the mixture inlet in plan.

According to Fig. 1 the water separator shows an upwardly elongated cylindrical vessel 1 having a vertical axis. The vessel 1 is composed of a pipe section 7, an upper hemispherical end 2 and a lower hemispherical end 3. At the upper end of the vessel 1 an axial steam exit connector 4 is provided which penetrates the hemispherical bottom 2. The lower end of connector 4 extends some distance into the interior of the vessel. The lower hemispherical end 3 is provided with a central manhole connector 5 which is closed by a cover 15. At the inside of the cover 15, baffles 8 are provided in order to destroy the rotating flow of the liquid locally. The hemispherical bottom 3 carries a water outlet 13 to which an outlet line 12 is connected approximately tangentially.

The vessel 1 has in its lower portion or zone, which extends about to the dashed line A, the water space of the separator while a separation zone extends from the line A to about the dashed line B. The upper end of the vessel encloses the steam space of the separator. In the separation zone an inlet 11 is provided in a wall section 7 for introducing the steam/water mixture to be separated. A feed line 10 is connected to the inlet approximately tangentially.

Dyson Ex1020
Page 1025

According to the invention, the separator is provided with a suction channel which has the form of a pipe 20 extending along the outside of the vessel 1. The inlet opening 21 of the suction line 20 is disposed in the vessel wall between the inlet 11 and the steam outlet connector 4. The suction line 20 terminates in an exit opening 22 located in the vessel wall below the mixture inlet 11 and above the water outlet 13, somewhat above the water space. The vertical distance a of the inlet 21 from the mixture inlet 11 is smaller than the vertical distance (b) of the outlet 22 of the suction line 20 from the mixture inlet 11. The suction line 20 makes it possible to prevent water which spreads as a film from the separating zone upwards along the vessel wall to rise beyond the opening 21. The film-like rising water is now drawn by a part of the steam flow into the suction line 20 and is returned to the vessel near the lower end of the separating zone.

In the example according to Fig. 2 and 3 which is designed like the example according to Fig. 1 with respect to the arrangement of the separator vessel 1, the suction channel is arranged inside the vessel 1 and is formed by the vessel wall and a liner sheet 30 placed inside the vessel. In the zone of the liner sheet 30 several, e.g. 8, spacer strips 31 are provided which are distributed uniformly over the circumference of the vessel and are welded to the vessel. The spacer strips 31 define an approximately helical course descending in the rotating direction of the steam/water mixture. The liner sheet 30 is fastened to the spacer strips by spot welds not shown. In the zone of the mixture inlet 11 the liner sheet 30 is perforated and the edge 33 of the so formed opening of the liner sheet is bent outwards so that the edge contacts the vessel wall near the opening 11. A welded seal between this edge and the vessel wall is usually not necessary.

The upper edge 32 of the liner sheet 30 is flanged

Dyson Ex1020
Page 1026

somewhat to the outside resulting in a narrowed gap as inlet opening of the suction channel. This narrowing produces in the gap a higher steam velocity which secures the entrainment of the water rising along the liner sheet. The axial length of the liner sheet in Fig. 2 is about 1.5-times the inner diameter of the liner sheet. In general one would not go beyond 4-times the inner diameter.

Many other variants of the present invention are readily conceivable. For instance it is possible to arrange the steam outlet connector 4 end flush with the hemispherical bottom 2 so that the connector section extending into the interior of the vessel is avoided. Furthermore, it is possible to install one or several tangential or radial outlet connectors on the vessel. Likewise, instead of one mixture inlet line 10, several such lines can be connected to the vessel either on the same level or at different levels. Then the respective vertical distance of the inlet opening and the outlet opening of the suction channel from the mixture inlet is measured between the uppermost inlet opening of the mixture and the inlet of the suction channel or between the lowermost inlet opening of the mixture and the exit of the suction channel.

Furthermore, in the example according to Fig. 1 also two or three suction lines, distributed over the circumference of the vessel, can be provided instead of one suction line 20.

These and other modifications, however, do not depart from the scope of this invention as defined in the accompanying claims.

Dyson Ex1020
Page 1027

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Water separator of the cyclone type for a steam/water mixture with a vessel having a vertical axis, said vessel having an upper zone defining a steam space, and a lower zone defining a water space, said vessel further having an intermediate zone between the former two, said intermediate zone defining means for introducing the steam/water mixture tangentially into the separator zone, the vessel being provided in the zone of the steam space and in the zone of the water space with at least one outlet each, wherein at least one suction channel is provided for the removal of water spreading in a film-like fashion over the vessel wall enclosing the steam space; an inlet of said suction channel being located at the inner wall of the vessel between the mixture inlet and the steam outlet, the outlet of said suction channel being located inside the vessel in a zone below the mixture inlet and above the water outlet.

2. Separator according to claim 1 wherein the suction channel is a conduit communicating with the interior of the vessel and extending exteriorly of said vessel.

3. Separator according to claim 1, wherein a liner sheet is arranged at a radial spacing from the inside wall of the vessel and perforated in the zone of the mixture inlet, to define the suction channel by a generally annular space between said liner sheet and the wall of said vessel.

4. Separator according to claim 1, characterized in that the vertical distance of the inlet opening of the suction channel from the mixture inlet is smaller than the vertical distance of the outlet opening of the suction channel from the mixture inlet.

5. Separator according to claim 2, characterized in that the inlet of said conduit is generally tangential relative

Dyson Ex1020
Page 1028

to said vessel, the remaining portion of said conduit extending generally in the direction of rotation of the steam-water mixture inside said vessel.

6. Separator according to claim 5, wherein the outlet of said conduit is disposed generally tangentially relative to said vessel, whereby the medium flowing in the conduit enters the vessel generally in the direction of rotation of the steam/water mixture inside the vessel.

7. Separator according to claim 3, characterized in that the spacer sheet is fixedly secured to a plurality of spacer strips, said spacer strips being disposed about the inside periphery of said vessel and being welded to said vessel.

8. Separator according to claim 7 characterized in that the liner sheet is fixedly secured to the spacer strips by spot welds.

9. Separator according to claim 3, wherein the vertical length of the liner sheet is at least 1.5-times the inside diameter of the liner sheet.

Dyson Ex1020
Page 1029

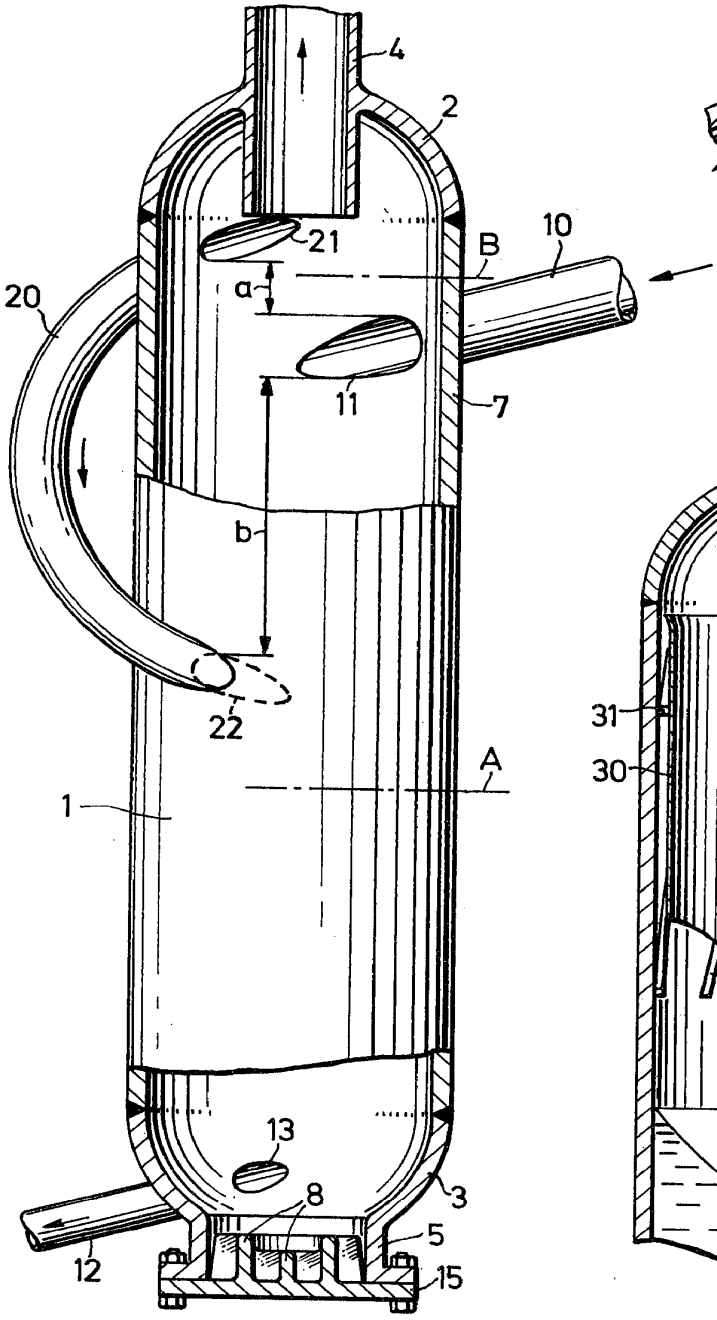


FIG. 1

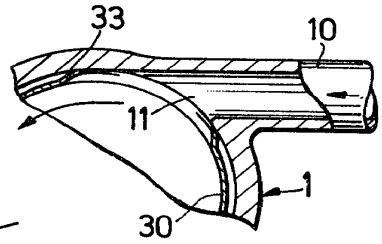


FIG. 3

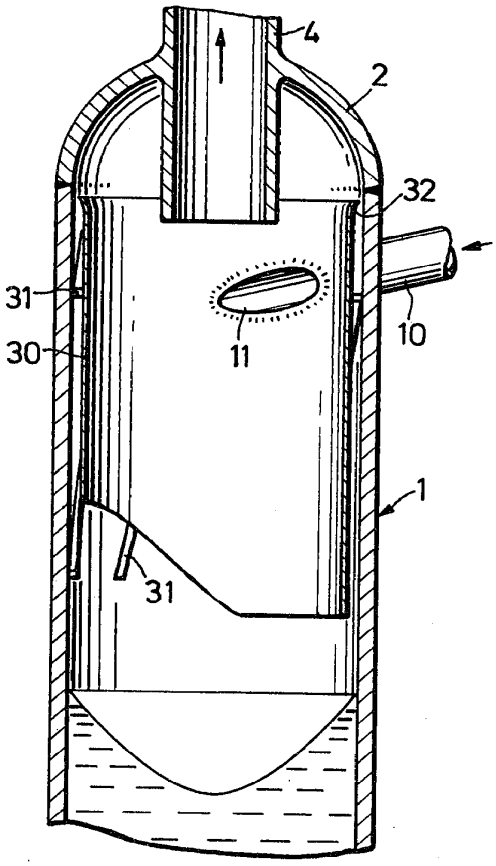


FIG. 2

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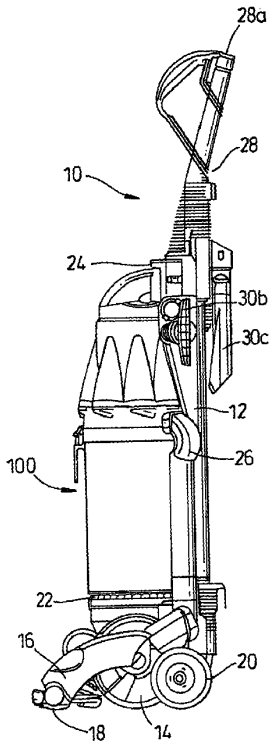
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(54) Title: VACUUM CLEANER



(57) Abrégé/Abstract:
The invention provides a vacuum cleaner (10) having an external surface and incorporating cyclonic separating apparatus (100) comprising a plurality of cyclones (104) arranged in parallel to one another, characterised in that each cyclone (104) has a tapering body (104a) having an outside wall (104b) and in that at least a part (104d) of each outside wall (104b) forms part of the external surface of the vacuum cleaner (10).

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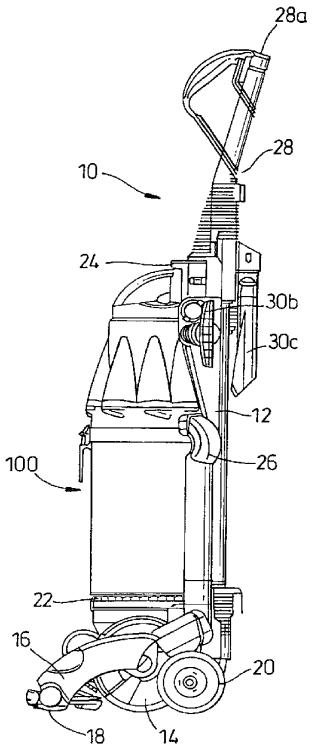
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(54) Title: VACUUM CLEANER



(57) Abstract: The invention provides a vacuum cleaner (10) having an external surface and incorporating cyclonic separating apparatus (100) comprising a plurality of cyclones (104) arranged in parallel to one another, characterised in that each cyclone (104) has a tapering body (104a) having an outside wall (104b) and in that at least a part (104d) of each outside wall (104b) forms part of the external surface of the vacuum cleaner (10).

WO 02/067757 A1

WO 02/067757 A1

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

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Vacuum Cleaner

The invention relates to a vacuum cleaner. Particularly, the invention relates to a vacuum cleaner incorporating cyclonic separating apparatus.

Over the last decade or so, the use of cyclonic separating apparatus to separate particles from an airflow in a vacuum cleaner has been developed and introduced to the market. Detailed descriptions of cyclonic separating apparatus for use in vacuum cleaners are given in, *inter alia*, US 3,425,192, US 4,373,228 and EP 0 042 723. From these and other prior art documents, it can be seen that it is known to provide two cyclone units in series so that the airflow passes sequentially through at least two cyclones. This allows the larger dirt and debris to be extracted from the airflow in the first cyclone, leaving the second cyclone to operate under optimum conditions and so effectively to remove very fine particles in an efficient manner. This type of arrangement has been found to be effective when dealing with airflows in which is entrained a variety of matter having a wide particle size distribution, as is the case in vacuum cleaners.

Some arrangements have been proposed in which the downstream cyclone has been replaced by a plurality of downstream cyclones arranged in parallel. Examples are shown in US 3,425,192 and JP 52-14775. In both of these arrangements, the downstream cyclones are housed within a casing which surrounds the cyclones so that the volume occupied by the cyclones is not minimised.

It is an object of the present invention to provide cyclonic separating apparatus which occupies a relatively small volume. It is another object of the invention to provide cyclonic separating apparatus suitable for use in vacuum cleaners and capable of ensuring that the size of the vacuum cleaner is as small as possible compared to the prior art. It is a further object of the invention to provide cyclonic separating apparatus capable of mitigating the disadvantages of the prior art.

The invention provides a vacuum cleaner having an external surface and incorporating cyclonic separating apparatus comprising a plurality of cyclones arranged in parallel to one another, characterised in that each cyclone has a tapering body having an outside wall and in that at least a part of each outside wall forms part of the external surface of the vacuum cleaner.

The incorporation of at least part of the outer walls of the tapering bodies of the cyclones into the external surface of the vacuum cleaner allows the overall volume of the vacuum cleaner to be kept to a minimum. A cover which might otherwise have been provided simply to smooth or streamline the external surface of the vacuum cleaner is not required. Also, the visual effect of being able to see the shape of the functional parts of the cyclonic separating apparatus is pleasing to the consumer and thus desirable. This effect can be enhanced by arranging the cyclones equi-angularly about an axis of the cyclonic separating apparatus and/or by providing that each cyclone has an axis which is inclined towards the axis of the cyclonic separating apparatus.

In a preferred embodiment, the cyclonic separating apparatus comprises at least one further cyclone arranged in parallel to the plurality of cyclones, and the or each further cyclone has a tapering body with an outside wall which does not form part of the external surface of the vacuum cleaner. Hence the number of cyclones arranged in parallel with one another is not limited by the physical limitations of the vacuum cleaner in question. Additional cyclones which do not form part of the external surface of the vacuum cleaner can be placed inside a ring of cyclones which do form part of the external surface of the vacuum cleaner.

In one embodiment, the or each further cyclone can be arranged closer to the axis of the cyclonic separating apparatus than those which are equi-angularly arranged about the axis. Each tapering body can be frusto-conical in shape. In one embodiment, all of the cyclones can be substantially the same size and shape. Each cyclone can have a larger lower end and a smaller upper end. The smaller end of each cyclone can open into a common collection area.

The cyclonic separating apparatus can comprise an upstream cyclone having an outer wall, at least a part of which forms part of the external surface of the vacuum cleaner. The outer wall of the upstream cyclone can be substantially cylindrical in shape. The plurality of cyclones arranged in parallel to one another can be located wholly outside the outer wall of the upstream cyclone.

Embodiments of the invention will now be described with reference to the accompanying drawings, wherein:

Figures 1a and 1b are front and side views, respectively, of a vacuum cleaner according to the invention;

Figures 2a, 2b and 2c are front, side and plan views, respectively, of a first embodiment of cyclonic separating apparatus forming part of the vacuum cleaner of Figures 1a and 1b;

Figures 3a and 3b are front and sectional side views, respectively, of the cyclonic separating apparatus of Figures 2a, 2b and 2c, Figure 3b being taken along the line III-III of Figure 3a; and

Figures 4a, 4b and 4c are perspective, plan and sectional side views, respectively, of a portion of the cyclonic separating apparatus of Figures 2a, 2b and 2c, Figure 4c being taken along line IV-IV of Figure 4b.

Figures 1a and 1b show a domestic vacuum cleaner 10 according to the present invention. The vacuum cleaner 10 comprises an upstanding body 12 at a lower end of which is located a motor casing 14. A cleaner head 16 is mounted in an articulated fashion on the motor casing 14. A suction inlet 18 is provided in the cleaner head 16 and wheels 20 are rotatably mounted on the motor casing 14 to allow the vacuum cleaner 10 to be manoeuvered over a surface to be cleaned.

Cyclonic separating apparatus 100 is mounted on the upstanding body 12 above the motor casing 14. The cyclonic separating apparatus 100 is seated on a generally horizontal surface formed by a filter cover 22. The filter cover 22 is located above the motor casing 14 and provides a cover for a post-motor filter (not shown). The cyclonic separating apparatus 100 is also secured to the upstanding body 12 by means of a clip 24 located at the top of the cyclonic separating apparatus 100. The upstanding body 12 incorporates upstream ducting (not shown) for carrying dirty air to an inlet of the cyclonic separating apparatus 100 and downstream ducting 26 for carrying cleaned air away from the cyclonic separating apparatus 100.

The upstanding body 12 further incorporates a hose and wand assembly 28 which may be retained in the configuration shown in the drawings so as to function as a handle for manoeuvering the vacuum cleaner 10 over a surface to be cleaned. Alternatively, the hose and wand assembly 28 may be released to allow the distal end 28a of the wand to be used in conjunction with a floor tool (not shown) to perform a cleaning function, eg on stairs, upholstery, etc. The structure and operation of the hose and wand assembly 28 is not material to the present invention and will not be described any further here. The general structure and operation of the hose and wand assembly 28 illustrated in Figures 1a and 1b is similar to that described in US patent number Re 32,257. Also, several tools and accessories 30a, 30b, 30c, are releasably mounted on the upstanding body 12 for storage purposes between periods of use.

The precise details of the features of the vacuum cleaner 10 described above are not material to the present invention. The invention is concerned with the details of the cyclonic separation apparatus 100 forming part of the vacuum cleaner 10. In order for the cyclonic separation apparatus 100 to be brought into operation, the motor located in the motor casing 14 is activated so that air is drawn into the vacuum cleaner via either the suction inlet 18 or the distal end 28a of the hose and wand assembly 28. This dirty air (being air having dirt and dust entrained therein) is passed to the cyclonic separation apparatus 100 via the upstream ducting. After the air has passed through the cyclonic separation apparatus 100, it is ducted out of the cyclonic separating apparatus 100 and down the upstanding body 12 to the motor casing 14 via the downstream ducting 26. The cleaned air is used to cool the motor located in the motor casing 14 before being exhausted from the vacuum cleaner 10 via the filter cover 22.

This principle of operation of the vacuum cleaner 10 is known from the prior art. This invention is concerned with the cyclonic separation apparatus 100 which is illustrated in Figures 2a, 2b and 2c in isolation from the vacuum cleaner 10.

The cyclonic separation apparatus 100 illustrated in Figure 2 comprises an upstream cyclone unit 101 consisting of a single upstream cyclone 102 and a downstream cyclone unit 103 consisting of a plurality of downstream cyclones 104. The upstream cyclone 102 consists essentially of a cylindrical bin 106 having a closed base 108. The open upper end 110 of the cylindrical bin abuts against a circular upper moulding 112 which defines an upper end of the upstream cyclone 102. An inlet port 114 is provided in the cylindrical bin 106 in order to allow dirty air to be introduced to the interior of the upstream cyclone 102. The inlet port 114 is shaped, positioned and configured to communicate with the upstream ducting which carries dirt-laden air from the cleaner head 16 to the cyclonic separating apparatus 100. A handle 116 and a catch 118 are provided on the cylindrical bin 106 and the upper moulding 112 respectively in order to provide means for releasing the cylindrical bin 106 from the upper moulding 112 when the cylindrical bin 106 requires to be emptied. A seal (not shown) can be provided between the cylindrical bin 106 and the upper moulding 112 if required.

The base 108 of the cylindrical bin can be hingedly connected to the remainder of the cylindrical bin in order to provide further access to the interior of the cylindrical bin 106 for emptying purposes if required. The embodiment illustrated herein will include a mechanism for allowing the base 108 to be hingedly opened in order to allow emptying, but the details of such a mechanism form the subject of a copending application and will not be described any further here.

Seven identical downstream cyclones 104 are provided in the downstream cyclone unit 103. The downstream cyclones 104 are equi-angularly spaced about the central longitudinal axis 150 of the downstream cyclone unit 103, which is coincident with the longitudinal axis of the upstream cyclone unit 101. The arrangement is illustrated in Figure 2c. Each downstream cyclone 104 is frusto-conical in shape with the larger end thereof located lowermost and the smaller end uppermost. Each downstream cyclone 104 has a longitudinal axis 148 (see Figure 3b) which is inclined slightly towards the longitudinal axis 150 of the downstream cyclone unit 103. This feature will be described in more detail below. Also, the outermost point of the lowermost end of each

downstream cyclone 104 extends radially further from the longitudinal axis 150 of the downstream cyclone unit 103 than the wall of the cylindrical bin 106. The uppermost ends of the downstream cyclones 104 project inside a collection moulding 120 which extends upwardly from the surfaces of the downstream cyclones 104. The collection moulding 120 supports a handle 122 by means of which the entire cyclonic separation apparatus 100 can be transported. A catch 124 is provided on the handle 122 for the purposes of securing the cyclonic separation apparatus 100 to the upstanding body 12 at the upper end thereof. An outlet port 126 is provided in the upper moulding 112 for conducting cleaned air out of the cyclonic separating apparatus 100. The outlet port 126 is arranged and configured to co-operate with the downstream ducting 26 for carrying the cleaned air to the motor casing 14.

As can be seen from Figures 4a and 4b, each cyclone 104 has a tapering body 104a which is frusto-conical in shape. Each cyclone 104 has an outer wall 104b. A first portion 104c of the outer wall 104b is located inside the collection moulding 120 whilst a further portion 104d is located outside the collection moulding 120. The portion 104d of each outer wall 104b located outside the collection moulding 120 forms part of the external surface of the vacuum cleaner, as can clearly be seen from Figures 1a and 1b.

The collection moulding 120 also carries an actuating lever 128 designed to activate a mechanism for opening the base 108 of the cylindrical bin 106 for emptying purposes as mentioned above.

The internal features of the cyclonic separating apparatus 100 will now be described with reference to Figure 3b. Figure 3a corresponds to Figure 2a and indicates the line III-III on which the section of Figure 3b is taken.

The internal features of the upstream cyclone 102 include an internal wall 132 extending the entire length thereof. The internal space defined by the internal wall 132 communicates with the interior of the collection moulding 120 as will be described below. The purpose of the internal wall 132 is to define a collection space 134 for fine

dust. Located inside the internal wall 132 and in the collection space 134 are components for allowing the base 108 to open when the actuating lever 128 is actuated. The precise details and operation of these components is immaterial to the present invention and will not be described any further here.

Mounted externally of the internal wall 132 are four equi-spaced baffles or fins 136 which project radially outwardly from the internal wall 132 towards the cylindrical bin 106. These baffles 136 assist with the deposition of large dirt and dust particles in the collection space 138 defined between the internal wall 132 and the cylindrical bin 106 adjacent the base 108. The particular features of the baffles 136 are described in more detail in WO 00/04816.

Located outwardly of the internal wall 132 in an upper portion of the upstream cyclone 102 is a shroud 140. The shroud extends upwardly from the baffles 136 and, together with the internal wall 132, defines an air passageway 142. The shroud 140 has a perforated portion 144 allowing air to pass from the interior of the upstream cyclone 102 to the air passageway 142. The air passageway 142 communicates with the inlet 146 of each of the downstream cyclones 104. Each inlet 146 is arranged in the manner of a scroll so that air entering each downstream cyclone 104 is forced to follow a helical path within the respective downstream cyclone 104.

As previously mentioned, the longitudinal axis 148 of each downstream cyclone 104 is inclined towards the longitudinal axis 150 of the downstream cyclone unit 103. The upper end of each downstream cyclone 104 is closer to the longitudinal axis 150 than the lower end thereof. In this embodiment, the angle of inclination of the relevant axes 148 is substantially 7.5°.

The upper ends of the downstream cyclones 104 project inside the collection moulding 120, as previously mentioned. The interior of the collection moulding 120 defines a chamber 152 with which the upper ends of the downstream cyclones 104 communicate. The collection moulding 120 and the surfaces of the downstream cyclones 104 together

define an axially extending passageway 154, located between the downstream cyclones 104, which communicates with the collection space 134 defined by the internal wall 132. It is thus possible for dirt and dust which exits the smaller ends of the downstream cyclones 104 to pass from the chamber 152 to the collection space 134 via the passageway 154.

Each downstream cyclone 104 has an air exit in the form of a vortex finder 156. Each vortex finder 156 is located centrally of the lowermost end of the respective downstream cyclone 104, as is the norm. In this embodiment, a centre body 158 is located in each vortex finder 156. Each vortex finder communicates with an annular chamber 160 which, in turn, communicates with the outlet port 126 (see Fig 2c).

Figures 4a, 4b and 4c illustrate the arrangement of the downstream cyclones 104 in greater detail. In particular, this helps to illustrate the configuration of the passageway 154. Figure 4b also helps to illustrate the fact that the side of each of the downstream cyclones 104 closest to the longitudinal axis of the downstream cyclone unit 103 lies substantially parallel thereto.

Figures 4a, 4b and 4c also illustrate the fact that each of the seven downstream cyclones 104 is moulded integrally with the remaining six cyclones 104 in a single part. The moulding illustrated in Figures 4a, 4b and 4c can be and is manufactured as a single part and this has advantages from the manufacturing and assembly point of view. Specifically, the cost of manufacturing this arrangement as a single part is cheaper than the cost of manufacturing the cyclones individually and assembling them together into the required configuration. Furthermore, the risk of errors occurring in the assembly procedure is eliminated by manufacturing the cyclones as a single unit. If the cyclones were manufactured separately and subsequently assembled, the risk of pressure inequalities occurring in the system would be increased and this could affect the separation performance of the cyclone assembly as a whole.

The mode of operation of the apparatus described above is as follows. Dirty air (being air in which dirt and dust is entrained) enters the cyclonic separating apparatus 100 via the inlet port 114 . The arrangement of the inlet port 114 is essentially tangential to the wall of the cylindrical bin 106 which causes the incoming air to follow a helical path around the inside of the cylindrical bin 106. Larger dirt and dust particles, along with fluff and other large debris, are deposited in the collection space 138 adjacent the base 108 by virtue of the effect of centrifugal forces acting on the particles, as is well known. Partially cleaned air travels inwardly and upwardly away from the base 108, exiting the upstream cyclone 102 via the perforated portion 144 of the shroud 140. The partially-cleaned air then moves along the air passageway 142 in which it is divided into seven portions. Each portion enters one of the downstream cyclones 104 via the respective inlet 146. As has been mentioned above, each inlet 146 is a scroll inlet which forces the incoming air to follow a helical path inside the downstream cyclone 104. The tapering shape of the downstream cyclone 104 causes further, intense cyclonic separation to take place inside the downstream cyclone 104 so that very fine dirt and dust particles are separated from the main airflow. The dirt and dust particles exit the uppermost end of the downstream cyclone 104 whilst the cleaned air returns to the lower end of the downstream cyclone 104 along the axis 148 thereof and exits via the vortex finder 156. The cleaned air passes from the vortex finder 156 into the annular chamber 162 and from there to the outlet port 126. Meanwhile, the dirt and dust which has been separated from the airflow in the downstream cyclone 104 falls from the chamber 152 through the passage way 154 to the collection space 134.

When it is desired to empty the cyclonic separating apparatus 100, the base 108 can be hingedly released from the sidewall of the cylindrical bin 106 so that the dirt and debris collected in collection spaces 134 and 138 can be allowed to drop into an appropriate receptacle. As previously explained, the detailed operation of the emptying mechanism does not form part of the present invention and will not be described any further here.

The invention is not limited to the precise details of the embodiments described above. It must be stressed that the features of the vacuum cleaner external to the cyclonic

cleaning apparatus are immaterial to the invention. It will be appreciated that there is no particular need for the apparatus to be arranged so that the axes of the cyclone units are vertical and the axes may indeed be inclined to the vertical or even horizontal if desired. The fact that centrifugal separation is not greatly affected by gravity makes this possible as long as the collecting areas of the cyclone units are arranged to collect the debris without interference to the airflow paths necessary to effect separation. In a further variation to the embodiments described in detail above, the downstream cyclones illustrated above may be arranged so that their respective axes are arranged parallel to one another instead of being inclined towards the axis of the downstream cyclone unit as shown in the drawings. Furthermore, as has been mentioned above, additional downstream cyclones may be provided in parallel to those illustrated in the embodiment described above. This can be achieved by increasing the number of cyclones spaced equi-angularly about the axis of the cyclonic separating apparatus, by adding additional cyclones inside the ring of cyclones already provided, or by a combination of both of these. Other variations and modifications will be apparent to a skilled reader.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A vacuum cleaner, comprising a body having an external surface, a suction inlet on the body for conveying dirty air from outside the vacuum cleaner into the body and a motor configured to draw the dirty air into the body through the suction inlet, the body comprising a plurality of cyclones arranged in parallel to one another, each cyclone including a tapering body having an outside wall, wherein at least a part of each outside wall forms part of the external surface of the vacuum cleaner.

2. A vacuum cleaner as claimed in claim 1, wherein the cyclones are equi-angularly arranged about an axis of the cyclonic separating apparatus.

3. A vacuum cleaner as claimed in claim 1 or 2, further comprising at least one further cyclone arranged in parallel to the plurality of cyclones, the further cyclone having a tapering body with an outside wall which does not form a part of the external surface of the vacuum cleaner.

4. A vacuum cleaner as claimed in claim 3, wherein the further cyclone is arranged closer to the axis of the cyclonic separating apparatus than the plurality of cyclones.

5. A vacuum cleaner as claimed in any one of claims 1 or 4, further comprising an upstream cyclone having an outer wall, at least a part of which forms a part of the external surface of the vacuum cleaner.

6. A vacuum cleaner having an external surface and incorporating cyclonic separating apparatus comprising a plurality of cyclones arranged in parallel to one another, each cyclone including a tapering body having an outside wall, wherein at least a part of each outside wall forms part of the external surface of the vacuum cleaner, wherein the cyclones are equi-angularly arranged about an axis of the cyclonic separating apparatus, and wherein each cyclone has an axis which is inclined towards the axis of the cyclonic separating apparatus.

7. A vacuum cleaner as claimed in claim 6, wherein the cyclonic separating apparatus comprises at least one further cyclone arranged in parallel to the plurality of cyclones, the further cyclone having a tapering body with an outside wall which does not form a part of the external surface of the vacuum cleaner.

8. A vacuum cleaner as claimed in claim 7, wherein the further cyclone is arranged closer to the axis of the cyclonic separating apparatus than the plurality of cyclones.

9. A vacuum cleaner as claimed in claim 6, 7 or 8, wherein the cyclonic separating apparatus comprises an upstream cyclone having an outer wall, at least a part of which forms a part of the external surface of the vacuum cleaner.

10. A vacuum cleaner as claimed in claim 9, wherein the outer wall of the upstream cyclone is substantially cylindrical in shape.

11. A vacuum cleaner as claimed in claim 9 or 10, wherein the plurality of cyclones arranged in parallel to one another are located wholly outside the outer wall of the upstream cyclone.

12. A vacuum cleaner as claimed in any one of claims 1 to 11, wherein each tapering body is frusto-conical in shape.

13. A vacuum cleaner as claimed in any one of claims 1 to 12, wherein all of the cyclones are substantially the same size and shape.

14. A vacuum cleaner having an external surface and incorporating cyclonic separating apparatus comprising a plurality of cyclones arranged in parallel to one another, each cyclone including a tapering body having an outside wall, wherein at least a part of each outside wall forms part of the external surface of the vacuum cleaner, wherein each cyclone has a lower end and an upper end, and wherein the lower end is larger than the upper end.

15. A vacuum cleaner as claimed in claim 14, wherein the upper end of each cyclone opens into a common collection area.

1/4

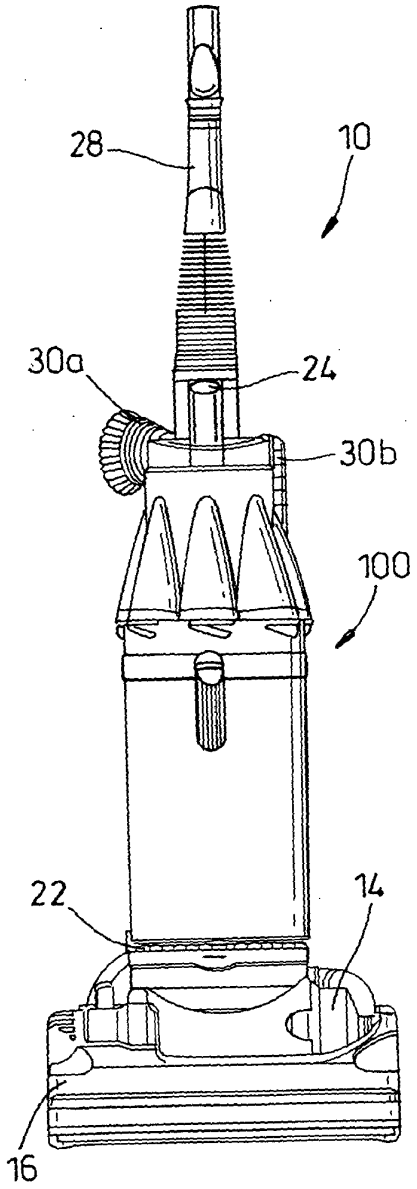


Fig. 1a

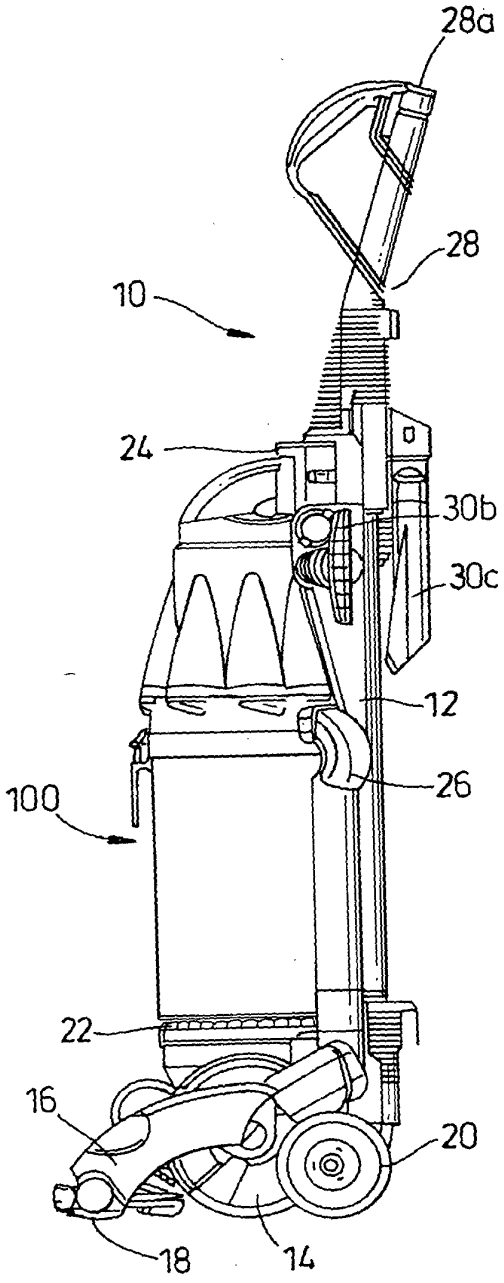


Fig. 1b

Dyson Ex1020
Page 1048

2/4

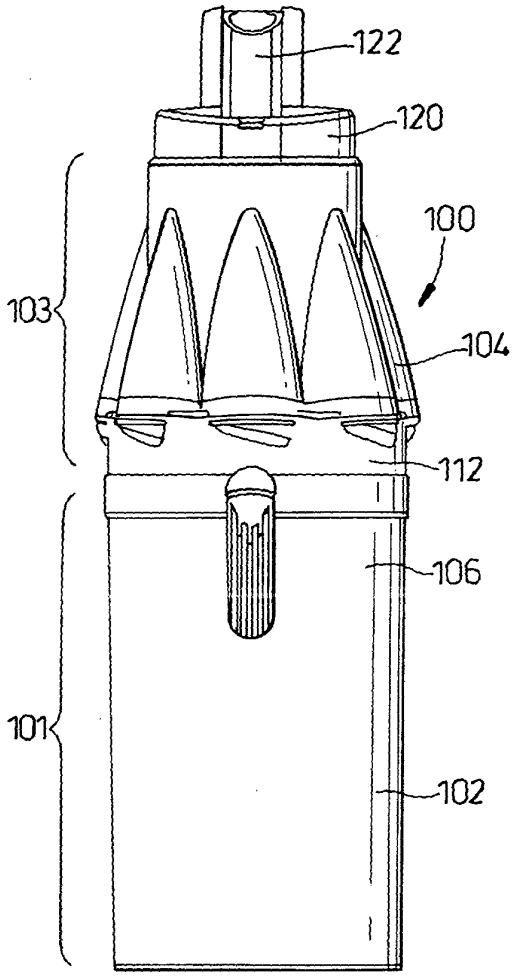


Fig. 2a

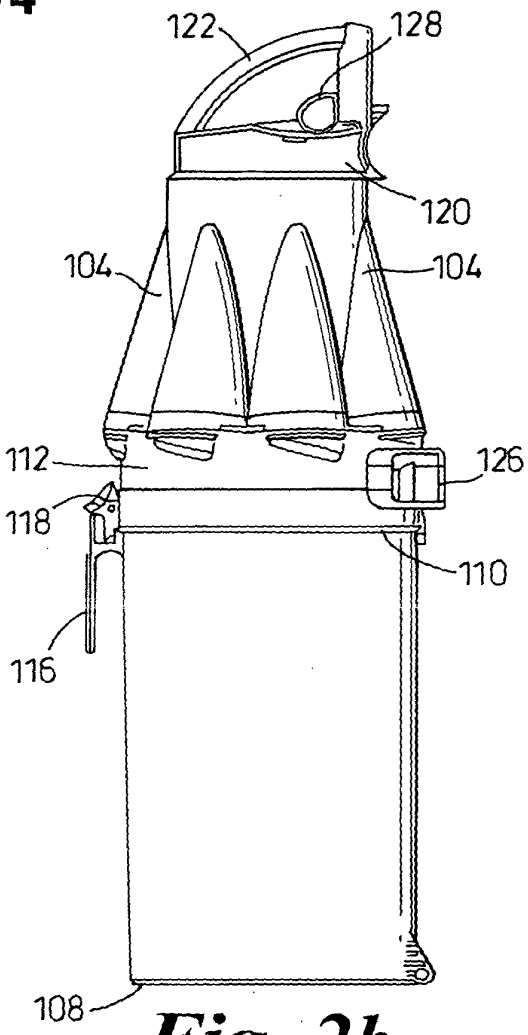


Fig. 2b

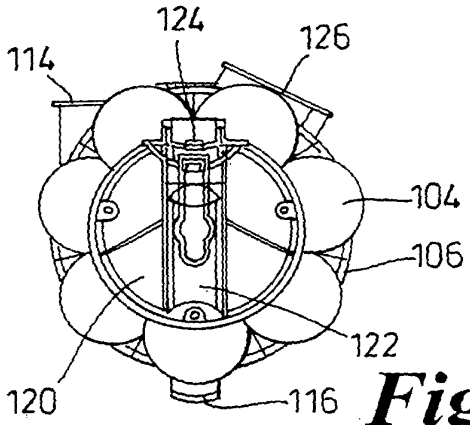


Fig. 2c

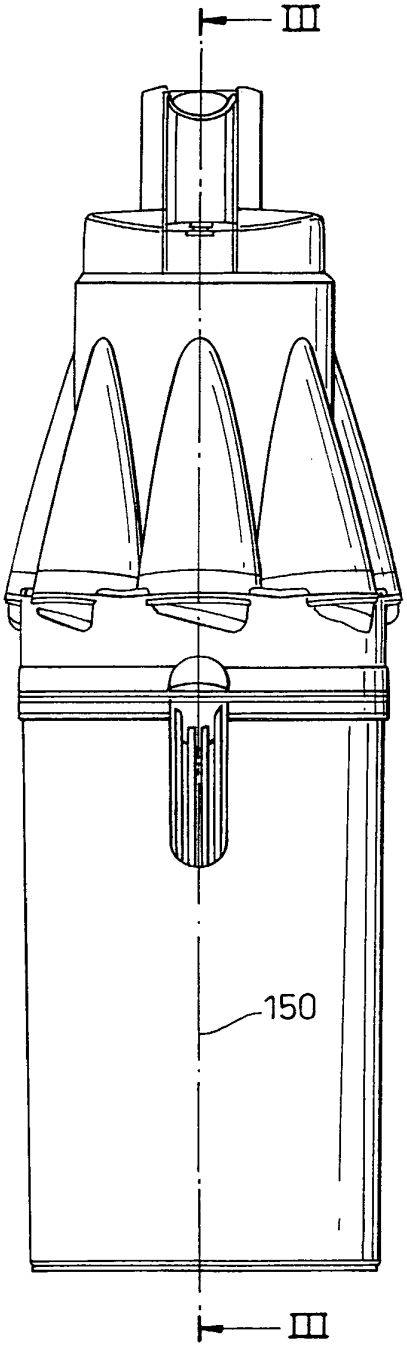

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Fig. 3a

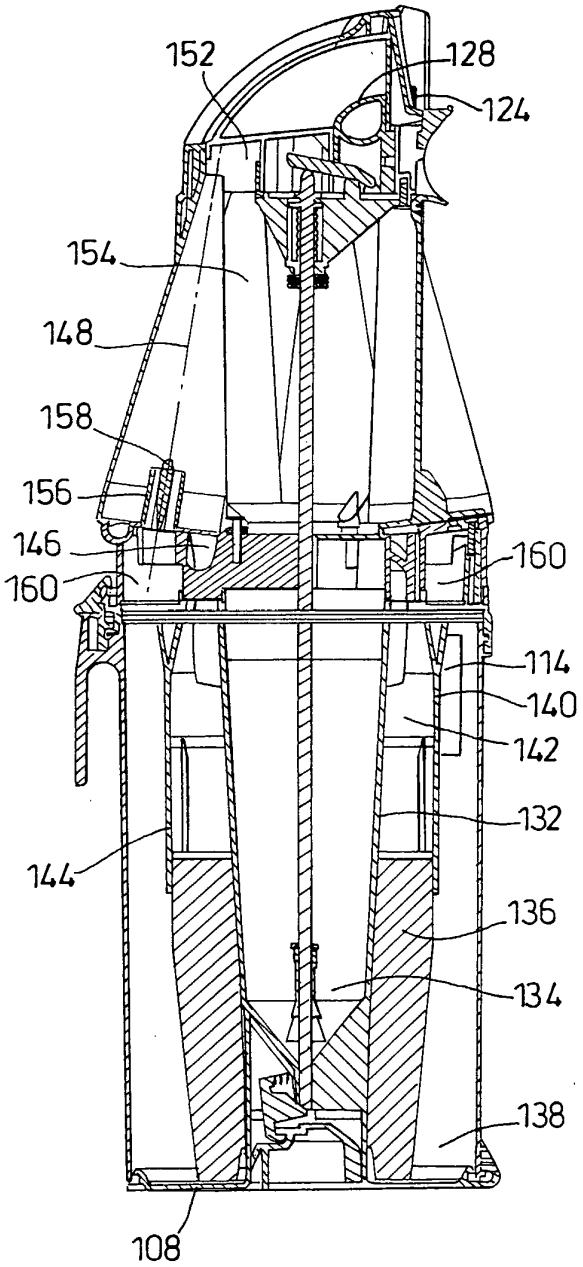
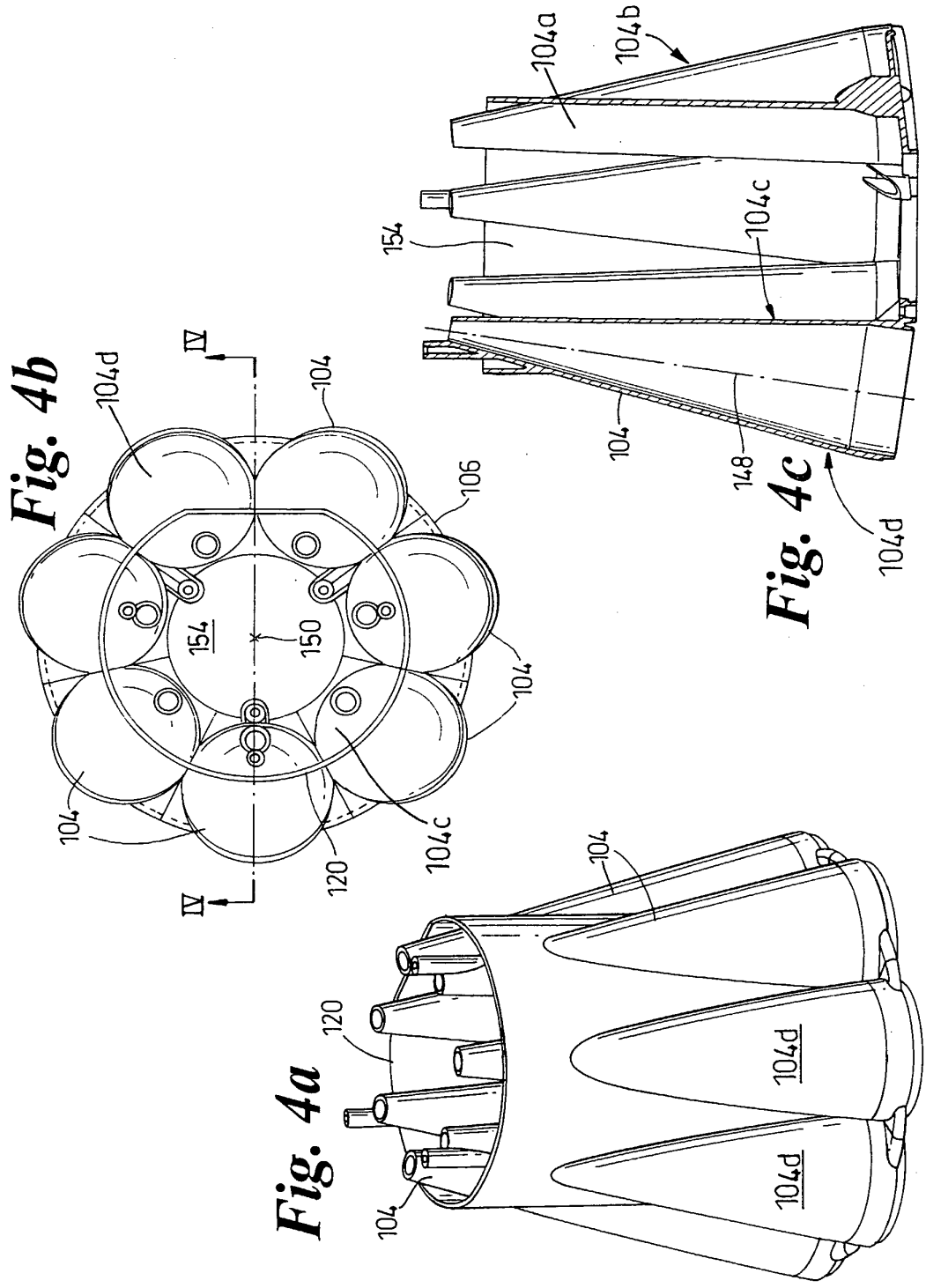

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Fig. 3b

4/4


Fig. 4b
104d
IV
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106
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104c
120
IV
Fig. 4c
104a
104b
154
104c
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148
104d
Fig. 4a
104
120
104d
104d
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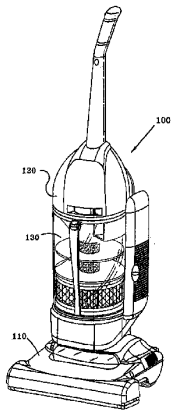
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权利要求书 5 页 说明书 10 页 附图 10 页

[54] 发明名称 地面维护器具的灰尘收集系统

[57] 摘要

一种真空吸尘器的灰尘收集系统包括一个圆筒形侧壁构成的尘杯，一个盘状构件将尘杯分成一个上部和一个下部。 脏空气流经过盘状构件穿过盘状构件外周和尘杯侧壁之间的间隙从上部流至下部。 盘状构件支承在位于中央的输送导管上，输送导管具有位于盘状构件上方和下面的带孔的壁。带孔的壁使空气流能流入输送导管以进一步过滤或排出尘杯。 盘状构件上方的带孔的壁使空气流在尘杯下部填满大尘粒，盘状构件下面的带孔的壁越来越受到限制时能继续流过尘杯，从而改善持久性能。 在本发明各实施例中，空气流通过输送导管引至尘杯底部或顶部的一个舱室中的细小尘粒过滤器，或引入尘杯上端的过滤袋。 或者细小尘粒过滤器也可设置在灰尘容器上方或下面的一个单独容器中。



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1.一种用于地面维护器具的灰尘收集系统，这种地面维护器具具有一个用于产生在吸嘴处起源的空气流的抽吸源，所述灰尘收集系统包括：

一个放置在空气流中、具有内侧壁的灰尘容器；

一个在灰尘容器内的进口，该进口与吸嘴流体连通，以便使空气流进入所述尘杯；

一条在所述灰尘容器内的、具有一个开口端部的输送导管；

一个构件，该构件具有从所述输送导管径向向外延伸的周缘，该周缘离开灰尘容器的内侧壁一个距离，该距离小于从输送导管至所述灰尘容器的整个距离；

一个带孔的壁的第一部分，该第一部分在所述构件上方的所述灰尘容器的一部分中在所述输送导管上形成，以便使所述空气流的一部分能够从所述进口经过它流动，同时防止大的颗粒流入所述输送导管；以及

一个带孔壁的第二部分，该第二部分在所述构件下面的所述灰尘容器的一部分中在所述输送管道上形成，以便使所述空气流的一部分能够从所述进口经过它流动，同时防止大的颗粒流入所述输送导管；

其中所述空气流的一部分经过所述构件，通过所述带孔的壁的第二部分流入所述输送导管，所述空气流的一部分流入所述带孔的壁的第一部分。

2.如权利要求 1 所述的灰尘收集系统，其特征在于：所述构件呈螺旋形，从所述构件的周缘至所述灰尘容器的内侧壁的距离围绕所述周缘的圆周是变化的。

3.如权利要求 1 所述的灰尘收集系统，其特征在于：所述构件具有一个位于外周上的缺口，以便使所述空气流携带的较大尘粒经过所述构件流入所述灰尘容器的在所述构件下面的一个部分中。

4.如权利要求 1 所述的灰尘收集系统，其特征在于：所述灰尘容

Dyson Ex1020
Page 1053

器还包括一个所述灰尘容器在所述构件上方所述部分及所述灰尘容器在所述构件下面的所述部分分开的一个舱室。

5.如权利要求 4 所述的灰尘收集系统，其特征在于：在所述舱室中还设有一个用于过滤细小尘粒的过滤元件。

6.如权利要求 4 所述的灰尘收集系统，其特征在于：所述输送导管的所述开口端部与所述舱室流体连通。

7.如权利要求 4 所述的灰尘收集系统，其特征在于：所述舱室还包括一个出口。

8.如权利要求 7 所述的灰尘收集系统，其特征在于：所述出口与所述抽吸源流体连通。

9.如权利要求 7 所述的灰尘收集系统，其特征在于：所述出口与大气流体连通。

10.如权利要求 7 所述的灰尘收集系统，其特征在于：所述出口与一个设置在所述舱室和所述灰尘容器外面的过滤构件流体连通。

11.如权利要求 1 所述的灰尘收集系统，其特征在于：所述输送导管的所述一个开口端部与所述抽吸源流体连通。

12.如权利要求 1 所述的灰尘收集系统，其特征在于：所述输送导管的所述一个开口端部与所述大气流体连通。

13.如权利要求 4 所述的灰尘收集系统，其特征在于：所述舱室设置在所述尘杯的位于所述构件下面的所述部分下面。

14.如权利要求 4 所述的灰尘收集系统，其特征在于：所述舱室设置在所述尘杯的在所述构件上方的所述部分的上方。

15.如权利要求 1 所述的灰尘收集系统，其特征在于：所述输送导管的所述一个开口端部与一个过滤袋流体连通，以便过滤细小尘粒。

16.如权利要求 15 所述的灰尘收集系统，其特征在于：所述过滤袋与所述抽吸源流体连通。

17.如权利要求 15 所述的灰尘收集系统，其特征在于：所述过滤袋与大气流体连通。

18.如权利要求 1 所述的灰尘收集系统，其特征在于：在所述进口

Dyson Ex1020
Page 1054

附近还包括一个圆锥形构件，使进入灰尘容器的空气流向下旋动。

19.一种用于地面维护器具的灰尘收集系统，这种地面维护器具具有一个用于产生在一个吸嘴处起源的空气流的抽吸源，所述灰尘收集系统包括：

一个放置在空气流中、具有一个内侧壁的灰尘容器；

一个在灰尘容器上的进口，与吸嘴流体连通，用于使空气流能够进入所述尘杯；

一条设置在所述灰尘容器内、具有一个开口端部的输送导管；

一个构件，该构件具有从所述输送导管径向向外延伸的周缘，该周缘离开灰尘容器的内侧壁一个距离，该距离小于从输送导管至所述灰尘容器内侧壁的整个距离；

一个带孔的壁的第一部分，该第一部分在所述灰尘容器的在所述构件上方的一个部分内在所述输送导管上形成，以便使所述空气流的一部分从所述进口能够穿过它流动，同时防止大的颗粒流入所述输送导管；

一个带孔的壁的第二部分，该第二部分在所述灰尘容器的在所述构件下面的一个部分内在所述输送导管上形成，以便使所述空气流的一部分能够从所述进口穿过它流动，同时防止大的颗粒流入所述输送导管；以及

一条与所述输送导管的所述一个开口端部流体连通的容器；其中所述空气流的一部分经过所述构件穿过所述带孔的壁的第二部分流入所述输送导管，所述空气流的一部分流入所述带孔的壁的第一部分，其中所述空气流从所述输送导管引至所述容器。

20.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述容器包括一个过滤构件。

21.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述容器与所述抽吸源流体连通。

22.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述容器与大气流体连通。

Dyson Ex1020
Page 1055

23.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述容器设置在所述灰尘容器的下面。

24.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述容器位于所述灰尘容器的上方。

25.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述构件呈螺旋形，从所述螺旋形构件的周缘至灰尘容器内侧壁的距离围绕所述周缘的圓周是变化的。

26.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：所述构件具有一个位于外周上的缺口，以便使所述空气流携带的较大尘粒能够经过所述构件进入所述灰尘容器在所述构件下面的一个部分中。

27.如权利要求 19 所述的用于地面维护器具的灰尘收集系统，其特征在于：还包括一个位于所述进口附近的圓锥形构件，以便使进入灰尘容器的空气流向下旋动。

28.一种从一个表面收集颗粒的方法，包括以下步骤：

产生在一吸嘴起源的载有灰尘的空气流；

将载有灰尘的空气流输入一个与吸嘴流体连通的灰尘容器，该灰尘容器具有一个内侧壁和一个使载有灰尘的空气流能够进入灰尘容器的进口；

引导来自所述进口的载有灰尘的空气流的一部分通过在所述灰尘容器的内侧壁和一个构件之间的间隙流至所述灰尘容器在所述构件下面的一个部分，所述构件用于防止大的尘粒再次进入灰尘容器与所述构件上方的部分内；

进一步引导来自所述进口的载有灰尘的空气流的所述部分穿过位于所述构件下面的一个带孔的壁的第一部分进入一条输送导管，大的尘粒被收集在灰尘容器的位于所述构件下面的部分中，从而从载有灰尘的空气流中滤出大的尘粒；

引导来自所述进口的载有灰尘的空气流的另一部分通过位于灰尘容器所述构件上方的一部分上方的第二带孔的壁流入一条输送导管，

Dyson Ex1020
Page 1056

以便防止大的尘粒进入所述输送导管，以及当灰尘容器位于所述构件下面的部分填满尘粒并限制所述第一带孔的壁时，进一步使载有灰尘的空气流的一个较大部分能够流入所述第二带孔的壁。

29.如权利要求 28 所述的从一个表面收集颗粒的方法，其特征在于：还包括一个将载有灰尘的空气流引入一个圆锥形构件以便使空气流向下旋动的步骤。

30.如权利要求 28 所述的从一个表面收集颗粒的方法，其特征在于：还包括通过所述输送导管的一个开口端部将载有灰尘的空气流引入一个过滤构件的步骤。

31.如权利要求 28 所述的从一个表面收集颗粒的方法，其特征在于：还包括通过所述输送导管的一个开口端部将载有灰尘的空气流引至大气的步骤。

32.如权利要求 28 所述的从一个表面收集颗粒的方法，其特征在于：还包括通过管状构件的一个开口端部将载有灰尘的空气流引入一个过滤袋的步骤。

Dyson Ex1020
Page 1057

地面维护器具的灰尘收集系统

技术领域

一般来说，本发明涉及地面维护器具。具体来说，本发明涉及地面维护器具如真空吸尘器的灰尘收集系统。更具体来说，本发明涉及一种灰尘收集装置，它设置在灰尘收集容器内以防止大的灰尘颗粒全部阻塞灰尘收集容器，从而在灰尘收集容器的排空操作之间使地面维护器具有更长久的维护性能。

背景技术

立式真空吸尘器在本专业是公知的。这种真空吸尘器一般包括借助枢轴安装在真空吸尘器底座上的真空吸尘器壳体。底座形成有管嘴孔口，并可包括一个安装在其它的搅拌器以弄松来自地面的灰尘和碎屑。一个电机可安装在底座或壳体上，以便在管嘴孔口处产生吸力。在管嘴孔口处的吸力拾起弄松的灰尘和碎屑，产生载有灰尘的空气流，通过导管送至设置在真空吸尘器内的灰尘收集系统。

在传统的真空吸尘器中，载有灰尘的空气借助导管送入支承在真空吸尘器壳体上或其内的真空吸尘器过滤袋内。但是，近来无袋式真空吸尘器在市场上变得更为流行起来。这些无袋式真空吸尘器借助导管将载有灰尘的空气流送入灰尘收集系统，灰尘收集系统通常由一个灰尘和一个过滤装置构成，过滤装置从空气流过滤灰尘颗粒后才将过滤后的空气流送入大气中。这些无袋式真空吸尘器的这些灰尘收集系统曾有许多变形，以便将灰尘颗粒与空气流分开。但是，当这些灰尘收集系统的灰尘收集容器填满时，由于过滤元件日益受到碎屑的限制，因而吸尘性能一般会降低。人们需要一种无袋式地面维护器具，其中即使灰尘收集容器被碎屑填满也可保持吸尘性能。

本发明满足了上述需要，提供一种灰尘收集系统，该系统利用一盘状构件来防止大的尘粒再次进入灰尘收集容器的上部，其中一个大

Dyson Ex1020
Page 1058

颗粒过滤器的至少一个部分设置在灰尘收集容器的上部，因而当尘杯或灰尘收集容器被碎屑填满时，大颗粒过滤器有一个部分不会变得受到限制。然后，载有灰尘的空气流被一个或多个其它过滤构件滤掉细小颗粒。

发明内容

本发明的目的包括提供一种用于无袋式真空吸尘器中的新颖和改进的灰尘收集系统。

本发明的另一个目的是提供一种新颖和改进的灰尘收集系统，它能提供改进的持续不变的过滤性能。

本发明的另一个目的是提供一种新颖和改进的用于无袋式真空吸尘器的灰尘收集系统，它在使用后可以容易地排空。

本发明的另一个目的是提供一种新颖和改进的用于无袋式真空吸尘器的灰尘收集系统，其中一个盘状构件及相关的构件用于防止大的尘粒再次进入尘杯的上部。

通过下面对照附图进行的描述可更容易理解上述的和其它的目的。

在以一种形式实施的本发明中，上述的和其它的目的是通过提供一种放置在载有灰尘的空气流中的灰尘收集系统实现的，该系统包括一个尘杯，该尘杯包括一个将尘杯或灰尘容器分成一个上部和一个下部的盘状构件。载有灰尘的空气流通过一弯曲的进口导管进入尘杯，借助重力引起向下的旋涡，通过一中央滤网，以及一截锥形构件抽吸。空气流在尘杯中下降，从上部流过盘状构件，通过盘状构件的外圆周和尘杯侧壁之间的一个小间隙，或通过在盘状构件的圆周的一个位置上的一个大的开口流至下部。盘状构件安装在位于尘杯内中央的一条输送管上，从而受到支承。该输送管形成空气流从尘杯内部流出的一条通路。输送管壁部分地形成有多个在盘状构件上方或下面的孔，以便使空气流能够从尘杯的内部容积流出并进入输送管。当空气流通过这种“带孔的壁”进入输送管的中空内部时，空气流被滤掉大的尘粒，使其沉积在尘杯的下部。载有灰尘的空气流可以被强制送入尘杯，这

Dyson Ex1020
Page 1059

与“直接”空气系统是共同的，或者载有灰尘的空气流也可以借助抽吸电机吸入尘杯，这与“间接”空气系统是共同的。

在盘状构件下面的带孔的壁从盘状构件延伸至输送管下端尘杯底部上方一个短距离处。在盘状构件上方的带孔的壁在盘状构件延伸一个短的距离。在盘状构件下面的带孔的壁有助于经过盘状构件将旋涡空气流向下吸入尘杯的下部。一旦载有灰尘的空气流流经盘状构件，大的尘粒基本被留在尘杯的下部，这是由于大的尘粒不再是被引导的空气流的一部分，所述被引导的空气流必须将大的尘粒引导通过盘状构件的外圆周和尘杯内侧壁之间的窄间隙或通过一个远离尘杯进口在盘状构件的圆周上形成一个角度的较大开口或切口。当尘粒蓄积在尘杯的下部时，在盘状构件下面的带孔的壁变得越来越受到限制。这通常会降低这种灰尘收集系统的性能，这是由于载有灰尘的空气流的流动受到限制。但是，通过尘杯流动的载有灰尘的空气流得到维持，这是由于空气流仍可以通过在盘状构件上方的带孔的壁流动的缘故。由于盘状构件将大的尘粒保持在尘杯的下部，因而可以防止尘粒蓄积在盘状构件上方的带孔的壁的周围。当灰尘充满下部的腔时，用户即得到排空尘杯的指令。

在本发明的推荐实施例中，一个环形过滤元件设置在一个在尘杯下部的下面的室中。已滤掉大的尘粒的空气流被引向该室及环形过滤元件以过滤细小尘粒。设置这个环形过滤器的室由在收集大的尘粒的尘杯下部下面的环形壁和尘杯的底部构成。在大的尘粒沉积在尘杯的下部之后，空气流从输送导管被引至设置环形过滤器的室以除去细小尘粒。在环形过滤器滤掉细小尘粒之后，空气流可被排至大气，或者引至一个或多个其它过滤器，以便过滤更细小的尘粒。或者，环形过滤器也可以同间接空气式系统（**indirect air type system**）中的一个抽吸源流体连通。

在本发明的第二实施例中，一个环形过滤元件设置在尘杯中一个载有灰尘的空气流最初进入尘杯的设置所述截锥形构件的上部上方的一个室内。已经滤掉大的尘粒的空气流从输送导管引至该室和环形过

Dyson Ex1020
Page 1060

滤器以便滤掉细小尘粒。该室是由尘杯上部上方的环形壁形成的，在大的尘粒沉积在尘杯的下部，且空气流通过带孔的壁流入输送导管之后，空气流被引至设置环形过滤元件的室，以便除去细小尘粒。在环形过滤元件滤掉细小尘粒之后，空气流可被排至大气或引至一个或多个其它过滤器，以便过滤更细小的尘粒。或者，环形过滤器也可以同一个间接空气式系统的抽吸源流体连通。

在本发明的第三实施例中，空气流被进一步引至载有灰尘的空气流最初进入尘杯的、设置截锥形构件的尘杯上部上方的一个室中。一个过滤袋跨过该室的开口端部，防止细小尘粒逸出该室。在过滤袋滤掉细小尘颗之后，空气流可排至大气或引至一个或多个其它过滤器以过滤更细小的尘粒。或者，该过滤袋可以同一个间接空气式系统的抽吸源流体连通。

在本发明的第四实施例中，一个环形过滤元件设置在一个单独的容器中，该容器确实地位于尘杯下面，与尘杯流体连通。已滤掉大尘粒的空气流被引至该容器和设置在该容器内的环形过滤器，以便过滤细小的尘粒。在大的尘粒沉积在尘杯的下部内之后，空气流从输送导管被引至设置环形过滤元件的室以除去细小尘粒。在环形过滤元件过滤细小尘粒之后，空气流可排至大气或引至一个或多个其它过滤器以过滤更细小的尘粒。或者，环形过滤器也可同一个间接空气式系统中的抽吸源流体连通。

在本发明的第五实施例中，一个环形过滤元件设置在一个单独的容器中，该容器确实地位于尘杯上方，并与尘杯流体连接。已过滤大的尘粒的空气流被引至该容器和设置在该容器内的环形过滤器以过滤细小尘粒。在大的尘粒沉积在尘杯的下部中之后，空气流从输送导管内被引至设置环形过滤元件的室以除去细小尘粒。在环形过滤元件过滤细小尘粒之后，空气流可排至大气或被引至一个或多个其它过滤器以过滤更细小尘粒。或者，环形过滤器也可以同一个间接空气式系统的抽吸源流体连通。

附图说明

Dyson Ex1020
Page 1061

图 1 是按照本发明推荐实施例带有本发明的灰尘收集系统的真空吸尘器的立体图;

图 2 是按照本发明推荐实施例的真空吸尘器的立体图，本发明的灰尘收集系统已从真空吸尘器壳体取出;

图 3 是按照本发明推荐实施例的、用于一个真空吸尘器如所示的真空吸尘器中的本发明的灰尘收集系统的分解图;

图 4 是按照本发明推荐实施例的本发明的灰尘收集系统的后视立体图;

图 5 是按照本发明推荐实施例的本发明的灰尘收集系统的侧视立体图;

图 6 是按照本发明推荐实施例的沿图 7 中 VI－VI 线的本发明的灰尘收集系统的顶视图;

图 7 是按照本发明推荐实施例的本发明的灰尘收集系统的侧剖图;

图 8 是按照本发明推荐实施例的本发明的灰尘收集系统的侧剖图，表示在盘状构件缺口下面的带孔的壁的一部分和充满碎屑的尘杯下部;

图 9 是真空吸尘器的立体图，第二实施例的灰尘收集系统已从真空吸尘器壳体中取出;

图 10 是真空吸尘器的立体图，第三实施例的灰尘收集系统已从真空吸尘器壳体中取出;

图 11 是真空吸尘器的立体图，第四实施例的灰尘收集系统已从真空吸尘器壳体中取出;

图 12 是真空吸尘器的立体图，第五实施例的灰尘收集系统已从真空吸尘器壳体中取出。

具体实施方式

装有本发明推荐实施例的灰尘收集系统的真空吸尘器表示在图 1－9 中，附图标记为 100。真空吸尘器 100 包括一个借助枢轴连接于吸嘴或真空吸尘器底座 110 的真空吸尘器壳体 120。底座 110 一般形成

Dyson Ex1020
Page 1062

有一个朝向地板表面的底部吸嘴开口（未画出）。一个或多个旋转搅拌器（未画出）可设置在一个与底部吸嘴开口连通的搅拌器室（未画出）内。搅拌器转动以弄松地板表面的灰尘，然后灰尘借助吸嘴 110 的抽吸而被除去。一个灰尘收集系统 130 设置在壳体 120 内，以便从来自吸嘴 110 的载有灰尘的空气流分离和收集灰尘。载有灰尘的空气流是由一个抽吸电机 116（图 2）产生的，该抽吸电机可设置在底座 110 或壳体 120 内。

灰尘收集系统 130 放在载有灰尘的空气流中，由一个灰尘容器或尘杯 131 构成，尘杯包括一块板或盘状构件 150，该盘状构件将尘杯 131 分成上部 131b 和下部 131c。载有灰尘的空气流通过进口 132a 切向进入尘杯 131，并且在进入尘杯 131 的上部 131b 之前，部分借助一条弯曲的进口导管产生旋涡。空气流通过弯曲导管出口 132a 流出弯曲导管 132，并被引至一个旋涡产生构件 140，该构件可呈截圆锥形，使空气流旋动，但也引导空气流沿尘杯 131 的内侧壁向下流动。空气流在尘杯 131 内下降，并从上部 131b 通过盘状构件 150 外圆周和尘杯 131 的内侧壁之间的间隙经过盘状构件 150 流至尘杯 131 的下部 131c。盘状构件 150 安装在一条输送导管 133 的外周上，从而受到支承，输送导管 150 设置在尘杯 131 的中央。输送导管 133 是中空的，形成一条通路，使空气流从尘杯 131 的内部 131a 流出。输送导管 133 的壁部分地形成有孔 141，从而形成在盘状构件 150 上方的带孔的壁 141a 和在盘状构件 150 下面的带孔的壁 141b，以便使空气流能够分别从尘杯 131 的上部 131b 和下部 131c 流出，并进入输送导管 133 的内部 133a。当空气流通过尘杯 131 下部 130a 中的带孔的壁 141a 进入输送导管 133 的内部 133a 时，空气流被过滤出大的尘粒，大的尘粒沉积在尘杯 131 的下部 131a。然后，已过滤出大的尘粒的空气流从输送导管 133b 的中空内部 133a 引至一个或多个其它过滤器以便进一步过滤。在本发明的图示推荐实施例中，请具体参阅图 3－5，空气流被引至一个圆筒形过滤器 160，该过滤器设置在一个室 158 中，该室是在尘杯 131 的底部中形成的。室 158 部分地是由一个圆形壁 155 形成的，该圆形壁具

Dyson Ex1020
Page 1063

有一个开口 155a，以便使载有灰尘的空气流从输送导管 133 的中空内部 133a 进入。

载有灰尘的空气流可被强制流入尘杯 131，这与“直接”空气系统是共同的，或者也可以被抽吸电机抽入尘杯中，这与“间接”空气系统是共同的。在图 1－9 所示的推荐实施例中，载有灰尘的空气流被设置在尘杯 131 下面的室 118 中的抽吸电机 116 抽入尘杯 131。抽吸电机 116 的吸力输出端通过腔 125 底部的抽吸开口 115 流体连接于尘杯 131 的抽吸开口 135。位于尘杯 131 的上部 131b 中的脏空气进口流体连接于设置在抽吸管道 127 的一端上的管道连接器 126。抽吸管道 127 的另一端流体连接于吸嘴 110。

现在具体参阅图 2，灰尘收集系统 130 通常安装在壳体 120 的腔 125 内。灰尘收集系统 130 包括一个尘杯 131，该尘杯可从腔 125 取出以便可被排空。在本发明的推荐实施例中，尘杯 131 可装有一个盖子 138，在盖子一端上可连接一个铰链、一个用于在排空过程中操纵盖子和铰链的、在盖子上设置的按片(thumb tab)和一个在美国专利申请第 09/123,456 中描述的手柄，上述美国专利申请属于共同受让人，在本说明书中用作参考。

现在更为具体地参阅图 3－5 和 8－9，在盘状构件 150 上方的带孔的壁 141b 在盘状构件 150 上方延伸一个短的距离。在盘状构件下面的带孔的壁 141a 有助于经过盘状构件 150 将旋动空气流向下吸入尘杯 131 的下部 131a。一旦载有灰尘的空气流流过盘状构件 150，大的尘粒基本被留在尘杯 131 的下部，这是由于大的尘粒不再是被引导的空气流的一部分，而所述空气流原来必须引导大的尘粒通过盘状构件 150 的外圆周和尘杯内壁之间的狭窄间隙。盘状构件 150 具有螺旋形外周，因而在盘状构件 150 的外周和尘杯 131 的内壁之间形成的狭窄间隙在周向上逐渐增大，从而使较小的颗粒能够首先流过盘状构件 150，然后才使较大的颗粒流过盘状构件 150。恰好在盘状构件 150 圆周上盘状构件 150 的边缘和尘杯 131 的内侧壁之间的狭窄间隙最大的那个点之后，在盘状构件 150 上形成一个小缺口 150a（图 7），以便使最大

Dyson Ex1020
Page 1064

的尘粒流过盘状构件 150。大多数尘粒应该在循环至缺口 150a 之前流过盘状构件 150。缺口 150a 应该设置在盘状构件 150 的圆周上的一个点上，该点远离进口 132a，因而最大的尘粒才有机会再次进入进口 132a 附近的空气流之间流过盘状构件 150。

当尘粒在尘杯 131 的下部 131a 积蓄时，在盘状构件 150 下面的带孔的壁 141a 变得越来越受到限制。由于载有灰尘的空气流受到限制，因而这通常会降低这种灰尘收集系统的性能。但是，通过尘杯 131 流动的载有灰尘的空气流得以维持，这是由于空气流仍能够流过盘状构件 150 上方的带孔的壁 141b。由于盘状构件 150 将大的尘粒保持在尘杯 131 的下部 131a，因而可防止尘粒围绕盘状构件 150 上方的带孔的壁 141b 积蓄。通过尘杯 131 的载有灰尘的空气流的流动可以在图 8 和 9 中清楚地看出。在图 8 中，载有灰尘的空气流进入尘杯，弯曲导管 132 和截圆锥形构件 140 使其旋动。空气流经过盘状构件 150 降至尘杯 131 的下部 131a。大的尘粒沉积在尘杯 131 的下部 131a，并被盘状构件 150 留在那里。空气流通过带孔的壁 141 流出下部 131a，并通过输送导管 133 引导至室 158 和过滤元件 160。空气流围绕过滤元件 160 的外周并通过过滤元件 160 流动，因而滤出空气流的细小尘粒。然后，空气流通过一个抽吸开口 135 流出室 158。如上所述，抽吸开口 158 流体连接于抽吸电机。在本发明的一个替代实施例中，室 158 可以通过一个设置抽吸开口 135 的室 158 的开口流体连接于大气，或连接于其它过滤装置。但是，如图 9 所示，当尘杯 131 的下部 131a 开始填注尘粒时，带孔的壁变得越来越受到限制，通过的空气流受到阻碍。为了尽可能长时间地使空气流通过尘杯 131 流动，带孔的壁 141b 设置在盘状构件 150 的上方。现在只有一部分空气流流过盘状构件 150，并继续直至下部 131a 完全填满尘粒。此时，必须将尘杯 131 取出并排空。

在本发明的第二实施例中，设有一个几乎相同的灰尘收集系统 230，其中一个过滤元件 260 设置在尘杯 231 内一个位于尘杯 231 顶部的室 258 中。灰尘收集系统 230 与灰尘收集系统 130 的功能相同，只

Dyson Ex1020
Page 1065

是滤出大的尘粒的空气流从一条输送管 133 被引导至室 258 及设在该室内的过滤元件 260，以便过滤细小尘粒。室 258 是由位于尘杯 131 的上部 131b 的一个环形壁 255 形成的。在过滤元件 260 滤出细小尘粒之后，空气流可排至大气或被引导至一个或多个其它过滤器，以便过滤更细小的尘粒。在图 10 所示的实施例中，其中设置过滤元件 260 的室 258 通过一个开口 235 流体连接至一个设置在尘杯 131 上方的室 218 内的抽吸电机 216。室 218 设置在吸尘器 100 的上部壳体部分 120 内，设有一个孔 215，使室 218 能够与尘杯 131 内的室 258 流体连接。

在本发明的第三实施例中，如图 11 所示，设置一个与第二实施例的灰尘收集系统类似的灰尘收集系统 330。但是，设置在尘杯 131 顶部内的过滤元件 260 被一个过滤袋 360 替代，该过滤袋跨过上部室 131b 的开口端部，以便过滤细小尘粒。在图 11 所示的实施例中，过滤袋 360 与设置在尘杯 131 上方的壳体 120 内的一个抽吸电机 216 流体连通。过滤袋 360 插入设置在壳体 120 内的一个室 318 中。省掉了在尘杯 131 顶部上的盖子 139。或者，由过滤袋 360 滤出细小尘粒后的空气流也可以被引导至一个或多个其它过滤器，以便过滤更细小的尘粒。在另一实施例中，例如，在一种“直接空气(directair)”系统中，被过滤袋 360 滤出细小尘粒的空气流可直接排至大气。

在本发明的第四实施例中，如图 12 所示，设置一个灰尘收集系统 430，它很类似于第一实施例的灰尘收集系统，只是设置在尘杯 131 底部上的过滤元件 160（其后标号为 460）设置在一个位于尘杯 131 下面的单独的容器 457 中。容器 457 具有一个设置过滤元件 460 的室 458。已经滤出大的尘粒的空气流被引至容器 458 和设置在该容器内的过滤元件 460，以便过滤细小的尘粒。在大的尘粒沉积在尘杯 131 的下部 131a 中以后，空气流从输送导管 133 被引至其中设有过滤元件 460 的容器 457。在图 12 所示的实施例中，过滤元件 460 与一抽吸电机 116 流体连通，该抽吸电机设置在一个尘杯 131 下面的壳体 113 中。或者，在过滤元件 458 将空气流中的细小尘粒滤出之后，空气流可被引导至一个或多个其它过滤器，以便过滤更细小的尘粒。在另一个实施例中，

Dyson Ex1020
Page 1066

例如，在“直接空气”系统中，被过滤元件 4548 滤出细小尘粒的空气流可直接排至大气。

在本发明的第五实施例中，如图 13 所示，设置一个灰尘收集系统 530，它与第四实施例中的灰尘收集系统 430 很类似，只是设置在尘杯 131 下面的单独容器 457 内的过滤元件 460（下文中标号为 560）设置在位于尘杯 131 上方的一个单独的容器 557 内。滤出大的尘粒的空气流被引至容器 557 和设置在该容器内的过滤元件 558，以便过滤细小尘粒。过滤元件 558 设置在容器 557 内的一个室 560 内。在大的颗粒沉积在尘杯 131 的下部 131a 内之后，空气流从输送导管 133 引至容器 557，以便除去细小尘粒。在图 13 所示的实施例中，过滤元件 560 与位于尘杯 131 上方的容器 557 内的一个抽吸电机 216 流体连通。一个室 218 设置在吸尘器 100 的上部壳体部分 120 内，设有一个孔 215，使室 218 能够与尘杯 131 内的室 258 流体连接。或者，在过滤元件 560 从空气流滤出细小尘粒之后，空气流也可被引至一个或多个其它过滤器，以便过滤更细小的尘粒。在另一个实施例中，例如，在“直接”空气系统中，在过滤元件 558 滤出细小尘粒之后，空气流可被排至大气。

因此，真空吸尘器的改进的灰尘收集系统得到简化，提供了一种可实现上述全部发明的装置。虽然已图示并描述了本发明的几个实施例，但是，本专业技术人员显然可以做出许多改变而并不背离本发明的精神和范围。因此，权利要求书的目的是覆盖落入本发明精神、范围内的全部变化。

Dyson Ex1020
Page 1067

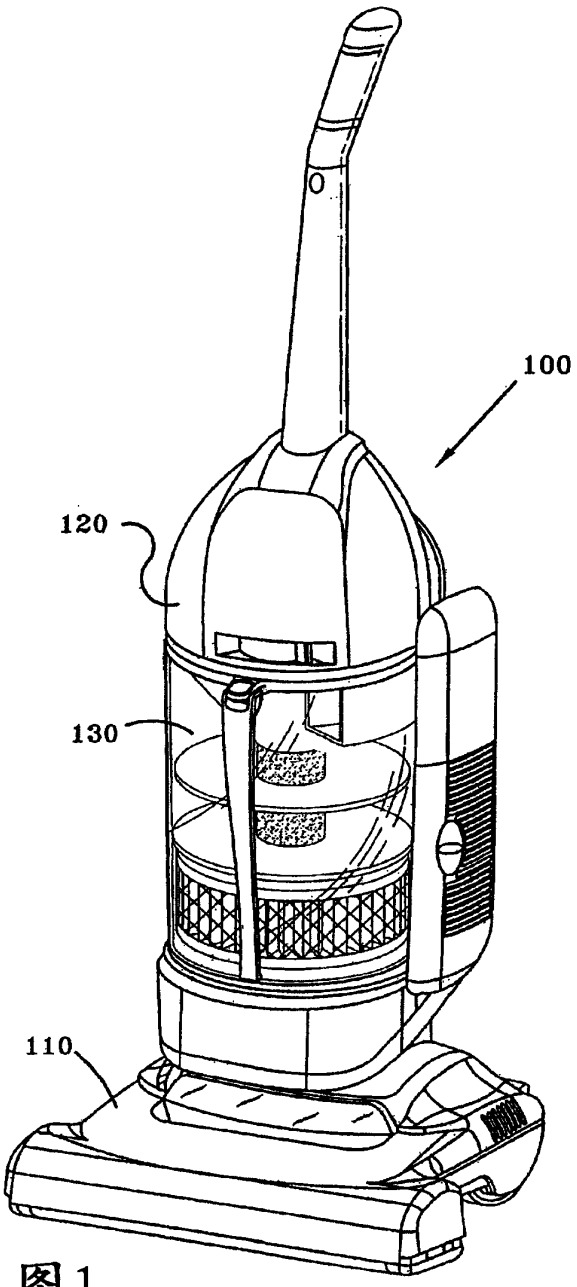


图1

Dyson Ex1020
Page 1068

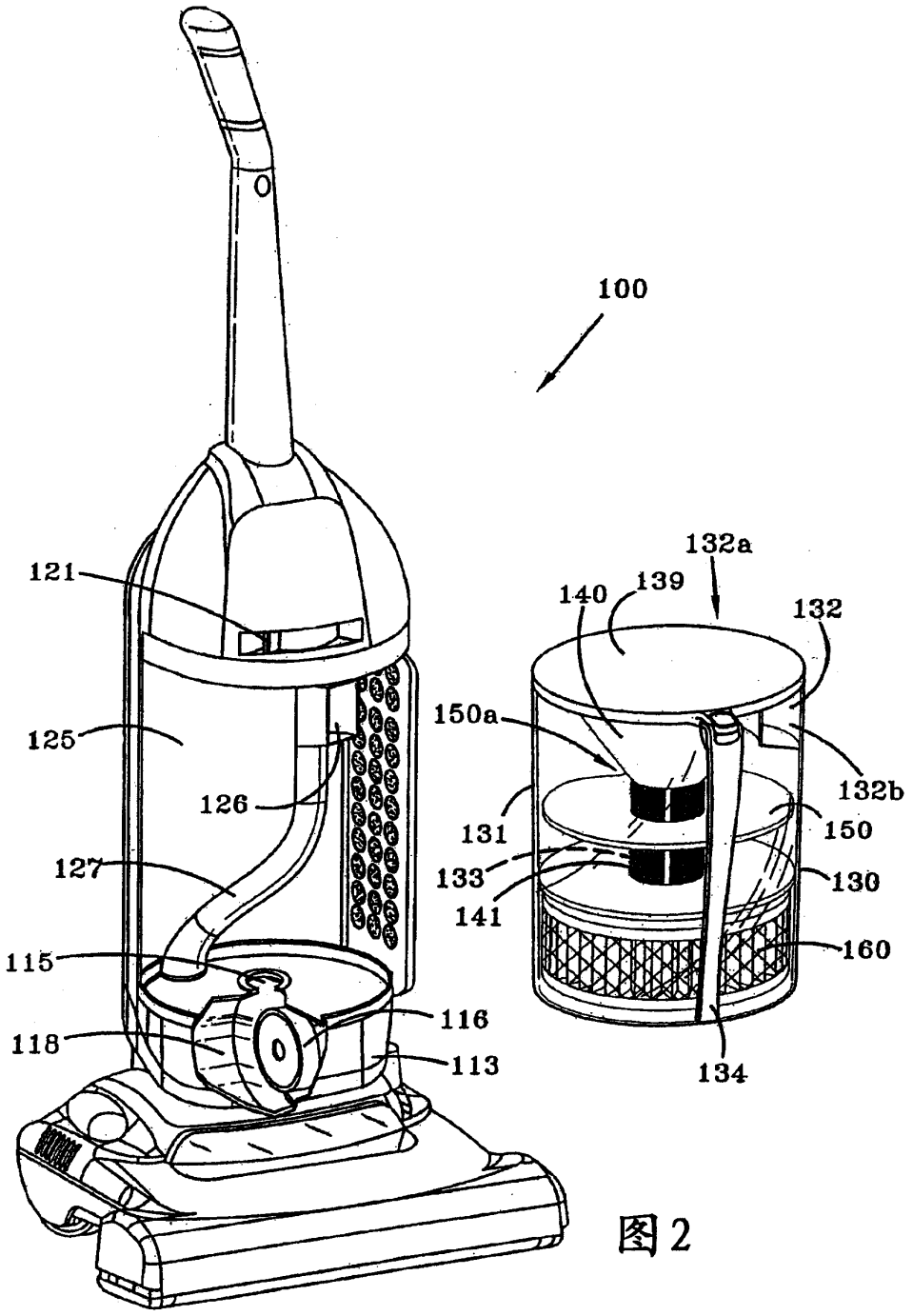


图 2

Dyson Ex1020
Page 1069

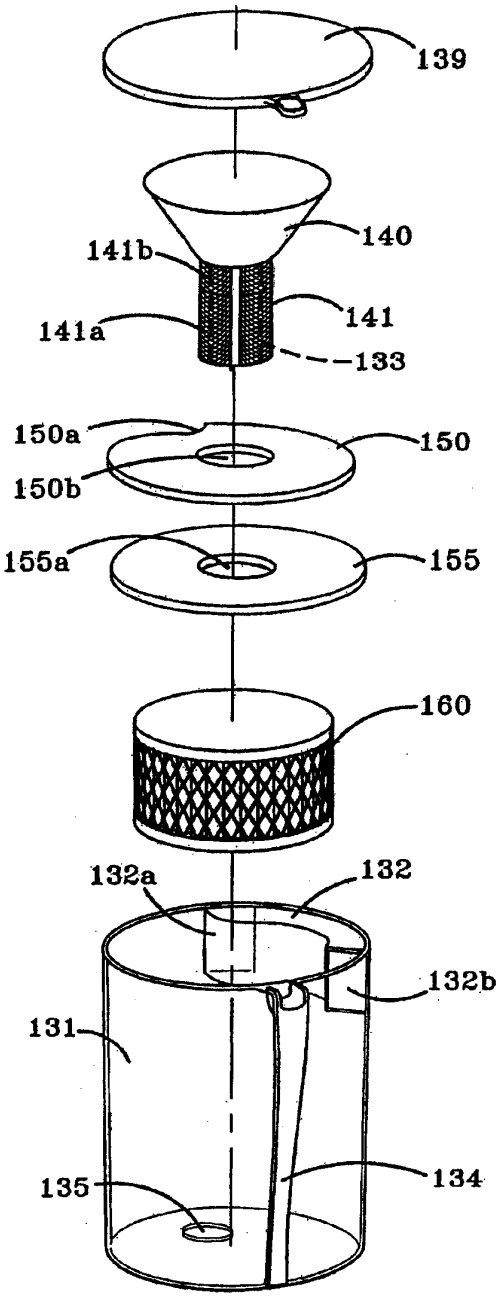


图 3

Dyson Ex1020
Page 1070

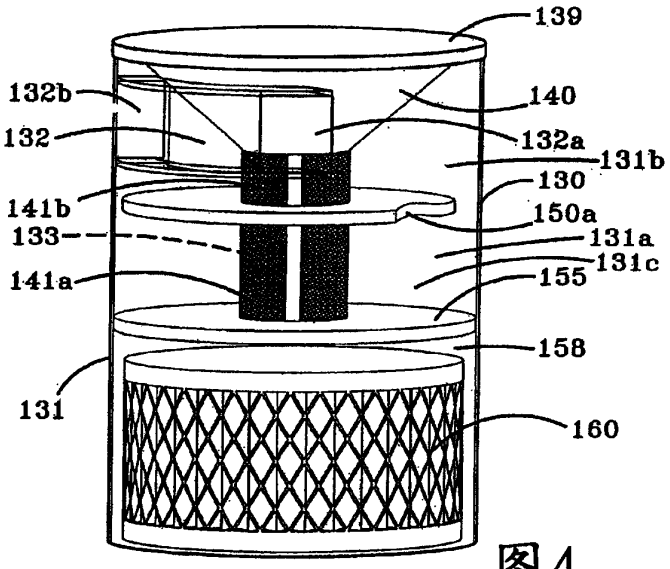


图 4

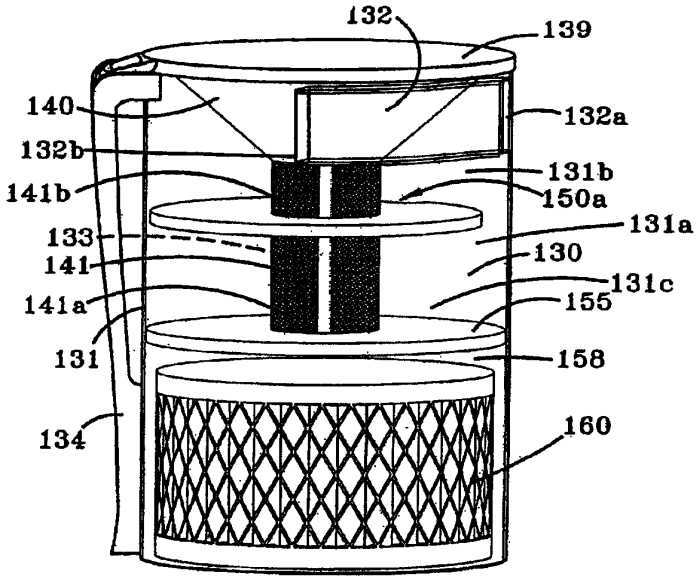


图 5

Dyson Ex1020
Page 1071

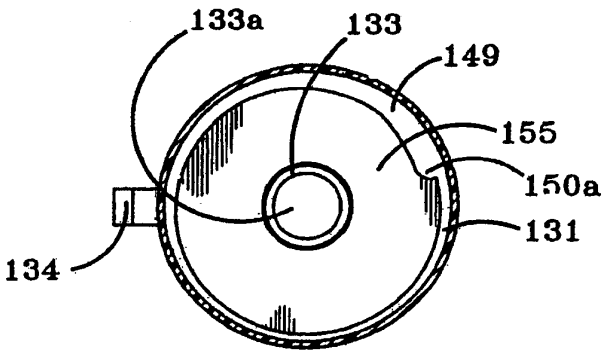


图6

Dyson Ex1020
Page 1072

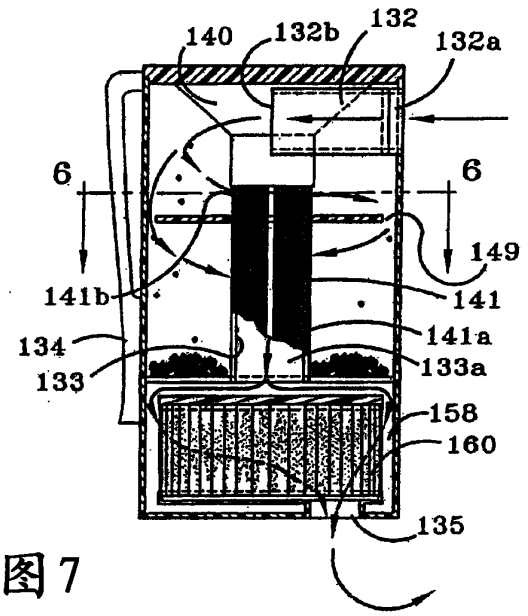


图 7

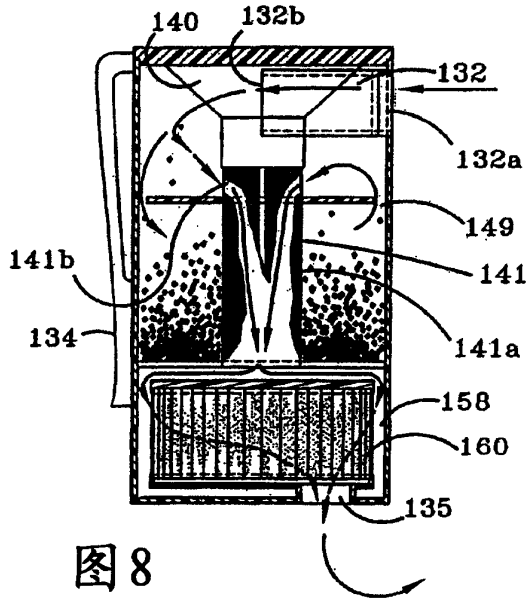


图 8

Dyson Ex1020
Page 1073

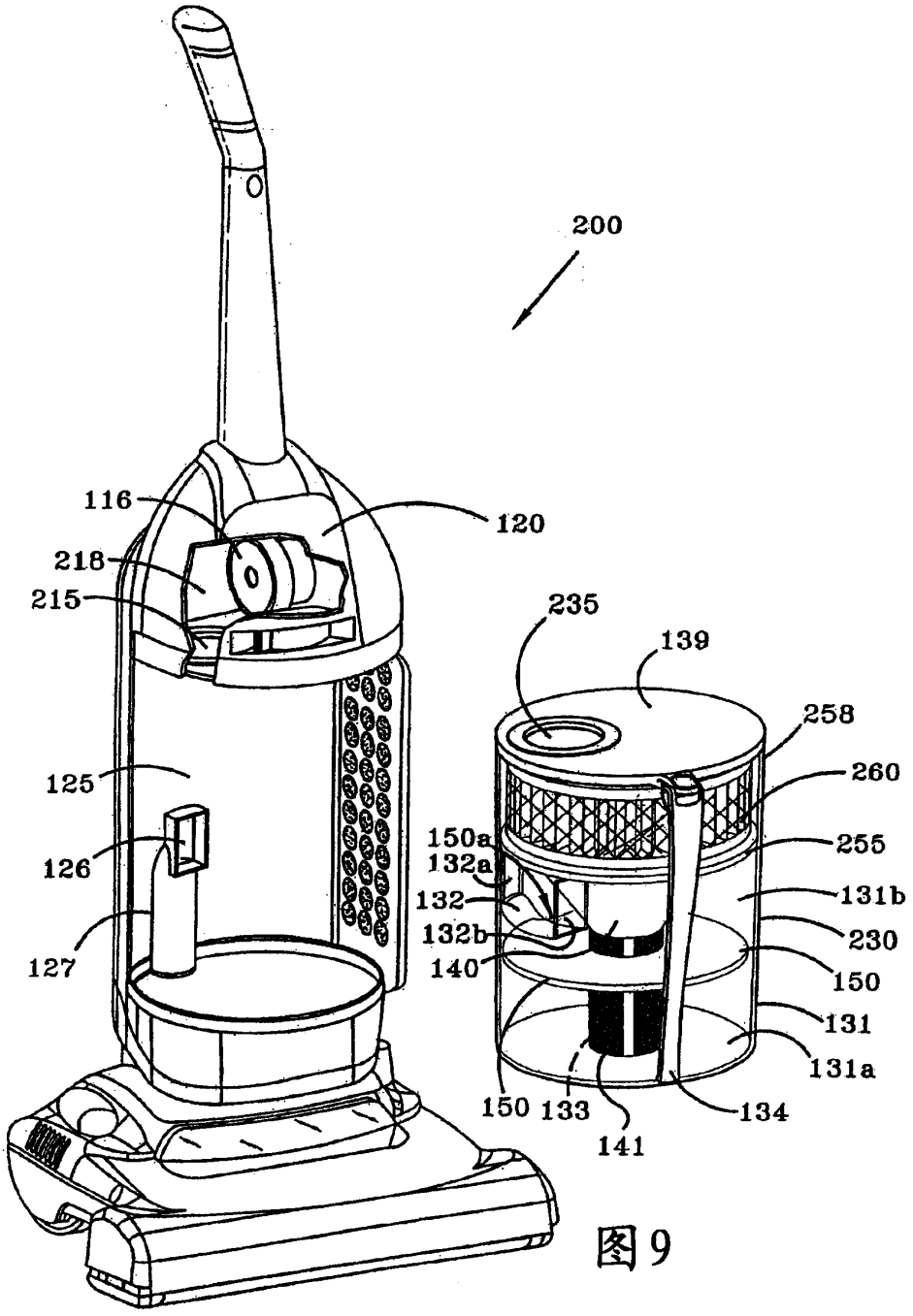


图9

Dyson Ex1020
Page 1074

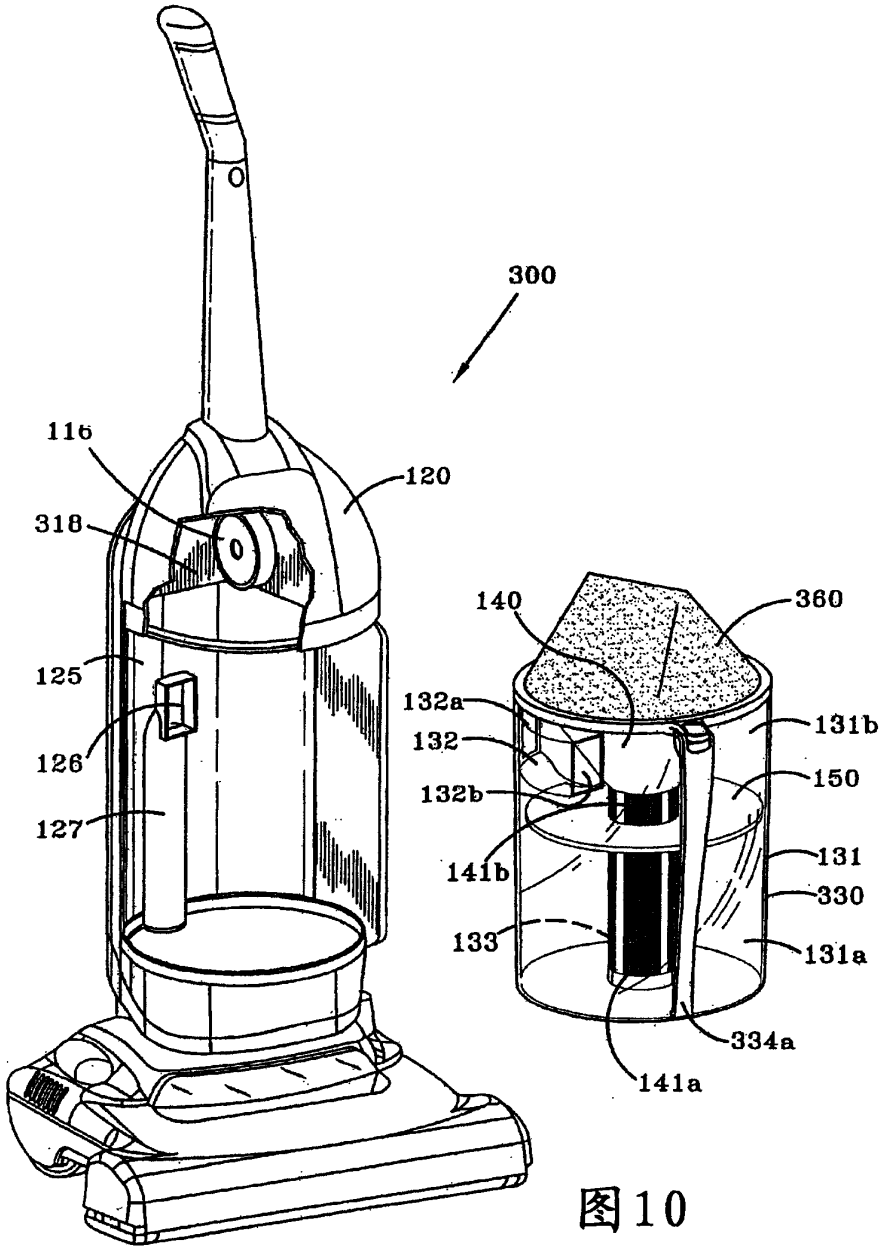


图10

Dyson Ex1020
Page 1075

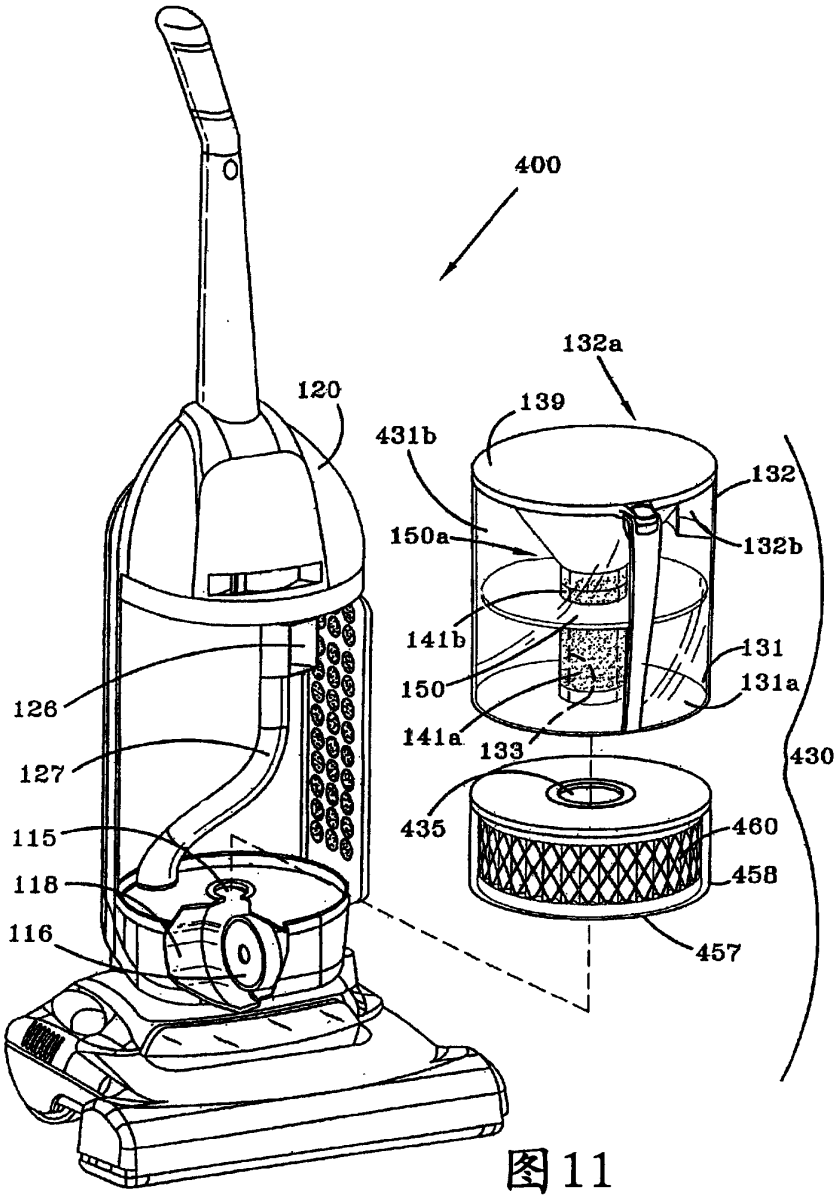


图11

Dyson Ex1020
Page 1076

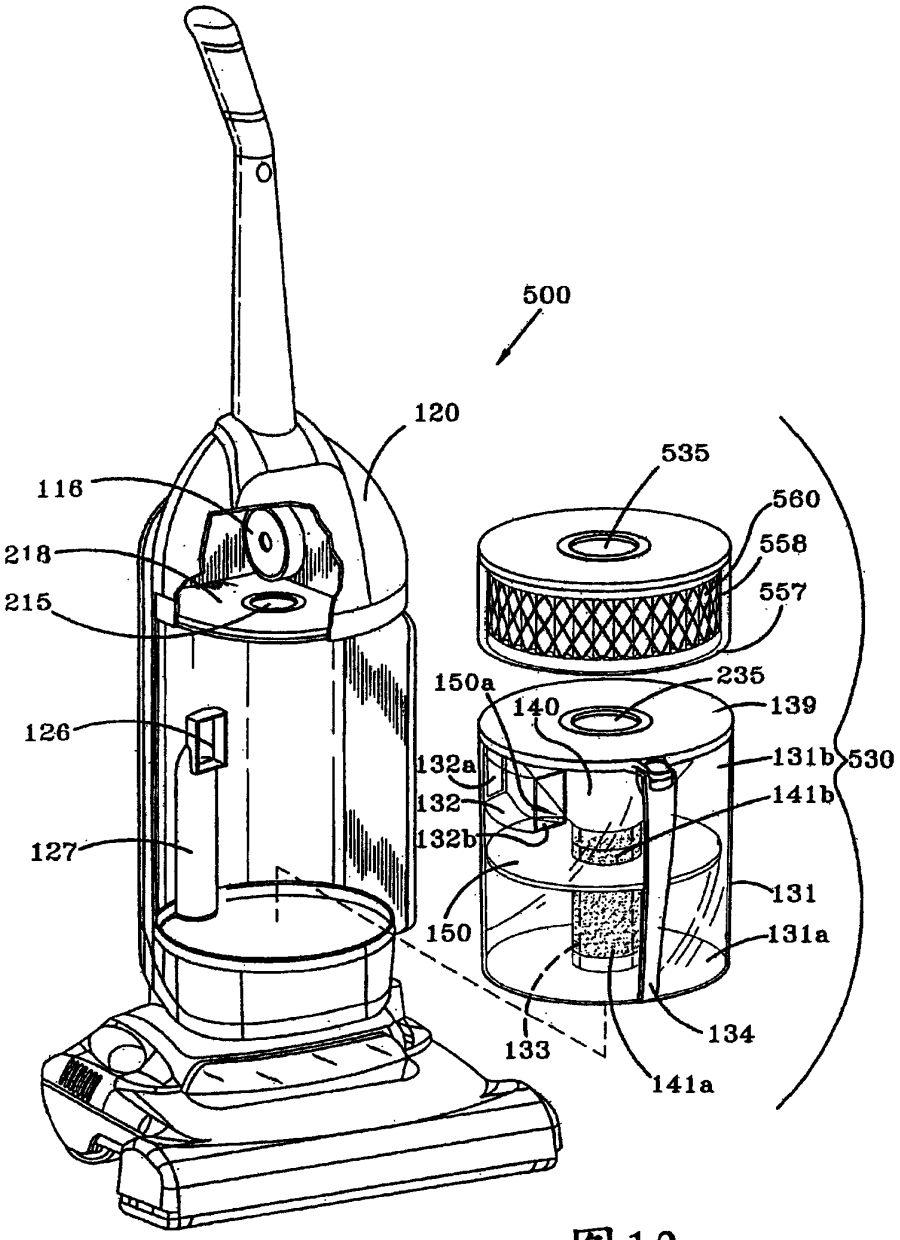


图12

Dyson Ex1020
Page 1077

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[51] Int. Cl.
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B04C 5/185 (2006.01)

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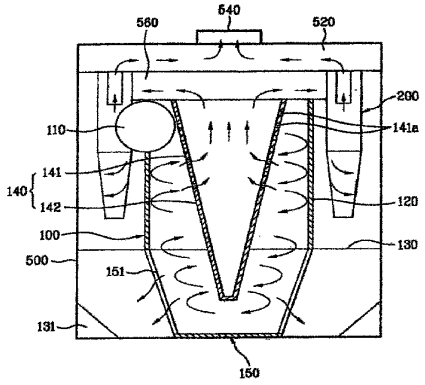
[22] 申请日 2005.6.30
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代理人 赵景华
权利要求书 2 页 说明书 8 页 附图 4 页

[54] 发明名称

多重旋风集尘装置

[57] 摘要

本发明的多重旋风集尘装置包括：1 次旋风集尘部，形成有使空气流入的第 1 流入部，分离出通过上述第 1 流入部流入的空气中的异物的第 1 主体，设置在上述第 1 主体的底部侧方的收集在上述第 1 主体内分离的异物的集尘桶，设置有从上述第 1 主体的底面延长而位于上述集尘桶的内侧的同时与上述集尘桶内部空间连通的延长部，使上述第 1 主体内的空气流出的第 1 流出部；安装于上述 1 次旋风集尘部的外侧，并且吸入通过上述第 1 流出部流出的空气，进而再次进行对异物的集尘作业的 2 次旋风集尘部。



Dyson Ex1020
Page 1078

1. 一种多重旋风集尘装置，其特征是包括:

1 次旋风集尘部或 1 重旋风集尘部，形成有使空气流入的第 1 流入部；分离出通过上述第 1 流入部流入的空气中的异物的第 1 主体；设置在上述第 1 主体的底部侧方的收集在上述第 1 主体内分离的异物的集尘桶；设置有从上述第 1 主体的底面延长而位于上述集尘桶的内侧的同时与上述集尘桶内部空间连通的延长部；使上述第 1 主体内的空气流出的第 1 流出部的;

安装于上述 1 次或 1 重旋风集尘部的外侧，并且吸入通过上述第 1 流出部流出的空气，进而再次进行对异物的集尘作业的 2 次或 2 重旋风集尘部；或者没有安装 2 次或 2 重旋风集尘部。

2. 根据权利要求 1 所述的多重旋风集尘装置，其特征是:

上述 1 次或 1 重旋风集尘部的延长部最好是从上述第 1 主体的底面越往其下部走越变窄。

3. 根据权利要求 2 所述的多重旋风集尘装置，其特征是:

在上述延长部的周面上至少形成有一个以上的异物排出孔，在这里，上述异物排出孔是为了把沿着其内表面流动的异物排出到集尘桶内的空间上而设置的。

4. 根据权利要求 3 所述的多重旋风集尘装置，其特征是:

上述异物排出孔是把上述延长部的周面沿着其高度方向长长的切开而形成。

5. 根据权利要求 1 所述的多重旋风集尘装置，其特征是:

上述 1 次或 1 重旋风集尘部的第 1 流出部呈现越往其底部走越变窄的锥体形状。

6. 根据权利要求 2 所述的多重旋风集尘装置，其特征是:

上述第 1 流出部包括如下几个部分所构成: 形成有多个通孔的多孔部；没有设置通孔的处于封闭状态的非多孔部。

7. 根据权利要求 6 所述的多重旋风集尘装置，其特征是:

上述第 1 流出部的多孔部大概位于上述第 1 流出部的中央侧的上侧位置，而上述第 1 流出部的非多孔部大概位于上述中央侧的下侧位置。

8. 根据权利要求 5 所述的多重旋风集尘装置，其特征是:

上述第 1 流出部的下端直至上述延长部的内部空间长长的形成。

Dyson Ex1020
Page 1079

9. 根据权利要求 1 所述的多重旋风集尘装置，其特征是:

上述集尘桶的内部空间中还设置至少一个以上的肋，上述肋起到如下作用：减小收集在其空间上的异物的旋转流动。

10. 根据权利要求 9 所述的多重旋风集尘装置，其特征是:

上述肋，其宽度较宽的形成，并且呈现厚度相对薄的板形状，上述肋以如下方式安装：上述肋的构成宽度的面面向在上述异物的流动流路上与上述流动相对的方向。

Dyson Ex1020
Page 1080

多重旋风集尘装置

技术领域

本发明涉及旋风集尘装置。更为详细的说，本发明是涉及：把多个旋风集尘器连在一起使用的多重旋风集尘装置的发明。

背景技术

一般而言，旋风集尘装置是：利用旋风分离原理，分离并集尘空气中含有的灰尘（下面称为“异物”）的装置。在这里，上述旋风集尘装置主要应用于真空吸尘器。

在近来，为了进一步提高集尘性能，市面上出现了把多个旋风集尘器连在一起使用的多重旋风集尘装置（Multi Cyclone Collector）。

在这里，上述多重旋风集尘装置是包含如下部件所构成：吸入包含灰尘等的空气后，集尘体积较大的灰尘的上流侧旋风集尘器（upstream cyclone）；与上述上流侧旋风集尘器相连接，并且集尘体积较小的灰尘的下流侧旋风集尘器（downstream cyclone）。

在通常情况下，上述多重旋风集尘装置中安装有 1 个上流侧旋风集尘器和 1 个下流侧旋风集尘器。但是，也有用多个小型旋风集尘器代替下流侧旋风集尘器使用的情况。在这里，上述多重旋风集尘装置的一实施例已公开在日本实用新型公开专利公报 52-14775。

下面，参照图 1，对依据现有技术的多重旋风集尘装置进行详细的说明。

上述多重旋风集尘装置是包含如下部件所构成：从外部吸入已被污染的空气后，集尘体积较大的灰尘的旋风集尘器 1（下面，称为“1 次旋风集尘部”）；与上述旋风集尘器 1 相连接，并且集尘体积较小的灰尘的旋风集尘器 3（下面，称为“2 次旋风集尘部”）。在这里，上述多重旋风集尘装置中的 2 次旋风集尘部 3 是多个小型旋风集尘器的集合。

更为详细的说明上述结构如下。

首先，1 次旋风集尘部 1 的外部周边设置有 2 次旋风集尘部 3。在这里，上述 2 次旋风集尘部 3 是由多个小型旋风集尘器构成。

然后，上述 1 次旋风集尘部 1 的第 1 主体 12 的上部形成有第 1 流入部 11。在这里，上述第 1 流入部 11 的作用如下：向切线方向吸入外部已被污染的空

Dyson Ex1020
Page 1081

气。另外，上述 1 次旋风集尘部内部的大概中央部位形成有第 1 流出部 14。在这里，上述第 1 流出部 14 的作用如下：把经过一次过滤的空气向 2 次旋风集尘部 3 排出。详细的说，上述第 1 流出部 14 通常呈现圆筒形状，并且其下部 14b 处于开放状态，上部 14a 的周边处于封闭状态。另外，根据情况的不同，可以在下部的开口部 14b 上设置过滤器 16。

另外，上述 2 次旋风集尘部 3 其实是设置在上述 1 次旋风集尘部 1 的外部周边的多个小型旋风集尘器。当然，各 2 次旋风集尘部 3 也具备第 2 流入部（图中未表示）及第 2 流出部 34。

然后，在通常情况下，上述 1 次旋风集尘部 1 和 2 次旋风集尘部 3 之间形成有缓冲空间 56，致使从上述 1 次旋风集尘部 1 流出的空气经由上述缓冲空间 56 后，流入到 2 次旋风集尘部 3。

而且，与多个 2 次旋风集尘部 3 的第 2 流出部 34 相连通的排出空间 52 将位于上述 2 次旋风集尘部 3 的上部。因此，空气经由上述排出空间 52 后，通过排出管 54 排出到外部。未进行说明的附图标记 5 是收容上述 1 次旋风集尘部 1 和 2 次旋风集尘部 3 等部件的外壳（case）。

下面，将说明上述依据现有技术的多重旋风集尘装置的作用。

首先，一旦驱动上述多重旋风集尘装置，吸入力生成装置[例如，真空吸尘器的吸入风扇（图中未表示）]将随之启动。然后，外部的已被污染的空气将通过上述 1 次旋风集尘部 1 的第 1 流入部 11 流入到上述 1 次旋风集尘部 1 的内部。这时，外部的已被污染的空气将向切线方向吸入，并且沿着上述 1 次旋风集尘部 1 的第 1 主体 12 的内表面旋转。因此，在此过程当中，由于离心力的作用，沿着上述 1 次旋风集尘部 1 的第 1 主体 12 的内表面旋转的空气中含有的灰尘将被分离。

这时，体积较大重量较重的灰尘将集尘于上述 1 次旋风集尘部 1 的下部 。另外，无法分离出来的小灰尘在上述 1 次旋风集尘部 1 内部旋转数回合后上升，然后通过上述第 1 流出部 14 排出。

另外，从上述 1 次旋风集尘部 1 排出的包含有小灰尘的空气（下面，称为“部分被污染的空气）将通过第 2 流入部（图中未表示）流入到上述 2 次旋风集尘部 3 的第 2 主体 32 的内部。

接着，在上述 2 次旋风集尘部 3 中再次经历空气的微小灰尘分离作业，上述净化空气将依次经由第 2 流出部 34、排出空间 52、排出管 54，排出到外部。

但是，综上所述的依据现有技术的多重旋风集尘装置存在如下问题。

Dyson Ex1020
Page 1082

第 1，在依据现有技术的多重旋风集尘装置中，流入到上述 1 次旋风集尘部 1 的第 1 主体 12 内的空气将下降至第 1 流出部 14 的下部，因此已集尘在上述第 1 主体 12 内的底部空间中的灰尘有再飞散的可能。

第 2，通过第 1 流入部 11 流入到第 1 主体 12 内部的空气将下落至上述第 1 流出部 14 的下部后上升，然后通过上述第 1 流入部 11 排出到上述第 1 主体 12 的外部，因此将引发压力损失的问题。这样将会降低吸入效率。

第 3，在依据现有技术的多重旋风集尘装置中，当设置在 1 次旋风集尘部 1 的第 1 流出部 11 的过滤器 16 堵塞时，将会产生严重的压力损失现象，因此诱发了吸入力的降低及集尘性能的下降。

发明内容

本发明是为了改善上述的问题而提出的。因此，本发明的目的是提供：不仅能够提高吸入性能，而且能够最大限度的防止在 1 次旋风集尘部中所集尘的异物的再飞散现象的适用新结构的多重旋风集尘装置。

为了实现上述目的，依据本发明的多重旋风集尘装置，其特征是包括：形成有使空气流入的第 1 流入部，并且具备有分离出通过上述第 1 流入部流入的空气中的异物的第 1 主体，并且具备有设置在上述第 1 主体的底部侧方的收集在上述第 1 主体内分离的异物的集尘桶，设置有从上述第 1 主体的底面延长而位于上述集尘桶的内侧的同时与上述集尘桶内部空间连通的延长部，使上述第 1 主体内的空气流出的第 1 流出部的 1 次或 1 重旋风集尘部；安装于上述 1 次或 1 重旋风集尘部的外侧，并且吸入通过上述第 1 流出部流出的空气，进而再次进行对异物的集尘作业的 2 次或 2 重旋风集尘部，或者是没有安装 2 次或 2 重旋风集尘部。

上述 1 次或 1 重旋风集尘部的延长部最好是从上述第 1 主体的底面越往其下部走越变窄。

尤其是，在上述延长部的周面上至少形成有一个以上的异物排出孔。在这里，上述异物排出孔最好是把上述延长部的周面沿高度方向长长的切开后形成。

而且，上述 1 次旋风集尘部的第 1 流出部呈现越往其底部走越变窄的锥体形状。

尤其是，上述第 1 流出部包括：形成有多个通孔的多孔部；没有设置通孔的处于封闭状态的非多孔部。

如上所述，根据本发明的多重旋风集尘装置具有如下效果：

Dyson Ex1020
Page 1083

第 1，依据本发明，能够提高集尘性能。而且，由于能够减小压力损失，进而能够提高吸入效率。

第 2，能够更为有效的防止收集在构成旋风集尘部的第 1 主体内的异物集尘空间内的灰尘再飞散的现象。

附图说明

图 1 是现有技术的多重旋风集尘装置的纵剖面图。

图 2 是本发明的多重旋风集尘装置的实施例的纵剖面图。

图 3 是沿着图 2 的 I-I 线剖开的剖面图。

图 4 是本发明的多重旋风集尘装置的第 1 流出部的另一实施例的纵剖面图。

图 5 是本发明的多重旋风集尘装置的第 1 流出部的确切实施例的纵剖面图。

主要部件附图标记说明

100. 1 次旋风集尘部	110. 第 1 流入部
120. 第 1 主体	130. 集尘桶
131. 肋	140. 第 1 流出部
141. 多孔部	142. 非多孔部
150. 延长部	151. 异物排出孔

具体实施方式

下面，将参考提供的附图 2 至图 5，对本发明的实施例进行详细的说明。

首先，依据本发明的多重旋风集尘装置是包含如下部件所构成：1 次旋风集尘部 100；与上述 1 次旋风集尘部 100 相连接的 2 次旋风集尘部 200。在这里，依据本发明的多重旋风集尘装置的上述 1 次旋风集尘部 100 包含有：第 1 流入部 110、第 1 主体 120、集尘桶 130、延长部 150、第 1 流出部 140 等部件。

在这里，上述第 1 流入部 110 作为从外部吸入空气的部位，虽未在图中表示，但上述第 1 流入部 110 与构成真空吸尘器的吸入软管相连接。

然后，上述第 1 主体 120 将形成：分离出通过从上述第 1 流入部 110 流入的空气中含有的异物的空间。

这时，上述第 1 流入部 110 如下连接：即，使空气的流动对于上述第 1 主体 120，向切线方向形成。

在这里，上述第 1 主体 120 可以形成为多种多样的形状，但是最好是形成

Dyson Ex1020
Page 1084

为内表面呈现曲面的圆桶形状。

然后，上述集尘桶 130 将沿着上述第 1 主体 120 的底部空间中的侧面空间形成。在这里，上述集尘桶 130 将形成收集在上述第 1 主体 120 内部分离出的异物的空间。

上述集尘桶 130 向上述第 1 主体 120 的侧方扩张形成，因此能够最大限度的增加收集体积相对大的异物的空间的同时，还能够防止收集在上述集尘桶 130 内部空间中的异物的再飞散。

当然，为了能够进一步扩大收集上述异物的空间，可以进一步增加第 1 主体 120 的高度。但是，由于限定了通常的适用多重旋风集尘装置的真空吸尘器的整体高度，因此很难增加第 1 主体 120 的高度。

不仅如此，通过进一步增大上述第 1 主体 120 的直径来进一步扩大上述收集异物的空间。但是，在这种情况下，是以减小上述 2 次 旋风集尘部 220 的安装空间为代价。

因此，如本发明的实施例所描述的那样，为了不影响上述 2 次旋风集尘部 200 的安装空间，可以使第 1 主体 120 的下部外侧空间构成异物的集尘空间的形成集尘桶 130。在这里，最好是使整体的异物的集尘空间更为变大。当然，虽然没有在图中表示，但是上述集尘桶 130 的内部空间可以与形成上述 2 次旋风集尘部 200 的异物排出的部位相连通。

尤其是，在本发明的实施例中，上述结构的集尘桶 130 内部空间上至少设置有一个以上的肋 131。

详细的说，上述肋 131 的作用如下：能够降低在上述集尘桶 130 的内部空间上集尘的异物的旋转流动，并且能够最大程度的减小上述异物的再飞散现象，并且大概由薄板构成。

这时，上述肋 131，其宽度较宽的形成，并且呈现厚度相对薄的板形状。在这里，如图 3 的重要部位剖面图所示，上述肋 131 最好是处于如下安装状态：上述肋 131 的构成宽度的面面向在上述异物的流动流路上与上述流动（附图中的箭头）相对着的方向，即向着切断上述流动的方向。

然后，上述延长部 150 是从上述第 1 主体 120 的底面向下延长，从而位于上述集尘桶 130 的内侧。另外，在上述延长部 150 上至少形成有一个以上的能够与上述集尘桶 130 的内部空间连通的异物排出孔 151。

在这里，上述延长部 150 最好是从上述第 1 主体 120 的底面越往其下部走变得越窄。其原因如下：为了能够更为顺畅的通过上述异物排出孔 151 排出

Dyson Ex1020
Page 1085

沿着上述延长部 150 的内表面旋转流动的异物。

这时，上述异物排出孔 151 可以由单纯的通孔形成。但是，为了能够更好的排出异物，把上述延长部 150 的周面沿着其高度方向长长的切开而形成异物排出孔 151。在这里，相互对称的部位最好是各自设置有一个上述异物排出孔 151。

然后，上述第 1 流出部 140 设置在上述第 1 主体 120 内的中央侧空间上，并且上述第 1 流出部 140 起到如下作用：为了使流动于上述第 1 主体 120 内的空气流出到上述 2 次旋风集尘部 200 而引导流出时的流动方向。

在这里，上述第 1 流出部 140 呈现越往其底部走越变窄的锥体形状。这样设置的理由如下：为了能够使第 1 主体 120 内的下部空间中也能够顺畅的进行异物的旋转流动。

当然，如图 4 所示，上述第 1 流出部 140 可以构成为，上部空间和下部空间的内径相同的圆桶形状。

尤其是，上述第 1 流出部 140，其特征是包括：周边形成有多个通孔 141a 的多孔部 141；没有设置通孔的处于封闭状态的非多孔部 142。并且，其底面形成为封闭的桶形状。

上述第 1 流出部 140 将具备如下结构：能够维持原来的集尘性能的情况下，能够缓解压力损失的现象。通过上述第 1 流入部 110 流入到上述底 1 主体 120 内部的空气，即使未下落到上述第 1 流出部 140 的下部，也能够使空气流出，因此能够缓解压力损失现象。

当然，依据现有技术的 1 次旋风集尘部 1 的第 1 流出部 14，其下部处于开口状态，上部处于没有通孔的状态。在这里，其理由描述如下：若想利用旋风分离的原理收集灰尘，就需要使流入的空气首先沿着第 1 主体 12 的内表面向下部旋转而分离出灰尘，然后使空气再次从大概中心部上升，之后排出。因此，以往认为，只能封闭第 1 流出部 14 的上部。但是，如本发明的实施例所描述的那样，封闭 1 次旋风集尘部 100 的第 1 流出部 140 的下部，并且在上部形成多个通孔 141a，也能够有效的收集灰尘。并且，由于上述构成，还能够缓解压力的损失。

而且，上述第 1 流出部 140 的多孔部 141 大概位于上述第 1 流出部 140 的中央侧的上侧位置，而非多孔部 142 位于上述中央侧的下侧位置，并以此为特征。

如果上述第 1 流出部 140 的下部也形成有多个通孔 141a，由于受到在上述

Dyson Ex1020
Page 1086

第 1 流出部 140 的下部侧空间中产生的上升气流的影响，异物的排出过程将非常容易的实现，而且由于产生于上述第 1 流出部 140 的下部通孔中的空气吸入力，异物将无法沿着第 1 主体 120 内的内表面下降而容易融合到由于上述空气吸入力而产生的气流中，因此是不可取的构造。

尤其是，如图 5 所示，上述第 1 流出部 140 的下端最好是直至上述延长部 150 的内部空间长长的形成。其理由如下：即，为了使在延长部 150 的内部空间中流动的异物最大限度的沿着其表面流动。

然后，依据本发明实施例的 2 次旋风集尘部 200 与上述 1 次旋风集尘部 100 相比具有：相对小型化和其个数至少是一个以上的区别。在这里，依据本发明实施例的 2 次旋风集尘部 200 各自沿着上述 1 次旋风集尘部 100 的外侧周边设置。

上述 2 次旋风集尘部 200 的作用如下：再次分离出从上述 1 次旋风集尘部 100 排出的空气中含有的微小异物并集尘。在这里，上述 2 次旋风集尘部 200 的整体结构与依据现有技术的结构相同，因此省略对其结构的详细说明。

然后，未进行说明的附图标记 500 是：收容 1 次旋风集尘部 100 及 2 次旋风集尘部 200 等部件的外壳。

下面，将详细说明综上所述的依据本发明多重旋风集尘装置的实施例的作用。

首先，一旦多重旋风集尘装置驱动，外部的已被污染的空气将通过 1 次旋风集尘部 100 的第 1 流入部 110 吸入到第 1 主体 120 的内部。

这时，外部的已被污染的空气由于是向第 1 主体 120 的切线方向吸入，因此本身将作用有离心力，致使由于上述离心力，重量比较重，体积比较大的灰尘能够从空气中分离，进而将沿着上述第 1 主体 120 的内表面下降。

上述分离的灰尘将提供到延长在第 1 主体 120 的底部的延长部 150。然后，在沿着上述延长部 150 的内表面流动的过程中，通过各异物排出孔 151 排出到集尘桶 130 的内部空间并被收集。而包含有微小灰尘的空气，即，部分污染空气将通过第 1 流出部 140 排出。

这时，上述集尘桶 130 由于处于与上述第 1 主体 120 的底部空间分离的状态，因此能够防止排出到上述集尘桶 130 内的异物重新再飞散到上述主体 120 内的现象。

尤其是，由于具备于上述集尘桶 130 内部的多个肋 131 的作用而集尘在上述集尘桶 130 内的异物，将无法沿着上述集尘桶 130 的内表面旋转流动，而

Dyson Ex1020
Page 1087

形成气流的稳定化。

这时，依据本发明，作为第 1 流出部 140 的上部的多孔部 141 中，形成有多个通孔 141a。然后，作为下部的非多孔部 142 由于整体处于被堵塞的状态，因此通过上述第 1 流入部 110 进入的空气将经过比以往少的旋转后流出第 1 主体 120。

空气不会流动至上述第 1 流出部 140 的下部，并且上述集尘桶 130 的内部空间处于与上述第 1 主体 120 分割的状态，因此能够有效的防止灰尘再次飞散的现象。

另外，在上述的实施例中，多重旋风集尘装置的 2 次旋风集尘部 200 是由多个小型旋风集尘器构成。但是，本发明并非只局限与此。本发明也可以适用于将 2 个旋风集尘部相互连接而形成的 2 重旋风集尘装置。而且，本发明也可以适用于只由一个旋风集尘装置构成的单式旋风集尘装置。

另外，上述的依据本发明的旋风集尘装置，可以设置在过滤形式的真空吸尘器及直立式吸尘器中使用。

Dyson Ex1020
Page 1088

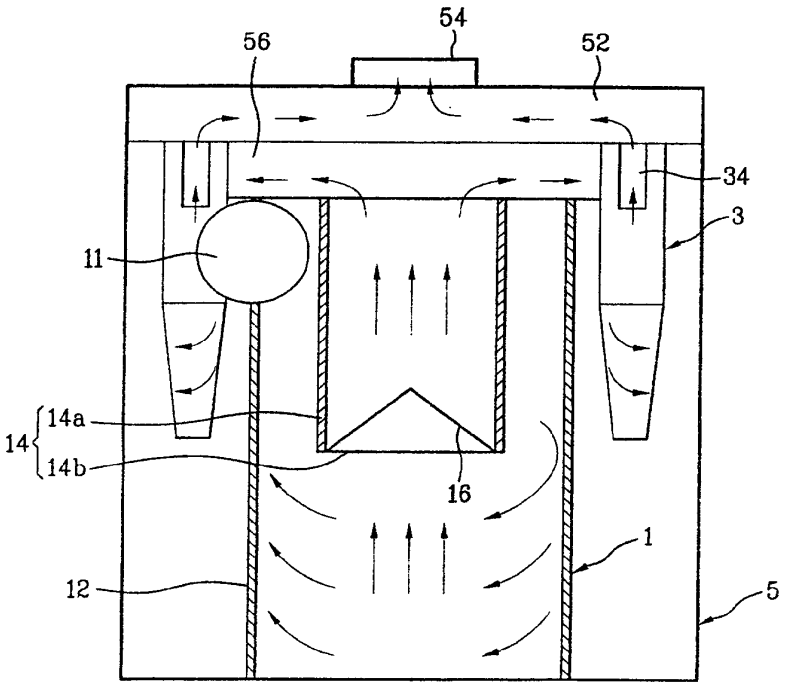


图 1

Dyson Ex1020
Page 1089

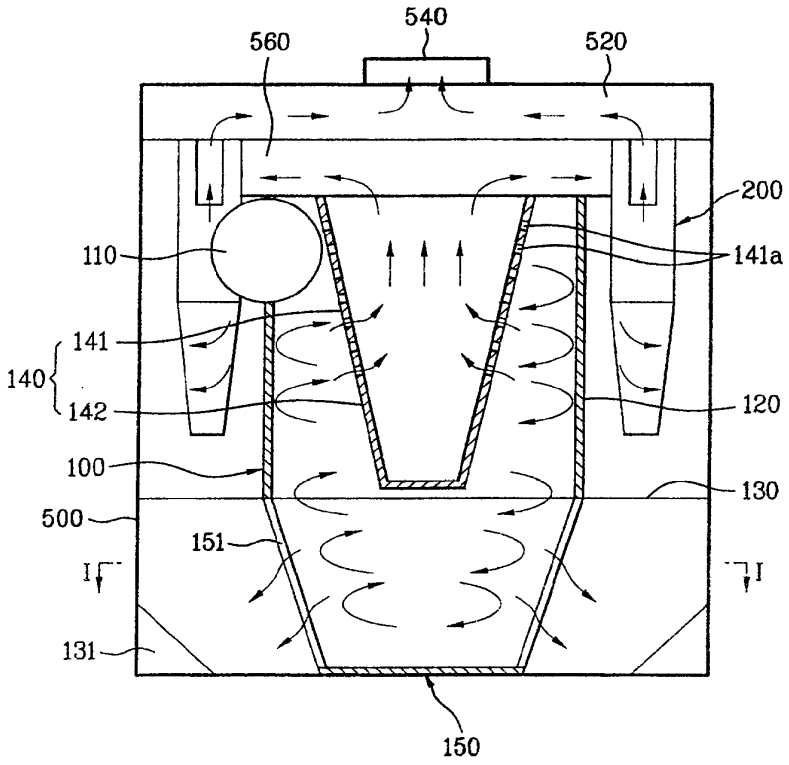


图 2

Dyson Ex1020
Page 1090

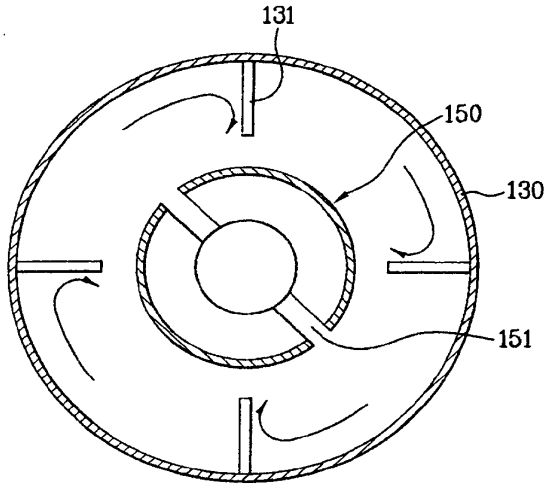


图 3

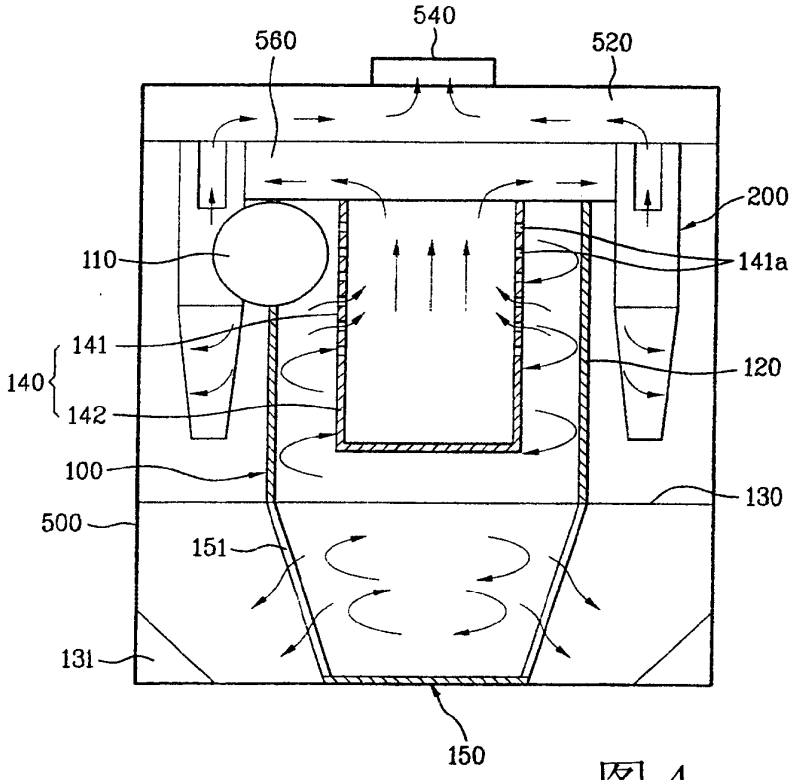


图 4

Dyson Ex1020
Page 1091

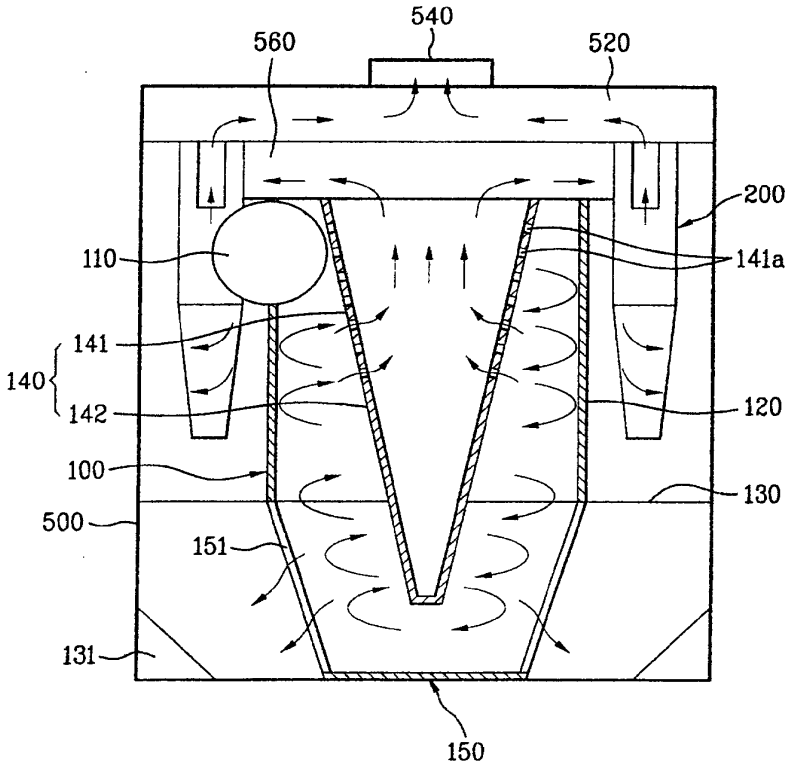


图 5

Dyson Ex1020
Page 1092

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Description

Centrifugal cleaners have been known for decades. In a typical use of a centrifugal cleaner it is desirable to remove as many contaminants (rejects, debris) as possible while removing as little desirable material (accepts) as possible. Many different structures and implementation schemes have been designed to accomplish this desirable end result, however conventional cleaners still are not as effective as desired for many applications. For example in the separation of contaminants -- such as pieces of plastic, particularly particles having a size of less than .5 mm^2 -- from conventional paper pulp furnish, even when four stages of centrifugal cleaner are utilized the effectiveness of contaminants removal is less than desired, and too much fiber is lost in the rejects stream.

According to the present invention, three improvements are provided to conventional centrifugal cleaners which remarkably improve their effectiveness. Virtually all centrifugal cleaners have a generally hollow main body with a side wall having a generally decreasing conical taper from the top toward the bottom, a tangential inlet nozzle in the side wall near the body top for introducing fluid material to be cleaned, a top outlet nozzle extending downwardly into the body through the top and centrally located in the body, the bottom of the top nozzle located below the tangential inlet nozzle, and a bottom nozzle disposed in the side wall and generally concentric with the top outlet nozzle, and spaced from the tangential inlet nozzle. The primary improvement according to the invention relates to the particular construction of the bottom nozzle to define a particular rejects opening whilst additional improvements relate to the configuration of the tangential inlet nozzle, the provision of a cylindrical section of the body in the side wall between conical upper and lower portions.

According to the present invention there is provided a centrifugal cleaner for treating fiber suspensions of pulp and paper industry comprising:

a generally hollow main body having a top and a bottom, and a side wall having at least a portion thereof with a generally decreasing conical taper from the top towards the bottom of the body, said main body having an internal diameter;
a tangential inlet nozzle in said side wall near said body top for introducing fluid material to be cleaned;
a top outlet nozzle extending downwardly into said body through said top and centrally located in said body, the bottom of said top nozzle located below said tangential inlet nozzle, said top nozzle having an internal diameter; and
a bottom nozzle disposed in said side wall decreasing conical taper portion and spaced from and generally concentric with said top outlet nozzle and spaced from said tangential inlet nozzle, characterised in that
said bottom nozzle includes particle flow restriction means for defining rejects opening therein, said restriction means being provided by: -

(a) said rejects opening having a diameter that is about 25-45% of the internal diameter of said side wall at said opening, and is about 25-45% of the internal diameter of said top outlet nozzle; and
(b) a plate having a substantially flat upper surface generally perpendicular to said top nozzle, said plate upper surface having a solid area greater than the area of said rejects opening therein; and
(c) an insert having a three dimensional parabola configuration having inner walls sloping downwardly to the central rejects opening or an interior three dimensional parabolic surface terminating at the bottom thereof in said rejects opening.

The primary improvement according to the invention is the most significant from the operational standpoint. By providing a particular design of bottom nozzle according to the present invention it is possible to eliminate multiple stages of multiple stage cleaners, to maximize the accepts portion, and minimize the rejects portion discharged from the cleaner, while effectively removing contaminants. The cleaner according to the present invention is particularly effective with contaminant particles having a size of less than about .5 mm^2. The cleaner according to the present invention has a cleaning quotient greater than .5, and a rejects by weight performance of less than 5%, for conventional paper pulp furnish, remarkable advances compared to prior art cleaners not utilizing the invention.

The bottom nozzle according to the invention includes means for defining a rejects opening having a diameter that is about 25-45% of the internal diameter of the top outlet nozzle, e.g. roughly 1/3 (about 37%) of the internal diameter of the top outlet nozzle. Preferably it has a diameter that is about 25-45% of the internal diameter of the side wall at the rejects opening too, again typically roughly 1/3 the internal diameter of the side wall at the rejects opening.

The rejects opening is best formed in one of two ways. In the first embodiment the means defining the rejects opening comprises a substantially flat plate having a main top surface generally perpendicular to the top nozzle, and having an exterior diameter equal to the interior diameter of the side wall at that point along the body. In this embodiment rejects particles build up in about one or two minutes of operation to form an internal three dimensional parabolic surface tapering down to the rejects opening. According to a second embodiment of the invention, an insert is provided that already has the three dimensional parabolic configuration so that actual discharge of rejects begins almost imme-

Dyson Ex1020
Page 1094

diately upon starting operation of the cleaner.

A typical tangential inlet nozzle is circular in configuration. It has been found according to the present invention that a circular configuration is far from ideal, causing turbulence and flow patterns which interfere significantly with the vortex action desirably introduced into the fluid by the tangential inlet. According to a first embodiment of the present invention, a non-circular opening of smaller cross dimension than is typically utilized is provided. The inlet opening has no portion thereof which intersects the top nozzle -- that is an extension from the straight leg of the D is substantially coincident with the exterior surface of the top nozzle. With such a configuration, for the same pressure drop there is higher velocity (and therefore better cleaning action) and increased throughput. A better free vortex is provided at the top of the cleaner, and since the type of turbulence and complicated flows typically ensuing when the flow of introduced fluid impacts the top nozzle is eliminated, the throughput is increased on the order of about 25%.

A second embodiment according to the present invention is the provision of an interior section of the cleaner body which increases retention time. When retention time is increased, the time for the particles to "settle" is also increased, and thus the removal efficiency. According to the present invention, the body side wall of the cleaner comprises an upper portion that is conical and extends past the bottom of the top nozzle, and a conical bottom portion of the side wall which is disposed in operative association with the bottom nozzle. Between them is a means for increasing retention time within the cleaner, comprising a generally cylindrical center portion of the side wall.

It is the primary object of the present invention to provide a centrifugal cleaner with enhanced effectiveness. This and other objects of the invention will become clear from an inspection of the detailed description of the invention and from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side schematic view of an exemplary centrifugal cleaner according to the invention;

FIGURE 2 is a cross-sectional view of the tangential inlet nozzle of the cleaner of FIGURE 1;

FIGURE 3 is an end view of the inlet nozzle of FIGURE 2;

FIGURE 4 is a detail view of the "D" shaped inlet opening of the nozzle of FIGURES 2 and 3;

FIGURE 5 is a schematic representation showing the relationship between the inlet nozzle of FIGURES 3 and 4 and the top nozzle of the cleaner of FIGURE 1;

FIGURE 6 is a schematic cross-sectional view of the cleaner of FIGURE 1;

FIGURE 7 is a detail cross-sectional view of an alternative configuration of the bottom nozzle of an exemplary cleaner according to the invention; and

FIGURE 8 is a graph comparing efficiency as a function of reject flow (by weight) of a cleaner according to the invention compared to identical prior art cleaners without the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

An exemplary centrifugal cleaner according to the invention is shown generally by reference numeral 10 in FIGURES 1 and 6. Major components include the tangential inlet nozzle 11 to a generally hollow main body 12, an accepts outlet defined by a top outlet nozzle 13, and a rejects outlet 14 from the bottom of the cleaner 10. Those elements, per se, are known in the art, however the particular configuration of the tangential inlet nozzle 11, the side wall of the body 12, and a bottom nozzle adjacent the bottom of the body 12, are different according to the invention.

The tangential inlet nozzle 11 -- as seen most clearly in FIGURES 2 through 5 -- is defined by a pipe 16 having an interior 17 defined by a tapered wall 18 from the end 19 most remote from the body 12, to an end 20 closest to the body 12. Typically, the external diameter 21 of the tube 16 at the end 19 is about 1.6 inches, while the internal diameter 22 just to the right thereof (see FIGURE 2) is about 1.5 inches. The wall 18 tapers down to a non-circular inlet opening 24 which has as its largest diameter (cross-sectional dimension) about .91 inches. This is smaller than the conventional design which has an external diameter of the pipe of about 1.6 inches but a generally constant diameter internal passageway of about 1.05 inches, terminating in a circular inlet opening with that same (about 1.05 inch) internal diameter.

Preferably the non-circular configuration of the inlet opening 24 approximates a D-shape, having a straight leg 25 portion "cutting off" what would otherwise be a circular opening. As earlier indicated, the largest cross dimension 26 (see FIGURE 4) of the opening 24 is about .91 inches in a preferred embodiment, while the perpendicular "cut off" dis-

Dyson Ex1020
Page 1095

tance 27 is about .18 inches.

As seen in FIGURE 5, the D shape of the opening 24 is designed so that no portion thereof intersects the top nozzle 13. As can be seen in FIGURE 5, an extension from the straight leg 25 of the D is substantially coincident with the exterior surface of the top nozzle 13.

The configuration of the inlet opening 24, and the rest of the nozzle 11, as described above results in an increase in throughput of about 25% compared to the conventional design of nozzle having a circular inlet opening of about 1.05 inches, while it has substantially the same pressure drop, and therefore provides a higher velocity (a better free vortex at the top of the cleaner), so that better cleaning action can occur. Thus -- unexpectedly -- a decrease in the size of the inlet opening 24, and a change in the shape thereof, reduce the resistance of the flow of fluent material into the cleaner, and thereby significantly increase throughput.

The second improvement according to the present invention -- which is independent of the inlet nozzle design 11 as described above -- comprises a particular construction of the side wall 12. As illustrated most clearly in FIGURE 6, the cleaner body side wall comprises an upper portion 30 that is at least slightly conical, tapering gradually inwardly from the top toward the bottom of the cleaner, with the flange 35 thereof extending past the bottom 29 of the circular top outlet nozzle 13. At the bottom of the cleaner 10 is a conical bottom portion 31 which also tapers inwardly from the top toward the bottom thereof, and has an upper flange 36. According to the invention, means are provided for increasing the retention time of particles within the cleaner, so as to enhance settling and thereby removal efficiency. Such retention time increasing means comprises the generally cylindrical (constant internal diameter) center portion 32 of the side wall 12, having upper and lower flanges 33, 34 which respectively cooperate with the flanges 35, 36 of the upper and lower portions 30, 31 of the cleaner.

The third improvement according to the present invention -- which is independent of both of the above structures, but of course may be utilized therewith to provide the most effective cleaner -- includes the particular construction of the bottom nozzle disposed within the side wall 12 and spaced from the top outlet nozzle 13 and tangential inlet nozzle 11. The bottom nozzle is disposed in operative association with the inner tapering wall 37 of the side wall section 31.

In the preferred embodiment of the bottom nozzle construction according to the invention as illustrated in FIGURE 6, a plate 38 is provided. Below the plate 38 the interior of the cleaner side wall continues to taper inwardly, as indicated at 39, and the cleaner terminates at a bottom lip 40, providing an extension 41 below the plate 38. The plate 38 has an exterior diameter 42 which is for all practical purposes equal to the internal diameter of the sloping inner wall 37 at the point along the portion 31 of the side wall 12 at which the plate is provided. The plate 38 has an upper surface which is substantially perpendicular to the top outlet nozzle 13, and is substantially flat. The plate defines a rejects opening 43 therein. The rejects opening 43 has a diameter 44. The diameter 44 is essentially equal to the diameter of the air core (inner vortex) 45 of the cleaner 10.

According to the present invention, the particular dimensional relationship between the diameter 44 and other components is important. Typically, the diameter 44 of the opening 43 is between about 25-45% of the internal diameter of the top outlet nozzle 13. Preferably it is roughly about 1/3 that diameter, for example in one embodiment it is about 37%. Also, typically the plate 38 is constructed so that the outer diameter 42 thereof is approximately equal to the internal diameter of the nozzle 13; that is, the diameter 44 is about 25-45% (e.g. roughly one-third) of the diameter 42, so that the area of the plate 38 outside of the centrally located rejects opening 43 therein is greater than the area of the opening 43.

In one typical construction according to the present invention, the rejects opening 43 has a diameter of about 11 mm., while the diameter 42 is about 30 mm., and the internal diameter 13'of the top outlet 13 is about 30 mm.

When the cleaner 10 illustrated in FIGURE 6 is utilized, the first one or two minutes of operation debris is not discharged through the bottom 40 of the cleaner 10, but rather it builds up on top of the upper surface of the plate 38. Debris particles build up in a substantially three dimensioned parabolic configuration 46 which terminates at the bottom thereof in the rejects opening 43. Once that configuration 46 of particles is established, then debris is discharged into the rejects line.

An alternative embodiment of the bottom nozzle is illustrated in FIGURE 7. In this embodiment, structures comparable to those in the FIGURE 6 embodiment are shown by the same reference numeral only preceded by a "1". In this embodiment, on top of the plate 138 -- or integral therewith -- is provided an insert 50 having an interior sloping wall 51. The configuration of the wall 51 is a simulation of a three dimensional parabola, which terminates at the bottom thereof in the rejects opening 143.

In both embodiments described above, the thickness of the plate 38, 138 is not particularly significant. The thickness does not really relate to the removal functions, but it is desirable that the plate have a substantial thickness just so that it does not wear out quickly. A thickness of about one-half inch for the plate 38 is practical.

Actual tests have been done on a number of different types of conventional cleaners having the bottom nozzle configuration as illustrated in FIGURE 6. In such trials, the particular inlet 11 and the particular cylindrical body section 32 described above and illustrated in FIGURE 6 were not utilized; rather the "flat bottom" configuration of the tip of the cleaner (bottom nozzle) described above was the only change made to the conventional cleaner. From such testing it

Dyson Ex1020
Page 1096

was clearly demonstrated that the bottom nozzle configuration according to the invention improves the debris removal effectiveness of the cleaner. Improvements were most significant as the particle size decreased, and were dramatically effective where the debris particles had a size of less than .5 mm^2. The pressure drop required to process 150 gpm through the cleaner increased slightly when the cleaner according to the invention was utilized, but the accept tonnage was significantly greater at comparable feed tonnages. Consequently, to get the same amount of clean, usable fiber a lower feed flow rate is provided.

Table I below illustrates the actual test results for a conventional cleaner having two different designs of conventional bottom nozzles, and the bottom nozzle according to the invention. The conventional cleaner of Table I is a Bauer 606 Top Inlet Cleaner. The cleaner included its typical size top outlet nozzle, and was essentially unmodified except for the bottom nozzle. The cleaner was attached to a laboratory DECULATOR and was run under boiling point vacuum. The fluent material used for the cleaning operation was bleached softwood kraft paper pulp having a consistency of about .80%. The debris particles -- which were standardized and introduced into the system for removal -- were polyvinyl chloride grindings that ranged in area from .009 mm^2 to 1 mm^2. The specific gravity was measured to be 1.4. Trials A through C in Table I compare a one inch diameter standard tip (bottom nozzle), a 7/8 inch diameter standard tip, and a .94 inch diameter (the size of the rejects opening 43) tip according to the invention, respectively.

TABLE I

BAUER 606 TOP INLET CLEANER REJECT TIP COMPARISONS					
Trial	Flow (gpm)	Const	Tons/Day	P(psid)	CSF
A	Feed: 150	.87	7.8	25.7	675 Qavg: .0151
	Acct: 127	.74	5.6		712 RWT: 19.4%
	Rejt: 23.0	1.10	1.5		710 EFF, 25.1%
B	Feed: 150	.79	7.1	27.2	715 Qavg: .3376
	Acct: 135	.65	5.3		691 RWT: 21.7%
	Rejt: 14.8	1.74	1.5		726 EFF: 35.8%
C	Feed: 150	.79	7.1	28.8	656 Qavg: .5459
	Acct: 149	.82	7.4		667 RWT: 1.6%
	Rejt: 0.95	1.98	.11		692 EFF: 9.5%
TRIAL A: 1.0" DIA STANDARD TIP TRIAL B: 7/8" DIA STANDARD TIP TRIAL C: .94" DIA TIP ACCORDING TO INVENTION					

Analyzing the results of Table I it will be seen that the cleaning quotient ("Qavg") for the cleaner according to the invention is enormously greater than the same quality for the conventional tip configurations. [Qavg, or cleaning quotient, is equal to the debris in the rejects minus the debris in the accepts, together divided by the debris in the rejects.] Similarly the rejects by weight ("RWT") performance value is dramatically less.

It should be noted that the efficiency ("EFF") calculation in Table I is misleading as far as the effectiveness of the units is concerned. The equation used to calculate the particular efficiency value in Table I is very dependent on reject rate, and is misleading as to actual efficiencies. FIGURE 8, on the other hand, plots percentage efficiency as a function of reject flow (by weight) for the trials of Table I, and indicates the superior performance of the cleaner (plot C) according to the invention.

In a typical operation of a cleaner 10 as illustrated in FIGURE 6, the material to be treated (e.g. paper pulp furnish having a consistency of about 0.5-1.5%) is introduced into inlet 11 so that a free vortex forms in the top of the body 12. The D-shape configuration of the inlet opening 24 maximizes throughput. As the pulp suspension spins downwardly in a vortex within the body 12, its retention time is significantly increased by the cylindrical section 32. Ultimately the downwardly spiralling vortex of pulp suspension impacts the plate 38, while an inner vortex or air core 45 extends upwardly therefrom to the accepts outlet 13. Particles (46) which have been separated out by the centrifugal action of the cleaner 10 collect on the top of the plate 38 and form a generally three dimensional parabolic surface. After about one or two minutes of operation the surface of particles 46 is formed, and then debris particles -- of very high consistency -- are discharged from the bottom 40 of the cleaner 10 into the debris line 14. Meanwhile, the accepts flow through the top nozzle 13 is maximized.

Dyson Ex1020
Page 1097

In this specification, and the following claims, the reference to "top", "bottom", and the like to describe the positions of the components is for reference and description purposes only, and does not imply an actual orientation with respect to vertical. That is the cleaner 10 will also operate with the debris outlet 40 vertically above and in line with the accepts outlet 13, and all orientations therebetween.

While the invention has been herein shown and described in what is presently conceived to be the most practical and preferred embodiment thereof, it will be apparent to those of ordinary skill in the art that many modifications may be made thereof within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent structures and devices.

Claims

1. A centrifugal cleaner (10) for treating fiber suspensions of pulp and paper industry comprising:

   a generally hollow main body (12) having a top and a bottom, and a side wall having at least a portion (31) thereof with a generally decreasing conical taper from the top towards the bottom of the body, said main body (12) having an internal diameter;
   a tangential inlet nozzle (11) in said side wall near said body top for introducing fluid material to be cleaned;
   a top outlet nozzle (13) extending downwardly into said body through said top and centrally located in said body (12), the bottom of said top nozzle located below said tangential inlet nozzle, said top nozzle having an internal diameter; and
   a bottom nozzle (38, 41; 138, 141, 50) disposed in said side wall decreasing conical taper portion (31) and spaced from and generally concentric with said top outlet nozzle (13) and spaced from said tangential inlet nozzle (11), characterised in that
   said bottom nozzle includes particle flow restriction means for defining rejects opening therein, said restriction means being provided by: -

   (a) said rejects opening (43) having a diameter (44) that is about 25-45% of the internal diameter of said side wall at said opening, and is about 25-45% of the internal diameter of said top outlet nozzle; and
   (b) a plate (38, 138) having a substantially flat upper surface generally perpendicular to said top nozzle, said plate upper surface having a solid area greater than the area of said rejects opening (43, 143) therein; and
   (c) an insert (50) having a three dimensional parabola configuration having inner walls sloping downwardly to the central rejects opening or an interior three dimensional parabolic surface (51) terminating at the bottom thereof in said rejects opening (43, 143).

2. A cleaner as claimed in claim 1 wherein said bottom nozzle (38, 41) includes means (38) defining a rejects opening (44, 144) having a diameter that is roughly one third the internal diameter of said top outlet nozzle (13).

3. A cleaner as claimed in claim 2 wherein said bottom nozzle (38, 41, 138, 141, 50) includes means (38) defining a rejects opening having a diameter that is about 37% the internal diameter of said top outlet nozzle (13).

4. A cleaner as claimed in any of claims 1 to 3 wherein said bottom nozzle means defining a rejects opening comprises a substantially flat plate (38, 138) having a main surface generally perpendicular to said top nozzle (13), and having an exterior diameter (42) equal to the interior diameter of said side wall at that point along said body.

5. A cleaner as claimed in claim 4 wherein said plate (38, 138) has an outer diameter (42) of roughly 30 mm, and said opening (44,144) therein has a diameter of roughly 11 mm, and said top outlet nozzle (13) has an internal diameter (13') of roughly 30 mm.

6. A cleaner as claimed in any of claims 1 to 5 wherein said inlet nozzle (11) includes means defining a non-circular inlet opening that has no portion thereof which intersects said top nozzle (13), so as to provide enhanced throughput.

7. A cleaner as claimed in claim 6 wherein said inlet nozzle (11) opening (24) has a substantially "D" shape, an extension from the straight leg (25) of the D being substantially coincident with an exterior surface of said top nozzle (13).

8. A cleaner as claimed in any of claims 1 to 7 wherein said body side wall comprises: an upper portion (30) that is conical and extends past the bottom of said top nozzle; means (32) for significantly increasing retention time within

Dyson Ex1020
Page 1098

said cleaner (10), comprising a generally cylindrical center portion (32) of said side wall; and a conical bottom portion (31) of said side wall, said bottom nozzle (38, 41) disposed in operative association with said bottom portion (31).

9. A cleaner as claimed in any of claims 1 to 8, characterised in that said body side wall comprises: an upper portion (30) that is conical and extends past the bottom of said top nozzle (11); means (32) for significantly increasing retention time within said cleaner (10) comprising a generally cylindrical center portion (32) of said side wall; and a conical bottom portion (31) of said side wall, said bottom nozzle (38, 138) disposed in operative association with said bottom portion (31).

10. A cleaner as claimed in any of claims 1 to 9 wherein said body side wall includes: an upper portion (130) that is conical and extends past the bottom of said top nozzle (11); and instead of said flow restriction means (a), (b) or (c), particle retention-time increasing means (d) are provided comprising means (32) for significantly increasing retention time within said cleaner provided by a generally cylindrical center portion (32) of said side wall: there also being included a conical bottom portion (31) of said side wall, said bottom nozzle (38, 138) disposed in operative association with said bottom portion (31).

11. A centrifugal cleaner as claimed in any of claims 1 to 10, wherein said means for defining a rejects opening in said bottom nozzle are such as to provide a cleaning quotient of the cleaner greater than .5, and a rejects by weight performance value of less than 5% for conventional paper pulp furnish.

Patentansprüche

1. Wirbelabscheider (10) zur Aufbereitung von Fasersuspensionen der Papier- und Zellstoffindustrie, umfassend:

einen generell hohlen Hauptkörper (12) mit einem Oberteil und Unterteil und einer Seitenwand, wobei sich zumindest ein Teil (31) derselben hauptsächlich konisch vom Oberteil zum Unterteil des Körpers hin verjüngt, welcher Körper (12) einen lichten Durchmesser aufweist; eine tangentiale Einlaßdüse (11) in der Seitenwand nahe dem oberen Ende des Körpers zur Einführung von zu reinigendem Fluid;
eine obere Auslaßdüse (13), die sich durch das obere Ende hindurch abwärts in den Körper hinein erstreckt und im Körper (12) zentrisch angeordnet ist, wobei die Unterkante der oberen Düse unterhalb der tangentialen Einlaßdüse zu liegen kommt, welche obere Düse einen lichten Durchmesser hat; und
eine untere Düse (38, 41; 138, 141, 50), die im sich konisch verjüngenden Abschnitt (31) der Seitenwand angeordnet und beabstandet und hauptsächlich konzentrisch zur oberen Auslaßdüse (13) und beabstandet zur tangentialen Einlaßdüse (11) ist, dadurch gekennzeichnet, daß
die untere Düse Partikelstrom-Begrenzungsmittel zur Bildung einer Spuckstofföffnung darin umfaßt, welche Begrenzungsmittel vorgesehen sind durch:

(a) eine Spuckstofföffnung (43) mit einem Durchmessers (44), der ca. 25-45 % vom lichten Durchmesser der Seitenwand an der Öffnung und ca. 25-45 % vom lichten Durchmesser der oberen Auslaßdüse ist; und,
(b) eine Platte (38, 138) mit einer wesentlich flachen, zur oberen Düse hauptsächlich senkrechten Oberfläche, wobei die Oberfläche der Platte eine durchgehende Fläche hat, die größer als die Fläche der Spuckstofföffnung (43, 143) derselben ist; und
(c) einen Einsatz (50) mit einer dreidimensionalen Parabelkonfiguration, die abwärts, zur zentrischen Spuckstofföffnung hin geneigte Seitenwände oder eine dreidimensionale parabolische Innenfläche (51) hat, die an ihrem unteren Teil in die Spuckstofföffnung (43, 143) mündet.

2. Abscheider nach Anspruch 1, dadurch gekennzeichnet, daß die untere Düse (38, 41) Mittel (38) zur Bildung einer Spuckstofföffnung (44, 144) mit einem Durchmesser umfaßt, der grob genommen ein Drittel vom lichten Durchmesser der oberen Auslaßdüse (13) ist.

3. Abscheider nach Anspruch 2, dadurch gekennzeichnet, daß die untere Düse (38, 41, 138, 141, 50) Mittel (38) zur Bildung einer Spuckstofföffnung mit einem Durchmesser umfaßt, der rund 37 % vom lichten Durchmesser der oberen Auslaßdüse (13) ist.

4. Abscheider nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die eine Spuckstofföffnung bildenden unteren Düsenmittel eine wesentlich flache Platte (38, 138) mit einer Hauptoberfläche umfassen, die zur oberen

Dyson Ex1020
Page 1099

Düse (13) hauptsächlich senkrecht ist und einen Außendurchmesser (42) hat, der dem lichten Durchmesser der Seitenwand an jenem Punkt des Körpers entspricht.

5. Abscheider nach Anspruch 4, dadurch gekennzeichnet, daß die Platte (38, 138) einen Außendurchmesser (42) von rund 30 mm hat, und die Öffnung (44,144) derselben einen Durchmesser von ungefähr 11 mm hat, und die obere Auslaßdüse (13) einen lichten Durchmesser (13') von ungefähr 30 mm hat.

6. Abscheider nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß die Einlaßdüse (11) Mittel umfaßt, die eine nichtkreisförmige Eintrittsöffnung bilden, wobei sich kein Teil derselben mit der oberen Düse (13) schneidet, um für gesteigerten Durchsatz zu sorgen.

7. Abscheider nach Anspruch 6, dadurch gekennzeichnet, daß die Öffnung (24) der Einlaßdüse (11) im wesentlichen eine "D"-Form hat, wobei eine Verlängerung des geraden Schenkels (25) des D im wesentlichen mit der Außenfläche der oberen Düse (13) zusammenfällt.

8. Abscheider nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die Seitenwand des Körpers umfaßt: einen Oberteil (30), der konisch ist und sich über die Unterkante der oberen Düse hinaus erstreckt; Mittel (32) zur bedeutenden Verlängerung der Verweilzeit innerhalb den Abscheiders (10), bestehend aus einem generell zylindrischen Mittelabschnitt (32) der Seitenwand; und einem konischen Unterteil (31) der Seitenwand, wobei die untere Düse (38, 41) in betrieblicher Verbindung mit dem Unterteil (31) angeordnet ist.

9. Abscheider nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß die Seitenwand des Körpers umfaßt: einen Oberteil (30), der konisch ist und über die Unterkante der oberen Düse (11) hinaus erstreckt; Mittel (32) zur bedeutenden Verlängerung der Verweilzeit innerhalb den Abscheiders (10), bestehend aus einem generell zylindrischen Mittelabschnitt (32) der Seitenwand; und einem konischen Unterteil (31) der Seitenwand, wobei die untere Düse (38, 138) in betrieblicher Verbindung mit dem Unterteil (31) angeordnet ist.

10. Abscheider nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß die Seitenwand des Körpers einen Oberteil (130) umfaßt, der konisch ist und sich über die Unterkante der unteren Düse(11) hinaus erstreckt; und anstelle der Strömungsbegrenzungsmittel (a), (b) oder (c) Verlängerungsmittel für die Verweilzeit der Partikel vorgesehen sind, bestehend aus Mitteln (32) zur bedeutenden Verlängerung der Verweilzeit innerhalb den Abscheiders (10), vorgesehen durch einen generell zylindrischen Mittelabschnitt (32) der Seitenwand; und ferner einen konischen Unterteil (31) der Seitenwand umfaßt, wobei die untere Düse (38, 138) in betrieblicher Verbindung mit dem Unterteil (31) angeordnet ist.

11. Wirbelabscheider nach einem der Ansprüche 1 bis 10, dadurch gekennzeichnet, daß die in der unteren Düse eine Spuckstofföffnung bildenden Mittel einen Reinigungsquotienten des Abscheiders über 0,5 und einen Gewichtrejekt unter 5 % für konventionellen Papierhalbstoff ergeben.

Revendications

1. Epurateur centrifuge (10) pour traiter des suspensions de l'industrie de la pâte et du papier comprenant :

un corps principal généralement creux (12) présentant un sommet et un fond, et une paroi latérale comportant au moins une portion (31) de celle-ci ayant une conicité qui généralement décroît depuis le sommet vers le fond du corps, ledit corps principal (12) possédant un diamètre interne ;
une buse d'admission tangentielle (11) dans ladite paroi latérale près dudit sommet du corps afin d'introduire un matériau fluide à épurer ;
une buse d'évacuation en partie haute (13) s'étendant vers le bas dans ledit corps à travers ledit sommet et étant située de façon centrale dans ledit corps (12), le fond de ladite buse en partie haute étant positionné en dessous de ladite buse d'admission tangentielle, ladite buse en partie haute possédant un diamètre intérieur, et
une buse de fond (38, 41; 138, 141, 50) disposée dans ladite portion de conicité décroissante de la paroi latérale (31) et espacée de, et en général concentrique avec, ladite buse d'évacuation en partie haute et espacée de ladite buse d'admission tangentielle (11), caractérisé en ce que
ladite buse de fond inclut des moyens de restriction d'écoulement de particules pour délimiter l'orifice de refus dans celle-ci, lesdits moyens de restriction étant constitués par :

Dyson Ex1020
Page 1100

(a) ledit orifice de refus (43) possédant un diamètre (44) de l'ordre de 25% à 45% du diamètre intérieur de ladite paroi latérale audit orifice, et qui est de 25% à 45% environ du diamètre intérieur de ladite buse d'évacuation en partie haute, et

(b) une plaque (38, 138) présentant une surface supérieure sensiblement plane généralement perpendiculaire à ladite buse en partie haute, ladite surface supérieure de la plaque présentant une aire solide supérieure à l'aire dudit orifice de refus dans celle-ci (43, 143), et

(c) un insert (50) présentant une configuration parabolique à trois dimensions ayant des parois intérieures inclinées vers le bas vers l'orifice central de refus ou une surface intérieure parabolique tridimensionnelle (51) qui se termine au fond sur ledit orifice de refus (43, 143).

2. Epurateur selon la revendication 1, dans lequel ladite buse de fond (38, 41) comprend des moyens (38) délimitant un orifice de refus (44, 144) présentant un diamètre en gros 1/3 du diamètre intérieur de la buse d'évacuation en partie haute (13).

3. Epurateur selon la revendication 2, dans lequel ladite buse de fond (38, 41, 138, 141, 50) comprend des moyens (38) délimitant un orifice de refus présentant un diamètre de l'ordre de 37% du diamètre intérieur de ladite buse d'évacuation en partie haute (13).

4. Epurateur selon l'une quelconque des revendications 1 à 3, dans lequel lesdits moyens de la buse de fond délimitant un orifice de refus comprennent une plaque sensiblement plane (38, 138) présentant une surface principale généralement perpendiculaire à ladite buse en partie haute (13), et qui possède un diamètre extérieur (42) égal au diamètre intérieur de ladite paroi latérale en ce point le long dudit corps.

5. Epurateur selon la revendication 4, dans lequel ladite plaque (38, 138) présente un diamètre extérieur (42) en gros de 30 mm, et ledit orifice (44, 144) dans celle-ci possède un diamètre de 11 mm en gros, et ladite buse d'évacuation en partie haute (13) présente un diamètre intérieur (13') sensiblement de 30 mm.

6. Epurateur selon l'une quelconque des revendications 1 à 5, dans lequel ladite buse d'admission (11) inclut des moyens délimitant un orifice d'admission non-circulaire dont aucune portion n'entrecroise ladite buse en partie haute (13) de façon à apporter un débit augmenté.

7. Epurateur selon la revendication 6, dans lequel ledit orifice (24) de la buse d'admission (11) présente une forme sensiblement en "D", un prolongement de la branche droite (25) du "D" coïncidant sensiblement avec la surface extérieure de ladite buse en partie haute (13).

8. Epurateur selon l'une quelconque des revendications 1 à 7, dans lequel ladite paroi latérale du corps comprend : une partie supérieure (30) conique qui s'étend au-delà du fond de ladite buse en partie haute; des moyens (32) pour augmenter significativement le temps de séjour à l'intérieur dudit épurateur (10), comprenant une portion centrale en général cylindrique (32) de ladite paroi latérale; et une partie de fond conique (31) de ladite paroi latérale, ladite buse de fond (38, 41) étant disposée en association opérationnelle avec ladite partie de fond (31).

9. Epurateur selon l'une quelconque des revendications 1 à 8, caractérisé en ce que ladite paroi latérale du corps comprend : une partie supérieure (30) qui est conique et qui s'étend au-delà du fond de ladite buse en partie haute (13); des moyens (32) pour augmenter de façon significative le temps de séjour à l'intérieur dudit épurateur (10) comprenant une portion centrale en général cylindrique (32) de ladite paroi latérale; et une partie de fond conique (31) de ladite paroi latérale, ladite buse de fond (38, 138) étant disposée en association opérationnelle avec ladite partie de fond (31).

10. Epurateur selon l'une quelconque des revendications 1 à 9, dans lequel ladite paroi latérale du corps inclut : une partie supérieure (130) conique qui s'étend au-delà du fond de ladite buse en partie haute (13); et au lieu dudit moyen de restriction d'écoulement (a), (b) ou (c), on prévoit des moyens qui augmentent le temps de séjour des particules (d) comprenant des moyens (32) pour augmenter le temps de séjour de façon significative à l'intérieur dudit épurateur réalisé par une partie centrale en général cylindrique (32) de ladite paroi latérale : on prévoit également une partie de fond conique (31) de ladite paroi latérale, et ladite buse de fond (38, 138) est disposée en association opérationnelle avec ladite partie de fond (31).

11. Epurateur centrifuge selon l'une quelconque des revendications 1 à 10, dans lequel lesdits moyens pour délimiter un orifice de refus dans ladite buse de fond sont tels qu'ils apportent un quotient d'épuration de l'épurateur supé-

Dyson Ex1020
Page 1101

rieur à 0,5, et une valeur de performance de refus en poids inférieure à 5%, pour une composition classique de pâte à papier.

Dyson Ex1020
Page 1102

FIG.1

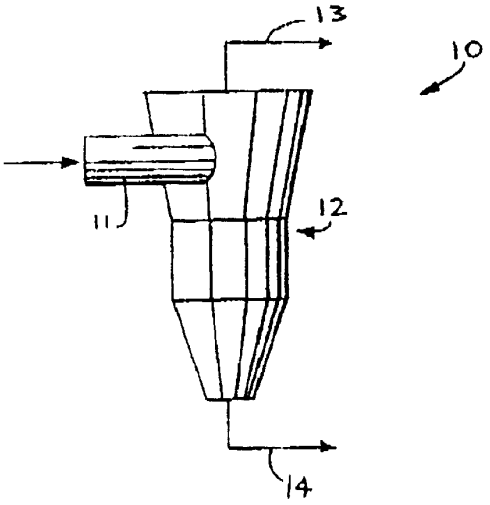
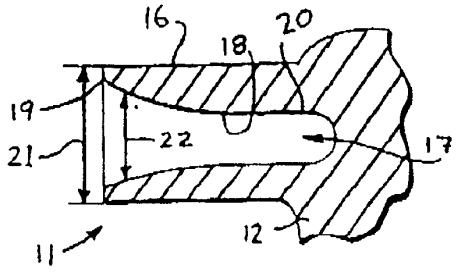


FIG.2



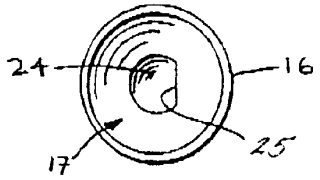


FIG.4

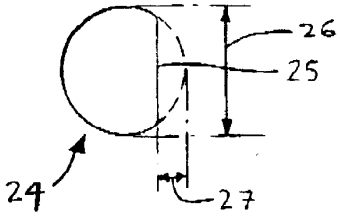


FIG.3

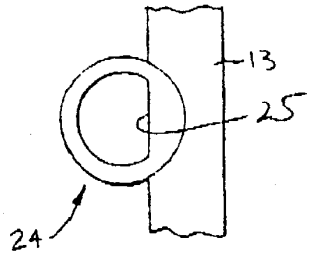
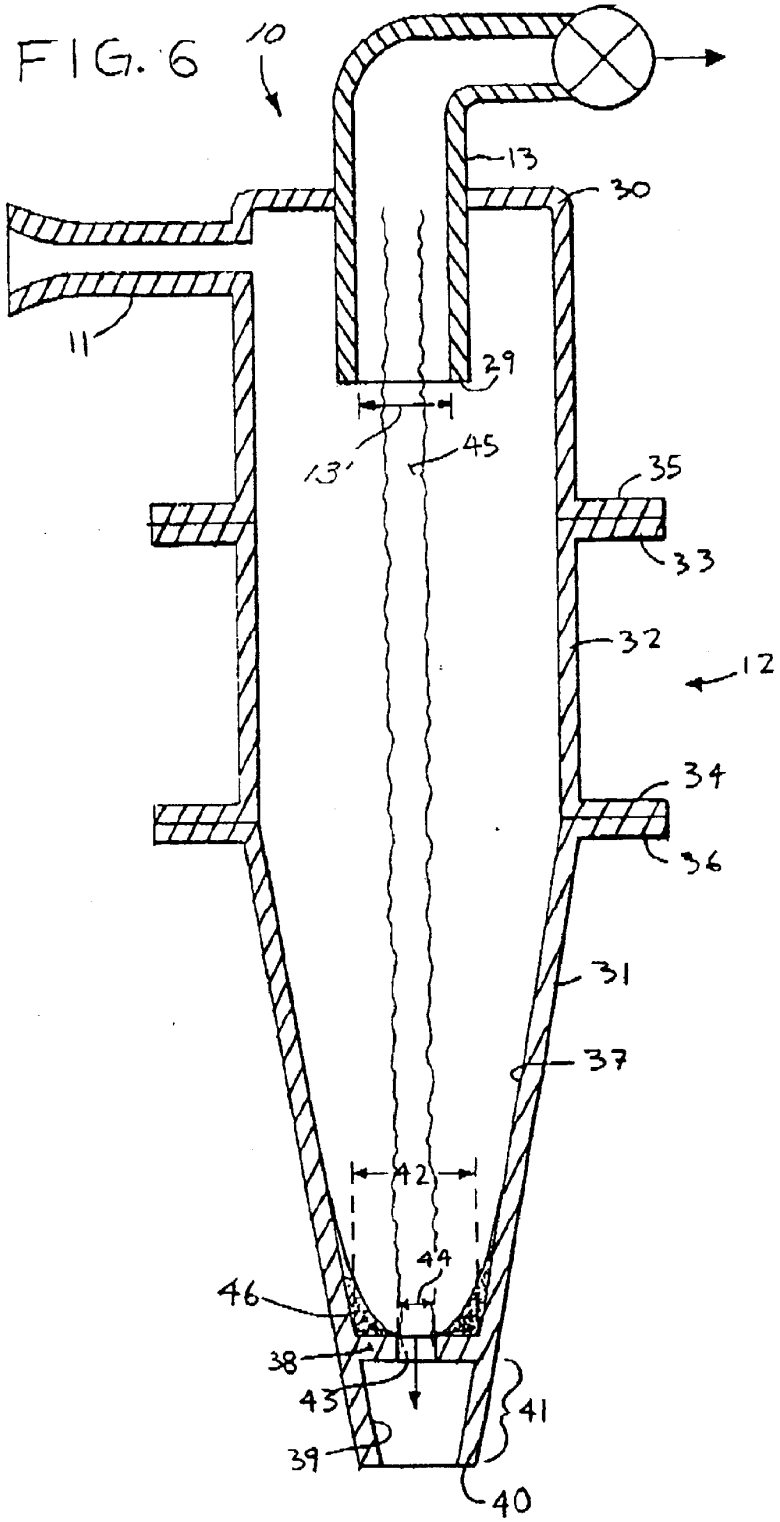


FIG.5

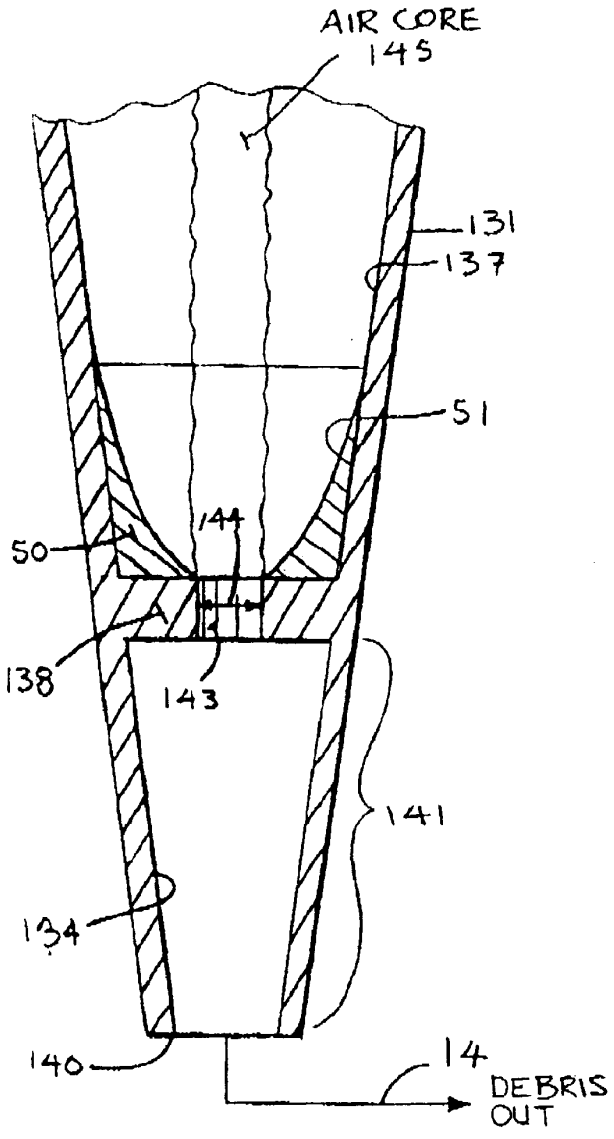
Dyson Ex1020
Page 1103

FIG. 6



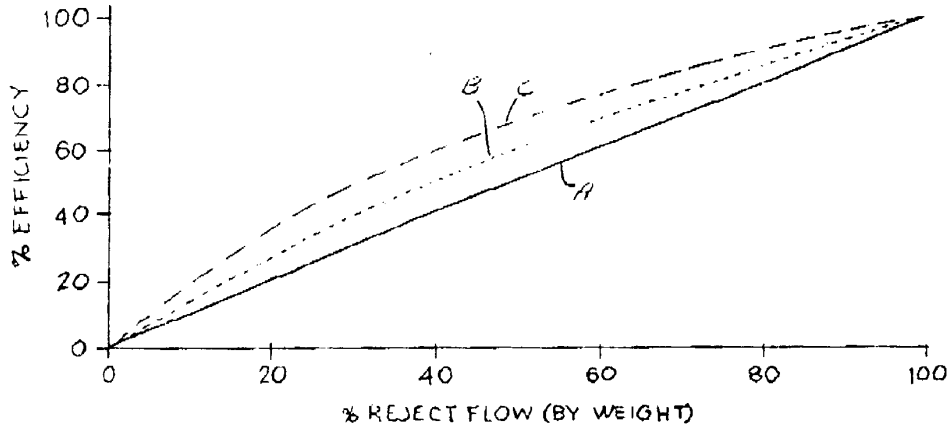
Dyson Ex1020
Page 1104

FIG. 7



Dyson Ex1020
Page 1105

FIG. 8



Dyson Ex1020
Page 1106

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(54) **Dust collection assembly and vacuum cleaner with the same**

System zum Auffangen von Staub und Staubsauger mit demselben

Système collecteur de la poussière et aspirateur avec le même

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EP 1 676 516 B1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a vacuum cleaner, and more particularly, to a dust collection assembly for a vacuum cleaner according to the preamble portion of claim 1 capable of improving dust collecting efficiency by serially installing the first dust collecting member and the second dust collecting member for filtering foreign objects contained in air and being simply manufactured.

Description of the Related Art

[0002] A vacuum cleaner is used to clean a room or other spaces by sucking air containing foreign objects and filtering the foreign object using vacuum pressure generated therein.

[0003] In the meantime, the vacuum cleaner has a dust collecting unit of a predetermined shape mounted within the vacuum cleaner and a filtering device installed in the dust collecting unit, for filtering foreign objects in order to filter foreign objects in sucked air.

[0004] The typical filter is formed of porous material so that the foreign objects are filtered while the air containing the foreign objects passes through the filter.

[0005] However, since it is inconvenient to reuse the filter formed of the porous material and it is difficult to clean the filter, in recent years, a cyclone unit has been widely used. However, the cyclone unit has a problem in that it cannot filter micro-scale foreign objects. Therefore, an additional porous filter formed of the porous material has been associated with the cyclone unit.

[0006] However, when the porous filter is combined with the cyclone unit, the problem of periodically cleaning the filter still remains. When the foreign objects are implanted in the porous filter, an airflow rate is reduced, thereby deteriorating the operational efficiency of the vacuum cleaner.

[0007] To solve above problems, a solution in which a plurality of cyclones are produced in the inside of a single dust collecting unit instead of using a porous filter in the inside of the dust collecting unit to allow even fine dusts to be completely filtered, has been suggested recently. Such a dust collecting unit may be called a multi-cyclone dust collecting unit.

[0008] In the meantime, since airflow is switched to several directions to produce a plurality of cyclones in the inside of the dust collecting, the inner structure of the multi-cyclone dust collecting unit is complicated. Therefore, it is general that a plurality of parts are coupled to each other to manufacture the multi-cyclone dust collecting unit.

[0009] However, when the dust collecting unit is manufactured by a process of assembling a plurality of parts, the possibility that defect occurs in the finished product increases as much as that and a labor of an operator increases.

[0010] DE 20109699 U1 discloses a dust collection assembly for a vacuum cleaner with the features of the preamble portion of claim 1.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is to provide a dust collection assembly for a vacuum cleaner having simple construction by optimizing arrangement of cyclone flow to simplify a dust collection assembly.

[0012] A further aspect of the present invention is to provide a dust collection assembly of a vacuum cleaner capable of reducing manufacturing cost and enhancing convenience in an assembling process by reducing the number of parts constituting a dust collection assembly and making coupling between the parts convenient.

[0013] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a dust collection assembly for a vacuum cleaner as defined in claim 1 and a vacuum cleaner as defined in claim 13. Preferred embodiments of the dust collection assembly are defined in the dependent claims.

[0014] According to the present invention, filtering performance of the vacuum cleaner improves. Also, the manufacturing process of the dust collecting unit is performed more conveniently and the construction of the dust collection assembly is simple, so that the manufacturing costs reduces and convenience in the assembling process is enhanced.

[0015] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0017] FIG. 1 is a perspective view of an appearance of a dust collection assembly of a vacuum cleaner ac-

Dyson Ex1020
Page 1108

cording to the present invention;

[0018] FIG. 2 is an exploded perspective view of a dust collection assembly of a vacuum cleaner according to the present invention;

[0019] FIG. 3 is a perspective view of the backside of an exhaust guider in a dust collection assembly of a vacuum cleaner according to the present invention;

[0020] FIG. 4 is a vertical sectional view of a dust collection assembly of a vacuum cleaner according to the present invention; and

[0021] FIG. 5 is a sectional view illustrating foreign objects discharged in a dust collection assembly of a vacuum cleaner according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0023] A dust collection assembly filters and collects foreign objects contained in sucked air. The dust collection assembly can be applied to any type vacuum cleaner regardless of a shape of a vacuum cleaner. For example, the dust collection assembly can be mounted in all types of cleaners including a canister type and a upright type, and applied at least to all types of vacuum cleaners for sucking air and separating foreign objects contained in the sucked air using cyclone airflow produced therein.

[0024] FIG. 1 is a perspective view of an appearance of a dust collection assembly of a vacuum cleaner according to the present invention, FIG. 2 is an exploded perspective view of a dust collection assembly of a vacuum cleaner according to the present invention, FIG. 3 is a perspective view of the backside of an exhaust guider in a dust collection assembly of a vacuum cleaner according to the present invention, and FIG. 4 is a vertical sectional view of a dust collection assembly of a vacuum cleaner according to the present invention.

[0025] As illustrated in the drawings, the dust collection assembly 100 of the present invention includes a dust collecting box 110 having a shape of two overlapped cylinders to form an appearance.

[0026] The dust collecting box 110 is partitioned into two spaces to form the first dust collecting space 110' and the second dust collecting space 110" . The first and second dust collecting spaces 110' and 110" are serially formed side by side. The first dust collecting space 110' is a part within which the first dust collecting member described later is installed and the second dust collecting space 110" is a part within which the second dust collecting member described later is installed.

[0027] The inside of the first dust collecting space 110' has a cylindrical shape. That is, a partition wall 110a partitioning the dust collecting space into the first dust collecting space 110' and the second dust collecting space 110" is formed in the inside of the dust collecting box 110. The partition wall 110a is rounded toward the second dust collecting space 110". Therefore, the cross-section of the first dust collecting space 110' has a circular shape. Also, a flow guide unit 150 described later is integrally formed in the vicinity of the upper end of the dust collecting box 110.

[0028] A suction guide 112 is formed in the dust collecting box 110, particularly, at the upper end on one side of the dust collecting box 110 forming the first dust collecting space 110'. The suction guide 112 has one end protruded to the outside of the dust collecting box 110 to allow air flowing into the dust collecting box 110 to flow to a tangential direction along the inner wall of the dust collecting box 110. Therefore, the suction guide 112 has a predetermined portion inclined in the outer surface of the dust collecting box 110.

[0029] The dust collecting box 110 has a knob 114 formed on a side thereof. The knob 114 is intended for allowing a user to easily grasp the dust collecting box 110 and protruded from the side portion of the dust collecting box 110.

[0030] The dust collecting box 110 has a fastening hinge 116 formed at a lower end on one side thereof. The fastening hinge 116 is a portion to which a lower cover 130 described below is rotatably fastened and may subside a predetermined extent toward the dust collecting box 110.

[0031] The dust collecting box 110 has an upper cover 120 formed on an upper side thereof, for forming an upper appearance. The upper cover 120 is formed in a shape that corresponds to the upper end of the dust collecting box 110 and may be detachably installed in the upper end of the dust collecting box 110. The upper cover 120 has an exhaust guide 122. The exhaust guide 122 is protruded to the upper side of the upper cover 120 to guide a discharge of the air filtered by the first and second dust collecting members.

[0032] The lower surface of the dust collecting box 110 is shielded by the lower cover 130. The lower cover 130 is detachably installed and formed in a shape that corresponds to the lower end of the dust collecting box 110 to simultaneously open/close the first and second dust collecting spaces 110' and 110" .

[0033] The lower cover 130 is rotatably installed by the fastening hinge provided in the dust collecting box 110. That is, the right end of the lower cover 130 is hinge-coupled to the fastening hinge 116 and the left end is selectively coupled to the lower end of the dust collecting box 110 by a fastening mechanism (not shown).

[0034] Also, the upper cover 120 has an exhaust guider 140 formed in the lower side thereof. The exhaust guider 140 has a shape that corresponds to the upper cover 120 and vertically partitions the upper space of the dust collecting box 110. An exhaust path 142 is formed between the upper cover 120 and the exhaust guider 140. That is, since the exhaust guider 140 is spaced downward a predetermined distance from the upper cover 120, a space of a predetermined size is formed between the exhaust guider 140 and the upper cover 120 to constitute the exhaust path 142.

Dyson Ex1020
Page 1109

[0035] The exhaust guider 140 has a plurality of discharge holes 143. That is, the plurality of discharge holes 143 vertically pass through the exhaust guider 140. The air filtered by small cyclones 160 described later flows to the upper side of the exhaust guider 140 through the discharge holes 143.

[0036] Discharge guide pipes 144 are further formed in the lower portion of the discharge holes 143 of the exhaust guider 140. Referring to FIG. 3, the discharge guide pipe 144 has a cylindrical shape and is protruded in a predetermined length to the lower side of the discharge holes 143. The discharge guide pipe 144 is disposed within the small cyclones 160. Therefore, the discharge guide pipes 144 allow the filtered air to pass through the exhaust guider 140 and flow into the exhaust path 142.

[0037] A blocking wall 146 is formed at the left and right on the upper surface of the exhaust guider 140. The blocking wall 146 is formed back and forth to guide airflow and consists of a left blocking wall 146' formed to the left and a right blocking wall 146" formed to the right. The left blocking wall 146' is disposed to the left of the plurality of discharge guide pipes 144 to allow the air guided upward through the discharge guide pipes 144 not to flow to the left any more.

[0038] The right blocking wall 146" is intended for allowing the air guided upward through the discharge guide pipes 144 not to flow to the right any more. The right blocking wall 146" further includes a semicircular groove 146" a. The semicircular groove 146" a is formed in a shape that corresponds to the lower end of the exhaust guide 122 to allow the air from the exhaust path 142 to easily flow toward the exhaust guide 122.

[0039] Also, the exhaust guider 140 has screw through holes 148 through which screws pass. The screw through holes 148 may be formed at left/right and back/forth of the exhaust guider 140, respectively. The exhaust guider 140 is fastened to the upper cover 120 by the screws.

[0040] The exhaust guider 140 has a flow guide unit 150 formed in a lower side thereof, for guiding airflow. The flow guide unit 150 is spaced downward a predetermined distance from the exhaust guider 140 and has a shape that corresponds to the exhaust guider 140. Therefore, a closed predetermined space is formed between the exhaust guider 140 and the flow guide unit 150 and airflows through the closed space.

[0041] Referring to FIG. 2, the flow guide unit 150 is integrally formed with the dust collecting box 110. That is, the flow guide unit 150 is integrally formed in the upper end of the dust collecting box 110. The dust collecting box 110 and the flow guide unit 150 may be simultaneously formed by an injection molding. With such a construction, the manufacturing process of the dust collecting unit is performed more simply and conveniently and the manufacturing cost is reduced. Also, since the interval between the two parts disappears, foreign objects do not leak or outside air does not flow in through the interval. Accordingly, dust collecting efficiency improves.

[0042] The injection molding is one of plastic molding processes and mainly used for molding thermoplastic resin. Since the injection molding is well known in the art, detailed description thereof will be omitted.

[0043] The flow guide unit 150 has a plurality of small cyclones 160 serving as the second dust collecting member. The small cyclones 160 are formed in the left portion of the flow guide unit 150 and filter fine dust using centrifugal force created by a rotating current of fluid.

[0044] The small cyclone 160 includes a cylindrical part 162 having a cylindrical shape and a conical part 164 formed in the lower end of the cylindrical part 162 and having a conical shape. The cylindrical part 162 is integrally formed in the flow guide unit 150 and protruded to the upper and lower portions of the flow guide unit 150.

[0045] The conical part 164 extends further downward from the lower end of the cylindrical part 162. The conical part 164 has a structure tapering toward the lower side and has an inner structure vertically passing through.

[0046] An inlet port 166 to which the air that has passed through the first dust collecting member flows is formed, in a passing through manner, at the upper side end of the cylindrical part 162 of the small cyclone 160. That is, the inlet port 166 is formed at the upper side end of the cylindrical part 162 protruded above the flow guide unit 150, preferably at a portion in which an inlet pipe 152 described later is disposed.

[0047] The inlet port 166 has a suction guide piece 168 protruded outward, for guiding airflow. The suction guide piece 168 may be formed at left and right of the inlet port 166 or may be formed on only one side of the inlet port 166 to face the inlet pipe 152.

[0048] A discharge guide pipe 144 formed in the exhaust guider 140 is disposed in the inside of the cylindrical part 162 of the small cyclones 160. Therefore, the air that has flowed downward by the small cyclone 160 is guided by the discharge guide pipe 144 and discharged to the upper side of the exhaust guider 140.

[0049] The inlet pipe 152 having a predetermined diameter is integrally formed at the right portion of the flow guide unit 150. The flow guide unit 150 is protruded a predetermined length below the flow guide unit 150 to guide the air that has passed through the first dust collecting member to the upper side of the flow guide unit 150.

[0050] The flow guide unit 150 further has a flow guide 154 formed on an upper side thereof. The flow guide 154 is protruded upward from the upper surface of the flow guide unit 150 to block dusts and foreign objects so that the air guided to the upper side of the flow guide unit 150 through the inlet pipe 152 and containing dusts may efficiently move to the direction of the inlet port 166 of the small cyclones 160 without being distributed over the entire portion of the flow guide unit 150. Therefore, the flow guide 154 has an about '>' shape when seen from the upper direction and is formed to enclose the upper right side of the inlet pipe 152.

[0051] The flow guide unit 150 further has screw fas-

Dyson Ex1020
Page 1110

tening parts 156. The screw fastening parts 156 are portions into which screws are fastened and formed at the back/forth and the left/right of the flow guide unit 150, i.e., the positions that correspond to the screw through holes 148 of the exhaust guider 140. Therefore, when one screw passes through and is fastened to the screw fastening part 156 and the screw fastening hole 148, the exhaust guider 140 and the upper cover 120 are coupled to the flow guide unit 150.

[0052] In the meantime, a sealing member for preventing air leakage is further provided between the upper cover 120 and the exhaust guider 140, and the exhaust guider 140 and the flow guide unit 150. The sealing member may be formed of an elastic material.

[0053] A filter member 170 is installed in a right lower side of the flow guide unit 150. The filter member 170 constitutes the first dust collecting member and primarily filters foreign objects contained in the air flowing from the suction guide 112 of the dust collecting box 110. The filter member 170 has a cylindrical shape and has a plurality of air holes 172. Therefore, the filter member 170 may be formed of an injection-molded material having a plurality of air holes.

[0054] The air holes 172 have a predetermined diameter to allow only foreign objects smaller than air to be selectively filtered. That is, foreign objects larger than the air cannot pass through the air holes 172 but fall downward.

[0055] The air holes 172 may not be formed in the portion against which the air flowing through the suction guide 112 directly collides. That is, the air holes 172 may not be formed in the portion to which the air flows so that the air flowing to a tangential direction along the inner wall surface of the dust collecting box 110 through the suction guide 112 may not go out through the air holes 172 before rotating.

[0056] The filter member 170 is disposed at the center of the first dust collecting member 110' and detachably mounted on the backside of the flow guide unit 150. Therefore, the inlet pipe 152 formed in the flow guide unit 150 is disposed in the upper inner side of the filter member 170.

[0057] A separation plate 174 is disposed at the lower end of the filter member 170. The separation plate 174 vertically partitions the first dust collecting space 110' to prevent the foreign objects that has fallen downward from scattering again upward.

[0058] A foreign object passing hole 174' is formed at both ends of the separation plate 174 to vertically pass through the separation plate 174. Therefore, the foreign objects in the upper portion fall down through the foreign object passing holes 174'. That is, after the foreign objects contained in the air that has flowed into the inside through the suction guide 112 is filtered by the filter member 170, the foreign objects fall down along the inner wall surface of the dust collecting box 110 while rotating, fall down through the foreign object passing holes 174' to the lower portion, and are accumulated on the lower cover 130.

[0059] A plurality of fastening ribs 176 are provided at the upper end of the filter member 170. The fastening ribs 176 allow the filter member 170 to be detachably mounted on the flow guide unit 150. Therefore, though not shown, fixing ribs at which the fastening ribs 176 are hooked and fixed are further formed on the backside of the flow guide unit 150.

[0060] Operation of the dust collection assembly will be described below with reference to FIGs. 4 and 5.

[0061] Though not shown, when the vacuum cleaner operates, outside air containing foreign objects is sucked through a sucking nozzle and the sucked air containing the foreign objects flows into the first dust collecting space 110' of the dust collecting box 110 through the suction guide 112.

[0062] Since the suction guide 112 extends and protrudes to the tangential direction of the dust collecting box 110, the air containing foreign objects that has flowed through the suction guide 112 rotates spirally in the inside of the first dust collecting space 110' of the dust collecting box 110. During the spiral rotation of the air, large foreign objects fall down through the foreign object passing holes 174' and the air containing micro-foreign objects flows into the inside of the filter member 170 through the air holes 172 of the filter member 170.

[0063] During the process where the air passes through the air holes 172 of the filter member 170, the large foreign objects 'd' contained in the air are primarily filtered and the air that has passed through the air holes 172 moves to the upper side of the flow guide unit 150 through the inlet pipe 152.

[0064] The air that has moved to the upper side of the flow guide unit 150 flows to the left where suction force is produced and flows into the small cyclones 160. At this point, the air is guided by the suction guide piece 168 of the small cyclones 160 and flows into the inside of the cylindrical part 162 of the small cyclone 160 through the inlet port 166.

[0065] Since the air that has flowed into the inside of the cylindrical part 162 is supplied to the tangential direction along the sidewall of the cylindrical part 162, the air falls down, circling along the inner wall of the cylindrical part 162. The air moves to the conical part 164 and continues to circle, falling down and reaching to the bottom of the conical part 164.

[0066] The air that has reached to the bottom of the conical part 164 is inverted in its center and moves upward. That is, when the air circles and falls down along the inner wall of the conical part 164, an ascending current is produced at the center and the ascending current moves to the exhaust path 142 formed in the upper side of the exhaust guider 140 through the discharge guide pipes 144.

[0067] In the meantime, micro-foreign objects 'd" such as dust particles contained in the air circle and move radially by centrifugal force and are filtered from the air to gather on the wall surface of the conical part 164 and

Dyson Ex1020
Page 1111

fall down spirally, and is discharged to the lower portion through the lower end (apex) of the conical part 164 and accumulated on the lower cover 130.

[0068] The air guided upward through the discharge guide pipes 144 gathers in the exhaust path 142 and the air in the exhaust path 142 is discharged to the upper outside through the exhaust guide 122 of the upper cover 120.

[0069] Next, to remove the dust accumulated on the lower cover 130, the lower cover 130 should be opened, which is illustrated in FIG. 5.

[0070] At this point, a fastening mechanism (not shown) provided at the left end of the lower cover 130 is released so that the lower cover may be opened. The lower cover 130 pivots downward at a fastening hinge 116 disposed at the right end to discharge downward the foreign objects 'd' and 'd" accumulated on the lower cover 130.

[0071] In the meantime, the foreign objects (dusts) are partially attached and accumulated on the separation plate 174. The foreign objects can be removed after the filter member 170 is separated from the flow guide unit 150.

[0072] In detail, the filter member 170 can be separated by rotation. That is, since the fastening ribs 176 of the filter member 170 are hooked at the fixing ribs (not shown) of the flow guide unit 150, the fastening ribs 176 are detached from the fixing ribs by rotating the filter member 170 in one direction and thus the filter member 170 is separated.

[0073] When the filter member 170 is separated, it is possible to wash the filter member 170 using water. That is, since the filter member 170 is made of an injection-molded material, it is possible to remove the foreign objects in the air holes 172 and the foreign objects attached on the separation plate 174 using water.

[0074] Also, since the flow guide unit 150 and the dust collecting box 110 are integrally formed, the exhaust guider 140 and the upper cover 120 are separated from the flow guide unit 150 in order to separate the exhaust guider 140 and the upper cover 120 from the dust collecting box 110. That is, since the upper cover 120 and the exhaust guider 140 are coupled with the flow guide unit 150 by a single screw to constitute one assembly, the upper cover 120 and the exhaust guider 140 are simultaneously separated by releasing the screws (not shown) fastened to the screw fastening parts 156 of the flow guide unit 150.

[0075] In the meantime, the flow guide unit 150 is formed as one body in the dust collecting box 110. Further, other elements integrally formed in the flow guide unit 150 are simultaneously formed during the manufacturing process of the dust collecting box 110. In detail, the small cyclones 160 in which cyclone airflows of small diameters are produced, the suction guide piece 168 for guiding the sucked air to the small cyclones 160, and the flow guide 154 for guiding the air discharged from the inlet pipe 152 to the small cyclones 160, are formed at a time while the dust collecting box 110 is formed.

[0076] Though the second dust collecting member is provided to the left side of the first dust collecting member in the above embodiment, the second dust collecting member may be disposed to the right or the back/forth of the first dust collecting member, of course. Further, the second dust collecting member may not be concentrated on one side but divided and scattered around the first dust collecting member.

[0077] Also, though the filter member 170 consists of the injection-molded material having the plurality of air holes 172 in the above embodiment, other molding methods or a filter member 170 having other construction can be readily applied as far as the function of filtering the foreign objects is provided. That is, a variety of filters having the function of filtering the foreign objects contained in the air, such as a general bent filter having a wrinkled shape or a multi-filter having a plurality of layers can be used. Also, the material of the filter can be modified in various ways.

[0078] Also, the exhaust guider 140 and the upper cover 120 are fastened to the flow guide unit 150 by a screw in the above embodiment, but it is also possible to fasten the upper cover 120, the exhaust guider 140, and the flow guide unit 150 using other fastening member other than the screw.

[0079] According to the dust collection assembly, since the first dust collecting member for primarily filtering the foreign objects contained in the air and the second dust collecting member for secondarily filtering the foreign objects contained in the air are serially provided in plurality when seen from the airflow direction, the foreign objects contained in the air can be removed more effectively and the removing efficiency of the foreign objects is enhanced even more.

[0080] Also, according to the present invention, the plurality of discharge guide pipes are integrally formed in the flow guide unit. Therefore, the assembly efficiency improves compared with the case where the discharge guide pipes and the small cyclones are separately installed. Resultantly, since the approximate whole structure of the dust collecting box is completed by the structure such that the flow guide unit and the exhaust guider are separately disposed, the assembling process can be efficiently performed.

[0081] Here, the flow guide unit is disposed on the upper side of the dust collecting box to operate as the passage connection portion between the large-diameter cyclone and the small-diameter cyclone in the inside of the dust collecting box, and the exhaust guider is disposed on the upper side of the flow guide unit to guide the air exhausted after the foreign objects have been completely filtered by the cyclone airflow.

[0082] Also, according to the present invention, the blocking wall and the flow guide for guiding the airflow are integrally formed on the upper surface of the exhaust guider and the flow guide unit. Therefore, the airflow is effectively guided and the airflow path is shortened,

Dyson Ex1020
Page 1112

which prevents deterioration in the suction force of the vacuum cleaner.

[0083] Also, since the dust collecting box and the flow guide unit are integrally formed by the injection molding, job efficiency improves.

[0084] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. A dust collection assembly for a vacuum cleaner comprising
a dust collecting box (110) having a plurality of partitioned dust collecting spaces (110',110") for storing foreign objects filtered by cyclone airflow, said dust collecting spaces (110',110") comprising a first dust collecting space (110') for collecting at least large foreign objects and a second dust collecting space (110") for collecting small foreign objects,
a flow guide unit (150) disposed on an upper side of the dust collecting box (110), for guiding airflow between the dust collecting spaces (110',110"),
an exhaust guider (140) spaced a predetermined interval above the flow guide unit (150), for guiding foreign object-free air discharged from the flow guide unit (150), and
a cover (120) disposed on an upper side of the exhaust guider (140),
characterized in that said dust collecting box (110) and said flow guide unit (150) are integrally formed as one body.

2. The dust collection assembly according to claim 1, wherein the flow guide unit (150) in the section covering the upper side of the second dust collecting space (110") has a plurality of small cyclones (160) extending downward, for producing cyclone airflow.

3. The dust collection assembly according to claim 2, wherein the small cyclones (160) are arranged adjacent the first dust collecting space (110').

4. The dust collection assembly according to claim 2 or 3, wherein the exhaust guider (140) has discharge guide pipes (144) provided on a lower portion thereof and extending to inner spaces of the small cyclones (160).

5. The dust collection assembly according to claim 4, wherein the discharge guide pipes (144) are integrally formed with the exhaust guider (140).

6. The dust collection assembly according to one of claims 2 through 5, wherein the small cyclones (160) have an upper end contacting a lower surface of the exhaust guider (140).

7. The dust collection assembly according to one of claims 2 through 6, wherein the small cyclones (160) are integrally formed with the flow guide unit (150).

8. The dust collection assembly according to one of preceding claims, wherein the flow guide unit (150) in the section covering the upper side of the first dust collecting space (110') has an inlet pipe (152) extending downward, for guiding air in an inside of the dust collecting space (110') in an upward direction.

9. The dust collection assembly according to one of preceding claims, wherein the flow guide unit (150) has a flow guide (154) provided thereon, for guiding air guided to an upper side of the flow guide unit (150) to one direction.

10. The dust collection assembly according to one of the preceding claims, wherein the first dust collecting space (110') is circularly partitioned from the second dust collecting space (110").

11. The dust collection assembly according to one of the preceding claims, wherein the first and second dust collecting spaces (110',110") are partitioned so as to be adjacent each other.

12. The dust collection assembly according to one of the preceding claims, wherein the dust collecting box (110) and the flow guide unit (150) are integrally formed as an injection-moulded body.

13. A vacuum cleaner comprising
a means for generating a sucking force;
a dust collection assembly according to any one of claims 1 through 12 for filtering foreign objects contained in air introduced by the sucking force.

Patentansprüche

1. Staubsammelanordnung für einen Staubsauger, mit einer Staubsammelbox (110) mit mehreren unterteilten Staubsammelräumen (110',110") zum Aufnehmen von durch Zyklonluftströmung gefilterten Fremdkörpern, wobei die Staubsammelräume (110', 110") einen ersten Staubsammelraum (110') zum Sammeln zumindest von großen Fremdkörpern und einen zweiten Staubsammelraum (110") zum Sammeln von kleinen Fremdkörpern umfassen,
einer Strömungsleiteinheit (150), die an einer oberen Seite der Staubsammelbox (110) angeordnet ist, zum Leiten von Luftströmung zwischen den Staubsammelräumen (110',110"),

Dyson Ex1020
Page 1113

einer Auslass-Leiteinrichtung (140), die in einem vorbestimmten Abstand über der Strömungsleiteinheit (150) beabstandet angeordnet ist, zum Leiten von fremdkörperfreier Luft, die aus der Strömungsleiteinheit (150) ausgetragen wird, und
einer Abdeckung (120), die an einer oberen Seite der Auslass-Leiteinrichtung (140) angeordnet ist,
dadurch gekennzeichnet, daß die Staubsammelbox (110) und die Strömungsleiteinheit (150) integral als ein Körper ausgebildet sind.

2. Die Staubsammelanordnung gemäß Anspruch 1, wobei die Strömungsleiteinheit (150) in dem die obere Seite des zweiten Staubsammelraums (110") abdeckenden Abschnitt mehrere kleine Zyklone (160) aufweist, die sich nach unten erstrecken, um Zyklonluftströmung zu erzeugen.

3. Die Staubsammelanordnung gemäß Anspruch 2, wobei die kleinen Zyklone (160) neben dem ersten Staubsammelraum (110') angeordnet sind.

4. Die Staubsammelanordnung gemäß Anspruch 2 oder 3, wobei die Auslass-Leiteinrichtung (140) Austrag-Leitröhren (144) aufweist, die an einem unteren Abschnitt derselben vorgesehen sind und sich zu Innenräumen der kleinen Zyklone (160) erstrecken.

5. Die Staubsammelanordnung gemäß Anspruch 4, wobei die Austrag-Leitröhren (144) integral mit der Auslass-Leiteinrichtung (140) ausgebildet sind.

6. Die Staubsammelanordnung gemäß einem der Ansprüche 2 bis 5, wobei die kleinen Zyklone (160) ein oberes Ende besitzen, das eine untere Oberfläche der Auslass-Leiteinrichtung (140) berührt.

7. Die Staubsammelanordnung gemäß einem der Ansprüche 2 bis 6, wobei die kleinen Zyklone (160) integral mit der Strömungsleiteinheit (150) ausgebildet sind.

8. Die Staubsammelanordnung gemäß einem der vorstehenden Ansprüche, wobei die Strömungsleiteinheit (150) in dem die obere Seite des ersten Staubsammelraums (110') abdeckenden Abschnitt ein Einlassrohr (152) besitzt, das sich nach unten erstreckt, um Luft in einer Innenseite des Staubsammelraums (110') in einer Aufwärtsrichtung zu leiten.

9. Die Staubsammelanordnung gemäß einem der vorstehenden Ansprüche, wobei die Strömungsleiteinheit (150) eine Strömungsführung (154) aufweist, die daran zum Leiten von Luft, die zu einer oberen Seite der Strömungsleiteinheit (150) geleitet wurde, in einer Richtung vorgesehen ist.

10. Die Staubsammelanordnung gemäß einem der vorstehenden Ansprüche, wobei der erste Staubsammelraum (110') kreisförmig von dem zweiten Staubsammelraum (110") abgeteilt ist.

11. Die Staubsammelanordnung gemäß einem der vorstehenden Ansprüche, wobei die ersten und zweiten Staubsammelräume (110',110'') so abgeteilt sind, daß sie nebeneinander liegen.

12. Die Staubsammelanordnung gemäß einem der vorstehenden Ansprüche, wobei die Staubsammelbox (110) und die Strömungsleiteinheit (150) integral als ein spritzgegossener Körper ausgebildet sind.

13. Ein Staubsauger mit
einem Mittel zum Erzeugen einer Saugkraft,
einer Staubsammelanordnung gemäß einem der Ansprüche 1 bis 12 zum Filtern von Fremdkörpern, die in durch die Saugkraft eingeleiteter Luft enthalten sind.

Revendications

1. Ensemble collecteur de poussière pour un aspirateur, comprenant :

une boîte collectrice de poussière (110) ayant une pluralité d'espaces collecteurs de poussière séparés (110', 110") pour stocker des corps étrangers filtrés par le flux d'air cyclonique, lesdits espaces collecteurs de poussière (110', 110") comprenant un premier espace collecteur de poussière (110') pour collecter au moins de gros corps étrangers et un second espace collecteur de poussière (110") pour collecter de petits corps étrangers,
une unité de guidage de flux (150) disposée sur un côté supérieur de la boîte collectrice de poussière (110), pour guider le flux d'air entre les espaces collecteurs de poussière (110', 110''),
un dispositif de guidage d'échappement (140) espacé à un intervalle prédéterminé au-dessus de l'unité de guidage de flux (150), pour guider l'air dépourvu de corps étrangers déchargé par l'unité de guidage de flux (150), et
un couvercle (120) disposé sur un côté supérieur du dispositif de guidage d'échappement (140),

caractérisé en ce que ladite boîte collectrice poussière (110) et ladite unité de guidage de flux (150) sont formées de manière solidaire en un seul corps.

2. Ensemble collecteur de poussière selon la revendication 1, dans lequel l'unité de guidage de flux (150) dans la section recouvrant le côté supérieur du second espace collecteur de poussière (110") a une

Dyson Ex1020
Page 1114

pluralité de petits cyclones (160) s'étendant vers le bas, pour produire le flux d'air cyclonique.

3. Ensemble collecteur de poussière selon la revendication 2, dans lequel les petits cyclones (160) sont agencés de manière adjacente au premier espace collecteur de poussière (110').

4. Ensemble collecteur de poussière selon la revendication 2 ou 3, dans lequel le dispositif de guidage d'échappement (140) a des tuyaux de guidage de décharge (144) prévu sur sa partie inférieure et s'étendant vers les espaces internes des petits cyclones (160).

5. Ensemble collecteur de poussière selon la revendication 4, dans lequel les tuyaux de guidage de décharge (144) sont formés de manière solidaire avec le dispositif de guidage d'échappement (140).

6. Ensemble collecteur de poussière selon l'une quelconque des revendications 2 à 5, dans lequel les petits cyclones (160) ont une extrémité supérieure en contact avec une surface inférieure du dispositif de guidage d'échappement (140).

7. Ensemble collecteur de poussière selon l'une quelconque des revendications 2 à 6, dans lequel les petits cyclones (160) sont formés de manière solidaire avec l'unité de guidage de flux (150).

8. Ensemble collecteur de poussière selon l'une quelconque des revendications précédentes, dans lequel l'unité de guidage de flux (150) dans la section recouvrant le côté supérieur du premier espace collecteur de poussière (110') a un tuyau d'entrée (152) s'étendant vers le bas, pour guider l'air dans un intérieur de l'espace collecteur de poussière (110') dans une direction ascendante.

9. Ensemble collecteur de poussière selon l'une quelconque des revendications précédentes, dans lequel l'unité de guidage de flux (150) a un guide de flux (154) prévu sur celle-ci, pour guider l'air guidé d'un côté supérieur de l'unité de guidage de flux (150) dans une direction.

10. Ensemble collecteur de poussière selon l'une quelconque des revendications précédentes, dans lequel le premier espace collecteur de poussière (110') est séparé de manière circulaire du second espace collecteur de poussière (110").

11. Ensemble collecteur de poussière selon l'une quelconque des revendications précédentes, dans lequel les premier et second espaces collecteurs de poussière (110', 110") sont séparés afin d'être adjacents l'un par rapport à l'autre.

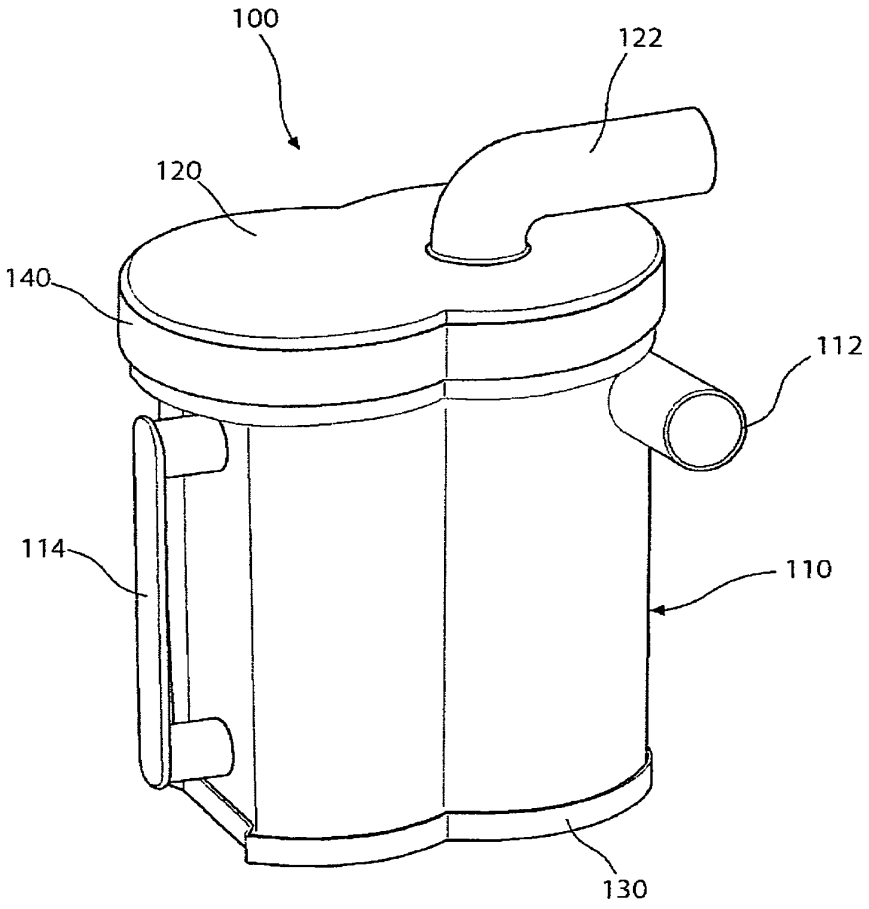
12. Ensemble collecteur de poussière selon l'une quelconque des revendications précédentes, dans lequel la boîte collecteur de poussière (110) et l'unité de guidage de flux (150) sont formées de manière solidaire sous la forme d'un corps moulé par injection.

13. Aspirateur comprenant :

des moyens pour générer une force d'aspiration ;
un ensemble collecteur de poussière selon l'une quelconque des revendications 1 à 12 pour filtrer des corps étrangers contenus dans l'air introduit par la force d'aspiration.

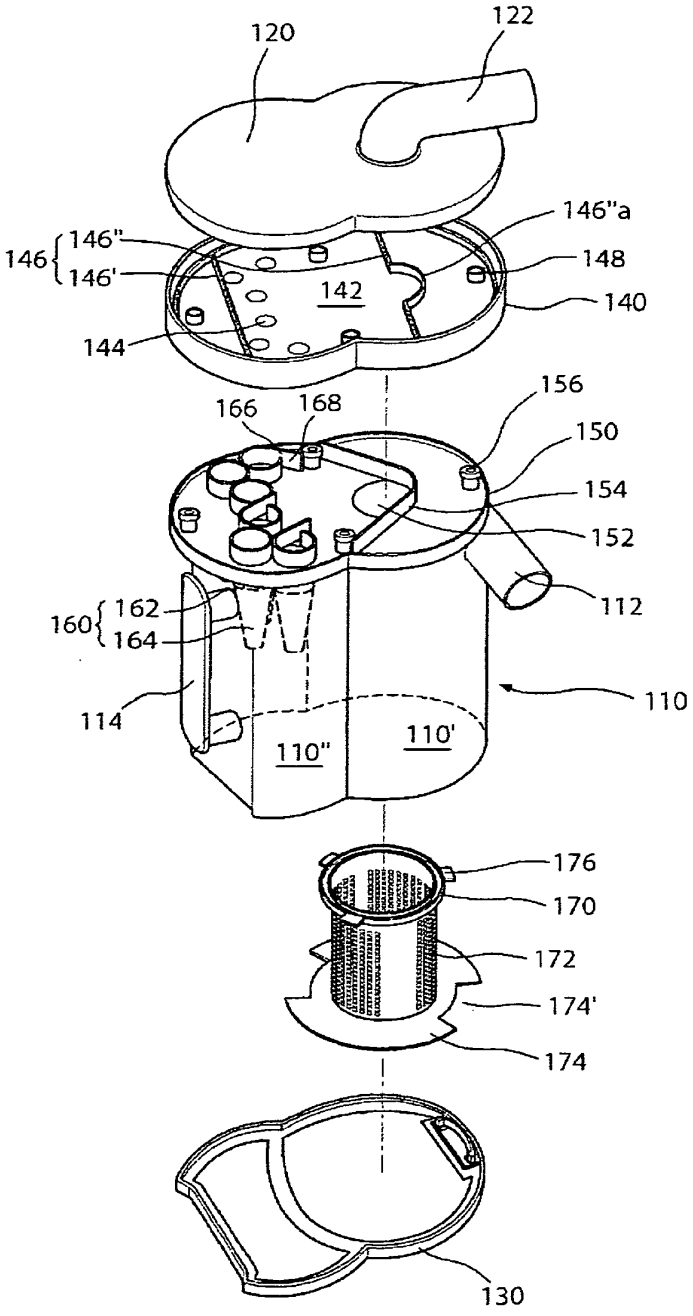
Dyson Ex1020
Page 1115

FIG.1



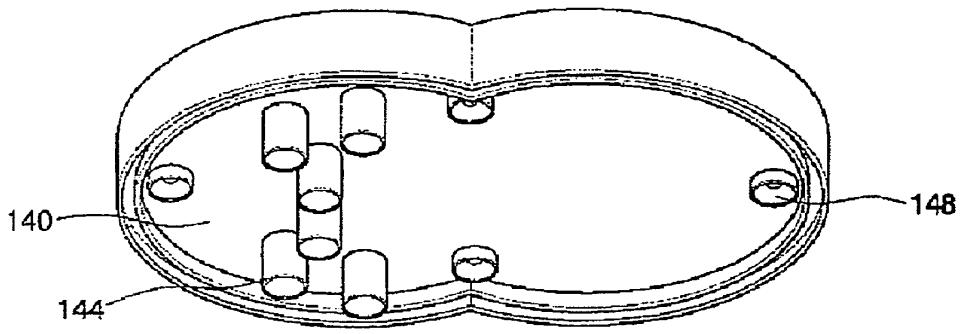
Dyson Ex1020
Page 1116

FIG.2



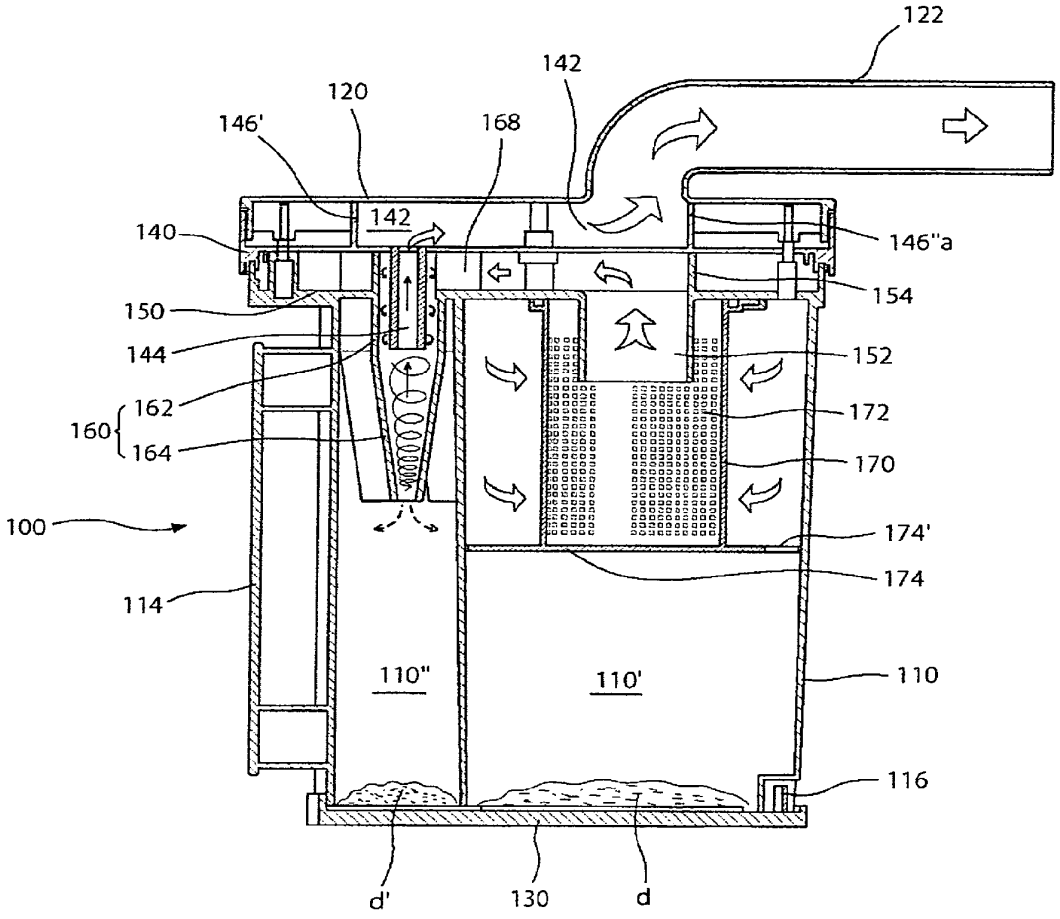
Dyson Ex1020
Page 1117

FIG.3



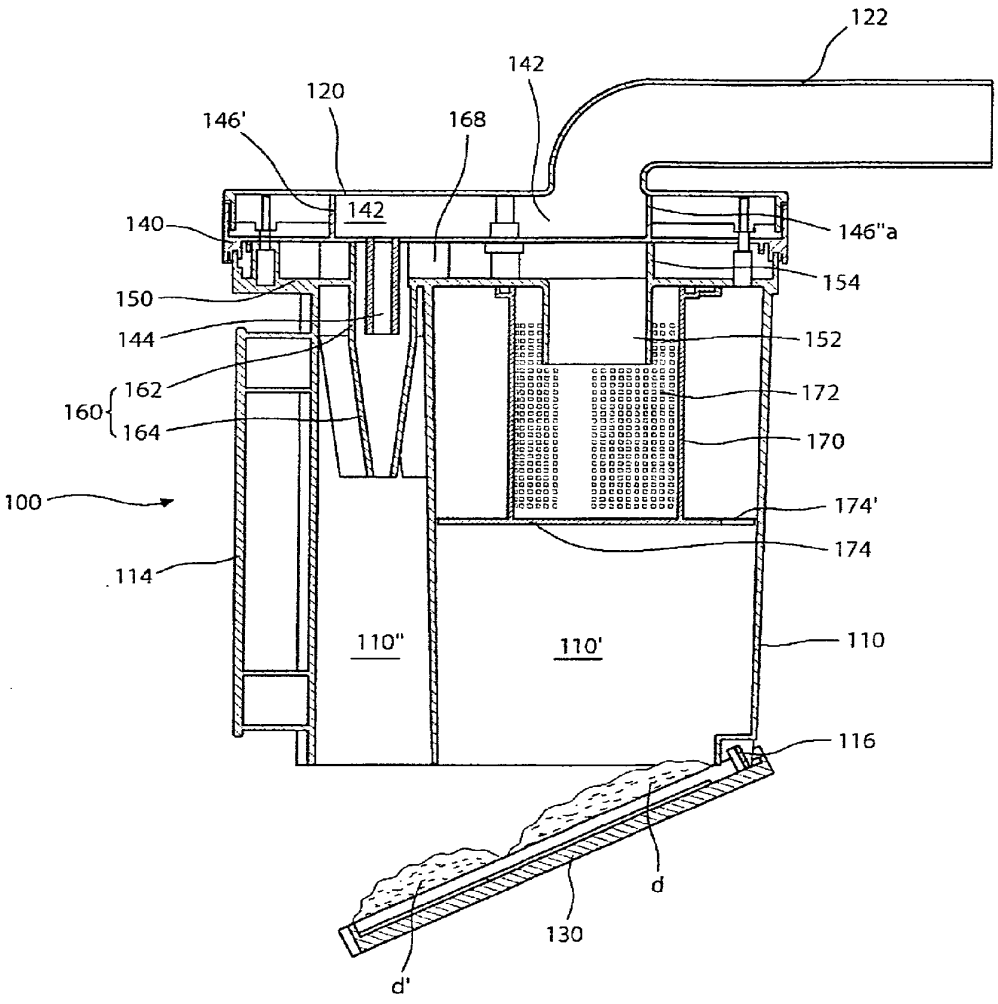
Dyson Ex1020
Page 1118

FIG.4



Dyson Ex1020
Page 1119

FIG.5



Dyson Ex1020
Page 1120

REFERENCES CITED IN THE DESCRIPTION

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Dyson Ex1020
Page 1121

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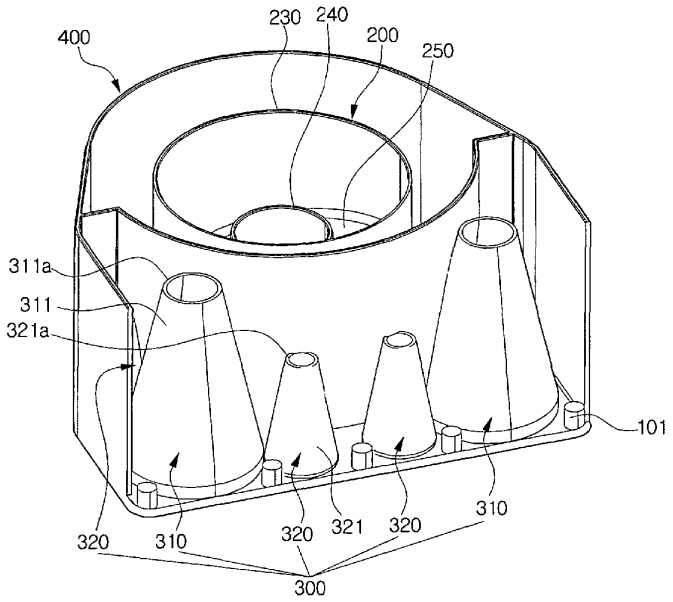
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(54) Multi-cyclone dust separating apparatus

(57) A multi-cyclone dust separating apparatus has a main cyclone (200) comprising one or more cyclones, a sub cyclone (300) comprising one or more cyclones (310,320), and being arranged around a part of the main cyclone (200) in parallel relation, and a dust collecting casing (400) provided to enclose the main (200) and the sub cyclones (300), and collects dust as the dust is separated from the air in the main (200) and the sub cyclones (300). At least a part of the dust collecting casing (400) enclosing the main cyclone (200) is formed in a half-circular shape.

FIG. 5



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EP 1 779 761 A2

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 2005-102613, filed October 28, 2005 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a dust separating apparatus for use in a vacuum cleaner, which draws in air and dust from a surface being cleaned, separates dust from the air and discharges clean air. More particularly, the present invention relates to a multi-cyclone dust separating apparatus, which centrifuges dust from air by plurality of stages.

2. Description of the Related Art

[0003] Various types of dust separating apparatuses have been employed in vacuum cleaners. Among these, a cyclone type dust separating apparatus, which is easy to use and almost permanently usable, is rapidly replacing disposable dust bag or dust filter dust separating apparatuses. FIG. 1 is a perspective view of a canister type vacuum cleaner, which employs a cyclone type dust separating apparatus.

[0004] Referring to FIG. 1, a vacuum cleaner 10 generally includes a cleaner body 11 which is divided into a motor driving chamber 12 where a motor (not shown) is installed, and a cyclone mount chamber 13 where a cyclone dust separating apparatus 30 is installed, a suction nozzle 21, an extension hose 22, and a flexible hose 23. The vacuum cleaner 10 generates suction force by driving the motor (not shown), and draws in dust and air into the cleaner body 11 through the suction nozzle 21, extension hose 22, and flexible hose 23. The vacuum cleaner 10 then separates dust from the drawn-in air using the cyclone dust separating apparatus 30, and collects the separated dust. The clean air is discharged out via the motor driving chamber 12.

[0005] The cyclone dust separating apparatus 30 induces a whirling air current in the drawn-in air, and thus the dust is separated from the air by the centrifugal force of the whirling air. Meanwhile, the general practice is that a cyclone body 31 of the cyclone dust separating apparatus 30 is formed in cylindrical shape, and air inlet 33 and outlet (not shown) are provided near the upper end of the cyclone body 31. The air inlet 33 is in fluid communication with the flexible hose 23 via the inlet port 14, and the air outlet (not shown) is in fluid communication with the motor driving chamber 12 via an outlet port 15. A dustbin 32 is provided to the lower part of the cyclone body 31 to hold dust separated from the air, and is generally formed in a cylindrical shape to correspond to the shape of the cyclone body 31. In other words, a conventional cyclone dust separating apparatus 30 overall has a cylindrical configuration.

[0006] Accordingly, as shown in FIG. 2, a dead space S is generated between the cyclone dust separating apparatus 30 and the cyclone mount chamber 13 housing the cyclone dust separating apparatus 30. In order to corresponding to the shape of the motor, the motor driving chamber 12 is usually square in section, while the adjoined cyclone mount chamber 13 is approximately half circle in section. Because the cyclone dust separating apparatus 30 has cylindrical shape, such different shape of the cyclone mount chamber 13 and the cyclone dust separating apparatus 30 inherently causes one or more dead spaces S therebetween. Meanwhile, the cyclone dust separating apparatus 30 has a limited height to be employed in the cyclone mount chamber 13, and thus, the dustbin 32 has a limited height too. As a result, dust capacity is limited.

[0007] A multi-cyclone dust separating apparatus has recently been introduced, which filters dust by more than two stages and, thus, improves dust collecting efficiency. One example of such multi-cyclone dust separating apparatus is disclosed in WO02/067755 and WO02/067756 to Dyson Ltd. According to the above patents, upstream cyclone as the first cyclone and downstream cyclone as the second cyclone are arranged in vertical arrangement, which requires height of the cyclone dust separating apparatus to extend. This limits the application of the multi-cyclone dust collecting apparatus to upright type vacuum cleaners. In other words, the multi-cyclone dust separating apparatus cannot be efficiently applied to canister type vacuum cleaners for home use. Additionally, as the entire path for air of the cyclone dust collecting apparatus is long, loss of suction force increases.

[0008] In order to overcome such shortcomings of the conventional arts, the same Applicant as the present application has developed a multi-cyclone dust separating apparatus as disclosed in Korean Patent No. 0554237. In the above patent, the multi-cyclone dust separating apparatus is provided with a plurality of second cyclones, which are arranged around the first cyclone. Therefore, the overall height of the multi-cyclone dust separating apparatus decreases, and dust collecting efficiency increases. However, compacter vacuum cleaners are still required.

SUMMARY OF THE INVENTION

[0009] The present invention has been made to overcome the above-mentioned problems of the art, and therefore, it is an object of the present invention to provide an improved multi-cyclone dust separating apparatus capable of utilizing dead spaces in the cleaner body, and increasing dust collecting capacity of a small-size vacuum cleaner.

[0010] It is another object of the present invention to

Dyson Ex1020
Page 1123

provide a multi-cyclone dust separating apparatus which has a compact size, but can provide improved dust collecting efficiency.

[0011] The above aspects and/or other features of the present invention can substantially be achieved by providing a multi-cyclone dust separating apparatus including a main cyclone comprising one or more cyclones, a sub cyclone comprising one or more cyclones, and being arranged around a part of the main cyclone in parallel relation, and a dust collecting casing provided to enclose the main and the sub cyclones, and collects dust as the dust is separated from the air in the main and the sub cyclones. At least a part of the dust collecting casing enclosing the main cyclone may be formed in a half-circular shape.

[0012] At least a part of the dust collecting casing enclosing the sub cyclone may be formed in a square shape with one side open.

[0013] The dust collecting casing comprises a first half-circular wall enclosing the main cyclone, a second wall enclosing the sub cyclone and connecting to one and the other ends of the first half-circular wall, and a third wall connecting the second wall.

[0014] The first half-circular wall may be formed of a transparent material.

[0015] The first, the second and the third walls may be formed integrally with each other.

[0016] The sub cyclone comprises a plurality of cyclone cones of different sizes.

[0017] The plurality of cyclone cones may be arranged along the inner circumference of the second and the third walls in a row.

[0018] The plurality of cyclone cones comprise one or more first cyclone cones, and one or more second cyclone cones in size smaller than the first cyclone cones.

[0019] The first and the second cyclone cones may each be formed in a conical configuration, which has narrower diameter toward the upper end, and the first cyclone cones have the same height as the main cyclone.

[0020] The main cyclone comprises a main air inlet at a lower end through which an external air is drawn, and a main air outlet at a lower end through which the air of the main cyclone is discharged.

[0021] The main air inlet and the main air outlet may be formed on the same plane.

[0022] The first and the second cyclone cones comprise first and second cone inlets at lower ends, through which the air discharged out of the main air outlet is branched off and drawn, with the first and the second cone inlets being formed such that entrance gates thereof being on the same plane.

[0023] The main air outlet of the main cyclone and the first and the second cone inlets of the firs and the second cyclones may be formed on the same plane.

[0024] The dust collecting casing comprises a partition for dividing the dust collecting chamber into a main chamber to collect the separated dust of the main cyclone, and a sub chamber to collect the separated dust of the sub cyclone.

[0025] An upper cover may be further provided for detachably connecting to the upper end of the dust collecting casing.

[0026] Upon mounting to the upper end of the dust collecting casing, the upper cover may form a dust outlet in cooperation with the upper end of the main cyclone, and comprise a backflow preventive member for preventing the dust of the main dust collecting chamber from flowing back into the main cyclone, and a sealing member connecting to the upper end of the partition and isolating the main dust collecting chamber from the sub dust collecting chamber.

[0027] A lower cover unit may be further provided, with being coupled to the lower end of the dust collecting casing to guide the air of the main cyclone into the sub cyclone. The lower cover unit includes an air inlet port for drawing in external air into the main cyclone, and an air outlet port for discharging the air of the sub cyclone to the outside.

[0028] According to one aspect of the present invention, a multi-cyclone dust separating apparatus includes a main cyclone for drawing in external air and separating dust from the drawn air using centrifugal force, the main cyclone comprising one or more cyclones, and a sub cyclone for drawing in the air discharged from the main cyclone and separating minute dust using centrifugal force. The sub cyclone comprises a plurality of cyclones, and at least one of the plurality of cyclones of the sub cyclone may have different size from the others.

[0029] Said one or more cyclones of the main cyclone and said one or more cyclones of the sub cyclone draw in the external air through the lower part, discharge dust of the drawn air through the upper part, and then discharge the dust-removed air through the lower part.

[0030] At least one of the cyclones of the sub cyclone may have the uppermost end of smaller diameter than the uppermost ends of the other cyclones.

[0031] At least one of the cyclones of the sub cyclone may be shorter than the others.

[0032] The main cyclone and the sub cyclone may be arranged in parallel, and said one or more cyclones of the main cyclone may be formed in substantially cylindrical configuration, and said one or more cyclones of the sub cyclone may be formed in a substantially conical configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The above aspects and features of the present invention will be more apparent by describing certain embodiments of the present invention with reference to the accompanying drawings, in which:

[0034] FIG. 1 is a perspective view of a vacuum cleaner employing a conventional cyclone dust-separating apparatus;

[0035] FIG. 2 is a schematic top plan view of a body of the vacuum cleaner of FIG. 1;

Dyson Ex1020
Page 1124

[0036] FIG. 3 is a perspective view of a multi-cyclone dust separating apparatus according to an embodiment of the present invention;

[0037] FIG. 4 is an exploded perspective view of the multi-cyclone dust separating apparatus of FIG. 3;

[0038] FIG. 5 is a perspective view showing a cyclone body in a partially-cut dust collecting casing of FIG. 4;

[0039] FIG. 6 is a bottom perspective view of the cyclone body of FIG. 5;

[0040] FIG. 7 is a perspective view of a vacuum cleaner body employing a multi-cyclone dust separating apparatus according to an embodiment of the present invention; and

[0041] FIGS. 8 and 9 are partially-cut views of a multi-cyclone dust separating apparatus to explain the operations according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0042] Certain embodiments of the present invention will be described in greater detail with reference to the accompanying drawings.

[0043] In the following description, same drawing reference numerals are used for the same elements even in different drawings. The matters defined in the description such as a detailed construction and elements are nothing but the ones provided to assist in a comprehensive understanding of the invention. Thus, it is apparent that the present invention can be carried out without those defined matters. Also, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0044] Referring to FIGS. 3 and 4, a multi-cyclone dust separating apparatus 100 includes a cyclone body 110, an upper cover 500, and a lower cover unit 600.

[0045] The cyclone body 110 includes a main cyclone 200, a sub cyclone 300, and a dust collecting casing 400. The main cyclone 200 centrifuges dust from the air drawn from outside. More specifically, the main cyclone 200 filters relatively large dust from the air. The sub cyclone 300 secondly centrifuges dust from the air drawn from the main cyclone 200. That is, the sub cyclone 300 filters relatively minute dust, which is too small to be filtered in the main cyclone 200. The dust collecting casing 400 forms the outer part of the cyclone body 110, and has a dust collecting chamber 450, which collects dust from the main cyclone 200 and the sub cyclone 300.

[0046] Referring to FIGS. 5 and 6, the main cyclone 200 includes a main air inlet 210, a main air outlet 220, and an outer chamber wall 230, which forms the cyclone chamber.

[0047] As shown, the main air inlet 210 and the main air outlet 220 are formed on the lower end of the main cyclone 200. The outer chamber wall 230 takes on a substantially cylindrical configuration to induce whirling air current from the drawn air containing dust, and has a slightly lower height than the dust collecting casing 400. An air outlet pipe 240 is formed approximately at the center of the outer chamber wall 230 and to a predetermined height. The air outlet pipe 240 is in fluid communication with the main air outlet 220. An upwardly inclining spiral air guide 250 is continuously formed along the outer side of the air outlet pipe 240 and along the inner side of the outer chamber wall 230 to induce upwardly moving air from the air drawn through the main air inlet 210. Accordingly, air drawn through the main air inlet 210 is guided along the upwardly inclining spiral air guide 250 to form an upwardly moving current. In this process, dust is separated from the air within the outer chamber wall 230 and the clean air is discharged out via the air outlet pipe 240 and the main air outlet 220.

[0048] As shown, the main cyclone 200 has, at its lower end, the main air inlet 210 and the main air outlet 220 in parallel relation with the main air inlet 210. Both the main air inlet 210 and the main air outlet 220are on the same plane. According to one aspect of the present invention, the main cyclone 200 has the air drawing and discharging structure at its lower end.

[0049] One main cyclone 200 is employed in this particular embodiment of the present invention. However, one will understand that this should not be considered as limiting. For example, two cyclones may well be employed.

[0050] Referring to FIGS. 5 and 6, the sub cyclone 300 is arranged in parallel relation with the main cyclone 200, and includes at least one cyclone cone. It is more preferable to provide a plurality of cyclone cones, and still more preferable to have a plurality of cyclone cones of different sizes. The sub cyclone 300 includes one or more first cyclone cones 310, and one or more second cyclone cones 320. In this particular embodiment, there are two first cyclone cones 310 and four second cyclone cones 320 arranged. The second cyclone cone 320 has a smaller size than the first cyclone cone 310. The 'size' may refer to the height or diameter of the cyclone cone.

[0051] By arranging the first cyclone cones 310 and the second cyclone cones 320 of different sizes, and by properly arranging the first cyclone 310 and the second cyclone 320 according to the size or shape of the allowed space, dust collecting efficiency is improved and maximum space utilization can be provided.

[0052] Although not shown, a third cyclone cone, which is smaller in size than the second cyclone cone 320, may additionally be employed. In this particular embodiment of the present invention, there are four second cyclone cones 320 employed. However, the number of second cyclone cones 320 can be varied according to the shape or size of the dust collecting casing 400. For example, two second cyclone cones 320 and two third cyclone cones may be employed.

[0053] Both the first cyclone cone body 311 and the second cyclone cone body 321 are open at upper and lower ends, and each has the conical configuration, which has a gradually decreasing diameter toward the

Dyson Ex1020
Page 1125

upper end 311a. First and second cone inlets 312 and 322 are formed on lower ends of the first cyclone body 311 and the second cyclone cone body 321, respectively. As shown, the first and the second cone inlets 312 and 322 may be formed on the approximately same plane. The air is discharged from the main air outlet 220 of the main cyclone 200, and distributed to enter through the first and the second cone inlets 312 and 322. The distributed air is drawn into the first and the second cyclone cones 310 and 320, respectively. The drawn air forms a whirling current inside the first and the second cyclone cones 310 and 320, thus shedding dust by the centrifugal force of the whirling air. The separated dust is discharged through the upper ends 311a and 321a of the first and second cyclone cone bodies 311 and 321, and clean air descends and flows out of the first and the second cyclone cones 310 and 320.

[0054] As shown, the first and the second cone inlets 312 and 322 are arranged on the same plane as the main air outlet 220 of the main cyclone 200. Accordingly, the shortest path of the air can be provided from the main cyclone 200 to the first and the second cyclone cones 310 and 320, respectively. As the path of air shortens, loss of suction force can be minimized.

[0055] Referring back to FIG. 4, the dust collecting casing 400 is arranged to surround the main cyclone 200 and the sub cyclone 300. The dust collecting casing 400 has a dust collecting chamber 450 which collects dust which is separated in the main cyclone 200 and the sub cyclone 300. The dust collecting chamber 450 includes a main dust collecting chamber 451 to receive dust which is separated in the main cyclone 200, and a sub dust collecting chamber 452 to receive dust, which is separated in the first and the second cyclone cones 310 and 320 of the sub cyclone 300.

[0056] The dust collecting casing 400 includes a first wall 410 extending around a part of the main cyclone 200 and forming a part of the main dust collecting chamber 451, a pair of second walls 420, and a third wall 430 extending around a part of the sub cyclone 300 and forming a part of the sub dust collecting chamber 452. The second and the third walls 420 and 430 may form an approximately square space therewithin that has one side open.

[0057] The first wall 410 is approximately half circle in section. A handle 460 may be formed on the outer side of the first wall. Each second wall 420 may be connected to an end of the first wall 410, and the third wall 430 may connect the second walls 420 to one another. Accordingly, the length of the third wall 430 is approximately same as the distance between one and the other ends of the first wall 410. The first wall 410, the second walls 420, and the third wall 430 may be formed integrally with each other for the convenience of manufacture.

[0058] The dust collecting casing 400 may include a partition 440 to divide the dust collecting chamber 450 therewithin into the main dust collecting chamber 451 and the sub dust collecting chamber 452. As a result, the main dust collecting chamber 451 is formed by the first wall 410 and the partition 440, and the sub dust collecting chamber 452 is formed by the second walls 420, the third wall 430 and the partition 440.

[0059] The partition 440 is a half circle in section and at a predetermined distance away from the outer chamber wall 230 of the main cyclone 200. Both ends 441 of the partition 440 are partially bent and connected to the first wall 410 for the convenience of assembly and manufacture. The main cyclone 200 filters relatively large particles of dust, while the sub cyclone 300 filters relatively minute particles of dust. Therefore, it is more advantageous to form the main dust collecting chamber 451 larger than the sub dust collecting chamber 452, and the partition 440 is formed to face the third wall 430.

[0060] Referring to FIG. 7, when the multi-cyclone dust separating apparatus 100 is mounted on the vacuum cleaner body 11, the first wall 410 is exposed to the outside. At least the first wall 410 of the dust collecting casing 400 is preferably formed of a transparent material so that the user can observe the interior of the main dust collecting chamber 451 (see FIG. 4) through the first wall 410. As mentioned above, because the main cyclone 200 filters most of dust excluding minute dust, the main dust collecting chamber 451 frequently gets full. Therefore, a user feels convenient as he can check the amount of collected dust without having to separate the multi-cyclone dust separating apparatus 100 from the vacuum cleaner body 11.

[0061] As mentioned above, by the dust collecting casing 400 of half circle section which corresponds to the mount chamber of the vacuum cleaner body 11, and by arranging the main cyclone 200, the sub cyclone 300 and the dust collecting chamber 450 in parallel to each other inside the dust collecting casing, the dust collecting chamber 450 can have improved dust collecting efficiency, and the overall height of the multi-cyclone dust separating apparatus 100 decreases. As shown in FIG. 1, a conventional cyclone dust separating apparatus 30 has a dustbin 32 at the lower end of the cyclone body 31 and thus has a limit in its dust collecting capacity. According to one aspect of the present invention, the dust collecting casing 400 is formed to have a half circle shape in section, thus removing dead spaces S (see FIG. 2) in the dust collecting chamber 13 of the vacuum cleaner body, and the first dust collecting chamber 451 can replace the dead spaces S. Accordingly, while maintaining the size of the vacuum cleaner 11 as designed, the dust collecting capacity of the dust collecting chamber 450, and particularly, the capacity of the first dust collecting chamber 451 increases. Additionally, by arranging the dust collecting chamber 450 in parallel relation with the cyclones 200 and 300, the overall height can reduce, and as a result, compact multi-cyclone dust separating apparatus 100 can be provided. By providing a compact multi-cyclone dust separating apparatus 100, the vacuum cleaner of compact size can be provided.

[0062] Furthermore, by arranging a plurality of first and

Dyson Ex1020
Page 1126

second cyclone cones 320 and 330 of different sizes according to the configuration of the interior space of the dust collecting casing 400, maximum space utilization can be provided and dust collecting efficiency can improve.

[0063] Referring again to FIG. 4, the upper cover 500 is detachably coupled to the upper end of the dust collecting casing 400. To repair the inside of the dust collecting casing 400 or to empty the dust collecting chamber 450, the user is simply required to separate the upper cover 500. Meanwhile, the height of the upper end of the outer chamber wall 230 lower than the height of the upper end of the dust collecting casing 400. Accordingly, when the upper cover 500 is connected to the upper end of the dust collecting casing 400, a dust outlet 510 (see FIG. 8) is defined between the inner side of the upper cover 500 and the upper end of the outer chamber wall 230.

[0064] A backflow preventive member 520 protrudes from the inner side of the upper cover 500 to a predetermined length, to prevent dust collected in the first dust collecting chamber 451 from flowing backward into the outer chamber wall 230. The backflow preventive member 520 has a diameter D1 longer than that D2 of the outer chamber wall 230. Additionally, a sealing member 50 protrudes from the inner side of the upper cover 500 to a predetermined length to sealingly separate the sub dust collecting chamber 452 from the main dust collecting chamber 451.

[0065] The lower cover unit 600 includes a guide cover 610 and a discharge cover 620. The discharge cover 620 is coupled to the lower end of the dust collecting casing 400 by fasteners such as screws, with the guide cover 610 therebetween: For screw coupling, coupling bosses 621 (see FIG. 4) and 101 (see FIG. 5) are formed in the discharge cover 620 and the dust collecting casing 400, and the guide cover 610 has a screw hole 611 to receive screw therein.

[0066] The guide cover 610 has an air suction port 612 in one side, in fluid communication with the main air inlet 210 (see FIG. 6) of the main cyclone 200. The air suction port 612 is in fluid communication with the suction nozzle 21 (see FIG. 1) of the vacuum cleaner 10. The guide cover 610 has, on its other end, an inlet guide path 613 in fluid communication with the main air outlet 220 (see FIG. 6) of the main cyclone 200, and with the first and the second cone inlets 312 and 322 (see FIG. 6) of the first and the second cyclone cones 310 and 320, respectively. The inlet guide path 613 includes a first inlet guide path 613a in fluid communication with the first cone inlet 312 of the first cyclone cone 310, and a second inlet guide path 613b in fluid communication with the second cone inlet 322 of the second cyclone cone 320. Each of the inlet guide paths 613a and 613b has a spiral section to guide air from the main air outlet 220 into each of the first and the second cyclone cones 310 and 320 in a whirling current. An outlet guide path 614 has a tubular form of a predetermined length, and through the outlet guide path 614, clean air is discharged from the first and the second cyclone cones 310 and 320. In order to prevent the drawn dust-laden air from mixing with the clean air inside the cyclone cones 310 and 320, a part of upper end of the outlet guide path 614 is inserted in the first and the second cyclone cones 310 and 320, respectively. The outlet guide path 614 includes a first outlet guide path 614a through which the air of the first cyclone cone 310 is discharged, and a second outlet guide path 614b through which the air of the second cyclone cone 320 is discharged.

[0067] The discharge cover 620 includes an air outlet port 622 which gathers air from the plurality of first and second outlet guide paths 614a and 614b and discharges the air out of the multi-cyclone dust separating apparatus 100. The air outlet port 622 is in fluid communication with the motor driving chamber 12 (see FIG. 1) of the vacuum cleaner 10. The motor driving chamber 12 houses a vacuum source therein, and accordingly, the suction force of the vacuum source is transmitted to the suction nozzle 21 (see FIG. 1) via the air outlet port 622 and the air inlet port 612.

[0068] Hereinbelow, the operation and effect of the multi-cyclone dust separating apparatus according to an embodiment of the present invention will be described with reference to FIGS. 8 and 9. FIG. 8 is a partially cut view to show the air path of the main cyclone 200, and FIG. 9 is a partially cut view to show the air path from the main cyclone 200 to the sub cyclone 300.

[0069] Referring to FIG. 8, when the electricity is supplied to the vacuum cleaner and suction force is generated, dust of the surface being cleaned is drawn with air through the suction nozzle 21 (see FIG. 1), and passes through the air inlet port 312 and the main air outlet 210 to flow into the main cyclone 200.

[0070] The drawn air and dust is guided along the air guide 250 in the direction of arrow A, and ascends inside the outer chamber wall 230 in a whirling current. At this time, as being heavier than the air, dust in the drawn air is particularly gathered toward the inner side of the outer chamber wall 230, and then entrained in the ascending air current to be thrown out through the dust outlet 510 as indicated by the arrow B. The dust is then piled in the first dust collecting chamber 451. Dust in the dust collecting chamber 451 cannot flow back into the outer chamber wall 230 due to the presence of the backflow preventive member 520. The clean air, from which relatively large dust has been removed, collides against the inner side of the upper cover 500 and descends, and exits out of the main air outlet 220 via the air outlet pipe 240 as indicated by the arrow C.

[0071] Referring to FIG. 9, air discharged from the main air outlet 220 is branched off to be then guided along the first and the second inlet guide paths 613a and 613b as indicated by the arrow E. Accordingly, the air is drawn into the first and the second cyclone cones 310 and 320 through the first and the second cone inlets 312 and 322 (see FIG. 6). The air then ascends inside the first and the second cyclone cones 310 and 320 in a whirling cur-

Dyson Ex1020
Page 1127

rent as indicated by the arrow F. Minute dust is separated from the air by the centrifugal force, drawn toward the inner wall of the first and the second cyclone cones 310 and 320, lifted in the ascending air current, thrown through the upper ends 311a and 311b of the body as indicated by the arrow G, and piled in the sub dust collecting chamber 452. The clean air descends by the suction force, guided along the first and the second outlet paths 614a and 614b, and discharged out of the first and the second cyclone cones 310 and 320 as indicated by arrow H. Air discharged from the first and the second cyclone cones 310 and 320 is gathered in the interior space of the discharge cover 620 and exits out of the multi-cyclone dust separating apparatus 100 through the air outlet port 622 as indicated by the arrow I.

[0072] As explained above with reference to a few exemplary embodiments of the present invention, the multi-cyclone dust separating apparatus according to the present invention is provided with not only reduced height but also increased dust collecting capacity of the dust collecting chamber by arranging the dust collecting casing in a half-circular configuration to correspond to the mount chamber of the cleaner body and arranging the main and sub cyclones and the dust collecting chamber in parallel inside the dust collecting casing. Accordingly, dead space can be removed from the cleaner body where the multi-cyclone dust separating apparatus is mounted, and by replacing the dead spaces with the dust collecting chamber, much increased dust collecting capacity can be provided within the limited structure. Furthermore, the multi-cyclone dust separating apparatus can be compact-sized, which will eventually bring in compact vacuum cleaner.

[0073] Additionally, because one or more first and second cyclones of different sizes are arranged in shapes or sizes corresponding to those of the interior of the dust collecting chamber, cyclone cones of different sizes of small cyclone cones can be arranged in the dead spaces, both the maximum space utilization and the improved dust collecting efficiency can be provided.

[0074] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. Also, the description of the embodiments of the present invention is intended to be illustrative, and not to limit the scope of the claims, and many alternatives, modifications, and variations will be apparent to those skilled in the art.

Claims

1. A multi-cyclone dust separating apparatus comprising:

   a main cyclone comprising one or more cyclones;
   a sub cyclone comprising one or more cyclones, the sub cyclone being arranged around a part of the main cyclone and being arranged in parallel relation to the main cyclone; and
   a dust collecting casing provided to enclose the main and the sub cyclones, the dust collecting casing collecting dust as the dust is separated from air in the main and the sub cyclones,
   the dust collecting casing having at least a first part enclosing the main cyclone, wherein the first part is formed in a half-circular shape.

2. The multi-cyclone dust separating apparatus of claim 1, wherein the dust collecting casing has at least a second part enclosing the sub cyclone, the second part being formed in a square shape with one side open.

3. The multi-cyclone dust separating apparatus of claim 2, wherein the first part comprises a first half-circular wall enclosing the main cyclone, the second part comprises a pair of second walls enclosing the sub cyclone and connecting to opposite ends of the first half-circular wall, and the second part comprises a third wall connecting the pair of second walls to one another.

4. The multi-cyclone dust separating apparatus of claim 3, wherein the first half-circular wall is formed of a transparent material.

5. The multi-cyclone dust separating apparatus of any of claims 3 and 4, wherein the first, the second and the third walls are formed integrally with each other.

6. The multi-cyclone dust separating apparatus of any of claims 3 to 5, wherein the sub cyclone comprises a plurality of cyclone cones of different sizes.

7. The multi-cyclone dust separating apparatus of claim 6, wherein the plurality of cyclone cones are arranged along an inner circumference of the second and the third walls in a row.

8. The multi-cyclone dust separating apparatus of any of claims 6 and 7, wherein the plurality of cyclone cones comprise one or more first cyclone cones and one or more second cyclone cones, the one or more second cyclone cones being smaller in size than the one or more first cyclone cones.

9. The multi-cyclone dust separating apparatus of claim 8, wherein the one or more first and second cyclone cones are each formed in a conical configuration having a narrower diameter toward an upper end, and wherein the one or more first cyclone cones have a height that is the same as the main cyclone.

10. The multi-cyclone dust separating apparatus of any

Dyson Ex1020
Page 1128

of claims 1 to 9, wherein the main cyclone comprises a main air inlet at a lower end through which an external air is drawn, and a main air outlet at a lower end through which the air of the main cyclone is discharged.

11. The multi-cyclone dust separating apparatus of claim 10, wherein the main air inlet and the main air outlet are formed on the same plane.

12. The multi-cyclone dust separating apparatus of claim 8 combined to claim 10, wherein the one or more first and second cyclone cones comprise first and second cone inlets at lower ends, through which the air discharged out of the main air outlet is branched off and drawn, with the first and the second cone inlets being formed such that entrance gates thereof are on the same plane.

13. The multi-cyclone dust separating apparatus of claim 12, wherein the main air outlet of the main cyclone and the first and the second cone inlets of the first and the second cyclone cones are formed on the same plane.

14. The multi-cyclone dust separating apparatus of any of claims 1 to 13, wherein the dust collecting casing comprises a partition for dividing the dust collecting chamber into a main chamber to collect the separated dust of the main cyclone, and a sub chamber to collect the separated dust of the sub cyclone.

15. The multi-cyclone dust separating apparatus of any of claims 1 to 14, further comprising an upper cover for detachably connecting to an upper end of the dust collecting casing.

16. The multi-cyclone dust separating apparatus of claim 15, wherein, upon mounting to the upper end of the dust collecting casing, the upper cover forms a dust outlet in cooperation with an upper end of the main cyclone, and the upper cover comprising:

a backflow preventive member for preventing the dust of the main dust collecting chamber from flowing back into the main cyclone, and
a sealing member connecting to an upper end of the partition and isolating the main dust collecting chamber from the sub dust collecting chamber.

17. The multi-cyclone dust separating apparatus of any of claims 1 to 16, further comprising a lower cover unit coupled to a lower end of the dust collecting casing to guide the air of the main cyclone into the sub cyclone, the lower cover unit comprising:

an air inlet port for drawing in external air into the main cyclone, and
an air outlet port for discharging the air of the sub cyclone to the outside.

18. A multi-cyclone dust separating apparatus comprising:

a main cyclone for drawing in external air and separating dust from the drawn air using centrifugal force, the main cyclone comprising one or more cyclones; and
a sub cyclone for drawing in air discharged from the main cyclone and separating minute dust using centrifugal force, the sub cyclone comprising a plurality of cyclones,
at least one of the plurality of cyclones of the sub cyclone has a different size from others of the plurality of cyclones of the sub cyclone.

19. The multi-cyclone dust separating apparatus of claim 18, wherein said one or more cyclones of the main cyclone and said plurality of cyclones of the sub cyclone draw in the air through a lower part, discharge dust of the air through an upper part, and then discharge the dust-removed air through the lower part.

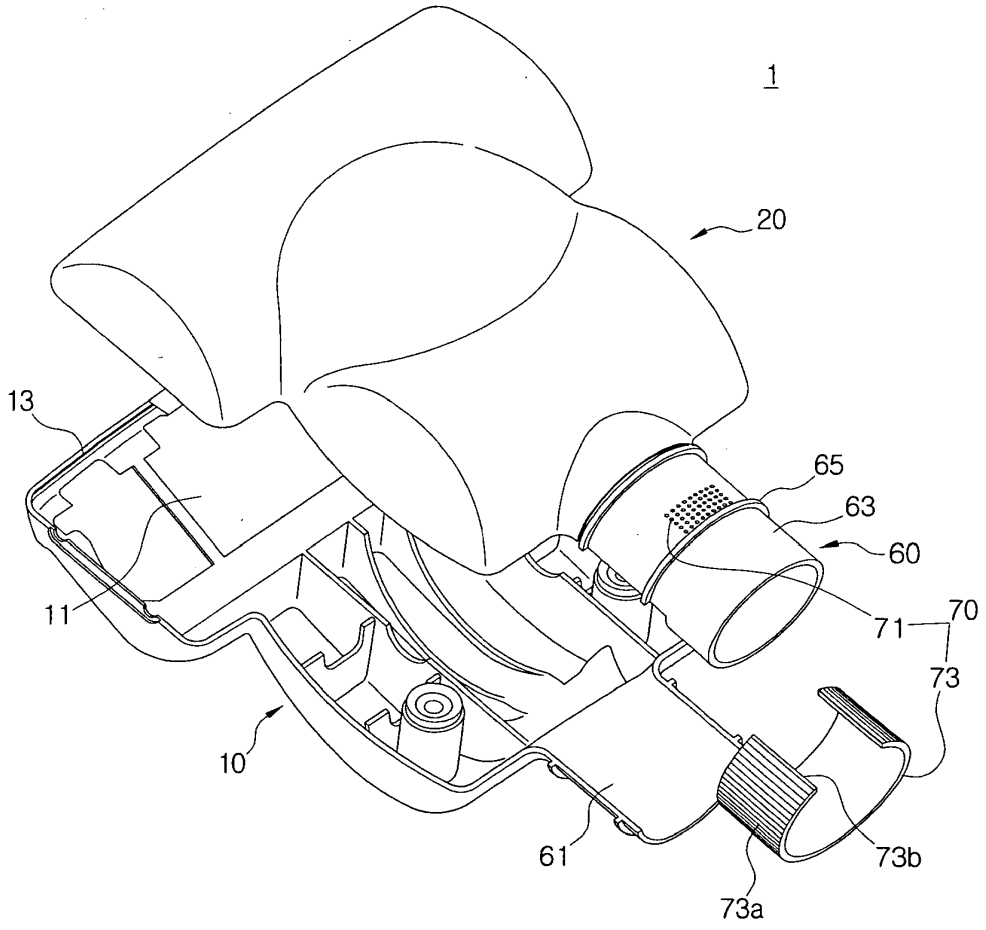
20. The multi-cyclone dust separating apparatus of any of claims 18 and 19, wherein at least one of the plurality of cyclones of the sub cyclone has an uppermost end of smaller diameter than an uppermost ends of the others.

21. The multi-cyclone dust separating apparatus of any of claims 18 to 20, wherein at least one of the plurality of cyclones of the sub cyclone is shorter than the others.

22. The multi-cyclone dust separating apparatus of any of claims 18 to 21, wherein the main cyclone and the sub cyclone are arranged in parallel, and said one or more cyclones of the main cyclone are formed in substantially cylindrical configuration, and said plurality of cyclones of the sub cyclone are formed in a substantially conical configuration.

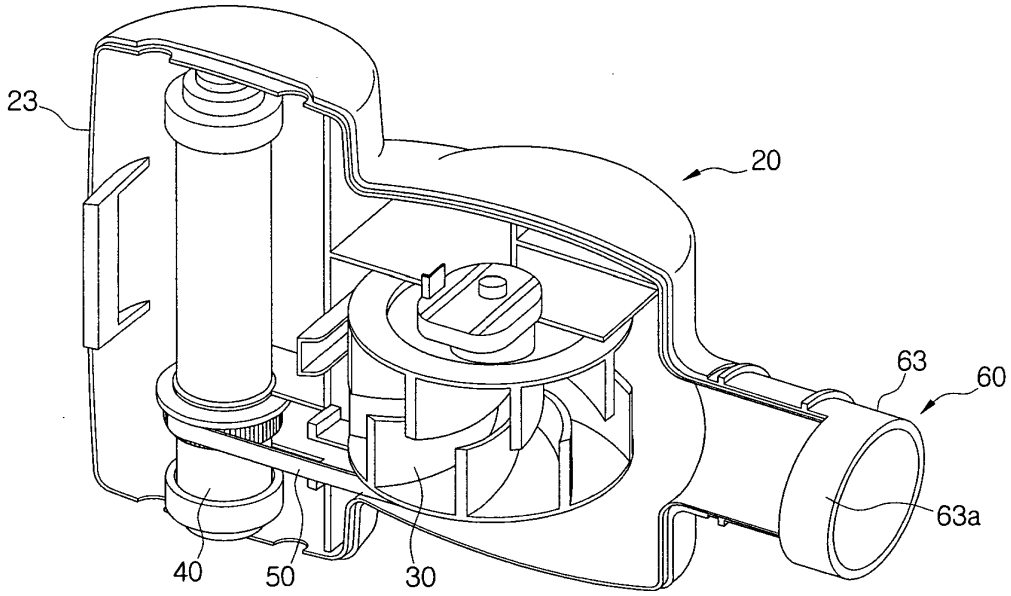
Dyson Ex1020
Page 1129

FIG. 1



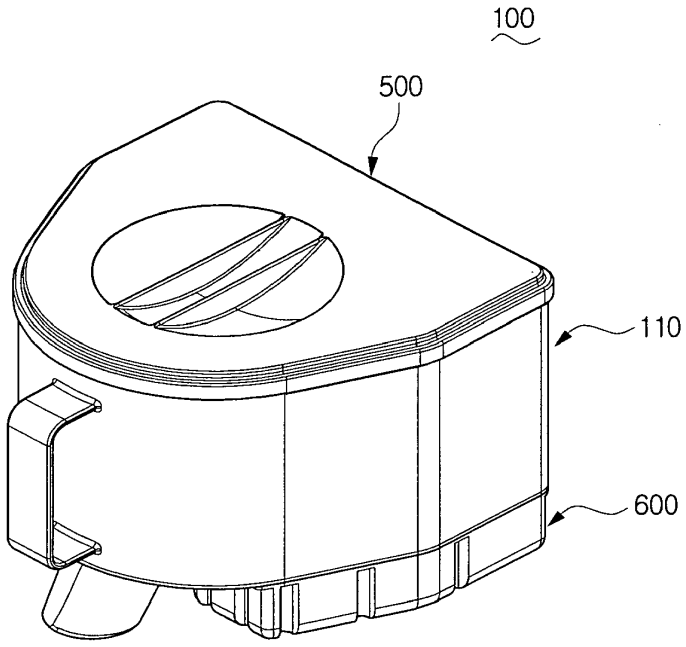
Dyson Ex1020
Page 1130

FIG. 2



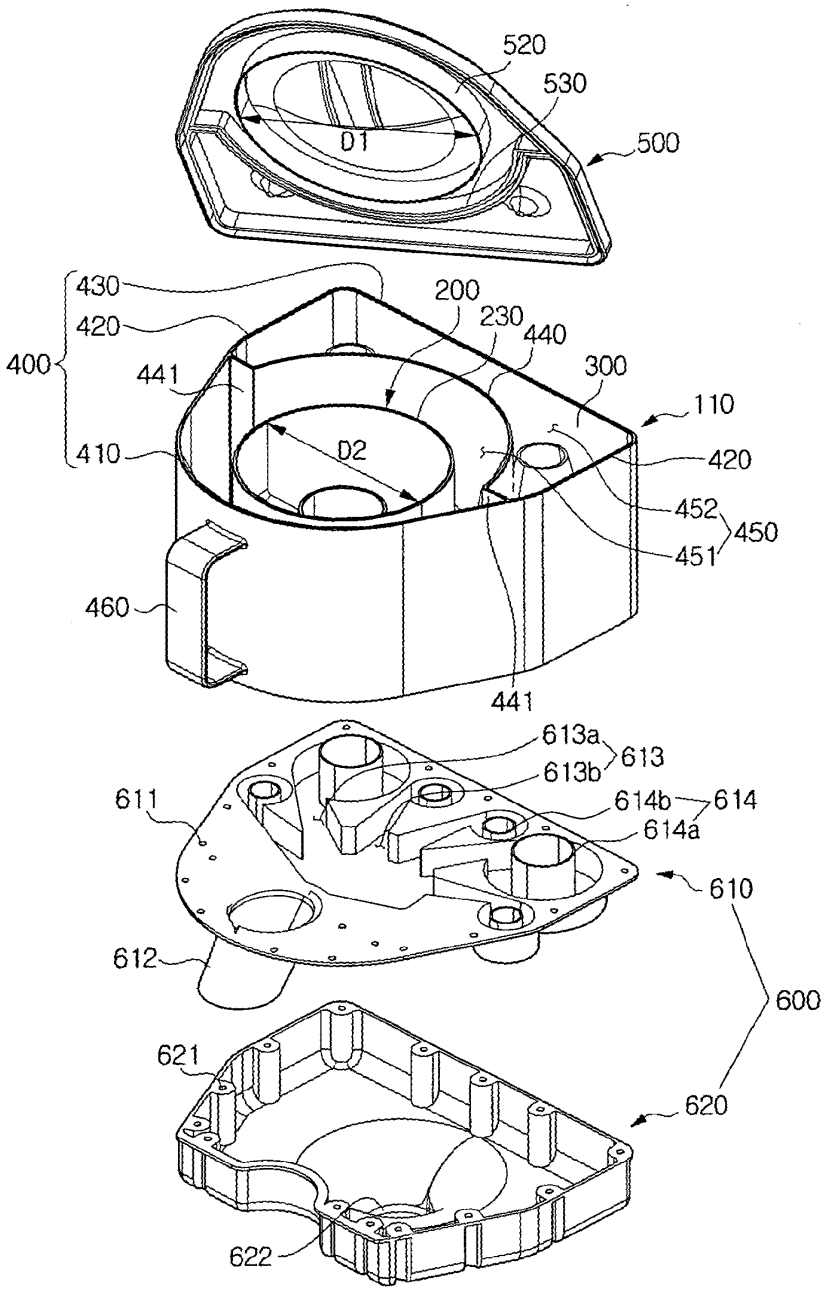
Dyson Ex1020
Page 1131

FIG. 3



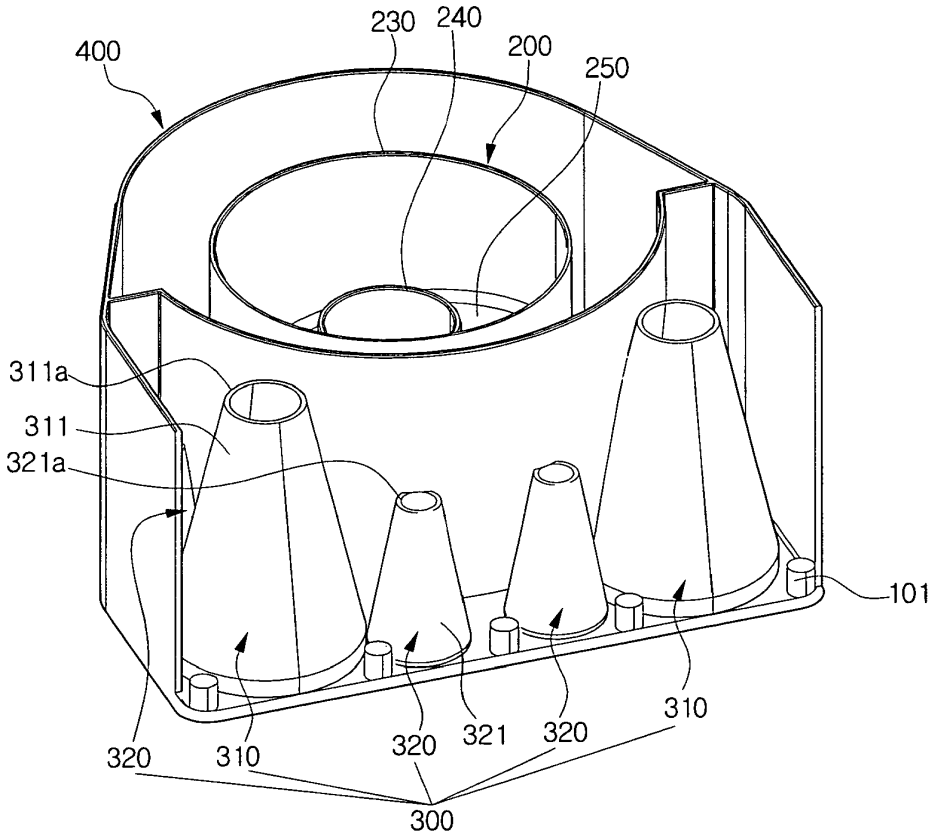
Dyson Ex1020
Page 1132

FIG. 4



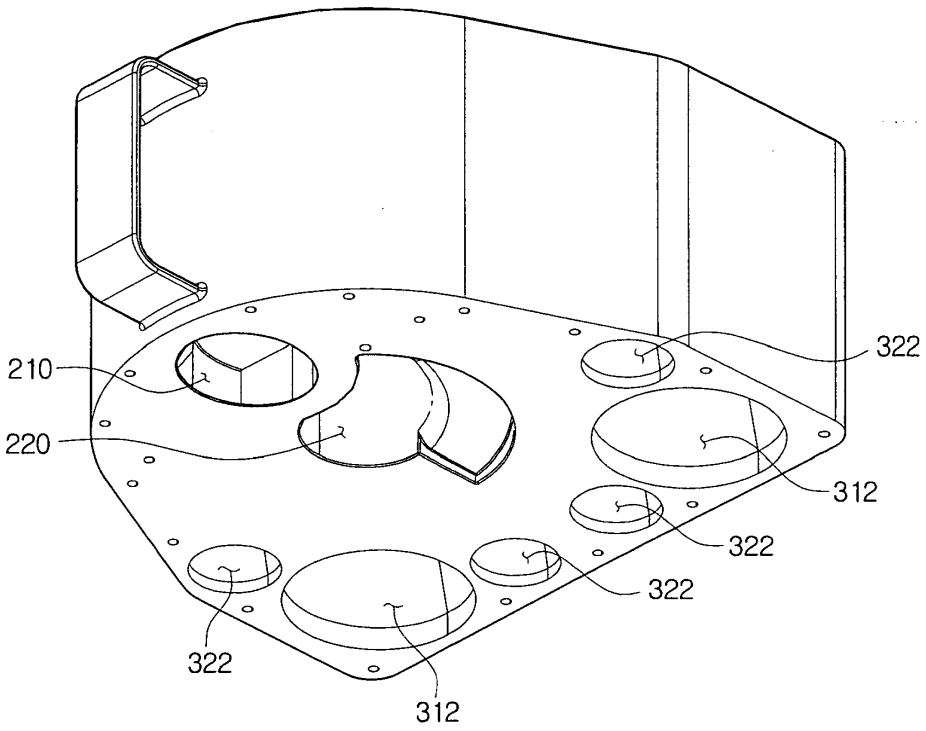
Dyson Ex1020
Page 1133

FIG. 5



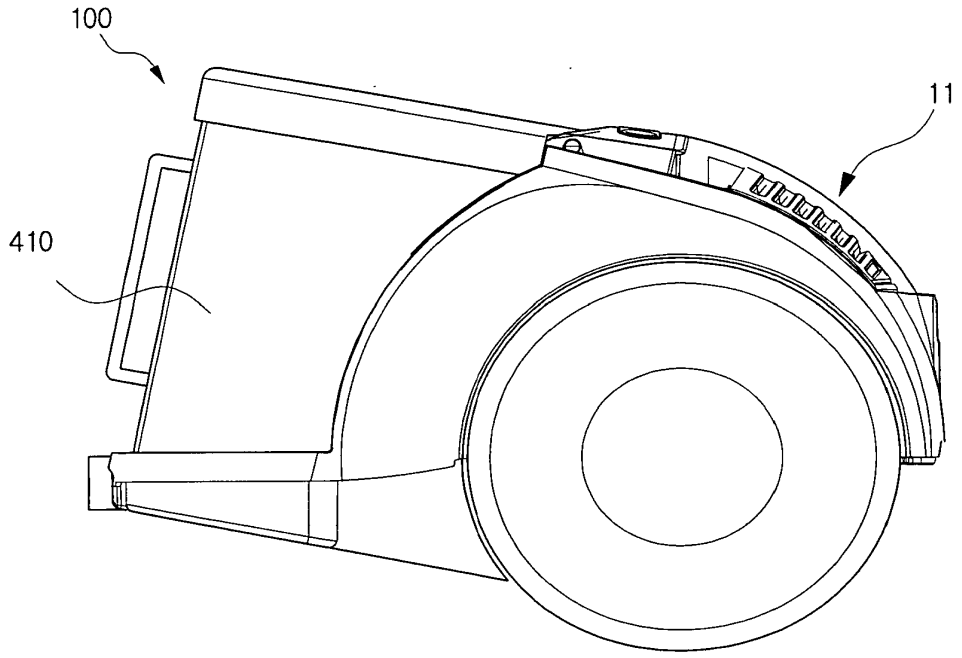
Dyson Ex1020
Page 1134

FIG. 6



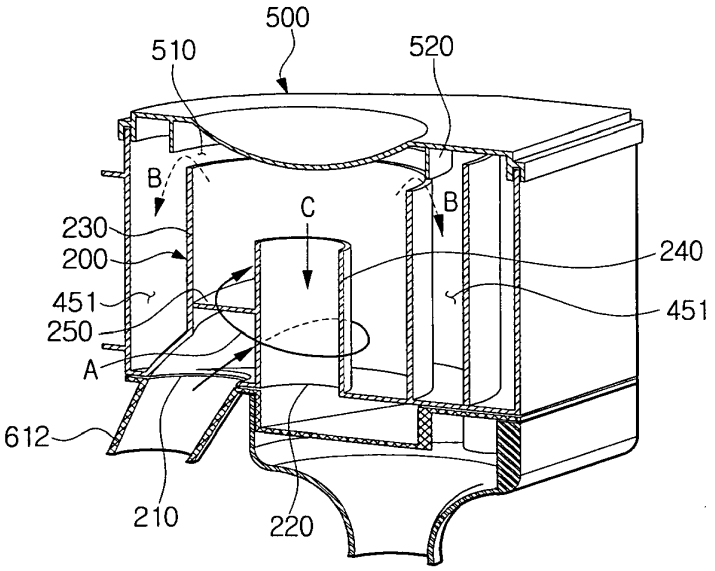
Dyson Ex1020
Page 1135

FIG. 7



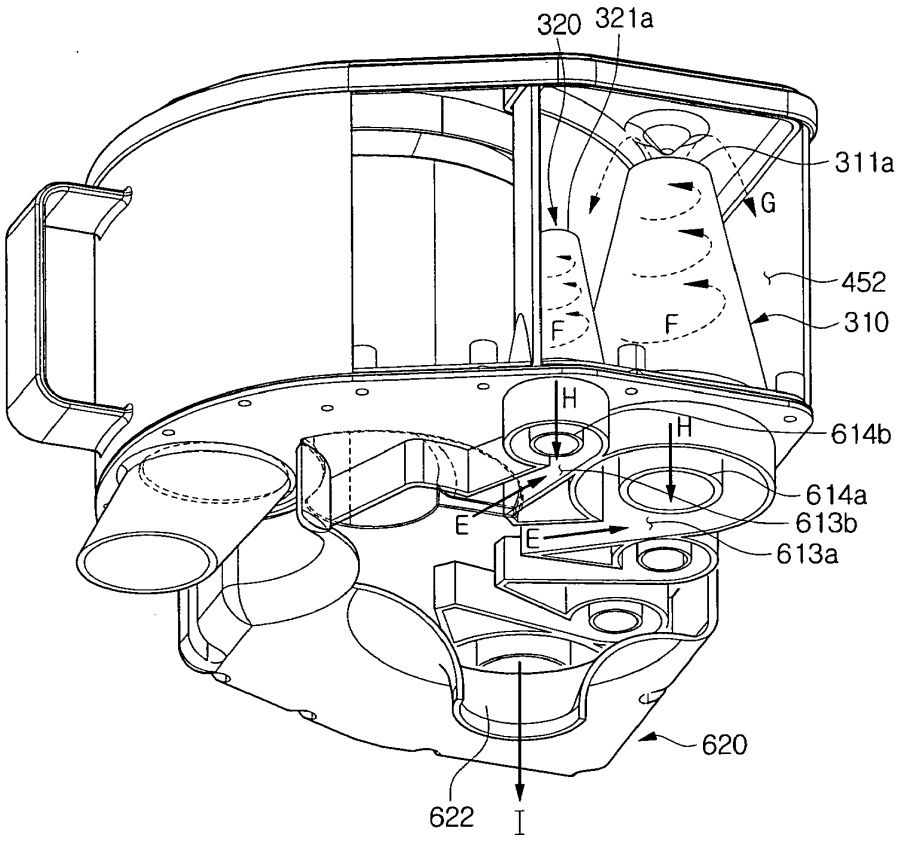
Dyson Ex1020
Page 1136

FIG. 8



Dyson Ex1020
Page 1137

FIG. 9



Dyson Ex1020
Page 1138

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Dyson Ex1020
Page 1139

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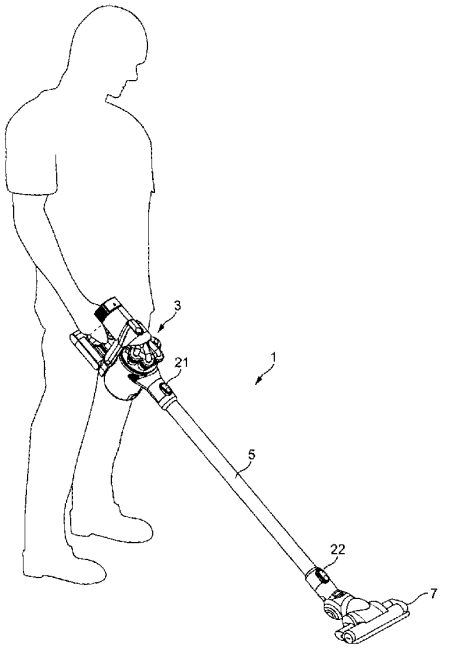
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最終頁に続く

(54)【発明の名称】真空掃除装置

(57)【要約】
【課題】真空掃除機、特に、細長吸引ワンドによって床ツールに接続された可搬型吸引ユニットを一般的に含むタイプの「スティックバキューム」掃除機を提供する。
【解決手段】装置は、スティックバキューム掃除機を形成するために細長吸引ワンドと組み合わされた可搬型吸引ユニットを含み、装置は、更に、使用しない時に壁上のスティックバキューム掃除機を直立のドック位置に支持するための壁掛け可能なドッキングステーションを含む。装置は、使用に便利なように直立位置のスティックバキューム掃除機の比較的安定な保管を提供する。
【選択図】図1



【特許請求の範囲】
【請求項１】
細長吸引ワンドによって床ツールに接続された可搬型吸引ユニットを含むスティックバキューム掃除機と
使用しない時に直立のドック位置で壁上に前記スティックバキューム掃除機を解除可能に係止するように配置された壁掛け可能なドッキングステーションと、含むことを特徴とするバキューム掃除装置。
【請求項２】
前記可搬型吸引ユニットは、バッテリ作動式であり、かつ搭載再充電可能バッテリに接続された１組の外部充電接点を組み込み、該ドッキングステーションは、主電源に接続するためのそれぞれの組の充電接点を含み、該ドッキングステーション上の該充電接点は、該可搬型吸引ユニット上の該外部充電接点と係合するように配置されて前記スティックバキューム掃除機が前記直立のドック位置にある時にバッテリ充電回路を形成することを特徴とする請求項１に記載の装置。
【請求項３】
前記ドッキングステーションは、前記可搬型吸引ユニットを直立のドック位置に直接に支持するために該可搬型吸引ユニットと係合するように配置されることを特徴とする請求項１又は請求項２に記載の装置。
【請求項４】
前記ドッキングステーションは、前記直立のドック位置に前記スティックバキューム掃除機を係止するように前記可搬型吸引ユニットと係合するためのキャッチを含み、該キャッチは、該可搬型吸引ユニット上の前記充電接点を該ドッキングステーション上の前記充電接点との係合状態に保持するように配置されることを特徴とする請求項２又は請求項３に記載の装置。
【請求項５】
前記キャッチは、前記可搬型真空掃除機上の前記充電接点を前記ドッキングステーション上の前記充電接点との係合状態に押し付けるためにバネ荷重されることを特徴とする請求項４に記載の装置。
【請求項６】
前記可搬型吸引ユニット上の前記外部充電接点は、それらが、前記スティックバキューム掃除機が前記直立のドック位置にある時に上方を向くように位置決めされ、前記ドッキングステーション上の前記充電接点は、該充電接点を下方に押し付けて該可搬型吸引ユニット上の該上向き充電接点と係合させるためにバネ付勢されることを特徴とする請求項１から請求項５のいずれか１項に記載の装置。
【請求項７】
前記ドッキングステーションは、１組の対向する締め付け部材を含み、該締め付け部材の少なくとも一方は、他方の締め付け部材に対して前記スティックバキュームを弾力的に締め付けて該スティックバキュームを前記直立のドック位置に係止するために該他方の締め付け部材の方向に弾力的に付勢されることを特徴とする請求項１から請求項６のいずれか１項に記載の装置。
【請求項８】
前記締め付け部材の対は、前記可搬型吸引ユニットのそれぞれの下部部分に対して上方に締め付けるように配置された下部締め付け部材、及び該可搬型吸引ユニットのそれぞれの上部部分に対して下方に締め付けるように配置された対向する上部締め付け部材から構成されることを特徴とする請求項７に記載の装置。
【請求項９】
前記下部締め付け部材は、使用時に前記壁に対して固定され、前記上部締め付け部材は、該下部締め付け部材の方向に下方に弾力的に付勢されることを特徴とする請求項８に記載の装置。
【請求項１０】

前記締め付け部材は、締め付け軸に沿って相対摺動移動して前記スティックバキュームと係合するように配置され、少なくとも一方の締め付け部材は、更に、他方の締め付け部材との締め付けアラインメントに入りかつ出る移動に対して配置されることを特徴とする請求項７から請求項９のいずれか１項に記載の装置。

【請求項１１】

前記締め付け部材は、前記他方の締め付け部材との締め付けアラインメントに入りかつ出るピボット回転移動に対して配置されることを特徴とする請求項１０に記載の装置。

【請求項１２】

壁上に装着された前記ドッキングステーションとの使用において、前記ピボット回転可能締め付け部材は、該壁から離れるピボット回転移動に対して配置されることを特徴とする請求項１１に記載の装置。

【請求項１３】

前記上部締め付け部材は、滑り嵌めで前記可搬型ユニットの第１の部分を受け取るように配置されたドッキング受け台の形態であり、該ドッキング受け台は、前記下部締め付け部材に対して摺動可能であり、かつ該下部締め付け部材の方向に弾力的に付勢され、該ドッキング受け台は、更に、該可搬型ユニットの該第１の部分を受け取るために該下部締め付け部材との締め付けアラインメントから出る移動のために、使用時に前記壁から離れるようにピボット回転可能であることを特徴とする請求項１０に記載の装置。

【請求項１４】

前記下部締め付け部材は、該下部締め付け部材に対する横方向移動に対して前記スティックバキュームを固定するために前記可搬型ユニットの第２の部分と係合するための係止要素を含む固定式締め付け部材であることを特徴とする請求項１３に記載の装置。

【請求項１５】

請求項１から請求項１４のいずれか１項に記載の装置のドッキングステーションとして使用するためのドッキングステーション。

【発明の詳細な説明】

【技術分野】

【０００１】

本発明は、真空掃除機の分野に関し、より具体的には、細長吸引ワンドによって床ツールに接続された可搬型吸引ユニットを一般的に含むタイプの「スティックバキューム」掃除機に関する。

【背景技術】

【０００２】

広い意味では、「直立型」真空掃除機、「円筒形型」掃除機（「キャニスタ」掃除機とも呼ばれる）、「可搬型」真空掃除機、及び「スティック型」真空掃除機の４つのタイプの真空掃除機があり、最後のものは、「スティックバキューム」掃除機又は単に「スティックバキューム」と呼ばれる。

【０００３】

直立型掃除機及び円筒形型掃除機は、公知である。これらは、電源コンセント作動式である傾向があり、比較的苛酷な清掃用途に対して用いられる。

【０００４】

可搬型真空掃除機は、家庭における床及び内装のスポット清掃、車及びボートなどの内部の清掃のような比較的低荷重用途に最も適する比較的小さな携帯性に優れた真空掃除機である。直立型掃除機及び円筒形型掃除機と異なり、これらは、使用中に手で運ぶように設計され、バッテリ作動式である傾向がある。

【０００５】

スティックバキューム掃除機は、基本的に、床にこぼれたものの掃除のような比較的低荷重床清掃用途のための直立型掃除機の軽量の機能的代替手段を提供する。

【０００６】

広い意味では、２つのタイプのスティックバキュームがある。第１のタイプは、ある意

味では、超薄型直立型掃除機であるが、通常電源コンセント作動式ではなくて「コードレス」である。このタイプのスティックバキューム掃除機の例は、英国特許出願番号ＧＢ第２３７７８８０号Ａ１に示され、この場合には、取外し可能な可搬型真空清掃のためのユニットを更に組み込んでいる。このタイプのスティックバキュームは、支柱なしで立つことができ、そうでなければ、これらは、使用していない時には簡単にスティックバキュームを壁に立て掛けることによって格納される傾向がある（長いハンドルブラシ又はほうきのように）。

【０００７】

第２のタイプのスティックバキューム掃除機は、可搬型真空掃除機からの副産物であり、ユーザが床面を清掃する間は立ったままでいることができるように、可搬型真空掃除機と同じ方法であるが、実質的に床に届く剛性の細長吸引ワンドと組み合わせて手で運ぶ可搬型吸引ユニットを含む。床ツールは、典型的には、剛性の細長吸引ワンドの端部に取り付けられ、又は代替的にワンドの底端部と一体化することができる。このタイプのスティックバキューム掃除機の設計は、ＵＳＤ第２９８８７５号、ＵＳＤ第３０３１７３号、及びＵＳＤ第２８００３３号に示されている。いずれの場合にも、可搬型吸引ユニットは、モータと、ファンと、バッグ又はサイクロン分離システムとすることができる何らかの種類の分離装置とを組み込んでいる。

【０００８】

第２のタイプのスティックバキューム掃除機は、主にマルチモードのハイブリッド機械であり、そのような場合には、ワンドは取外し可能であり、可搬型吸引ユニットは、次に、必要に応じて可搬型真空掃除機として独立して使用することができる。しかし、これは、これらのタイプのスティックバキューム掃除機の基本的な特徴ではなく、ワンドは、可搬型吸引ユニットに恒久的に取り付けることができると考えられる。

【０００９】

第２のタイプのスティックバキュームを第１のタイプのスティックバキュームと区別する特徴は、第１のタイプが「底重」（下部が重い）であり、モータが普通サイズの直立型掃除機と類似の方式で下方に低く位置するが、第２のタイプは、「頭重」（上部が重い）であり、細長吸引ワンドと組み合わせた可搬型吸引ユニットの使用は、モータ（可搬型吸引ユニットの内側にある）が機械の上端により近く位置することを意味するという点である。

【００１０】

第２のタイプのスティックバキュームにおける重量の「頭重」配分は、これらが、スティックバキュームモードで格納するのに特に便利なものではないことを意味する。スティックバキューム掃除機が、床に支持された床ツール及び壁にもたれかかった可搬型吸引ユニットと共に直立位置の壁に立て掛けられる場合、可搬型吸引ユニットの相対重量は、スティックバキューム掃除機を全体として不安定にする傾向がある。他方、スティックバキューム掃除機は、床に支持されたかなり重い可搬型真空掃除機と共に上下を逆にして壁に立て掛ける場合、掃除機の比較的汚れた下端は、結果的に壁にもたれかかることになり、これは、望ましくない。同様に、スティックバキューム掃除機が、直立位置ではなくて逆さまの位置に格納される時に、使用するために掃除機を元に戻して直立位置に変えるためにスティックバキューム掃除機の比較的汚れた下端の領域でスティックバキューム掃除機が把持されるのが自然な傾向である。

【先行技術文献】

【特許文献】

【００１１】

【特許文献１】ＧＢ２３７７８８０Ａ１
【特許文献２】ＵＳＤ２９８８７５
【特許文献３】ＵＳＤ３０３１７３
【特許文献４】ＵＳＤ２８００３３

【発明の概要】

【発明が解決しようとする課題】
【００１２】
その結果、第２のタイプの従来のスティックバキューム掃除機は、多くの場合、床の上に格納される傾向があり、又はそうするための空間が不十分な場所では、使用後格納するために部分的に分解され、次に、スティックバキュームモードの機械を使用することが望ましい時に再び組み立てられる傾向がある。分解及び再組立の必要性は、スティックバキュームモードでの機械の使用を特に妨げる。
【課題を解決するための手段】
【００１３】
本発明によると、スティックバキューム掃除機を形成するために細長吸引ワンドと組み合わせた可搬型吸引ユニットを含む装置が提供され、装置は、使用していない時には直立のドック位置の壁上のスティックバキューム掃除機を支持するための壁掛け可能なドッキングステーションを更に含む。
【００１４】
「直立位置」により、細長吸引ワンドが、可搬型吸引ユニットから床の方向に下方に延びる位置を意味する。直立位置のスティックバキューム掃除機を格納することは、スティックバキュームが直立位置で準備が整っている時点で、ドッキングステーションからスティックバキュームを外すためにユーザが都合よく可搬型真空掃除機を把持することができるという点で有利であり、使用するための直立位置までスティックバキューム掃除機を操作するために、ユーザがスティックバキュームの比較的汚れた下端を把持する傾向はない。同時に、「頭重」スティックバキューム掃除機は、ドッキングステーション（これは、直立位置のスティックバキューム掃除機を横方向に支持する）によって比較的安定な直立位置に有利に支持される。
【００１５】
特に安定な配置では、ドッキングステーションは、直立のドック位置のスティックバキュームを固定するために、すなわち、スティックバキューム掃除機が基本的に直立のドック位置のドッキングステーションに対して固定されるように解除可能に配置される。
【００１６】
ドッキングステーションは、スティックバキューム掃除機が直立のドック位置にある時に可搬型吸引ユニットを直接支持するために、可搬型吸引ユニットと係合するように配置することができる。その結果、質量中心が大部分は可搬型吸引ユニットの内側にあるモータの位置によって決定付けられるので、スティックバキューム掃除機の質量中心は、壁の上の支点に比較的近くなり、これは、特に安定な直立のドック位置を提供し、ドッキングステーション構成要素に対して比較的低い応力をもたらす。
【００１７】
可搬型掃除機は、バッテリ式可搬型掃除機とすることができ、この場合には、可搬型掃除機は、搭載再充電可能バッテリに接続された１組の外部充電接点を組み込むことができ、ドッキングステーションは、主電源に接続するためのそれぞれの組の充電接点を含むことができ、ドッキングステーション上の充電接点は、可搬型掃除機上の上述の外部充電接点と係合するように配置され、スティックバキューム掃除機が直立のドック位置にある時にバッテリ充電回路を形成する。従って、ドッキングステーションは、スティックバキューム掃除機が直立のドック位置にある時に可搬型ユニットに搭載されたバッテリを有利に充電する。
【００１８】
可搬型吸引ユニット上の充電接点は、あらゆる好ましい方式で配置することができる。一部の場合では、スティックバキューム掃除機が直立位置にある時に接点が上方を向くことを意味する方法で、可搬型吸引ユニット上に接点を配置することが望ましいであろう。
【００１９】
可搬型吸引ユニット上の充電接点は、これらが、スティックバキューム掃除機が直立のドック位置にある時に上方を向くように配置される場合、充電接点が、スティックバキュ

ーム掃除機の重量の下でドッキングステーション上のそれぞれの接点から引き離される傾向がある可能性があることが見出されている。この問題に対処するために、ドッキングステーション上の充電接点は、可搬型吸引ユニット上の上述の上方向き充電接点と係合するように充電接点を下方に押し付けるためにバネ付勢することができる。

【００２０】

ドッキングステーションは、直立のドック位置にスティックバキューム掃除機を固定するために可搬型吸引ユニットと係合するためのキャッチを含むことができ、キャッチは、ドッキングステーション上の充電接点と係合状態の可搬型吸引ユニット上に充電接点を保持するように配置される。従って、スティックバキューム掃除機が直立のドック位置にある時にバッテリを充電するための確実な接点が保証される。

【００２１】

キャッチは、可搬型吸引ユニット上の充電接点を押し付けてドッキングステーション上の充電接点と係合するようにバネ付勢することができる。これは、ドッキングステーション上の充電接点を上述のようにバネ荷重することに加えて又はその代替とすることができる。

【００２２】

ドッキングステーションは、締め付け部材の対向する対を含むことができ、締め付け部材の少なくとも一方は、直立のドック位置のスティックバキュームを固定するために他方の締め付け部材に対してスティックバキュームを弾力的に締め付けるために他の締め付け部材の方向に弾力的に付勢される。これは、特に安定な装置を提供し、スティックバキュームは、直立のドック位置に確実に締め付けられる。更に、掃除機のドッキング及び解除は、下でより詳細に説明するように基本的に片手によるものである。

【００２３】

締め付け部材の対は、可搬型吸引ユニットのそれぞれの下部部分に対して上方に締め付けるように配置された下部締め付け部材と、可搬型吸引ユニットのそれぞれの上部部分に対して下方に締め付けるように配置された対向する上部締め付け部材とから構成することができる。これは、掃除機にかかる締め付け荷重が、重力の力と正反対であるという点で有利である。

【００２４】

特定の装置では、下部締め付け部材は、壁に対して使用時には固定され、上部締め付け部材は、下部締め付け部材の方向に下方に弾力的に付勢される。

【００２５】

締め付け部材は、締め付け軸に沿って相対摺動移動してスティックバキュームと係合するように配置することができ、少なくとも一方の締め付け部材は、他方の締め付け部材との締め付けアラインメントに入りかつそこから出る移動に対して更に配置される。他方の締め付け部材との締め付けアラインメントから締め付け部材を取り出す機能は、締め付け部材との掃除機の連続係合を考慮するものであり、これは、ドッキングを更に便利にする。締め付けアラインメントに出入りする締め付け部材の移動は、ピボット回転移動とすることができる。特に、壁上に装着されたドッキングステーションで使用する時には、上述のピボット回転可能締め付け部材は、ドッキングステーションが壁上に装着されて使用されている時に、締め付け部材が壁から離れてピボット回転移動するように配置されるように配置することができる。この後者の配置は、ピボット回転可能締め付け部材が、ドッキングステーションの占有面積内で移動するので、壁上のドッキングステーションの占有面積を低減するのに特に有利と考えられる。

【００２６】

直立位置に掃除機を係止するための特に安定な配置では、上部締め付け部材は、滑り嵌めで可搬型ユニットの第１の部分を受け取るように配置されたドッキング受け台の形態であり、ドッキング受け台は、下部締め付け部材に対して摺動可能であり、かつ下部締め付け部材の方向に弾力的に付勢され、ドッキング受け台は、更に、使用時に、可搬型ユニットの上述の第１の部分を受け取るために下部締め付け部材との締め付けアラインメントか

ら出る移動に対して壁から離れてピボット回転可能である。この場合には、下部締め付け部材は、下部締め付け部材に対する横方向移動に対してスティックバキュームを固定するために、可搬型ユニットの第２の部分と係合するための係止要素を含む固定した締め付け部材とすることができる。

【００２７】

本発明の実施形態をここで添付の図面を参照して以下に説明する。

【図面の簡単な説明】

【００２８】

【図１】使用時のスティックバキューム掃除機を示す概略図である。

【図２】図１のスティックバキューム掃除機の一部の拡大斜視図である。

【図３】ドッキングステーションにより壁に支持されたスティックバキューム掃除機を示す斜視図である。

【図４】スティックバキューム掃除機のドッキング前のドッキングステーション及びスティックバキューム掃除機の一部の拡大斜視図である。

【図５】スティックバキューム掃除機のドッキング中のドッキングステーション及びスティックバキューム掃除機の一部の拡大斜視図である。

【図６】直立のドック位置のドッキングステーション及びスティックバキューム掃除機の一部を示す拡大斜視図である。

【図７】ドッキングステーションにより代替の向きに支持されているが依然として直立位置にあるスティックバキューム掃除機を示す斜視図である。

【図８】代替ドッキングステーションとドッキングしたスティックバキューム掃除機の斜視図である。

【図９】分離した状態の代替ドッキングステーションの斜視図である。

【図１０】ドッキングステーション上のドッキング受け台のピボット回転移動を示す代替ドッキングステーションの一部（及びスティックバキューム掃除機の一部）を示す斜視図である。

【図１１】ドッキングステーションからのスティックバキューム掃除機の解除を示すスティックバキューム掃除機及び代替ドッキングステーションの斜視図である。

【図１２】ドッキングステーションを有する掃除機のドッキングを示すスティックバキューム掃除機及び代替ドッキングステーションの斜視図である。

【図１３】ドッキングステーションを有する掃除機のドッキングを更に示すスティックバキューム掃除機及び代替ドッキングステーションの斜視図である。

【図１４】掃除機上のバッテリパックとのアラインメントまでドッキング受け台を最初にピボット回転させるために比較的浅い角度での掃除機の挿入を示すスティックバキューム掃除機及び代替ドッキングステーションの斜視図である。

【発明を実施するための形態】

【００２９】

図１は、可搬型真空掃除機３、細長ワンド５、及び床ツール７の形態の可搬型吸引ユニットを含むスティックバキューム掃除機１を示している。

【００３０】

図２を参照すると、可搬型真空掃除機３は、可搬型真空掃除機３の前部に位置決めされた吸引ノズル１１を通って空気を吸い込むためにモータケーシング９の内側に配置された電動ファンを含む。吸引ノズル１１を通して吸い込んだ汚れた空気は、サイクロン分離システム１３を通ってファン発生吸引圧力の下でダクトを通され、そこで、ごみは、比較的清浄な空気が次に１つ又はそれよりも多くの微粒子フィルタ（見えない）を通じて周囲に排出されて戻される前に、空気から分離される。サイクロン分離システム１３の内側の空気流から分離されたごみは、廃棄するためのごみ容器１５に収集される。可搬型真空掃除機３は、バッテリパック１７に収容されたマルチセル再充電可能バッテリで作動する。

【００３１】

使用時には、可搬型真空掃除機３は、ハンドル１９を用いて手で運ばれる。

【００３２】
可搬型掃除機３は、比較的小型である。それにも関わらず、手における均衡した感覚を容易にするために、モータ及びバッテリパック１７のようなより重い構成要素は、意図的にハンドル１９の比較的の近くに位置し、ごみ容器１５のような比較的軽い構成要素は、ハンドル１９から更に離れて位置する。従って、可搬型掃除機３の質量の大部分は、可搬型掃除機３の後部の方向に分配される。
【００３３】
細長ワンド５は、吸引ノズル１１に接続され、床ツール７は、次に、ワンド５の下端に接続される。汚れた空気は、床ツール５の下部の吸引開口部を通して吸い込まれ、ワンド５を通じて吸引ノズル１１に移動する。
【００３４】
キャッチ２１は、可搬型掃除機３をスティックバキューム掃除機１の一部としてではなく可搬型掃除機として使用することができるように、可搬型掃除機３からワンド５を切り離すために設けられる。キャッチ２２はまた、可搬型掃除機３及びワンド５が、スティックバキューム掃除機１の一部として用いられるのではなく、代替的に何らかの他の吸引ツールと組み合わせて用いられて部屋などの上部コーナ内を清掃するために「遠くまで届く」可搬型真空掃除機を形成することができるように、ワンド５から床ツール７を切り離すために設けられる。
【００３５】
スティックバキューム掃除機１は、「頭重」であり、従来の方式のこのタイプのスティックバキューム掃除機は、それを使用していない時には格納し難かった。スティックバキューム掃除機１が、床ツール７が床に支持されて可搬型掃除機３が壁にもたれかかった状態で、直列位置の壁に立て掛けられる場合、スティックバキューム掃除機１は、全体として比較的不安定になる傾向があり、他方、スティックバキューム掃除機１が、可搬型掃除機３が床に支持されて床ツール７が壁にもたれかかった状態で、逆さまに壁に立て掛けられる場合、使用するための直立位置にスティックバキューム掃除機１を操作して戻すために、ユーザは、比較的汚れた床ツール７を把持する傾向がある。比較的汚れた床ツール７はまた、壁にマークを付ける場合がある。
【００３６】
図３は、使用していない時にスティックバキューム掃除機１を都合よく格納するための配置を示し、スティックバキューム掃除機１は、壁掛け式ドッキングステーション２３によって壁２１上の直立位置に支持されている。
【００３７】
ドッキングステーション２３は、ドッキング直前、ドッキング中、及びドックした位置にそれぞれスティックバキューム掃除機を示す図４から６により詳細に示されている。
【００３８】
スティックバキューム掃除機１は、緊密な滑り嵌めでバッテリパック１７を受け取るように成形されたドッキング受け台２５に上方に（図４の方向Ａに）入り込むバッテリパック１７を通じてドッキングステーション２３とドッキングする。ドッキング受け台２５の前壁２５ａは、受け台２５の入口から後方へ延びるブラインドスロット２７を組み込み、このブラインドスロット２７は、バッテリパックがドッキング受け台２５に上方に挿入される時にハンドル１９を収容する。
【００３９】
１組の充電接点が、スロット２７の端部に隣接して位置決めされたジャックホルダ３１にクリップ式に入る充電ジャック２９の形態でドッキングステーション２３上に設けられる。充電ジャック２９は、差込式電源コード３４を通じて主電源に接続され、ハンドル１９の後方の充電ソケット３３を通じてドック位置の可搬型掃除機３上の対応する組の充電接点と係合するように配置される。充電ソケット３３と充電ジャック２９の係合は、ドック位置のスティックバキューム掃除機１を充電するためのバッテリ充電回路を完成する。
【００４０】

Dyson Ex1020
Page 1147

キャッチ３５は、スティックバキューム掃除機１を図６に示すドック位置に確実に係止するために設けられる。

【００４１】

キャッチ３５は、ドッキング受け台２５の側面に適合するキャッチハウジング３６上にピボット回転可能に装着され、図４に示す係止位置の方向にバネ付勢される。スティックバキューム掃除機１のドッキング中に、キャッチ３５は、キャッチ３５の下部の第１のカム表面３５ａと係合し、キャッチ３５を図４に示す係止位置から離れるように図５に示す位置にピボット回転させる可搬型掃除機３上の対応するキャッチ部分３７と協働する。可搬型掃除機３が、図５に示す位置から図６に示すドック位置に移動すると、キャッチ部分３７は、キャッチ３５を最終的にクリアし、これは、次に、係止位置の方向にかつキャッチ部分３７の下側に対する係止係合に戻るようにバネ付勢され、ドック位置にスティックバキューム掃除機１を保持する。

【００４２】

スティックバキューム掃除機１は、それがドッキングステーション２３とドッキングする時に、ドッキング受け台２５の側壁によって直立位置に横方向に支持される。更に、ドッキング受け台２５の側壁は、比較的重い可搬型掃除機３に対して直接横方向支持を有利に提供する。

【００４３】

スティックバキューム掃除機１の重量は、キャッチ３５上に実質的に支持される。更に、キャッチ３５は、比較的重い可搬型掃除機３を有利に直接に支持する。

【００４４】

製造公差は、キャッチ３５が充電ソケット３３をドック位置でジャック２９との係合状態に保持するように制御される。従って、可搬型掃除機に搭載されたバッテリは、スティックバキューム掃除機１が直立のドック位置にある時に確実に充電される。

【００４５】

製造公差の制御は、充電ソケット３３が、スティックバキューム掃除機が直立のドック位置にある時に上方を向き、従って、スティックバキューム掃除機の重量がソケット３３をジャック２９から離れるように引っ張る傾向があるので、図１から６に示すような配置において特に重要であると考えられる。

【００４６】

充電信頼性に対する製造公差の潜在的な悪影響は、ドッキングステーション上で充電接点にバネ荷重をかけることによって軽減することができる。例えば、代替的な実施形態（図示せず）では、ジャックホルダ３１は、充電ソケット３３との充電ジャック２９の正の係合を保証するために下方にバネ付勢することができる。

【００４７】

スティックバキューム掃除機１をドック位置から取り外すために、ユーザは、単に手動解除レバー３８を用いてキャッチ３５を解除し、バッテリパック１７がドッキング受け台２５から外れるまでスティックバキューム掃除機を下方に摺動させる。スティックバキューム掃除機は、次に、直立位置にあって有利に使用準備が整っている。

【００４８】

スティックバキューム掃除機１の重量の下でキャッチ３５が係止位置で動かなくなり、キャッチ３５の手動解除を妨げる場合があるその傾向を低減するために、キャッチ３５の上部側面３５ｂは、適切に傾斜している（図４参照）。代替的に、キャッチ３５の上部側面は、平坦にすることができ（図６の点線Ｂによってごく概略的に示す）、これは、上部側面が、次に、例えばドック位置にユーザによって強打された可搬型掃除機３の結果としてのいずれの偶然の横方向解除力もキャッチ３５に伝達することができないという利点を有する。スティックバキューム掃除機１の重量がキャッチ３５を動かなくする傾向がある場合、それにも関わらず平坦なプロフィールのキャッチを用い、キャッチの手動解除前にユーザがスティックバキューム掃除機１をキャッチ３５から持ち上げることを可能にするために少量の遊びを設けることが可能である場合があるが、しかし、スティックバキュー

ム掃除機が、図６に示す直立のドック位置にある時に、ソケット３３をジャック２９から引き離せるほどの十分な遊びがないことを保証するように注意を要するであろう。

【００４９】

このドッキングステーション２３は、受け台２５の後壁２５ａの皿穴クリアランス孔（見えない）を通して壁２１にねじ込まれる壁固定式ネジ（図示せず）を用いて壁２１に固定することができる。接着パッドなどのような表面ファスナを含むあらゆる他の適切に強力な従来の壁固定法を用いて、壁２１上にドッキングステーション２３を装着することができる。

【００５０】

この場合には、スティックバキューム掃除機１は、完全に直立のドック位置に格納され、ワンド５は、実質的に垂直に下方に「ぶら下がる」。しかし、スティックバキューム掃除機が直立位置に格納される限り、これは、本発明の利点を得るのに必要であるとは考えられない。

【００５１】

図７は、壁２１に固定され（例えば、ネジを用いて）、壁上のドッキングステーション２３を支持するためにドッキング受け台２５上の装着ラグ４１（図４）と係合するように配置された装着ブラケット３９を用いて、代替の向きで壁２１上に装着されたドッキングステーション２３を示している。

【００５２】

キャッチハウジング３６は、摩擦嵌めでキャッチハウジング上に保持される間隙用ツール及び内装用ブラシのための装着点を組み込んでいる。

【００５３】

図８は、壁上の直立のドック位置にスティックバキューム掃除機１を固定するための代替の壁掛け可能なドッキングステーション２３０を示している。

【００５４】

この配置では、可搬型ユニット３は、ドッキング受け台２５０の形態の上部締め付け部材と、ごみ容器支持体３５０の形態の下部締め付け部材の間で直立のドック位置に確実に締め付けられる。締め付け荷重は、F_1及びF_2によって図８に表され、掃除機の重量と正反対にある。

【００５５】

ごみ容器支持体３５０は、使用時に好ましい壁固定を用いて示した向きで壁に対して平坦に固定される壁掛けプレート３７０（図９）に固定される。この特別の場合には、下部ごみ容器支持体３５０は、実際に壁掛けプレート３７０と一体的に形成されるが、これは必須ではない。係止要素３６０（図９）が、ごみ容器支持体３５０上に設けられ、これは、ごみ容器１５の前部上でキャッチ凹部１５ａ（図１１で少し見える）と係合し、ドック位置の横方向移動に対してごみ容器１５を固定する。「万能嵌め」ツールホルダ３４０は、ツール又は場合によってはワンド５を保持するために下部ごみ容器支持体３５０の下部に設けられる。

【００５６】

ドッキング受け台２５０は、ドッキング受け台２５と類似しているが、長さが短く、ドッキング受け台２５０も同様に緊密滑り嵌めでバッテリパック１７を受け取るように配置される。ブラインドスロット２７０は、ドッキング受け台２５０の前壁に設けられてハンドル１９を収容し、電源コンセント作動式充電ジャック２９０は、ハンドル１９（図８）の後方で充電ソケット３３と係合するように、スロット２７０のブラインド端に隣接してジャックホルダ３１０内に保持される。

【００５７】

ドッキング受け台２５０は、壁掛けプレート３７０に対して上下に移動してドッキング受け台２５０とごみ容器支持体３５０の間の（垂直）分離を変更することができる個別のキャリッジプレート３９０（図９）によって支持される。付勢バネ４１０（キャリッジプレート３９０の窓を通して図９で少し見える）は、キャリッジプレートと装着プレート３

７０との間でドッキング受け台２５０をごみ容器支持体３５０の方向に下方に付勢するように作用する。バネ４１０は、従って、ドッキング受け台２５０とごみ容器支持体３５０の間に正の締め付け作用をもたらし、これは、ドック位置で充電ジャック２９０と充電ソケット３３の間の確実な電気接点を維持するのに役立つ。

【００５８】

ドッキング受け台２５０は、支持ヨーク４３０を通じてキャリッジプレート３９０上にピボット回転可能に装着される。これは、ごみ容器支持体３５０（図１０参照）との締め付けアラインメントからドッキング受け台２５０を移動させるように、ドッキング受け台２５０が軸Ｏの周りでキャリッジプレート３９０から離れてピボット回転することを可能にする。

【００５９】

スティックバキューム掃除機１を図８に示すドック位置から解除するために、ユーザは、スティックバキューム掃除機を把持し、スティックバキューム掃除機１を上方に押し、係止要素３６０がごみ容器１５中のキャッチ凹部１５ａをクリアするまでバネ４１０の付勢に対してドッキング受け台２５０を移動させる。係止要素３６０がごみ容器１５上のキャッチ凹部１５ａをクリアした状態で、スティックバキューム掃除機１は、次に、装着プレートから離れてかつごみ容器支持体３５０との締め付けアラインメントから出て横方向にドッキング受け台２５０をピボット回転させるように操作することができ、これは、次に、バッテリパック１７が、掃除機１（図１１）を解除するためにごみ容器支持体３５０の前縁を過ぎてドッキング受け台２５０から摺動して出ることを可能にする。

【００６０】

図８に示すドック位置からのスティックバキューム掃除機１の解除は、ユーザが掃除機１を保持するのに片方の手、及びドッキングステーション２３０を作動させるのに他方の手を使用する必要がないという意味で片手作動である（ユーザは、勿論、掃除機１をドッキング又は解除する時に任意的に両手で掃除機１を把持することができ、実際にドッキングステーション２３０は、有利に人がそうすることを可能にする）。

【００６１】

ドッキングステーション２３０との掃除機１のドッキングも片手作動である。掃除機１の解除の後にドッキングステーション２３０と掃除機１をドッキングさせるために、バッテリパック１７は、単にドッキング受け台２５０に摺動して戻り、ドッキング受け台２５０は、次に、掃除機１を用いて移動され、下部ごみ容器支持体３５０（図１２及び１３）との締め付けアラインメントに戻る。この位置では、ユーザが掃除機１を手放すと、掃除機１は、圧縮バネ４１０の作用の下でドッキング受け台２５０とごみ容器支持体３５０との間で自動的に締め付けられ、係止要素３６０は、ごみ容器１５中のキャッチ凹部１５ａと係合する。

【００６２】

差込式電源コード３４０は、装着プレート３７０に成形されたチャンネル３７０ａを通って装着プレート３７０の背後で下方に延びている。チャンネル３７０ａの上端は、トランペット形状であり、これは、ドッキング受け台２５０のピボット回転移動中にコード３４０への応力を低減するのに役立つ。止め具３４０ａが、電源コード３４０上に設けられ、ドッキング受け台２５０が軸Ｏの周りでピボット回転される時にチャンネル３７０ａの内側の電源コード３４０の取り込みを防止し、止め具３４０ａの使用は、更に、電源コード３４０の長さがチャンネル３７０ａの上端とジャックホルダ２９０の間で固定されたままであることを保証することにより、電源コード３４０にかかる応力を低減する。

【００６３】

係止要素３６０には、傾斜前面３６０ａ（図１０）が設けられ、ドッキング受け台２５０が移動してごみ容器支持体３５０との締め付けアラインメントに戻る時にごみ容器１５が最初に係止要素３６０を超えることを可能にする。これは、ドッキング作動を簡略化するが、それは必須ではない。係止要素は、代替的に平坦な前面を有することができ、又は実際に固定係止要素とすることができ、これは、次に、ユーザが、掃除機１及びドッキン

グ受け台２５０を上方に押して、ドッキング受け台２５０が移動してごみ容器支持体３５０との締め付けアラインメントに戻る前にごみ容器１５が係止要素を完全にクリアすることを確実にする必要があるであろう。

【００６４】

ドッキングステーション２３０は、掃除機１が直立のドック位置で横方向の機械的衝撃を受ける場合、掃除機１及び／又はドッキングステーション２３０に対する偶然の損傷を低減するのに役立ついくつかの特徴を組み込んでいる。これらは、ごみ容器１５が横方向の衝撃力の下で係止要素３６０を横方向に超えることを可能にする係止要素３６０上の傾斜側面（側面３６０ｂのみが、図１０で見える）の具備と、同じくドッキング受け台２５０とキャリッジ３９０の間の横方向ある程度の「遊び」の具備とを含む。横方向荷重が、バネ４１０の付勢に対して垂直のドッキング受け台２５０の移動によって取り込まれるように、横方向力の下で掃除機１を上方に案内するガイド面（例えば、ごみ容器支持体３５０の湾曲面３５０ａ）も設けることができる。任意的に、ドッキング受け台２５０が結果的に軸Ｏの周りで外方に回転するように横方向力の下で掃除機１を案内するガイド面も設けることができ、その場合には、掃除機１は、十分な横方向荷重の下で「抜け出て」自動的に解除することができる。

【００６５】

図１２は、バッテリパック１７のドッキング受け台２５０への挿入を示しており、ドッキング受け台２５０は、ごみ容器支持体３５０との締め付けアラインメントから既に移動している。実際に、ドック位置からの掃除機１の解除の後に、ドッキング受け台２５０は、それ自体の重量の下で移動してごみ容器支持体３５０との締め付けアラインメントに戻る傾向があることになる。この場合には、図１４に示すように、ドッキング受け台２５０へのバッテリパック１７の部分的挿入は、それにも関わらず、掃除機１の片手ドッキングが依然として可能であるように、壁から離れてバッテリパック１７とのアラインメントに入るようにドッキング受け台２５０をピボット回転させる傾向があることになる。ドッキング受け台２５０のこの「自己アラインメント」は、バッテリパック１７が比較的浅い角度でドッキング受け台２５に挿入することを可能にするドッキング受け台２５０の比較的短い長さに一部は助けられる（図４から６のドッキング受け台２５０を参照）。付勢バネ（図示せず）は、必要に応じてドッキング受け台２５０を意図的に付勢して掃除機１の解除に続いてごみ容器支持体３５０との締め付けアラインメントに戻すのに使用することができると考えられる。

【００６６】

本発明によると、ドッキングステーション上の締め付け部材のいずれか又は両方は、弾力的付勢の作用に対して壁に対して移動するように装着することができる。例えば、ドッキングステーション２３０において、ドッキング受け台２５０は、壁に固定することができ、ごみ容器支持体３５０は、付勢バネの作用に対してドッキング受け台２５０に対して摺動移動するように装着することができるであろう。上部締め付け部材が固定される場合、下部締め付け部材は、図１１から１４のドッキング受け台２５０の作動と同様に、上部締め付け部材との締め付けアラインメントに入るか又は出るように移動可能にすることができる。ドッキングステーション２３の場合には、キャッチ３５及び／又はドッキング受け台２５はまた、締め付け部材として配置することができる。例えば、キャッチ３５は、係止位置でキャッチが実際にドッキング受け台２５に対して上方に掃除機１を積極的に締め付けるようにバネ付勢することができ、解除レバー３８は、必要に応じてドッキング受け台２５との締め付けアラインメントから出てキャッチ３５をピボット回転させるのに使用することができる。ドッキング受け台２５も、同様にバネ付勢し、掃除機をキャッチ３５に対して確実に締め付けることができる。

【００６７】

締め付け部材の一方（例えば、ドッキング受け台２５０）の他方の締め付け部材（例えば、ごみ容器支持体３５０）との締め付けアラインメントへの出入りの移動は、ピボット回転移動である必要はない。例えば、ドッキング受け台２５０は、ごみ容器支持体３５０

との締め付けアラインメントから出て横方向に摺動するように配置することができると考えられる。しかし、ピボット回転締め付け部材の使用は、ドッキングステーションの占有面積を最小にするのに役立つ。

【００６８】

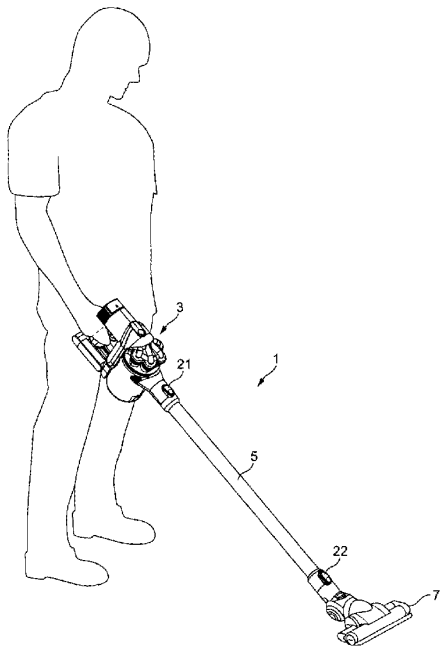
対向する締め付け部材との締め付けアラインメントに出入りして移動することができる第１の締め付け部材の使用は、有利であるが、片手ドッキング及び解除に対して必須ではない。例えば、ドッキング受け台２５０は、代替的に、摺動キャリッジプレート３９０に対してそれが固定ごみ容器支持体３５０との締め付けアラインメントに常に維持されるように固定することができると考えられる。固定ドッキング受け台は、ある程度までバッテリパックの挿入を抑制すると考えられ、これは、バッテリパック１７を非常に浅い角度で固定ドッキング受け台に挿入することができるようにドッキングの長さを最小にすることにより、必要に応じてある一定の範囲で軽減することができると考えられる。

【符号の説明】

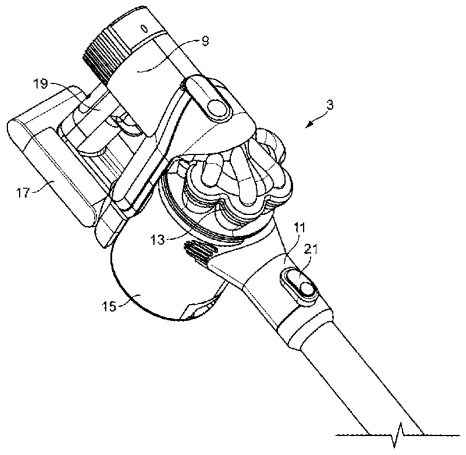
【００６９】

１　スティックバキューム掃除機
３　可搬型真空掃除機
５　細長ワンド
７　床ツール

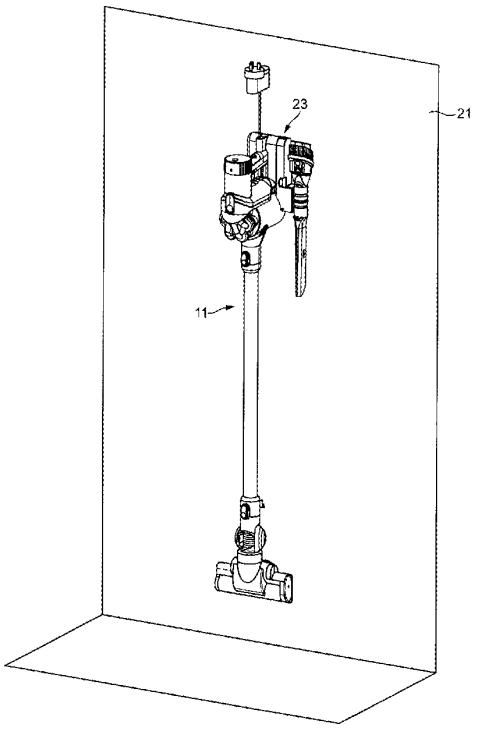
【図１】



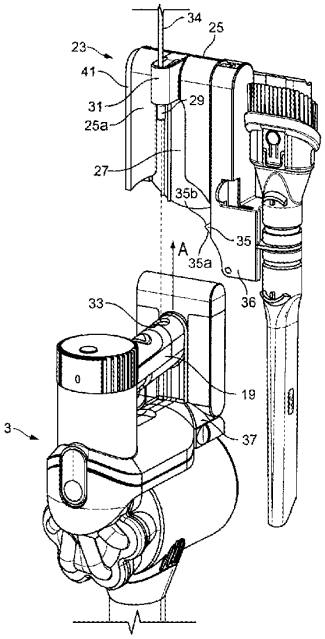
【図２】



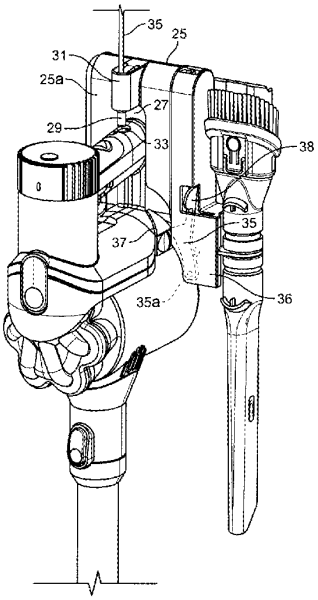
【図３】


21
23
11

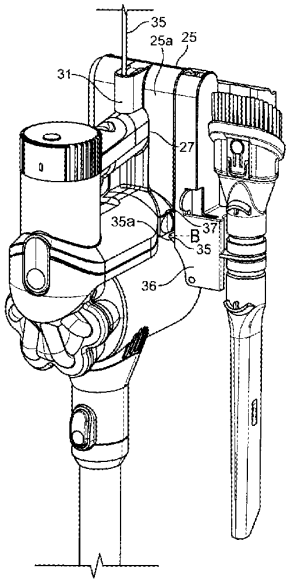
【図４】


34
25
23
41
31
29
25a
27
35b
35
A
35a
36
33
19
3
37

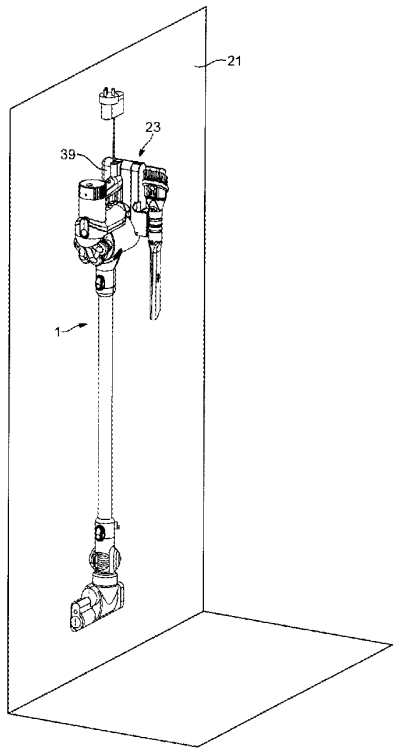
【図５】


35
25
31
25a
27
29
33
38
35
37
35a
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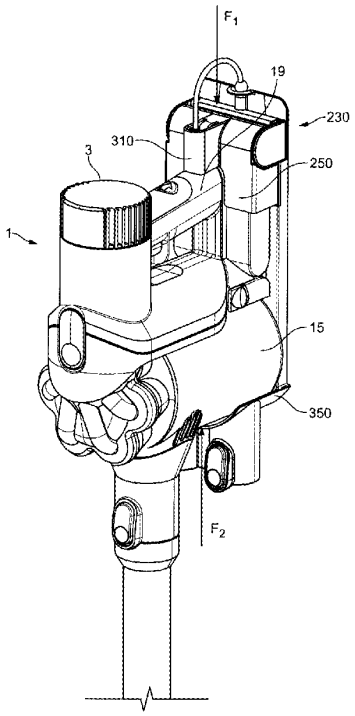
【図６】


35
25a
25
31
27
35a
B
37
35
36

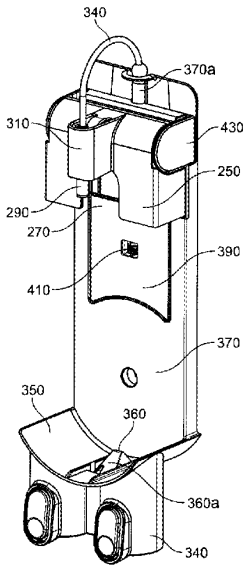
【図７】


21
23
39
1

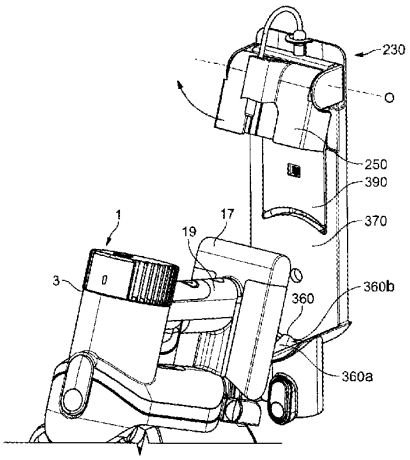
【図８】


F1
19
230
310
3
250
1
15
350
F2

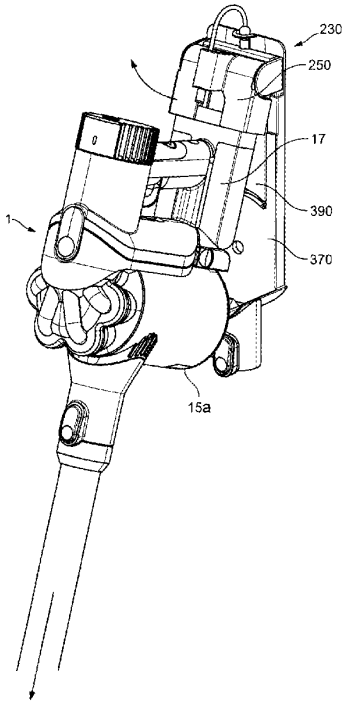
【図９】


340
370a
310
430
250
290
270
390
410
370
350
360
360a
340

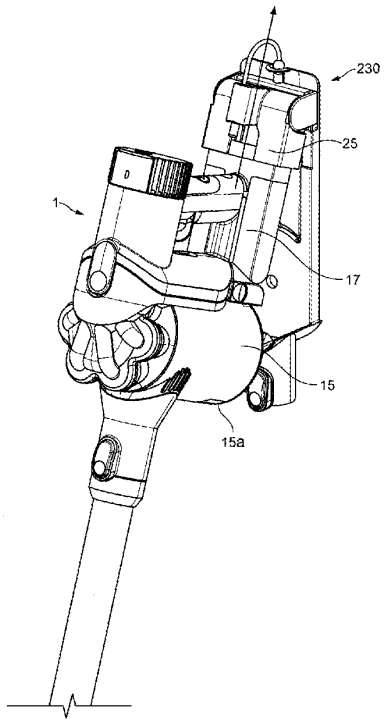
【図１０】


230
O
250
390
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17
19
370
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360b
360
360a

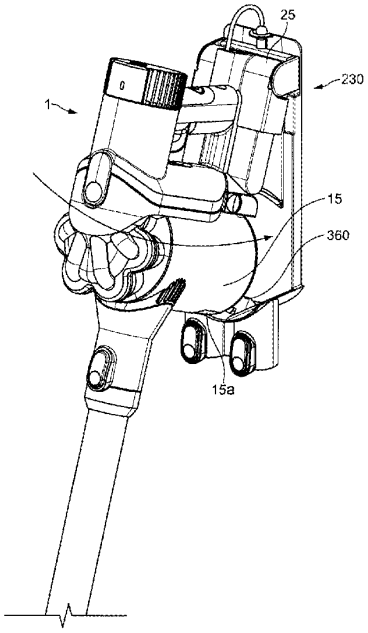
【図１１】



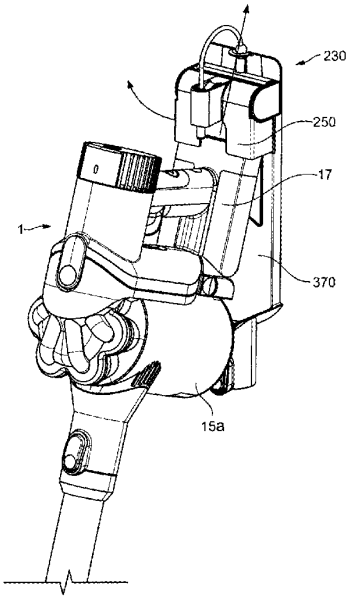
【図１２】



【図１３】



【図１４】



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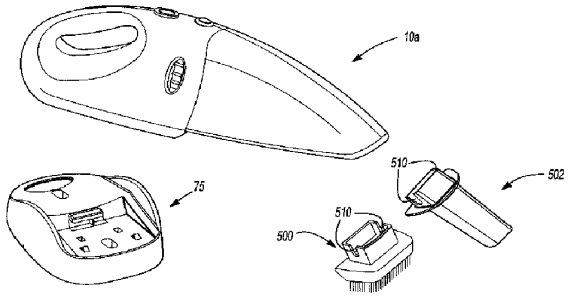
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(54) ASPIRATEUR AMELIORE A MAIN SANS CORDON
(54) IMPROVED HAND-HELD CORDLESS VACUUM CLEANER

(57)

A hand-held vacuum cleaner with a container for the storage of dirt and debris therein. To provide improved efficiency and performance, the hand-held vacuum may employ a primary HEPA filter, a device for swirling a dirt and debris laden air flow and/or a mechanized filter cleaning device. Swirling may be employed to direct entrained dirt and debris in a desired direction relative to the container to slow the rate with which dirt and debris accumulates on the primary filter and/or to centrifugally remove dirt and debris from the air flow. Mechanized cleaning is employed to shake, scrape or otherwise remove accumulated dirt and debris from the primary filter.



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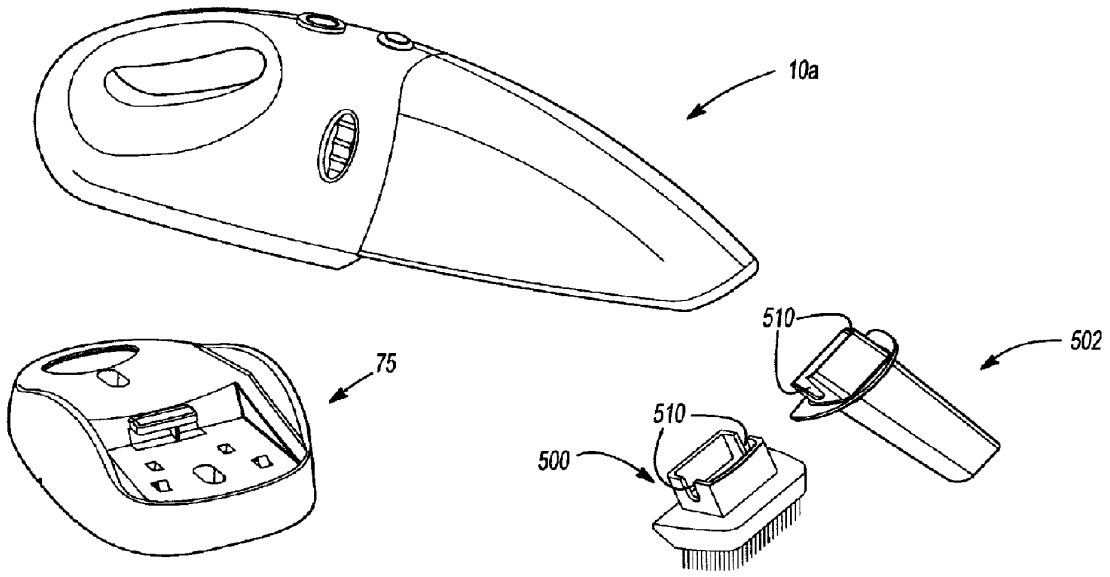
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(57) Abrégé/Abstract:
A hand-held vacuum cleaner with a container for the storage of dirt and debris therein. To provide improved efficiency and performance, the hand-held vacuum may employ a primary HEPA filter, a device for swirling a dirt and debris laden air flow and/or a mechanized filter cleaning device. Swirling may be employed to direct entrained dirt and debris in a desired direction relative to the container to slow the rate with which dirt and debris accumulates on the primary filter and/or to centrifugally remove dirt and debris from the air flow. Mechanized cleaning is employed to shake, scrape or otherwise remove accumulated dirt and debris from the primary filter.

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ABSTRACT OF THE DISCLOSURE

A hand-held vacuum cleaner with a container for the storage of dirt and debris therein. To provide improved efficiency and performance, the hand-held vacuum may employ a primary HEPA filter, a device for swirling a dirt and debris laden air flow and/or a mechanized filter cleaning device. Swirling may be employed to direct entrained dirt and debris in a desired direction relative to the container to slow the rate with which dirt and debris accumulates on the primary filter and/or to centrifugally remove dirt and debris from the air flow. Mechanized cleaning is employed to shake, scrape or otherwise remove accumulated dirt and debris from the primary filter.

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HAND-HELD CORDLESS VACUUM CLEANER

INTRODUCTION

[0001] The present invention generally relates to hand-held portable vacuum cleaners and improvements thereto.

[0002] Typically, hand-held portable vacuum cleaners employ a motor that is powered by either a main supply of electricity (i.e., a source of alternating current power) or a battery pack, which may be rechargeable, to drive an impeller. Rotation of the impeller generates an air flow which entrains therein dirt and debris which enter the vacuum cleaner via an inlet. One or more filters may be employed to retain the dirt and debris within the vacuum.

[0003] One problem with such vacuum cleaners concerns the relatively rapid rate with which the efficiency and performance of such vacuum cleaners may deteriorate. Specifically, the use of such vacuums to collect relatively small sized particles can rapidly load the filter and substantially reduce the amount of air that passes therethrough. When filter loading is encountered in the known hand vacuum configurations, the user must disassemble the vacuum, remove the filter, clean (or dispose of and replace) the filter and replace the filter. In some situations, the user may be reluctant to perform the tasks of removing and cleaning the filter due to the unwholesomeness of the material that has accumulated on the filter. In situations where the filter is heavily loaded, the vacuum will have a relatively low efficiency and consequently, vacuuming tasks

will take longer, the vacuum will experience greater wear, and if battery powered, the user will be able to perform relatively fewer vacuuming tasks per charge.

SUMMARY OF THE INVENTION

[0004] In one form, the present teachings provide a hand-held portable vacuum having a housing, an impeller that is at least partially disposed in the housing, a dirt cup and a HEPA filter. The dirt cup, which is removably attached to the housing, includes an inlet and defines a container for storage of dirt and debris therein. The HEPA filter is disposed between the impeller and the inlet.

[0005] In another form, the present teachings provide provides a method for filtering a dirt and debris laden air flow. The method includes: providing a hand-held vacuum with a housing, an impeller, an inlet, a container and a primary filter, the housing including a handle that permits a user to employ the hand-held vacuum for vacuuming with a single hand, the impeller being disposed within the housing, the inlet being configured to receive the dirt and debris laden air flow therethrough, the container being configured to retain dirt and debris removed from the dirt and debris laden air flow and the primary filter being disposed between the impeller and the inlet; rotating the impeller to generate the dirt and debris laden air flow; and swirling the dirt and debris laden air flow about the interior of the container.

[0006] In yet another form, the present teachings provide a hand-held portable vacuum including a housing with a handle, a dirt cup, an impeller at least partially disposed in the housing, a filter and a filter cleaning device. The dirt cup,

which is removably attached to the housing, has an inlet and defines a container for storage of dirt and debris therein. The filter, which is disposed between the impeller and the inlet, is formed with a plurality of pleats. The filter cleaning device is coupled to at least one of the housing and the dirt cup and includes at least one rib and a hub. The hub is coupled to one of the filter and the rib and configured to rotate the one of the filter and the rib about the other one of the filter to generate contact between the rib and the filter to at least partially dislodge accumulated dirt and debris from the pleats.

[0007] In a further form, the present teachings provide a hand-held portable vacuum including a housing with a handle, a dirt cup, an impeller, a filter and a means for swirling the dirt and debris laden air in the dirt cup. The dirt cup, which is removably attached to the housing, has an inlet and defining a container for storage of dirt and debris therein. The impeller is at least partially disposed in the housing and operable for generating an air flow that flows through the inlet. The filter is disposed between the impeller and the inlet.

[0008] Further areas of applicability of the present teachings will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Additional advantages and features of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, wherein:

[0010] Figure 1 is a perspective view of a vacuum kit constructed in accordance with the teachings of the present invention;

[0011] Figure 2 is a side elevation view of a portion of the vacuum kit of Figure 1 illustrating the vacuum in greater detail;

[0012] Figure 3 is a longitudinal section view of the vacuum of Figure 2;

[0013] Figure 4 is a perspective view of a portion of the vacuum of Figure 2 illustrating the dirt cup in greater detail;

[0014] Figure 5 is a longitudinal section view of the dirt cup of Figure 4;

[0015] Figure 6 is a longitudinal section view of a portion of the vacuum of Figure 2 illustrating the dirt cup assembly in greater detail;

[0016] Figure 7 is a sectional view taken along the line 7-7 of Figure 6;

[0017] Figure 8 is a perspective view illustrating the interior of the dirt cup assembly;

[0018] Figure 9 is a perspective view of a portion of the dirt cup assembly illustrating the elbow in greater detail;

[0019] Figure 10 is a top view of a portion of the vacuum of Figure 2 illustrating the housing assembly in greater detail;

[0020] Figure 11 is a side elevation view of a portion of the housing assembly illustrating a housing shell in greater detail;

[0021] Figure 12 is an exploded perspective view of a portion of the housing assembly;

[0022] Figure 13 is a elevation view of a portion of the vacuum of Figure 2 illustrating the exhaust grille in greater detail;

[0023] Figure 14 is section view taken along the line 14-14 of Figure 13;

[0024] Figure 15 is a side elevation view of a portion of the vacuum of Figure 2 illustrating the cleaning wheel in greater detail;

[0025] Figure 16 is a front elevation view of the housing assembly;

[0026] Figure 17 is a side elevation view of the housing assembly;

[0027] Figure 18 is a perspective view of a portion of the housing assembly illustrating the prefilter in greater detail;

[0028] Figure 19 is a longitudinal section view of the prefilter;

[0029] Figure 20 is a longitudinal section view of the primary filter;

[0030] Figure 21 is a longitudinal section view of a portion of the housing assembly illustrating the second seal portion of the primary filter in sealing engagement with the prefilter;

[0031] Figure 22 is an exploded perspective view of the vacuum and recharging base of Figure 1;

[0032] Figure 23 is an exploded perspective view of the vacuum and recharging base illustrating one means by which the vacuum and recharging base may be keyed to one another;

[0033] Figure 24 is a schematic illustration of a portion of an injection mold for forming the mating key that is associated with the vacuum in the example provided;

[0034] Figure 25 is a perspective view of a family of vacuums and recharging bases constructed in accordance with the teachings of the present invention;

[0035] Figure 26 is a perspective view of an alternately constructed prefilter;

[0036] Figure 27 is a longitudinal section view similar to that of Figure 3 but illustrating the prefilter of Figure 26;

[0037] Figure 28 is a perspective view of another alternately constructed prefilter;

[0038] Figure 29 is a perspective view of an alternately constructed vacuum;

[0039] Figure 30 is an exploded perspective view of the vacuum of Figure 29;

[0040] Figure 31 is a partial longitudinal section view of another alternately constructed vacuum illustrating a lock-out device for inhibiting the operation of the cleaning wheel;

[0041] Figure 32 is a schematic illustration of another alternately constructed vacuum illustrating an electronic lock-out device for inhibiting the operation of the motor when the cleaning wheel is rotated;

[0042] Figure 33 is a sectional view taken along the line 33-33 of Figure 32;

[0043] Figure 34 is a schematic illustration of yet another alternately constructed vacuum illustrating a drive system for rotating the cleaning wheel under a source of power;

[0044] Figure 35 is a schematic illustration of still another alternately constructed vacuum illustrating another drive system for rotating the cleaning wheel under a source of power;

[0045] Figure 36 is an exploded perspective view of a portion of the vacuum of Figure 2 illustrating the battery pack and motor assembly in greater detail;

[0046] Figure 37 is another exploded perspective view of the battery pack and motor assembly;

[0047] Figure 38 is an exploded side elevation view of the battery pack and motor assembly;

[0048] Figure 39 is a bottom plan view of the battery pack as coupled to the motor assembly;

[0049] Figure 40 is an exploded perspective view of an alternately constructed primary filter;

[0050] Figure 41 is a longitudinal section view of the primary filter of Figure 40;

[0051] Figure 42 is an exploded perspective view of another alternately constructed primary filter;

[0052] Figure 43 is a longitudinal section view of the primary filter of Figure 42;

[0053] Figure 44 is an exploded perspective view of yet another alternately constructed primary filter;

[0054] Figure 45 is a longitudinal section view of the primary filter of Figure 44;

[0055] Figure 46 is a rear view of another prefilter constructed in accordance with the teachings of the present invention;

[0056] Figure 47 is a bottom view of the prefilter of Figure 46; and

[0057] Figure 48 is a perspective view of yet another prefilter constructed in accordance with the teachings of the present invention.

DESCRIPTION OF VARIOUS EMBODIMENTS

[0058] With reference to Figure 1 of the drawings, a vacuum kit constructed in accordance with the teachings of the present invention is generally indicated by reference numeral 10. The vacuum kit 10 may include a hand-held cordless vacuum 10a and an optional set of accessories 10b. With reference to Figures 2 and 3, the vacuum 10a may include a dirt cup assembly 12 and a housing assembly 14. In the particular example provided, the dirt cup assembly 12 includes an inlet housing or dirt cup 20 and an elbow 22, while the housing

assembly 14 may include motor assembly 30, an outlet housing or housing 32, a filter system 34, a filter cleaning system 36 and a latch release 38 having a conventional latch mechanism 40 and a conventional retaining tab 42 that may be integrally formed with the housing 32.

[0059] In Figures 4 and 5, the dirt cup 20 includes a wall member 50 that defines a container-like housing structure 52 and an inlet port 54 that may be formed through the housing structure 52 and which may extend rearwardly therefrom. A pair of securing apertures 56a and 56b may be formed in and through the housing structure 52, respectively, and a plurality of prefilter locating tabs 58 may extend inwardly from the wall member 50 about the inside perimeter of the housing structure 52. Both the securing apertures 56a and 56b and the prefilter locating tabs 58 will be discussed in additional detail, below.

[0060] The inlet port 54 may have a generally rectangular cross-sectional shape that extends rearwardly from the housing structure 52 and terminates at a rearward face 60. As will be discussed in greater detail, below, the front end of the inlet port 54 may be configured to frictionally engage various components of the accessory set 10b (Fig. 1), while the rear end of the inlet port 54 may be configured to frictionally engage the elbow 22, which is shown in Figure 6.

[0061] With reference to Figures 6 through 9, the elbow 22 may include an attachment portion 62 that may be sized to frictionally but removably engage the rear end of the inlet port 54 and a body portion 64 that turns the incoming air flow in a desired manner as will be discussed in greater detail, below. The body

portion 64 may be sized so as not to choke or diffuse the air flow that is provided through the inlet port 54. The interior of the dirt cup 20 (i.e., a cross section taken perpendicular to the longitudinal axis of the dirt cup 20) may be at least somewhat circular in shape (i.e., lacking sharp corners - see, Figure 7) so as to promote the swirling of the inlet air flow about the longitudinal axis of the dirt cup 20.

[0062] In Figure 3, the motor assembly 30 may include a motor 70, a fan assembly 72, a battery pack 74 and a power switch 76. The motor 70 may be a conventional DC motor having a motor output shaft 88. The fan assembly 72 may be a conventional centrifugal fan that includes a fan or impeller 90, which may be coupled for rotation with the output shaft 88, and a fan housing 92. The fan housing 92 includes an inlet aperture 94 that may be centered about the rotational axis of the impeller 90, and one or more discharge apertures 96, which may be located on a bottom side of the fan housing 92 generally transverse to the inlet aperture 94. Air that is discharged from the discharge aperture 96 may be guided through an associated flow channel 98 that is also integrally formed with the fan housing 92 in the particular example provided. The flow channel 98 may direct the air downwardly and somewhat rearwardly.

[0063] The battery pack 74 conventionally includes a plurality of rechargeable batteries 100, which are adapted to be electrically coupled to a source of electrical power, as through the recharging base 75 that is illustrated in Figure 1. The battery pack 74 may be coupled to the motor 70 and the power switch 76 in a conventional and well known manner. In the alternative, the battery

pack 74 may be coupled to the motor 70 by way of an integrated snap connector 108 as illustrated in Figures 36 through 39. The snap connector 108 may have a first portion 108a that may be integrated with the motor 70 and a second portion 108b that may be integrated with the battery pack 74. The first portion 108a may include a circuit board 110 with a plurality of terminals, such as blade-type male terminals 112. The circuit board 110 may include all of the integrated circuits and solid state components that are employed for controlling the distribution of electrical power from the battery pack 74 to the motor 70, as well as for controlling the charging of the battery pack 74 (e.g., timers). The second portion 108b may include a plurality of mating terminals, such as blade receiving terminals 114, that matingly engage the terminals of the first portion 108a. In the particular embodiment illustrated, the blade receiving terminals 114 slidably receive the blade-type male terminals 112 to permit the motor assembly 30 to be coupled to the battery pack 74 prior to their installation to the housing 32.

[0064] The battery pack 74 may further include a housing 120 having a pair of engagement features 122 that co-engage mating features 124 (Fig. 11) to permit the battery pack 74 to be coupled to the housing 32 without separate fasteners, etc. In the particular embodiment illustrated, the engagement features 122 are tabs and the mating features 124 are slots that are configured to receive an associated one of the tabs to thereby fixedly but removably couple the battery pack 74 to the housing 32. At least one of the tabs may be a cross-tab (i.e., a tab with two portions that are skewed to one another) that is configured to engage an

associated mating feature 124 in a manner that inhibits vertical and horizontal movement of the cross-tab relative to the associated mating feature 124. In the particular embodiment illustrated, the structure into which the cross-tab is received defines a cross-slot (i.e., a slot with two portions for receiving the two portions of the cross-tab), but as those skilled in the art will appreciate from this disclosure, one portion of the cross-tab may be disposed in the slot while the other portion of the cross-tab abuts an end of the structure that defines the slot. Additionally, the housing 120 may house a pair of charging terminals 126 that may be configured to extend through the housing 32 so as to be accessible by the recharging base 75 (Fig. 1) when the vacuum 10a is coupled thereto.

[0065] One suitable power switch 76 is described in detail in U.S. Patent No. 5,544,274, which is hereby incorporated by reference as if fully set forth herein. Briefly, the power switch 76 may include a conventional slide switch 76a that selectively enables or disables the transmission of electric power therethrough to close or open the electrical circuit between the batteries 100 and the motor 70. The slide switch 76a may be fixedly coupled to the circuit board 110 in the particular example provided and employed to move contacts into and out of electrical connection with terminals on the circuit board 110.

[0066] With reference to Figures 3, 10 and 11, the housing 32 of the particular embodiment provided may include a pair of housing shells 150a and 150b and an exhaust deflector 154. The housing shells 150a and 150b may be configured to be coupled together in a conventional and well known manner to

define a switch mounting structure 160, a switch aperture 162, a latch mounting structure 164, the retaining tab 42 and a handle 168. The switch mounting structure 160 may be conventionally configured to receive therein and support the power switch 76 of the motor assembly 30 such that the power switch 76 extends through the switch aperture 162 so as to be actuate-able by the user of the vacuum 10a.

[0067] The latch mounting structure 164 may be configured to receive therein and support a conventional latch mechanism 40 having a latch member 170 for engaging the securing aperture 56a in the housing structure 52 of the dirt cup assembly 12 and a spring (not shown) for biasing the latch member 170 upwardly relative to the housing 32.

[0068] The retaining tab 42 extends outwardly from the housing 32 and defines an abutting wall 174. The retaining tab 42 may be configured to project through the securing aperture 56b when the dirt cup assembly 12 is coupled to the housing assembly 14 to permit the abutting wall 174 to cooperate with the rear edge of the securing aperture 56b to thereby limit forward movement of the dirt cup assembly 12 relative to the housing assembly 14.

[0069] In the example provided, the handle 168 is integrally formed with the housing shells 150a and 150b and may extend between the forward and rearward portions of the housing 32 and above the body of the housing 32 to define therebetween a handle aperture 180 that is sized to receive the hand of the user of the vacuum 10a. Those skilled in the art will appreciate, however, that the handle

168 may be otherwise positioned and/or a discrete component that is joined or fastened to the remainder of the housing 32 in a known manner.

[0070] Except as noted below, each of the housing shells 150a and 150b may be constructed in an identical manner so that further description of the housing shell 150a will suffice for both. With primary reference to Figure 11 and additional reference to Figure 12, the housing shell 150a includes a wall member 186 that may define a front wall 188, a central cavity 196, an exhaust cavity 200 and a recessed area 202 through which an elliptical through-hole 204 is formed. The wall member 186 may also define a motor mount 206 and a hub mount 208, both of which being disposed in the central cavity 196.

[0071] The motor mount 206 may include first and second mount portions 206a and 206b, respectively, that are employed to fixedly couple the motor 70 to the housing 32. The motor mount 206 may be configured to receive the motor 70 in a snap-fit manner so that discrete fasteners and the like are not required.

[0072] The hub mount 208 may include structure which, in association with the fan housing 92 in the example provided, serves to maintain the filter cleaning system 36 in a desired location along a longitudinal axis of the vacuum 10a relative to the filter system 34. In the example provided, the hub mount 208 includes first and second bearing portions 208a and 208b, respectively, which are axially spaced apart along an axis that is coincident with a rotational axis of the motor 70. The first bearing portion 208a may be semi-circular in shape so as to form a circular aperture when the housing shells 150a, 150b are coupled to one

another. The second bearing portion 208b may include a rear wall 210 that may be generally transverse to the rotational axis of the motor 70.

[0073] As is apparent from the discussion above, the fan housing 92 may form the inlet aperture 94 and one or more discharge apertures 96 through which air is introduced and discharged, respectively, from the fan assembly 72. In the particular example provided, the fan housing 92 forms a volute that terminates at the discharge aperture 96. The flow channel 98 may serve as a fluid conduit which couples the discharge aperture 96 with the exhaust cavity 200.

[0074] With specific reference to Figure 13, the exhaust deflector 154 may include a frame 270 and a plurality of flow guiding vanes 272 that are set into the frame 270 and fixedly coupled thereto. The flow guiding vanes 272 of the particular embodiment illustrated are shaped so as to direct the air exiting the exhaust cavity 200 both downwardly and rearwardly.

[0075] With additional reference to Figures 3 and 14, the frame 270 of the exhaust deflector 154 may extend upwardly of the flow guiding vanes 272 to create a pocket 276 into which may be fitted an optional exhaust filter 280. The exhaust filter 280 operates to filter the air that exits the exhaust cavity 200 and thereby prevents fine dust particles from being expelled from the vacuum 10a. The exhaust filter 280 may be formed from a non-woven mesh fabric so as to be washable should it become undesirably dirty or clogged. Those skilled in the art will appreciate from this disclosure, however, that the exhaust filter 280 may be formed from another washable filter media or may alternately be a disposable type

filter (e.g., paper). Those skilled in the art will also appreciate from this disclosure that the exhaust filter may be configured to provide HEPA (high efficiency particulate air) filtration or ULPA (ultra low penetration air) filtration. As used herein, a "HEPA" filter will be understood as being capable of removing 99.97% of particles as small as 0.3 μm from an air flow, while a "ULPA" filter will be understood as being capable of removing 99.999% of particles as small as 0.12 μm from an air flow.

[0076] Returning to Figures 3 and 13, the frame 270 may also include a pair of trunnions 284 and a pair of clip structures 286. The trunnions 284 permit the exhaust deflector 154 to be pivotably coupled to the housing 32. More specifically, each of the housing shells 150a and 150b may include a recess (not specifically shown) for receiving an associated one of the trunnions 284. Each trunnion 284 is illustrated as being coupled to a portion of the frame 270 that may be deflected laterally inward (i.e., toward the centerline of the exhaust deflector 154) so that the trunnions 284 may be installed to their respective recess when the housing shells 150a and 150b are coupled to one another. With the trunnions 284 engaged to recesses, the exhaust deflector 154 may be pivoted between a closed position, wherein the rear surface of the exhaust deflector 154 covers the exhaust cavity 200, and an open position, wherein the exhaust deflector 154 substantially clears the exhaust cavity 200.

[0077] The clip structures 286 are configured to resiliently deflect in response to the application of a modest force to the exhaust deflector 154 to

permit the exhaust deflector 154 to be secured to or released from the wall member 186 when the exhaust deflector 154 is moved into or out of the closed position. As will be apparent to those of ordinary skill in the art, engagement of the clip structures 286 to the wall member 186 effectively maintains the exhaust deflector 154 in the closed position. Those skilled in the art will also appreciate that features such as recesses or tabs 288 may be formed into the wall member 186 to serve as points that enhance or improve the ability of the clip structures 286 to engage the wall member 186.

[0078] Returning to Figures 3 and 13, the top of the frame 270 of the exhaust deflector 154 may be arcuately shaped to define a finger grip 290 that is configured to receive the thumb or finger of the user of the vacuum 10a so that the thumb or finger may be employed to move the exhaust deflector 154 out of the closed position. The finger grip 290 may include a gripping feature, such as a raised lip, that permits the user to pry downwardly and outwardly on the exhaust deflector 154 with their thumb or finger to thereby disengage the clip structures 286 from the wall member 186.

[0079] With renewed reference to Figure 12, the filter cleaning system 36 may include a cleaning wheel 300 that housed by the housing 32. With additional reference to Figures 3, 15 and 16, the cleaning wheel 300 may be generally hollow and may include a gripping portion 302, a hub portion 304, a filter drive portion 306 and a filter engagement portion 308. The gripping portion 302 may be an annular ring that may be coupled to the rearward side of the hub portion 304 and which

may include a plurality of circumferentially spaced apart recesses 310. The hub portion 304 may define a bearing surface 312 that may be journally supported by the housing 32. The filter drive portion 306 may be formed on a wall 314 that is coupled to the hub portion 304 generally transverse to the bearing surface 312.

[0080] In the particular example provided, the filter drive portion 306 includes a plurality of radially extending drive tabs 316 that are circumferentially spaced apart from one another and collectively oriented concentric with the bearing surface 312. Those skilled in the art will appreciate from this disclosure, however, that the filter engagement portion 308, through frictional engagement or other engagement with the primary filter 414, may also serve in whole or in part as the filter drive portion 306.

[0081] The filter engagement portion 308 may be an elongated annular structure that may extend forwardly from the wall 314 of the filter drive portion 306. The cleaning wheel 300 may also include a grille 320 which inhibits the passage of relatively large objects from passing through the cleaning wheel 300 and contacting the impeller 90.

[0082] The cleaning wheel 300 may be installed over the fan housing 92 prior to the installation of the motor 70 and fan assembly 72 to the housing 32, thereby permitting these components to be collectively assembled to one of the housing shells (e.g., housing shell 150a) substantially simultaneously. The cleaning wheel 300 may be positioned relative to the housing 32 such that gripping portion 302 partially extends through the elliptical through-holes 204 in the

recessed areas 202 of the housing 32 as shown in Figure 17. Once the cleaning wheel 300 has been installed to the housing 32, movement of the cleaning wheel 300 in an axial direction along the rotational axis of the motor 70 may be limited through contact between the gripping portion 302 and housing 32 along the perimeter of the elliptical through-holes 204. Additionally or alternatively, contact with the fan housing 92 and the rear wall 210 of the second bearing portion 208b (Figure 11) may be employed to limit movement of the cleaning wheel 300 axially along the rotational axis of the motor 70.

[0083] The first and second bearing portions 208a and 208b of the hub mount 208, however, cooperate with the bearing surface 312 to limit the movement of the cleaning wheel 300 vertically and horizontally relative to the rotational axis of the motor 70, but permit the cleaning wheel to be rotated about the rotational axis of the motor 70. The recesses 310 in the gripping portion are specifically configured to be gripped by the thumb and/or fingers of a user of the vacuum 10a to rotate the cleaning wheel 300.

[0084] In Figures 3 and 12, the filter system 34 may include an intake filter 400 and the above-discussed optional exhaust filter 280. The intake filter 400 may include a prefilter 412 and a primary filter 414. In Figure 18 and with additional reference to Figures 10 and 16, the prefilter 412 may include a filter flange 420, a prefilter body 422 and a securing means 424 for releasably securing the prefilter 412 to the housing 32. The filter flange 420 may extend radially outwardly from the prefilter body 422 and may be configured to abut the front face 188 of the

housing 32. The filter flange 420 may be unitarily formed with the remainder of the prefilter 412 from a material that is structural, such as polyethylene or polpropylene. Those skilled in the art will appreciate, however, that the filter flange 420 could alternatively include a resilient band of material (not shown) that is coupled to the remainder of the filter flange 420, via a mechanical connection, adhesives or overmolding, and employed to sealingly engage at least one of the housing 32 and the dirt cup 20.

[0085] With additional reference to Figure 19, the prefilter body 422 may have a truncated cone shape, with a front wall 430 and a side wall 432 that has a plurality of filtering apertures 434 formed therethrough. The filtering apertures 434 may be sized to prevent relatively coarse dirt and debris from contacting the primary filter 414 (Fig. 3). In the example provided, the filtering apertures 434 are about 0.020 inch (0.5 mm) to about 0.040 inch (1.0 mm) in diameter. In the particular embodiment provided, one or more ribs 436 are formed on the interior surface 438 of the side wall 432. The ribs 436 will be discussed in greater detail, below.

[0086] As those of ordinary skill in the art will appreciate from this disclosure, any appropriate means may be employed to removably couple the filter flange 420 to one or both of the housing 32 and the dirt cup 20. Preferably, the securing means 424 will not automatically detach from the housing 32 when the dirt cup 20 is removed from the housing 32.

[0087] In the particular example provided, the securing means 424 is illustrated in Figure 18 to include a plurality of holes 440 that are configured to receive therethrough corresponding pegs 442 that extend from the front face 188 of the housing 32 as illustrated in Figure 16. The holes 440 may be shaped to directly correspond to the shape of the pegs 442, but in the example illustrated, include first and second portions 440a and 440b, respectively, that intersect one another. The first portion 440a is relatively large and configured to receive therethrough an associated peg 442, which is illustrated in Figure 10 to include a relatively large head portion 442a and a somewhat smaller body portion 442b. In contrast, the second portion 440b is configured only to receive therethrough the body portion 442b of the associated peg 442. Accordingly, once the prefilter 412 has been installed over the pegs 442, it may be rotated to position the body portion 442b of the pegs 442 into the second portion 440b of the holes 440. As the head portion 442a of the pegs 442 is relatively larger than the second portion 440b, the filter flange 420 will remain attached to the housing 32 when the dirt cup 20 is removed, unless the filter flange 420 is rotated to align the pegs 442 with the first portion 440a of the holes 440.

[0088] To guard against undesired rotation of the filter flange 420 relative to the housing 32 when the dirt cup 20 has been removed from the rear housing, the securing means 424 may include a resilient finger 440c that contacts the body portion 442b of an associated peg 442 to inhibit rotation of the filter flange 420

unless a force in excess of a predetermined force has been applied to rotate the filter flange 420 in a desired rotational direction relative to the housing 32.

[0089] In Figure 20, the primary filter 414 may have a filter body 450 with first and second seal portions 452 and 454, respectively, disposed on opposite sides thereof. The filter body 450 may have a shape that is similar to that of the prefilter body 422 (Fig. 19) and in the example provided, is illustrated to have a truncated cone shape. The filter body 450 may be formed from any appropriate filter media, such as paper, plastic or fabric and is preferably formed with a plurality of pleats 460. Also preferably, the filter media is wear resistant or includes a wear resistant outer layer 462. Furthermore, the filter body 450 is preferably formed from a filter media that provides HEPA or ULPA filtration. One such suitable filter media is manufactured by W. L. Gore & Associates, a Delaware Corporation having a place of business in Elkton, Maryland.

[0090] In the example provided, the pleats 460 are formed such that their outer ends or peaks 464 lie along a straight line that intersects the axis of a theoretical cone (not shown) that includes the peak 464 of each pleat 460 on the filter body 450. Alternatively, the pleats 460 may be formed such that their peaks 464 are straight but skewed to the axis of the theoretical cone or generally helical in shape. For reasons that will be apparent from the discussion below, however, the pleats 460 should be formed relative to the theoretical cone in a manner that is consistent with the ribs 436 on the interior surface 438 of the filter housing 432.

[0091] The first seal portion 452, which is coupled to the smaller end of the filter body 450, may be a plate-like structure that is formed from a suitable material and is sealingly bonded to a lower end of the filter body 450. Alternatively, the first seal portion 452 may be wholly or partially formed from an appropriate filter material, such as the material from which the filter body 450 is manufactured, and bonded or otherwise sealingly coupled to the filter body 450.

[0092] The second seal portion 454 may be an annular flange that may be sealingly bonded to an upper end of the filter body 450. With additional reference to Figures 12 and 21, the second seal portion 454 may include a body 470 that defines a receiving aperture 472, a primary seal 474 which is disposed about the perimeter of the receiving aperture 472 and sized to sealingly engage the seal engaging portion 308 of the cleaning wheel 300 (Fig. 15), a secondary seal 476 that sealingly engages the interior surface 436 of the prefilter body 422 of the prefilter 412, and a plurality of drive tabs 478. The drive tabs 478, which extend radially outward and are circumferentially spaced apart from one another, are configured to engage the drive tabs 316 that are formed on the filter drive portion 306 of the cleaning wheel 300.

[0093] With the primary filter 414 installed to the cleaning wheel 300 such that the primary seal 474 sealingly engages the seal engaging portion 308 and the drive tabs 316 and 478 are meshingly engaged with one another, the prefilter 412 may be positioned over the primary filter 414 such that the first portion 440a of the through-holes 204 in the filter flange 420 are aligned to the pegs 442 on the

housing 32. The prefilter 412 may be urged toward the housing 32 such that the pegs 442 are fitted through the through-holes 204 and thereafter the prefilter 412 is rotated to position the pegs 442 within the second portion 440b of the through-holes 204. With the dirt cup 20 coupled to the housing assembly 14, the prefilter locating tabs 58 urge the filter flange 420 rearwardly toward the front face 188 of the housing 32 so that the secondary seal 476 sealingly engages the prefilter body 422 of the prefilter 412.

[0094] While the primary filter 414 has been illustrated and described as including first and second seal portions 452 and 454 which are bonded directly to the filter body 450, the primary filter 414 may be formed in various other manners. For example, the primary filter 414 may include a pair of discretely formed, caps 480a and 480b as illustrated in Figures 40 and 41. The cap 480a may be generally cup shaped, with a closed top 482 and a side wall 484 with a plurality of teeth 486 formed about the inside perimeter of the side wall 484. The cap 480b may be an annular ring that similarly includes a plurality of teeth 488 formed about its inside perimeter. The caps 480a, 480b may be secured to the opposite ends of the filter body 450 through an adhesive, heat staking or sonic welding, for example, so that the teeth 486 and 488 of the caps 480a and 480b meshingly engage the pleats 460 of the filter media. The first seal portion 452 may be integrally formed with, molded onto or bonded to the annular cap 480b. The second seal portion 454 is optional in this embodiment, as the cap 480a may be formed with a closed configuration, rather than the annular shape of the cap 480b.

[0095] The embodiment of Figures 42 and 43 is similar to that discussed above in that it likewise employs a pair of discretely formed caps 480c and 480d. However, the teeth 486 and 488 are formed on the exterior surfaces of the caps 480c and 480d so as to meshingly engage the pleats 460 from the interior of the filter body 450.

[0096] The embodiment of Figures 44 and 45 employs a pair of ring sets 490 and 492. The ring set 490 may include an outer ring 490a, which may be similar to the cap 480a, and an inner ring 490b, which may be similar to the cap 480c. The outer and inner rings 490a and 490b are assembled to the filter body 450 such that the filter media is sandwiched therebetween and secured to the filter body 450 and/or to one another via an adhesive, heat staking or sonic welding, for example. Likewise, the ring set 492 includes an outer ring 492a, which may be similar to the cap 480b, and an inner ring 492b, which may be similar to the cap 480d. The outer and inner rings 492a and 492b are assembled to the filter body 450 such that the filter media is sandwiched therebetween. The outer and inner rings 492a and 492b are secured to the filter body 450 and/or to one another via an adhesive, heat staking or sonic welding, for example.

[0097] With reference to Figures 3 and 8, when the vacuum 10a is operated, the fan assembly 72 expels air from the fan housing 92 which creates a negative pressure differential relative to atmospheric conditions and causes a dirt and debris laden air flow to rush into the dirt cup 20 through the inlet port 54. When coupled to the inlet port 54, the elbow 22 directs the dirt and debris laden air

that is flowing through the inlet port 54 toward the interior wall of the dirt cup 20, causing the dirt and debris laden air to swirl about the interior of the dirt cup. In the particular example provided, the outlet 500 of the elbow 22 is configured to direct the dirt and debris laden air flow in a direction to the side and rear of the dirt cup 20. Those of ordinary skill in the art will appreciate from this disclosure, however, that the elbow 22 may be configured to direct the dirt and debris laden air flow in a direction generally transverse to the inlet port 54, that the outlet 500 of the elbow 22 may or may not lie in the same "plane" as the inlet port 54 (i.e., the centerline of the elbow 22 at the outlet 500 may or may not lie in a plane that is contains the centerline of the inlet port 54) and that any portion of the elbow 22 between the outlet 22 and the inlet port 54 may be formed with a desired shape (e.g., helical) to enhance the swirling effect produced by the elbow 22 and the dirt cup 20.

[0098] In some situations, the swirling effect may be so strong as to create centrifugal force that causes the dirt and debris to move outwardly toward and collect against the dirt cup 20. The swirling effect may also slow the collection of dirt and debris on the prefilter 412 and the primary filter 414 to thereby provide improved efficiency of the vacuum 10a. Improved efficiency is particularly important with cordless vacuums, as it permits extended operation on a given battery charge. Those of ordinary skill in the art will readily appreciate in view of this disclosure that the swirling effect may not be desirable under some circumstances and as such, the elbow 22 may be removable from the inlet port 54.

[0099] With reference to Figures 3, 12, 19 and 20, the vacuum 10a may be additionally and further maintained in an efficient state by rotating the cleaning wheel 300 as needed or at a desired interval when the impeller 90 is not rotating to at least partially clear accumulated dirt and debris from the pleats 460 of the primary filter 414. More specifically, as the primary filter may be coupled to the cleaning wheel 300, rotation of the cleaning wheel 300 causes contact between the ribs 436 and an associated set of the pleats 460 which may deflect the pleats 460 and vibrate the pleats 460 after the pleat 460 has rotated past the rib 436. The force of the impact, the deflection of the pleat 460 and its subsequent vibration may cooperate to dislodge particles of dirt and debris from both the prefilter 412 and the primary filter 414.

[0100] Those skilled in the art will appreciate from this disclosure that various modifications may be made to the prefilter 412 to aid in discharging dirt and debris that are dislodged from the primary filter 414 and/or to slow the rate with which the pleats 460 of the primary filter 414 wear. For example, the prefilter 412 may be constructed with one or more apertures 5000 as shown in Figures 46 and 47. The apertures 5000 are relatively larger than the filtering apertures 434 so that dirt and debris that are dislodged from the primary filter 414 (Fig. 20) during cleaning, e.g., rotation of the cleaning wheel 300 (Fig. 15), may more readily fall through the prefilter body 422 and collect in the dirt cup 20 (Fig. 1). In the example of Figure 48, the prefilter body 422 is constructed such that at least a portion of the ribs 436 are shifted along the longitudinal axis of the prefilter body 422. In the

particular example provided, each of the ribs 436 is shifted so that no two ribs 436 contact the same area of the pleats 460 (Fig. 20).

[0101] Returning to Figures 1 and 3, the tool set 10b may include a brush tool 500 and a crevice tool 502 that may be fixedly but removably engaged to the front end of the inlet port 54 via a friction fit. Unlike the known configurations of accessories, the brush tool 500 and crevice tool 502 each employ a body portion 504 having first and second portions 506 and 508 with a U-shaped aperture 510 formed therebetween. The U-shaped aperture 510 permits a relatively large degree of flexure between the first and second portions 506 and 508 so as to ensure high quality friction fit and associated seal between the body portion 504 and inlet port 54 of the dirt cup 20.

[0102] In the particular example provided, the brush tool 500 may be stored in a cavity 518 formed in the rear of the housing 32, while the crevice tool 502 may be coupled to a bottom face 520 of the housing 32. One or more resilient clips 522 may be employed to retain the particular accessory to the housing 32.

[0103] With reference to Figure 22, the recharging base 75 is illustrated in association with the vacuum 10a. The recharging base 75 may include a base 1000, a charging circuit 1002, a pair of terminals 1004 and a key 1006. The base 1000 may be a molded structure and may be configured to slidably receive the vacuum 10a such that a pair of mating terminals 1014 and a mating key 1016 matingly engage the terminals 1004 and the key 1006, respectively. The charging circuit 1002 may be configured in a conventional and well known manner to

receive electrical power from a source of A.C. power and provide a source of D.C. power of a predetermined voltage to the terminals 1004.

[0104] In the particular example provided, the terminals 1004, which may be mounted to the base 1000, may extend outwardly from the base 1000 so as to contact associated ones of the mating terminals 1014 when the vacuum 10a is fully received into the base 1000. As the terminals 1014 are electrically coupled to the battery pack 74, contact between the terminals 1004 and 1014 permits electrical energy to be transmitted from the charging circuit 1002 to the batteries 100.

[0105] The key 1006 and the mating key 1016 coordinate with one another to permit the base 1000 to fully receive the vacuum 10a. In the particular example provided, the key 1006 includes a pedestal 1028, a flange 1030 and optionally one or more engagement tabs 1032, while the mating key 1016 includes a receiver 1040. The pedestal 1028 of the key 1006 may be coupled to the base 1000 in any conventional manner, including for example, threaded fasteners and/or features that are integrally formed onto and/or into the pedestal 1028 and base 1000 that permit the pedestal 1028 and the base 1000 to be engaged to one another in a snap-fit manner. The flange 1030 may be coupled to the pedestal 1028, extending upwardly therefrom so as to protrude from a corresponding aperture 1036 in the base 1000 when the key 1006 and the base 1000 are coupled to one another. If employed, the engagement tabs 1032 extend from the flange 1030 in the example provided.

[0106] The receiver 1040 may be coupled to the housing 32 in any conventional manner, including for example, threaded fasteners and/or features that are integrally formed onto and/or into the receiver 1040 and housing 32 that permit the receiver 1040 and the housing 32 to be engaged to one another in a snap-fit manner. The receiver 1040 of the mating key 1016 may optionally include one or more slots 1042 for receiving the engagement tabs 1032. The engagement tabs 1032 and slots 1042 are positioned such that they must engage one another before the terminals 1020 and 1022 may contact one another. Those of ordinary skill in the art will appreciate from this disclosure that although the vacuum 10a has been described thus far as including slots 1042 for receiving engagement tabs 1032 that are associated with the recharging base 75, the slots 1042 and engagement tabs 1032 may alternatively be associated with the recharging base 75 and the vacuum 10a, respectively.

[0107] With reference to Figure 23, the interchangeable nature of the charging system of the present invention is illustrated. Specifically, several terminal block (1004) and key (i.e., 1006a, 1006b, 1006c, 1006d, and 1006e) combinations are illustrated as being interchangeable with the base 1000, while several receivers (1040a, 1040b, 1040c, 1040d, and 1040e) are illustrated in association with the vacuum 10a. Significantly, the injection molds for each of the key and the receiver employ exchangeable tooling segments that permit the molds to be readily converted so that they may be employed to form each of the various key configurations and receiver configurations. With reference to Figure 24, five

tooling segments 1050a, 1050b, 1050c, 1050d and 1050e are employed in conjunction with a base mold 1052 to produce each of the receiver combinations.

[0108] One especially significant aspect of providing various key and mating key combinations is the ability to provide a family of similar vacuums having different batteries (i.e., different voltages) yet which utilize as many common components as possible. In this regard, the various key and mating key combinations are employed to "key" a particular vacuum to a particular recharging base so as to prevent a vacuum from being coupled to a recharging base having a charging circuit that provides a charging voltage in excess of that which the batteries of the vacuum are designed to be charged.

[0109] With reference to Figure 25, a family of hand-held cordless vacuums is generally indicated by reference numeral 2000. The family of vacuums 2000 includes vacuums 2002a, 2004a, 2006a, 2008a and 2010a, which are associated with recharging bases 2002b, 2004b, 2006b, 2008b and 2010b, respectively. The vacuums 2002a, 2004a and 2006a are generally identical to vacuum 10a and differ from one another only in the design charging voltage of their respective battery packs 74. For example, the vacuum 2002a may have a design charging voltage of 14.4 volts, the vacuum 2004a may have a design charging voltage of 12 volts and the vacuum 2006a may have a design charging voltage of 9.6 volts. The vacuums 2008a and 2010a are similar to the vacuum 10a (Fig. 1) except that they lack a filter cleaning system 36 and may have design charging voltages of 7.2 volts and 4.8 volts, respectively. The recharging bases 2002b, 2004b, 2006b,

2008b and 2010b are generally identical to the recharging base 75 (Fig. 1) and differ from one another only in the charging voltage that they output.

[0110] As those skilled in the art will appreciate from this disclosure, the recharging bases (i.e., the keys) may be configured so that they will only engage one vacuum (i.e., mating key). However, it is permissible for a recharging base (i.e., key) to receive more than one type of vacuum (i.e., mating key) so long as the charging voltage provided by the recharging base will not exceed the design charging voltage of any vacuum that may be engaged thereto. In the particular example provided, any member of the family of vacuums 2000 may be engaged to the recharging base 2010b. Furthermore, the vacuum 2004a may also be engaged to the charging bases 2004b, 2006b, and 2008b.

[0111] While the vacuum 10a has been described thus far as employing an elbow to impart a swirling action to an incoming dirt and debris laden air flow and a manually rotatable cleaning wheel for use in dislodging particles of dirt and debris from a filter, those skilled in the art will appreciate that the invention, in its broader aspects, may be constructed somewhat differently. For example, the vacuum 10c may employ one or more vanes to swirl the incoming dirt and debris laden air flow as shown in Figures 26 and 27. In this example, the vacuum 10c is identical to the vacuum 10a described above, except that the elbow 22 (Fig. 3) is not employed and a prefilter 412c has been substituted for the prefilter 412. The prefilter 412c is substantially similar to the prefilter 412, except for the inclusion of a plurality of flow guiding vanes 600 on the front wall 430c of the prefilter body 422c. The flow

guiding vanes 600 are disposed axially in-line with the inlet port 54c such that the axially directed incoming dirt and debris laden air flow is turned by the flow guiding vanes 600 outwardly toward the interior surface of the wall of the dirt cup 20c. As with the elbow 22, the flow guiding vanes 600 may be configured aggressively, wherein the entire flow is turned outwardly at the interior surface of the dirt cup 20c, or somewhat less aggressively, wherein the flow is turned outwardly but retains a portion of its original axial velocity.

[0112] As those of ordinary skill in the art will appreciate from this disclosure, vanes 600d for swirling the incoming dirt and debris laden air flow may be additionally or alternatively formed on another surface, such as the exterior surface 620 of the side wall 432d of the prefilter 412d, as illustrated in Figure 28.

[0113] Alternatively, the vacuum 10e may be configured as is shown in Figures 29 and 30. In this embodiment, the housing assembly 14e defines a filter recess 700 into which the filter system 34e is disposed. The filter system 34e includes a hat-shaped prefilter 412e and a hat-shaped primary filter 414e. The prefilter 412e includes a filter flange 420e and a prefilter body 422e, while the primary filter 414e includes a filter flange 710 and a filter body 712. A nozzle 720 is pivotally coupled to the housing assembly 14e and unlike the dirt cup 20 of Figure 1, the nozzle 720 has no capacity for the storage of the dirt and debris that is drawn up by the vacuum 10e. Rather, coarse dirt and debris are retained in the prefilter 412e while finer dirt and debris which pass through the prefilter 412e are contained by the primary filter 414e. Pivoting of the nozzle 720 into the closed

position causes the nozzle 720 to compress the filter flange 420e and filter flange 710 against one another such that a seal is formed between the nozzle 720 and the housing assembly 14e.

[0114] The nozzle 720 includes an outlet 730 that directs an incoming flow of dirt and debris laden air tangentially into the prefilter 412e, thereby generating a swirling effect that tends to reduce the accumulation of dirt and debris against the side wall 432e of the prefilter 412e. This configuration is highly advantageous in that it permits the user to not only perform vacuuming operations with a single hand, but also to empty the vacuum 10e of dirt and debris with a single hand. More specifically, the user need only access the latch release 38 to unlatch the nozzle 720 from the housing assembly 14e to permit the nozzle 720 to pivot into the open condition. A detent (not specifically shown) may be employed to retain the nozzle 720 in the open condition. The user need only grasp the handle 168 of the housing assembly 14e and overturn the vacuum 10e to empty the contents of the prefilter 412e.

[0115] As is apparent from the discussion above, rotation of the cleaning wheel 300 when the impeller 90 is rotating renders the cleaning action relatively less effective (as compared to when the impeller 90 is not rotating) since dirt and debris that are dislodged when the cleaning wheel 300 is rotated tends to be immediately drawn back into the primary filter 414. Accordingly, it is within the scope of the present invention to include with the vacuum 10a a device that either locks the cleaning wheel 300 or electrically disables the fan assembly 72 when the

cleaning wheel 300 is rotated. In Figure 31, a lock-out device 800 is illustrated to be coupled to the power switch 76 for translation therewith. When the power switch 76 is activated, a lock-out member 802 translates into locking engagement with one of the circumferentially spaced apart recesses 310 in the gripping portion 302 of the cleaning wheel 300 to prevent the cleaning wheel 300 from being rotated. In Figure 32, a sensor 850 is employed to detect the rotation of the cleaning wheel 300 relative to the housing 32 and generate a sensor signal in response thereto. In the particular example provided, the sensor 850 includes a pair of spaced apart contacts 850a and 850b which are normally not in contact with one another but which are urged into electrical contact with one another by actuating features 852 that are formed on the cleaning wheel 300. In response to receipt of the sensor signal, a controller 860 is employed to inhibit the flow of electricity from the batteries 100 to the motor 70 to thereby deactivate the fan assembly 72. In the example provided, the controller 860 employs a conventional relay 862 to inhibit the flow of electricity from the batteries 100 to the motor 70. In this latter embodiment, the controller 860 may include a timer 864 which maintains the motor 70 in a deactivated state for a predetermined amount of time after receipt of the sensor signal.

[0116] In the embodiments of Figures 34 and 35, the cleaning wheel is illustrated to be driven by a motor rather than manually operated. In Figure 34, a clutch 900 having an input shaft 902, which is coupled to the output shaft 88 of the motor 70, a first output shaft 904, to which the impeller 90 is coupled for rotation

therewith, and a second output shaft 906, which is concentric with the first output shaft 904, which is meshingly engaged with an idler gear 908. A shaft 910 couples an output pinion 912, which is meshingly engaged with teeth 310g formed on the cleaning wheel 300g, for rotation with the idler gear 908. The clutch 900 is normally operable in first condition, wherein rotary power is transmitted to the first output shaft 904 but not the second output shaft 906, and a second condition, wherein rotary power is transmitted to the second output shaft 906 but not the first output shaft 904. The clutch 900 is preferably electronically controlled, so that the user need only press a button to change the condition of the clutch 900 from the first condition to the second condition (such as by translating the power switch 76 (Fig. 3) in a direction opposite that which is normally employed to actuate the vacuum 10a). As noted above, the clutch 900 is normally operable in the first condition, so that when the button is released, the clutch 900 will revert to the first condition. In the embodiment of Figure 35, a second motor 950 is employed to rotate the cleaning wheel 300.

[0117] While the invention has been described in the specification and illustrated in the drawings with reference to various embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention as defined in the claims. Furthermore, the mixing and matching of features, elements and/or functions between various embodiments is expressly contemplated herein so that one of ordinary skill in the art would

appreciate from this disclosure that features, elements and/or functions of one embodiment may be incorporated into another embodiment as appropriate, unless described otherwise, above. Moreover, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment illustrated by the drawings and described in the specification as the best mode presently contemplated for carrying out this invention, but that the invention will include any embodiments falling within the foregoing description and the appended claims.

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CLAIMS

What is claimed is:

1. A hand-held portable vacuum comprising:

a housing;

a dirt cup having an inlet and defining a container for storage of dirt and debris therein, the dirt cup being removably attached to the housing;

an impeller at least partially disposed in the housing;

a HEPA filter disposed between the impeller and the inlet, the HEPA filter being formed with a plurality of pleats;

means for swirling the incoming air about the dirt cup; and

a filter cleaning device coupled to at least one of the housing and the dirt cup, the filter cleaning device including at least one rib and a hub, the hub being coupled to one of the HEPA filter and the rib and configured to rotate the one of the HEPA filter and the rib about the other one of the HEPA filter to generate contact between the rib and the HEPA filter to at least partially dislodge accumulated dirt and debris from the pleats.

2. The hand-held vacuum of Claim 1, wherein the swirling means includes a flow deflector associated with the inlet of the dirt cup.

3. The hand-held vacuum of Claim 2, wherein the flow deflector is an elbow.

4. The hand-held vacuum of Claim 1, wherein the swirling means includes a plurality of vanes disposed in an axially spaced relation to the inlet.

5. The hand-held vacuum of Claim 4, wherein the vanes are associated with a prefilter, the vanes being disposed between the inlet and the HEPA filter.

6. The hand-held vacuum of Claim 1, wherein the hub includes a gripping portion that extends through the housing and is manually rotatable.

7. A hand-held portable vacuum comprising:

a housing;

an impeller at least partially disposed in the housing;

a dirt cup having an inlet and defining a container for storage of dirt and debris therein, the dirt cup being removably attached to the housing; and

a HEPA filter disposed between the impeller and the inlet.

8. The hand-held portable vacuum of Claim 7, wherein the HEPA filter is formed with a plurality of pleats.

9. The hand-held portable vacuum of Claim 8, further comprising a filter cleaning device associated with at least one of the housing and the dirt cup, the filter cleaning device including at least one rib and a hub, the hub being coupled to

one of the HEPA filter and the rib and configured to rotate the one of the HEPA filter and the rib about the other one of the HEPA filter to generate contact between the rib and the HEPA filter to at least partially dislodge accumulated dirt and debris from the pleats.

10. The hand-held portable vacuum of Claim 9, wherein the hub is rotatably coupled to the housing.

11. The hand-held portable vacuum of Claim 10, wherein the HEPA filter is sealingly attached to the hub.

12. The hand-held portable vacuum of Claim 10, wherein the hub includes a plurality of drive tabs that meshingly engage a plurality of drive tabs formed on the HEPA filter.

13. The hand-held portable vacuum of Claim 10, further comprising a prefilter, the prefilter having a prefilter body that surrounds the HEPA filter, the prefilter body having an open end which is sealingly engaged with the HEPA filter.

14. The hand-held portable vacuum of Claim 10, further comprising a prefilter, the prefilter having a prefilter body that surrounds the HEPA filter, the rib extending from an interior surface of the prefilter body.

15. The hand-held portable vacuum of Claim 7, further comprising a prefilter, the prefilter having a prefilter body that surrounds the HEPA filter

16. The hand-held portable vacuum of Claim 15, wherein the prefilter body has an open end and the prefilter and HEPA filter are sealingly engaged to close the open end.

17. A method for filtering a dirt and debris laden air flow, the method comprising:

providing a hand-held vacuum with a housing, an impeller, an inlet, a container and a primary filter, the housing including a handle that permits a user to employ the hand-held vacuum for vacuuming with a single hand, the impeller being disposed within the housing, the inlet being configured to receive the dirt and debris laden air flow therethrough, the container being configured to retain dirt and debris removed from the dirt and debris laden air flow and the primary filter being disposed between the impeller and the inlet;

rotating the impeller to generate the dirt and debris laden air flow; and

swirling the dirt and debris laden air flow about the interior of the container.

18. The method of Claim 17, further comprising removing the container from the housing to empty the container.

19. The method of Claim 18, wherein the container and the inlet are fixedly coupled to one another.

20. The method of Claim 17, further comprising pivoting the inlet relative to the housing to gain access to the container.

21. The method of Claim 20, further comprising rotating the housing with the single hand grasping the handle to overturn the vacuum and empty the container.

22. A hand-held portable vacuum comprising:

a housing having a handle;

a dirt cup having an inlet and defining a container for storage of dirt and debris therein, the dirt cup being removably attached to the housing;

an impeller at least partially disposed in the housing;

a filter disposed between the impeller and the inlet, the filter being formed with a plurality of pleats;

a filter cleaning device coupled to at least one of the housing and the dirt cup, the filter cleaning device including at least one rib and a hub, the hub being coupled to one of the filter and the rib and configured to rotate the one of the filter and the rib about the other one of the filter to generate contact between the rib and the filter to at least partially dislodge accumulated dirt and debris from the pleats.

23. The hand-held vacuum of Claim 22, wherein the hub is rotatably coupled to the housing.

24. The hand-held portable vacuum of Claim 23, wherein the hub includes a gripping portion that extends through the housing and is manually rotatable.

25. The hand-held portable vacuum of Claim 23, wherein the filter is sealingly attached to the hub.

26. The hand-held portable vacuum of Claim 23, wherein the hub includes a plurality of drive tabs that meshingly engage a plurality of drive tabs formed on the filter.

27. The hand-held portable vacuum of Claim 23, further comprising a prefilter with a prefilter body that surrounds the filter, the prefilter body having an open end which is sealingly engaged with the filter, the rib extending from an interior surface of the prefilter body.

28. The hand-held portable vacuum of Claim 27, wherein the prefilter body has an open end and the prefilter and filter are sealingly engaged to close the open end.

29. The hand-held portable vacuum of Claim 27, wherein the prefilter body has a truncated cone shape.

30. The hand-held portable vacuum of Claim 29, wherein the filter has a truncated cone shape.

31. The hand-held portable vacuum of Claim 22, wherein the filter has a truncated cone shape.

32. A hand-held portable vacuum comprising:

a housing having a handle;

a dirt cup having an inlet and defining a container for storage of dirt and debris therein, the dirt cup being removably attached to the housing;

an impeller at least partially disposed in the housing, the impeller being operable for generating an air flow that flows through the inlet;

a filter disposed between the impeller and the inlet; and

means for swirling the air flow about the dirt cup.

33. The hand-held vacuum of Claim 32, wherein the swirling means includes a flow deflector associated with the inlet of the dirt cup.

34. The hand-held vacuum of Claim 33, wherein the flow deflector is an elbow.

35. The hand-held vacuum of Claim 32, wherein the swirling means includes a plurality of vanes disposed in an axially spaced relation to the inlet.

36. The hand-held vacuum of Claim 35, wherein the vanes are associated with a prefilter, the vanes being disposed between the inlet and the filter.

37. A hand-held portable vacuum comprising:

a housing having a handle;

a dirt cup having an inlet and defining a container for storage of dirt and debris therein, the dirt cup being removably attached to the housing;

an impeller at least partially disposed in the housing, the impeller being operable for generating an air flow that flows through the inlet;

a filter disposed between the impeller and the inlet; and

a flow deflector associated with the inlet of the dirt cup, the flow deflector being configured to direct the air flow toward an interior surface of the dirt cup in a manner that causes dirt and debris entrained in the air flow to swirl about the interior surface of the dirt cup.

38. The hand-held vacuum of Claim 37, wherein the flow deflector is an elbow that is coupled to the inlet.

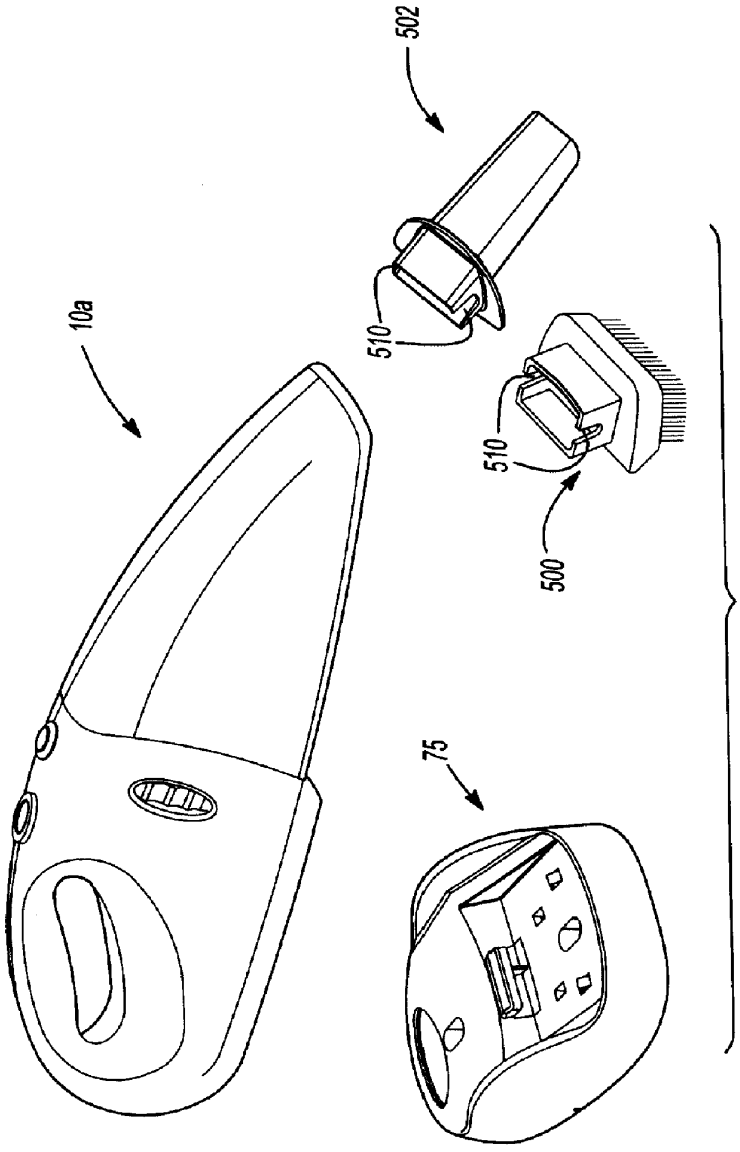


Fig-1

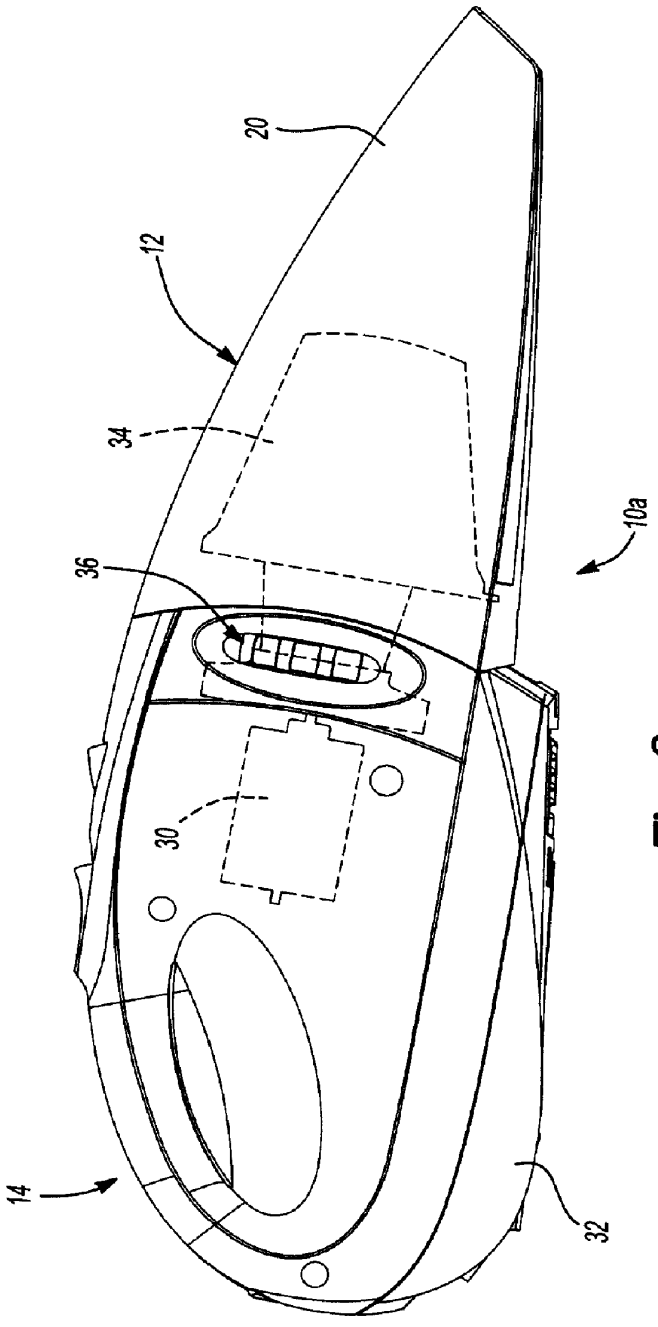


Fig-2

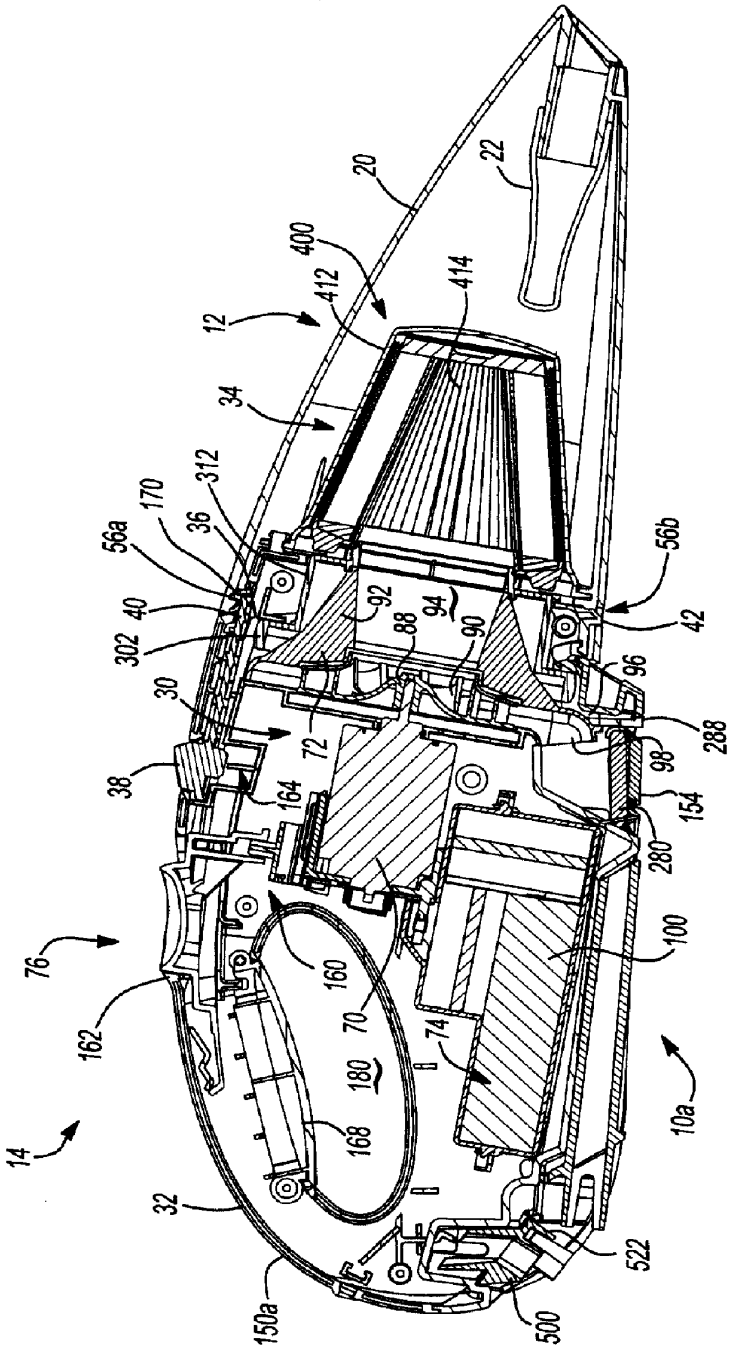

20
22
400
412
414
12
34
312
170
36
56a
56b
40
302
92
88
94
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96
30
72
288
98
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162
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10a
14
168
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522
150a
500

Fig-3

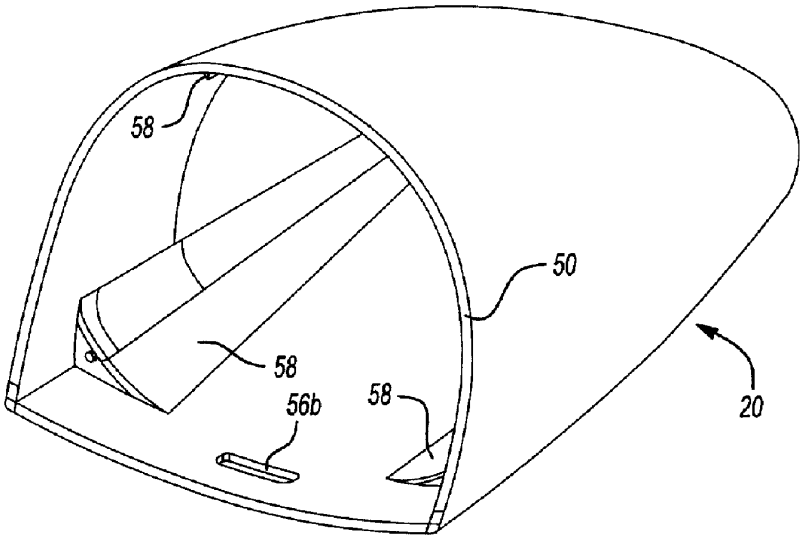


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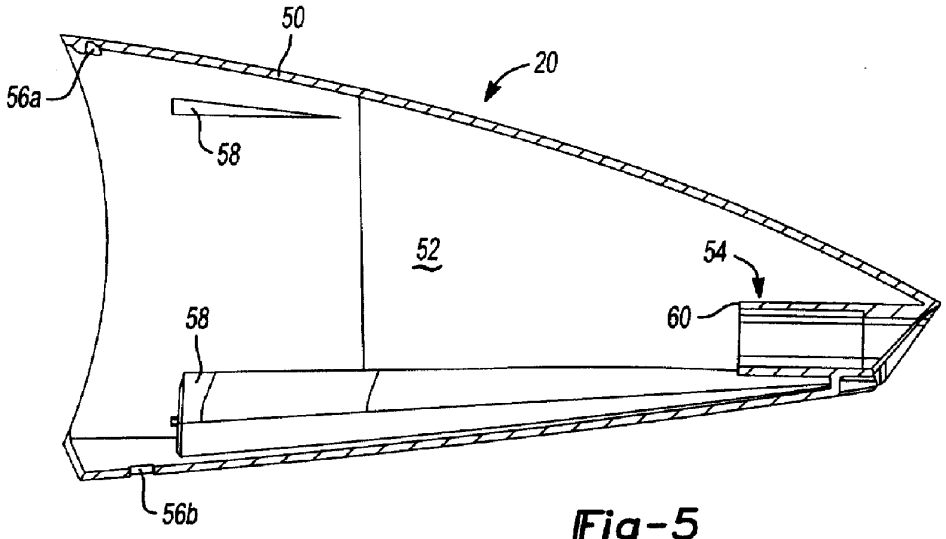


Fig-5

Fig-6

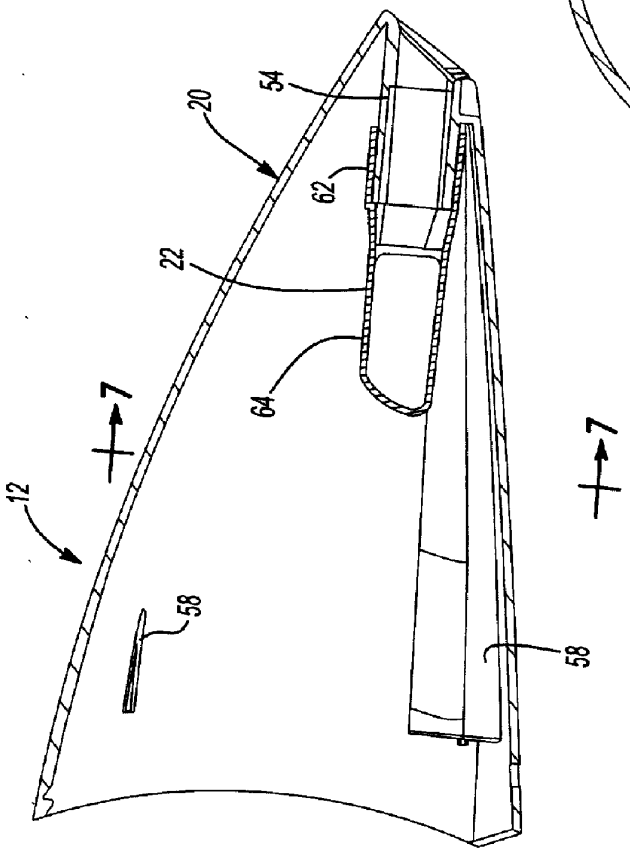
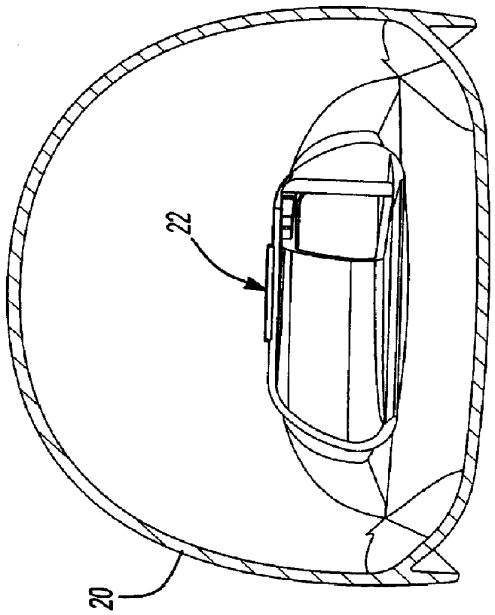


Fig-7



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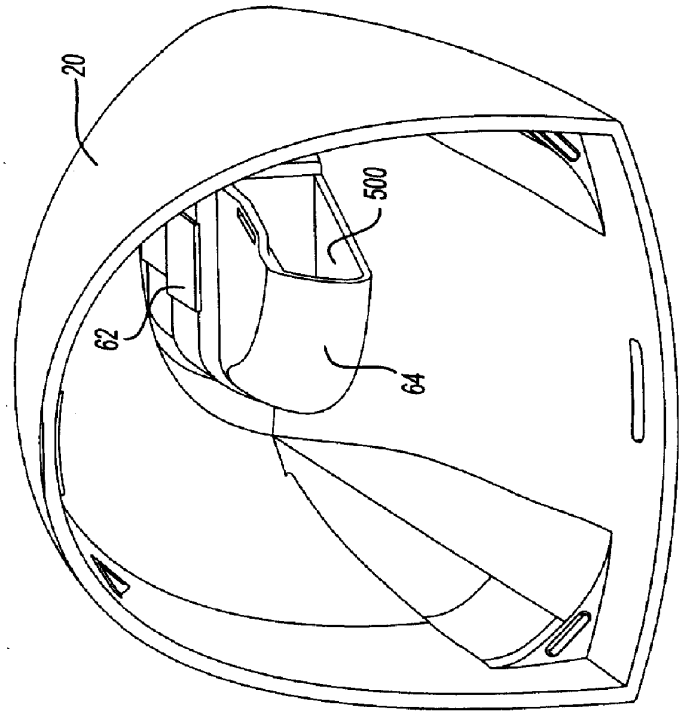


Fig-8

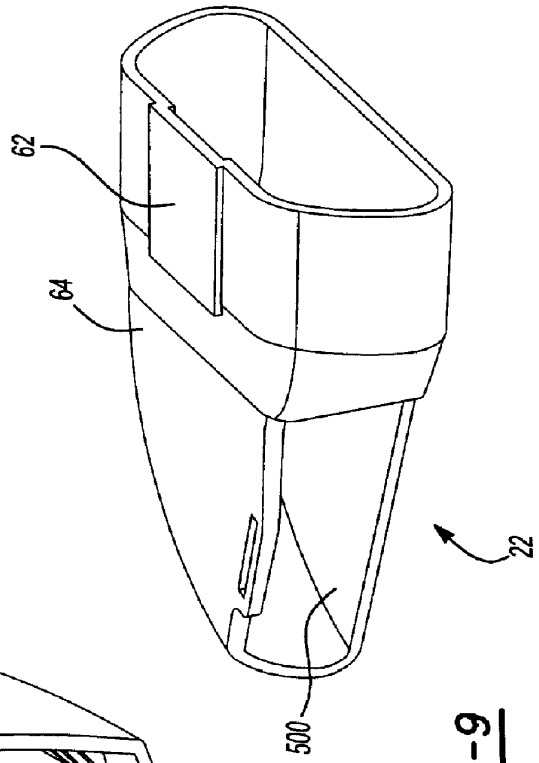


Fig-9

Fig-10

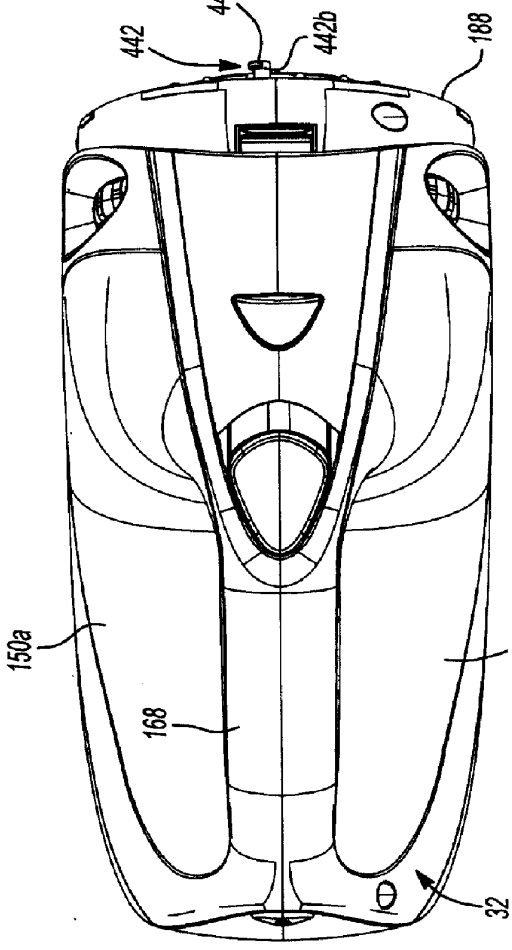
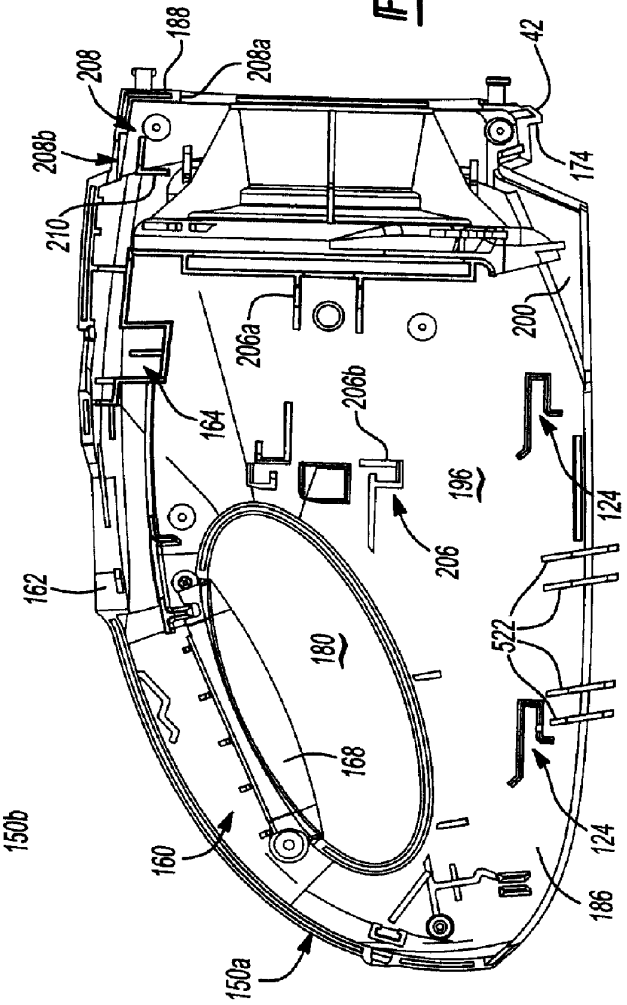


Fig-11



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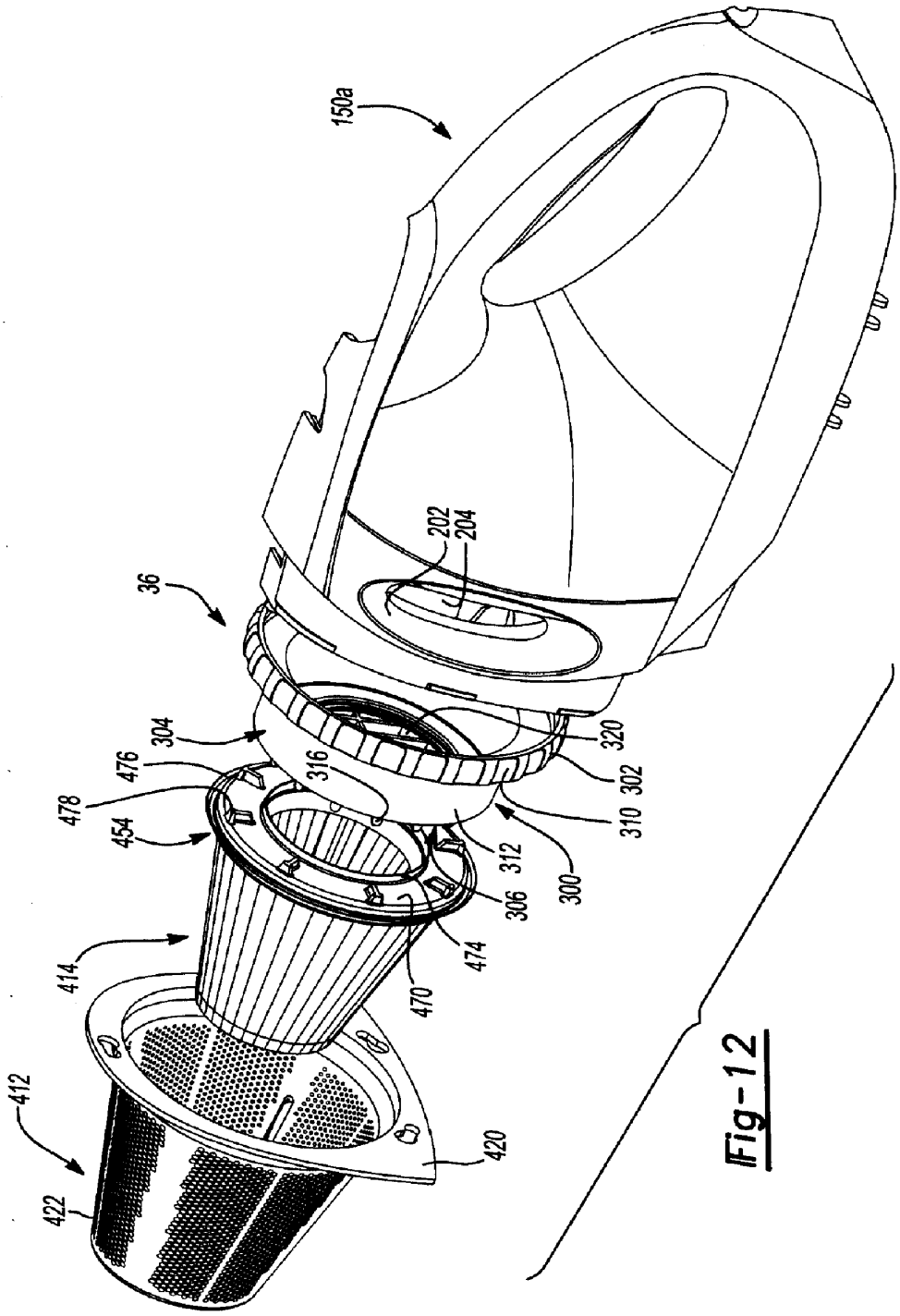


Fig-12

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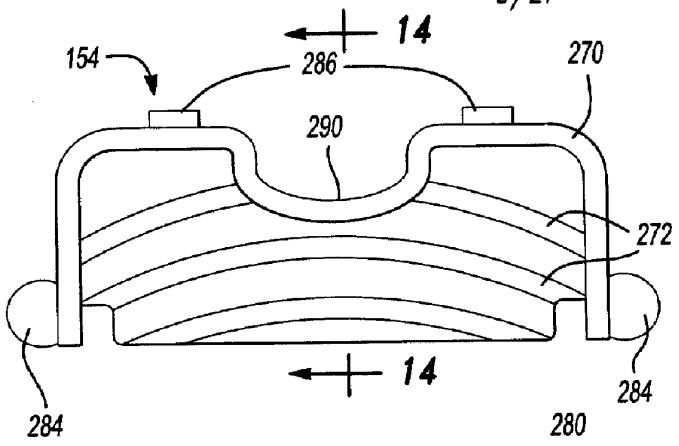


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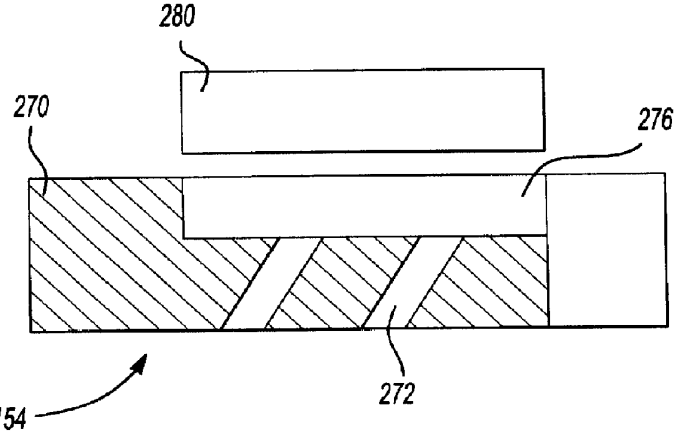


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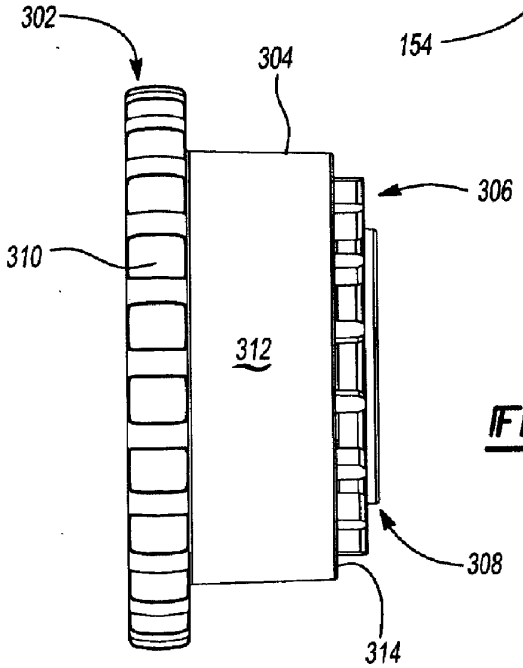


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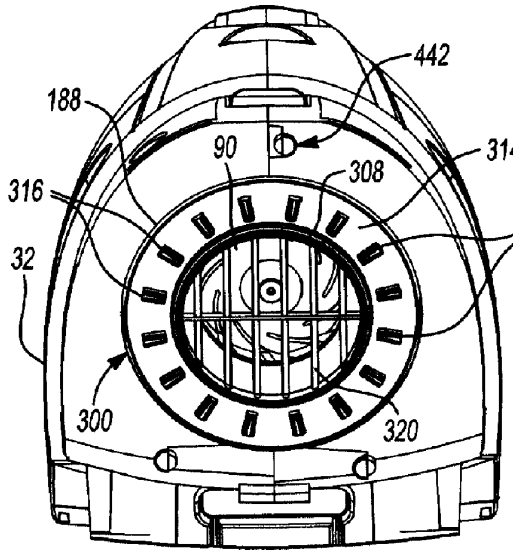


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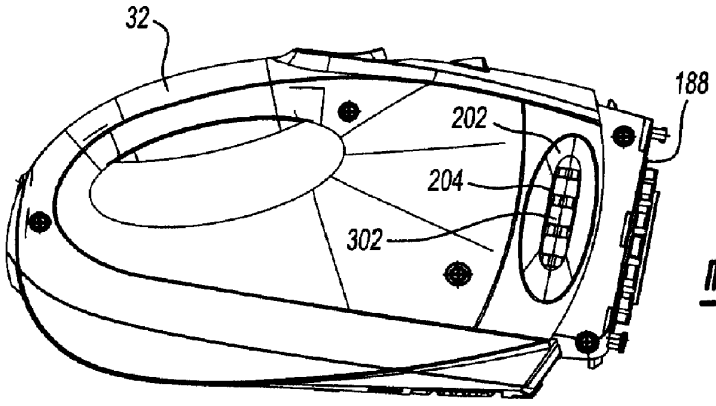


Fig-17

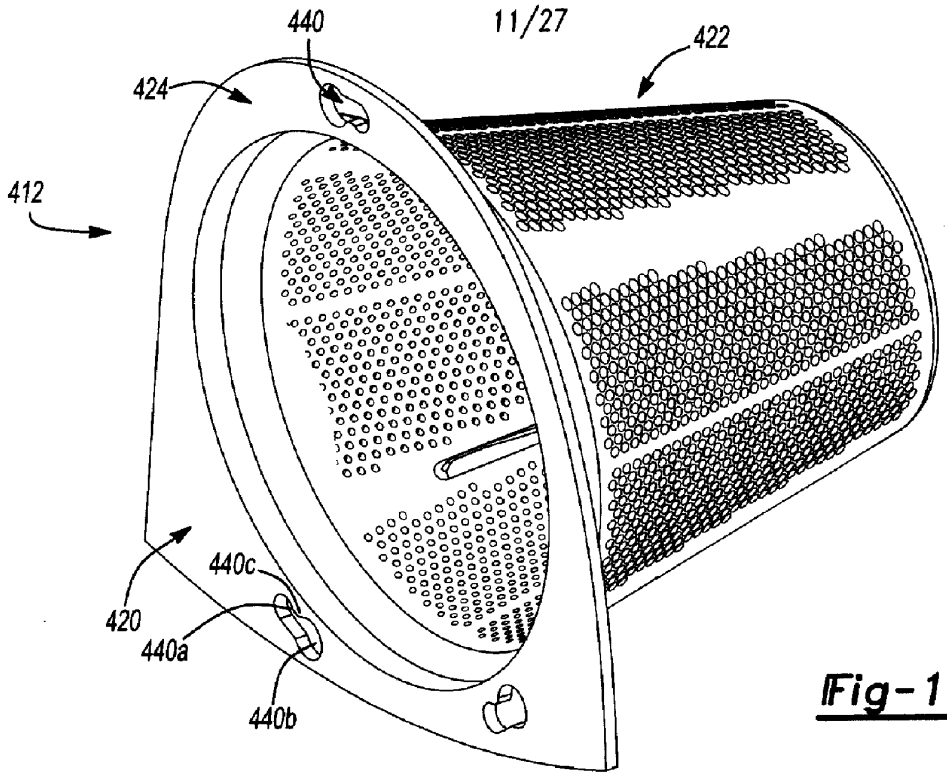

440
422
424
412
440c
420
440a
440b

Fig-18

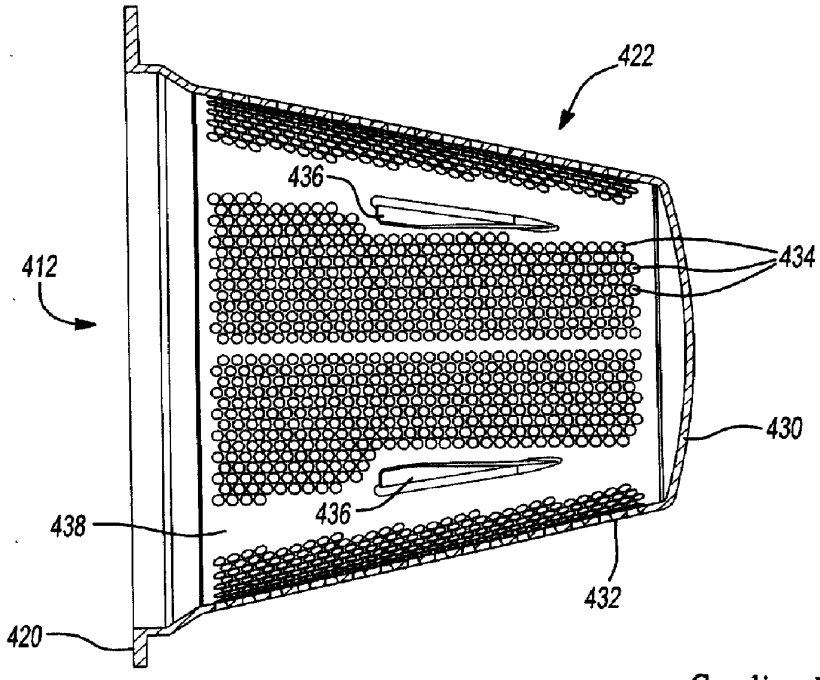

422
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434
412
430
438
436
432
420

Fig-19

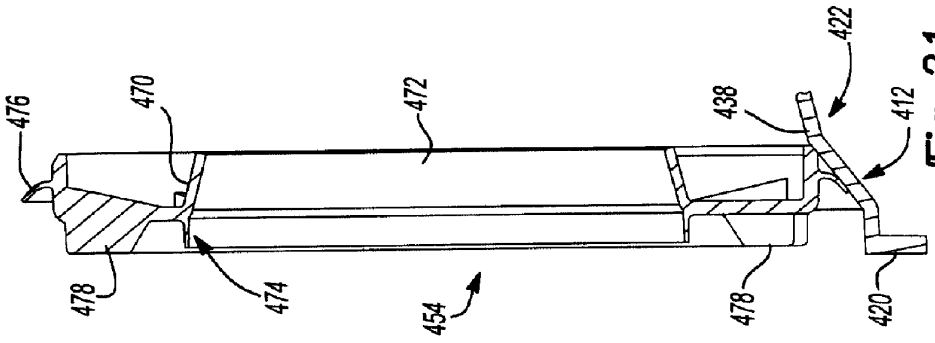

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422
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474
454
478
420

Fig-21

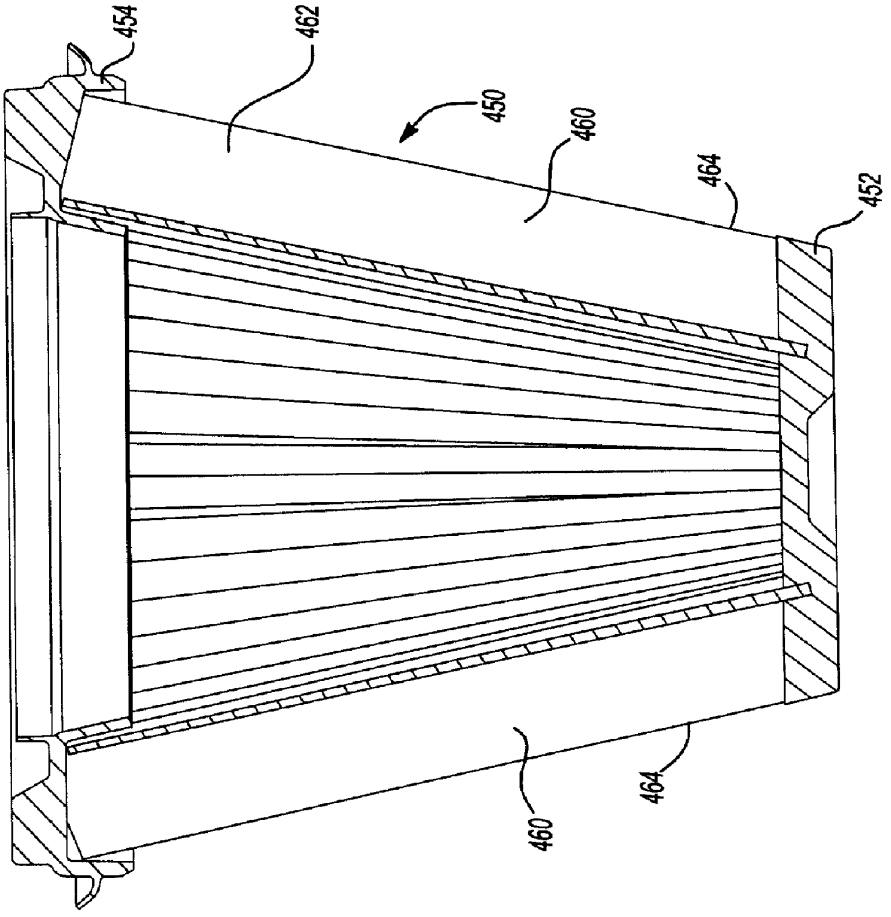

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462
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452
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464

Fig-20

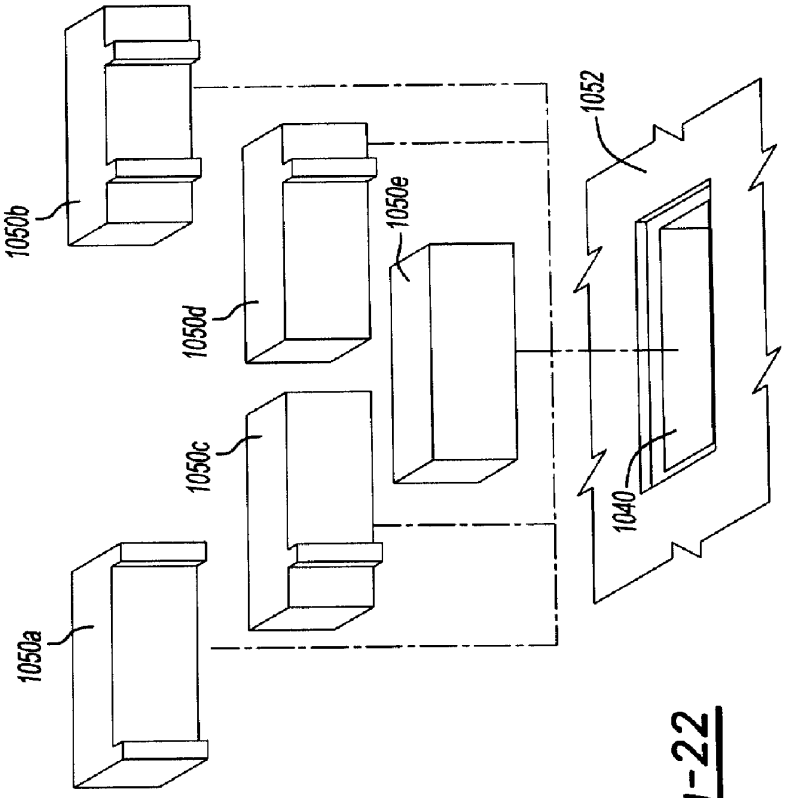


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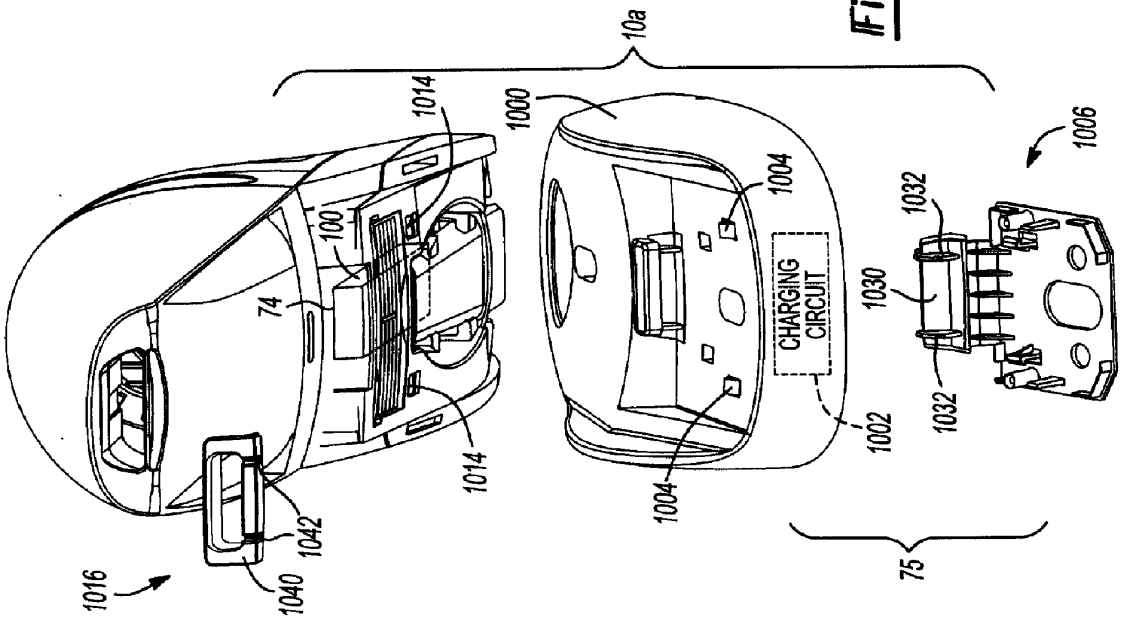


Fig-22

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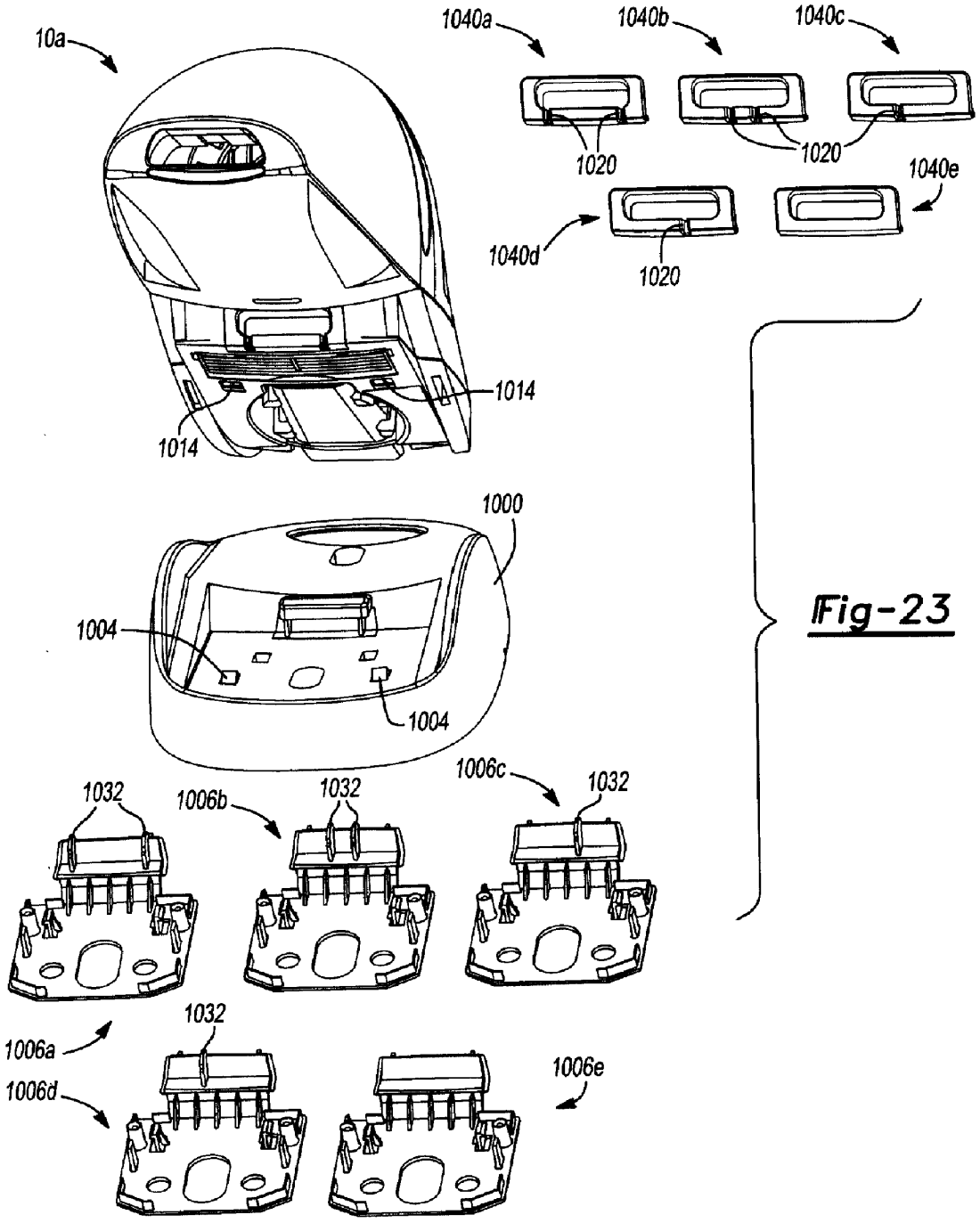

10a
1040a
1040b
1040c
1020
1020
1040e
1040d
1020
1014
1014
1000
1004
1004
1032
1006b
1032
1006c
1032
1032
1006a
1006d
1006e

Fig-23

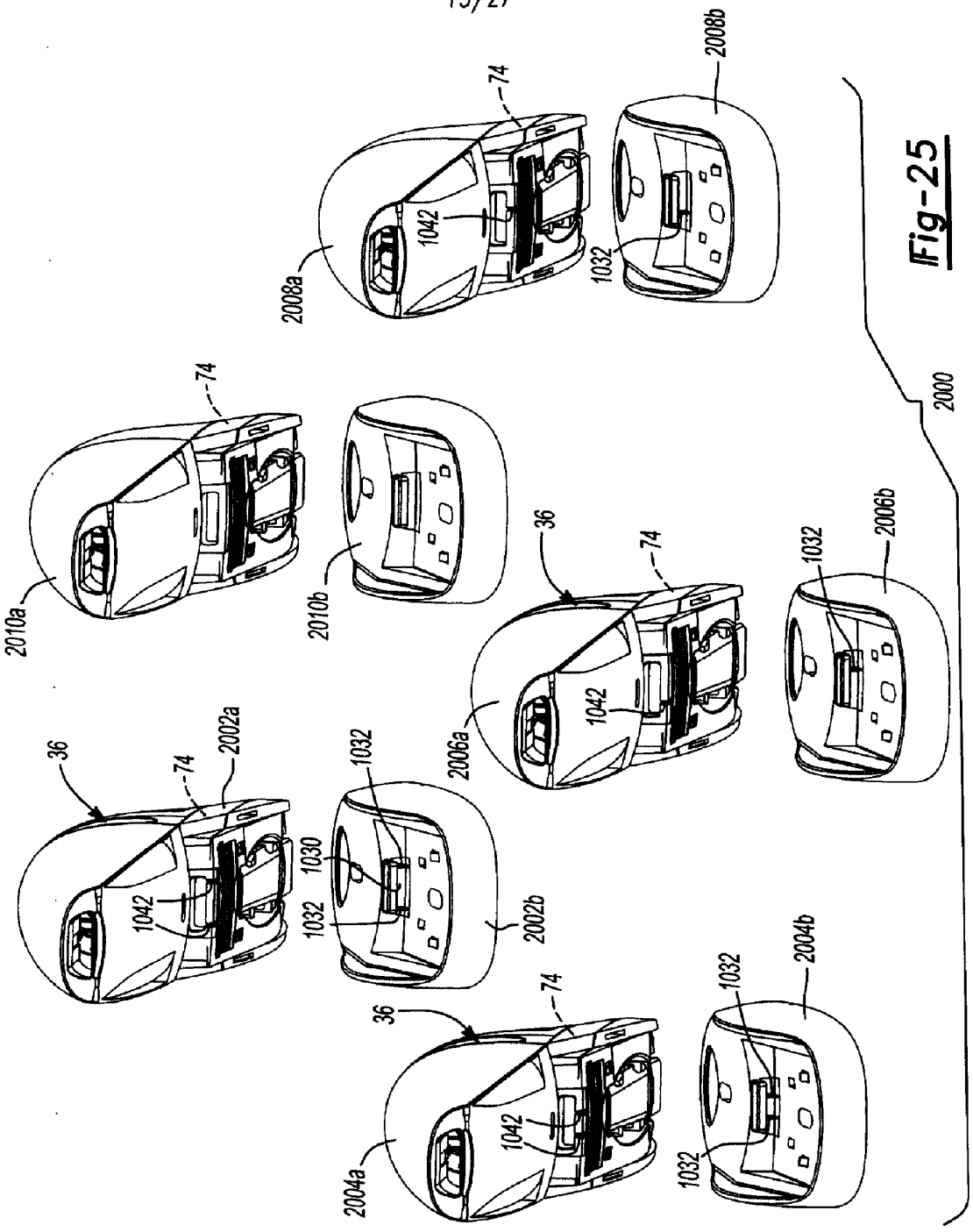


Fig-25

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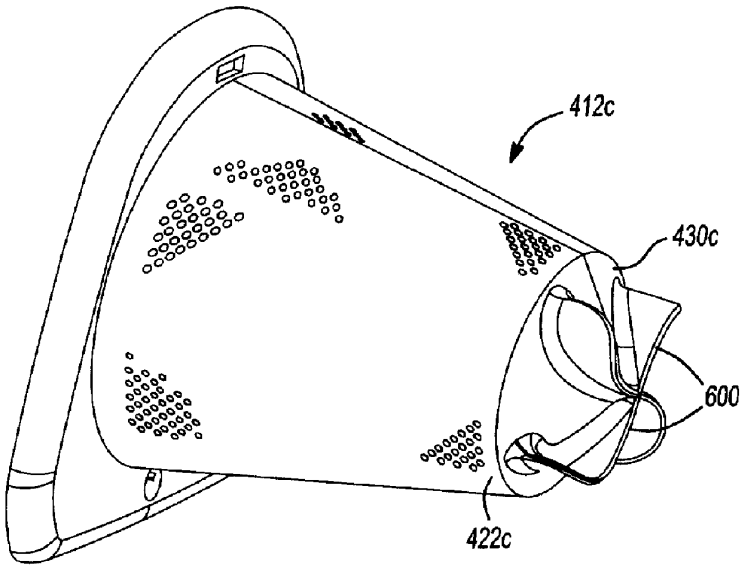


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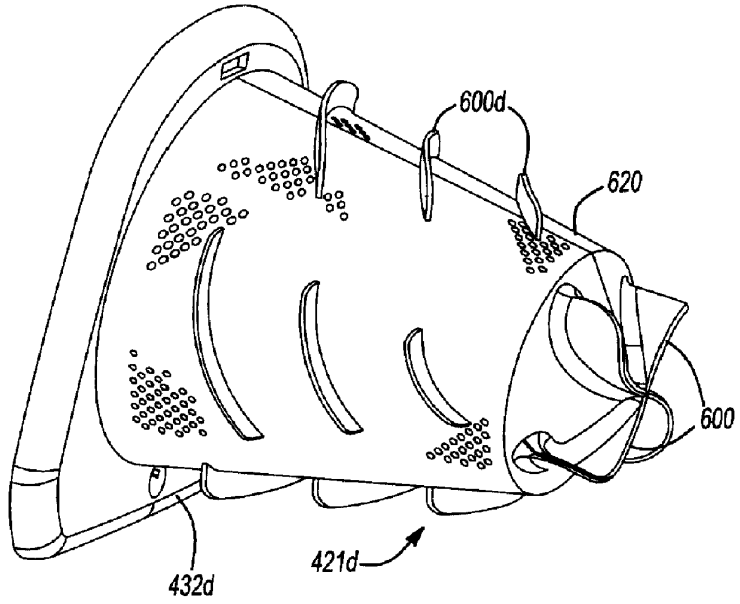


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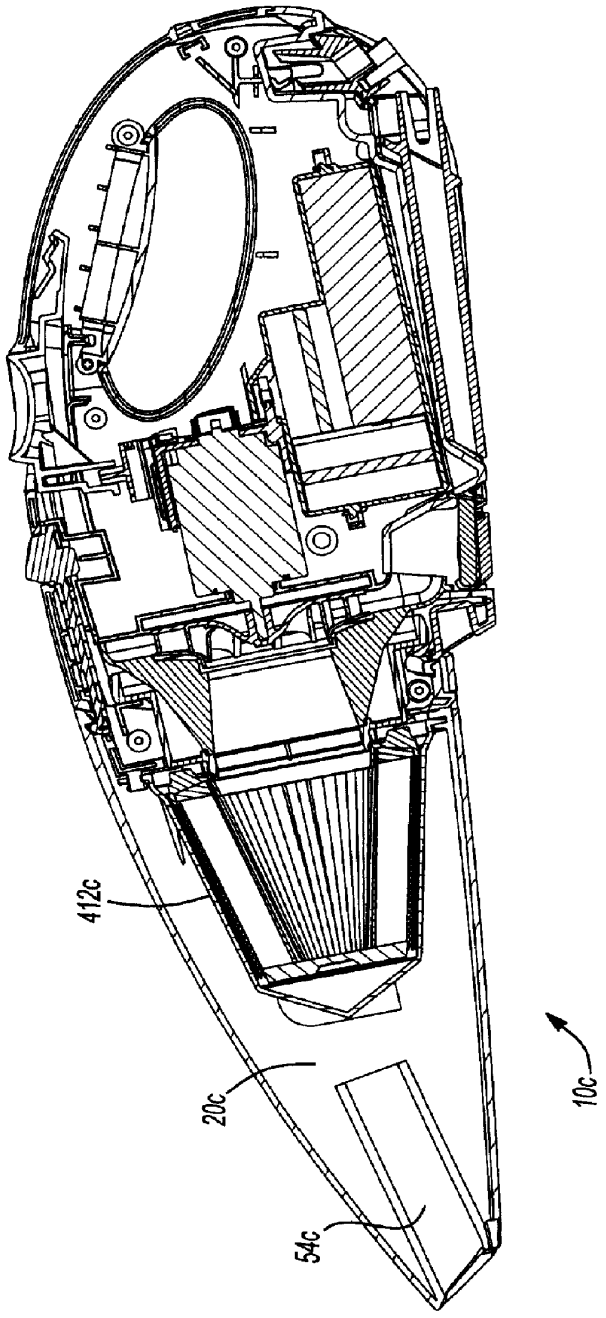


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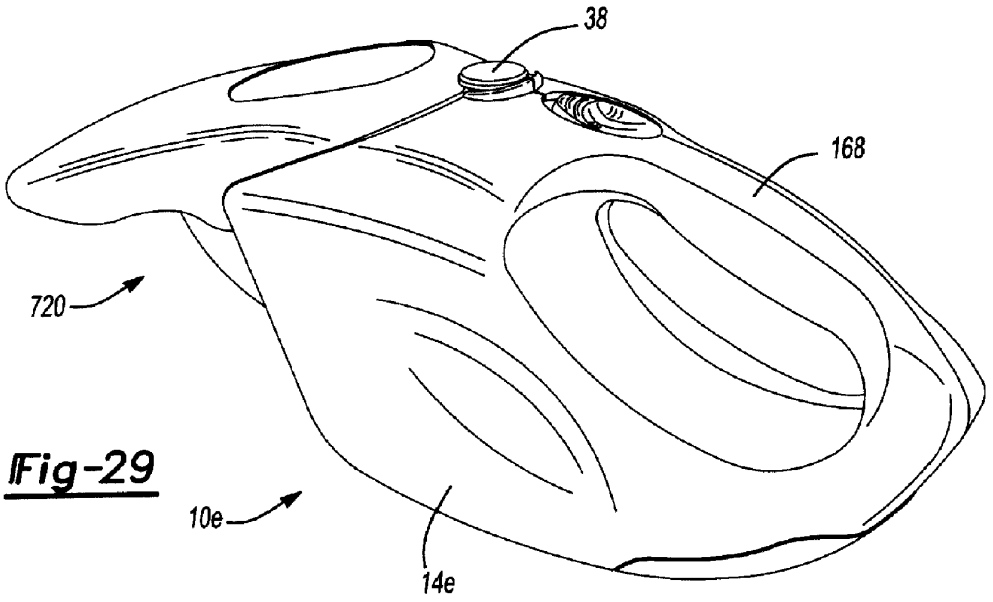

38
168
720
10e
14e

Fig-29

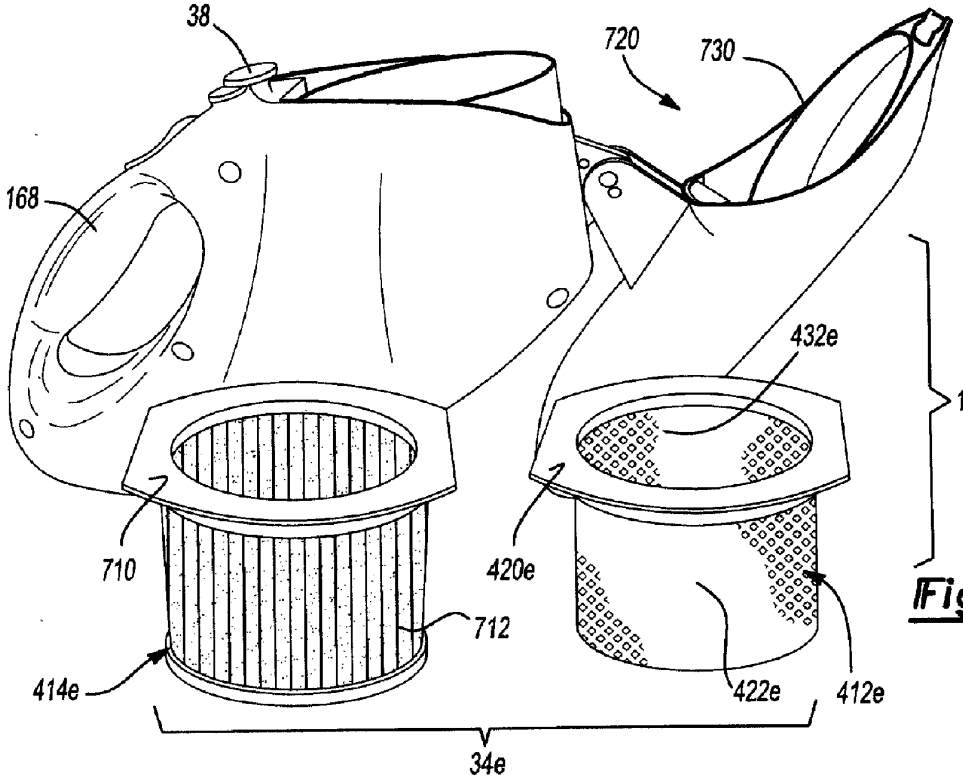

38
720
730
168
432e
10e
710
420e
712
414e
422e
412e
34e

Fig-30

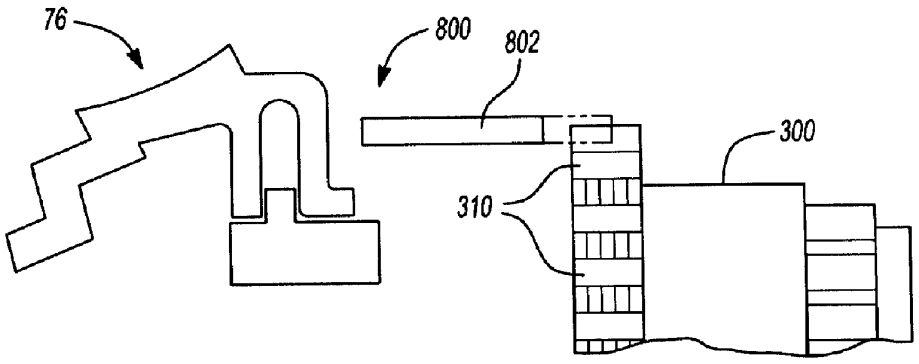

76
800
802
300
310

Fig-31

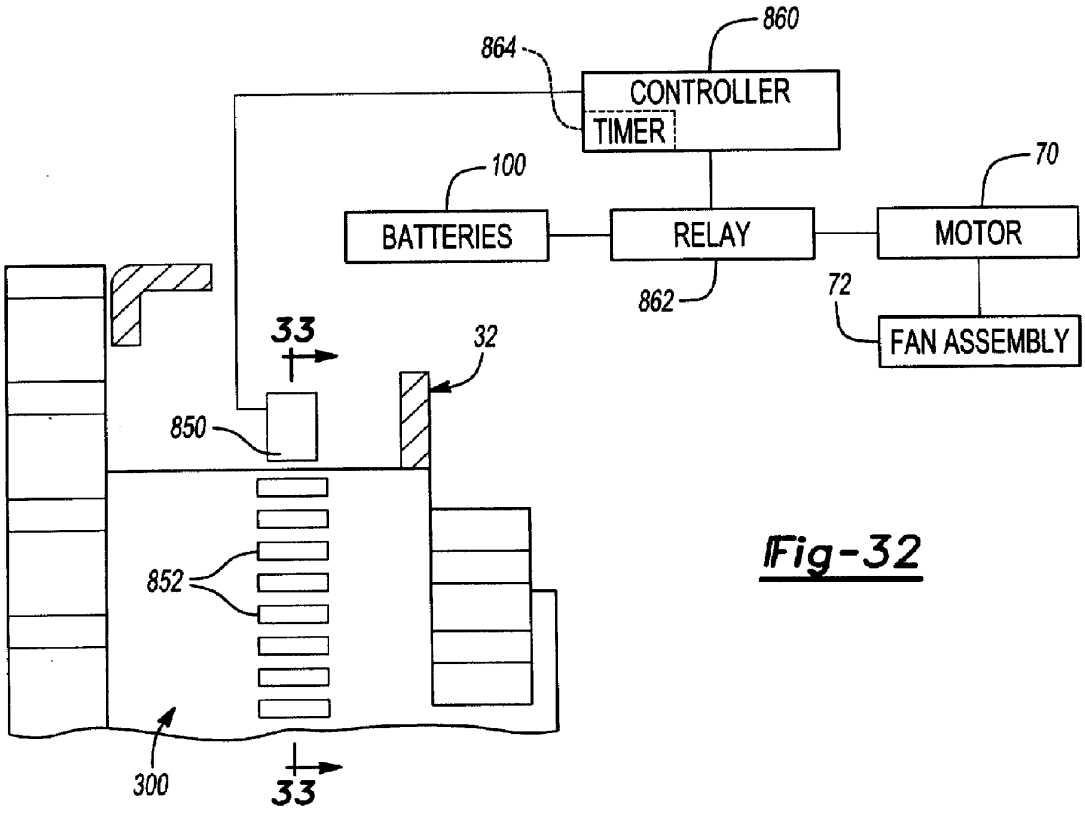

860
864
CONTROLLER
TIMER
100
70
BATTERIES
RELAY
MOTOR
862
72
FAN ASSEMBLY
33
32
850
852
300
33

Fig-32

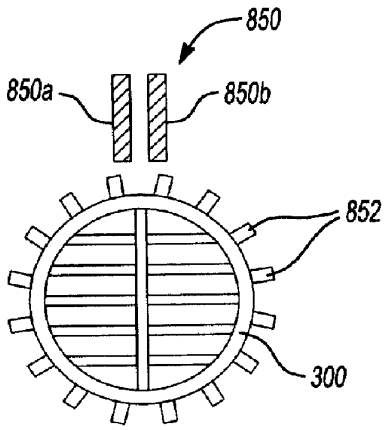

850
850a
850b
852
300

Fig-33

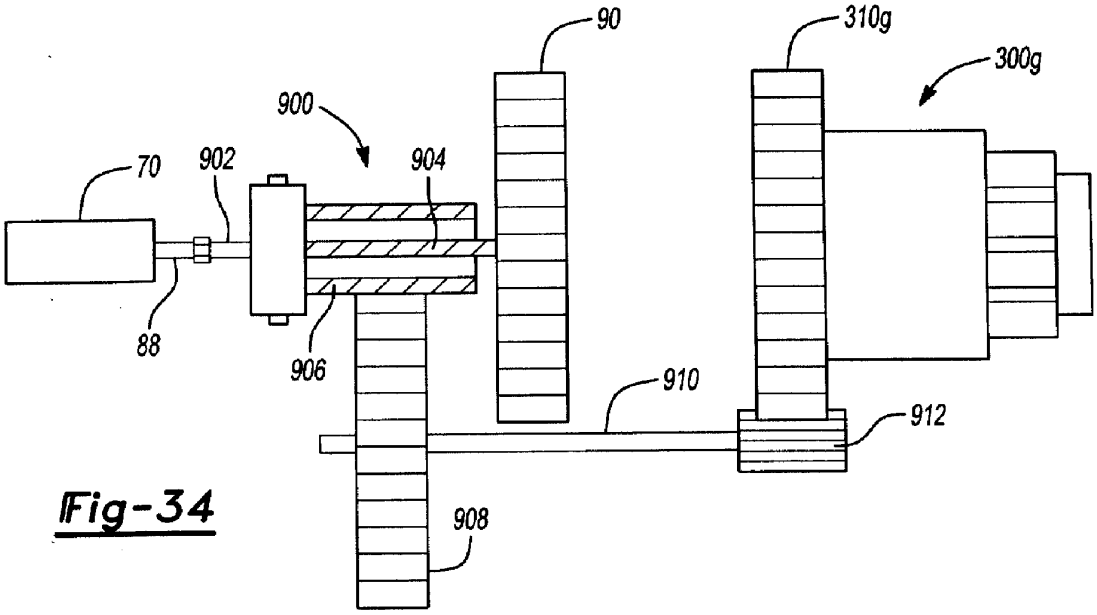

90
310g
300g
900
70
902
904
88
906
910
912
908

Fig-34

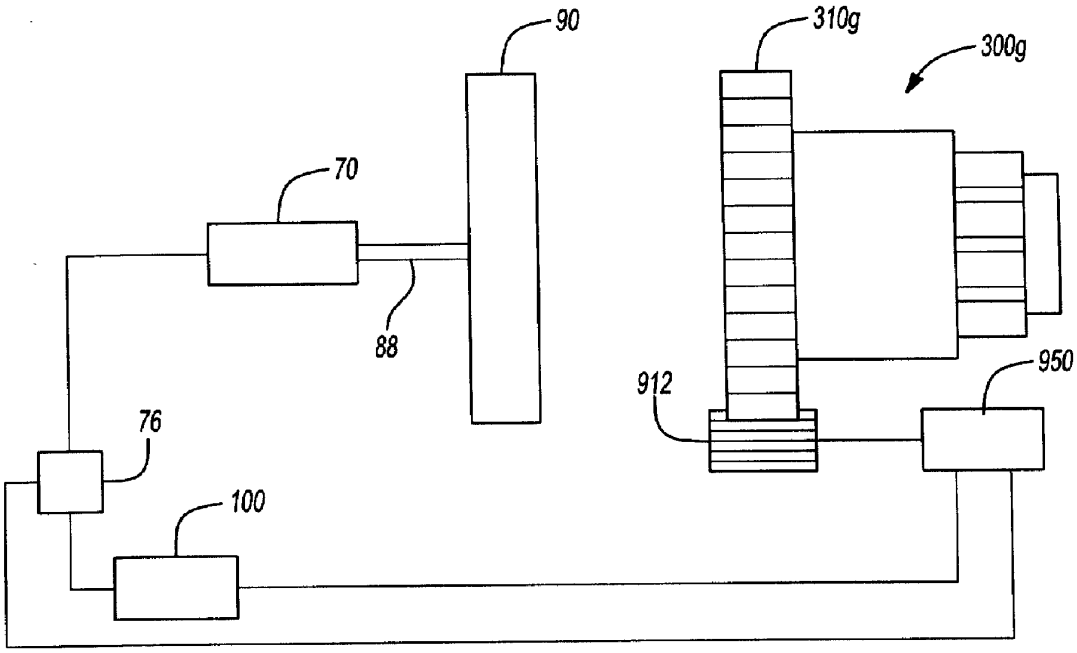

90
310g
300g
70
88
912
950
76
100

Fig-35

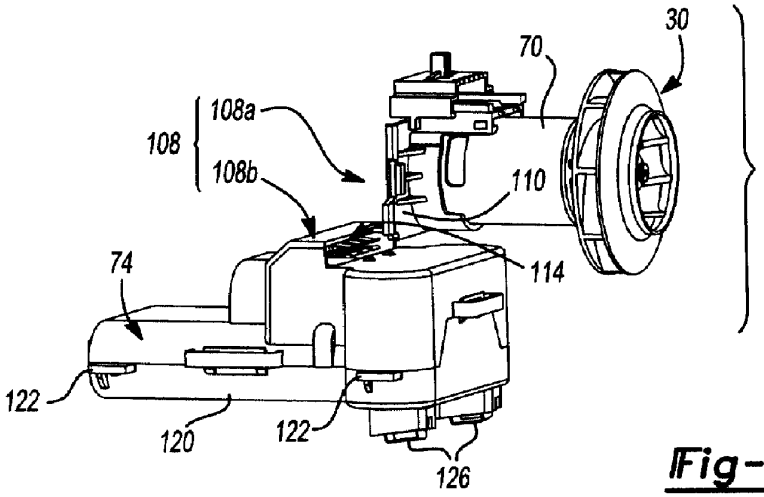

30
70
108
108a
108b
110
74
114
122
120
122
126

Fig-36

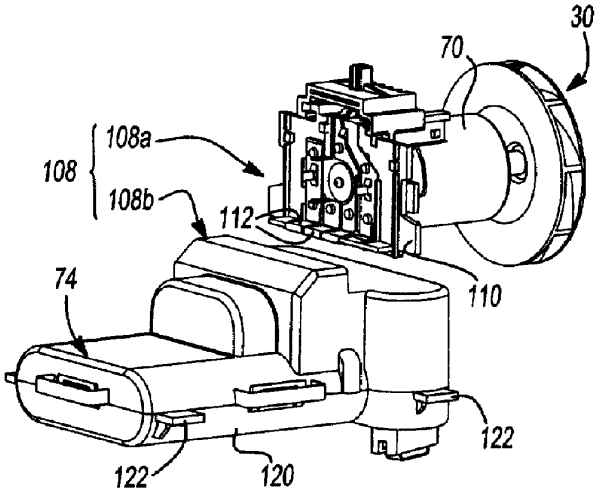


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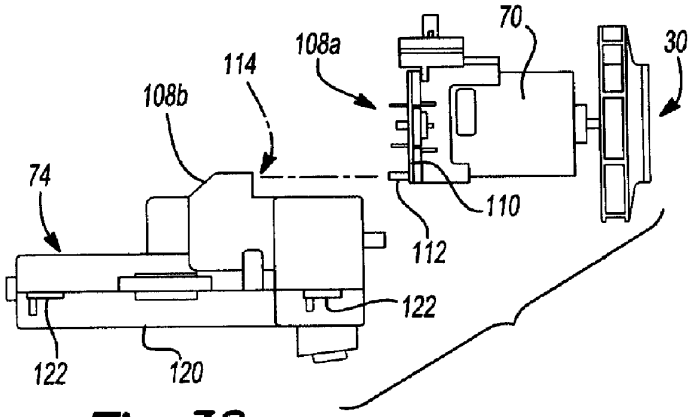


Fig-38

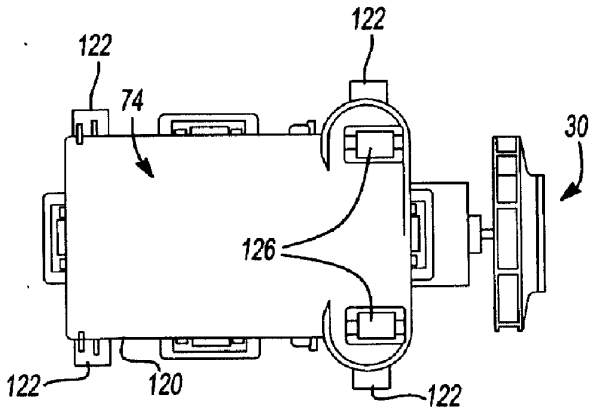


Fig-39

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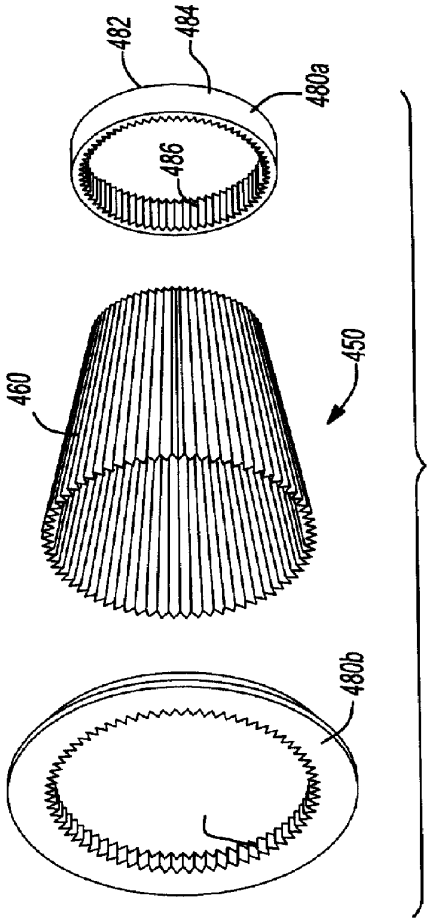


Fig-40

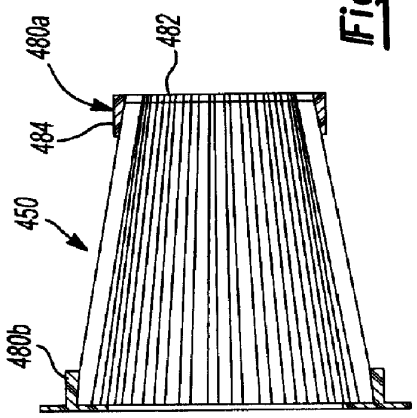


Fig-41

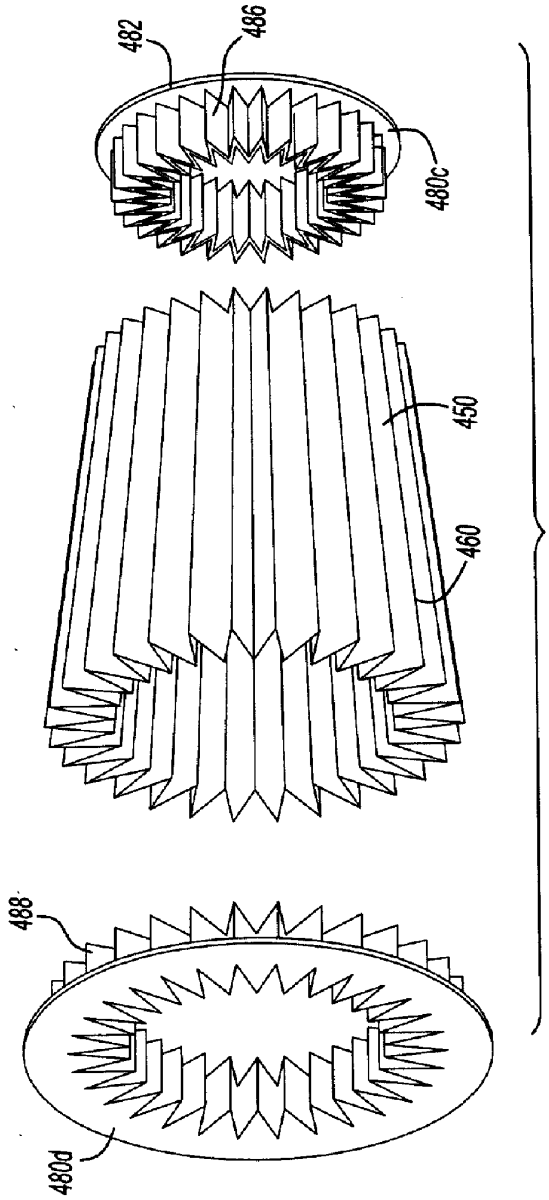


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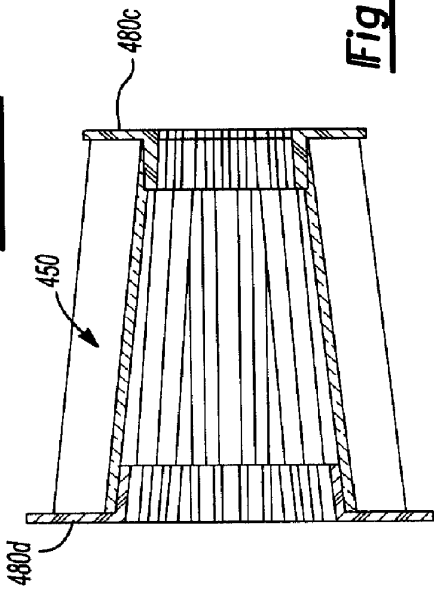


Fig-43

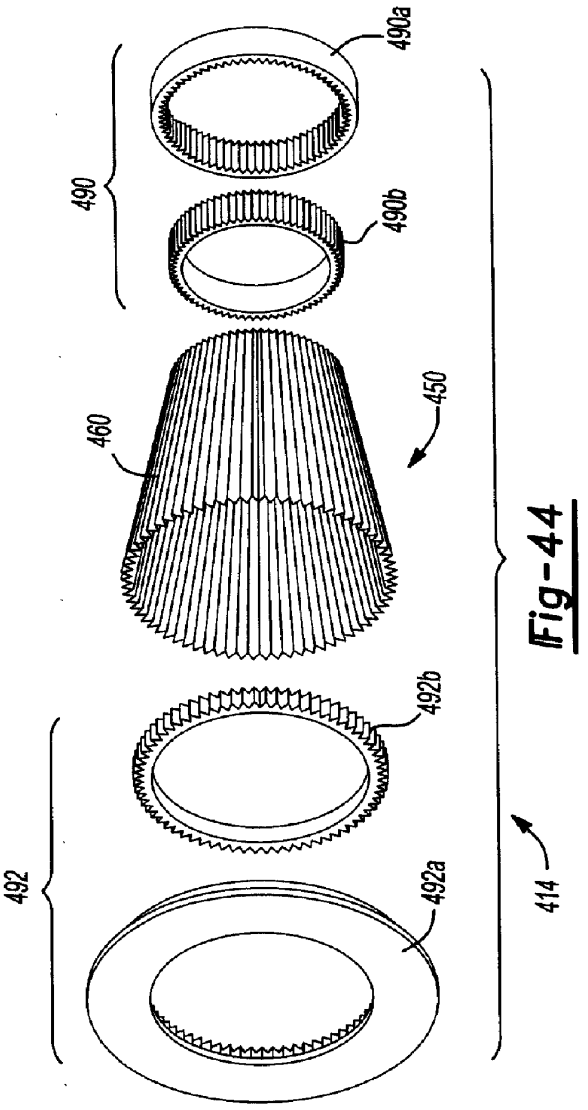

490a
490
490b
460
450
492b
492
492a
414

Fig-44

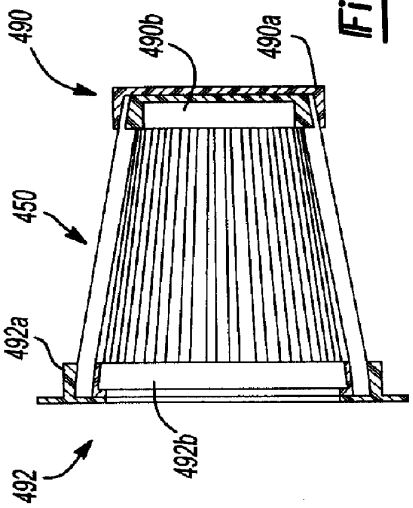

490
490b
490a
450
492a
492
492b

Fig-45

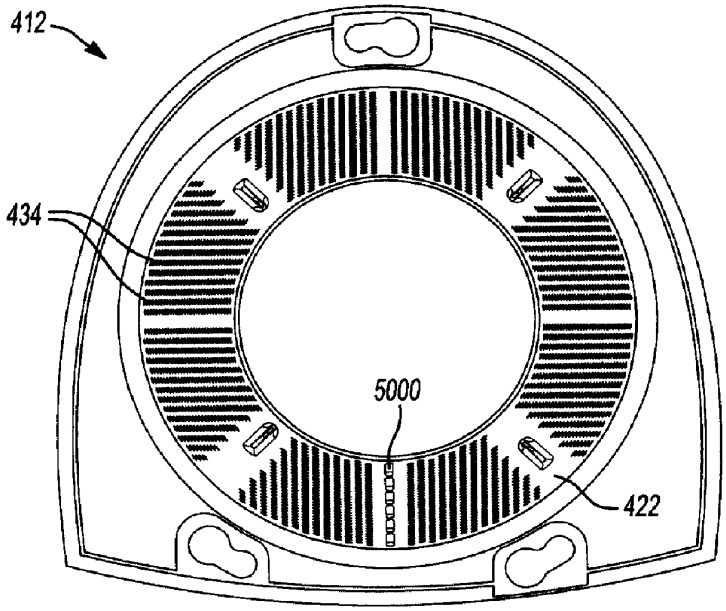


Fig-46

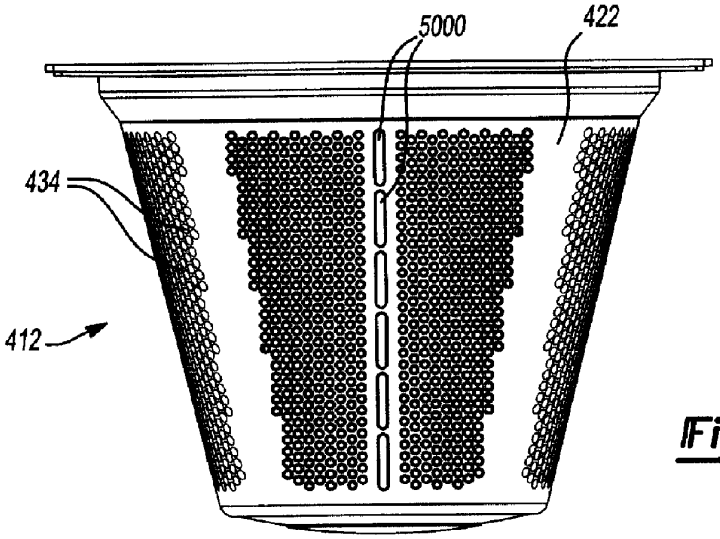


Fig-47

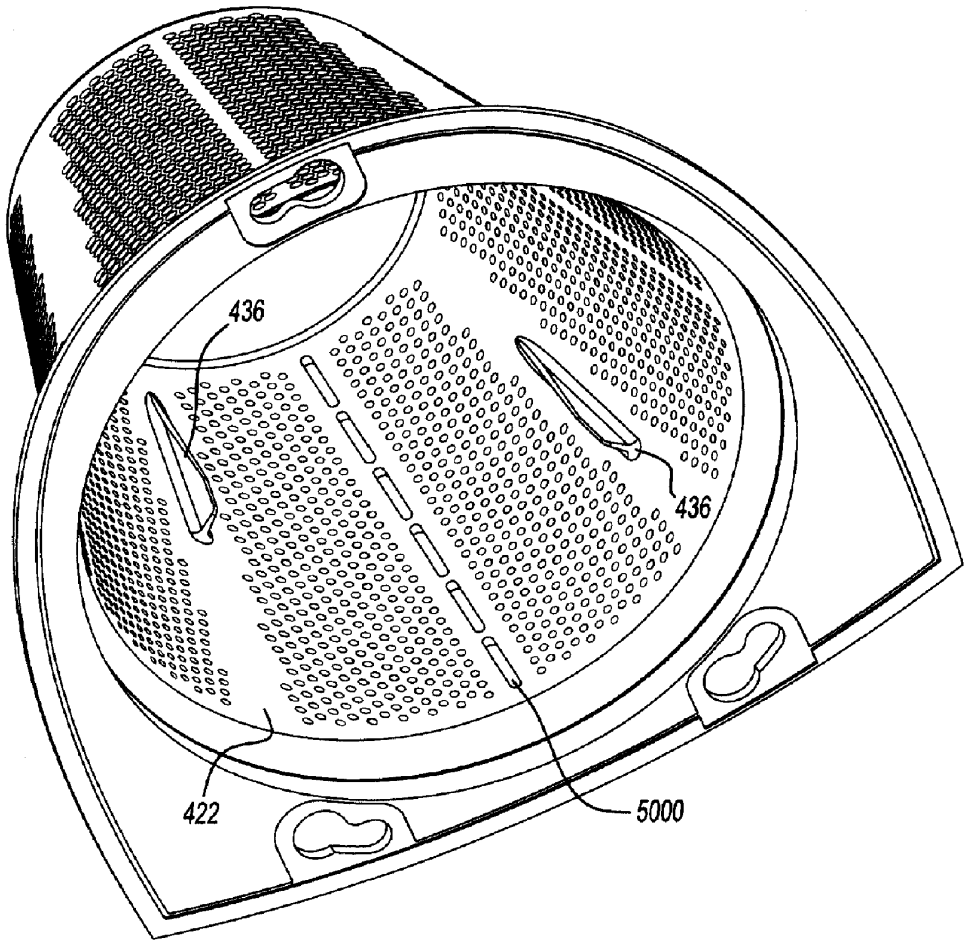


Fig-48

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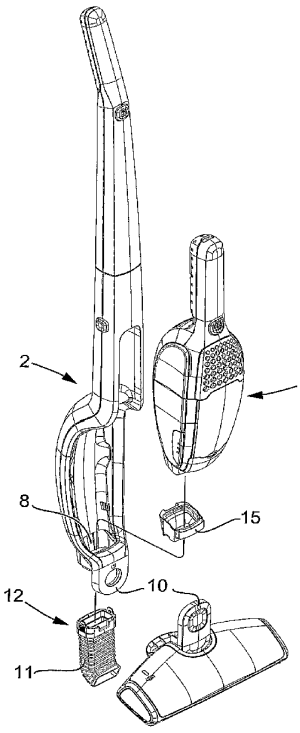


FIG 3

(57) Abstract: The invention relates to improvements in vacuum cleaners in order to reduce air flow losses in air pas- sages through a vacuum cleaner. More precisely, by the invention is avoided abrupt contractions or enlargements, changes of the cross sectional shape or sharp direction changes of the air passages, leakage of air into the air passages and clogging of debris in the air passages. The invention is applicable in hand held vacuum cleaner units, stick formed vacuum cleaners, vacuum cleaners of so called 2-in-1 type comprising a releasable hand held unit and a support body, and vacuum cleaners having a cyclone-like type of debris collector.

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IMPROVEMENTS RELATING TO AIR FLOW LOSSES IN A VACUUM CLEANER

The invention relates to improvements in vacuum cleaners in order to reduce air flow losses in air passages through a vacuum cleaner.

Background of the invention

The suction efficiency of a vacuum cleaner is determined, besides of the effective power of the electric motor, also to a large extent of the suction effect losses or air flow losses in the air passages through the vacuum cleaner.

Avoiding air flow losses in the air passages is important in all kinds of vacuum cleaners in order to achieve a high suction efficiency and reduce energy consumption. However, it is especially important in vacuum cleaners having an electrical motor powered by batteries. In such a case it is not a preferred option to compensate for air flow losses in the air passages by increasing the motor power, since this will have the effect that the battery power will be used up in a shorter time, necessitating more frequent recharging. As an alternative the battery power capacity could be increased by providing more batteries in the vacuum cleaner, but this will have the effect that also the costs and the weight of the vacuum cleaner will increase.

Battery powered vacuum cleaners are known in many different embodiments. The most common type of battery powered vacuum cleaners are small hand held units used for easy cleaning of kitchens, motor cars and the like. Due to the battery operation, which eliminates the need for connecting a mains supply cable, it is possible to perform e.g. daily cleaning of a kitchen swift and easy.

There is also known battery powered vacuum cleaners of a stick formed type, having a nozzle device in a lower end and a handle in an upper end, by means of which it is possible to vacuum clean for example floors. There is also known battery powered vacuum cleaners being a combination of these two types, i.e. a so called 2-in-1 vacuum cleaner comprising a hand held unit which optionally can be inserted into an elongated support body to form a stick-type vacuum cleaner having a nozzle device in a lower end and a handle in an upper end, by means of which e.g. floors easily can be vacuum cleaned, whereas also the hand held unit can be used separately to vacuum clean for example tables, worktops or narrow spaces. In this latter type of vacuum cleaner, all of the machinery, such as motor, fan unit, batteries and debris collector, is positioned inside the comparatively small hand held unit, whereas the support body only functions as a carrier for the hand held unit when vacuum cleaning floors. As a consequence the available space for the machinery is limited at the same time as the air must be drawn a comparatively long distance from the nozzle device in the lower end of the support body, through the air passages inside the same and through the hand held unit.

Summary of the invention

It is an object of the invention to improve the suction efficiency by reducing the air flow losses in the air passages of a vacuum cleaner.

According to a first aspect of the invention, it is an object to improve the suction efficiency through the air passages of a vacuum cleaner of a hand held unit type. At least this object is achieved by a vacuum cleaner according to claims 6, 7, 8 and 11.

According to a second aspect of the invention, it is an object to improve the suction efficiency through the air passages of a stick formed vacuum cleaner. At least

this object is achieved by a vacuum cleaner according to claims 1, 6, 7, 8 and 12.

According to a third aspect of the invention, it is an object to improve the suction efficiency through the air passages of a vacuum cleaner of a so called 2-in-1 type comprising a hand held unit and a support body, in which the hand held unit is insertable in order to optionally use the hand held unit separately or as a stick-type vacuum cleaner. At least this object is achieved by a vacuum cleaner according to claims 1, 3, 6, 7, 8, 12 and 13.

According to a fourth aspect of the invention, it is an object to improve the suction efficiency through the air passages of a vacuum cleaner having a cyclone-like type of debris collector. At least this object is achieved by a vacuum cleaner according to claims 6, 7 and 8.

Generally, avoiding abrupt contractions or enlargements, changes of the cross sectional shape or sharp direction changes of air passages, leakage of outside air into the air passages and preventing clogging of debris in the air passages, reduces air flow losses in vacuum cleaners.

In order to render stick-type vacuum cleaners compact, smooth and easy to control during use and cost-effective to manufacture, it is known to attach the nozzle device in a lower end mechanically by means of an articulated joint and pneumatically by means of a flexible hose, preferably in the area behind the articulated joint in order to as well as possible hide the flexible hose behind the articulated joint. Traditionally, this flexible hose has an oval or circular cross section. In order to make the appearance of the flexible hose as discrete as possible, the maximum width of the flexible hose has to be restricted. Since the cross section is oval or circular, this has the effect that the cross sectional area of the flexible hose becomes unnecessarily restricted,

which increases the air flow losses through the flexible hose. According to the invention, the flexible hose instead is made with a generally rectangular or square cross section. In this way the available space behind the articulated joint is utilized effectively to the outmost possible extent to hide the flexible hose behind the articulated joint and at the same time provide an air passage having a comparatively large cross sectional area. A rectangular or square hose will also be thinner, from a front side to a rear side, than an oval or circular hose having the same cross sectional area. This is advantageous e.g. when vacuum cleaning in narrow spaces under furniture. With a thinner hose it is also possible to lower the articulated joint between the nozzle device and the support body, which likewise facilitates access under furniture. Another advantage is that the movability of the nozzle is increased since the rectangular hose is less likely to contact the floor than an oval circular hose due to the concave walls thereof.

As mentioned before, it is advantageous to maintain substantially the same shape and cross sectional dimension of the air passages at least to the debris collector for the purpose of lowering the air flow losses. By forming the flexible hose with a rectangular or square cross section, it is easier to achieve this object since it normally is more favourable to form the air passages in the support body with a rectangular cross section. However, though it is a disadvantage, in respect of restricting the air flow losses, to have air passages with too small cross sectional dimensions, it is also a disadvantage if they are to big. It has been found, according to the invention, that a cross sectional dimension of the air passages between 0,07-0,03 dm^2 is optimal for an air flow of 18-7 l/sec (litre per second). This is due to the fact that the air flow rate must be sufficient high to be able to perform vacuum cleaning with a good result.

In order to reduce air flow losses in the air passages, it is also important to prevent clogging of debris in the air passages. However, if any debris should nevertheless get stuck in the air passages, it is advantageous if the vacuum cleaner is constructed such that the debris can easily be removed. Accordingly, in one embodiment of the invention, the flexible hose is attached to the support body and/or to the nozzle device by a quick release arrangement such that at least one end of the flexible hose easily can be released and any stuck debris can be removed from the hose.

In case of a so called 2-in-1 vacuum cleaner having a small hand held unit, which is insertable in a support body, it has been found that one weak point for air flow losses is the connection between the hand held unit, i.e. the tube formed air inlet of the hand held unit, and the air passage in the support body from the nozzle device. To reduce air flow losses it is beneficial that as little air as possible can be drawn from the outside through the connection and into the air passage. At the same time the hand held unit must be easily and readily releasable from the support body to enable vacuum cleaning with the hand held unit alone. In one embodiment of the invention the connection is formed by an annular shoulder in the support body, being adapted to abut against the annular rim of the tube formed air inlet at the hand held unit, and a bead which is adapted to abut against the outer surface of the air inlet at least partially around its circumference. In a hereinafter described and illustrated embodiment, the connection is formed by an insert sleeve, having an annular shoulder as well as a bead, which is mounted in the air passage in the support body. However, it would also be possible to arrange the connection by means of a separate bead forming element, e.g. mounted in a circumferential groove in the air passage, and a separate sealing element being positioned on an annular shoulder in the air passage. In order to ensure conven-

ient releasing of the hand held unit from the support body, it is sometimes suitably to provide the sealing bead only partly around the circumference. Preferably the insert sleeve and the separate bead element and sealing element, respectively, are formed of a material being at least slightly resilient to ensure sealing abutment against the air inlet tube of the hand held unit.

Battery powered vacuum cleaners and especially hand held units, are often equipped with a debris collector in form of a cyclone-like separator to separate the debris from the air flow. Mainly because the available space in the debris collector of battery powered vacuum cleaners, is too small for bags with ordinary size, which would necessitate an unwanted frequent replacement of bags. It has been found that the shaping of the air channel and the inlet opening to the cyclone-like separator is important for restricting the air flow losses in the vacuum cleaner. According to one embodiment of the invention, the air passage from the air inlet of the hand held unit is curved and has an inlet opening into the cyclone-like separator which is positioned off centre in relation to the symmetry plane of the cyclone-like separator, such that the air flow enters the cyclone-like separator substantially in the tangential direction in the upper periphery of the cyclone-like separator. Thereby direction changes of the air passage at the inlet opening into the cyclone like separator are reduced, and air flow losses are lowered.

To direct the air flow inside the cyclone-like separator, there is provided a partition wall between the filter insert and the inner surface of the debris container, which extends from the inlet opening of the cyclone-like separator and preferably at least about one quarter to half the distance around the filter insert. In an end portion distant from the inlet opening, the partition wall is curved in the direction towards an end of the filter insert in order to smoothly direct the air

flow helically around the filter insert. Accordingly, it is formed a substantially rectangular air passage, having mainly the same shape and cross sectional size as the air passage in the support body, which is defined between the filter surface, the inner surface of the debris container, an end wall of the debris container and the partition wall, and extends about a quarter to half of the distance around the filter insert. This is advantageous in respect of restricting air flow losses and maintaining a sufficient air flow rate, as mentioned before, and creates a favourable air flow inside the cyclone-like separator.

In a further embodiment, also the inner end surface of the cyclone-like separator is formed with a curved directing portion in the vicinity of the end portion of the partition wall to further direct the air flow helically around the filter insert.

In a further embodiment, the filter insert is provided with filter material for the passage of air through the filter into the filter insert also at a portion thereof which follows the portion that starts the cyclonic rotation of the air. Thereby the filter area is increased as compared with prior art filter inserts, which has the effect that the air flow losses over the filter insert are reduced.

After passage of the filter insert in the cyclone-like separator, the air flow is passed through the filter insert to the motor-fan unit through an inlet opening. According to an embodiment of the invention, the inlet opening to the motor-fan unit is funnel shaped in order to reduce air flow losses when the air flow is transferred from the cyclone-like separator to the motor-fan unit after passage of the filter insert.

According to regulations in most countries, the inlet opening to the motor-fan unit has to be covered by an intake screen to prevent physical injuries from the rotating fan. In order to reduce air flow losses, the in-

take screen has been formed with a dome-shape. This is beneficial for the reduction of air flow losses in two different ways. On the one hand this has the effect that the area of the intake screen will become larger such that the total area of the air flow openings through the intake screen can be made larger. On the other hand this has also the effect that the intake screen will become stronger, due to the dome-shape, which can be utilized to reduce the cross-sectional dimensions of individual screen members, which also will reduce the air flow losses through the intake screen.

To reduce the air flow losses through a vacuum cleaner, it is important not to unnecessarily slow down the air flow through the air exhaust section from the fan unit. Therefore, in one embodiment of the invention, the vacuum cleaner is provided with a first air outlet on a front side as well as a second air outlet on a rear side. This feature can be incorporated in a hand held unit, in a stick formed vacuum cleaner, as well as in a 2-in-1 type of vacuum cleaner. In the latter case the hand held unit is provided with a first air outlet in the front side and a second air outlet in the rear side, whereas the support body is provided with air flow openings in the rear side of the recess for accommodating the hand held unit, which substantially coincide with the second air outlet.

It is to be understood that it is within the scope of the invention that all the features, mentioned in this specification, for reducing air flow losses through a vacuum cleaner, can be applied separately in a vacuum cleaner or in any combination.

Brief description of the drawings

An exemplary embodiment will now be described in form of a so called 2-in-1 vacuum cleaner, with reference to the drawings, in which:

Fig 1 is a perspective view of a stick-formed vacuum cleaner of a 2-in-1 type;

Fig 2 is a perspective view of the vacuum cleaner according to fig 1, with a hand held unit released from a stick-formed support body;

Fig 3 is an illustration of the mechanical and pneumatic connection between the nozzle device, the support body and the hand held unit;

Fig 4 is a perspective view in an enlarged scale of the connection between a flexible hose and the support body;

Fig 5 is an enlarged cross section of the connection between an inlet tube of the hand held unit and an air passage in the support body;

Fig 6 is a perspective view from below of the hand held unit with a debris container released;

Fig 7 is a perspective view from above of the hand held unit with the debris container released and turned and a filter insert withdrawn from the debris container;

Fig 8 is a cut through view of the debris container from above showing the filter insert and the air flow inside the debris container;

Fig 9 is a cross sectional view through an intake screen and an inlet opening to a motor and a fan unit; and

Fig 10 is a perspective view from behind of the vacuum cleaner with the hand held unit released.

Detailed description of an embodiment of the invention

A vacuum cleaner of a 2-in-1 type, is shown in fig 1 in an assembled state and in fig 2 with a hand held unit 1 released from a stick formed support body 2. The support body 2 comprises a nozzle device 3 in a lower end, a handle 4 in an upper end and a recess 5 for accommodating the hand held unit 1. The hand held unit comprises an electrical motor, chargeable batteries, a fan unit driven

by the electrical motor, a handle 6 and a cyclone-like separator including a debris container 7 for collecting debris and dust. The nozzle device 3 is of an ordinary, previously known kind, by means of which floors can be vacuum cleaned when the hand held unit 1 is inserted in the support body 2, in which case air is drawn by the fan unit in the hand held unit from the nozzle device 3 through an air passage 8 in the support body 2. When, on the other hand, the hand held unit is released from the support body, the hand held unit can be used separately to vacuum clean e.g. tables, worktops or narrow spaces in which case air and debris is drawn through a tube formed inlet 9. The inlet tube can be connected to various nozzle adapters to facilitate vacuum cleaning of different surfaces.

Reference is now made to fig 3 in which is shown the support body 2 and the nozzle device 3 in a disassembled state. In the assembled state the support body 2 and the nozzle device 3 are connected by means of an articulated joint 10 such that the nozzle device can be rotated in relation to the support body during vacuum cleaning. To allow air flow from the nozzle device 3 to the air passage 8 in the support body 2, a flexible hose 11 is connected between the nozzle device and the support body. According to the invention, the flexible hose has a general rectangular cross sectional shape. In this way the flexible hose 11 can be made with a comparatively large cross sectional area and still to a large extent be hidden behind the articulated joint. This contributes to an attractive appearance of the vacuum cleaner while minimizing the air flow losses. Since also the air passage 8 in the support body has a general rectangular cross section, this also has the effect that there will be small or substantially no air flow losses due to changing cross sectional shapes between the nozzle device and the air passage.

Moreover, the upper end of the flexible hose 11 is attached to the support body 2 by means of a quick release fitting 12, which facilitates removing of possible stuck debris in the flexible hose and eliminates the risk of air flow losses for this reason. The quick release fitting 12 is illustrated more in detail in fig 4, from which it appears that the upper end of the hose 11 is provided with a rigid collar 13 which includes resilient tabs 14 having holes which can go into engagement with matching protrusions on the support body 2.

In fig 3 and 5 is illustrated the connection between the inlet tube 9 of the hand held unit 1 and the air passage 8 in the support body 2. As can be seen the hand held unit is to be mounted in the recess 5 such that the inlet tube 9 of the hand held unit is inserted into the air passage 8. To minimize air leakage between the inlet tube 9 and the air passage 8, a sealing collar 15 of a resilient material is mounted in the air passage 8. In fig 5 is illustrated in greater detail the shape of the sealing collar 15 in a cross section in the area of the connection between the inlet tube 9 of the hand held unit 1 and the air passage 8 of the support body 2. According to the invention the sealing collar is formed with a step formed shoulder surface 16, which is adapted to abut the circumferential rim of the inlet tube 9. In the direction of the air flow, the inner surface of the sealing collar 15 is provided with a bead 17, which is adapted to bear against the outer surface of the inlet tube 9. In this way is achieved an adequate sealing of the inlet tube which restricts the air leakage into the inlet tube through the connection between the air passage 8 and the inlet tube 9. To facilitate releasing and mounting of the hand held unit in the support body, the bead 17 may be discontinuous and be missing in certain portions around the circumference of the inner surface of the sealing collar, e.g. in the rear surface of the sealing collar. In such a case a bead in the front surface can be util-

ized, due to its resilient characteristics, to press the inlet tube of the hand held unit against the rear surface of the sealing collar, which also is of a resilient material, such that an adequate sealing effect is achieved.

To restrict the air flow losses in the hand held unit from the inlet tube 9 to the cyclone-like separator , an air channel 18 in the hand held unit has, according to the invention, been formed with a curved shape, as is illustrated in fig 6 and 7, which are partly cut through perspective views of the hand held unit from the bottom side and from the upper side, respectively, with the debris container 7 released from a base unit 19 of the hand held unit. In these figures have been indicated the extension of the air channel 18 and an outlet opening 20 to the debris container 7 by broken lines. In fig 7 the debris container 7 is released from the base unit 19 and turned such that a bottom side of the debris container 7 is visible. In the view also a filter insert 21 is withdrawn from inside the debris container, wherein the debris container 7 and the filter insert 21 forms the cyclone-like separator of the hand held unit. During operation the air flows in through the inlet tube 9, passes through the curved air channel 18 in the base unit 19, exits the outlet opening 20 in the base unit and enters an inlet opening 22 in the debris container. The air channel 18 is curved in such a way that the outlet opening 20 and inlet opening 22 are positioned off centre in respect of a symmetry plane of the hand held unit and the air flow enters the debris container directed substantially tangentially in respect of the periphery of the inner surface of the debris container 7 and the outer surface of the filter insert 21 (as is illustrated by the flow arrows in the figures).

To further direct the air flow, the filter insert 21 is provided with partition walls which, when the filter insert is mounted in the debris container 7, extends between the outer filter surface, which is elongated with a

substantially circular cross section and positioned centrically in the debris container, and the inner surface of the debris container. In this way is formed an air passage between the filter, the inner surface of the debris container, an end wall of the debris container and the partition wall 24, which has substantially the same shape and cross sectional dimension as the air passage through the support body. More precisely the partition walls comprise one first semi-circular partition wall 23, which restricts the air passage in the "wrong" direction from the inlet opening 22, and one second straight partition wall 24, which directs the air flow circumferentially around the filter. According to the invention, the straight partition wall 24 is provided, in an end distant from the inlet opening 22, with a curved directing portion 25, which is curved in the direction toward an end of the filter and directs the air flow helically around the filter insert. Also an end wall 26 of the filter insert 21 which, when the filter insert is mounted in the debris container 7, forms an end wall of the debris container, is provided with a curved directing portion 27, which likewise is curved in the direction toward the end of the filter and has the purpose of contributing to the helically directing of the air flow. The air flow around the filter insert is further illustrated in fig 8 by arrows. As can be seen, the filter is provided with several filter panels 28 in a supporting frame structure 29 of an airtight material, e.g. plastics. While the air flows helically around the filter, it gradually enters radially through the filter panels 28 and subsequently flows in the axial direction inside the filter insert to the fan unit, which is positioned inside the base unit 19.

In fig 6 and 7 it is also visible an inlet opening 30 to the fan unit inside the hand held unit. The inlet opening 30 is covered by an intake screen 31 to prevent physical injuries from the rotating fan. The inlet opening is formed by an insert collar 32 which, together with

the intake screen 31, a motor 33 and a fan wheel 34 is shown in a cross sectional view in fig 9. To restrict the air flow losses trough the inlet opening 30, it has been formed with a smoothly rounded, tapering funnel portion 35 and a smoothly rounded, widening portion 36 of the fan wheel 34, as can be seen from the figure. In this way is avoided unnecessary turbulent flow due to abrupt dimension changes when transferring the air from the cyclone-like separator to the fan unit. Moreover, the intake screen 31 is formed with a dome shape. This has the effect that the total area of the air flow openings through the intake screen can be made larger. This will also make the intake screen stronger to forces acting in a perpendicular direction towards the dome, which can be utilized to reduce the cross-sectional dimensions of individual screen members.

One way to further restrict the air flow losses through a vacuum cleaner is to reduce the air flow resistance in the air exhaust section from the fan unit. According to the invention, the hand held unit therefore is provided with a first air outlet 37 on the front side as well as a second air outlet 38 on the rear side, as can be seen e.g. from fig 1 and 10, respectively. In order to reduce the air flow resistance also when the hand held unit is mounted in the support body 2, the rear side of the support body, in the region of the recess 5 for accommodating the hand held unit 1, is provided with air flow openings 39 to allow air flow from the second air outlet 38 to the environment through the air flow openings 39 in the support body. In case of a stick formed vacuum cleaner, which is not provided with a separate releasable hand held unit, as in the described embodiment, the vacuum cleaner can be provided with a similar second air outlet 39 on the rear side.

CLAIMS

1. A vacuum cleaner comprising an elongated support body (2), a nozzle device (3) being attached to a lower end of the elongated support body by means of an articulated joint (10), a motor, a fan unit, a debris container (7), and an air passage, which extends from the nozzle device, past the articulated joint by means of a flexible hose (11) and to an air passage (8) in the support body, c h a r a c t e r i z e d in that the flexible hose (11) is formed with a generally rectangular cross section.

2. A vacuum cleaner according to claim 1, c h a r a c t e r i z e d in that the flexible hose (11) is attached with a quick release fitting (12) to the vacuum cleaner in at least one of its ends.

3. A vacuum cleaner comprising; a hand held unit (1) including a motor, a fan unit, a debris container (7), and an air passage (18) extending from a tube formed air inlet (9) to the debris container; and an elongated support body (2) adapted to accommodate the hand held unit and having a nozzle device (3) in a lower end, which is attached to the elongated support body by means of an articulated joint (10), and an air passage (8) extending from the nozzle device, past the articulated joint and through the lower part of the support body to the air inlet tube of the hand held unit, c h a r a c t e r i z e d in that the elongated support body (2) comprises a sealing connection (16, 17) for connecting the air inlet tube (9) of the hand held unit (1) to the air passage (8) in the elongated support body, the sealing connection comprising a step formed, annular shoulder portion (16), adapted to abut against an annular rim of the air inlet tube, and a bead (17) of an elastic material which is adapted to surround the air inlet tube at least partly

around its circumference and bear against the outside of the air inlet tube.

4. A vacuum cleaner according to claim 3, c h a r a c t e r i z e d in that also the annular shoulder portion (16) of the sealing connection is formed of an elastic material.

5. A vacuum cleaner according to claim 3, c h a r a c t e r i z e d in that the sealing connection is formed as an compliant insert sleeve (14).

6. A vacuum cleaner including a motor, a fan unit, a debris container (7), an air passage (18) extending from an air inlet tube (9), through the debris container and to an air outlet (37, 38), the debris container constituting a part of a cyclone-like separator comprising at least one filter insert (21), c h a r a c t e r i z e d in that the air passage (18) from the air inlet tube (9) to the debris container (7) is curved such that an inlet opening (22) is positioned off centre in relation to a symmetry plane of the cyclone-like separator such that the air flow enters peripherally in a substantial tangential direction of the cyclone-like separator.

7. A vacuum cleaner including a motor, a fan unit, a debris container (7), an air passage (18) extending from an air inlet tube (9), through the debris container and to an air outlet (37, 38), the vacuum cleaner also comprising at least one elongated filter insert arranged in the debris container, whereby an air guiding partition wall (24), extending from the debris container inlet opening (22), is provided between the filter insert and the inner surface of the debris container, c h a r a c t e r i z e d in that the partition wall (24), in an end portion distant from the inlet opening (22), is formed with a

curved directing portion (25), which is curved in the direction towards an end of the filter insert (21).

8. A vacuum cleaner including a motor, a fan unit, a debris container (7), an air passage (18) extending from an air inlet tube (9), through the debris container and to an air outlet (37, 38), the vacuum cleaner also comprising at least one filter (21) being arranged centrally in the debris container, the debris container constituting a part of a cyclone-like separator, the filter being formed as an elongated filter insert with a substantially circular cross section, which is arranged inside the debris container such that a passageway for the air is defined in an area between the filter insert and the inner surface of the debris container, and an air guiding partition wall (24) being formed between the filter insert and the inner surface of the debris container, such that a rectangular air passage is defined between the filter insert, the inner surface of the debris container, an end wall (26) of the filter insert and the partition wall, from the area adjacent the air inlet opening (22) in the debris container and extending at least one quarter of the distance around the circumference of the filter insert to direct the air flow helically around the filter insert, c h a r a c t e r i z e d in that the partition wall (24), in an end portion distant from the inlet opening (22), is formed with a curved directing portion (25), which is curved in the direction towards an end of the filter insert (21).

9. A vacuum cleaner according to claim 8, c h a r a c t e r i z e d in that an end surface (26) of the debris container (7) is formed with a curved directing portion (27), which is curved in the direction towards an end of the filter insert (21).

10. A vacuum cleaner according to claim 8 or 9, comprising an air inlet (30) to the fan unit, c h a r a c t e r i z e d in that the air inlet (30) to the fan unit is funnel shaped.

11. A vacuum cleaner according to claim 10, comprising an intake screen (31) provided in front of the air inlet (30), c h a r a c t e r i z e d in that the intake screen (31) is dome-shaped in cross section.

12. A vacuum cleaner comprising an elongated support body (2), a nozzle device (3) in a lower end being attached to the elongated support body by means of an articulated joint (10), a motor, a fan unit, a debris container (7), an air passage (11, 18) extending from the nozzle device, past the articulated joint, through the debris container and to an air outlet, c h a r a c t e r i z e d in that the air outlet comprises one first air outlet (37) on a front side of the vacuum cleaner as well as one second air outlet (38) on a rear side.

13. A vacuum cleaner according to claim 12, the vacuum cleaner comprising a hand held unit (1) which is releasable arranged in a support body (2), c h a r a c t e r i z e d in that the hand held unit (1) is provided with a first outlet (37) on its front side as well as a second air outlet (38) on its rear side and that also the support body (2) is provided with air openings (39) in the recess (5) for accommodating the hand held unit, to allow passage of air from the second air outlet (38) in the hand held unit through the air openings in the support body.

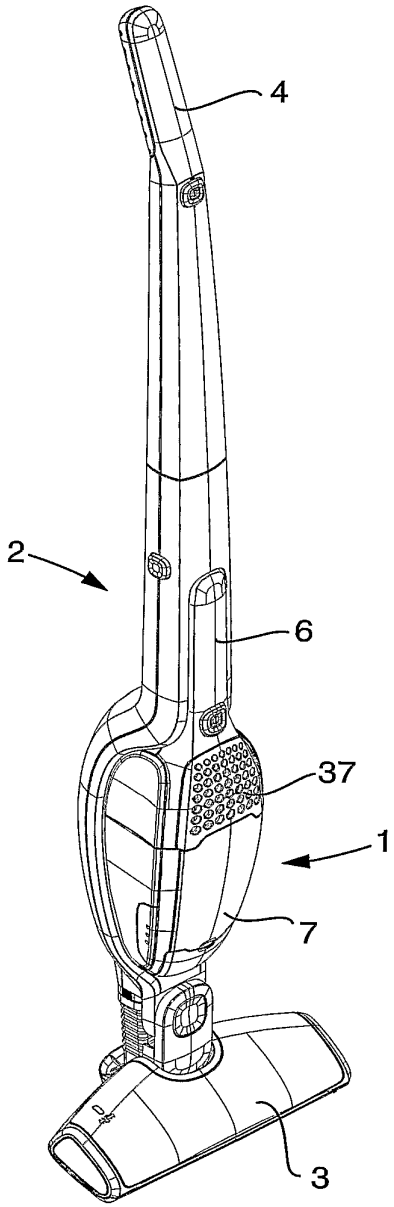


Fig 1

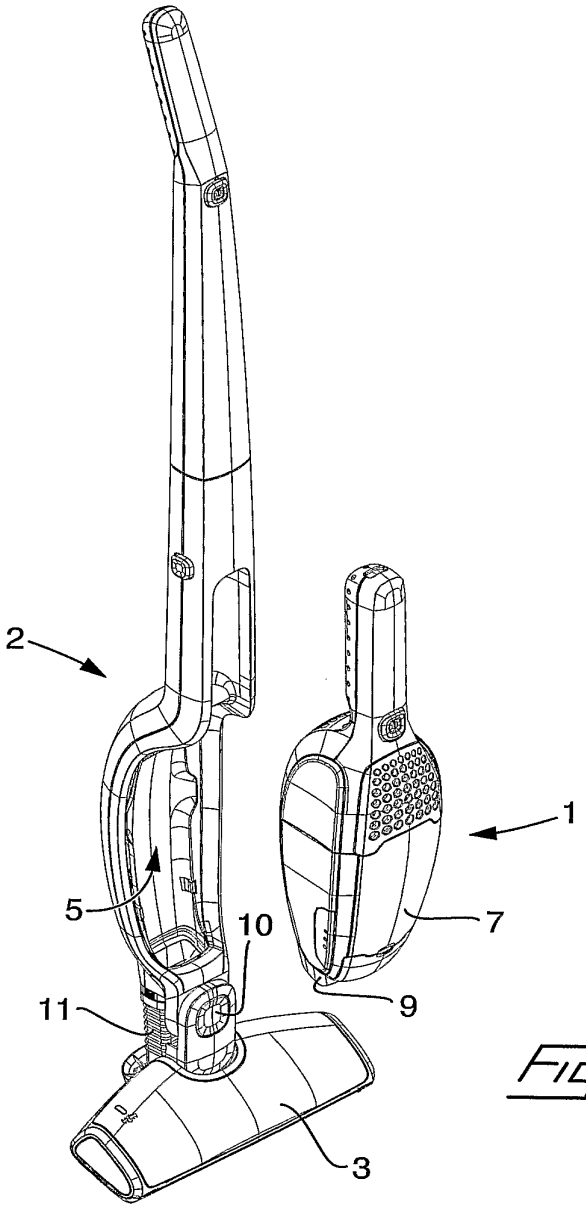


Fig 2

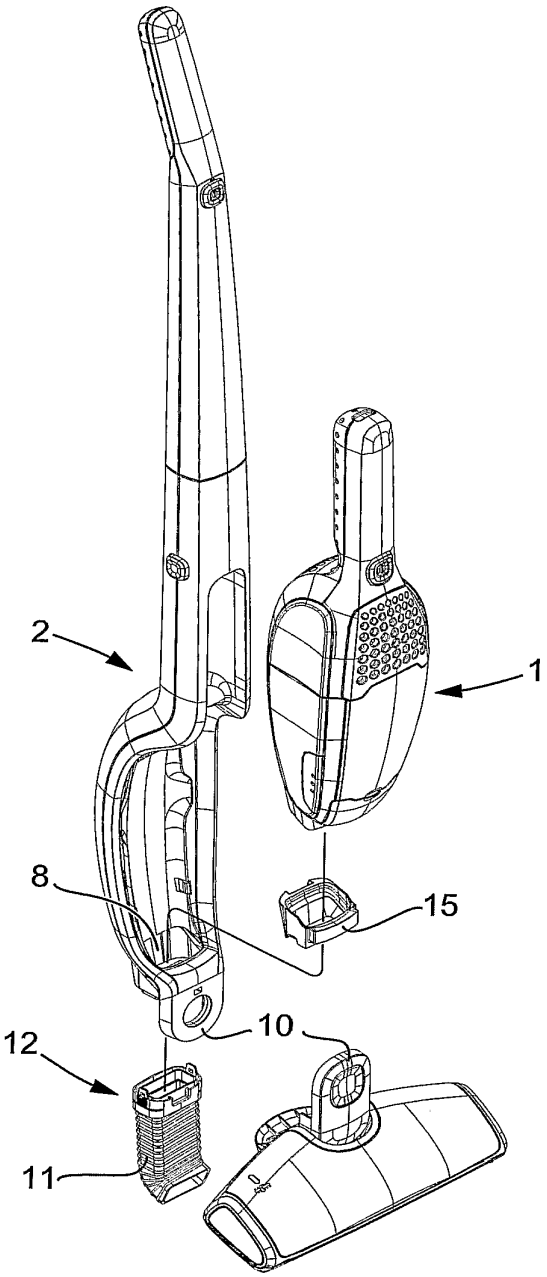


Fig 3

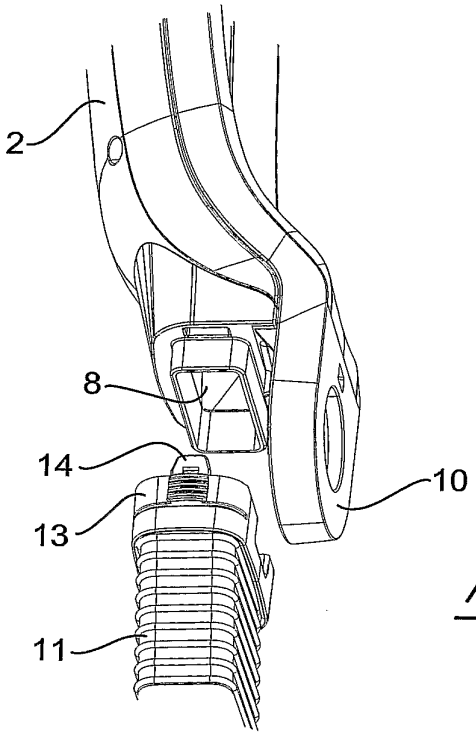


Fig 4

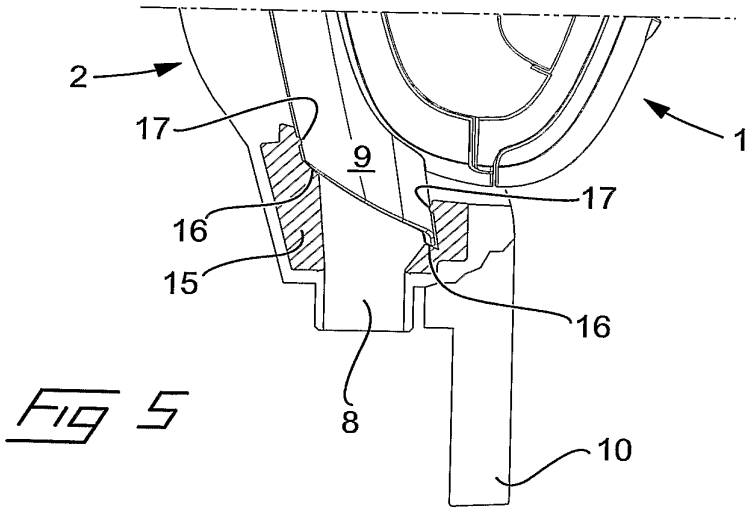


Fig 5

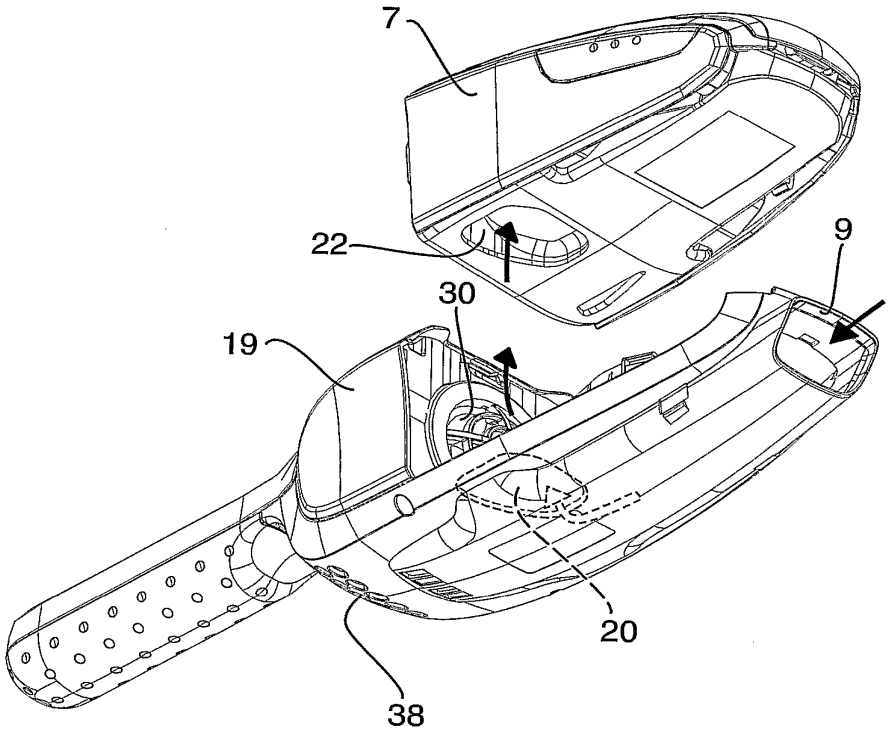


Fig 6

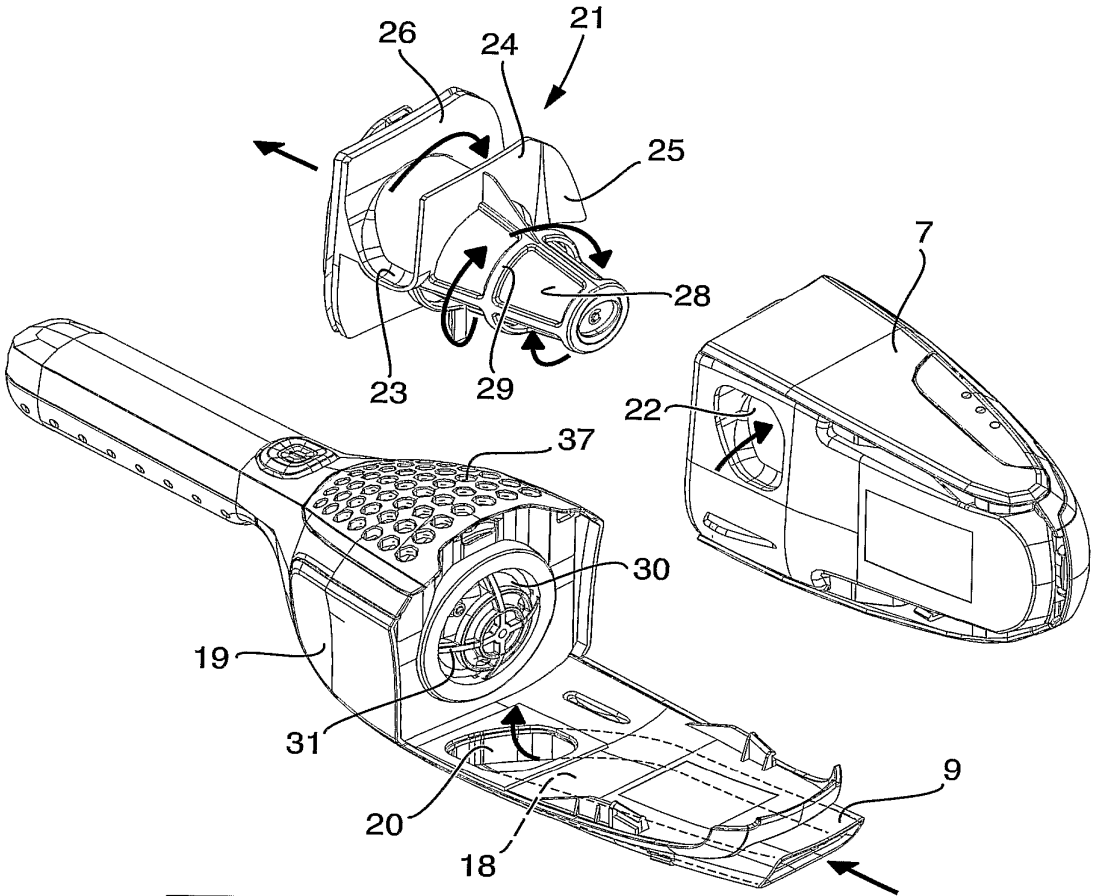


Fig 7

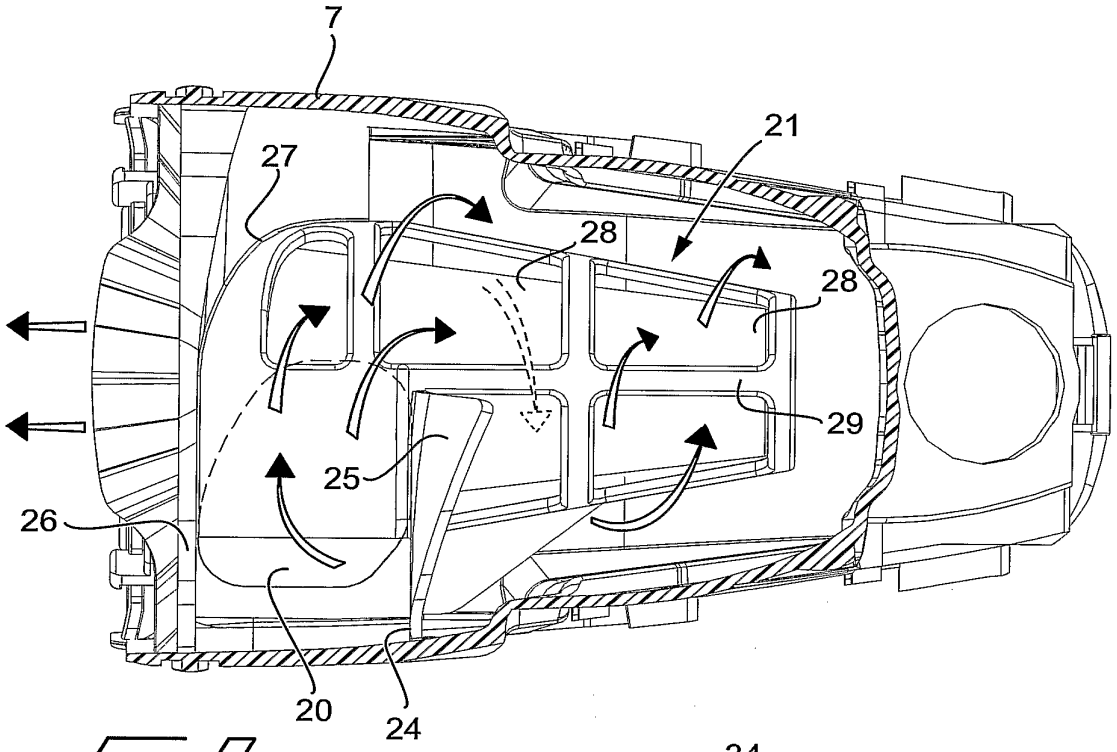


Fig 8

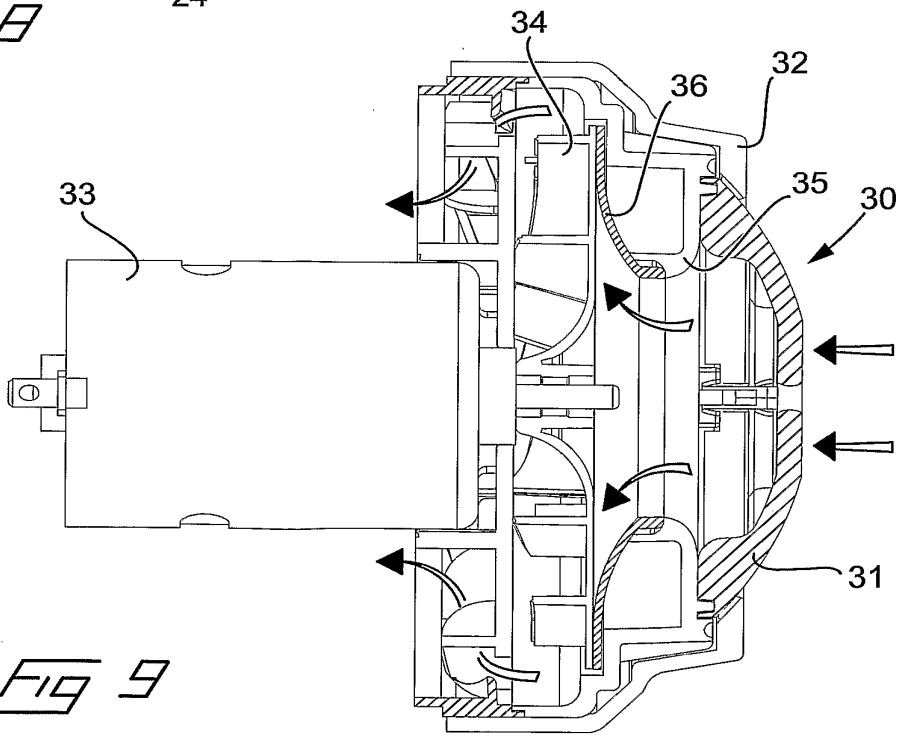


Fig 9

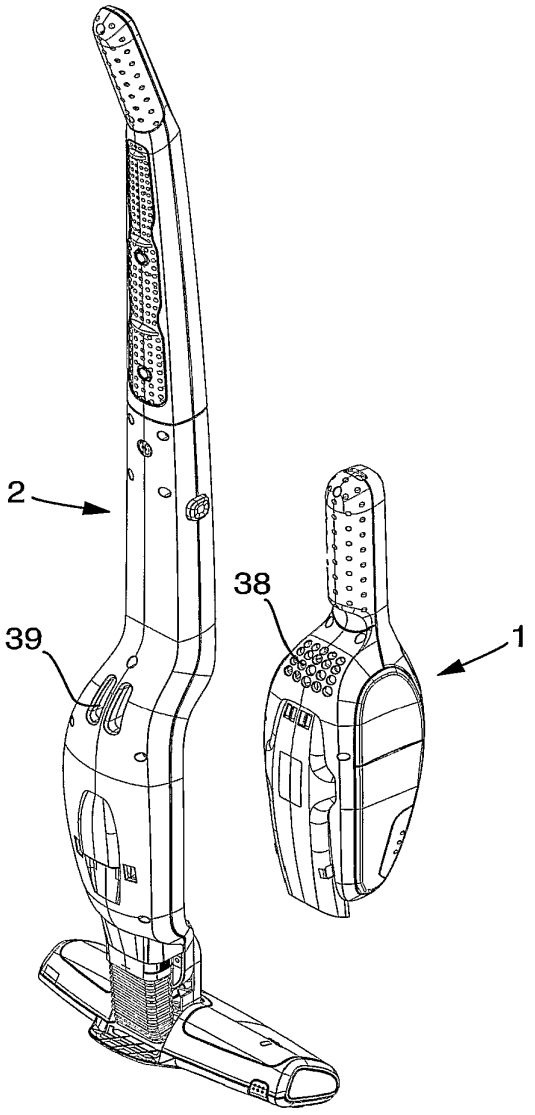


Fig 10

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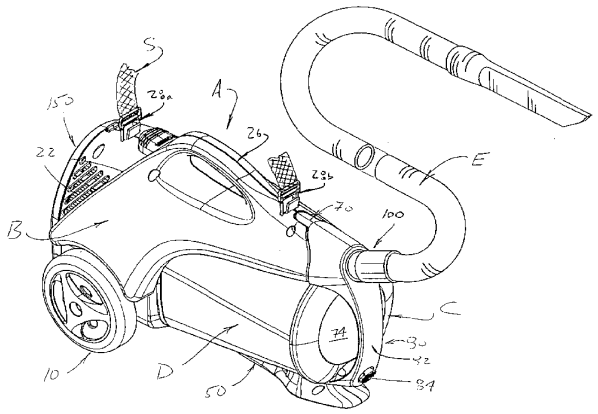
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(54) Title: BAGLESS CANISTER VACUUM CLEANER



(57) Abstract: A bagless canister vacuum cleaner (A) includes a selectively removable dirt cup (D), and an airstream (S) flows rotationally through the dirt cup (D) between an interior wall (31) of the dirt cup (D) and a filter assembly (F) selectively mounted in the dirt cup (D) so that entrained contaminants are separated from the airstream (S) flowing through the dirt cup (D) and collected by the dirt cup (D). The filter lies substantially parallel to the support surface on which the vacuum cleaner (A) is supported. A cover member (74) is connected to the main housing (B), and the cover member (74) is selectively movable to and held in an operative position in covering relation with an open first end (32) of a dirt cup (D). The main housing (B) defines a base (150) conformed to self-support the main housing (B) on a support surface with the dirt cup (D) arranged with its open first end (32) at a higher elevation than is closed second end (34). The removable dirt cup (D) includes a handle (80) adapted for being held by a user, and the dirt cup (D) defines or includes a spout (58) to facilitate emptying dirt therefrom.

WO 02/17766 A2

BAGLESS CANISTER VACUUM CLEANER

Background of the Invention

Canister vacuum cleaners are well known and in widespread use. Typically, a canister vacuum cleaner comprises a main body housing including wheels that movably support the housing on a floor or other support surface. The housing carries a suction source such as a motor-driven fan assembly, and defines a bag-receiving region adapted to receive a disposable vacuum bag. An elongated hose extends outwardly from the housing and is in fluid communication with the disposable vacuum bag through a mouth of the bag.

In use of these conventional canister vacuum cleaners, the suction source establishes relative negative pressure inside the bag-receiving region so that an airstream is pulled into the hose and passes therethrough into the bag. Dust, dirt, and other contaminants entrained in the airstream are trapped inside the bag while the airstream passes through the bag and exits the bag-receiving region of the housing. The airstream is then exhausted from the housing by the suction source.

Recently, bagless upright vacuum cleaners have been developed that rely upon a dirt separation chamber to separate contaminants from an airstream without use of a bag. The separated contaminants are collected in a dirt cup or like container which must be emptied periodically. Because these types of vacuum cleaners do not require use of disposable bags, they have been found to be highly convenient and cost-effective to operate.

In light of the success of bagless upright vacuum cleaners, it has been deemed desirable to develop a bagless canister vacuum cleaner displaying corresponding effectiveness and convenience of use.

Summary of the Invention

In accordance with a first aspect of the present invention, a canister vacuum cleaner includes a body defining a suction inlet and an exhaust outlet, and a suction source contained in the body and located fluidically between the suction inlet and the exhaust outlet. A dirt cup is releasably connected to the

body. The dirt cup defines a dirt separation chamber and an airstream outlet that releasably mates with the suction inlet when the dirt cup is connected to the body. The dirt separation chamber is conformed to impart a rotational flow pattern to an airstream passing therethrough whereby contaminants entrained in the airstream are separated from the airstream and deposited in the dirt cup. A filter is located in the dirt separation chamber of the dirt cup in covering relation with the airstream outlet.

In accordance with another aspect of the present invention, a bagless vacuum cleaner includes a body and a dirt cup releasably connected to and selectively separable from the body. A plurality of wheels are each connected to one of the body and the dirt cup and movably support the body and the dirt cup on an associated support surface when the dirt cup is connected to the body. At least one of the wheels is connected to the dirt cup.

In accordance with a further aspect of the present invention, a bagless canister vacuum cleaner includes a main housing defining a suction source inlet, an exhaust outlet and a receiver region adapted to receive a dirt cup. A suction source is located fluidically between the suction source inlet and the exhaust outlet. A dirt cup is releasably coupled to the receiver region of the main housing. The dirt cup includes: (i) an interior wall defining a dirt separation chamber; (ii) an open first end in communication with the dirt separation chamber; and, (iii) a closed second end with an aperture forming an airstream outlet from the dirt separation chamber. The dirt cup is releasably coupled to the main housing with the airstream outlet of the dirt cup mated with the suction source inlet of the main housing. A filter assembly is releasably connected to the dirt cup and is located in the dirt separation chamber. The filter assembly includes a filter element located in covering relation with the airstream outlet of the dirt cup and is positioned so that an annular airflow space is defined between the filter element and the interior wall of the dirt cup. A cover is pivotably connected to the housing and is movable between an open position, where the cover is disengaged from the dirt cup, and a closed, operative position where said the is placed in covering relation with and blocks the open first end of the dirt

cup. The cover, when located in the closed position, prevents separation of the dirt cup from the main housing.

In accordance with still another aspect of the invention, a bagless canister vacuum cleaner includes a main housing defining an airflow inlet, an airflow outlet and a receiver region adapted to receive a dirt cup. A suction source is located in the housing and is operational to establish and maintain an airstream that flows from the airflow inlet to the airflow outlet. A dirt cup is releasably coupled to the receiver region of the main housing. The dirt cup includes: (i) an interior wall defining a dirt separation chamber conformed to impart a rotational flow path to a dirty airstream passing therethrough whereby contaminants are separated from the dirty airstream and deposited in the dirt cup; (ii) an open first end in communication with the dirt separation chamber; and, (iii) an airstream outlet from the dirt separation chamber, the dirt cup releasably coupled to the main housing with the airstream outlet of the dirt cup mated with the airflow inlet of the main housing. A filter assembly is releasably connected to the dirt cup and is located in the dirt separation chamber. The filter assembly comprises a filter element located in covering relation with the airstream outlet of the dirt cup. A cover is connected to the housing and is movable between an open position, where it is disengaged from the dirt cup, and a closed, operative position where it is placed in covering relation with and blocks the open end of the dirt cup. The cover, when located in its closed position, prevents separation of the dirt cup from the main housing.

In accordance with a still further aspect of the present invention, a bagless vacuum cleaner includes a main housing defining a suction source inlet, an exhaust outlet and a receiver region adapted to receive a dirt cup. A suction source is located fluidically between the suction source inlet and the exhaust outlet. A dirt cup is releasably coupled to the receiver region of the main housing. The dirt cup includes: (i) an interior wall defining a dirt separation chamber; (ii) an open first end in communication with the dirt separation chamber; and, (iii) an airstream outlet from the dirt separation chamber. The dirt cup is releasably coupled to the main housing with said airstream outlet of the

dirt cup mated with the suction source inlet of the main housing. A filter assembly is releasably connected to the dirt cup and is located in the dirt separation chamber. The filter assembly includes a filter element located in covering relation with the airstream outlet of the dirt cup and positioned so that an annular airflow space is defined between the filter element and the interior wall of the dirt cup. A base is connected to the main housing and is conformed to support the main housing, and the dirt cup releasably connected to the receiver region of the main housing, on the support surface in a second, non-operative position, with the open first end of the dirt cup located at a select elevation relative to the dirt separation chamber to prevent spillage of associated dirt and debris contents of the dirt separation chamber from the open first end of the dirt cup.

In accordance with another aspect of the present invention, a vacuum cleaner includes a housing; a dirt cup releasably connected to the housing and defining a dirt separation chamber; a filter located in the dirt separation chamber of the dirt cup; and, a suction source located in the housing and in fluid communication with the dirt separation chamber. The suction source, when selectively operated, establishes and maintains a suction airstream that flows into and through the dirt separation chamber to an exhaust outlet defined by the housing. The suction airstream, when moving through the dirt separation chamber, moves rotationally around a substantially horizontal axis of the filter before passing through the filter and exiting the dirt separation chamber.

In accordance with still another aspect of the present invention, a bagless vacuum cleaner includes a body and a dirt cup releasably connected to and selectively separable from said body. The dirt cup includes a handle and a pour spout.

Still other benefits and advantages of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following specification.

Brief Description of the Drawings

The invention comprises a variety of components and arrangements of components, a preferred embodiment of which is illustrated in the accompanying drawings that form a part hereof and wherein:

FIGURE 1 is a perspective view of a bagless canister vacuum cleaner formed in accordance with the present invention;

FIGURE 2 is a left side elevational view of the vacuum cleaner shown in FIGURE 1;

FIGURE 3 is a front elevational view of the vacuum cleaner shown in FIGURE 1;

FIGURE 4 is an exploded perspective view of a dirt cup and associated filter assembly of the vacuum cleaner shown in FIGURE 1;

FIGURE 5 is a sectional view along line 5-5 of FIGURE 3;

FIGURE 6 is a sectional view along line 6-6 of FIGURE 2;

FIGURE 7 is a sectional view along line 7-7 of FIGURE 5;

FIGURE 8 is a sectional view along line 8-8 of FIGURE 2; and,

FIGURE 9 is an exploded left side view of the vacuum cleaner shown in FIGURE 1, with the cover in an open position and with the dirt cup separated from the main housing for emptying.

Detailed Description of Preferred Embodiment

Referring now to the drawings, wherein the showings are for purposes of illustrating a preferred embodiment of the invention only and not for purposes of limiting same, FIGURE 1 illustrates a bagless canister vacuum cleaner **A** formed in accordance with the present invention. The vacuum cleaner **A** generally comprises a main housing **B**, a cover **C**, a dirt cup **D**, a hose **E**, a filter assembly **F** (FIGURE 6) positioned in the dirt cup, and a suction source **G** (FIGURES 5,6,8). A tool, such as a crevice tool **H** illustrated herein, is carried by the distal end of the hose. The main housing **B** includes or defines a handle **26** to facilitate carrying of the vacuum cleaner **A**. First and second strap

supports **28a, 28b** are connected to the main housing **B** and project outwardly therefrom. A carrying strap **S** (shown only partially) is connected at opposite ends to the supports **28a, 28b**, respectively, and can be placed over the shoulder of a user for hands-free carrying of the vacuum cleaner **A**.

The main housing **B** is defined from a plurality of interconnected molded plastic pieces. One or more wheels **10** are rotatably connected to the main housing and movably support same on a floor or other support surface.

As illustrated in FIGURES 5, 6 and 8, the main housing supports the suction source **G** therein. The suction source can comprise an electrically driven motor operably coupled to a fan/impeller assembly that rotates in response to operation of the motor. The suction source **G** establishes and maintains an airstream that flows from an suction source inlet **20** to an exhaust outlet **22**, both defined by the housing **B**.

The dirt cup **D** is releasably connected to the main housing **B**. With reference to FIGURES 4-6 and 9, the dirt cup **D** is defined as a one-piece construction or from a plurality of interconnected pieces of molded plastic, and a hollow interior dirt separation chamber **30** is defined therein by an inner wall **31**. At least the portion of the dirt cup **D** in which the dirt separation chamber **30** is defined can be molded from transparent or partially transparent plastic so that a user of the vacuum cleaner **A** can view the dirt and other contents or at least appreciate the volume of the contents.

The dirt cup **D** defines an open first end **32** and an end wall **34** closes the opposite, second end thereof. However, a dirt cup airstream outlet **36** is defined through the end wall **34** and is located and dimensioned to mate closely with the suction source inlet **20** when the dirt cup **D** is operably connected to the main housing **B** as illustrated, e.g., in FIGURES 4 and 5. An O-ring gasket or the like **38** can be located at the interface of the dirt cup airstream outlet and the suction source inlet **20** and sealingly engages these openings. If desired, a screen or filter **40** can be positioned in the suction source inlet **20** as an emergency filter to prevent passage of potentially damaging contaminants into

the suction source **G** should any pass through the dirt cup airstream outlet **36** due to a malfunction or misuse of the vacuum cleaner.

The dirt cup **D** further comprises an external handle assembly **50** projecting outwardly therefrom. The handle assembly comprises a handle member **52** adapted for being held by a user of the vacuum cleaner **A**, and a wheel assembly **54**. When the dirt cup **D** is operably connected to the main housing **B** as shown in FIGURES 1-3, and with the vacuum cleaner **A** in its operative position, the wheel assembly **54** works together with the wheels **10** to movably support the vacuum cleaner **A** on a floor or other support surface. The wheel assembly **54** includes a caster wheel or the like **56** that facilitates steering of the vacuum cleaner **A** on the floor or other support surface. In an alternative embodiment, multiple wheels can be connected to the dirt cup without departing from the overall scope and intent of the present invention.

The dirt cup **D**, adjacent the open first end **32** and opposite the handle assembly **50**, includes or defines a spout **58**. The spout facilitates emptying of dirt and other contents of the dirt cup in a pouring operation when a user is holding the dirt cup by the handle assembly **50**.

With reference to FIGURES 5 and 9, the main housing **B** defines a socket, recess or other receiver region **60** adapted to receive the dirt cup therein so that the dirt cup is operably positioned. The dirt cup **D**, itself, includes or defines a tongue or like projection **62** adjacent the second end thereof that releasably mates with a corresponding female receptacle **64** secured to or defined by the housing **B**. The members **62,64** are engageable with a sliding action and disengageable with a reverse sliding action while the dirt cup D is simultaneously tilted or pulled away from the inner wall **66** of the housing recess **60** by application of manual force on the handle **52**.

The cover assembly **C** of the vacuum cleaner **A** is pivotally or otherwise movably connected to the main housing **B**. As shown herein, the cover assembly **C** is pivotally connected to the main housing **B** by a hinge assembly **70** so that it pivots on an arc **72** (FIGURE 9) between an open or

inoperative position (as shown in FIGURE 9) and a closed or operative position (as shown in FIGURES 1-3, 5, 6). With reference briefly to FIGURE 4, the cover assembly **C** comprises a cover member **74** adapted to sealingly engage and close the open first end **32** of the dirt cup **D** when the cover assembly **C** is operably positioned. A gasket **76** is connected to the inner face of the cover member **74** and sealingly engages the cover member **74** to the open first end **32** of the dirt cup **D**.

Referring also to FIGURES 5 and 9, a handle assembly **80** is connected to and projects outwardly from the cover member **74**. The handle assembly **80** includes a handle **82** adapted for being held by a user of the vacuum cleaner **A** for purposes of pivoting the cover member **74** on the arc **72**. A latch **84** is connected to the cover member **74** and is biased into a normally engaged position by a spring **86**. A portion of the latch **84** projects through the handle **82** and is manually operable by a user to disengage a projecting tongue **88** of the latch **84** from a mating female portion **90** connected to or defined in the dirt cup **D** or, alternatively, the housing **B**. With the latch disengaged, the cover member **74** is freely movable away from the open first end of the dirt cup **D**. In contrast, with the cover member **74** seated on the open first end of the dirt cup and with the latch **84** of the cover assembly engaged with the portion **90** of the dirt cup, the dirt cup is fixedly and operably secured in the housing recess **60** with the dirt cup airstream outlet **36** fluidically communicating with the suction source inlet **20** as described.

A hose fitting **100** is connected to or forms a part of the cover assembly **C**. The hose fitting **100** comprises an inlet conduit **102** that projects outwardly away from the cover assembly **C** and that is adapted for connection to a conventional vacuum cleaner hose **E** (Fig. 1) so that the hose communicates with a passage **104** formed through the inlet conduit **102**. The hose fitting **100** further comprises an outlet conduit **108** that, together with the cover member **74** defines a passage **110** that communicates with the passage **104** in the inlet conduit **102**. With the cover assembly **C** in its operative position, the outlet

conduit **108** is located in or adjacent the open first end **32** of the dirt container **D** so that the passages **104,110** are both in fluid communication with the dirt separation chamber **30** defined in the dirt cup **D**. As illustrated herein, the outlet conduit **108** can be obliquely arranged relative to the interior wall **31** of the dirt container **D** so that an airstream delivered to the dirt separation chamber **30** from the outlet **108** is directed toward the dirt cup inner wall **31** adjacent the open first end of the dirt cup **D**. This imparts a rotational pattern to the airstream that enters the dirt separation chamber **30** by way of the hose fitting outlet **108**.

The filter assembly **F** is releasably secured in the dirt cup **D**, and can be located coaxial with the longitudinal axis **L** thereof as shown in FIGURE 5. The filter assembly comprises a frame **120** defined from one or more pieces of molded plastic, and a filter element **122** comprising paper, plastic, or any other suitable filter medium that is carried by the frame **120**. The filter element **122** can comprise a pleated washable filter medium such as GORE-TEX® brand polytetrafluoroethylene (PTFE) or another polymeric filter medium. With reference to FIGURES 4 and 5, the filter frame **120** comprises: (i) a base plate **120a** adapted to fit adjacent a lower edge **122a** of the filter element **122**; (ii) an internal skeleton **120b** connected at a second end to the base plate **120a** and adapted to fit closely within a central opening **126** defined in the filter element **122**; and, (iii) a cap **120c** connected to a first end of the skeleton **120b** and that closes the opening **126** at the upper edge **122b** of the element **122**.

With continuing reference to FIGURES 4 and 5, the base plate **120a** defines an opening **124** adapted to frictionally or otherwise releasably mate with a boss **130** projecting from the end wall **34** of the dirt cup **D** around the dirt cup airstream outlet **36**. A gasket **128** can be connected to the filter assembly base plate **120a** to engage and seal together the base plate **120a** and the dirt cup end wall **34**. With the base plate **120a** and boss **130** mated as described or in an equivalent manner, the filter assembly **F** is releasably connected to the dirt cup in an operative position and is self-supporting within the dirt cup, with a longitudinal axis of the filter assembly **F** located close to parallel with the support

surface (typically at least substantially horizontal) on which the wheels 10,56 are located, i.e., inclined less than about 20° - 25° relative to the associated support surface.

With the filter assembly **F** in its operative position, it is located in covering relation with the dirt cup airstream outlet **36** so that an airstream exiting the dirt separation chamber **30** through the dirt cup airstream outlet **36** must pass through the filter element **122**. As shown in FIGURES 4 and 7, the cap **120c** of the filter assembly **F** is defined with an integral scalloped grip or the like to facilitate manual grasping of the filter element **F** as required to connect same to and disconnect same from the dirt cup **D**.

Downstream from the suction source **G**, a final filter or exhaust filter **140** (FIGURE 8) can be located between the suction source **G** and the exhaust outlet **22** of the main body **B**. The exhaust filter **140**, which can comprise a HEPA or conventional filter medium, filters contaminants from the airstream exhausted by the suction source **G** before same exits the main housing **B** through the exhaust outlet **22**.

Referring now to FIGURES 5-7, in operation, the suction source **G** establishes and maintains an airstream **S** that flows from the hose **E** (FIGURE 1) into the dirt separation chamber **30** by way of the hose fitting outlet **108**. Owing to the generally annular airflow space defined between the filter assembly **F** and the dirt cup inner wall **31**, and due to the oblique arrangement of the outlet **108** by which the airstream **S** passes into the chamber **30**, the airstream flows in a rotational manner around the filter assembly F and simultaneously moves from the open first end **32** toward the opposite end wall **34** of the dirt cup **D**. The rotational airflow dislodges contaminants that are entrained in the airstream **S**. The dislodged contaminants are collected in the dirt separation chamber **30**. The flow of the airstream as described tends to urge the collected contaminants toward the wall **34** at the second end of the dirt cup **D**.

The airstream **S** then passes through the filter element **122** that removes residual contaminants therefrom (a portion of the airstream S also

passes through the collected dirt and other contaminants in the dirt cup which act as an auxiliary filter media). After passing through the filter element **122**, the airstream **S** exits the dirt cup **D** through the dirt cup airstream outlet **36** and flows through the suction source **G** and is exhausted thereby. The airstream exhausted by the suction source passes through the exhaust filter **140** (FIGURE 8) that removes more residual contaminants therefrom, and the airstream then exits the main housing **B** through one or more exhaust outlets **22**.

The main housing **B**, at a second end opposite the cover assembly **C**, defines or includes a base **150** conformed to support the vacuum cleaner **A** in a second, non-operative position on a floor or other support surface with at least the wheel **56** and/or all wheels **10,56** not in contact with the floor or other support surface. The base **150** can be conformed as a face that is adapted to support the vacuum cleaner **A** with the dirt cup **D** in an upright position, with the open upper end **32** at a higher elevation than the opposite end wall **34** located at the second end thereof, e.g., with the dirt cup vertically oriented as shown in FIGURE 9. With the vacuum cleaner **A** in this second, non-operative position, the handle assembly **80** of the cover assembly **C** and the handle assembly **50** of the dirt cup **D** are freely accessible by a user so that the dirt cup can be separated from, emptied, and reconnected to the main housing as described above.

From the foregoing, it should be apparent that the present invention relates to a new and improved bagless canister vacuum cleaner. The bagless canister vacuum cleaner includes a selectively removable dirt cup, wherein an airstream flows rotationally through the dirt cup between an interior wall of the dirt cup and a filter assembly selectively mounted in the dirt cup so that entrained contaminants are separated from the airstream flowing through the dirt cup and collected by the dirt cup. A cover member is pivotally or otherwise movably connected to a main housing, and the cover member is selectively movable to and held in an operative position in covering relation with an open first end of a dirt cup. Also, the main housing defines a base conformed to self-support the

main housing on a support surface with the dirt cup arranged with its open first end at a higher elevation than its closed second end. The removable dirt cup includes a handle adapted for being held by a user, and the dirt cup defines or includes a spout to facilitate emptying dirt therefrom.

The invention has been described with reference to a preferred embodiment. Modifications and alterations will occur to others upon reading and understanding this preceding specification. It is intended that the invention be construed as including all such modifications and alterations insofar as they are encompassed by the appended claims as construed literally and/or according to the doctrine of equivalents.

Claims

Having thus described the preferred embodiment, what is claimed is:

1. A vacuum cleaner comprising:

a main housing defining a suction source inlet, an exhaust outlet and a receiver region adapted to receive a dirt cup;

a suction source located fluidically between said suction source inlet and said exhaust outlet;

a dirt cup releasably coupled to said receiver region of said main housing, said dirt cup comprising: (i) an interior wall defining a dirt separation chamber; (ii) an open first end in communication with said dirt separation chamber; and, (iii) a closed second end with an aperture forming an airstream outlet from said dirt separation chamber, said dirt cup releasably coupled to said main housing with said airstream outlet of said dirt cup mated with said suction source inlet of said main housing;

a filter assembly releasably connected to said dirt cup and located in said dirt separation chamber, said filter assembly comprising a filter element located in covering relation with said airstream outlet of said dirt cup; and,

a cover pivotably connected to said housing, said cover movable between an open position, where said cover is disengaged from said dirt cup, and a closed, operative position where said cover is placed in covering relation with and blocks said open first end of said dirt cup.

2. The vacuum cleaner as set forth in claim 1, further comprising:

at least one wheel rotatably supported by said dirt cup external to said dirt separation chamber, said at least one wheel cooperating with said plurality of wheels connected to said main housing to movably support said main housing and said dirt cup on said associated support surface when said dirt cup is coupled to said receiver region of said main housing.

3. The vacuum cleaner as set forth in claim 1, further comprising:

a hose fitting adapted for connection to an associated hose, said hose fitting connected to said cover and movable therewith and arranged in fluid communication with said dirt separation chamber when said cover is located in said closed, operative position;

a manually operable latch comprising a first portion and a second portion adapted to releasably mate with said first portion, wherein one of said first and second portions is connected to said cover and the other of said first and second portions is connected to one of said dirt cup and said main housing, said latch selectively retaining said cover in said closed, operative position.

4. The vacuum cleaner as set forth in claim 3, wherein said first portion of said latch is connected to said cover and said second portion of said latch is connected to said dirt cup, said cover, when retained in said closed operative position relative to said dirt cup by said latch, preventing separation of said dirt cup from said housing.

5. The vacuum cleaner as set forth in claim 4, wherein said dirt cup defines a projecting male portion that mates with a female portion of said main housing when said dirt cup is coupled to said receiver region of said main housing, and wherein said male and female portions are inseparable when said cover is located in its closed, operative position.

6. The vacuum cleaner as set forth in claim 1, wherein said filter assembly is releasably connected to and projects away from said second end.

7. The vacuum cleaner as set forth in claim 6, wherein said second end defines a boss surrounding said airstream outlet and wherein said filter assembly includes a base plate that is releasably engaged with said boss by a friction fit.

8. The vacuum cleaner as set forth in claim 6, wherein said filter assembly is defined about a longitudinal axis that lies parallel to an associated support surface when said main housing is movably and operatively supported on said associated support surface by a plurality of wheels.

9. The vacuum cleaner as set forth in claim 1, further comprising:

a final filter located downstream from said suction source and upstream from said exhaust outlet to filter an exhaust airstream exhausted by said suction source prior to said exhaust airstream being exhausted from said exhaust outlet of said main housing.

10. The vacuum cleaner as set forth in claim 9, wherein said final filter comprises a HEPA filter medium.

11. The vacuum cleaner as set forth in claim 3, wherein said hose fitting comprises an inlet conduit projecting outwardly away from said cover and an inlet conduit projecting into said dirt separation chamber adjacent said open first end of said dirt cup, said inlet conduit directed obliquely toward said interior wall of said dirt cup defining said dirt separation chamber.

12. The vacuum cleaner as set forth in claim 1, further comprising:

a handle assembly connected to said dirt cup; and,

a wheel assembly connected to said handle assembly and comprising a rotatable wheel that cooperates with a plurality of wheels connected to said main housing to movably support said main housing and said dirt cup releasably connected to said main housing above an associated support surface.

13. The vacuum cleaner as set forth in claim 12, wherein said wheel assembly comprises a caster wheel assembly including said rotatable wheel.

14. The vacuum cleaner as set forth in claim 1 wherein said filter is so positioned in said dirt cup as to define an annular airflow space between said filter element and said interior wall of said dirt cup.

15. The vacuum cleaner as set forth in claim 1, further comprising a handle connected to said cover to facilitate manual movement of said cover between said open and closed positions.

16. The vacuum cleaner as set forth in claim 15, further comprising a hose and a hose fitting interconnecting said hose to said cover, said hose fitting comprising a first portion projecting outwardly away from said cover and a second portion projecting into said dirt separation chamber adjacent said open first end of said dirt cup, said second portion directed obliquely toward said interior wall of said dirt cup defining said dirt separation chamber.

17. The vacuum cleaner as set forth in claim 1, further comprising:

a plurality of wheels for movably supporting said main housing and said dirt cup on a support surface when said dirt cup is coupled to said receiver region of said main housing, at least one of said plurality of wheels connected to said dirt cup.

18. The vacuum cleaner as set forth in claim 17, wherein said dirt cup comprises a handle and wherein said at least one of said plurality of wheels connected to said dirt cup is connected to said handle.

19. The vacuum cleaner of claim 1 further comprising a base connected to said main housing and conformed to support said main housing and said dirt cup releasably connected to said receiver region of said main housing on an associated support surface in a non-operative position with said open first end of said dirt cup located at a select elevation relative to said dirt separation chamber to prevent spillage of associated dirt and debris contents of said dirt separation chamber from said open first end of said dirt cup.

20. The vacuum cleaner as set forth in claim 19, further comprising:

a plurality of wheels for supporting said main housing above the associated support surface, wherein said base is conformed to support said main housing and said dirt cup releasably connected to said main housing in the non-operative position with at least one of the plurality of wheels out of contact with said associated support surface.

21. The vacuum cleaner as set forth in claim 1, wherein said open first end of said dirt cup defines a spout that is conformed to facilitate pouring associated dirt and debris contents from said dirt separation chamber of said dirt cup and wherein said dirt cup further comprises a handle located generally opposite said spout.

22. The vacuum cleaner as set forth in claim 1 wherein said cover, when located in said closed, operative, position, prevents separation of said dirt cup from said main housing.

23. The vacuum cleaner of claim 1 wherein said suction source, when selectively operated, establishes and maintains a suction airstream that flows into and through said dirt separation chamber to the exhaust outlet of said housing, wherein said suction airstream, when moving through said dirt separation chamber, moves rotationally around a substantially horizontal axis of said filter before passing through said filter and exiting said dirt separation chamber.

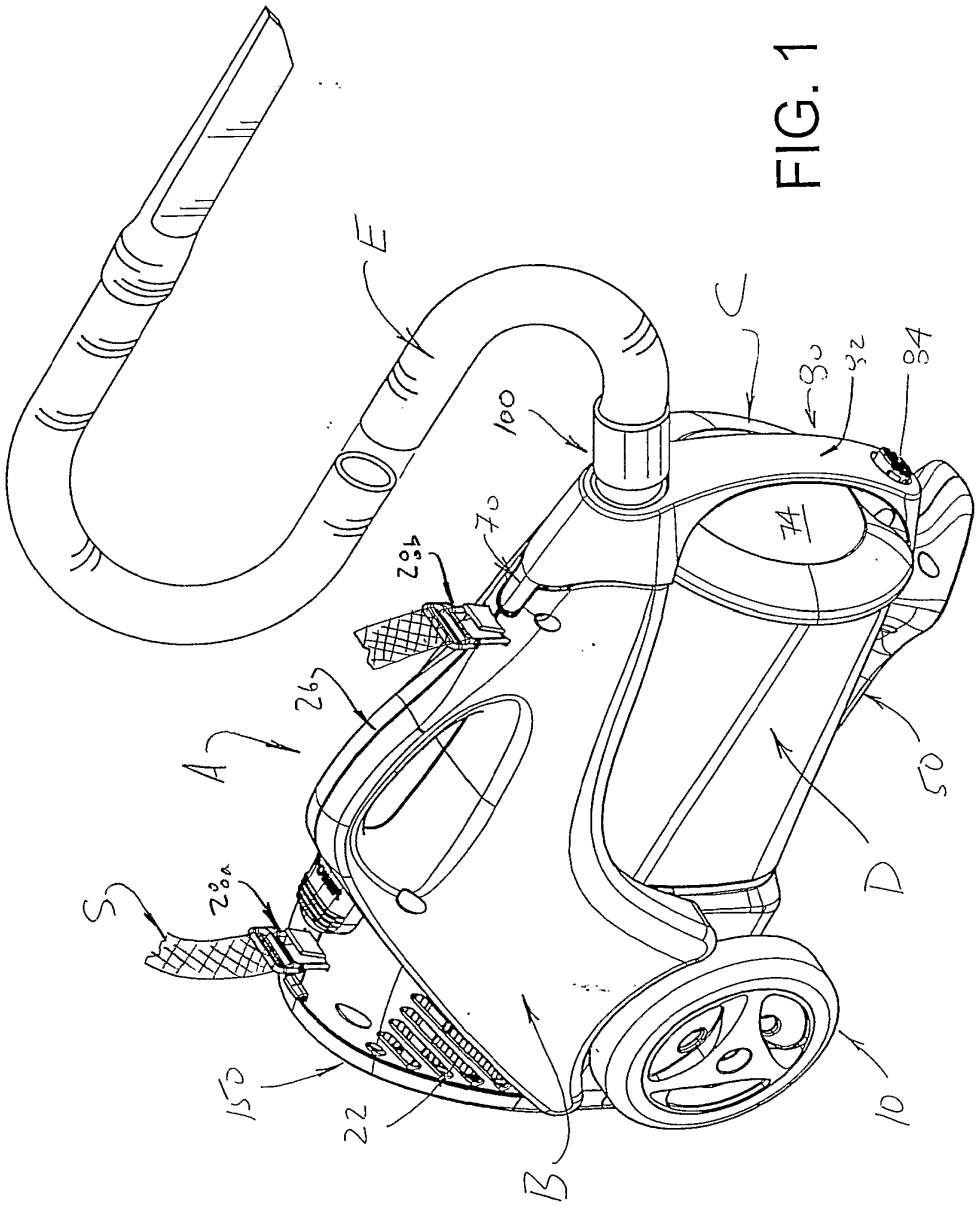


FIG. 1

Dyson Ex1020
Page 1280

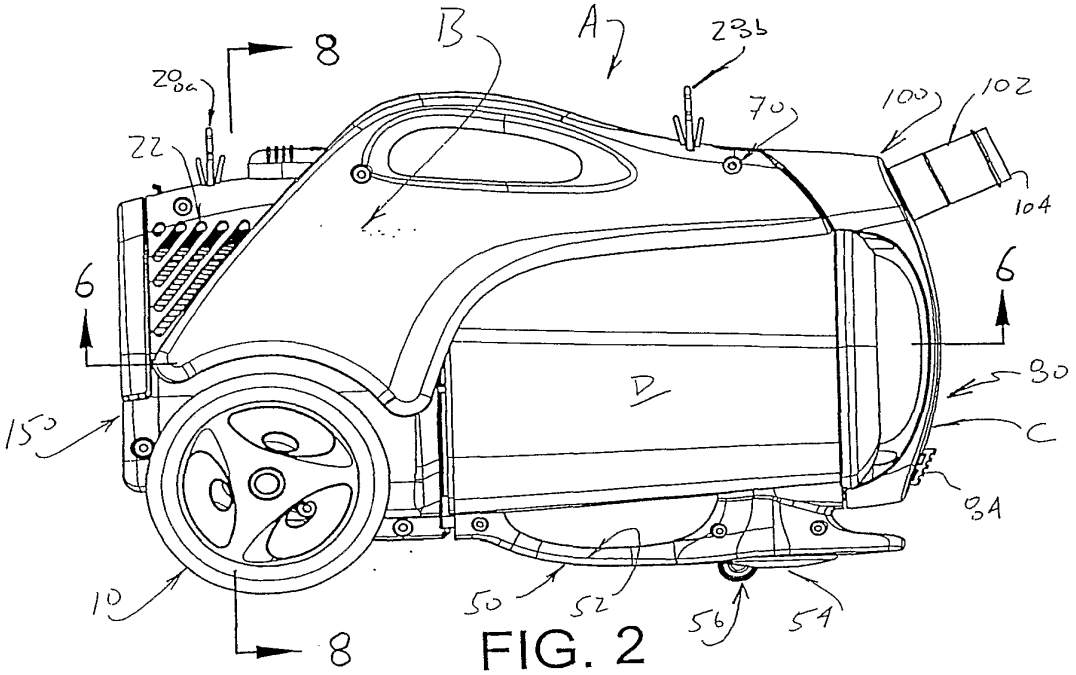


FIG. 2

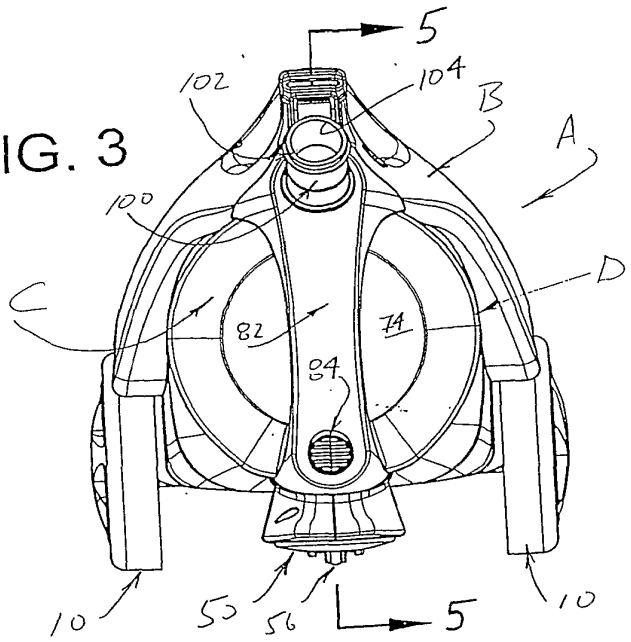
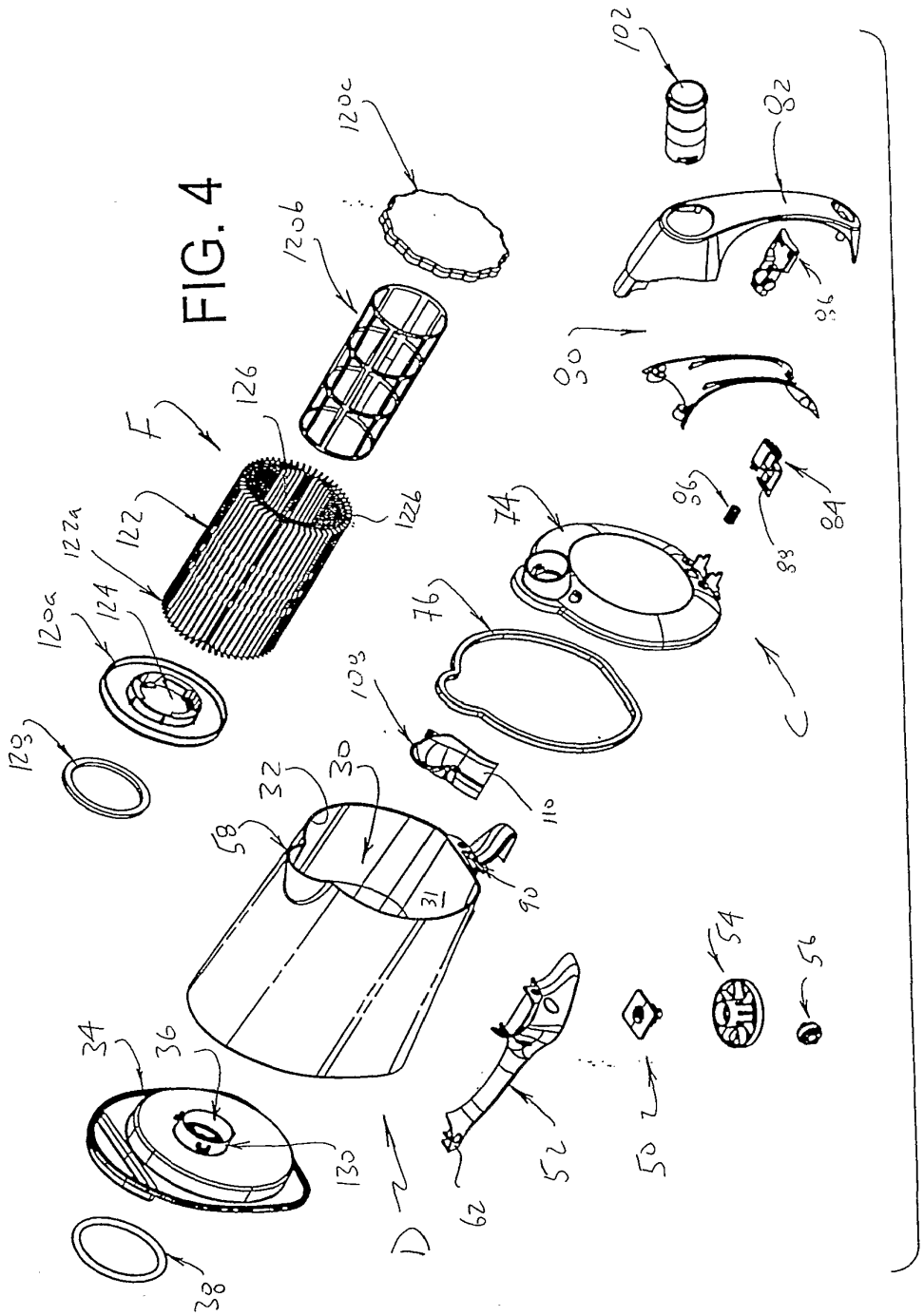


FIG. 3

Dyson Ex1020
Page 1281

FIG. 4



Dyson Ex1020
Page 1282

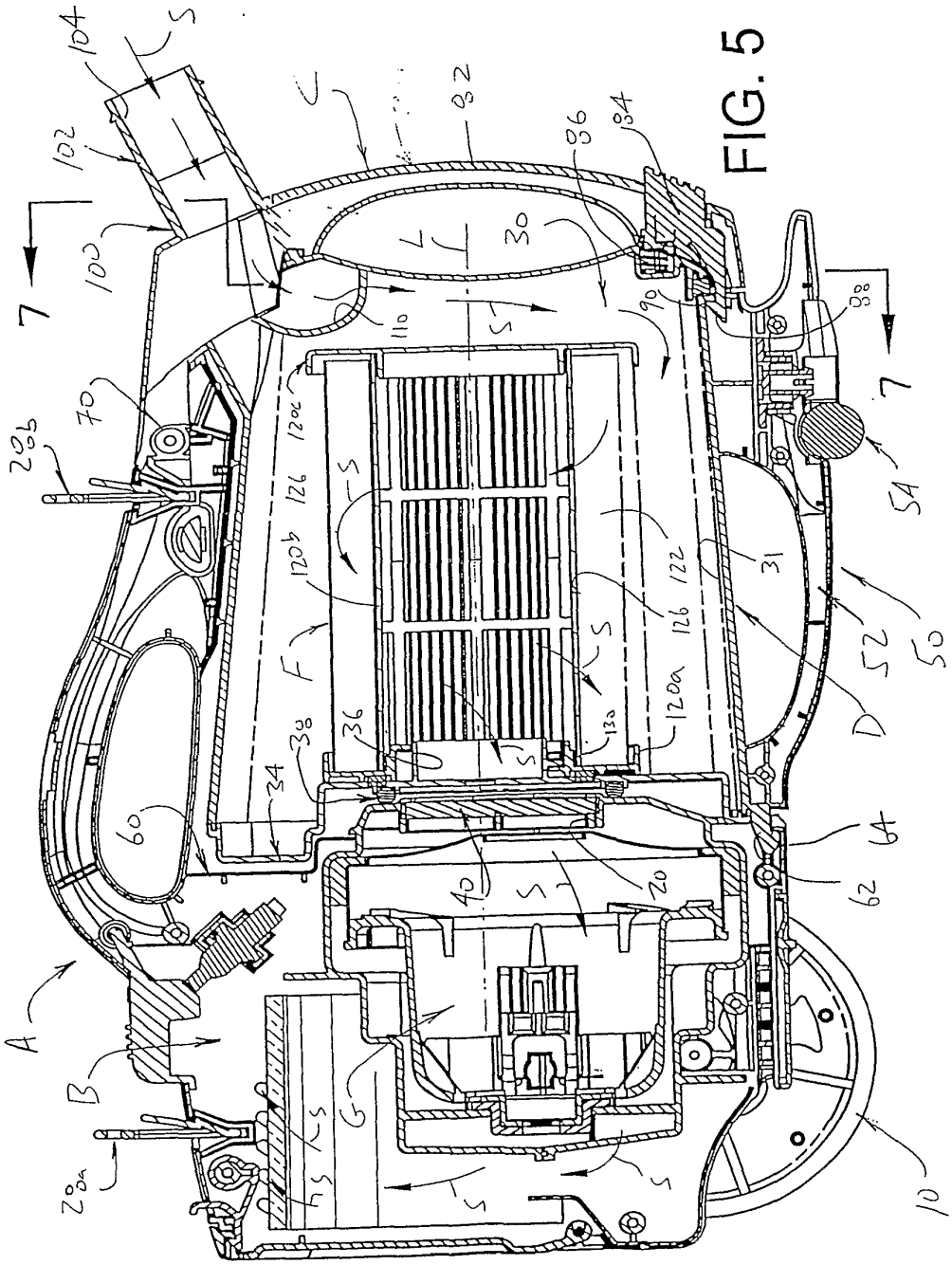


FIG. 5

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Page 1283

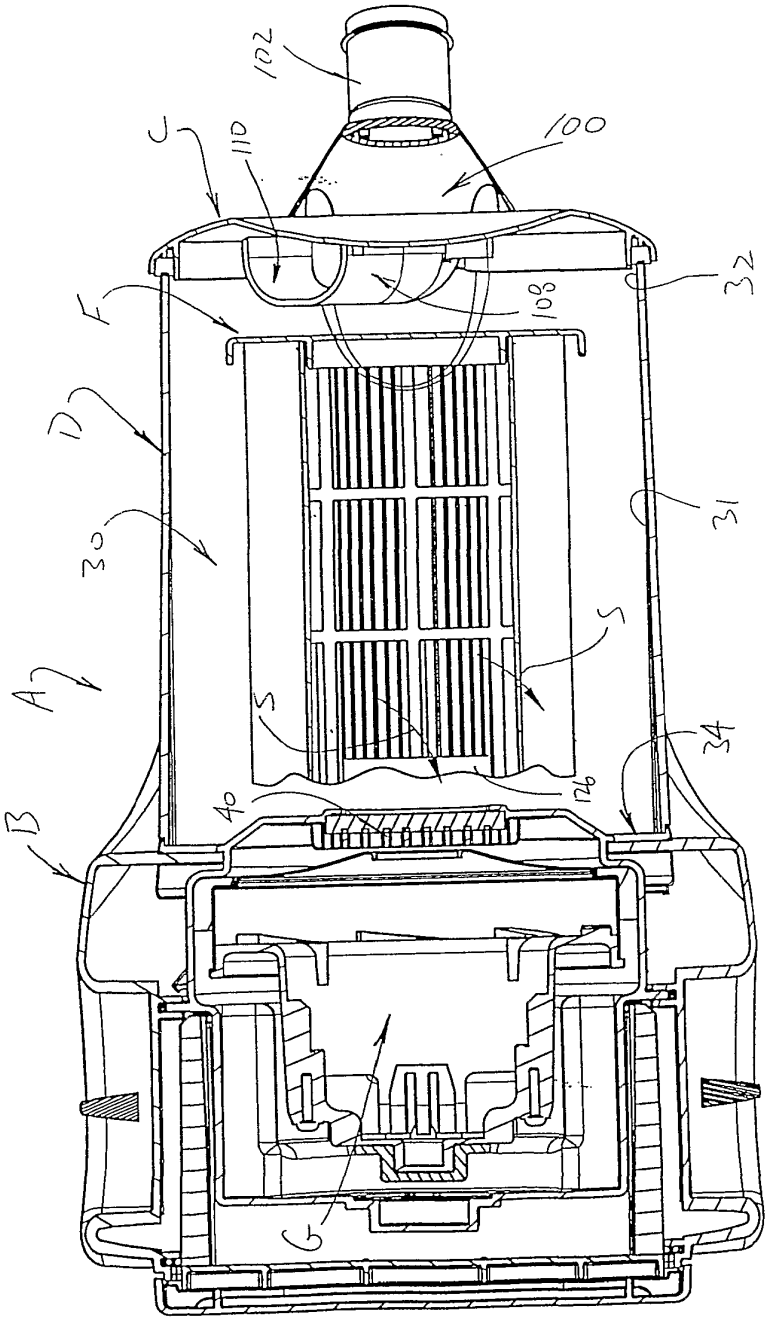


FIG. 6

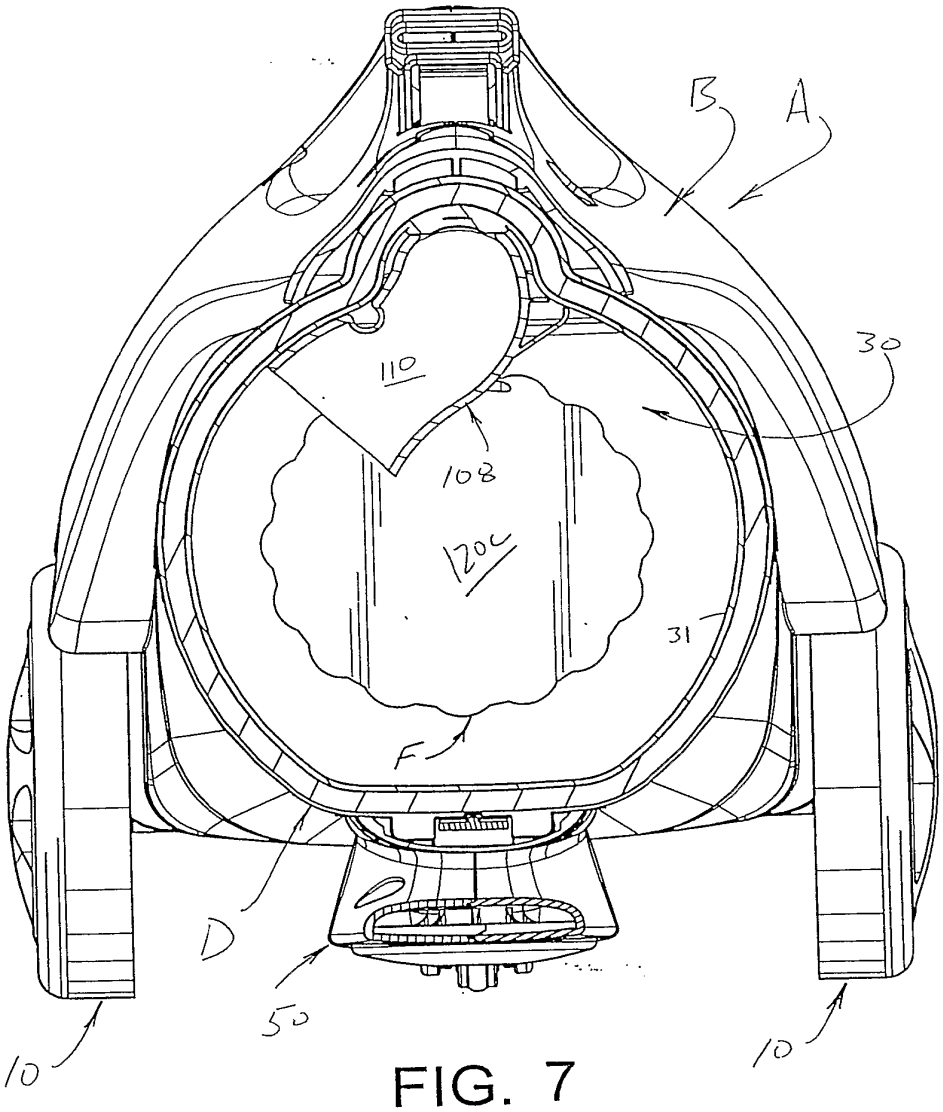


FIG. 7

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Page 1285

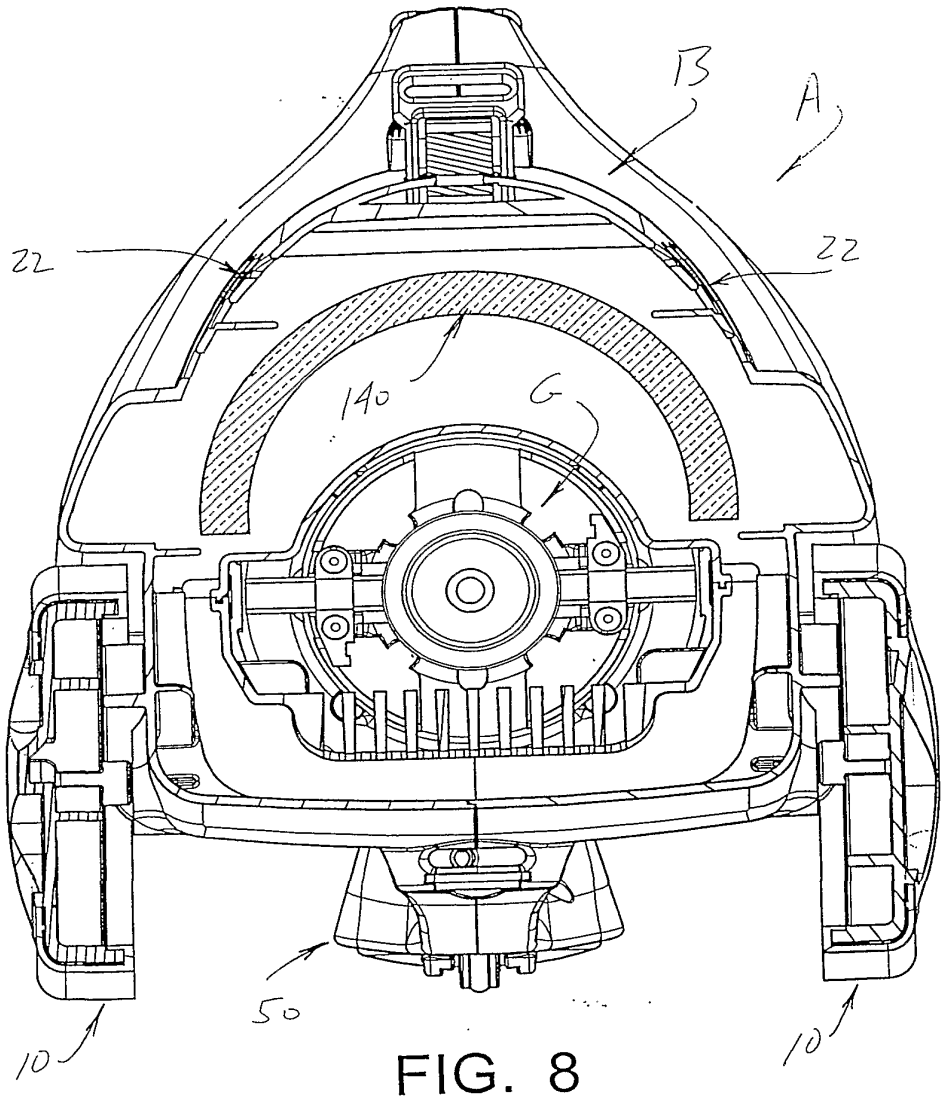


FIG. 8

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Page 1286

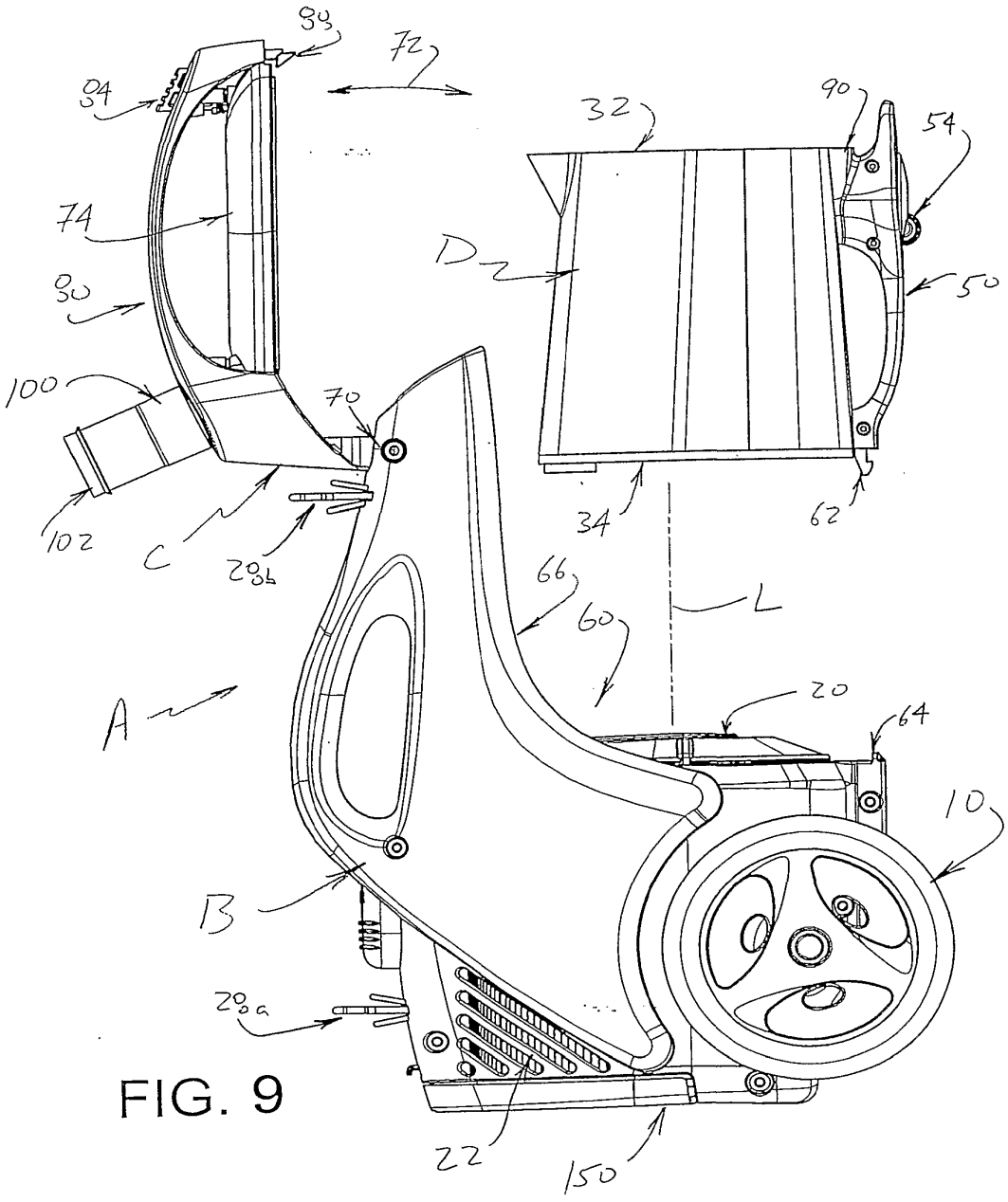

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FIG. 9

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(51) INT CL:
A47L 9/16 (2006.01) ***A47L 5/24*** (2006.01)

(56) Documents Cited:
WO 2010/061211 A2 **WO 2008/009891 A1**

(58) Field of Search:
INT CL **A47L, B04C**
Other: **WPI, EPODOC, TXTE**

(54) Title of the Invention: **Cleaning appliance**
Abstract Title: **Cleaning appliance**

(57) A cleaning appliance comprises a main body (4, fig 1) and a separating apparatus (12, fig 1) including a dirt collector 24 having a base 26 that is openable to allow the dirt collector 24 to be emptied. The cleaning appliance includes an actuator 98 that is operable sequentially such that, during a first operation, the actuator 98 causes the base 26 to be opened and, during a second operation, the actuator 98 causes the dirt collector 24 to disengage from the separating apparatus (12, fig 1). A single actuator 98 is therefore used for two functions: firstly to open the dirt collector 24 for emptying purposes and, secondly, to disengage the dirt collector 24 from the separating apparatus (12, fig 1) for cleaning purposes. Such an arrangement is space efficient and intuitive for the user. The base 26 of the dirt collector 24 may be openable when the separating apparatus (12, fig 1) is coupled to the main body (4, fig 1) or alternatively the base 26 is only openable when the separating apparatus(12, fig 1) is decoupled from the main body (4, fig 1).

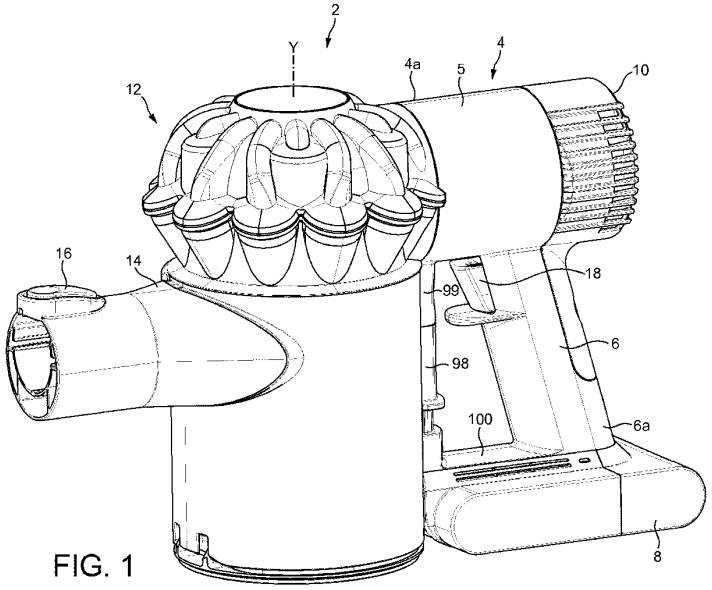
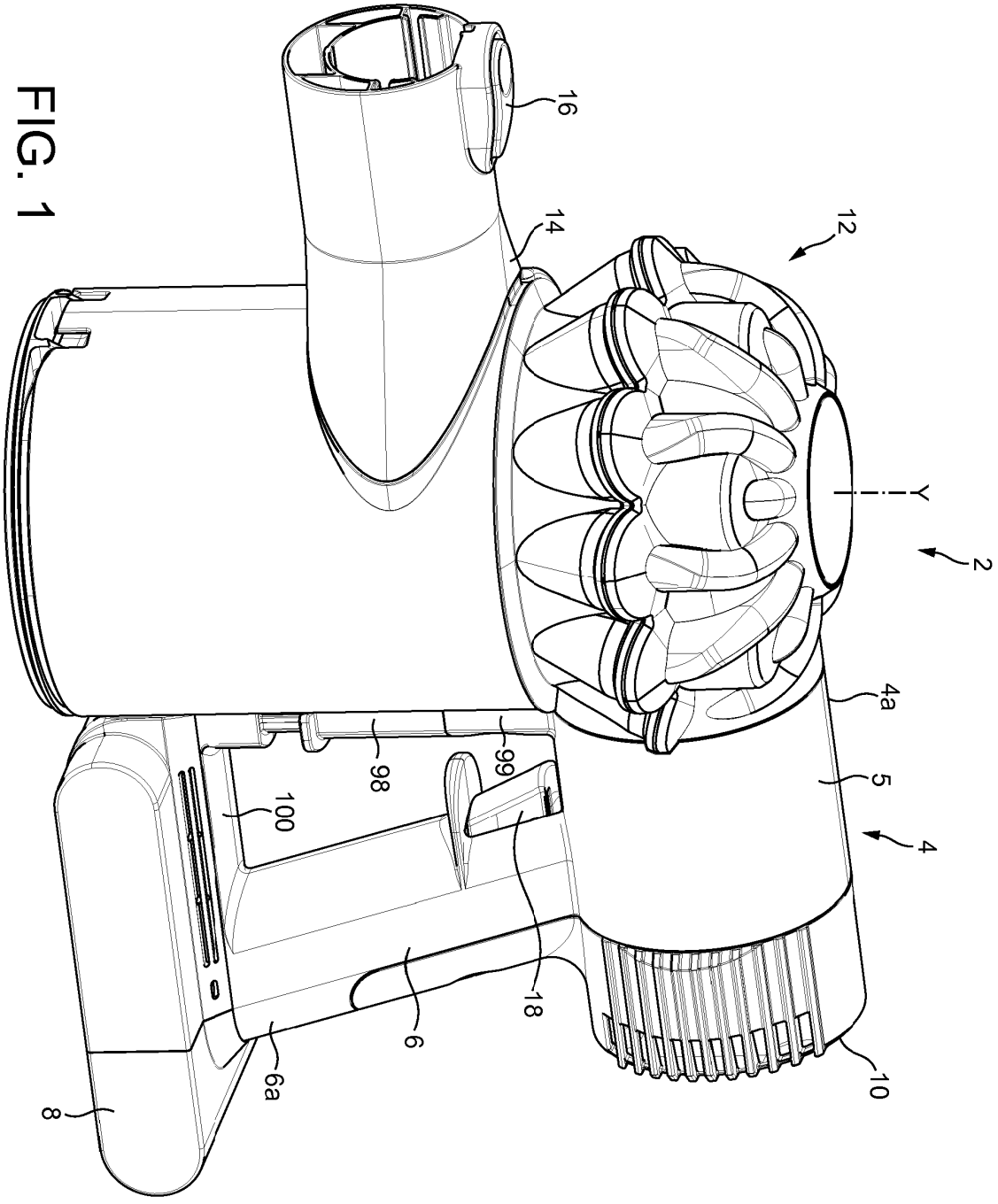


FIG. 1

GB 2508035 A

FIG. 1



Dyson Ex1020
Page 1289

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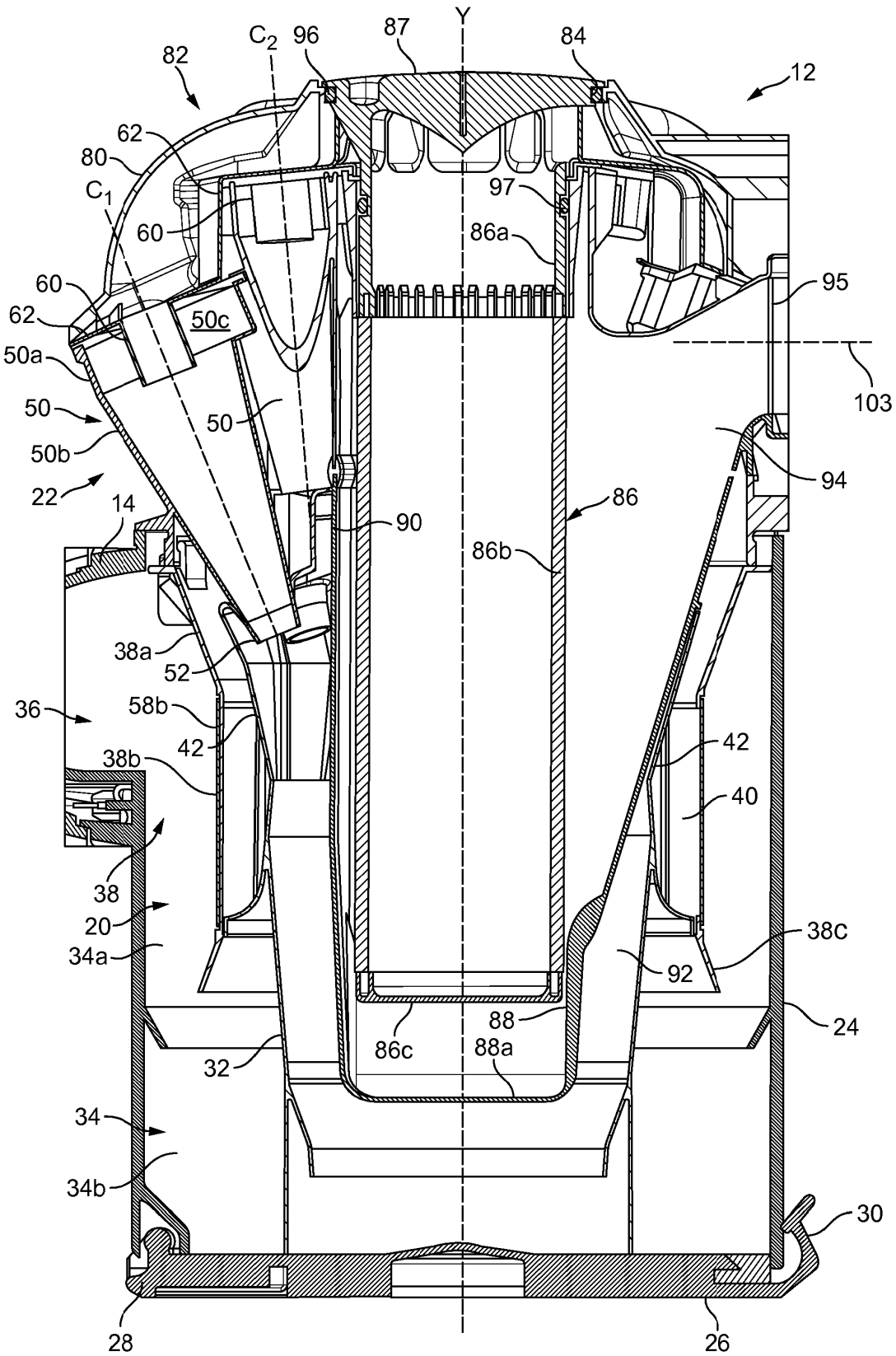


FIG. 2a

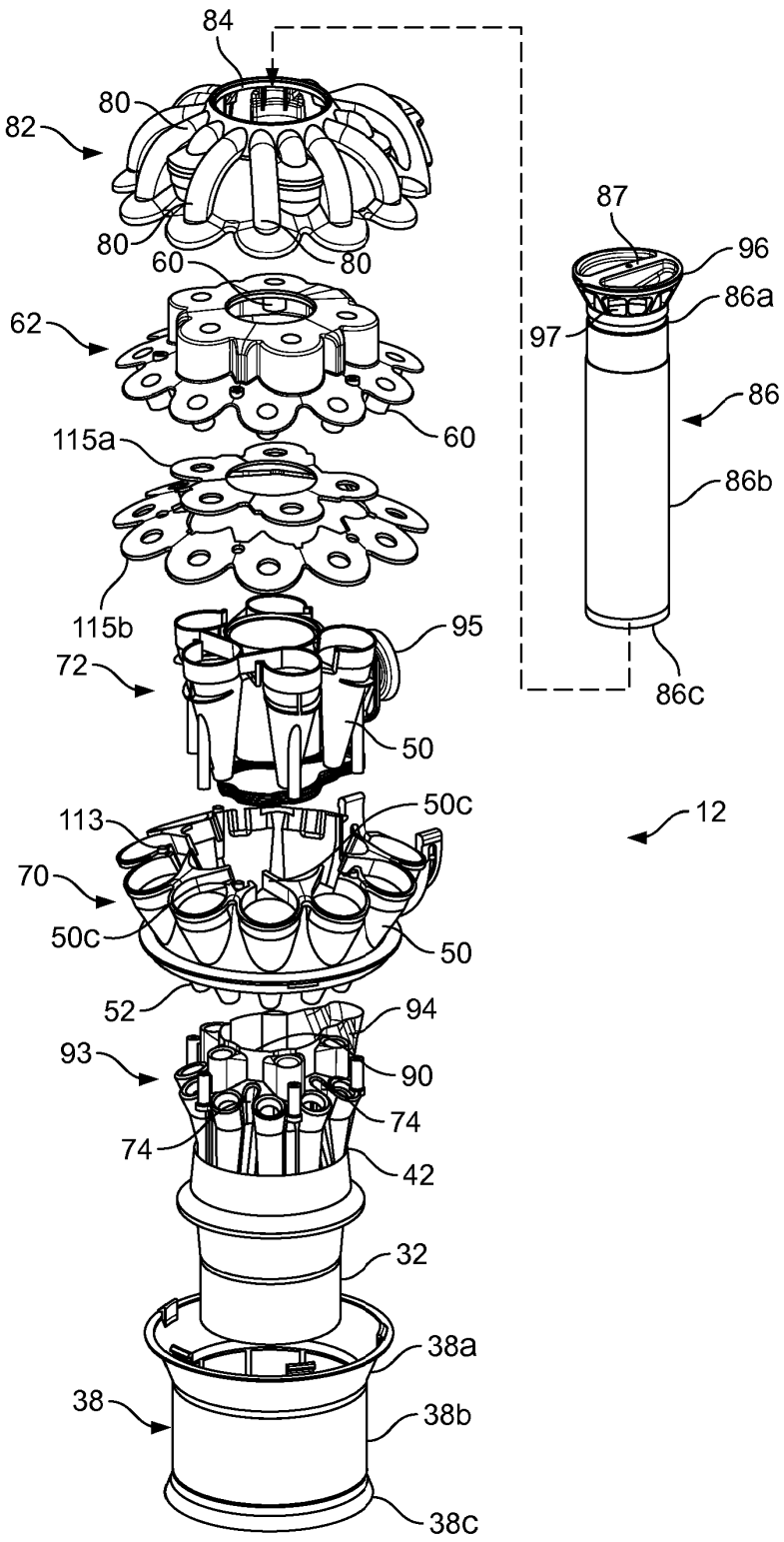

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FIG. 2b

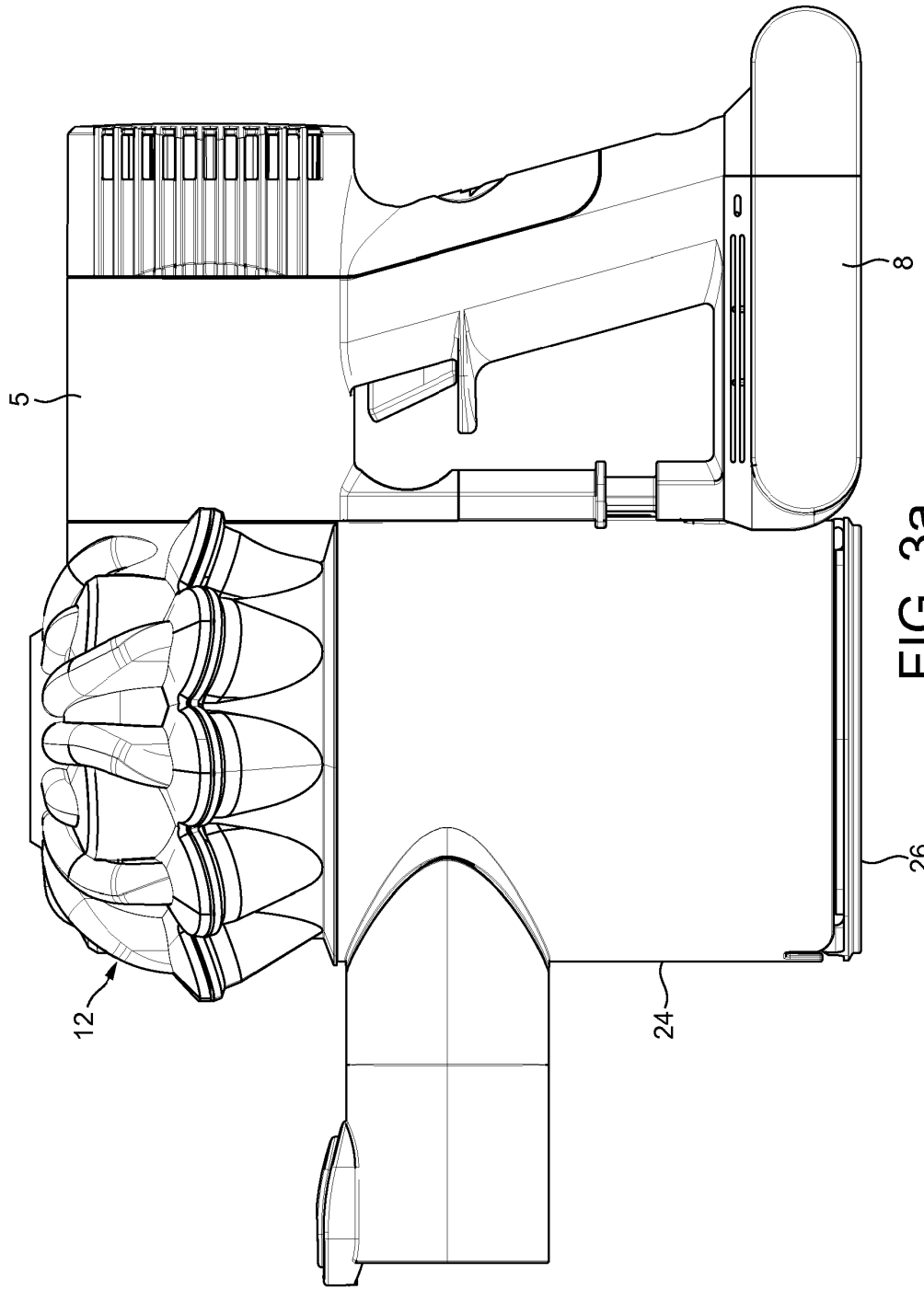


FIG. 3a

FIG. 3b

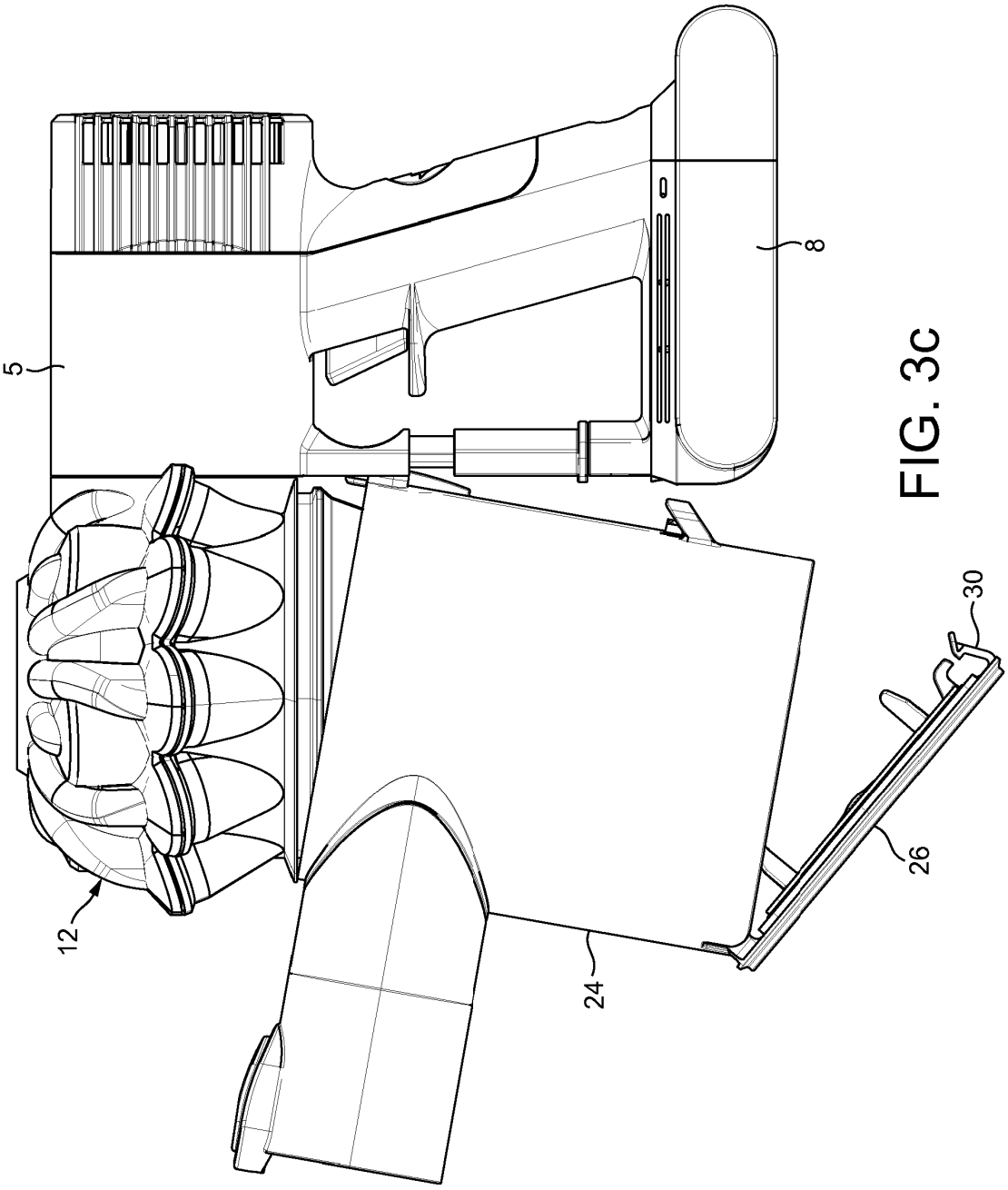


FIG. 3c

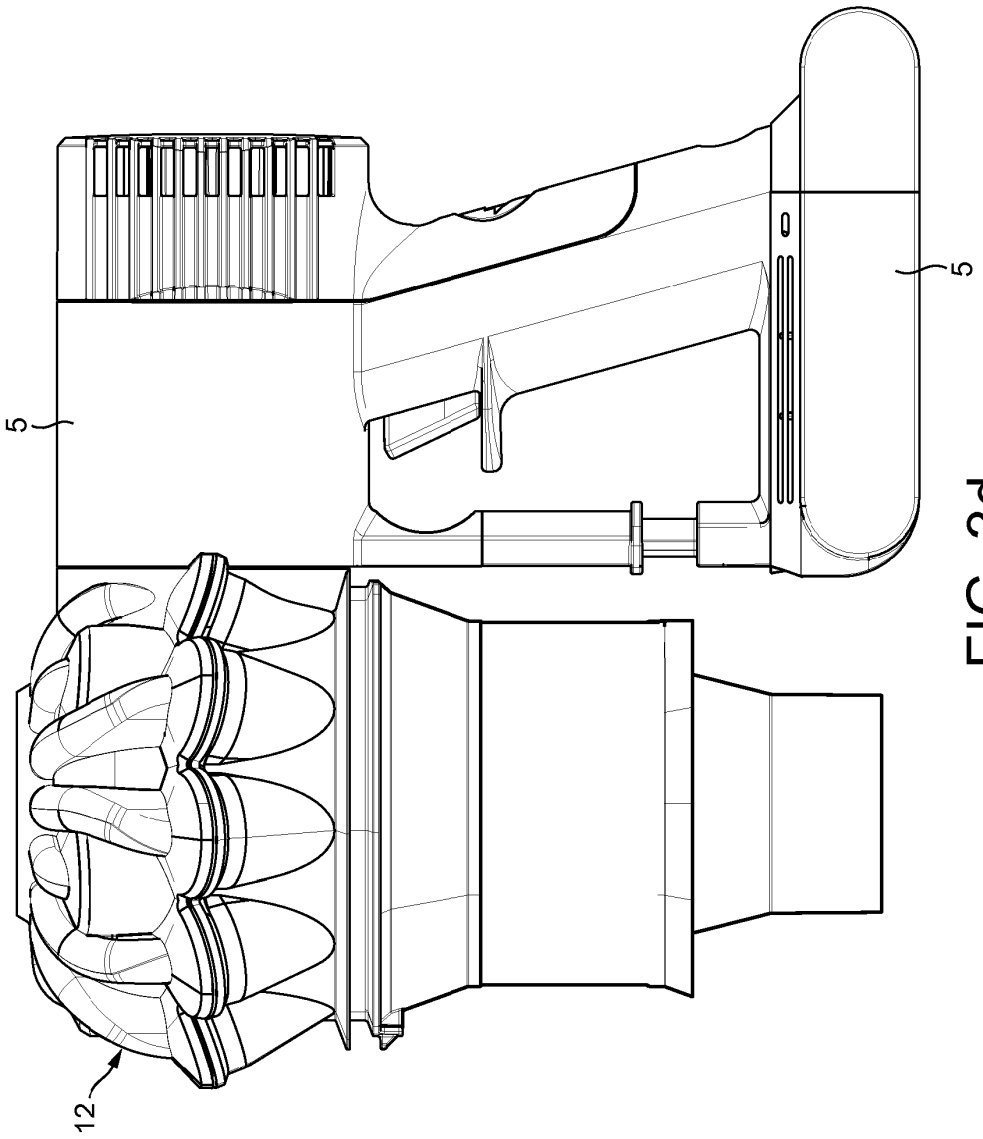


FIG. 3d

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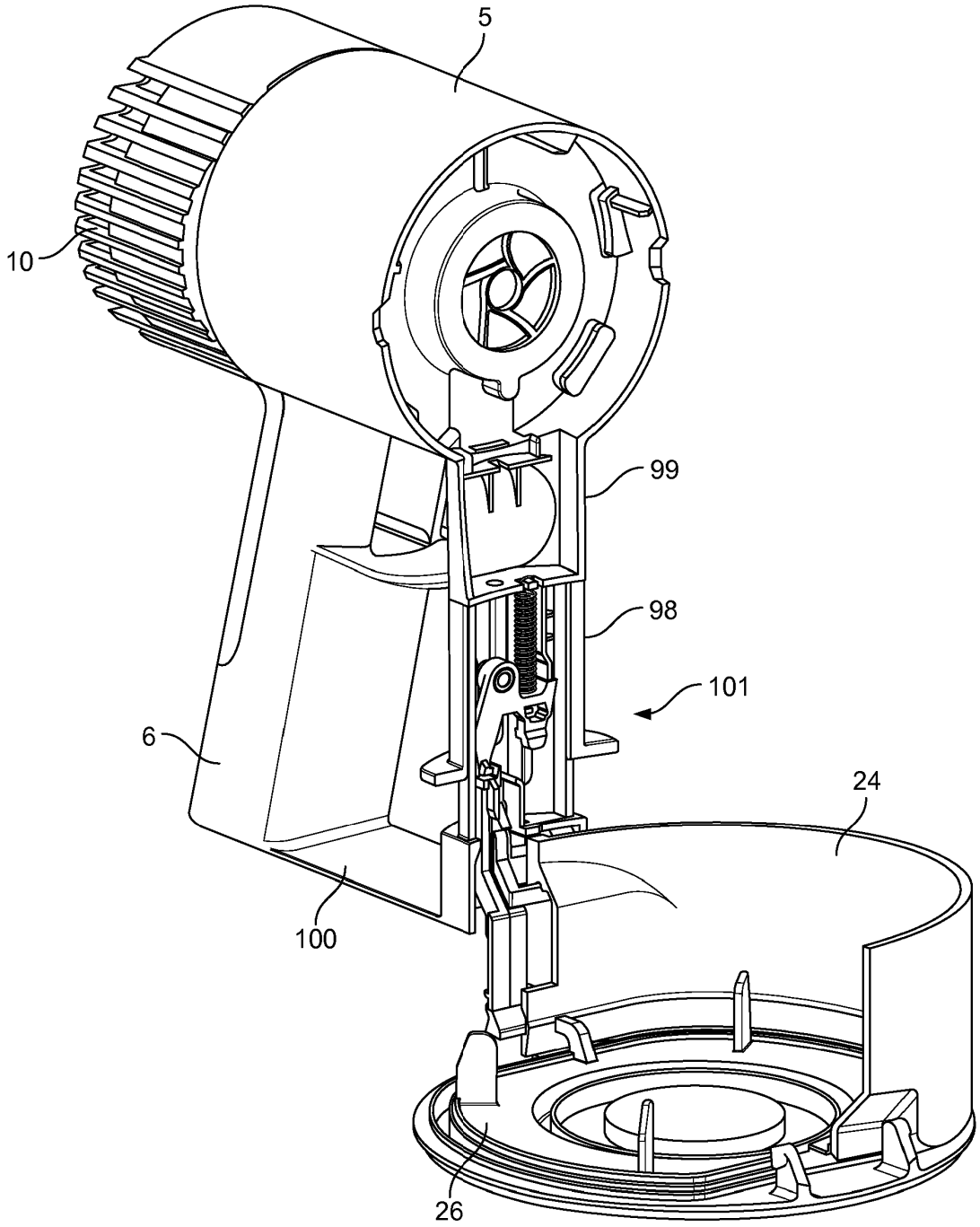


FIG. 4

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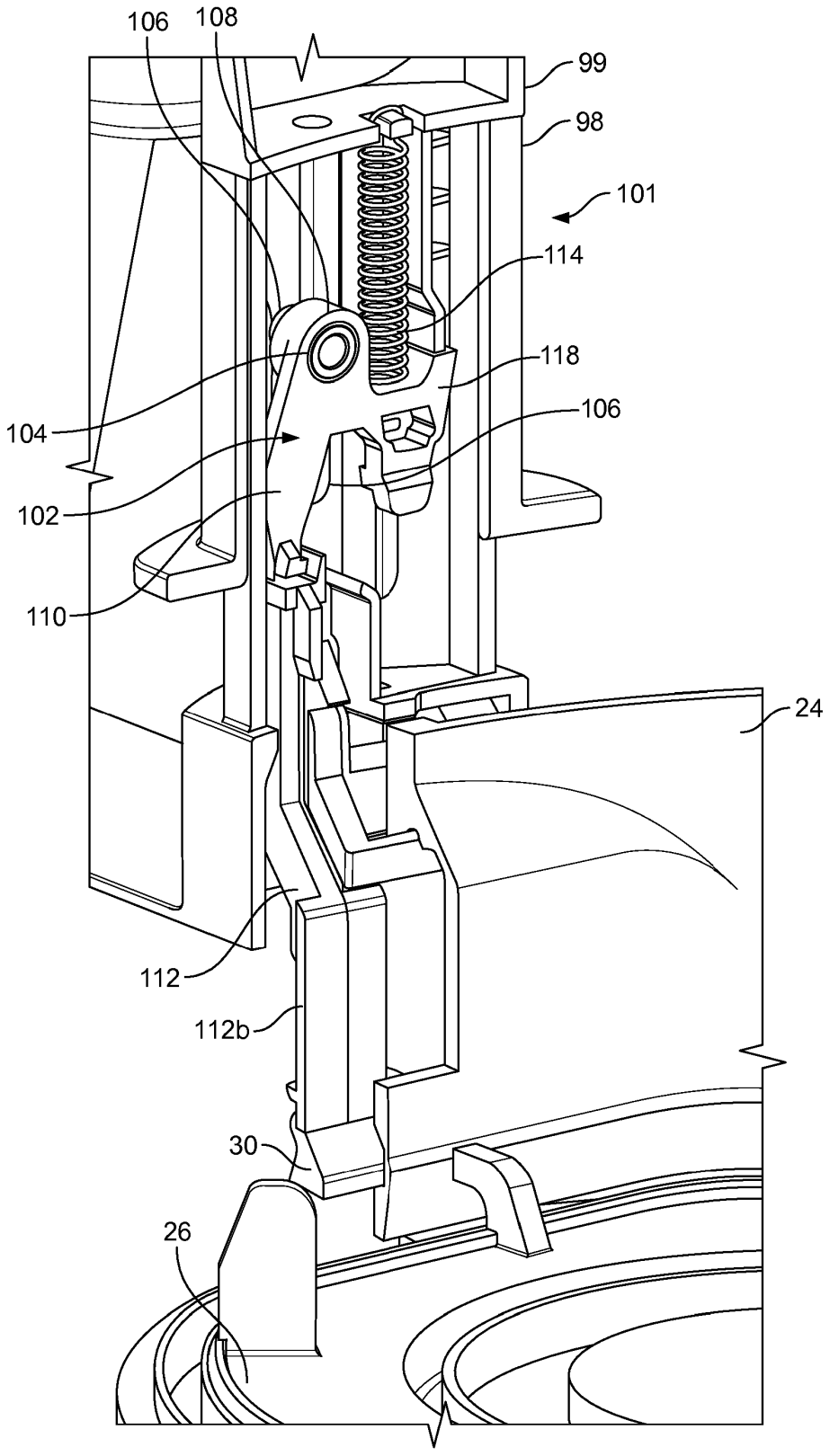


FIG. 5

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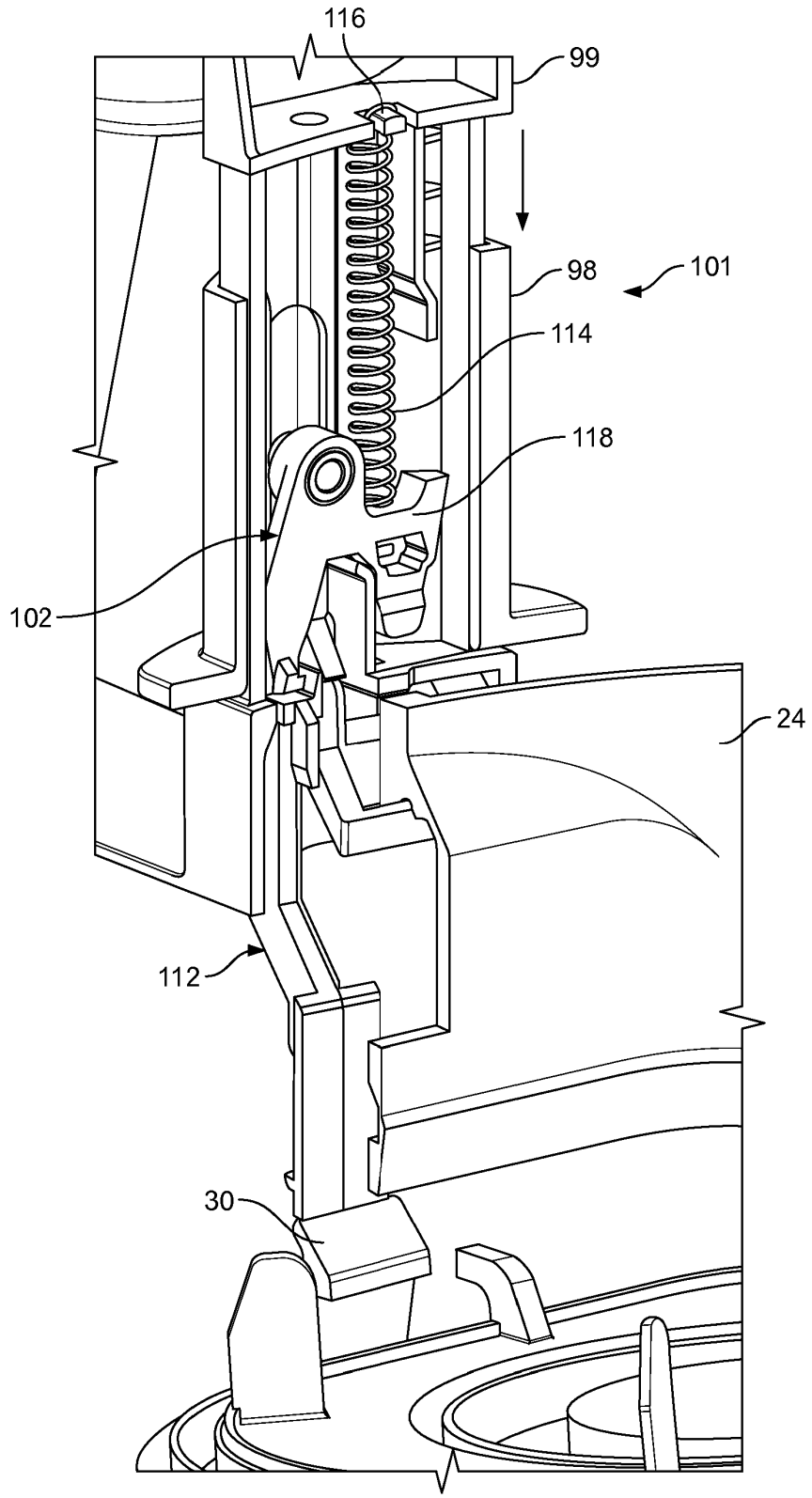


FIG. 6

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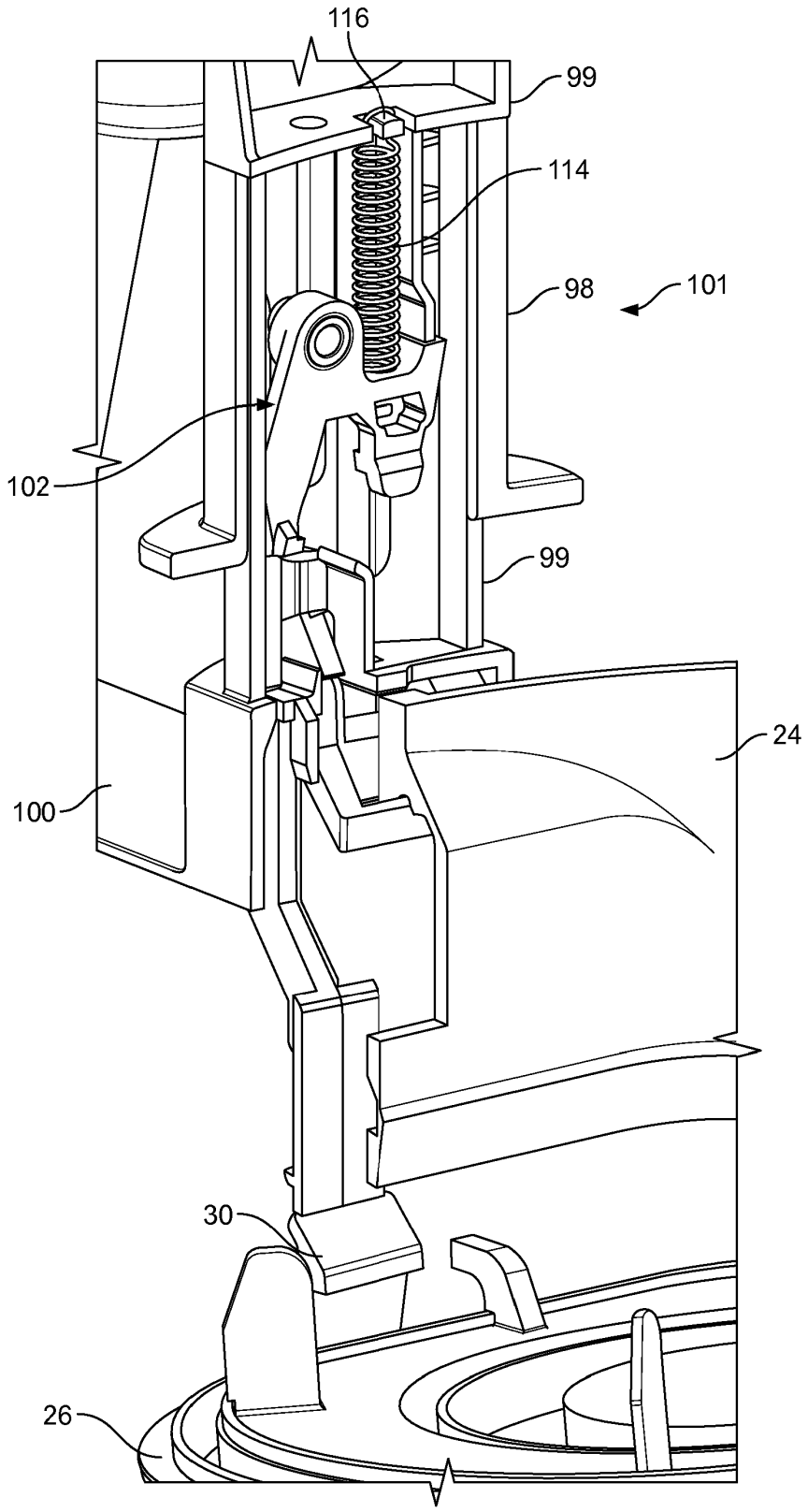


FIG. 7

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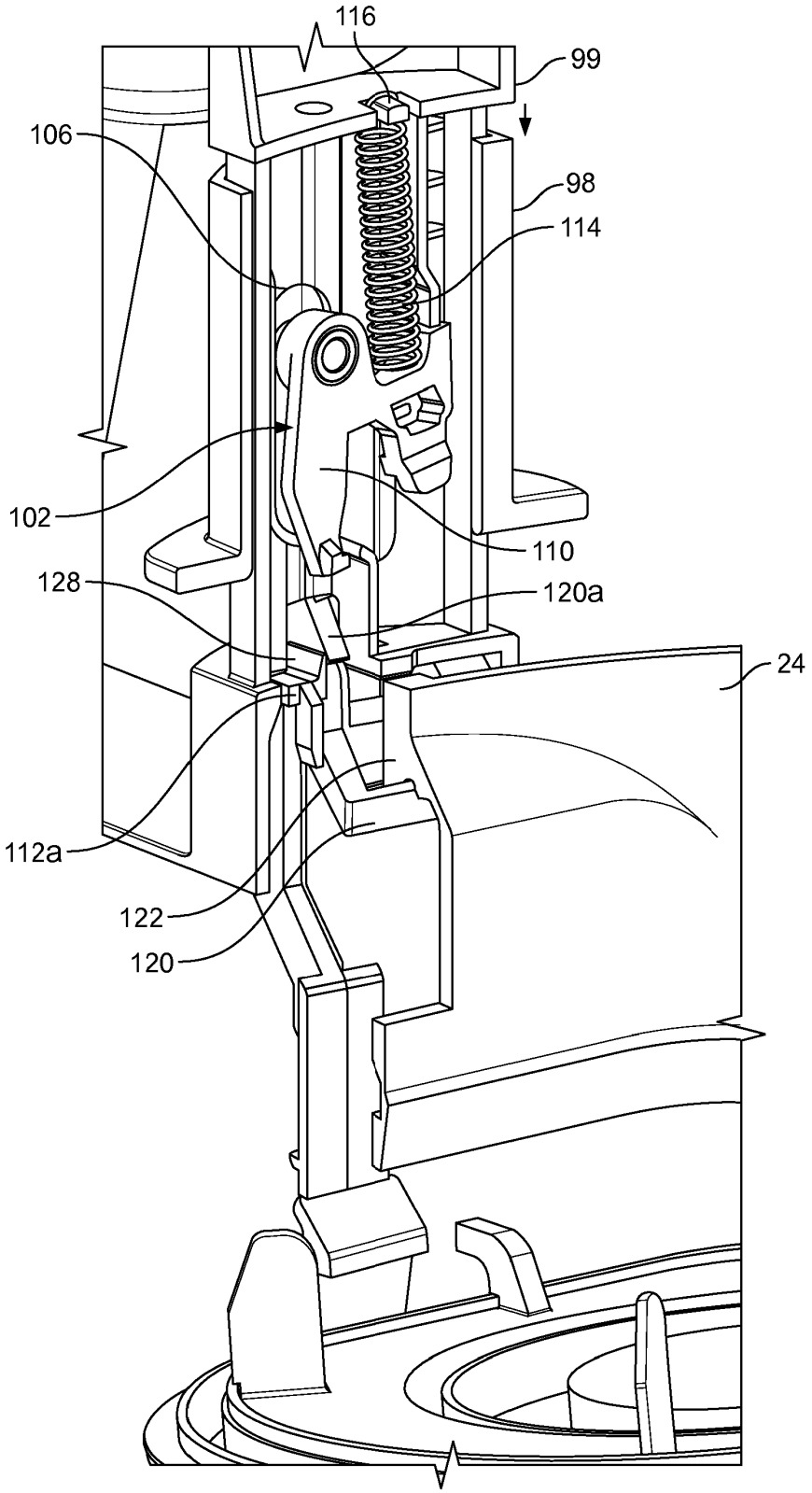


FIG. 8

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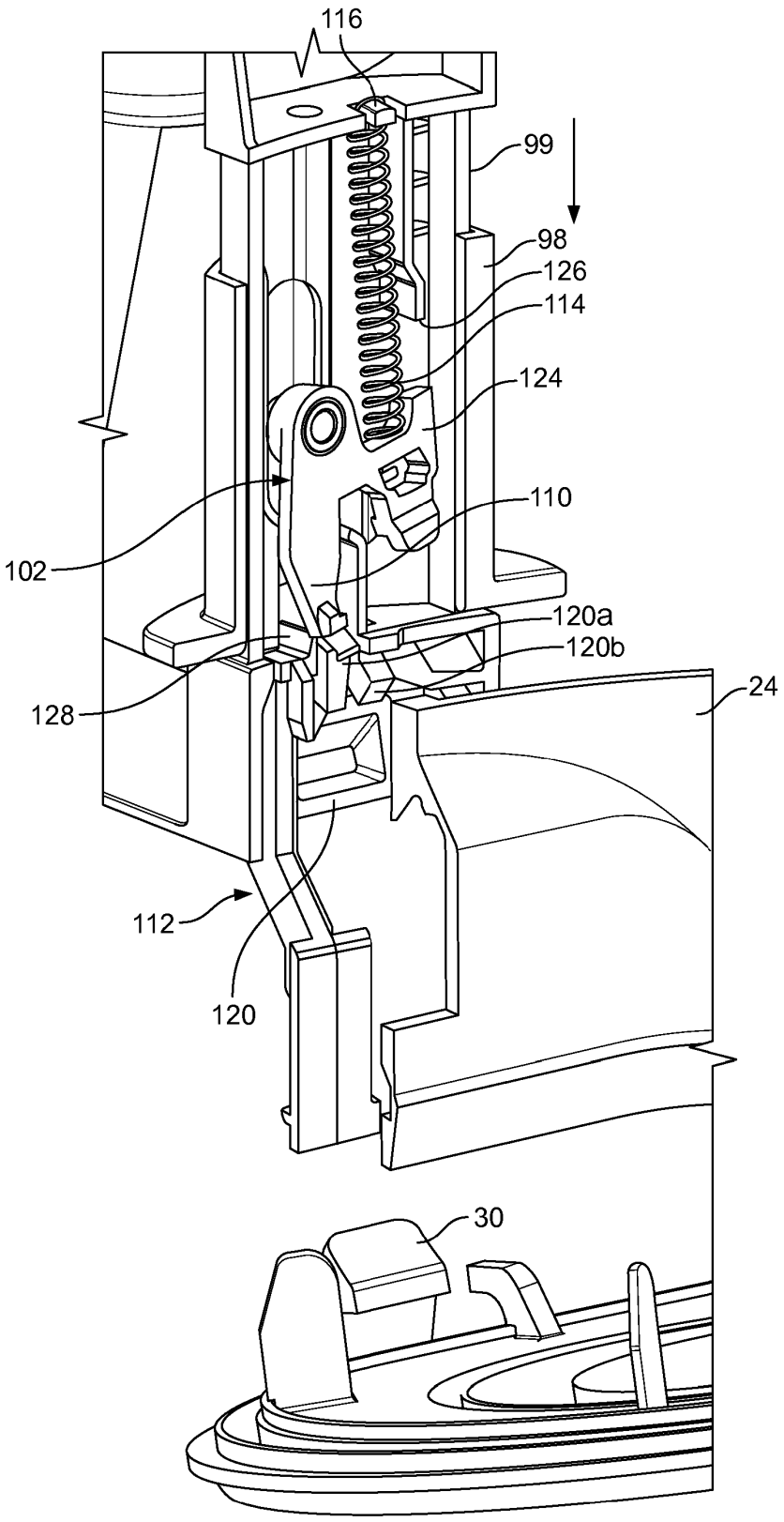


FIG. 9

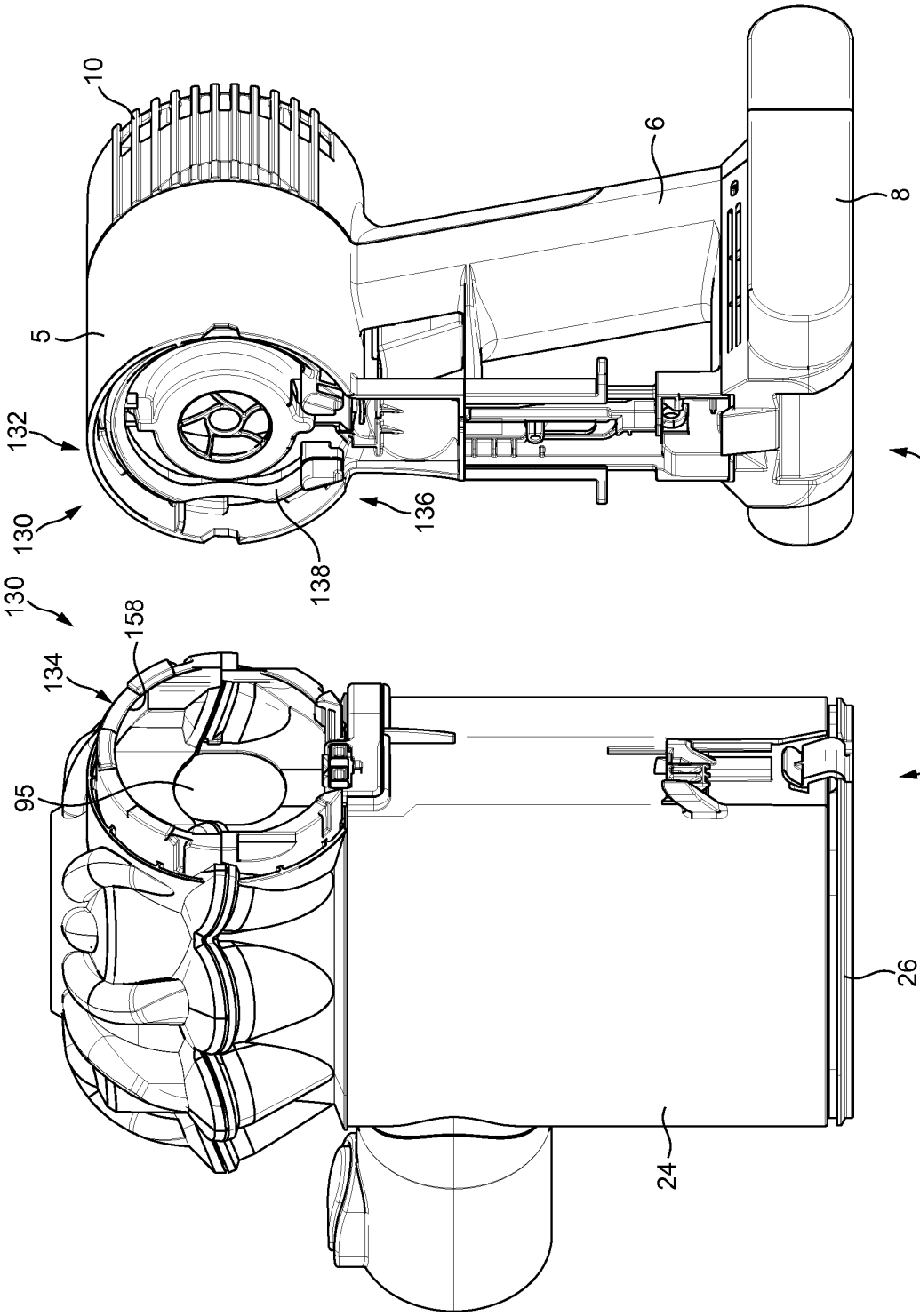


FIG. 10

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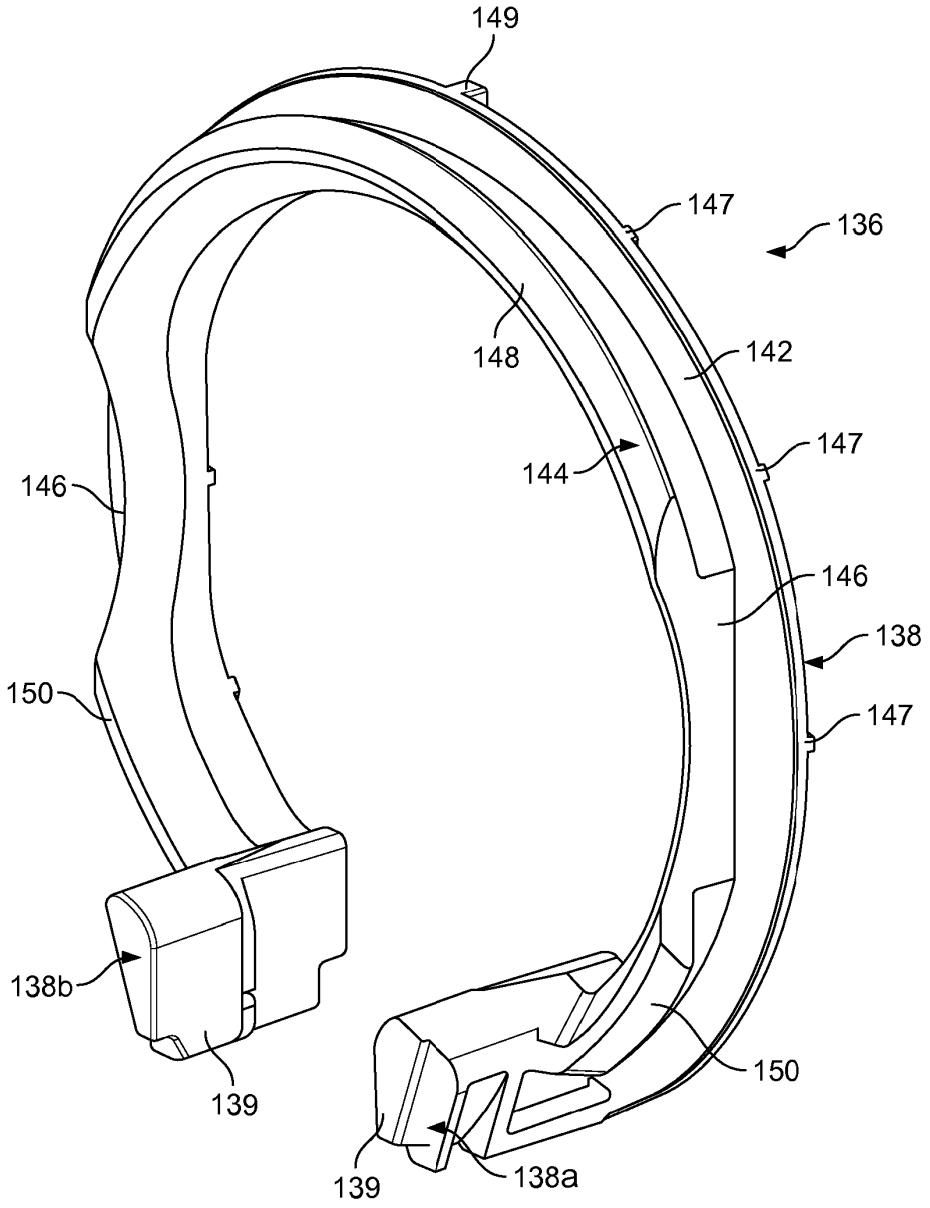


FIG. 11

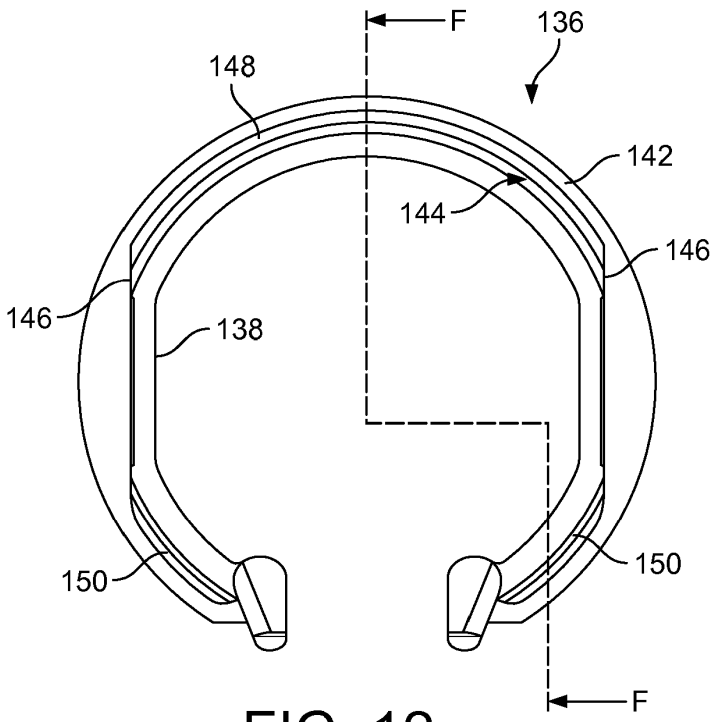


FIG. 12a

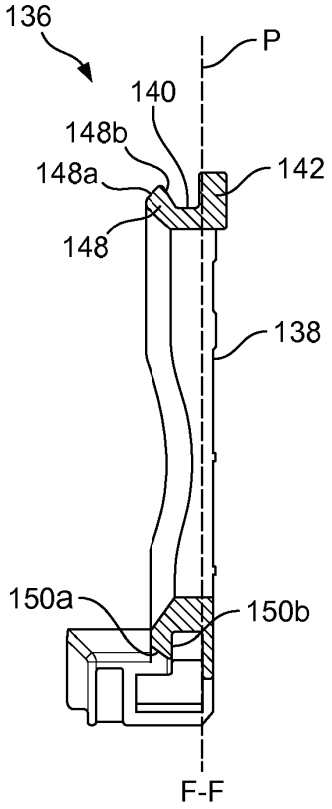


FIG. 12b

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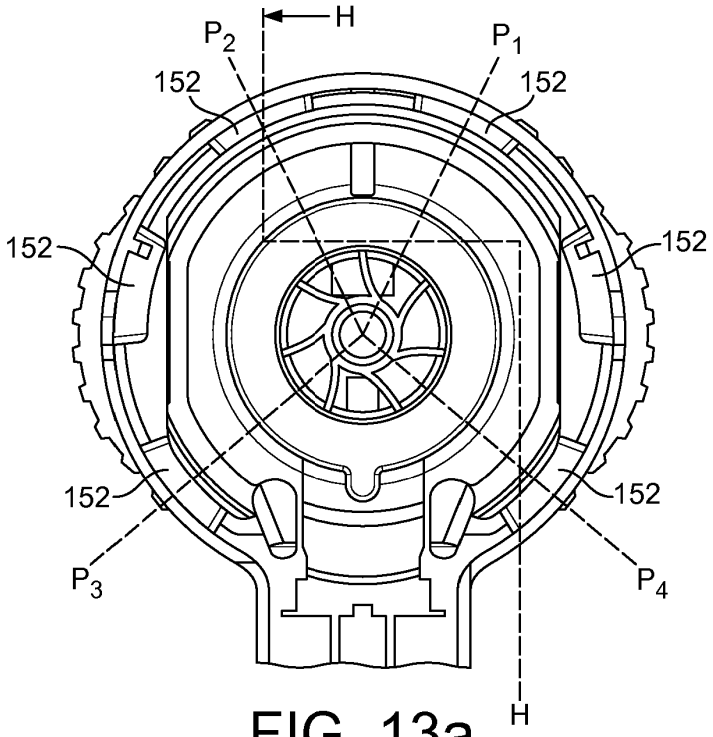


FIG. 13a

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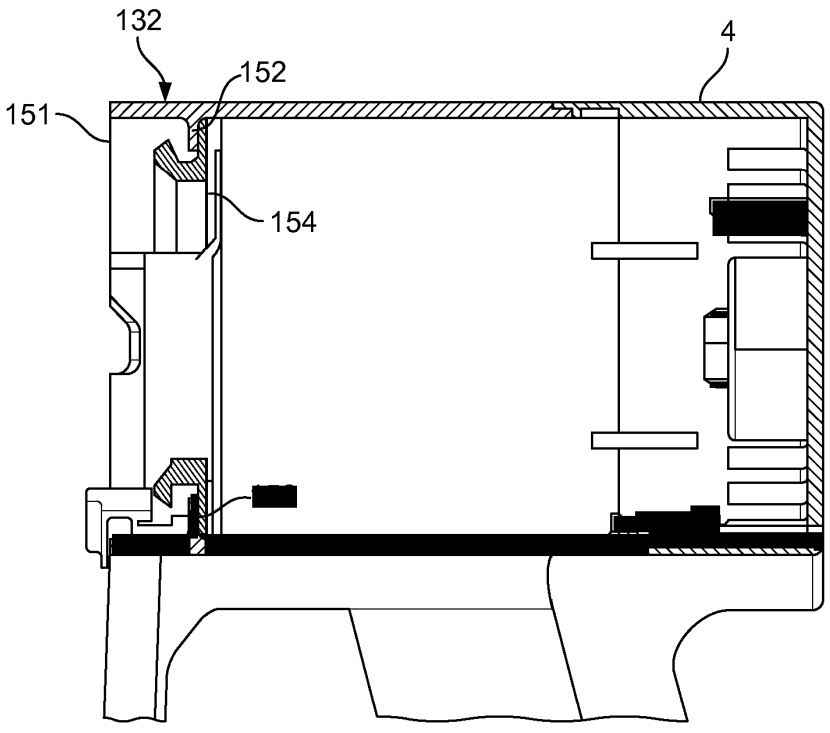


FIG. 13b

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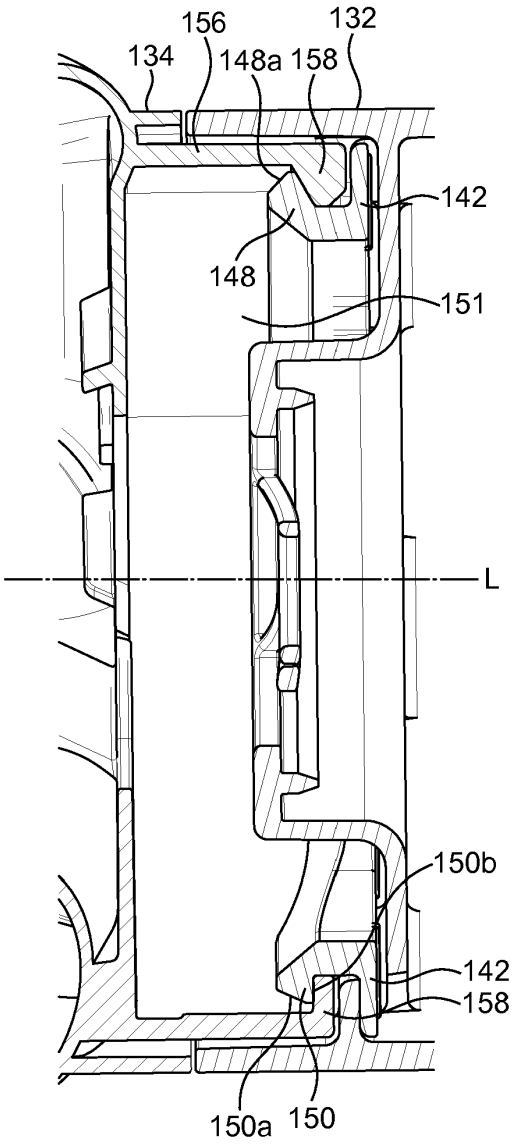


FIG. 14

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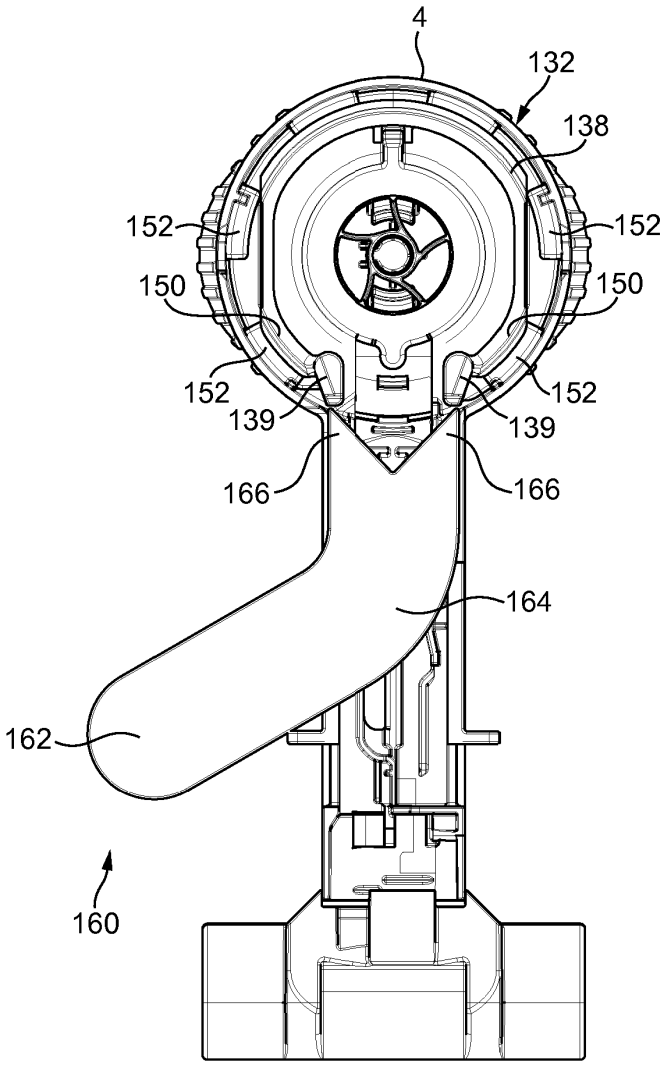


FIG. 15

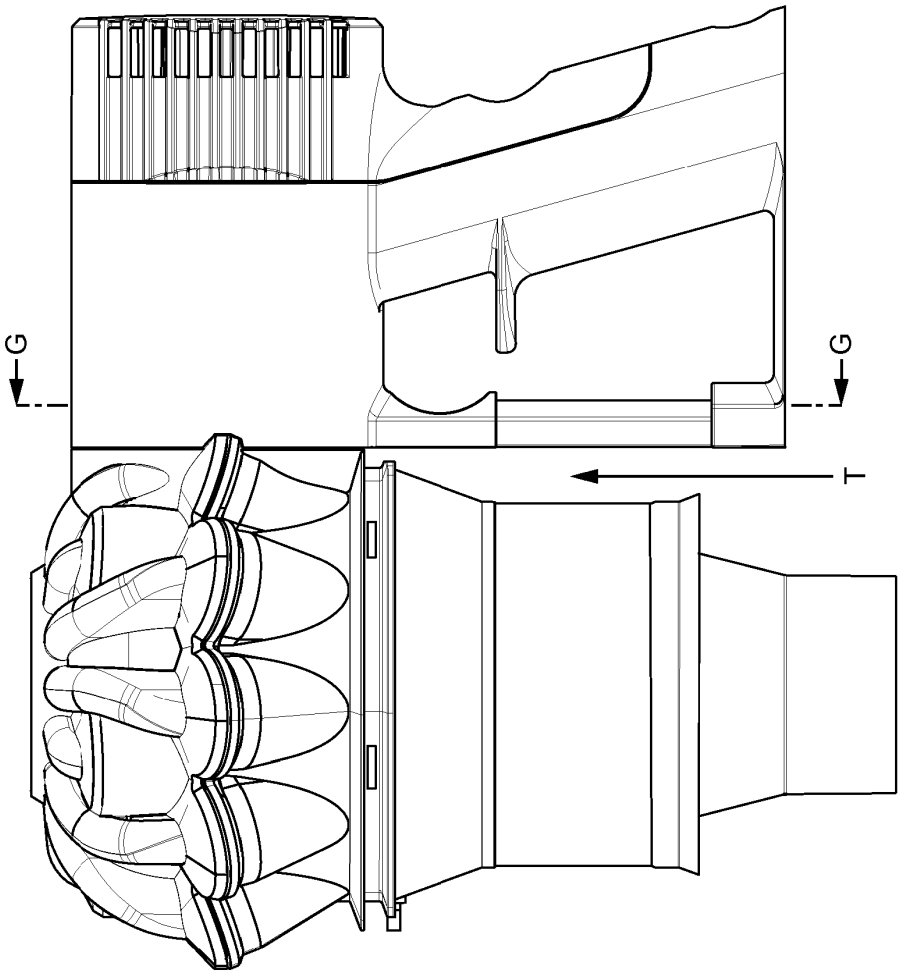


FIG. 16

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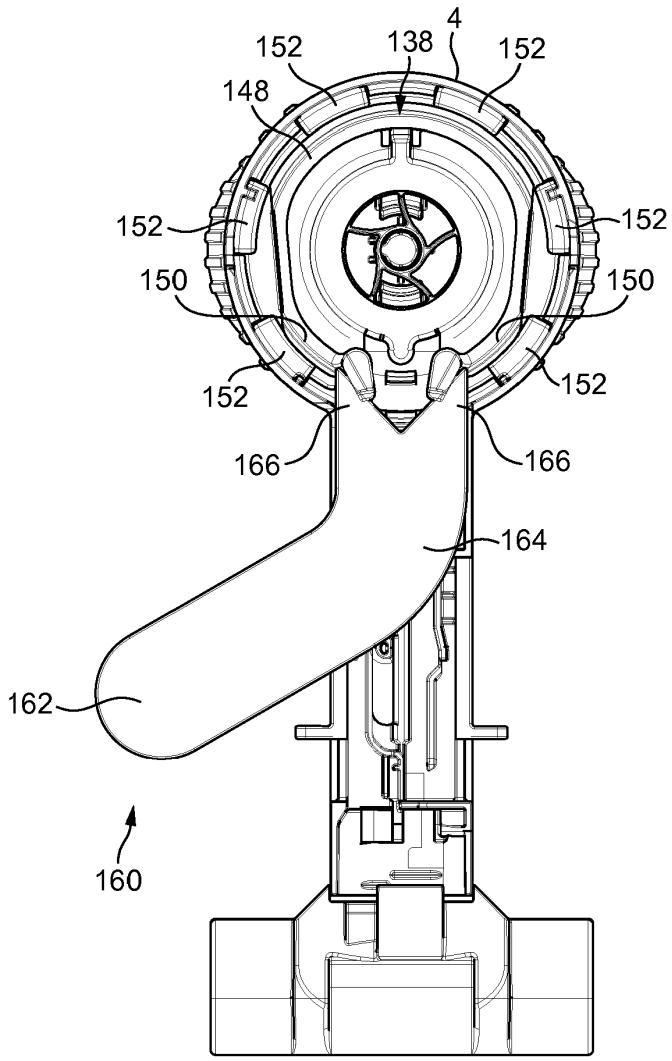
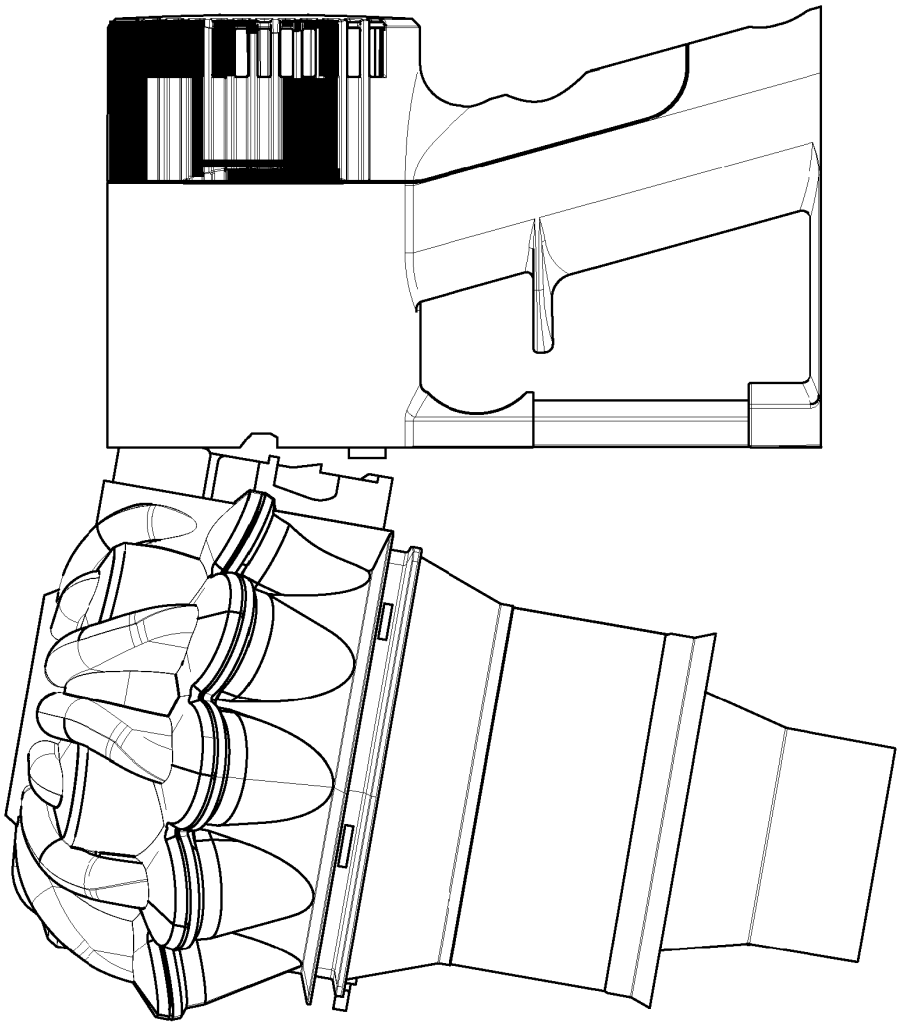


FIG. 17

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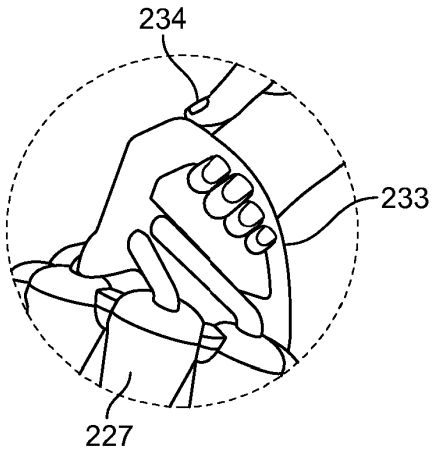


FIG. 20

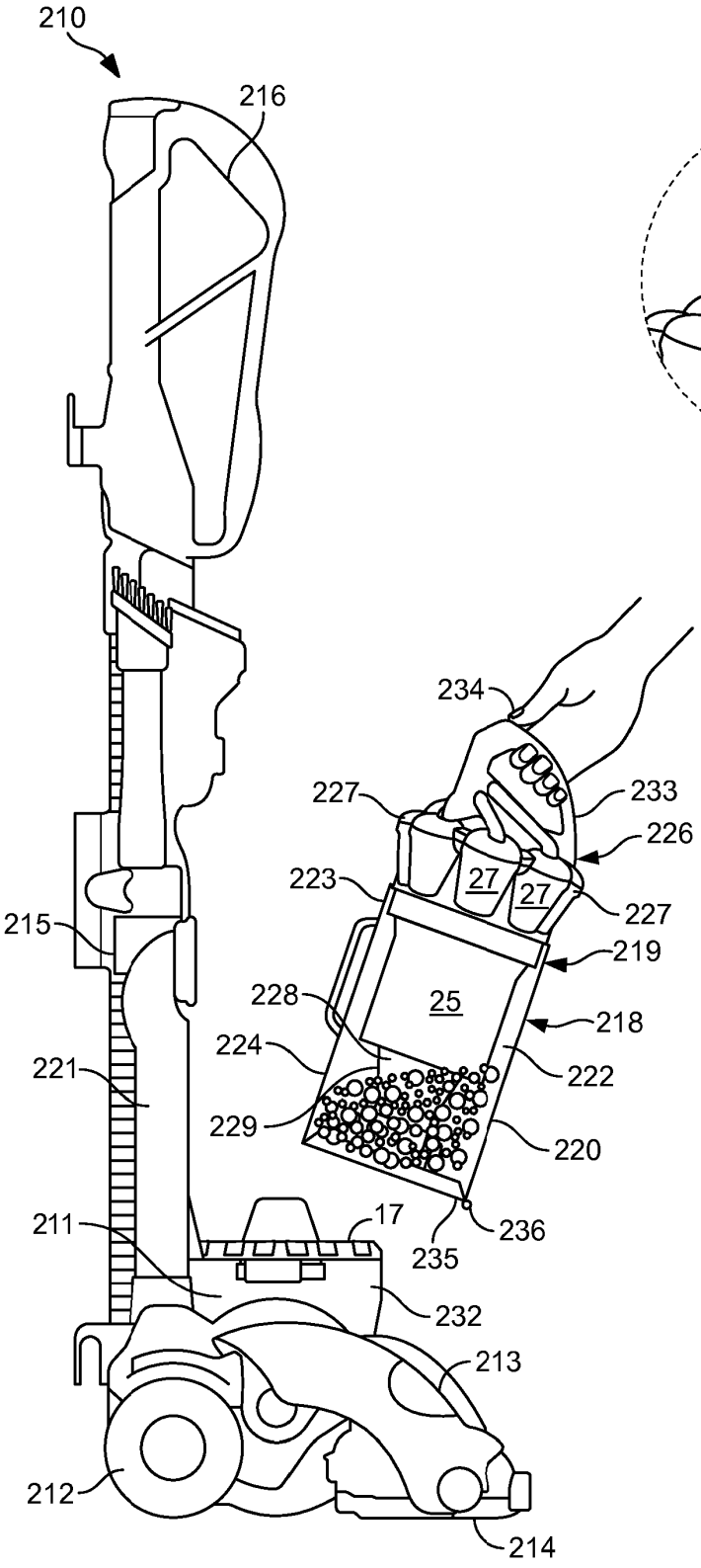


FIG. 19

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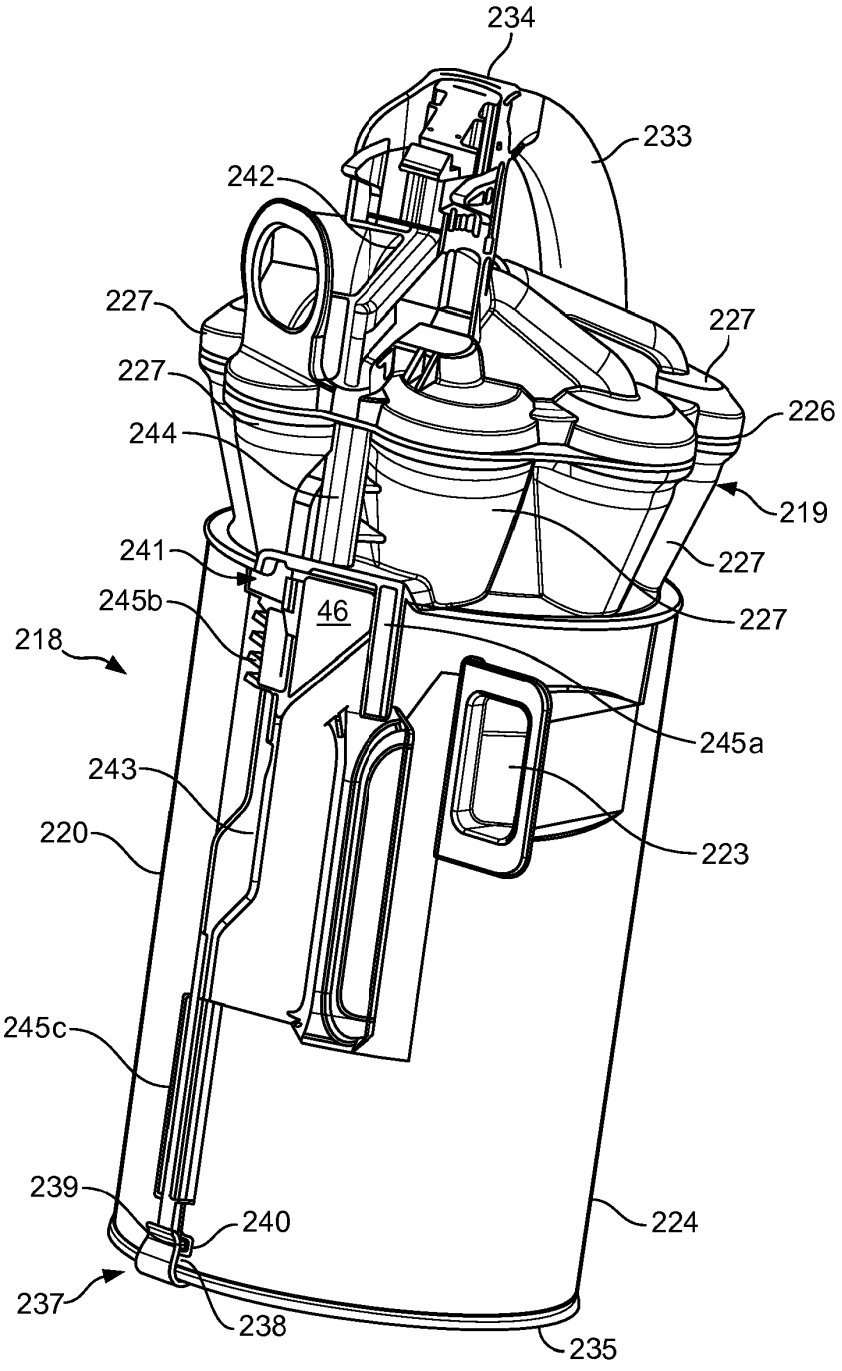


FIG. 21

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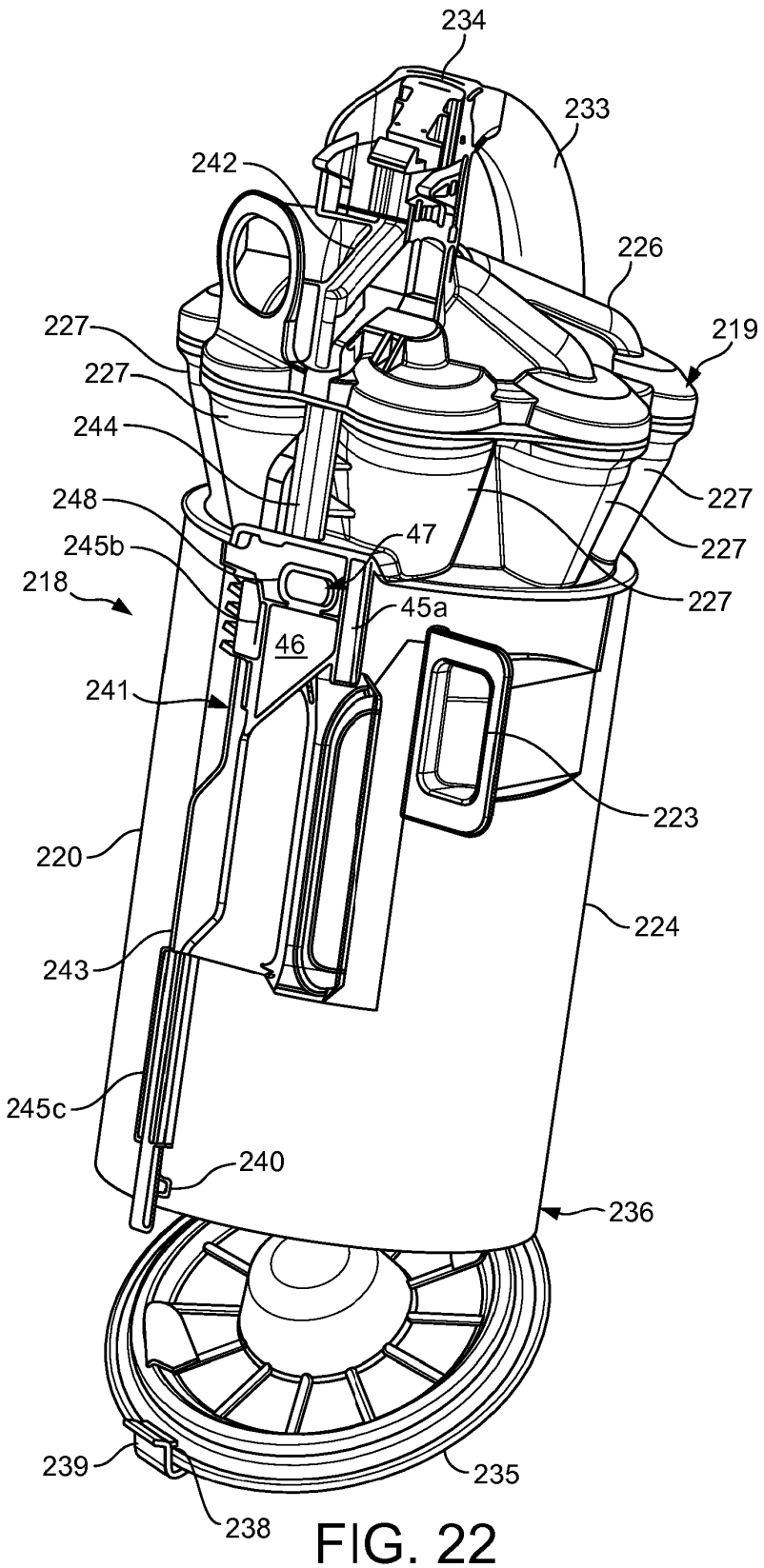


FIG. 22

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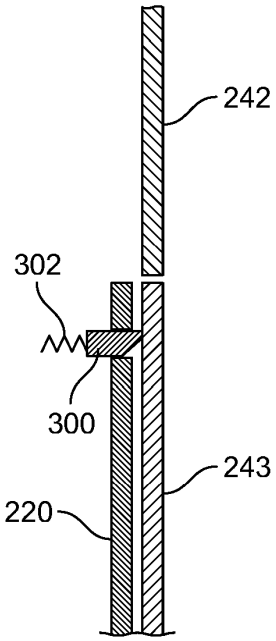


FIG. 23a

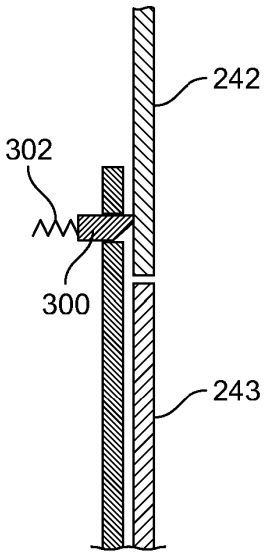


FIG. 23b

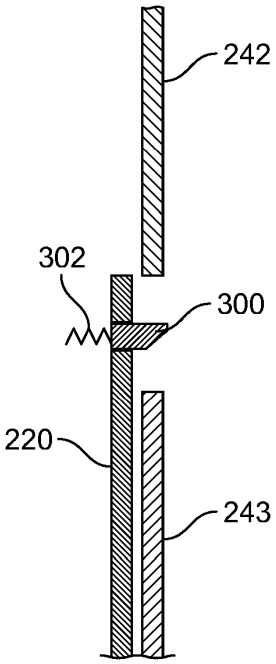


FIG. 23c

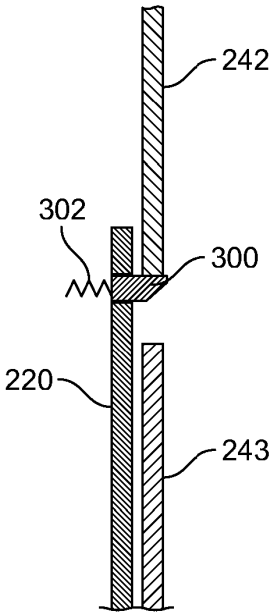


FIG. 23d

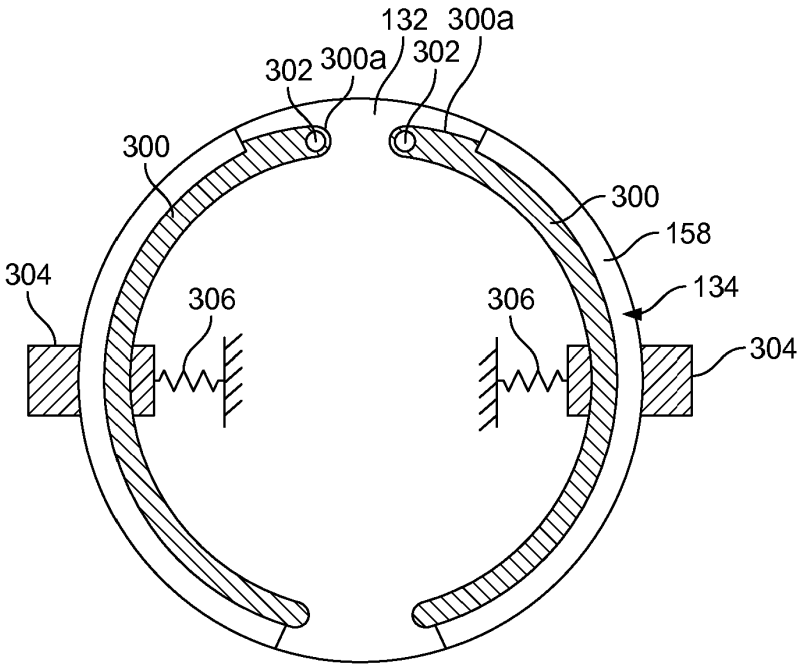


FIG. 24a

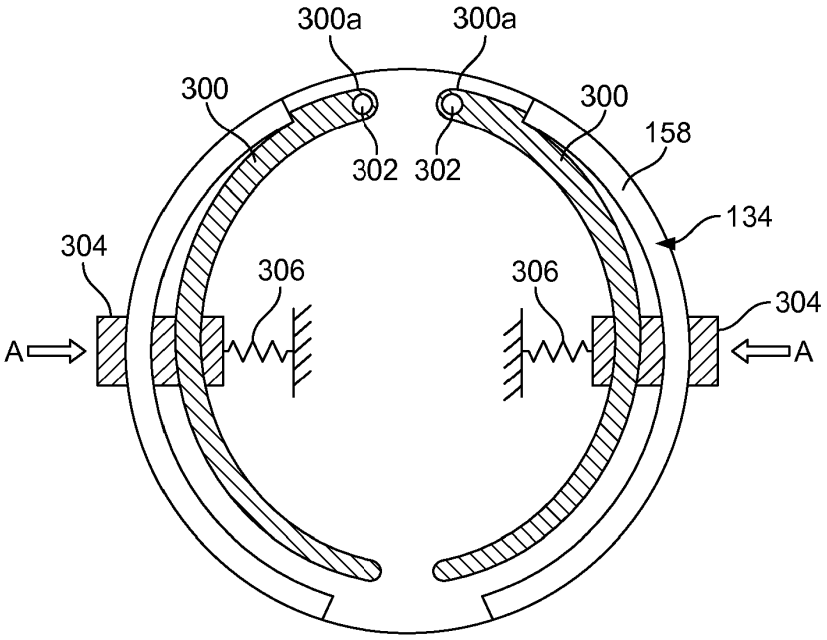


FIG. 24b

14 11 13

Cleaning Appliance

Technical field

The invention relates to a cleaning appliance including a separating apparatus having a dirt collector which can be emptied and also which is removable from the separating apparatus. The invention has particular utility in handheld and stick-type cleaning appliances, but also is applicable to other types of appliances such as upright and cylinder variants.

Background of the invention

Handheld vacuum cleaners are well known and have been manufactured and sold by various manufacturers for several years. One such handheld vacuum cleaner is described in EP2040599B, and as marketed by Dyson Limited as model number DC16. A similar vacuum cleaner of the so-called 'stick-vac' type is also marketed by Dyson Limited as model number DC35.

The vacuum cleaner of EP2040599B comprises a main body including a motor and fan unit located on the upper side of a handle and a power source in the form of a battery located on a lower side of the handle. The main body is connected to a cyclonic separator which includes a dirty air inlet through which dirt is drawn into the cyclonic separator when the motor and fan unit in the main body is operated. The cyclonic separator unit functions in the usual way to separate dirt from the air flow following which clean air is discharged from the cyclonic separator, through the motor and fan unit and exhaust from the air vents defined in the main body.

Two significant user-related features of the vacuum cleaner of EP2040599B are the mechanism by which the cyclonic separator is emptied and the way in which the main body and the cyclonic separator are joined.

Referring firstly to the joint between the main body and the cyclonic separator, the main body and the cyclonic separator are releasably connectable to each other at a generally rectangular interface. Part of this interface is defined by the cyclonic separator and the other part of the interface is defined by the main body. The two interface parts are engageable with one another in a type of 'clam shell' arrangement the interface defining an internal chamber within which an air filter is housed.

The main body interface part includes a tab on a lower portion thereof that is receivable in a receptacle on the interface part of the cyclonic separator. The two interface parts are therefore hinged about the tab and receptacle. The upper part of the cyclonic separator includes a user operated latch which engages with a catch defined on the upper part of the main body. In this way, the interface parts of the main body and the cyclonic separator can be brought together, hinged about the lower tab and cooperating receptacle, and secured to one another with the latch. It is a simple operation for a user to release the part by actuating the latch thereby disengaging the upper portion of the interface parts. However, a disadvantage with this arrangement is that there is a degree of 'lateral flex' between the main body and the cyclonic separator which may be noticeable particularly when a significant sideways load is exerted on the dirty air inlet of the cyclonic separator. Flex in a vacuum cleaning device is generally undesirable since it may be perceived by a user as an area of mechanical weakness, or simply an indicator of low quality. Therefore, it is desirable to develop a mechanism which provides a stronger interface between the dust separator and the main body of a handheld vacuum cleaner in particular.

Turning to the mechanism by which the cyclonic separator is emptied, the cyclonic separator has an openable base which is pivoted against the cylindrical wall of the cyclonic separator so that it can swing open. The side of the base opposite the pivot is lockable into a catch. The catch is operated by a user-operated actuator in the form of a slider-button mounted on the main body. The actuator includes a rod which pushes against the base when the actuator is pushed and releases the base so that it is free to

swing away from the door. Further, removal of the outer bin of the cyclonic separator is possible, but this requires a user to undo a dedicated catch proximate the lower rim of the bin and physically pull the bin away from the remainder of the cyclonic separator. A more user-friendly mechanism is desired.

Summary of the invention

It is against this background that the invention provides, in a first aspect, an apparatus, for example a cleaning apparatus and, more particularly a cleaning appliance such as a vacuum cleaner, comprising a first component that is releasably connected to a second component at an interface, the interface including a first interface portion and a second interface portion, and connecting means including at least one radially interlocking region extending about at least a portion of the interface.

When embodied in a cleaning appliance such a vacuum cleaner, the interface may be between a separating apparatus and a main body of the appliance. In this context the invention provides a improved connection between the two components since they are interlocked radially about the interface.

In one embodiment the connecting means includes a connecting member captive on the first interface portion and operable to lock onto one or more radial catch regions provided on the second interface portion. The connecting member may be a part-circular clip, such as a circlip that is compressible in a radial direction to reduce its outer diameter.

In a particularly advantageous arrangement, the apparatus includes an airflow generator for drawing air into the appliance and through the separating apparatus, wherein an airflow path from the separating apparatus to the main body is defined internally through the interface. Preferably, the first interface portion is associated with the body and the second interface portion is associated with the separating apparatus.

Although the resilient member may be configured so that the two components may be pulled apart under a application of a predetermined force, in one embodiment a tool is required to enable the resilient member to disengage the interface.

Further preferred and/or optional features are provided in the dependent claims.

In a second aspect, the invention provides, a cleaning appliance comprising a main body and a separating apparatus including a dirt collector having a base that is openable to allow the dirt collector to be emptied, wherein the cleaning appliance includes an actuator that is operable sequentially such that, during a first operation, the actuator causes the base to be opened and, during a second operation, the actuator causes the dirt collector to disengage from the separating apparatus.

The invention enables a single user-operable interface to perform two functions: firstly to open the bin door and secondly, when the bin door has been opened, to remove the bin from the separating apparatus. This is particularly useful in the case of a handheld cleaning apparatus when it is generally required to empty the bin when the separating apparatus is attached to the main body. However, in the context of an upright or cyclone type vacuum cleaner, the same actuator could also be used to decouple the separating apparatus from the main body. This sequence of operation therefore provides a simplified user interface because only a single actuator is required to perform two, or even three functions, but it is also a solution which is space efficient and lighter in weight.

Preferred and/or optional features of this aspect of the invention are provided in the dependent claims.

Brief description of the drawings

In order that it may be more readily understood, embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a perspective view of a handheld cleaning appliance according to the invention;

Figure 2a is a section view of the cyclonic separating apparatus of the appliance in Figure 1, and Figure 2b is an exploded view of the internal components of the separating apparatus;

Figures 3a to 3d are a sequence of side views of the cleaning appliance which show the sequential operations to, firstly, open a door of the bin and, secondly, to remove the bin from the separating apparatus;

Figure 4 is a perspective view in which the main body of the appliance is split from the separating apparatus and which shows internal components of the actuating mechanism by which the separating apparatus may be opened for emptying purposes;

Figures 5 to 9 are a sequence of perspective views, based on Figure 4, which show the internal components of the actuating mechanism in a series of operations to open the bin door and to release the bin from the separating apparatus;

Figure 10 is a perspective view of the main body of the cleaning appliance separated from the separating apparatus showing a further aspect of the invention;

Figure 11 is a perspective view of the resilient member in Figure 10;

Figure 12a is a view of the resilient member from the front and Figure 12b is a section view along the line F-F in Figure 12a;

Figure 13a is view of the resilient member in-situ in the mechanical interface of the main body, and Figure 13b is a cross section along the line H-H;

Figure 14 is an interior view of the mechanical interface between the main body and the separating apparatus in an assembled condition thereby showing the engagement between the first interface portion, the resilient member and the second interface portion;

Figure 15 is a view of the main body and a tool for interacting with the resilient member;

Figure 16 is a side view of the main body attached to the separating apparatus and illustrates the insertion point of the tool shown in Figure 15;

Figure 17 is a view of the main body like that shown in Figure 15 but shows the tool compressing the resilient member in a radial direction;

Figure 18 is a side view that shows the main body and the separating apparatus being separated from one another;

Figure 19 is a side view of an alternative vacuum cleaner arrangement;

Figure 20 is an enlarged view of part of Figure 19,

Figures 21 and 22 are perspective views of a cyclonic separating apparatus from the upright vacuum cleaner in Figure 19;

Figure 23a to Figure 23d are schematic views of a mechanism associated with the cyclonic separating apparatus of Figures 21 and 22; and

Figures 24a and 24b show schematically an alternative arrangement to the embodiment of Figures 10 to 17.

Detailed description of the embodiments

With reference to Figures 1 and 2, a handheld vacuum cleaner 2 has a main body 4 which houses an airflow generator 5 in the form of a motor and fan unit above a generally upright handle or grip portion 6. The handle 6 has a lower end 6a that supports a generally slab-like battery pack 8. A set of exhaust vents 10 are provided on the main body 4 for exhausting air from the handheld vacuum cleaner 2.

The main body 4 supports a cyclonic separating apparatus 12 that is operable to remove dirt, dust and other debris from a dirt-bearing airflow drawn into the vacuum cleaner by the airflow generator. The cyclonic separator 12 is attached to a forward part 4a of the main body 4 and an air inlet nozzle 14 extends from a forward portion of the cyclonic separator that is remote from the main body 4. The air inlet nozzle 14 is configured so that a suitable brush tool can be removably mounted to it and includes a catch 16 for securely holding such a brush tool when the tool is engaged with the inlet. The brush tool is not material to the present invention and so is not shown here. It should also be appreciated that the air inlet nozzle could also be connected to a suitable wand having a cleaning head and, in such a configuration, would take the form of a stick-vac type cleaner. Such a configuration is known in the market, for example the Dyson DC35.

The cyclonic separating apparatus 12 is located between the main body 4 and the air inlet nozzle 14 and so also between the handle 6 and the air inlet nozzle 14. The separating apparatus 12 has a longitudinal axis Y which extends in a generally upright direction so that the handle 6 lies at a shallow angle to the axis Y.

The handle 6 is oriented in a pistol-grip formation which is a comfortable configuration for a user since it reduces stress on a user's wrist during cleaning. The separating apparatus 12 is positioned close to the handle 6 which also reduces the moment applied

to the user's wrist when the handheld vacuum cleaner 2 is in use. The handle 6 carries an on/off switch in the form of a trigger 18 for turning the vacuum cleaner motor on and off. In use, the motor and fan unit 5 draws dust laden air into the vacuum cleaner 12 via the air inlet nozzle 14. Dirt and dust particles entrained within the air flow are separated from the air and retained in the separating apparatus 12. The cleaned air is ejected from the rear of the separating apparatus 12 and conveyed by a short duct to the motor and fan unit 5 located within the main body 4, and is subsequently expelled through the air outlets 10.

The separating apparatus 12 forming part of the handheld vacuum cleaner 2 is shown in more detail in Figure 2 which is a cross section through the separating apparatus 12 along the centreline of the vacuum cleaner. In overview, the separating apparatus 12 comprises a first cyclonic separating unit 20 and a second cyclonic separating unit 22 located downstream from the first cyclonic separating unit 20. A collecting bin 24 of the separating apparatus 12 is defined by an outer wall being substantially cylindrical in shape and which extends about a longitudinal axis Y of the separating apparatus 12 .

The lower end of the outer bin 24 is closed by a bin base 26 or 'door' that is pivotably attached to the outer wall 24 on the side opposite from the main body by means of a pivot 28 and held in a closed position by a catch 30, as will described in further detail later. Radially inward of and coaxial with the outer wall 24 is a second cylindrical wall 32 so that a chamber 34 is defined between the two walls. The second cylindrical wall 32 engages and is sealed against the base 26 when it is closed. The upper portion of the annular chamber 34 forms a cylinder-shaped cyclone chamber or, more simply 'cyclone' 34a, of the first cyclonic separating unit 20 and the lower portion of the annular chamber 34 forms a dust collecting zone 34b of the first cyclonic separating unit 20. Although there is no definite physical demarcation between the cyclone and the dust collecting zone, in general the dust collecting zone is beneath a downwardly angled lip 35 that protrudes radially inwards from the outer wall 24. The lip 35 helps to prevent dirt in the dirt collecting zone being entrained back into the airflow in the cyclone chamber.

A bin inlet 36 is provided at the upper end of the chamber 34 for receiving an air flow from the air inlet nozzle 14. Although not shown in the Figures, the bin inlet 36 is arranged tangentially to the chamber 34 so as to ensure that incoming dirty air is encouraged to follow a helical path around the chamber 34.

A fluid outlet from the chamber 34 is provided in the outer bin in the form of a generally cylindrical shroud 38. More specifically, the shroud 38 has an upper frustoconical wall 38a that tapers towards a lower cylindrical wall 38b that depends downwardly into the chamber 34. A skirt 38c depends from the lower part of the cylindrical wall and tapers outwardly in a direction towards the outer wall 24. The lower wall 38b of the shroud is perforated therefore providing the only fluid outlet from the chamber 34. By 'perforations', it is meant that the shroud is formed to be air-permeable for example in the form of a plastic or metal mesh, or a solid wall having a plurality of holes through which air may pass. Currently a plastics mesh is preferred.

Referring also to Figure 3, a second annular chamber 40 is located behind the shroud 38 and provides a manifold from which airflow passing through the shroud 38 from the first separating unit 20 is fed to the second cyclonic separating unit 22 through channels defined by a centrally positioned cyclone support structure 42. The second cyclonic separating unit 22 comprises a plurality of cyclones 50 arranged fluidically in parallel to receive air from the first cyclonic separating unit 20. In this example, the cyclones 50 are substantially identical in size and shape, and each one comprises a cylindrical portion 50a and a tapering portion 50b depending downwardly from it (only one cyclone is labelled in Figure 2 for clarity). The cylindrical portion 50a comprises an air inlet 50c for receiving fluid from the second annular chamber 40. The tapering portion 50b of each cyclone is frusto-conical in shape and terminates in a cone opening 52 at its bottom end through which dust is ejected, in use, into the interior of the cyclone support structure 42. An air outlet in the form of a vortex finder 60 is provided at the upper end of each cyclone 50 to allow air to exit the cyclone. Each vortex finder 60 extends downwardly from a vortex finder member 62.

The cyclones of the second cyclonic separating unit 22 are grouped into a first set of cyclones 70 and a second set of cyclones 72 and, as can be seen in Figures 2 and 3, the second, upper, set of cyclones is positioned axially above the first, lower, set of cyclones 70. Although not essential to the invention, in this embodiment the first set of cyclones 70 contains more cyclones (ten in total) than the second set of cyclones 72 (five in total). Each cyclone 50 of both sets has a longitudinal axis C which is inclined downwardly and towards the longitudinal axis Y of the outer wall 52. However, to enable a greater degree of nesting of the second set of cyclones into the first set of cyclones, the longitudinal axes C_2 of the second set of cyclones 72 are all inclined at to the longitudinal axis Y of the outer wall at a shallower angle than the longitudinal axes C_1 of the first set of cyclones 70.

Circulating air is discharged from the secondary cyclones 50 via the vortex finders 60, and these are defined by a short cylindrical tube that extends downwardly into an upper region of a respective cyclone 50. Each vortex finder 60 leads into a respective vortex finger 80 defined by an exhaust plenum or manifold 82 located at the top of the separating apparatus 12 that serves to direct air from the outlets of the cyclones to a central aperture 84 of the manifold 82. The aperture 84 constitutes the upper opening of a central duct 88 of the separating apparatus into which a filter member 86 is received. In this embodiment, the filter member 86 is an elongate sock filter that extends down into the central duct 88 along the axis Y, the duct 88 being delimited by a third cylindrical wall 90 defined by the cyclone supporting structure 42.

The third cylindrical wall 90 is located radially inwardly of the second cylindrical wall 32 and is spaced from it so as to define a further annular chamber 92 which extends down to the bin base 26. An upper region of the cyclone support structure 42 provides a cyclone mounting arrangement 93 to which the cone openings 52 of the cyclones of the second cyclonic separating 22 are mounted so that they communicate with the interior of the support structure 42. In this way, in use, dust separated by the cyclones 50 of the second cyclonic separating unit 22 is ejected through the cone openings 52 into the

chamber 92 where it can collect prior to being emptied. The chamber 92 therefore form a 'fine dust collector' of the second cyclonic separating unit 22 that can be emptied simultaneously with the dust collecting zone of the first cyclonic separating unit 20 when the base 26 is moved to an open position.

During use of the vacuum cleaner, dust laden air enters the separating apparatus 12 via the bin inlet 36. Due to the tangential arrangement of the bin inlet 36, the dust laden air follows a helical path around the outer wall 24. Larger dirt and dust particles are deposited by cyclonic action in the first annular chamber 34 and collect at the bottom of the chamber 34 in the dust collecting bin. The partially-cleaned dust laden air exits the first annular chamber 34 via the air-permeable shroud 38 and enters the second annular chamber 40. The partially-cleaned air then passes into the air channels 74 of the cyclone support structure 42 and is conveyed to the air inlets 50c of the first and second sets of cyclones 70, 72. Cyclonic separation is established inside the two sets of cyclones 70, 72 in order to separate the relatively fine dust particles still entrained within the airflow.

The dust particles separated from the airflow by the first and second set of cyclones 70, 72 are deposited in the third annular chamber 92. The further cleaned air then exits the cyclones via the vortex finders 60 and passes into the manifold 82, from which the air enters the sock filter 86 in the central duct 88 and from there passes into an outlet passage 94 of the cyclone separator. As can be seen, the filter 86 comprises an upper mounting portion 86a and lower filter portion 86b that carries out the filtering function and so is formed from a suitable mesh, foam or fibrous element. The upper mounting portion 86a supports the filter portion 86b and also serves to mount the filter 86 within the duct 88 by engaging with the aperture 84 of the exhaust manifold 82. The mounting portion 86a defines a circular outer rim that carries a sealing member 96, for example in the form of an o-ring, by which means the mounting portion 86a is received removably, but securely, within the aperture 84 of the manifold. Although not shown here, it should be appreciated that the filter 86 could also be provided with a locking mechanism if it is desired to more securely hold the filter in position. For example, the filter mounting

portion 86a could carry a twist-lock fitting formation so that the filter could be twisted in a first direction to lock it into position within the aperture 84, and twisted in the opposite direction to unlock the filter.

The mounting portion 86a also includes an annular upper section provided with apertures or windows 97 distributed around its circumference, the windows 97 providing an airflow path for air to enter the interior of the filter 86. Air therefore flows into the filter 86 in a radial direction through the windows 97, following which the air flows down the interior of the filter 86 and then exits through the cylindrical filter media in a radial direction. After flowing out of the filter 86, the cleaned air then travels up the outlet passage 94 and exhausts the separating apparatus 12 via an exit port 95 located at the rear of the separating unit 12.

Having described the general function of the separating apparatus 12, the skilled reader will appreciate it includes two distinct stages of cyclonic separation. First, the first cyclonic separating unit 12 comprises a single cylindrical cyclone 20 having a relatively large diameter to cause comparatively large particles of dirt and debris to be separated from the air by virtue of the relatively small centrifugal forces. A large proportion of the larger debris will reliably be deposited in the dust collecting zone 34.

Second, the second cyclonic separating unit 22 comprises fifteen cyclones 50, each of which has a significantly smaller diameter than the cylindrical first cyclone unit 20 and so is capable of separating finer dirt and dust particles due to the increased speed of the airflow therein. The separation efficiency of the cyclones is therefore considerably higher than that of the cylindrical first cyclone unit 20.

It will be appreciated that the first and second cyclonic separating units function to remove dirt particles from the air flow and deposit them in the dust collecting zone 34 from which they may be removed by the openable door 26. Having described the operation of the cyclonic separator in detail, the description will now focus on the mechanism by which the cyclone separating apparatus can be emptied and, moreover,

how the outer bin may be removed from the separating apparatus by a user to allow access to other components of the cyclonic separator such as the shroud for cleaning.

Figure 3a, 3b, 3c and 3d illustrate, in overview, the procedure by which the door 26 of the separating apparatus 12 is opened in order for dirt to be emptied, and the way in which the bin 24 of the separating apparatus 12 may be removed so that a user is able to clean the bin 24, and also the shroud 38, as part of periodic maintenance.

The bin door 26 may be opened by means of an actuator 98 that is provided on the main body. In this embodiment, the actuator 98 is slidably mounted to a spine component 99 of the main body which lies adjacent to the bin 24 and extends in an upright direction between the motor housing 5 and a horizontal battery mount member 100.

In Figure 3a, the actuator 98 is in a first position, in which state the bin door 26 is locked closed against the lower end of the bin 24. The actuator 98 is movable downwards from this position into a second position, as shown in Figure 3b, which causes the bin door 26 to swing away from the bin 24, thereby allowing the bin 24 to be emptied. The actuator 98, once released, is biased to return to the first position, as will be described.

During circumstances when the bin door 26 is opened, as in Figure 3b, the actuator 98 is movable a second time from the first position into the second position in which state the actuator 98 causes the bin 24 to be disengaged from the separating apparatus 12. Figure 3c shows the actuator 98 in the second position during a second operation. It will be appreciated that the bin is disengaged slightly from its engaged position so as to be 'presented' to a user so that a user can pull the bin 24 away from the rest of the separating apparatus 12.

Figure 3d shows the bin 24 removed completely from the separating apparatus 12, with the actuator 98 moved back into the first position. In summary, the actuator 98 is operable to carry out a sequence of two operations: a first operation to open the bin door

26 and a second operation to disengage the bin 24 from the separating apparatus 12. The benefit of this is that the user need only manipulate a single actuator in order to perform two operations. Ordinarily, the user will more often only need to operate the actuator 98 once in order to open the bin door 26 so as to empty the bin 24. However from time to time, the user may also wish to remove the bin 24 from the separating apparatus 12 in order to clean the shroud 38 of blockages and perhaps to clean the walls of the bin 24. With the invention, the user is simply required to operate the actuator 98 a second time whilst the bin door 26 is opened in order to release the bin 24 from the separating apparatus 12. This provides a simple user interface as there is no need for the user to locate a second actuator in order to remove the bin. Furthermore, the sequence of operation ensures that dirt is emptied from the bin 24 before the bin 24 can be removed from the separating apparatus 12 which has an associated hygiene benefit.

By way of example of a mechanism that embodies the invention, reference will be made to Figures 4 to 9 which show the actuator 98 and its associated actuating mechanism 101 together with the position of the bin 24 and bin door 26 in the positions illustrated in Figures 3a to 3d. Note that Figure 5 shows an enlarged portion of Figure 4. At this point, it should be mentioned that the bin 24 is shown in 'cut-away' form and that the separating apparatus 12 is not shown in order that the actuating mechanism 101 can be illustrated more clearly.

As mentioned above, the actuator 98 is slideably mounted to the spine 99 between a first, upper position and a second, lower position. Note that the actuator 98 is shown in the first position in Figures 4 and 5 and in the second position in Figure 6. The actuator 98 is associated with a primary linkage member 102 that is directly coupled to the actuator 98 and is slidable therewith on the opposite side of the spine 99. The primary linkage member 102 is mounted to the actuator 98 on a pivot pin 104 associated with the actuator 98 and which projects through a slot 106 in the spine 99 and is slidable within the slot 106 through a vertical movement. Movement of the actuator 98 up and down along the spine 99 therefore moves the primary linkage member 102.

The primary linkage member 102 is generally an inverted L-shaped and is mounted to the pivot pin 104 at an elbow portion 108. The primary linkage member 102 further includes a first arm portion 110 that extends from the elbow portion 108 in a downwards direction and bears against an upper end 112a of an intermediate link member 112 in the form of a push rod. The push rod 112 further includes a lower end 112b which bears against the catch 30 of the bin door 26. The actuator 98 therefore is able to act on the catch 30 through the primary linkage member 102 and the push rod 112.

As can be seen by comparing Figures 4 and 5, as the actuator 98 is pushed downwards from the first position to the second position, the primary linkage member 102 also moves in a downward direction thereby acting through the push rod 112 to release the catch 30 on the bin door 30 which enables the bin door 26 to swing away from the bin 24 so that it can be emptied of dirt.

Following the release of the bin door 26, the actuator 98 returns to the first, upper, position assisted by biasing means which, in this embodiment, takes the form of a coil spring 114, although it will be appreciated that other means to return the actuator to the first position are possible such as a resilient rubber member. This position is shown in Figure 7. The spring 114 is connected between a spring mount 116 on an upper part of the spine 99 and a second arm portion 118 of the primary linkage member 102 which extends away from the first arm portion 110 approximately at a right angle.

Figure 8 shows the actuator 98 moved away from the first position towards the second position in order to release the bin 24 from the main body 4, whereas Figure 9 shows the actuator 98 fully depressed into the second position. Referring firstly to Figure 8, when the actuator 98 is moved in a downwards direction for a second operation, the retaining force of the spring member 114 causes the primary linkage member 102 to move angularly in a counter-clockwise direction which moves the first arm portion 110 out of line with the upper end 112a of the push rod 112 and into line with a contact point 120a of a U-shaped bin catch member 120 which is ordinarily engaged with a lug 122 defined

on the lower end of the bin 24. As the primary linkage member 102 is moved further downwards, as shown in Figure 9, the first arm portion 110 of the primary linkage member 102 comes into contact with the contact point 120a of the bin catch member 120 which is then rotated out of engagement with the lug 122 on the bin 24. As the bin catch member 120 rotates, an extension part 120b of the bin catch member 120 contacts the lug 122 which pushes the entire bin 24 in a downwards direction by a small amount so as to break the upper seal of the bin 24. In this manner, the bin 24 is slightly dislodged from its 'home' position following the disengagement of the bin catch member 120 from the lug 122 thereby presenting the bin 24 which acts as a visual cue for the user that the bin 24 may now be removed from the separating apparatus.

Following the release of the bin, the actuator 98 is released so as to return into the first position as shown in Figures 5 and 6. As the primary linkage member 102 is returned to its 'starting' position, an enlarged end 124 of the second arm portion 118 contacts a stop feature 126 of the spine 99 which causes the primary linkage member 102 to move angularly in a clockwise direction thereby moving the end of the first arm portion 110 into alignment with the upper end 112a of the push rod 112 when the bin door 26 is closed. It should be noted at this point that the upper end 112a of the push rod 112 includes an upstanding projection or 'lip' 128 which retains the first arm portion 110 in alignment with the push rod 112 throughout the first push sequence moving from the first position to the second position.

From the above, the skilled person will appreciate that the bin opening mechanism 101 operates to perform two functions sequentially using a single actuating button: a user presses the actuator 98 a first time to open the bin door 26, but the user may also press the actuator 98 a second time when the bin door 26 is in an open position in order to remove the bin 24 from the cyclonic separating apparatus 12. This arrangement provides a simple user interface since a single button does the job of two buttons provided in known handheld vacuum cleaners, such as disclosed in WO2010/061211. It is therefore intuitive to use and, moreover, it is not necessary for the user to remove the separating apparatus from the cleaning appliance before emptying the bin. Furthermore,

such an arrangement is advantageous in terms of packaging because only a single opening mechanism needs to be provided on the vacuum cleaner which therefore allows for a more compact design.

Having described the manner in which the bin door 26 may be opened to release dirt from the separating apparatus 12, and how the bin 24 itself may be removed from the separating apparatus 12, discussion will now focus on the arrangement by which the separating apparatus 12 is connectable with the main body 4 of the vacuum cleaner. In the following description, reference will be made particularly to Figures 10 to 18.

Referring firstly to Figure 10, the main body 4 of the handheld vacuum cleaner is removably connected to the separating apparatus 12 at a mechanical interface 130. The mechanical interface 130 comprises a first interface portion 132 provided on the main body 4 and a second interface portion 134 provided on the separating apparatus 12. In this embodiment, the first interface portion 132 and the second interface portion 134 are substantially circular, although it should be appreciated that this is not essential to the invention as will become apparent in the following description. As can be seen, the air flow from the separating apparatus flows through the interface 130. As will be explained, the first interface portion and the second interface portion are locked together radially about at least a portion of the interface. Since the interlock between the first and second interface portions extends about at least a portion of their circumference, this results in a very strong, but releasable, connection. At the extreme, the two portions can be interlocked continuously about the entirety of the interface. Alternatively, the two portions can be interlocked at multiple discrete points distributed radially about the interface.

In this specific embodiment, the two portions 132, 134 of the mechanical interface 130 are releasably connected by way of an connecting means 136 which includes, at least in part, a ring-shaped resilient member 138 or 'C-clip/circlip'having first and second ends, labelled here as 138a and 138b. The resilient member 138 is shown *in situ* in Figure 10 but is shown in isolation from the main body 4 in Figures 11, 12a and 12b.

Each of the first and second ends 138a, 138b of the resilient member 138 has an enlarged gripping foot 139. In this embodiment the resilient member 138 is polymeric, preferably polycarbonate, although it may also be a different material such as a suitable metal. Plastics are currently preferred due to cost and strength. By virtue of the shape of the resilient member 138 and the material of which it is made, it is resilient radially, in that it is flexible such that its outer diameter may be reduced. Therefore, a force applied to the gripping feet 139 of the resilient member 138 to close the gap between the ends acts to decrease the outside diameter of the resilient member, and the importance of this feature will be explained later.

The resilient member 138 has a generally U-shaped cross section thereby forming a circumferential channel 140 around its outer periphery. A first radial flange 142 provides a first, rear, wall of the channel 140 and a second radial flange 144 provides the front wall of the channel 140. In this particular embodiment, the rear flange 142 is continuous about substantially the entire circumference of the resilient member 138 although, as can be seen particularly clearly in Figure 12a, the continuity of the second flange 144 is interrupted by two cut-outs or 'flats' 146, one on each side of the resilient member 138. It should be appreciated that the flats 146 are not essential to the invention and are provided here in order to provide space within the internal volume of the interface for additional structural features, for example screw bosses. If the flat 146 were omitted, the second flange 144 may be continuous and therefore provide an even stronger connection.

The flats divide the front flange 144 into a first, upper wall portion 148 and first and second lower wall portions 150. The lower wall portions 150 have a different cross sectional profile to the upper wall portion 148, as is shown most clearly in Figure 12b, and as will now be explained.

The upper wall portion 148 comprises inner and outer faces 148a, 148b, both of which are inclined with respect to the rear flange 142, which extends along a vertical plane P

as shown in Figure 12b. In contrast, the lower wall portions 150 also comprise inner and outer faces 150a, 150b, but only the inner face 150a is inclined to the rear flange 142 whereas the outer face 150b is parallel to the rear flange 142 and, thus, the plane P. The cross sectional profile of the front flange 144 enables the mechanical interface to be connected and disconnected, as will now be explained.

Although it is a separate part, the resilient member 138 is captive on the first interface portion 132 of the main body 4 and so is held within an internal chamber 151 defined by the first interface portion. As shown in Figure 13a and 13b, the first interface portion 132 includes a plurality of tabs 152. In this embodiment there are five tabs 152 in total, although the skilled person will appreciate that this is not essential. The tabs 152 are spaced radially around the circumference of the first interface portion 132 and extend inwardly by a short distance. The tabs 132 are spaced from a back plate 154 of the first interface portion 132 which enables the rear flange 142 of the retaining member 138 to be secured behind the tabs 152 such that the tabs 152 sit in the channel 140 of the retaining member 138. This is shown clearly in Figure 13b.

In order to secure the second interface portion 134 to the first interface portion 132, the two interface portions can simply be pressed together. As shown in Figure 14, the second interface 134 portion includes a short tubular section 156 having a smaller diameter than that of the circular profile of the first interface portion 132 so that the second interface portion 134 can be received inside the first interface portion 132. The second interface portion 134 includes an inwardly extending radial lip 158 that connects to the resilient member by engaging over the upper wall portion 148 and the lower wall portions 150. Thickened segments 159 of the lip 158 fit between the tabs 152 and have the effect of reducing the axial length of the interface 130.

As the second interface portion 134 is pushed into enagement with the first interface portion 132, the leading edge of the lip 158 engages the angled outer faces 148a, 150a of the front wall 144 of the resilient member 138. This radially compresses the resilient member 138 and therefore allows the lip 158 of the second interface portion 134 to

engage into the channel 140 of the resilient member 138. It should be noted that Figure 14 shows the first interface portion and the second interface portion in the fully engaged position such that the interface 130 extends about the longitudinal axis L.

When in the fully engaged position, the first and second interface portions 132, 134 are securely locked together and cannot be pulled apart freely. The resilient member interlocks the first and second interface portions at radial regions that extend about the interface. As illustrated by the enlarged view of the interlock between the two interface portions 132, 134 in Figure 14, the lower wall portions 150 of the resilient member 138 and the lip 158 of the second interface portion 134 engage at a plane P which is parallel to the rear wall 142 of the resilient member 138. Therefore, by virtue of the complementary profiles of the resilient member 138 and the second interface portion 134, the lip 158 cannot simply be pulled out of engagement from the channel 140 of the resilient member 138. Furthermore, the first and second interface portions 132, 134 interlock at multiple points or regions that extend radially about the periphery of the portions which results in a very strong connection in multiple 'planes', as is illustrated by the planes P1 to P4 in Figure 13a. The resilient member therefore acts as a mechanical fastener.

It should be appreciated that if the outer face 150b of the resilient member 138 and the lip 158 were angled as opposed to being parallel with the back plane P, then it would be possible for the interface to be split apart relatively easily since the outer face 150b and the lip 158 profiles would cause the resilient member 138 to be 'bumped out' under a predetermined separation force pulling the interface components apart. In such an arrangement, then it would be necessary to include an interference means to the connection arrangement which would selectively prevent the resilient member from compressing in the radial direction.

In the illustrated embodiment, however, a tool is required to enable the first interface portion 132 and the second interface portion 134 to be separated, as will now be explained with reference to Figures 15 to 18. A tool 160 for separating the main body 4

from the separating apparatus 12 comprises a handle 162 and a working end 164 that extends obliquely to the handle. The working end 164 defines a forked interface for engaging the resilient member 138 and includes two spaced apart wedge shaped forks 166 that may be inserted through an aperture (not shown) in the second interface portion 134 so as to engage the gripping feet 139 of the resilient member 138. The insertion point for the tool is shown by the arrow T in Figure 16.

The gripping feet 39 provide angled faces to complement the forks 166 of the tool 160. The tool 160 therefore acts to squeeze the gripping feet 139 towards one another thereby radially compressing the resilient member 138. As shown in Figure 17, insertion of the tool 160 has compressed the resilient member 138 such that the lower wall portions 150 are pulled clear of the lip 158 of the second interface portion 134. In order to minimise the force required to compress the resilient member, a plurality of running ribs 147 are provided on the rear wall to bear against an adjacent part of the first interface portion 132. The running ribs 147 reduce the surface area of the resilient member 138 that is in contact with the first interface portion and so reduces the friction between these parts. Of particular note is running rib 149 which projects further from the resilient member than the other running ribs 147. Running rib 149 locates with a key way (not shown) on the first interface portion and therefore stops the resilient member from turning angularly in use which may otherwise impair the function of the resilient member 138.

With the resilient member 138 compressed in this way, the second interface portion 134 can be pulled away from the first interface portion 132. The most effective way to achieve this is for the user to 'peel' the lower parts of the two interface portions 132, 134 away from one another thereby levering the upper part of the second interface portion 134 away from the angled catch faces of the first interface portion 132. This separating movement is shown in Figure 18.

The connecting arrangement between the first and second interface portions 132, 134 provides a particularly robust configuration of securing the separating apparatus 12 to the main body 4 since the two interface portions are locked together across a radial

span. In this specific embodiment a plurality of engagement regions or points distributed are radially spaced around the mechanical interface. This provides an interlocking connection between the two interfacing portion in multiple planes which results in there being very little 'play' between the parts. This provides a very secure connection and a high quality feel to the cleaning appliance. As an alternative to discrete points, or regions, of locking between the interface components, there may be provided a continuous locking interface over a significant portion of the circumference of the interface; in this case the separate tabs 152 would in effect be a single arcuate tab.

Although the interface has been described in the context of connecting a main body of a vacuum cleaning appliance to an associated separating apparatus, it should be appreciated that the same connecting scheme could also be used to connect together any two functional components of a vacuum cleaning appliance or, indeed any household appliance. For example, the same connection scheme could be used to connect a cleaner head to a wand or hose assembly, two parts of a wand/hose assembly, or even the base and a removable upper unit of a fan assembly, for example.

The skilled person will appreciated that variants and modifications to the specific embodiment described are feasibly within the scope of the invention as defined by the claims. Some have been mentioned above; others will be explained below. For example, it should be appreciated that the specific overall shape of the separating apparatus can be varied according to the type of vacuum cleaner in which the separating apparatus is to be used. For example, the overall length of the separating apparatus can be increased or decreased with respect to the diameter of the separating apparatus. Also, although the cyclonic separation is currently the preferred method of separating contaminants in the airflow within the context of the invention, a different means of dust separation could be used, for example a bagged separation system which does not involve cyclonic airflows or even a more conventional bagged system.

In the embodiments of Figures 10 to 17, a secure means of connection between the two interface components is achieved by way of a radially compressible resilient member.

The skilled person will, however, appreciate that other components would achieve the same purpose, an example of which is shown in Figures 24a and 24b. Note that parts similar to the previous embodiments are referred with like reference numerals. In this arrangement, instead of a c-shaped resilient member 138 as in previous embodiments, the connection means is in part embodied by first and second opposed resilient members or 'catches' 300. Each catch is generally semi-circular in shape and upper ends 300a of the catches are pivotably mounted at pivot points 302 on the first interface portion 132. Each catch 300 is movable inwardly by way of a respective user-operable button 304 and is biased outwardly, in this embodiment, by means of a spring 306.

In Figure 24a, the catches 300 are in a locked position and are therefore in engagement with the lip 158 of the second interface portion. In this position, therefore, the first and second interface portions 132, 134 are locked together. In Figure 24b, the catches 300 are in a second position. In this position, the buttons 306 are actuated, as indicated by the arrows A, which moves the catches 300 angularly about their respective pivots 302. In effect, therefore, the outer dimension of the catches 300 reduces so that they disengage with the lips 158 provided by the second interface portion 134. The catches 300 function in a comparable manner to the resilient member 138 to compress radially in order to release the interlock between the first and second interface portions 132, 134, so that the interface can be split apart. In the same way as the embodiment of Figures 10 to 17, the first and second interfaces are locked together in a radially distributed manner.

Returning to the arrangement discussed specifically in relation to Figures 3 to 9, it should be appreciated that one specific mechanism has been described by which a vacuum cleaner, and particularly an handheld vacuum cleaner, may be provided with a single actuating mechanism that enables both the bin door to be opened and also enables the bin to be released from the separating apparatus itself. However, within this concept, the skilled person will appreciate that other mechanisms may be devised that perform the same function.

In the arrangement described specifically in relation to Figures 10 to 17, the resilient member provides a convenient mechanism by which an interlocking interface may be provided between mating portions of the main body and the separating apparatus at radially extending region or regions about the circumference of the mating portions, thereby providing a robust connection between the main body and the separating apparatus that is resistant to torsion and bending forces. However, other mechanisms are feasible within the broad inventive concept defined by the claims.

The invention has been described within the context of a handheld vacuum cleaner which may also form part of a stick-vac cleaner. However, the skilled person will appreciate that the invention may also apply to other types of vacuum cleaners, for example upright vacuum cleaners and cylinder vacuum cleaners (also referred to as canisters or barrels.

By way of example, in Figures 19 to 22 an upright vacuum cleaner 210 comprises a main body 211 which includes a motor and fan unit (not shown) and a pair 212 of wheels. A cleaner head 213 is pivotably mounted on the lower end of the main body 211 and a dirty air inlet 214 is provided in the underside of the cleaner head 213 facing the floor surface. The main body 211 further includes a spine 215 which extends vertically upward and merges into a hand grip 216. The hand grip 216 can be manipulated by a user to manoeuvre the vacuum cleaner 210 across a floor surface. The main body 211 further includes outlet ports 217 for exhausting air from the vacuum cleaner 210.

Separating apparatus 218 is releasably held on the main body 211 of the vacuum cleaner 210. The separating apparatus 218 comprises a separator 219 and a collecting chamber 220. The separating apparatus 218 is supported on the main body 211 above the outlet ports 217 and lies adjacent the spine 215. The interior of the separating apparatus 218 is in communication with the dirty air inlet 214 through ducting 221 adjacent the spine 215. The separating apparatus 218 can be removed from the main body 211 for emptying and for maintenance.

In use, the motor and fan unit draws dirty air into the vacuum cleaner 210 via the dirty air inlet 214. The dirty air is carried to the separating apparatus 218 via the ducting 221 adjacent the spine 215. The separating apparatus 218 includes an upstream cyclone 222 in the collecting chamber 220. An air inlet 223 is formed in the cylindrical side wall 224 of the chamber 220. When the separating apparatus 218 is held on the main body 211 of the vacuum cleaner 210, the air inlet 223 is in communication with the dirty air inlet 214 and forms a communication path between the ducting 221 adjacent the spine 215 and the interior of the upstream cyclone 222. The air inlet 223 is arranged tangentially to the upstream cyclone 222 so that the incoming air is encouraged to follow a helical path around the interior of the upstream cyclone.

A shroud 225 is located inwardly of the cylindrical wall 224 of the upstream cyclone 222. The shroud 225 comprises a cylindrical wall having a plurality of through-holes. The shroud 225 provides a communication path between the upstream cyclone 222 and a downstream cyclone assembly 226.

The downstream cyclone assembly 226 comprises a plurality of downstream cyclones 227 arranged in parallel. In this embodiment, seven downstream cyclones 227 are provided. Each downstream cyclone 227 is in communication with a downstream collector 228 forming part of the collecting chamber 220. The downstream collector 228 has a collector wall 229 located inwardly of the shroud 225. Each of the downstream cyclones 227 has a diameter smaller than that of the upstream cyclone 222 and so are able to separate smaller particles of dirt and dust from the partially-cleaned airflow than the upstream cyclone 222. Separated dirt and dust exits the downstream cyclones 227 and passes into the downstream collector 228.

Cleaned air then flows back up through the downstream cyclones 227 and enters a duct 230. The cleaned air then passes from the duct 230 sequentially through a pre-motor filter 231, the motor and fan unit, and a post-motor filter 232 before being exhausted from the vacuum cleaner 210 through the outlet ports 217.

A handle 233 is located over the separating apparatus 218 and is arranged to allow a user to carry the vacuum cleaner 210. When the separating apparatus 218 is released from the main body 211, as is shown in Figure 20, the handle 233 may also be used to carry the separating apparatus alone. With reference to Figure 20, a user-operable button 234 is located on the separating apparatus 218 at the upper end portion of the handle 233. By depressing the button 234, the user releases a catch holding the separating apparatus 218 to the main body 211. The user can then place the separating apparatus 218 over a suitable dirt and dust receptacle such as a dustbin for emptying of dirt and dust that has been collected in the collecting chamber 220.

Referring now to Figures 21 and 22, the collecting chamber 220 includes a closure member which, in this embodiment, comprises the base 235 of the collecting chamber. The base 235 is pivotably mounted on the lower end of the cylindrical side wall 224 by means of a hinge 236. The base 235 is retained in a closed position (as shown in Fig 21) by means of a first catch 237. The first catch 237 includes a lug 238 and a flange 239. In this embodiment, the lug 238 and flange 239 are integral with the base 235 and extend from it. The lug 238 is inwardly directed and is received by a cooperating groove 240 formed in the external surface of the cylindrical side wall 224. The lug 238 is formed from a resilient material which biases the lug into the groove 240 when the base 235 is in the closed position. The flange 239 extends outwardly and upwardly from the lug 238.

The separating apparatus 218 further includes first releasing means in the form of an actuator 241. The actuator 241 comprises a first push member 242 and a second push member 243 which are generally in the form of elongated rods. The first push member 242 is arranged at the upper end of the rear of the separating apparatus 218, adjacent some of the downstream cyclones 227. The uppermost end portion of the first push member 242 includes the user-operable button 234 at the upper end of the handle 233. The button 234 is biased upwardly by a spring (not shown). The first push member 242 is arranged to be slideably movable by depression of the button 234 against the bias of

the spring. The first push member 242 is supported by a guide 244 that constrains the first push member to slide in a generally vertical direction, namely towards the base 235 of the collecting chamber 220.

The second push member 243 is arranged on the lower portion of the rear of the separating apparatus 218, adjacent the collecting chamber 220. The second push member 243 is supported by a plurality of guides 245a, 245b, 245c that constrain the second push member 243 also to slide in a generally vertical direction. An upper portion of the second push member 243 comprises a cover 246 which, in this embodiment, takes the form of a triangular-shaped member which extends to one side of the elongate rod. A lower portion of the second push member has a thick dog-leg shape for increased robustness. The second push member 243 is not biased in any direction. The lower end portion of the second push member 243 is arranged to abut the flange 239 of the first catch 237. In this embodiment, the second push member 243 is interposed between the flange 237 and the wall 224 of the collecting chamber 220.

When a user decides to empty the collecting chamber 220 of the separating apparatus 218, he pushes the button 234 against the force of the spring, as shown in Figure 20. The guide 244 constrains the first push member 242 to slide downwardly towards the collecting chamber 220 into a lower second position. The lower end of the first push member 242 normally abuts the upper end of the second push member 243, and so the action of pushing down the first push member also urges the second push member downwardly into a lower second position. The bottom end of the second push member 243 is forced against the flange 239 of the first catch 237 and applies an outwardly-directed force to it. The lug 238, being integral with the flange 239, also experiences an outwardly-directed force, which force urges the lug 238 away from the groove 240. Thus, the first catch 237 holding the base 235 to the cylindrical side wall 224 of the collecting chamber 220 is released. The action of the second push member 243 against the flange 239 forces the base 235 to swing open on its hinge 236, as is shown in Figure 22. The dirt and dust collected in the collecting chamber 220 can thus be emptied

conveniently and efficiently. The upstream cyclone 22 and the downstream collector 28 are emptied simultaneously during this process.

When the user releases pressure on the button 234, the spring urges the button and the first push member 242 upwards into their original positions. The second push member 243 is not biased and so remains in its lower second position as shown in Figure 21. In moving the second push member 243 from its original position to its lower position, the cover 246 associated with the second push member slides downwardly to reveal a second catch 247, which was concealed behind the cover. This second catch 247 holds the collecting chamber 220 to the separator 219. Activation of this second catch 247 therefore enables the collecting chamber 220 to be removed from the separator 219.

Instead of the second catch 247, the separating apparatus 218 of Figures 19 to 22 may alternatively be configured so that the user-operable button 234 also acts to release the collecting chamber 220 from the separator 219. A schematic illustration of such an arrangement is shown in Figures 23a-23d in which the same reference numerals are used.

In Figure 23a, the collecting chamber 220 is attached to the separator and the first push member is in a deactivated position. In this position, a slidable lug 300 that forms part of the collecting chamber is retained in a recessed position behind the second push member 243. In this condition the base 35 is in the position as shown in Figure 21.

In Figure 23b, a user has depressed the button 243 which slides the first push member 242 in a downwards direction and also, therefore, the second push member 243 which opens the base 235. This position corresponds to the position of the base 235 shown in Figure 22. In this position, the lug 300 is still retained in a recessed position by the presence of the first push member 242.

In Figure 23c, the first push member has returned to its original position which allows the lug 300 to deploy from the collecting chamber by virtue of the biasing means 302 which, in this arrangement, is in the form of a spring 302.

Figure 23d shows the movement of the first push member 242 during a second actuation. As can be seen, the lower end of the first push member 242 engages the lug 300 after movement of a short distance. Further downwards movement of the first push member 242 bears against the lug 300 and, in turn, against the collecting chamber 220 itself and so urges the collecting chamber 220 to disengage from the separator 219.

It will therefore be appreciated that the bin opening and bin release arrangement of the vacuum cleaner in Figures 19 to 23 functions similarly to the arrangement described in Figure 1 to 9 in that a single user-operable button is operable to perform two functions sequentially: a first press of the button 234 opens the base 235 of the dirt collecting chamber 220 and, once the base 235 is open, a second press of the button 234 releases the collecting chamber 220 from the separator 219.

CLAIMS

1. A cleaning appliance comprising a main body and a separating apparatus including a dirt collector having a base that is openable to allow the dirt collector to be emptied, wherein the cleaning appliance includes an actuator that is operable sequentially such that, during a first operation, the actuator causes the base to be opened and, during a second operation, the actuator causes the dirt collector to disengage from the separating apparatus.

2. The cleaning appliance of claim 1, wherein the base of the dirt collector is openable when the separating apparatus is coupled to the main body.

3. The cleaning appliance of claim 1 or claim 2, wherein the actuator is a user-operable button.

4. The cleaning appliance of any one of claims 1 to 3, wherein the actuator includes a linkage member which, during the first operation, actuates a push rod that is engagable with the base.

5. The cleaning appliance of claim 4, wherein the linkage member is further operable, during the second operation, to engage a release member on the main body for retaining a lug on the dirt collector.

6. The cleaning appliance of claim 5, wherein the linkage member is rotatable between a first angular position in which the linkage member engages with the push rod and a second position in which the linking member engages with the release member.

7. The cleaning appliance of claim 6, wherein the linkage member rotates from the first to the second position after completion of the first operation of the actuator.

8. The cleaning appliance of claim 7, wherein the linkage member rotates from the first to the second position during the second operation of the actuator.

9. The cleaning appliance of any of claims 6 to 8, wherein the linkage member is biased into the second angular position.

10. The cleaning appliance of claim 9, wherein the pushrod includes a lip to retain the linkage member in the first angular position during the first operation of the actuator.

11. The cleaning appliance of claims 5 to 10, wherein during the second operation the release member is moved out of engagement with the lug on the dirt collector so as to allow the dirt collector to be disengaged from the separating apparatus.

12. The cleaning appliance of claim 11, wherein the release member includes a projection that, during the second operation, moves in synchronisation with the release member to push the lug away from the main body therefore to present the dirt collector for a user to remove from the separating apparatus.

13. The cleaning appliance of any of claims 1 to 12, wherein the main body includes a spine against which the dirt collector abuts when the separating apparatus is coupled to the main body.

14. The cleaning appliance of claim 13, wherein the actuator is slidably mounted to the spine.

15. The cleaning appliance of any of the preceding claims, wherein the actuator is arranged to be accessible from either side of the vacuum cleaner.

16. The cleaning appliance of any of the preceding claims, wherein the separating apparatus includes a cyclonic separator.

17. The cleaning appliance of claim 1, wherein the base of the dirt collector is openable only when the separating apparatus is decoupled from the main body.

18. The cleaning appliance of claim 17, wherein the actuator is also operable to release the separating apparatus from the main body.

19. The cleaning appliance of claims 17 or 18, wherein the actuator for opening the base and releasing the dirt collector from the separating apparatus is located on the separating apparatus.

20. A cleaning appliance as hereinbefore described with reference to or as illustrated in the accompanying drawings.

5

INTELLECTUAL PROPERTY OFFICE

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Claims searched:	1-20	**Date of search:**	18 March 2013

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	WO 2008/009891 A1 (Dyson)
A	-	WO 2010/061211 A2 (Dyson)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

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The following online and other databases have been used in the preparation of this search report

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(54) Improved cyclonic chamber for air filtration devices

(57) A cyclonic chamber (1) for use in air filtration devices (2). The chamber (1) includes an apex (3) opposite a base (4) with sidewalls (5) extending therebetween. The cyclonic chamber (1) is preferably parabolic in cross-section or tubular with a hemi-spherical cap. The base (4) contains an outflow passage (12) and a conical filter (9) extending therefrom. An inflow passage (13) is provided proximate the apex (13). The inflow and outflow passages (13,12) are parallel but not aligned. The chamber interior is smooth. The smooth interior and offset relationship of the inflow and outflow passages (13,12) causes air to take a cyclonic path between the inflow passage (13) and the filter (9). Debris in the airstream is pushed outward - away from the filter (9) - by centripetal force. Eddies form proximate the base (4). Debris escapes the airstream there, where it either remains or, depending upon the chamber's orientation relative to gravity, falls back into the airflow where it is again directed away from the filter (9).

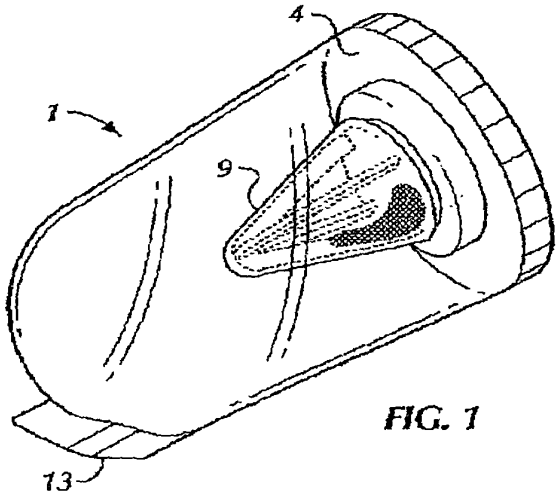


FIG. 1

EP 2 308 360 A2

Description

Background of the Invention

Cross-Reference to Related Applications

[0001] This application is a continuation-in-part of pending U.S. patent application, serial no. 12/800,569, which is hereby incorporated by reference in its entirety.

[0002] **Field of the Invention:** The invention relates to vacuums in general and to cyclonic vacuums in particular.

[0003] **Prior Art:** Cyclonic vacuums are well know in the art. For example, U.S. Patent 4,373,228 to Dyson discloses a cyclonic vacuum. Such vacuums offer advantages over traditional vacuums in that they either require no conventional filter or, more commonly, the cyclonic action keeps dust and dirt away from the conventional filter, thereby preventing it from clogging. This tends to both prolong the life of the conventional filter and prevent a decline in the overall strength of the vacuum as the filter clogs. However, many cyclonic designs impede vacuum strength. In most cyclonic designs, cyclonic motion is imparted by configuring the air to enter the cyclonic chamber at a significant angle relative to the path the air exits the cyclonic chamber. This angular or tangential entry creates a vortex within the cyclonic chamber. However, the hard turn in the air path necessarily slows the flow of air as it enters the cyclonic chamber. Slowing the flow of air lessens the strength of the vacuum. As a result and with all other things being equal, the suction of most cyclonic vacuums will be weaker than the suction provided by a conventional vacuum with a similar motor and fan. The length of the passage through which air must pass increases resistance, slowing the air and weakening the strength of the vacuum. Thus, the addition of attachments to any vacuum will reduce its strength. This weakening is enhanced when the attachment is added to a cyclonic vacuum wherein the cyclonic flow is induced by tangential entry to the cyclonic chamber.

[0004] In other prior art cyclonic designs, cyclonic motion is imparted via a curved nozzle. These vacuums have their own associated problems. In such vacuums, the air inflow passage leads into a nozzle which extends into the cyclonic chamber. As air enters the nozzle and into the cyclonic chamber, the curvature of the nozzle causes the air to bit the side of the wall at an angle, creating cyclonic motion. However, because the body of the nozzle itself extends into the cyclonic chamber, it acts as a physical obstruction to the cyclonic motion of the air. This in turn substantially inhibits and/or destroys the cyclonic motion and slows the flow of the eir. As a result, the suction strength of the vacuum is weakened.

[0005] In view of the foregoing, a cyclonic vacuum meeting the following objectives is desired.

Objects of the Invention

[0006] It is an object of the invention to provide a cyclonic vacuum.

[0007] It is another object of the invention to provide a cyclonic vacuum comprising an improved inflow nozzle that does not act as a physical obstruction to the cyclonic motion of air.

[0008] It is another object of the invention to provide a cyclonic vacuum in which suction is optimized.

[0009] It is still another object of the invention to provide a cyclonic vacuum wherein air does not slow substantially upon entering the cyclonic chamber.

[0010] It is yet another object of the invention to provide a cyclonic vacuum capable of receiving a variety of vacuum attachments.

[0011] It is still another object of the invention to provide a cyclonic vacuum wherein the path of air entering and exiting the cyclonic chamber are substantially parallel.

[0012] It is another object of the invention to provide a Cyclonic vacuum wherein the interior of the cyclonic chamber is substantially smooth.

[0013] It is still another object of the invention to provide a cyclonic vacuum wherein the interior of the cyclonic chamber is substantially free of obstructions.

[0014] It is yet another object of the invention to provide a cyclonic chamber that can be used in a variety of vacuums.

Summary of the Invention

[0015] The invention is a cyclonic chamber for use in vacuums and other air filtration devices. In a first preferred embodiment, the cyclonic chamber comprises an apex opposite a base with sidewalls extending therebetween. The cyclonic chamber will preferably be generally parabolic in cross-section or generally tubular in cross-section with a hemi-spherical cap at the apex end. The base contains an outflow passage. A conical filter extends from the outflow passage. The filter and outflow passage are configured so that during operation air cannot pass out of the cyclonic chamber without passing through the filter. An inflow passage is also provided at the apex end of the chamber. The inflow passage and the outflow passage are parallel but not aligned. The interior of the cyclonic chamber is substantially smooth. The smooth interior walls of the cyclonic chamber in combination with the offset relationship of the inflow and outflow passages will cause the air in the chamber to take a cyclonic path between the inflow passage and the fitter. Debris entrained in the airflow will be pushed to the exterior of the chamber - away from the filter - by centripetal force. Eddies will form in the cyclonic path proximate the base of the chamber. Debris will escape the airflow there. Debris that escapes will either remain at the base or, depending upon the orientation of the chamber relative to gravity, fall back into the airflow where it will again be directed away from the filter.

Dyson Ex1020
Page 1350

[0016] In another preferred embodiment of the invention, the construction of the cyclonic chamber will be similar to the one discussed above, with the following deviations: the curved chamber will comprise a recessed cavity. In construction, the recessed cavity will be situated external to the cyclonic airflow path within the chamber. Positioned within this cavity will be a curved inflow nozzle, said nozzle in turn being in communication with the inflow passage. As the nozzle is positioned outside of the air flow in the chamber, it will not act as a physical obstruction to the cyclonic motion of the air.

Brief Description of the Drawings

[0017]

Figure 1 is a perspective exterior view of a preferred embodiment of a cyclonic chamber.

Figure 2 is a cut-away top view of the cyclonic chamber of figure 1.

Figure 3 is a cut-away side view of the cyclonic chamber of figure.

Figure 4 is a perspective view of a hand-held vacuum containing a preferred embodiment of a cyclonic chamber.

Figure 5 is a cut-away side view of another hand-held vacuum containing a preferred embodiment of a cyclonic chamber.

Figure 6A depicts a conventional prior art curved nozzle.

Figure 6B depicts an internal view of a prior art cyclonic chamber, depicting the conventional positioning of the curved nozzle of Figure 6A.

Figure 7 depicts a perspective view of a preferred embodiment of a hand held vacuum containing a preferred embodiment of the cyclonic chamber and curved nozzle of the present invention.

Figure 8 is an exploded view of Figure 7.

Figure 9 is an interior view of a preferred embodiment of the cyclonic chamber.

Figure 9A is an interior view of a preferred embodiment of the cyclonic chamber depicting the nozzle flap in the closed position.

Figure 9B is an interior view of a preferred embodiment of the cyclonic chamber, depicting the nozzle flap in the slightly open and angled position, with the arrows further depicting the cyclonic path.

Figure 10 is a perspective rear-end view of a preferred embodiment of the cyclonic chamber.

Figure 11 is a front end view of a a preferred embodiment of the cyclonic chamber.

Figure 12 is a cross-sectional view of a preferred embodiment of the cyclonic chamber, taken along lines A-A of Figure 9.

Figure 13 is perspective view of one preferred embodiment of a filter capable of being utilized in the cyclonic chamber.

Detailed Description of the Invention

[0018] The invention comprises a cyclonic chamber 1 for a vacuum 2. A first preferred embodiment of chamber 1 will be discussed, followed by a second preferred construction. In a first preferred construction, cyclonic chamber 1 has an apex 3 opposite a base 4 and walls 5 extending therebetween. Cyclonic chamber 1 is either generally parabolic in cross section or generally tubular with a hemi-spherical cap at the apex end. The interior surface 6 of walls 5 and apex 3 are substantially smooth and free of obstructions. Extending inwardly from base 4 is an outflow passage 12, which terminates in an outflow aperture 7 that allows air to exit cyclonic chamber 1. Outflow passage 12 will preferably separate outflow aperture 7 from base 4. In the preferred embodiment, outflow aperture 7 will lead to a fan 8 which will generate suction for vacuum 2. Positioned over outflow passage 12 and outflow aperture 7 and extending into cyclonic chamber 1 is a filter 9. Filter 9 will preferably be conical or parabolic in cross section. The exterior of filter 9 will also preferably be substantially smooth. Any supporting ribs 10 and the like will preferably be on the interior of filter 9. Outflow passage 12, outflow aperture 7 and filter 9 are preferably centrally positioned in cyclonic chamber 1. Filter 9 should be configured and positioned so that air cannot pass from cyclonic chamber 1 to outflow passage 12 without passing through filter 9.

[0019] An inflow aperture 11 is provided proximate apex 3. Inflow aperture 11 is preferably elliptical in cross section. It will be appreciated that although inflow aperture 11 is described herein as if it were a two dimensional opening, it will, of course, have some length, such that inflow aperture 11 is in fact a passage, namely inflow passage 13. These passages - inflow passage 13 and outflow passage 12 - are preferably substantially parallel to, but offset from, one another.

[0020] Air entering cyclonic chamber 1 via inflow aperture 11 must travel from inflow aperture 11 to outflow aperture 7. The smooth curvature of walls 5 will entrain air and debris that enters cyclonic chamber 1 in a curving path. This path will follows walls 5 from inflow aperture 11 to outflow aperture 7, imparting a cyclonic flow pattern to the air within cyclonic chamber 1. Because air entering cyclonic chamber 1 is able to change directions gradually across the length of cyclonic chamber 1 instead of changing immediately upon entry into cyclonic chamber 1, the flow of air is not constricted as air enters cyclonic chamber I and airflow remains substantially laminar. This allows air to flow through cyclonic chamber 1 without slowing substantially, which in turn allows more air to flow through vacuum 2 per unit time, thereby enhancing the strength of vacuum 2.

[0021] As noted above, the smooth curvature of walls 5 and, to a lesser degree, apex 3 will cause the air and debris entering cyclonic chamber I to follow a cyclonic pattern as they move around cyclonic chamber 1 from inflow aperture 11 to outflow aperture 7. Centripetal force

Dyson Ex1020
Page 1351

caused by this cyclonic path will push dirt and debris in the airstream outward toward walls 5 and away from filter 9. This will keep dirt and debris from clogging filter 9, increasing its life span while maintaining the strength of vacuum 2.

[0022] The lack of obstructions on walls 5 and apex 3 will prevent eddies from forming in these areas. Similarly, the smooth outer surface of filter 9 will prevent eddies from tormina along its surface. This will serve to maintain laminar cyclonic flow in these areas. However, base 4 of cyclonic chamber 1 is not obstruction free. It is preferably provided with relatively sharp corners where walls 5 meet base 4 end where outflow passage 12 extends from base 4. Other obstacles may be provided there as well. These will cause eddies to form near base 4. Debris will fall out of the cyclonic airflow in these eddies. Depending upon the position of cyclonic housing I relative to gravity, debris falling out of the airstream will either fall onto base 4 or fall back into the airstream. It will be noted that debris falling onto base 4 will be displaced from outflow aperture 7 and filter 9. For debris deposited onto base 4 to travel to filter 9, it would have to pass through the cyclonic airstream, which will tend to drive debris away from filter 9 via centripetal force, as discussed above. Cyclonic chamber I should open, preferably at or proximate to base 4, in order to allow any dust and debris that have been collected in cyclonic chamber 1 to be discarded.

[0023] In the preferred embodiment, fan 8 is positioned immediately downstream from cyclonic chamber 1. However, it will be appreciated that multiple cyclonic chambers maybe provided in sequence, such that one or more cyclonic chambers are provided downstream from cyclonic chamber 1, and a fan is provided downstream from all of the cyclonic chambers.

[0024] In the preferred embodiment, the cyclonic chamber 1 is shown in a hand held vacuum. However, it will be appreciated that cyclonic chamber I could be utilized in any conventional vacuum system or air filtration system.

[0025] In a second preferred embodiment of the invention, chamber 1 will be constructed in substantially the same manner as discussed above *i.e.* chamber 1 will be defined by a base 4, apex 3. and a plurality of sidewalls 5 in which a cyclonic airflow will be generated. However, in this embodiment, sidewalls 5 will contain a recess aperture 5a and a recessed cavity 34 will depend from sidewalls 5 at recess aperture 5a. As will be discussed further below, recessed cavity 34 will house an inflow nuzzle 33 and the positioning and construction of cavity 33 will keep nozzle 33 substantially exterior to the cyclonic airflow path within chamber 1. In a preferred embodiment, cavity 34 will be substantially square or rectangular in shape.

[0026] Continuing with a discussion of the second preferred embodiment of the invention, inflow nozzle 33 will be in communication with inflow passage 13. Inflow nozzle 33 will further comprise a curved body region 33a having a top surface 33e. Inflow nozzle 33 should substantially fill cavity 34, and should further be positioned such that top surface 33e of nozzle 33 substantially closes the recess aperture 5a of sidewalls 5 to prevent air from entering into recessed cavity 34. Inflow nozzle 33 will further terminate into an aperture 33b covered by a directional valve 33c configured to release the air into cyclonic chamber 1 at an angle that is substantially tangential to the curvature of sidewalls 5 of chamber 1. In a preferred embodiment, directional valve 33c will comprise a rubber flap 33d. Rubber flaps are known in the art and often utilized with curved nozzles. See Figure 6A. However, the placement and angled opening of rubber flap 33d is part of the novelty of the present invention, as will be discussed further below.

[0027] In use, cyclonic chamber 1 with recessed cavity 34 may be utilized with any hand held vacuum cleaner body. However, it is to be appreciated that vacuum source need not be limited to vacuum cleaners, and that chamber 1 may be utilized with any appropriate high velocity air purification system.

[0028] In operation, air will enter cyclonic chamber 1 parallel to inflow passage 13 and then into body region 33a of inflow nozzle 33. A cyclonic path will be generated as follows. The force of the air moving through body region 33a ofnozzle 33 will cause valve 33c of nozzle 33 to become partially and directionally opened, such that air will exit nozzle 33 at an angle that is substantially tangential to the curvature of walls 5 of chamber 1. The tangential approach of the air to sidewalls 5 will cause the air to travel in a cyclical path amund chamber I and across top surface 33e of nozzle 33. Thus, the position of nozzle 33 within recessed cavity 34 of chamber 1, the angled partial opening of valve 33c, and the curvature of sidewalls 5 are all preferred features of the invention that, in conjunction with each other, impart a cyclonic flow pattern to the air within chamber 1. After such a cyclonic pattern has been created, nozzle 33 will only minimally interfere with the flow pattern. As discussed above, the positioning and construction of recessed cavity 33 will keep nozzle 33 substantially exterior to the cyclonic airflow path within chamber 1. Furthermore, and as also discussed above, top surface 33e of nozzle 33 will substantially prevent air from entering into recessed cavity 34. In this fashion, the cyclonic air flow pattern will be maintained. To further enhance the cyclical motion of the air, any gaps between nozzle 33 and walls of chamber 5 will preferably beminimized or eliminated to prevent eddies from forming in these areas and to maintain laminar cyclonic flow.

[0029] This above-discussed preferred construction of chamber 1 is in contrast to prior art practices, whereby, as mentioned above, the body of nozzle 33 is not kept out of the airflow and thus acts as a physical obstruction to the cyclonic motion of the air. See Figure 6B. Thus, by keeping the interior surface 6 of sidewalls 5 and apex 3 substantially smooth and free of obstructions and by eliminating any gaps between nozzle 33 and sidewalls 5 a cyclical motion can be more efficiently maintained around filter 9. This in turn will prevent dust, debris, and

Dyson Ex1020
Page 1352

other particles from facing into filter 9 and clogging the same. In this manner, the integrity and life of filter 9 will be preserved.

[0030] Filter 9 may be identical to the one discussed previously, alternatively filter 9 may comprise pleats 9a to provide for an increased surface area for the passage of air, thereby resulting in a more effective clearing.

[0031] Any variety of conventional vacuum attachments 14 may be added upstream of inflow passage 13. Attachments 14 include crevice tools, fixed brushes, and motorized rotational brushes. The addition of any such tool to a vacuum will necessarily weaken the strength of the vacuum because they increase the distance between the exterior of the vacuum and the vacuum source- i.e., the fan. However, because cyclonic chamber 1 is more efficient than comparable cyclonic filters, there will be more vacuum suction available in a vacuum containing cyclonic chamber 1. The net result is that a vacuum containing cyclonic chamber 1 should be better able to provide the necessary suction to effectively operate an attachment than a comparable vacuum containing a convention cyclonic filter.

[0032] Although the invention has been described in terms of its preferred embodiment, other embodiments will be apparent to those of skill in the art from a review of the foregoing. Those embodiments as well as the preferred embodiments are intended to be encompassed by the scope and spent of the following claims.

Claims

1. A Cyclonic dust collection chamber for use with a vacuum source wherein the chamber comprises:

   a base opposite an apex and a plurality of sidewalls extending therebetween, the apex and sidewalls having interior surfaces, wherein the interior surfaces are substantially smooth;
   an outflow passage;
   an inflow passage extending from an inflow aperture contained in the sidewalls proximate the apex and distal from the base, wherein the sidewalls of the chamber contain a recess aperture;
   the chamber further comprising a recessed cavity depending from the sidewalls at the recess aperture;
   an inflow nozzle positioned in the cavity, wherein the inflow nozzle is in communication with the inflow passage;
   the inflow nozzle further having a curved body with a top surface, wherein the curved body terminates in an aperture covered by a directional valve configured to open at an angle selected to discharge air into the chamber in a direction substantially tangential to the curvature of the sidewalls;
   a filter positioned over the outflow passage whereby air exiting the chamber via the outflow passage must pass through the filter; and
   wherein the vacuum source is in operative fluid engagement with the outflow passage whereby operation of the vacuum source will draw air into the chamber via the inflow passage and inflow nozzle, whereby air will be discharged through the directional valve at the selected angle, whereby the air will travel in a cyclonic path around the sidewalls of the chamber and across the top surface of the nozzle, and wherein the recessed cavity is further configured to keep the inflow nozzle substantially exterior to the cyclonic path of the airflow in the chamber.

2. A cyclonic dust collection chamber for use with a vacuum source according to claim 1, wherein the recess aperture is substantially closed.

3. A cyclonic dust collection chamber for use with a vacuum source according to claim 2, wherein the top surface of the nozzle substantially closes the recess aperture.

4. A cyclonic dust collection chamber for use with a vacuum source according to claim 1, wherein the directional valve comprises a rubber flap.

5. A cyclonic dust collection chamber for use with a vacuum source according to claim 1, wherein the recessed cavity is substantially rectangular in shape.

6. A cyclonic dust collection chamber for use with a vacuum source according to claim 1, wherein the filter comprises pleats.

7. A cyclonic dust collection chamber for use with a vacuum source wherein the chamber comprises:

   a base opposite an apex and sidewalls extending therebetween, said apex and sidewalls having interior surfaces, wherein said interior surfaces are substantially smooth,
   an outflow passage extending from said base toward said apex, said outflow passage having an outflow aperture distal from said base; said outflow aperture further having a longitudinal axis:
   an inflow passage extending from an inflow aperture contained in said sidewalls proximate said apex away from said base, said inflow passage having a longitudinal axis, wherein said longitudinal axes of said inflow passage and said outflow passage are substantially parallel and wherein said longitudinal axes of said inflow passage and said outflow passage are not aligned;
   a filter positioned over said outflow aperture whereby air exiting said chamber via said out-

Dyson Ex1020
Page 1353

flow aperture must pass through said filter; and wherein said vacuum source is in operative fluid engagement with said outflow passage whereby operation of said vacuum source will draw air: into said chamber via said inflow passage; through said chamber along a cyclonic path; and out of said chamber via said outflow passage.

8. A cyclonic dust collection chamber for use with a vacuum source according to claim 1 or 7 wherein said interior surfaces of said apex and said sidewalls are substantially free of any aerodynamic obstructions.

9. A cyclonic dust collection chamber for use with a vacuum source according to claim 1 or 8 wherein said chamber is substantially parabolic in cross section.

10. A cyclonic dust collection chamber for use with a vacuum source according to claim 1 or 8 wherein said filter is substantially parabolic in cross section.

11. A cyclonic dust collection chamber for use with a vacuum source according to claim 1 or 10 wherein said filter has an exterior surface that is substantially smooth.

12. A cyclonic dust collection chamber for use with a vacuum source according to claim 1 or 8 wherein said filter is substantially conical.

13. A cyclonic dust collection chamber for use with a vacuum source according to claim 1 or 8 wherein said cyclonic dust collection chamber is contained within a vacuum cleaner.

14. A cyclonic dust collection chamber for use with a vacuum source according to claim 13 further comprising at least one vacuum attachment operatively and fluidly connected to said inflow passage.

15. A cyclonic dust collection chamber for use with a vacuum source according to claim 14 wherein said vacuum attachment is a motorized brush.

Dyson Ex1020
Page 1354

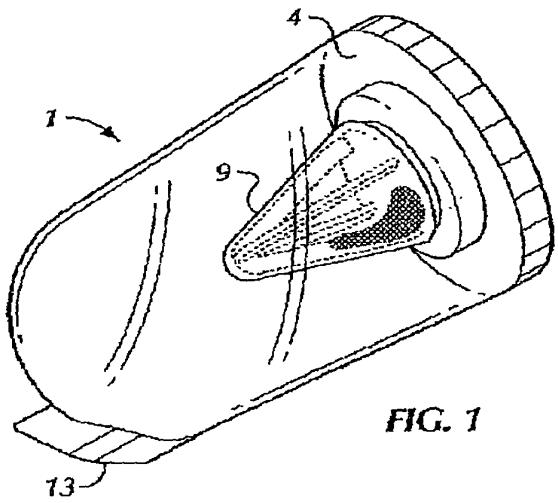


FIG. 1

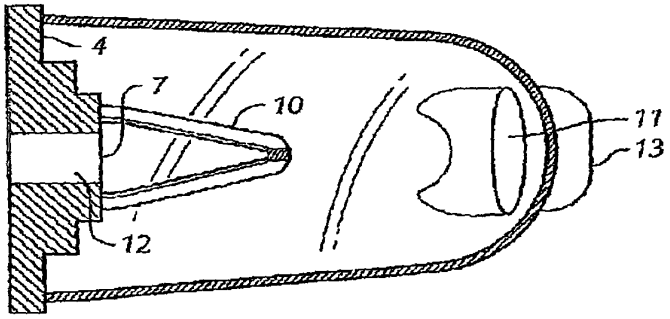


FIG. 2

Dyson Ex1020
Page 1355

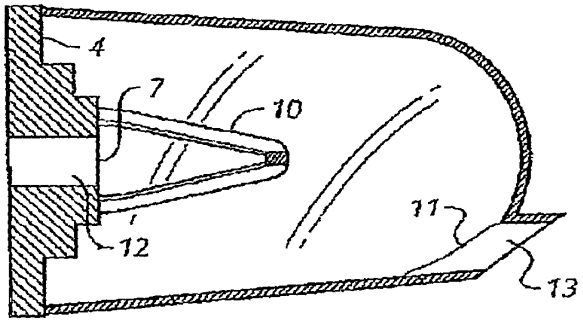


FIG. 3

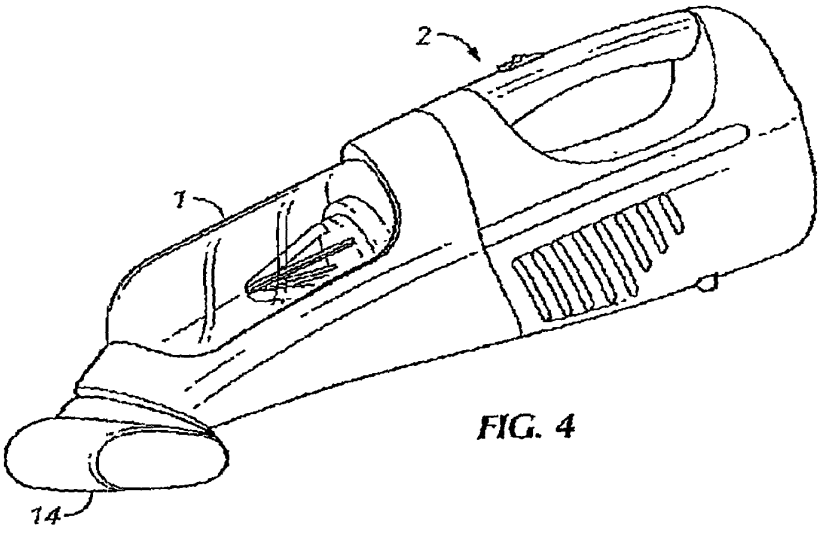


FIG. 4

Dyson Ex1020
Page 1356

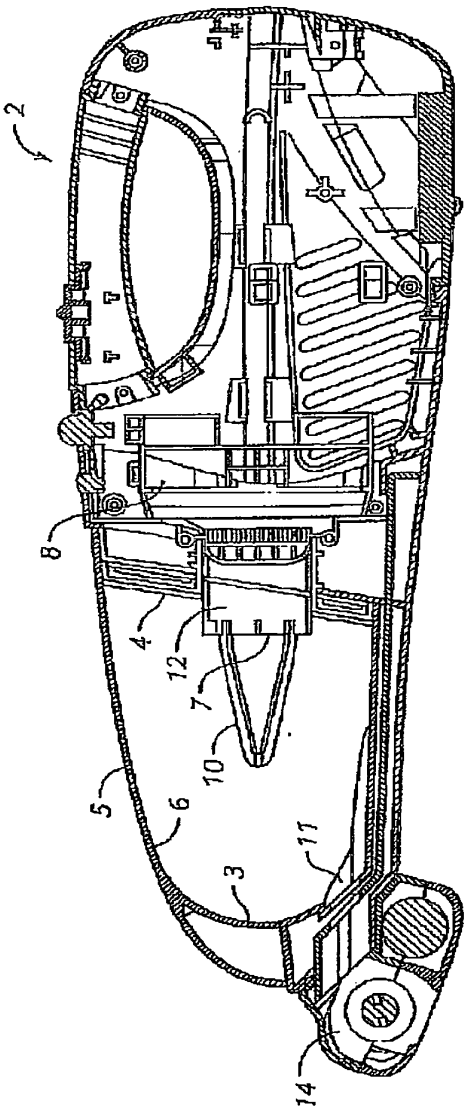


FIG. 5

Dyson Ex1020
Page 1357

Fig 6A

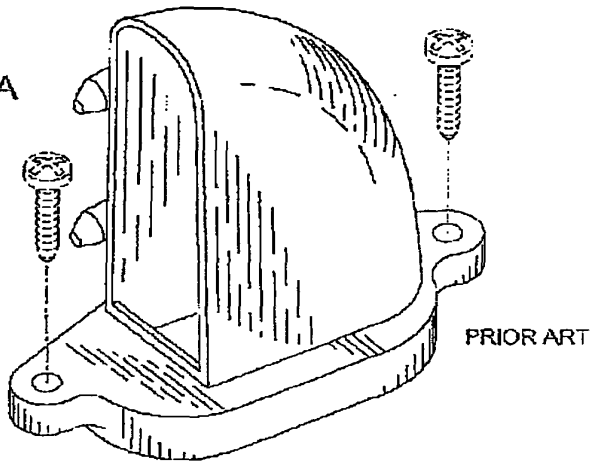
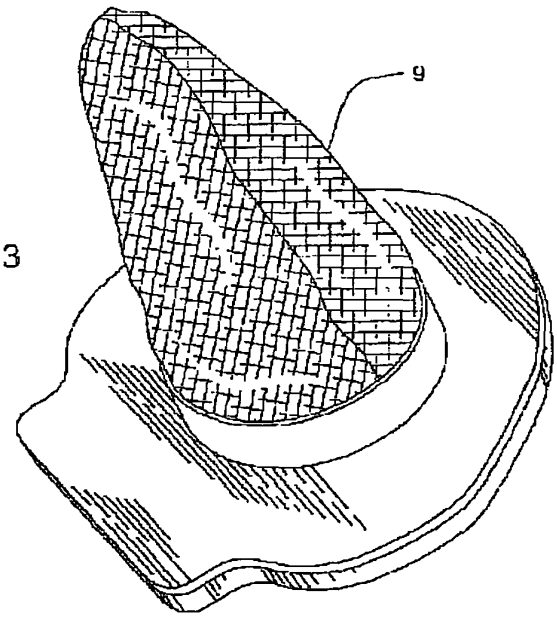
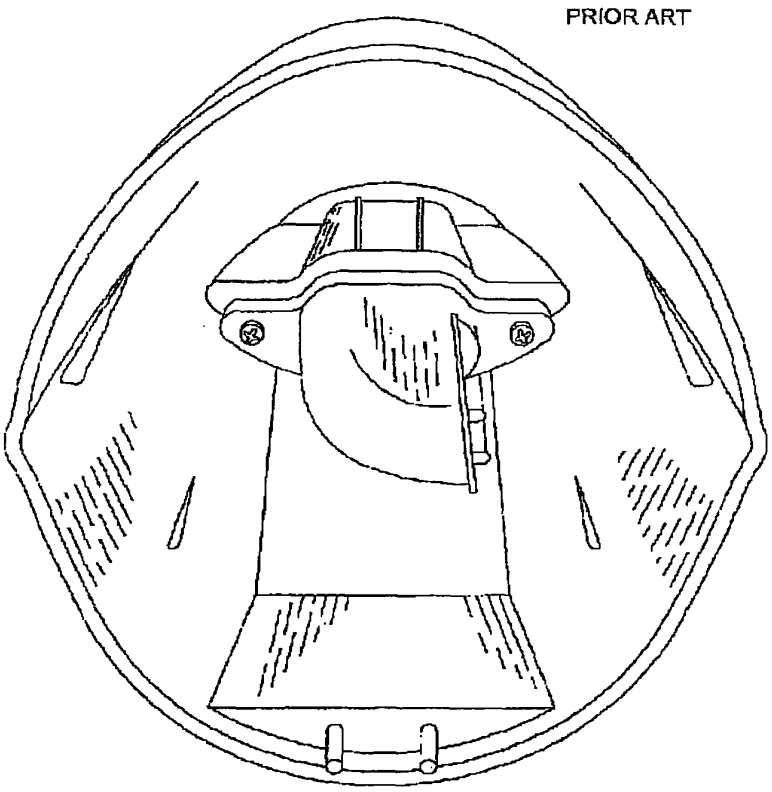


Fig 13



Dyson Ex1020
Page 1358

Fig 6B



Dyson Ex1020
Page 1359

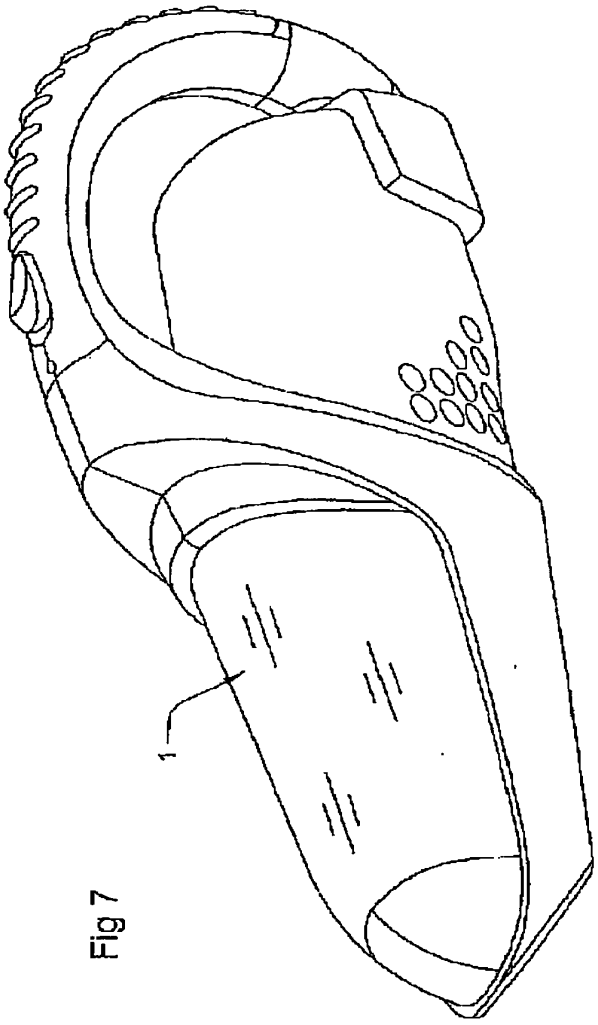
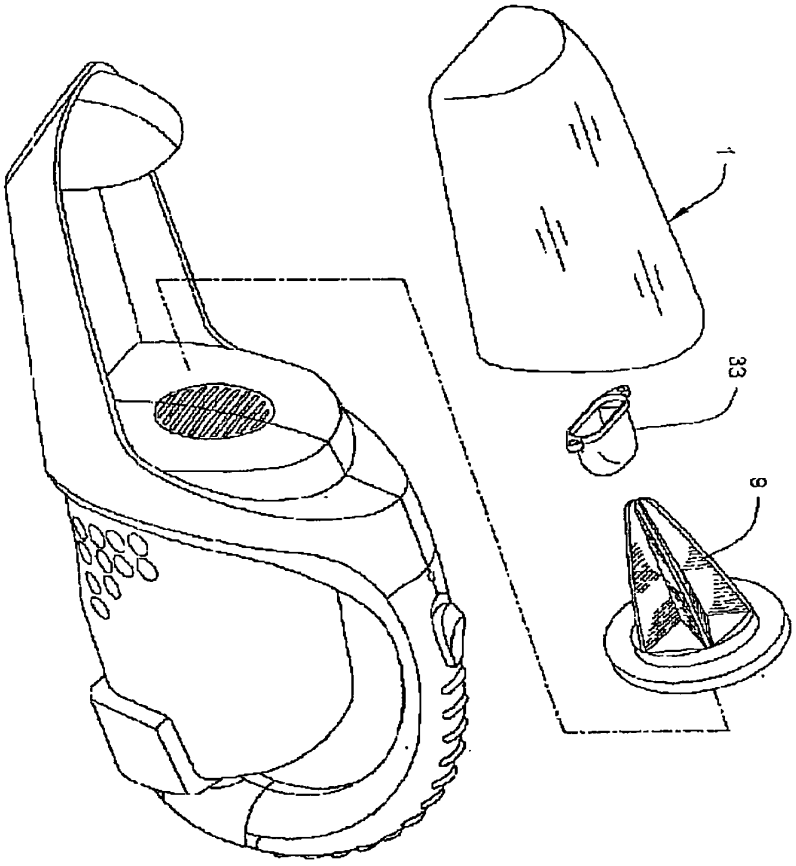


Fig 7

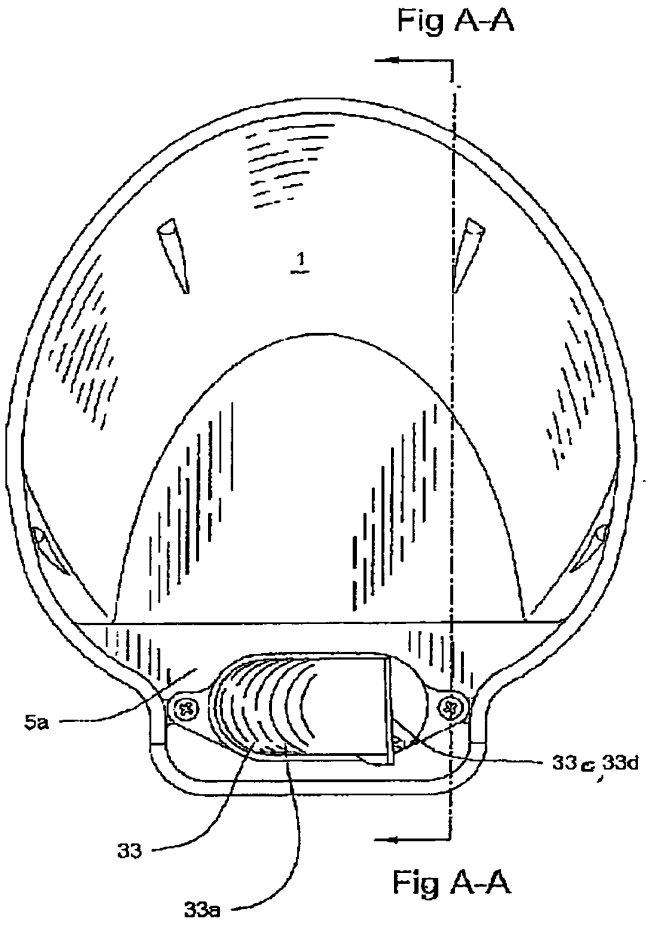
Dyson Ex1020
Page 1360

Fig 8



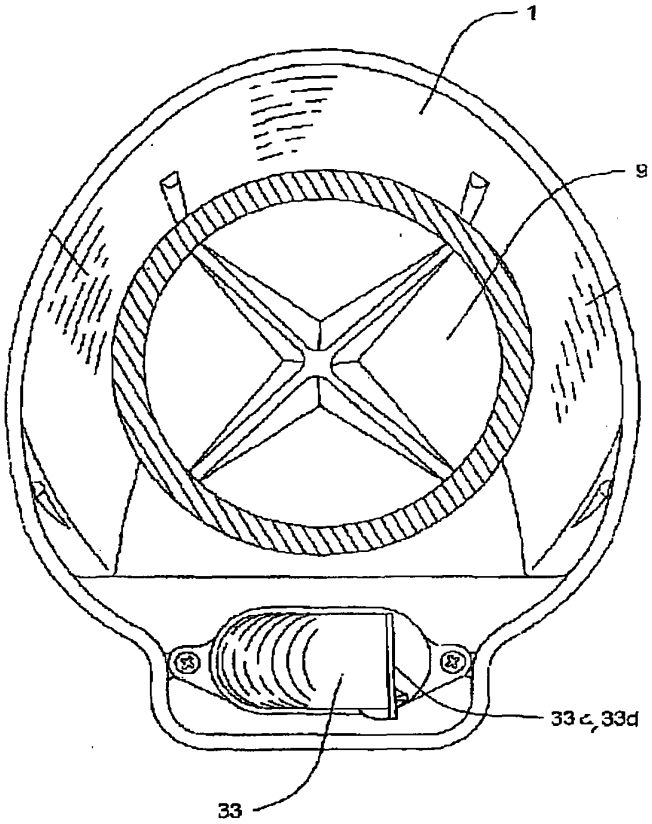
Dyson Ex1020
Page 1361

Fig 9



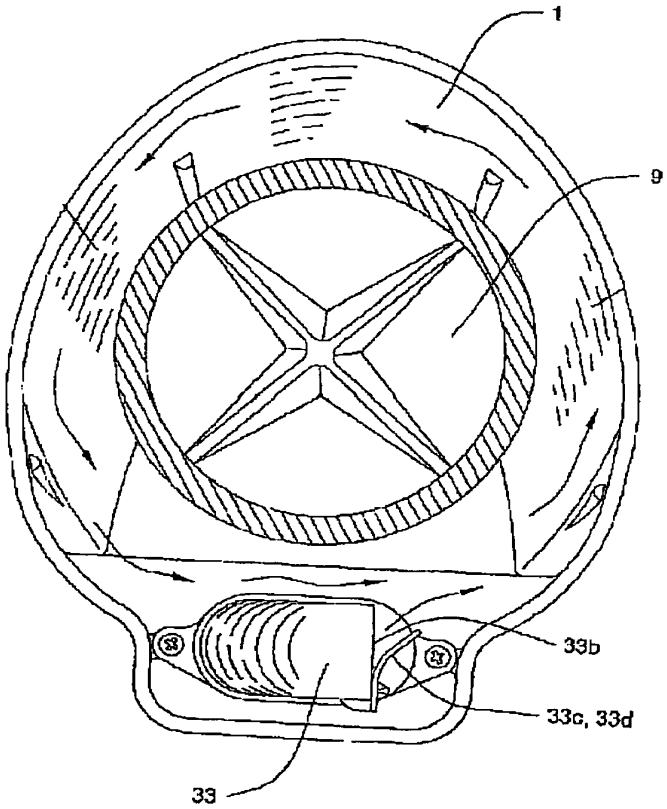
Dyson Ex1020
Page 1362

Fig 9A



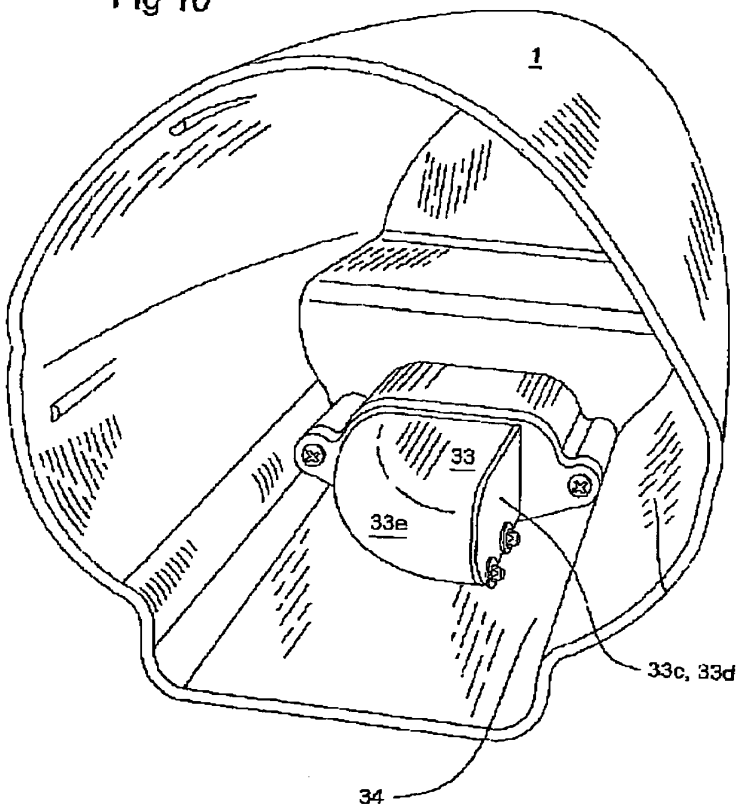
Dyson Ex1020
Page 1363

Fig 9B



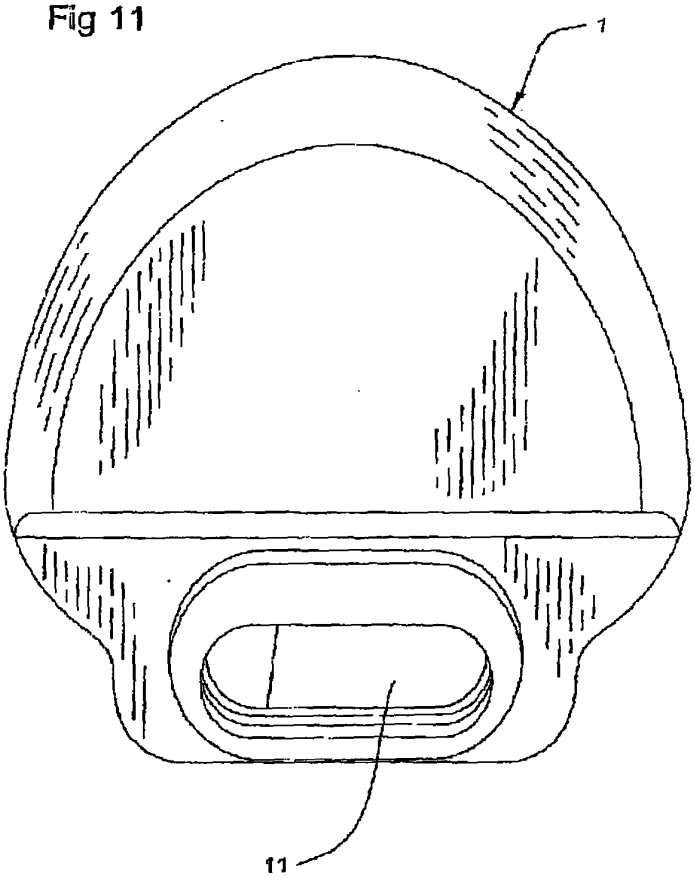
Dyson Ex1020
Page 1364

Fig 10



Dyson Ex1020
Page 1365

Fig 11



Dyson Ex1020
Page 1366

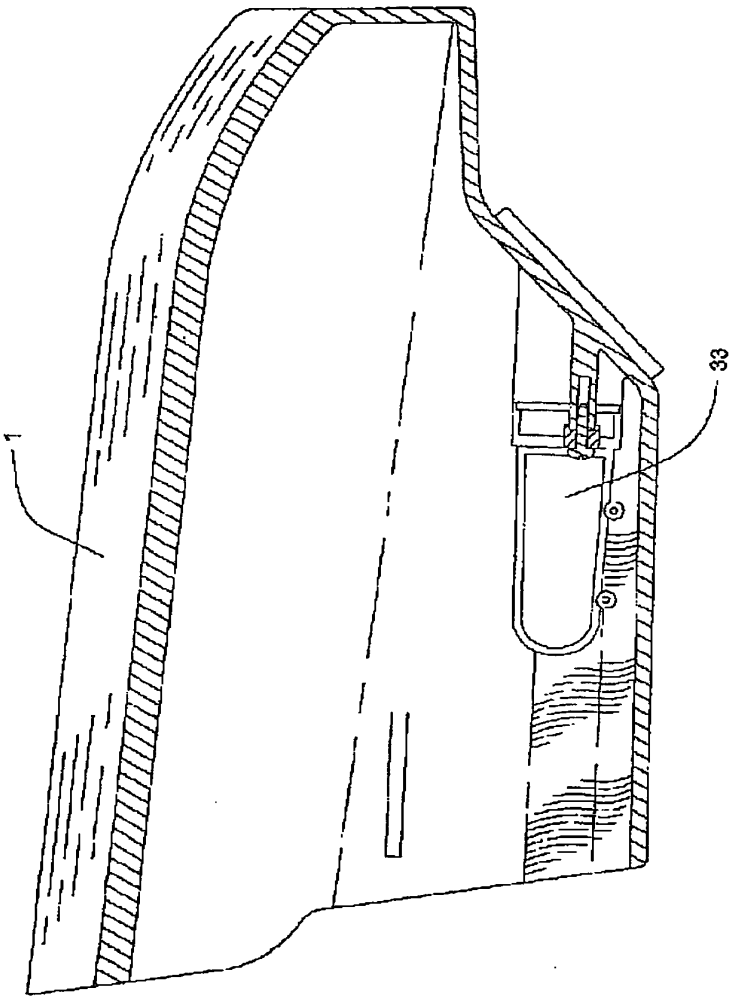


Fig 12

Dyson Ex1020
Page 1367

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Dyson Ex1020
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(54) **HAND HELD VACUUM CLEANER**

TRAGBARER STAUBSAUGER

ASPIRATEUR PORTATIF

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EP 1 594 386 B1

Description

[0001] This invention relates to a hand held vacuum cleaner comprising a housing supporting a motor-fan unit, a dust container and an air passage ending in the dust container through which dust laden air is directed into the dust container, the vacuum cleaner also comprising at least one filter arranged after the dust container as seen in the flow direction, the dust container constituting a part of a cyclone separator arranged between the air passage and the filter.

[0002] Hand held vacuum cleaners which are battery powered as well as powered by mains supply, are previously known, see for instance US 4967443, and are used for fast cleaning of small surfaces. It is important that such vacuum cleaners are easily accessible and user friendly designed. These vacuum cleaners are usually designed such that the dust container together with the filter can be removed from the remaining part of the vacuum cleaner housing that contains the fan unit. In order to empty the vacuum cleaner also the filter has to be removed from the dust container before the content can be emptied through the opening which is established when the filter has been taken away. Removal of the dust from the dust container is hence troublesome, dirty and time consuming. It should in this connection be mentioned that the volume of the dust container for this type of vacuum cleaners is very limited and that the filter is rapidly clogged which means lost suction efficency and that emptying has to be done with short intervals.

[0003] It is further known, see EP 914795, to provide a hand held vacuum cleaner of the type mentioned above with a large opening covered by a pivotable lid in order to facilitate emptying but since the dust usually get stuck to the filter the dust can not be easily poured out of the opening. Moreover since the conventional filter system is quickly clogged the suction efficiency is still not sufficient.

[0004] It is also previously known to use the type of hand held vacuum cleaner described above in combination with a shaft part whose, lower portion supports a nozzle (so called stick cleaner), see for instance SE 9701543-2. The shaft part is provided with a tube connection by means of which dust laden air is transferred from the nozzle to the air inlet of the hand held vacuum cleaner which is removably secured to the shaft part. This means that the combined stick cleaner in a comfortable way can be used for floor cleaning purpose. Of course this type of vacuum cleaners also has the same disadvantages as the hand held vacuum cleaner described above with respect to filter clogging and handling when being emptied.

[0005] The purpose of this invention is to create an arrangement which eliminates a too fast clogging of the filter and which fascilitates emptying of the vacuum cleaner at the vacuum cleaner types described above. This is achieved by means of a device having the characteristics mentioned in the claims.

[0006] An embodiment of the invention will now be described with reference to the accompanying drawings on which Fig. 1 is a perspective view of the vacuum cleaner in question together with a shaft part, Fig. 2 is a schematic sectional view through the shaft part shown in Fig. 1, Fig. 3 is a perspective view of the vacuum cleaner being removed, Fig. 4 is a sectional view through the vacuum cleaner, Fig. 5 is an exploded view showing the vacuum cleaner being separated and at the emptying procedure, Fig. 6 is a perspective view of the vacuum cleaner showing a different method for emptying the vacuum cleaner whereas Fig. 7 in a perspective view shows a further method for emptying the vacuum cleaner.

[0007] As appears from Fig. 1 the shown vacuum cleaner comprises an elongated shaft part 10 in which a hand held vacuum cleaner 11 is removably arranged. The lower end of the shaft part supports a floor nozzle 12 enclosing an electrically driven brush roll 13, not described in detail, and which is turnably secured to the shaft part 10. The nozzle has an elongated suction opening 14 extending in the length direction of the nozzle and the suction opening is via a flexible tube passage 15 connected to the hand held vacuum cleaner 11 in a manner which will be described below. The upper portion of the shaft part 10 is shaped as a handle 16 and has an operating knob 17 that via an electric circuit, not shown in detail, is connected to the hand held vacuum cleaner when it is secured to the shaft part. The shaft part might also enclose one or several batteries 18 which are connected to the electric circuit.

[0008] The nozzle 12 is provided with a supporting part 12a having one end that via a shaft is pivotally arranged about a first axis A extending mainly horizontally and mainly parallel to the suction opening 14. The other end of the supporting part 12a is pivotally secured to the lower portion of the shaft part 10 about a second axis B that is mainly perpendicular to the length direction of the shaft part 10 and to the first axis A. This means that there is a double link arrangement between the shaft part 10 and the nozzle 11 which gives an excellent manoeuvrability of the vacuum cleaner when being used as a stick cleaner. This arrangement also makes it possible to easily hide the electric wires between the shaft part 10 and the nozzle within the support arm 12a. In order to create a reliable nozzle link the shaft ends defining the axis A are supported by two shaft supports comprising separate units that are removably inserted into pockets in the nozzle.

[0009] The hand held vacuum cleaner 11 comprises a housing 20 with a handle 21 and the housing encloses a motor-fan unit 22 driven by one or several batteries 23 placed in the handle 21. The motor-fan unit is controlled by means of a control knob 24 placed at the handle and the part of the electric circuit which is placed in the hand held vacuum cleaner is via a connection 25 connected to the part of the circuit which is placed in the shaft part 10 when the hand held vacuum cleaner is fixed to the shaft part 10. The housing is provided with several openings 26 through which the air flowing through the fan unit

Dyson Ex1020
Page 1370

leaves the housing. The housing also has an inlet channel 27 extending from the front part of the housing to an outlet opening 28 arranged at the middle part of the housing. In the channel 27 a tube part 29 is slidably arranged the outer end of the tube part being shaped as a nozzle. When the hand held vacuum cleaner is fastened to the shaft part the tube part 29 is pushed into the channel 27 and is thereby a direct continuation of the tube passage 15 of the shaft part. The tube part can also be pulled out to an extended position and by means of a retaining mechanism, not shown, be locked temporarely in the extended position.

[0010] The housing is provided with a recess 30 in which a dust container 31 is removably arranged the dust container being removed by means of locking knobs 32 arranged at each side of the container. The dust container 31 is shaped as an elongated body with an open end and is partly made of transparent material. Close to the open end of the dust container there is an inlet 33 that is coaxially to the outlet opening 28 of the channel 27. The open end is partly covered by a filter liner 34 that follows the dust container when it is removed from the housing but which is removably arranged with respect to the dust container. The filter liner comprises a collar shaped portion 35 resting against a seat arranged at the wall of the dust container the collar shaped portion continuing into a sleeve shaped portion 36 centrally arranged in the dust container. The sleeve shaped portion has a flange 37 overbridging the distance between the sleeve shaped portion 36 and the surrounding container wall and extends around a part of the circumference of the sleeve shaped portion. The part 38 of the sleeve shaped portion which is placed at one side of the flange 37 is together with the collar shaped portion 35 made by homogenous material whereas the part which is placed at the other side of the flange comprises a grating structure which is covered by a coarse filter 39 that also extends over the end 40 of the sleeve shaped portion. The coarse filter 39 preferably comprises a washable fine meshed plastic net. Further the filter liner 34 is provided with a radially extending wall 41 that streches between the flange 37 and the collar shaped portion 35 close to the inlet 33. The wall 41 prevents the dust in the dust container from falling out through the inlet 33 if the vacuum cleaner should be turned up-side-down and also limits an annular flow channel around a part of the circumference of the filter liner 34. When dust laden air flows through this channel it contributes to the creation of a vortex in the dust container which will thus operate as a cyclone separator in which larger particles are separated from the air flow at the same time as the process is visualized through the transparent container wall. Thus, the cyclone prevents the filter from being clogged by means of larger dust particles and dirt. By means of the transparent container wall it is also possible to see the dust level in the container and hence also to establish when it is time to empty the container.

[0011] The filter liner 34 encloses a removable support body 42 for a fine filter 43 for instance a flat circular paper filter that can be clamped between the support body 42 and the filter liner 34. The support body 42 mainly has the same sleeve shape as the filter liner 34 but is somewhat smaller and forms a flow passage 44 for the air which flows through the coarse filter 39 and the fine filter 43 to the inlet opening 45 of the fan unit. Alternatively the fine filter can be replaced by a body of foamed plastic or the like to separate finer particles after the coarse filter whereby the body is secured in a suitable way in the filter liner.

[0012] The dust container has a large emptying opening 46 extending over the entire bottom part of the dust container and the opening is normally covered by a lid 47 supported by a yoke 48 turnably secured at each side of the dust conatiner the yoke being acted on by two springs 49 normally pressing the lid against a sealing 50 surrounding the opening 46.

[0013] The lid 47 supports a flap 51, that is turnably fastened to the lid 47 by means of dowels 52, and is normally hiding a small, circular emptying opening 53 which is connected to the inside of the dust container. This opening might be covered by a tongue 54 of elastic material which is fastened at one of its sides and rests against a seat 55 surrounding the opening 53 the tongue serving as a check valve that opens when a tube 56 connected to an outer vacuum source is pressed against the seat 55 or is inserted into the opening 53. Instead of using an elastic tongue it is of course possible to provide the seat 55 or the flap 51 with a sealing that prevents air from flowing through the emptying opening 53 into the dust container when the flap is closed.

[0014] The hand held vacuum cleaner is used and operates in the following manner. At normal use the hand held vacuum cleaner 11 is removed from the shaft part 10 after which the tube part 29 is pulled out to the outer position. Then the motor fan unit is started by acting on the operating knob 24. This means that air together with dirt particles are sucked in through the tube part 29 and the inlet channel 27. The dust laden air flows through the outlet opening 28 and the inlet 33 of the dust container 31 after which the dust laden air flows into the channel which is limited by the filter liner 34, the flange 37 and the wall of the dust container and extending around the sleeve sheped portion 36. Thereby a vortex is created in the dust container the vortex separating heavier particles from the air flow such that they can be collected at the bottom of the container. The air then flows further through the coarse filter 39 and the fine filter 43 to the flow passage 44 from which the cleaned air leaves to the inlet opening 45 of the fan unit. After having passed the fan unit the air then leaves to atmosphere via the openings 26.

[0015] In order to empty the hand held vacuum cleaner there are three different alternatives. By manually opening the lid 46 against the action of the springs 49 the operator can uncover the emptying opening 46 and the collected dust is allowed to fall freely out of the opening

Dyson Ex1020
Page 1371

or to be shaken out through it. This means a quick emptying function whithout the need for removing the dust container from the hand held vacuum cleaner. A second quick emptying alternative is, when the operator uses a lager type of vacuum cleaner during a conventional vacuum cleaning operation, to open the flap 51 and press the inlet opening of the tube handle 56 of the larger vacuum cleaner against the seat 55. This means that the tongue 54 beacause of the vacuum created by the larger vacuum cleaner will uncover the opening 53 and the content in the dust container 31 will be sucked over to the dust container of the larger vacuum cleaner. Thereby also the coarse filter 39 and the fine filter 43 will be cleaned by the air that flows backwards through the hand held vacuum cleaner. A further emptying alternative is to remove the dust container 31 from the housing 20 by acting on the locking knobs 32. Thereby the dust container is removed together with the filter liner 34, the fine filter 43 and the support body 42. By removing the lastmentioned three parts from the dust container it can be emptied and the dust container 31, the filter liner 34 with the coarse filter 39 and the support body 42 can be cleaned separately and a new fine filter 43 can then be applied on the support body 43 before it is again inserted into the filter liner 34. The flat fine filter will then be folded such that it achieves a large filter area. The filter liner 34 can then again be inserted into the dust container 31 before the dust container is locked in the housing 20.

[0016] The hand held vacuum cleaner 11 can, if the operator so desires, be fixed to the shaft part 10 whereby the tube part 29 is moved to its retracted position at the same time as the electrical circuit of the hand held vacuum cleaner via the connection 25 is connected to the electrical circuit in the shaft part. This means that the motor fan unit of the hand held vacuum cleaner and the electric motor of the brush roll 13 now can be cativated by means of the operating knob 17 whereby additional energy is supplied by means of the batteries 18 in the shaft part. The shaft part can then be used as a normal so called stick cleaner for cleaning larger surfaces such as a floor whereby dust laden air is sucke in through the nozzle 12. This air via the flexible tube passage 15 passes to the inlet channel 27 of the hand held vacuum cleaner after which the dust particles are separated in the dust container 31 in a manner described above.

[0017] It should be stressed that the hand held vacuum cleaner and/or the shaft part in a conventional manner is provided with a connection, not shown, for an electrical charger to charge the batteries which are placed in the shaft part and/ or the hand held vacuum cleaner. The vacuum cleaner might of course also be mains supplied.

Claims

1. Hand held vacuum cleaner having a housing (20) comprising a motor-fan unit (22), a dust container (31) and an air passage (27) opening into the dust container through which dust laden air is directed into the dust container, the vacuum cleaner also comprising at least one filter (39) arranged after the dust container as seen in the flow direction, the dust container (31) being provided with a first emptying opening (46) normally being covered by a lid (47) and having such a size that the opening, allows the dust collected in the dust container to fall out through the opening when the lid is opened **characterized in that** the dust container constitutes a part of or communicates with a cyclone separator arranged between the air passage (27) and the filter (39).

2. Vacuum cleaner according to claim 1 **characterized in that** the dust container (31) is provided with a second emptying opening (53) that is adapted to be connected to an external vacuum source via a connection (56).

3. Vacuum cleaner according to claim 1 or 2 **characterized in that** the dust container (31) i removably arranged in the housing.

4. Vacuum cleaner according to any of claims 1-3 **characterized in that** the dust container (31) is provided with a removable filter liner (34) comprising an end wall part (35) continuing into a sleeve shaped portion (36) extending into the dust container and through which the air leaving the dust container flows towards the motor fan unit (22).

5. Vacuum cleaner according to claim 4 **characterized in that** the filter liner (34) supports a coarse filter (39).

6. Vacuum cleaner according to claim 4 or 5 **characterized in that** the filter liner (34) encloses a foamed plastic body serving as a separator of finer particles.

7. Vacuum cleaner according to claim 4 or 5 **characterized in that** the filter liner (34) encloses a coaxially arranged, removable support body (42) for a fine filter (43) arranged between the filter liner (34) and the support body (42).

8. Vacuum cleaner according to claim 7 **characterized in that** the fine filter (43) comprises a thin, flat filter blank which is applied on the filter body (42) such that it, when the filter body is inserted into the filter liner (34) becomes a folded shape.

9. Vacuum cleaner according to any of claims 4-8 **characterized in that** the filter liner (34) at its outside supports a flange (37) to overbridge the distance between the filter liner (34) and the surrounding dust container wall the flange extending around a part of the circumference of the liner.

10. Vacuum cleaner according to any of the preceding

Dyson Ex1020
Page 1372

claims **characterized in that** the dust container (31), at least partly, is made of transparent material.

11. Vacuum cleaner according to any of the preceding claims **characterized in that** it is removably secured to a shaft part (10) supporting a floor nozzle (12) having an elongated suction opening (14) extending in the length direction of the nozzle, the floor nozzle via a tube connection (15) being connected to the air passage (27) of the vacuum cleaner.

12. Vacuum cleaner according to claim 11 **characterized in that** the floor nozzle (12) and the shaft part (10) are connected to one another via a double link arrangement comprising a first pivot axis (A) that is arranged mainly horizontally and parallel to the suction opening of the floor nozzle and a second pivot axis (B) that is perpendicular to a longitudinal axis of the shaft part as well as to said first pivot axis (A).

13. Vacuum cleaner according to claim 11 or 12 **characterized in that** the tube connection (15) at least partly comprises a flexible hose.

14. Vacuum cleaner according to any of claims 12-13 **characterized in that** the floor nozzle (12) comprises an electrically driven brush roll (13) that via an electric circuit is connected to one or several batteries.

Patentansprüche

1. Handstaubsauger mit einem Gehäuse (20), das eine Motor-Ventilatoreinheit (22), einen Staubbehälter (31) und einen Luftdurchgang (27) umfasst, der sich zum Staubbehälter hin öffnet, durch den staubhaltige Luft in den Staubbehälter geführt wird, wobei der Staubsauger auch mindestens einen Filter (39) umfasst, der - in Strömungsrichtung gesehen - nach dem Staubbehälter angeordnet ist, wobei der Staubbehälter (31) mit einer ersten Entleerungsöffnung (46) versehen ist, die normalerweise von einem Deckel (47) bedeckt ist und eine Größe aufweist, dass die Öffnung dem im Staubbehälter gesammelten Staub das Herausfallen durch die Öffnung erlaubt, wenn der Deckel geöffnet ist, **dadurch gekennzeichnet, dass** der Staubbehälter einen Teil eines Fliehkraftabscheiders bildet oder mit einem Fliehkraftabscheider kommuniziert, der zwischen dem Luftdurchgang (27) und dem Filter (39) angeordnet ist.

2. Staubsauger nach Anspruch 1, **dadurch gekennzeichnet, dass** der Staubbehälter (31) mit einer zweiten Entleerungsöffnung (53) versehen ist, die geeignet ist, über einen Anschluss (56) an eine externe Vakuumquelle angeschlossen zu werden.

3. Staubsauger nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Staubbehälter (31) im Gehäuse herausnehmbar angeordnet ist.

4. Staubsauger nach einem der Ansprüche 1-3, **dadurch gekennzeichnet, dass** der Staubbehälter (31) mit einem herausnehmbaren Filtereinsatz (34) versehen ist, der ein Endwandteil (35) besitzt, das sich in einen hülsenförmigen Teil (36) fortsetzt, der sich in den Staubbehälter erstreckt und durch den die Luft, die den Staubbehälter verlässt, zur Motor-Ventilatoreinheit (22) strömt.

5. Staubsauger nach Anspruch 4, **dadurch gekennzeichnet, dass** der Filtereinsatz (34) einen Grobfilter (39) hält.

6. Staubsauger nach Anspruch 4 oder 5, **dadurch gekennzeichnet, dass** der Filtereinsatz (34) einen Schaumstoffkörper umschließt, der als Abscheider für feinere Partikel dient.

7. Staubsauger nach Anspruch 4 oder 5, **dadurch gekennzeichnet, dass** der Filtereinsatz (34) einen koaxial angeordneten, herausnehmbaren Trägerkörper (42) für einen Feinfilter (43) enthält, der zwischen dem Filtereinsatz (34) und dem Trägerkörper (42) angeordnet ist.

8. Staubsauger nach Anspruch 7, **dadurch gekennzeichnet, dass** der Feinfilter (43) ein dünnes, flaches Filter-Rohteil umfasst, das dergestalt am Filterkörper (42) angebracht wird, dass es, wenn der Filterkörper in den Filtereinsatz (34) eingesetzt wird, eine gefaltete Form annimmt.

9. Staubsauger nach einem der Ansprüche 4-8, **dadurch gekennzeichnet, dass** der Filtereinsatz (34) an seiner Außenseite einen Flansch (37) trägt, um die Distanz zwischen dem Filtereinsatz (34) und der umgebenden Staubbehälterwand zu überbrücken, wobei der Flansch um einen Teil des Außenumfangs des Einsatzes verläuft.

10. Staubsauger nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Staubbehälter (31) zumindest teilweise aus einem transparenten Material gemacht ist.

11. Staubsauger nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** er abnehmbar an einem Schaftteil (10) befestigt ist, das eine Bodendüse (12) hält, die eine längliche Saugöffnung (14) aufweist, die sich in die Längsrichtung der Düse erstreckt, wobei die Bodendüse über einen Rohranschluss (15) mit dem Luftdurchgang (27) des Staubsaugers verbunden ist.

Dyson Ex1020
Page 1373

12. Staubsauger nach Anspruch 11, **dadurch gekennzeichnet, dass** die Bodendüse (12) und das Schaftteil (10) über eine Doppelgelenksverbindung miteinander verbunden sind, die eine erste Schwenkachse (A) umfasst, die hauptsächlich horizontal und parallel zur Saugöffnung der Bodendüse angeordnet ist, und eine zweite Schwenkachse (B), die senkrecht zu einer Längsachse des Schaftteils sowie zur ersten Schwenkachse (A) angeordnet ist.

13. Staubsauger nach Anspruch 11 oder 12, **dadurch gekennzeichnet, dass** der Rohranschluss (15) zumindest teilweise einen flexiblen Schlauch umfasst.

14. Staubsauger nach einem der Ansprüche 12-13, **dadurch gekennzeichnet, dass** die Bodendüse (12) eine elektrisch betriebene Bürstenwalze (13) umfasst, die über einen elektrischen Schaltkreis an eine oder mehrere Batterien angeschlossen ist.

Revendications

1. Aspirateur à main comportant un boîtier (20) comprenant une unité de moteur ventilateur (22), un récipient à poussière (31) et un passage d'air (27) s'ouvrant dans le récipient à poussière à travers lequel de l'air chargé de poussière est dirigé dans le récipient à poussière, l'aspirateur comprenant aussi au moins un filtre (39) agencé après le récipient à poussière selon la direction d'écoulement, le récipient à poussière (31) étant pourvu d'une première ouverture de vidange (46) normalement recouverte par un couvercle (47) et ayant une taille telle que l'ouverture permet à la poussière récoltée dans le récipient à poussière de tomber à travers l'ouverture quand le couvercle est ouvert, **caractérisé en ce que** le récipient à poussière constitue une partie d'un ou communique avec un séparateur à cyclone agencé entre le passage d'air (27) et le filtre (39).

2. Aspirateur selon la revendication 1, **caractérisé en ce que** le récipient à poussière (31) est pourvu d'une seconde ouverture de vidange (53) qui est adaptée pour être raccordée à une source d'aspiration externe par un raccordement (56).

3. Aspirateur selon la revendication 1 ou 2, **caractérisé en ce que** le récipient à poussière (31) est agencé de façon amovible dans le boîtier.

4. Aspirateur selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le récipient à poussière (31) est pourvu d'une doublure filtre amovible (34) comprenant une pièce de paroi d'extrémité (35) prolongée en une partie en forme de manchon (36) s'étendant dans le récipient à poussière et à travers laquelle l'air quittant le récipient à poussière s'écoule vers l'unité de moteur ventilateur (22).

5. Aspirateur selon la revendication 4, **caractérisé en ce que** la doublure filtre (34) supporte un pré-filtre (39).

6. Aspirateur selon la revendication 4 ou 5, **caractérisé en ce que** la doublure filtre (34) renferme un corps en plastique expansé servant de séparateur de particules plus fines.

7. Aspirateur selon la revendication 4 ou 5, **caractérisé en ce que** la doublure filtre (34) renferme un corps de support amovible, agencé de manière coaxiale (42) pour un filtre fin (43) agencé entre la doublure filtre (34) et le corps de support (42).

8. Aspirateur selon la revendication 7, **caractérisé en ce que** le filtre fin (43) comprend un flanc filtre plat, fin qui est appliqué sur le corps de filtre (42) de sorte que, quand le corps de filtre est inséré dans la doublure filtre (34), il prend une forme repliée.

9. Aspirateur selon l'une quelconque des revendications 4 à 8, **caractérisé en ce que** la doublure filtre (34) supporte, à l'extérieur de celle-ci, une bride (37) pour réaliser un pont de distance entre la doublure filtre (34) et la paroi du récipient à poussière qui l'entoure, la bride s'étendant autour d'une partie de la circonférence de la doublure.

10. Aspirateur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le récipient à poussière (31), au moins partiellement, est fait d'un matériau transparent.

11. Aspirateur selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il est fixé de manière amovible à une pièce d'arbre (10) supportant une buse pour plancher (12) ayant une ouverture de succion allongée (14) s'étendant dans la direction longitudinale de la buse, la buse pour plancher étant raccordée par un raccord de tuyau (15) au passage d'air (27) de l'aspirateur.

12. Aspirateur selon la revendication 11, **caractérisé en ce que** la buse pour plancher (12) et la pièce d'arbre (10) sont raccordées l'une à l'autre par un agencement à double liaison comprenant un premier axe de pivot (A) qui est agencé de façon essentiellement horizontale et parallèle par rapport à l'ouverture de succion de la buse pour plancher et un second axe de pivot (B) qui est perpendiculaire à un axe longitudinal de la pièce d'arbre ainsi qu'audit premier axe de pivot (A).

13. Aspirateur selon la revendication 11 ou 12, **caractérisé en ce que** le raccord de tuyau (15) comprend

Dyson Ex1020
Page 1374

au moins partiellement un tuyau souple.

14. Aspirateur selon l'une quelconque des revendications 12 et 13, **caractérisé en ce que** la buse pour plancher (12) comprend un rouleau brosse à entraînement électrique (13) qui est connecté par l'intermédiaire d'un circuit électrique à une ou plusieurs batteries.

Dyson Ex1020
Page 1375

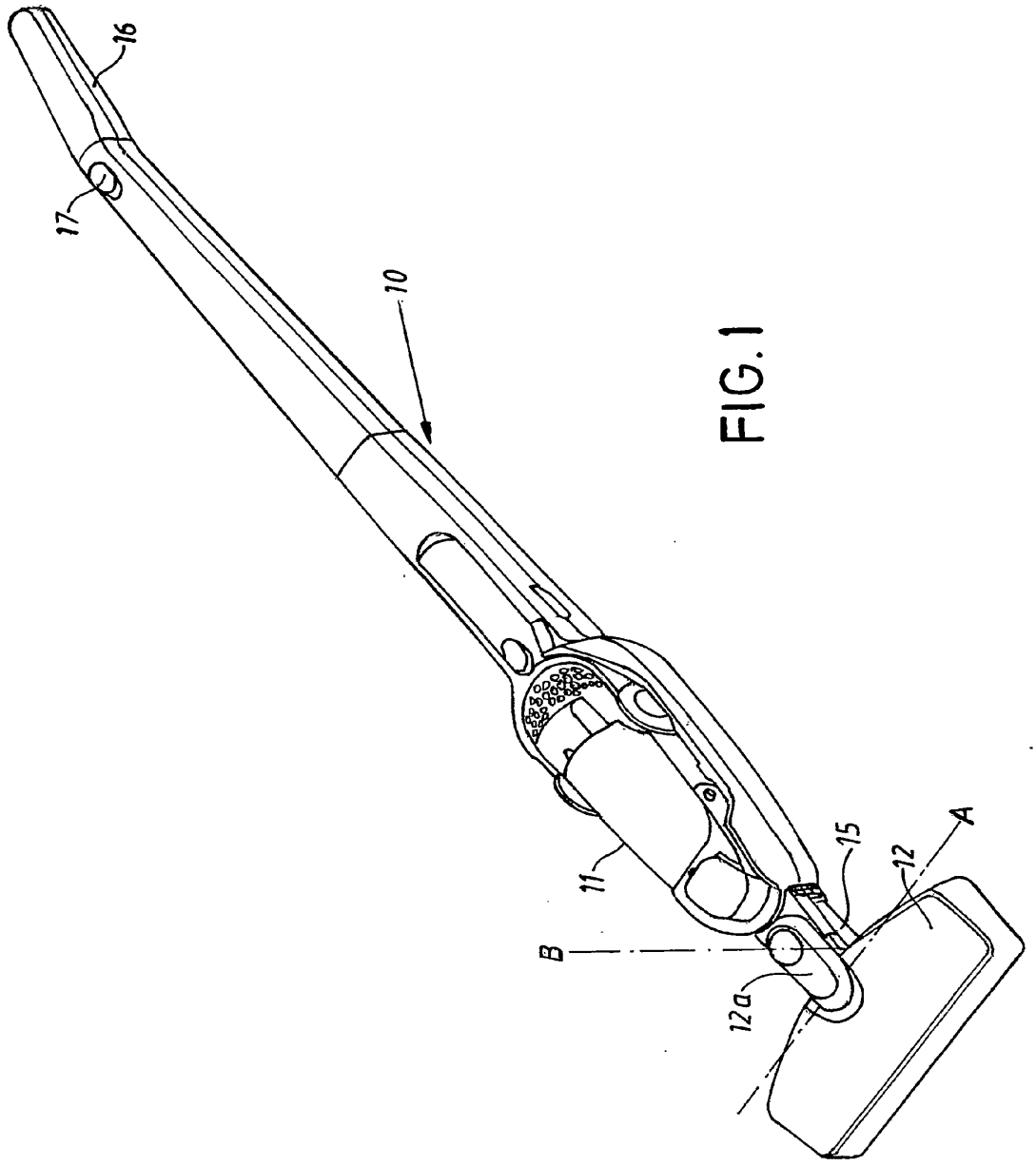


FIG. 1

Dyson Ex1020
Page 1376

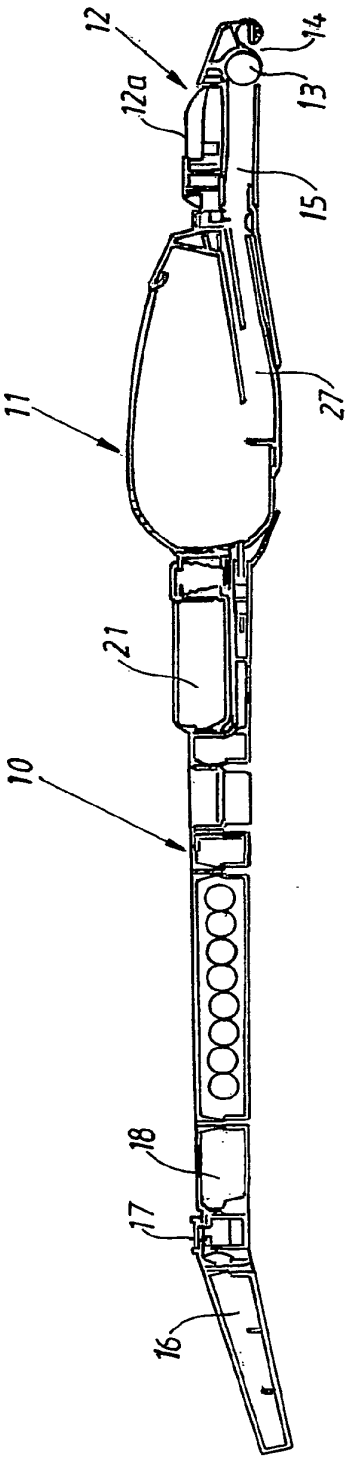


FIG. 2

Dyson Ex1020
Page 1377

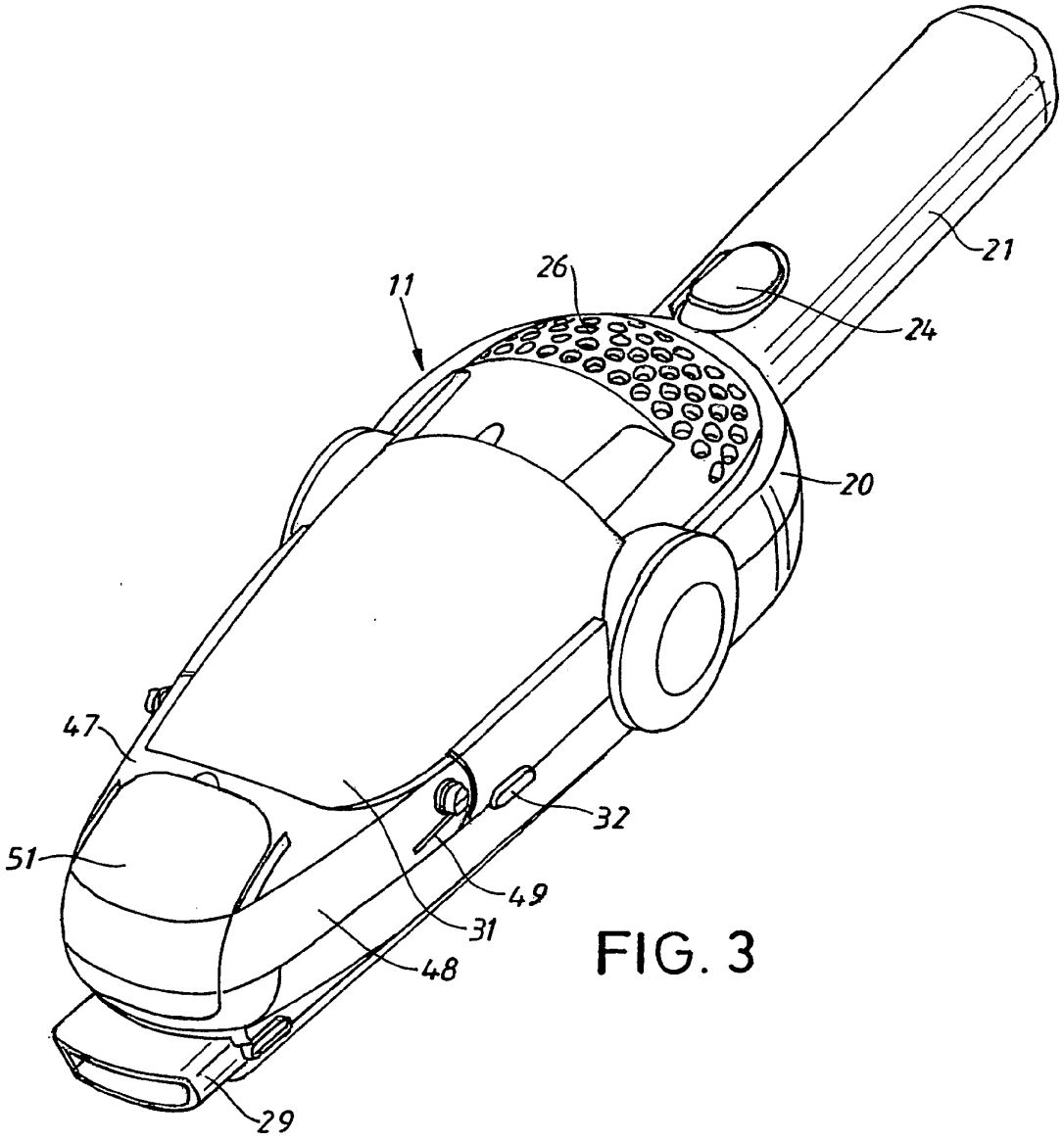


FIG. 3

Dyson Ex1020
Page 1378

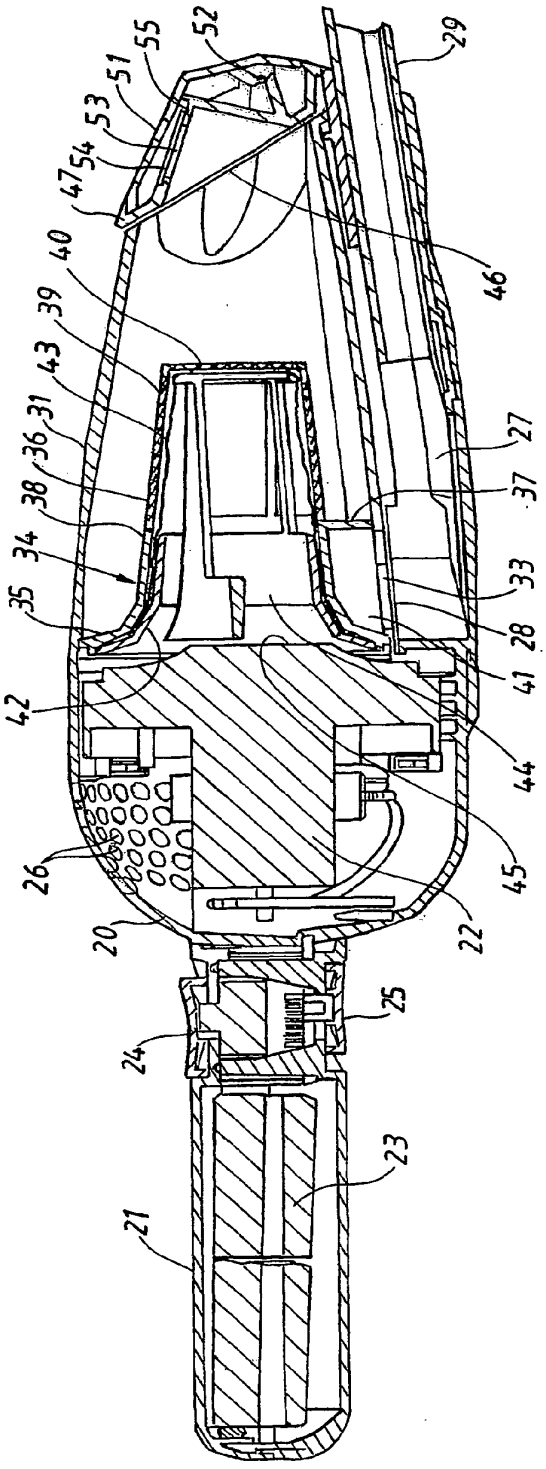


FIG. 4

Dyson Ex1020
Page 1379

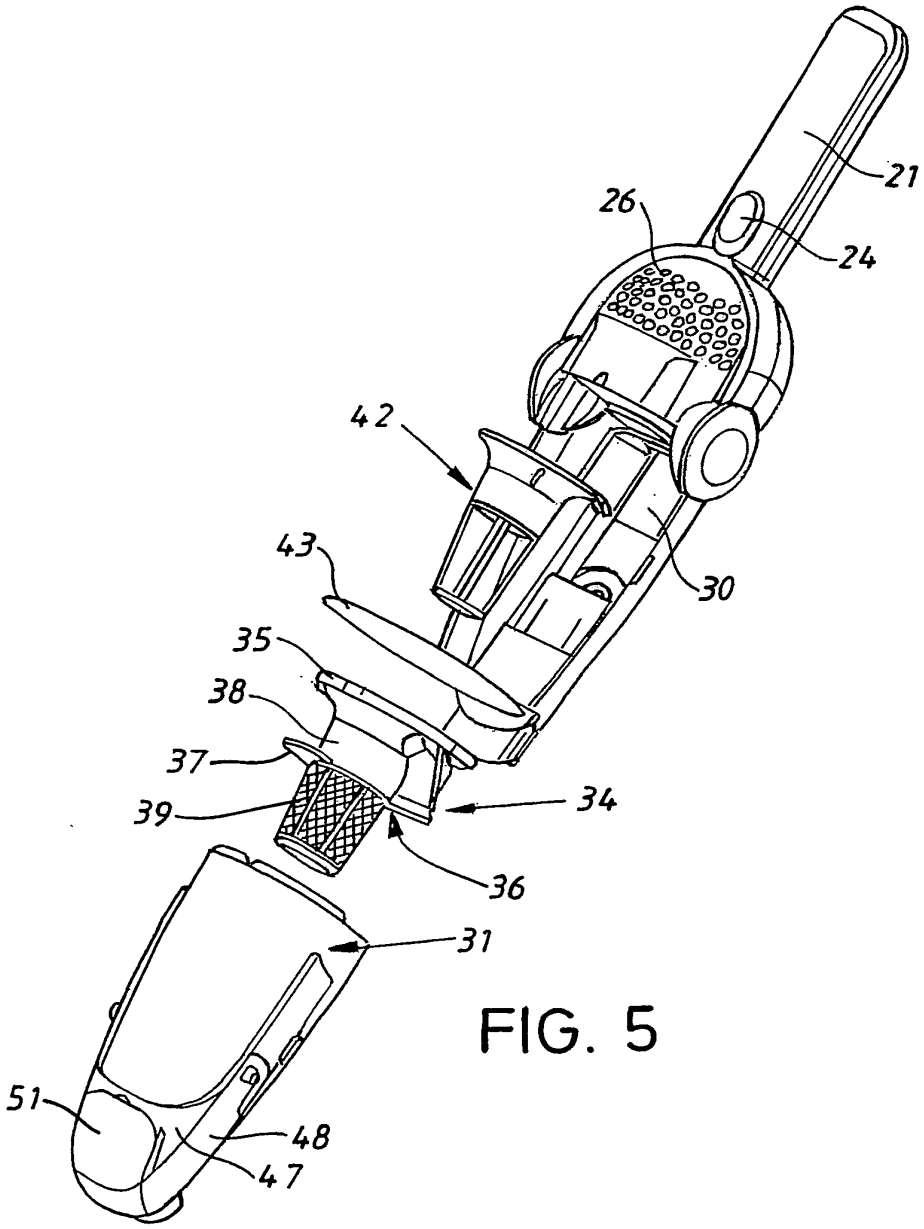


FIG. 5

Dyson Ex1020
Page 1380

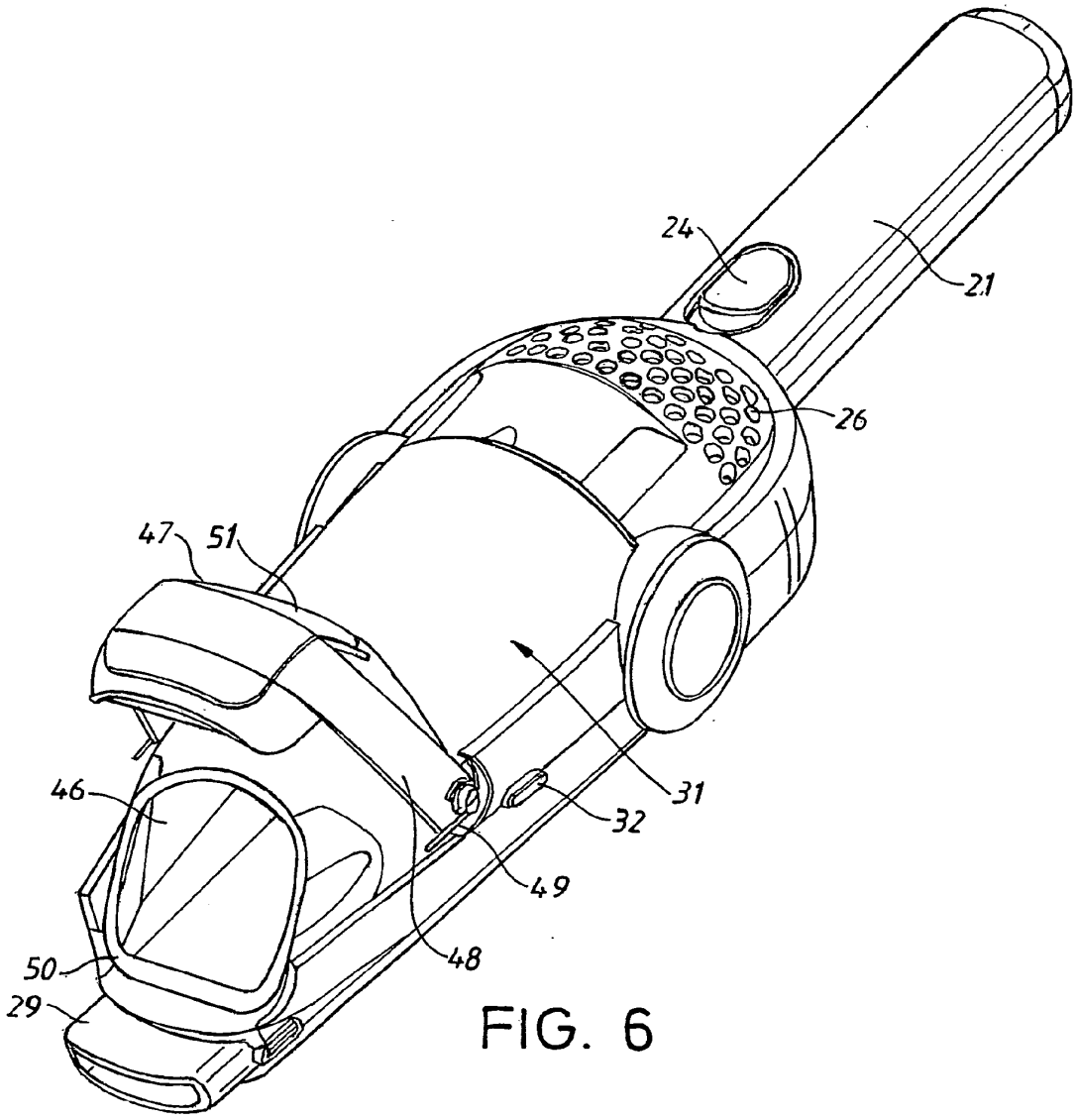


FIG. 6

Dyson Ex1020
Page 1381

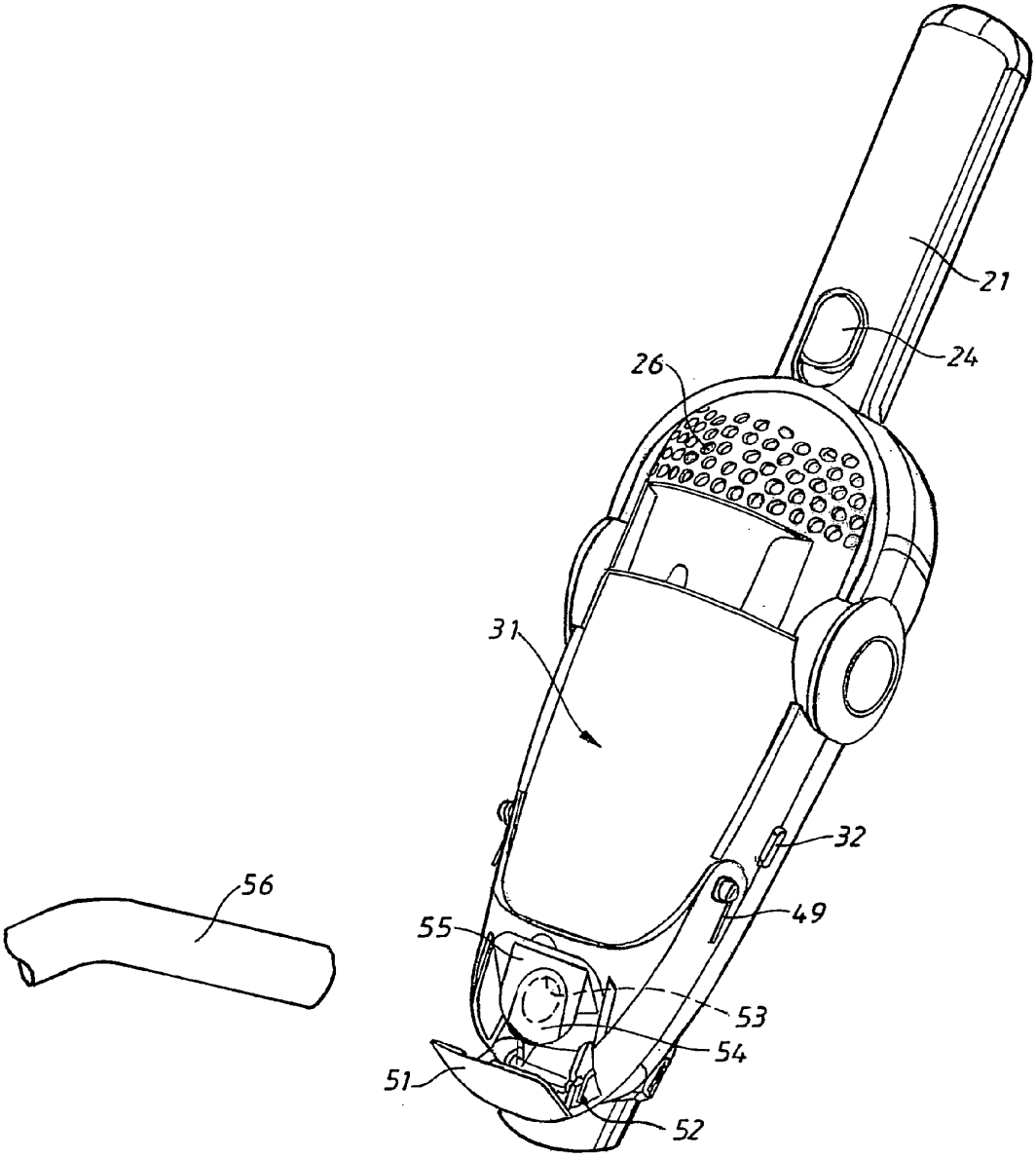


FIG. 7

Dyson Ex1020
Page 1382

REFERENCES CITED IN THE DESCRIPTION

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Dyson Ex1020
Page 1383

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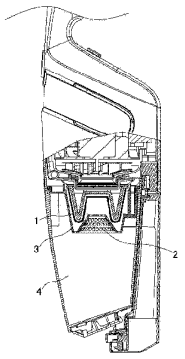
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(54)实用新型名称

一种旋风吸尘器

(57)摘要

本实用新型公开了一种旋风吸尘器，包括旋风筒体，所述旋风筒体的底部向内凹陷，内凹壁上设有过滤网孔。本实用新型将旋风筒体的底部向内凹陷，形成内凹结构，在实现正常旋风分离的同时，相对缩短了旋风筒体的轴向长度，从而相对增大了吸尘器的容尘空间，取得了较好的效果，这对于容尘量相对较小的吸尘器（如手持式吸尘器）具有积极的现实意义。



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1. 一种旋风吸尘器，其特征在于：包括旋风筒体 (1)，所述旋风筒体的底部向内凹陷，内凹壁上设有过滤网孔 (2)。

2. 根据权利要求 1 所述的旋风吸尘器，其特征在于：所述旋风筒体的底部向内凹陷，构成内锥结构。

3. 根据权利要求 1 所述的旋风吸尘器，其特征在于：所述旋风筒体的外部套设有第二过滤网罩 (3)。

4. 根据权利要求 3 所述的旋风吸尘器，其特征在于：所述第二过滤网罩与旋风筒体的结构相同，且两者同轴设置。

5. 根据权利要求 1 所述的旋风吸尘器，其特征在于：所述旋风筒体的侧壁设有复数个通孔，通孔的进气方向与进风方向相反。

6. 根据权利要求 1 所述的旋风吸尘器，其特征在于：所述旋风吸尘器为手持式吸尘器。

Dyson Ex1020
Page 1385

一种旋风吸尘器

技术领域

[0001] 本实用新型涉及一种吸尘器，具体涉及一种旋风吸尘器。

背景技术

[0002] 旋风吸尘器是近几年发展起来的一种吸尘器，其可以没有传统的集尘袋或过滤器系统，而是使气流沿着一条高速螺旋形的路径流经一个或多个圆筒；当气流沿螺旋形路径快速运动时，所有脏物颗粒都会因强大的离心力作用，被甩出气流；实现这种气流旋转的载体通常称作旋风筒体。

[0003] 现有技术中，不论旋风筒体的大小，现有的旋风筒体一般都是呈锥形，其上设有气流入口和气流出口，其底部为排灰口，其内腔即为旋风分离室。为了实现较好的分离效果，现有的旋风筒的轴向尺寸较大，造成了整个吸尘器的结构不紧凑；此外，对于较大尺寸的单个旋风筒而言，旋风筒的轴向尺寸越大，其下方的容尘空间越小，而若增大容尘空间，则又要增加整个吸尘器的体积。另一方面，现有的旋风筒中，外层旋风在向上返转时易将分离下来的灰尘（例如集尘桶中的灰尘）重新卷起，并被上升气流带走，即灰尘夹带，影响分离效果。

发明内容

[0004] 本实用新型的发明目的是提供一种旋风吸尘器。

[0005] 为达到上述发明目的，本实用新型采用的技术方案是：一种旋风吸尘器，包括旋风筒体，所述旋风筒体的底部向内凹陷，内凹壁上设有过滤网孔。

[0006] 上述技术方案中，所述旋风筒体的底部向内凹陷，构成内锥结构。该内锥上设有复数个过滤网孔；使整个旋风筒体构成锥形过滤网罩。

[0007] 进一步的技术方案，所述旋风筒体的外部套设有第二过滤网罩。

[0008] 上述技术方案中，所述第二过滤网罩与旋风筒体的结构相同，且两者同轴设置。

[0009] 上述技术方案中，所述旋风筒体的侧壁设有复数个通孔，通孔的进气方向与进风方向相反。

[0010] 上述技术方案中，所述旋风吸尘器为手持式吸尘器。包括把手、壳体，壳体内设有电机风扇单元、集尘桶、旋风过滤器等。

[0011] 由于上述技术方案运用，本实用新型与现有技术相比具有下列优点：

[0012] 1. 本实用新型将旋风筒体的底部向内凹陷，形成内凹结构，在实现正常旋风分离的同时，相对缩短了旋风筒体的轴向长度，从而相对增大了吸尘器的容尘空间，取得了较好的效果，这对于容尘量相对较小的吸尘器（如手持式吸尘器）具有积极的现实意义。

[0013] 2. 本实用新型在将旋风筒体的底部向内凹陷的同时，在其内凹壁上设置了过滤网孔，构成过滤网罩，从而防止了上升气流的灰尘夹带，提高了分离效果。

[0014] 3. 本实用新型在风筒体的外部套设第二过滤网罩，形成两道过滤结构，进一步提高了过滤效果。

Dyson Ex1020
Page 1386

[0015] 4 本实用新型的结构简单，易于制备，适于推广应用。

附图说明

[0016] 图 1 是本实用新型实施例一的结构示意图；

[0017] 图 2 是本实用新型实施例一的局部分解图；

[0018] 图 3 是本实用新型实施例一的局部剖视图。

[0019] 其中：1、旋风筒体；2、过滤网孔；3、第二过滤网罩；4、容尘空间。

具体实施方式

[0020] 下面结合附图及实施例对本实用新型作进一步描述：

[0021] 实施例一

[0022] 参见图 1~3 所示，一种手持式旋风吸尘器，包括旋风筒体 1，所述旋风筒体的底部向内凹陷，构成内锥结构，内凹壁上设有过滤网孔 2。

[0023] 所述旋风筒体的外部套设有第二过滤网罩 3。所述第二过滤网罩与旋风筒体的结构相同，且两者同轴设置。

[0024] 所述旋风筒体的侧壁设有复数个通孔，通孔的进气方向与进风方向相反。所述手持式旋风吸尘器还包括把手、壳体，壳体内设有电机风扇单元、容尘空间 4 等。

Dyson Ex1020
Page 1387

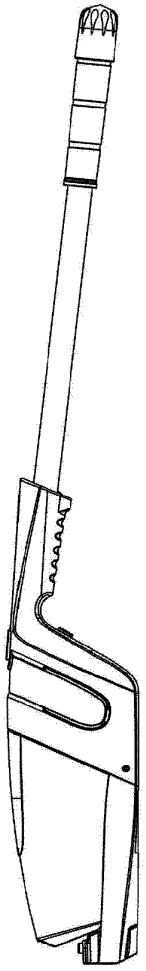


图 1

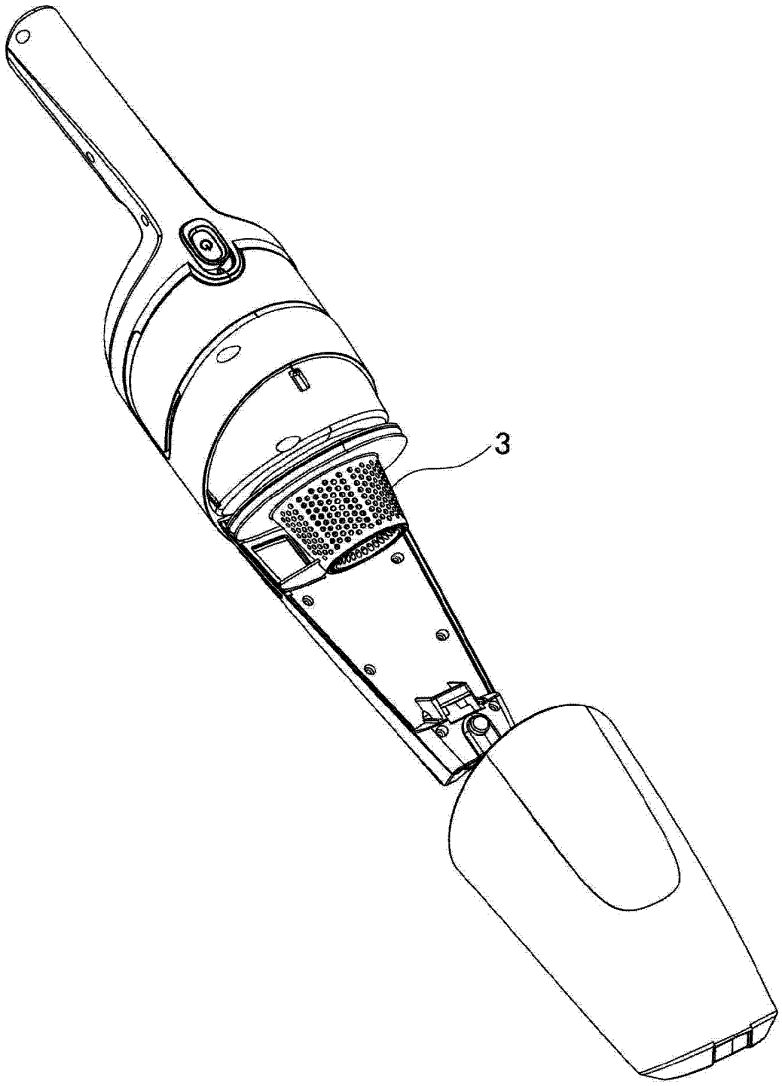


图 2

Dyson Ex1020
Page 1388

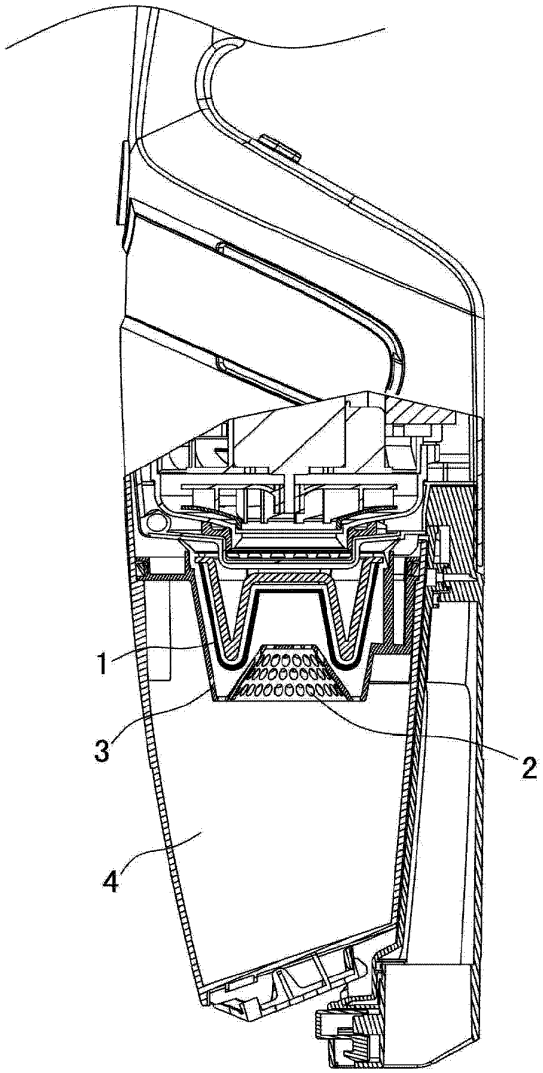


图 3

Dyson Ex1020
Page 1389

Electronic Acknowledgement Receipt

EFS ID:	24386660
Application Number:	14875381
International Application Number:	
Confirmation Number:	2483
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Customer Number:	1059
Filer:	Philip C. Mendes da Costa/Snezana Lisowsky
Filer Authorized By:	Philip C. Mendes da Costa
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Receipt Date:	16-DEC-2015
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Bereskin & Parr
INTELLECTUAL PROPERTY LAW

December 16, 2015

Philip C. Mendes da Costa
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416 957 1695 pmdcosta@bereskinparr.com

Your Reference: 10452- P39194US04

INFORMATION DISCLOSURE
STATEMENT UNDER 37 CFR.1.56 and 37 CFR 1.97(b)(1) and (2)

The Commissioner of Patents
and Trademarks
Washington, D.C.
U.S.A 20231

Dear Commissioner:

Re: United States Patent Application Serial No. 14/875381
For: SURFACE CLEANING APPARATUS
Filed: October 5, 2015
Applicant: Omachron Intellectual Property Inc.

In accordance with 37 CFR 1.97 and 1.98, and in recognition of the duty of disclosure set forth in 37 CFR 1.56, applicant hereby submits an Information Disclosure Statement including (1) a listing of patents and other publications of which applicant is aware on form PTO/SB/08a; (2) a copy of each listed item.

In accordance with the requirements of 1.97(b)(1) and (3), this Information Disclosure Statement is filed within three months of the filing date of the application or before the mailing date of a first Office Action on the merits, whichever event occurs last.

The filing of this statement shall not be construed as an admission that the information cited in the attached statement is, or is considered to be, material to patentability (37 CFR 1.97(h)), nor as an admission that it constitutes prior art.

Due to large number of cited references, this Information Disclosure Statement is being submitted in two parts.

(A) List of References

A list of the patents and other publications of which the applicant is aware is set out in the attached PTO Form SB08a which is attached hereto.

(B) Copies of References

Copies of the foreign and non-patent literature references are enclosed. The Applicant does not have translation of the Japanese patent references.

In view of the forgoing, it is respectfully submitted that the Information Disclosure Statement should be considered at this time by the Examiner.

Respectfully submitted,

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.

P. Mendes da Costa

Philip C. Mendes da Costa
Registration No. 33,106
/sl
Encl

Fulltext

Cyclone dust collector

List of publications

Publication number	Publ. date	Appl. Number	Appl. Date	Document type
CN202932850	2013-05-15	2012CN-U590369	20121109	U -

Other Title 一种旋风吸尘器

Abstract
The utility model discloses a cyclone dust collector comprising a cyclone cylinder body, wherein the bottom of the cyclone cylinder body is inwards sunken; and a filtering net hole is formed in the inwards-sunken wall. According to the cyclone dust collector, the bottom of the cyclone cylinder body is inwards sunken to form an inwards-sunken structure, so that the normal cyclone separation is achieved, the axial length of the cyclone cylinder body is relatively shortened, thereby relatively increasing the dust collection space of the dust collector and obtaining a good effect which play an active practical significance to the dust collector (for example a handheld dust collector) with a smaller dust holding amount.

Other Abstracts
本实用新型公开了一种旋风吸尘器，包括旋风筒体，所述旋风筒体的底部向内凹陷，内凹壁上设有过滤网孔。本实用新型将旋风筒体的底部向内凹陷，形成内凹结构，在实现正常旋风分离的同时，相对缩短了旋风筒体的轴向长度，从而相对增大了吸尘器的容尘空间，取得了较好的效果，这对于容尘量相对较小的吸尘器（如手持式吸尘器）具有积极的现实意义。

Application Language CHINESE (CHI)

Inventor(s) Wang Wei

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Main claim
1. A cyclonic vacuum cleaner, characterized in: including a cyclone barrel (1), the bottom of the cyclone barrel is inwardly recessed, concave wall is provided with a filter mesh (2).
2. Cyclonic vacuum cleaner according to claim 1, characterized in: cyclone bottom recessed inward, inner cone structure formed.
3. Cyclonic vacuum cleaner according to claim 1, characterized in: a cyclone barrel of the outer sleeve is provided with a 2nd filter screen cover (3).
4. Cyclonic vacuum cleaner according to claim 3, characterized in: 2nd with the cyclone structures are arranged on the same, and both are arranged coaxially.
5. Cyclonic vacuum cleaner according to claim 1, characterized in: cyclone side wall is provided with a plurality of through holes, with the inlet air in the intake direction through-hole reversed direction.
6. Cyclonic vacuum cleaner according to claim 1, characterized in: a cyclone cleaner is a hand-held cleaners.

Original Claims
1.一种旋风吸尘器，其特征在于：包括旋风筒体(1)，所述旋风筒体的底部向内凹陷，内凹壁上设有过滤网孔(2)。
2.根据权利要求1所述的旋风吸尘器，其特征在于：所述旋风筒体的底部向内凹陷，构成内锥结构。
3.根据权利要求1所述的旋风吸尘器，其特征在于：所述旋风筒体的外部套设有第二过滤网罩(3)。
4.根据权利要求3所述的旋风吸尘器，其特征在于：所述第二过滤网罩与旋风筒体的结构相同，且两者同轴设置。
5.根据权利要求1所述的旋风吸尘器，其特征在于：所述旋风筒体的侧壁设有复数个通孔，通孔的进气方向与进风方向相反。
6.根据权利要求1所述的旋风吸尘器，其特征在于：所述旋风吸尘器为手持式吸尘器。

Description
Cyclone dust collector
Technical Field
The present utility model relates to a cleaner, more particularly to a cyclonic vacuum cleaner.
Background Art
Cyclonic vacuum cleaner a suction cleaner were developed in the recent years, without conventional dust collection bag or filter system which may be, but is a high speed spiral path along the air stream flowing past one or more cylinder, when the airflow travels along a helical path through a fast motion, all dirt particles will occur because of the high centrifugal force acts, is thrown from the air flow; achieve such rotation of the cyclone barrel commonly referred to as a carrier gas stream.
The prior art, regardless of the size of the cyclone cylinder body, the existing cyclone barrel are generally conical in shape, and is provided with gas inlets and gas outlets, having a floor ash discharge port. the cyclone chamber is the interior volume thereof. In order to achieve a better separation effect, the axial dimension of the existing cyclone separation device is large, causing the entire vacuum cleaner structure is not compact, in addition, for larger size with respect to a single cyclone separation device, the greater the axial dimension of the primary separation, the smaller the dust-loading space below it, while making the dust-loading space, it is also to increase the overall volume of vacuum cleaner. On the other hand, in the conventional cyclone separation device, in the outer cyclone and is apt to wrap up the detached dust (dust in the dust-collecting bucket for example) re-rolled, and is taken away updrafts, the dust entrained, affects the separation effect.
Summary
The present utility model object of the invention is to provide a cyclonic vacuum cleaner.
To achieve the above object, the present utility model adopts the technical scheme is: a cyclonic cleaner, including a cyclone barrel, the bottom of the cyclone cylinder body is inwardly recessed, concave wall there are the filter mesh.
in the technical solution, the bottom of the cyclone cylinder body is inwardly recessed, constituting the inner cone structure.
The inner cone is provided with a plurality of the filter mesh, the entire cyclone barrel constituting the conical filter screen cover.
in a preferred embodiment, cyclone filter screen cover is provided with a 2nd outer sleeve.
in the technical solution, 2nd structure identical with the cyclone filter screen cover, and both are arranged coaxially.
in the technical solution, the sidewall of the cyclone cylinder body is provided with a plurality of through holes, with the air intake direction opposite the direction of the intake air passage hole.
in the technical solution, as a handheld cleaner cyclone dust collector. Includes a handle, housing, the housing and a motor in the fan unit, the dust collecting tub, a cyclone filter and the like.
Due to technical solution leverages, the present utility model has the following advantages over the prior art:
1. The present utility model will be recessed within the bottom of the cyclone, to form a concave structure, upon attaining normal cyclone separation at the same time, shortens the axial length of the cyclone opposed relation, so that the relative growth of the cleaner of the dust-loading space, has a good effect, this dust holding capacity for a relatively small vacuum cleaner (such as a handheld cleaner) has a positive real value.
2. The present utility model in the bottom of the cyclone cylinder body inwardly depressed at the same time, the filter mesh is provided in its inner wall, constituting the filter screen cover, thereby preventing the dust particles are entrained rising current of air, improving the separation effect.
3. The present utility model in the wind tunnel body is fitted on the outside of the 2nd filter screen cover, forms two filtering structure, further improve the filtering effect.
The present utility model 4 is of simple construction, ease of preparation, suitable for popularization and application.

The accompanying drawings
FIG. 1 is a schematic structural view of the present utility model embodiment one;
FIG. 2 is a partially exploded views of the present utility model embodiment one;
FIG. 3 is a partial sectional view of the present utility model embodiment one.
Wherein: 1, cyclone barrel; 2, the filter mesh; 3, are arranged on 2nd; 4, dust-loading space
Embodiment
The present utility model below in connection with the accompanying drawings and as further described embodiment:
One embodiment
See FIG. 1-3 below illustrates, a hand-held cyclonic vacuum cleaner, includes a cyclone cylinder 1, the bottom of the cyclone cylinder body is inwardly recessed, constituting the inner cone structure, the concave wall there are filtering mesh 2.
2nd cyclone outside of the drum sleeve is provided with filter screen cover 3. 2nd structure identical with the cyclone filter screen cover, and both are arranged coaxially
The sidewall of the cyclone cylinder body is provided with a plurality of through holes, with the incoming air in the intake direction through-hole reversed direction. A hand-held cyclonic vacuum cleaner also includes a handle, housing, the housing and a motor in the fan unit, dust-loading space 4 and the like.

Description

一种旋风吸尘器
技术领域
本实用新型涉及一种吸尘器，具体涉及一种旋风吸尘器。
背景技术
旋风吸尘器是近几年发展起来的一种吸尘器，其可以没有传统的集尘袋或过滤器系统，而是使气流沿着一条高速螺旋形的路径流经一个或多个圆筒；当气流沿螺旋形路径快速运动时，所有脏物颗粒都会因强大的离心力作用，被甩出气流；实现这种气流旋转的载体通常称作旋风筒体。
现有技术中，不论旋风筒体的大小，现有的旋风筒体一般都是呈锥形，其上设有气流入口和气流出口，其底部为排灰口，其内腔即为旋风分离室。为了实现较好的分离效果，现有的旋风筒的轴向尺寸较大，造成了整个吸尘器的结构不紧凑，此外，对于较大尺寸的单个旋风筒而言，旋风筒的轴向尺寸越大，其下方的容尘空间越小，而若增大容尘空间，则又要增加整个吸尘器的体积。另一方面，现有的旋风筒中，外层旋风在向上返转时易将分离下来的灰尘（例如集尘袋中的灰尘）重新卷起，并被上升气流带走，即灰尘夹带，影响分离效果。
发明内容
本实用新型的发明目的是提供一种旋风吸尘器。
为达到上述发明目的，本实用新型采用的技术方案是：一种旋风吸尘器，包括旋风筒体，所述旋风筒体的底部向内凹陷，内凹壁上设有过滤网孔。
上述技术方案中，所述旋风筒体的底部向内凹陷，构成内锥结构。该内锥上设有复数个过滤网孔；使整个旋风筒体构成锥形过滤网罩。
进一步的技术方案，所述旋风筒体的外部套设有第二过滤网罩。
上述技术方案中，所述第二过滤网罩与旋风筒体的结构相同，且两者同轴设置。
上述技术方案中，所述旋风筒体的侧壁设有复数个通孔，通孔地进气方向与进风方向相反。
上述技术方案中，所述旋风吸尘器为手持式吸尘器。包括把手、壳体，壳体内设有电机风扇单元、集尘桶、旋风过滤器等。
由于上述技术方案运用，本实用新型与现有技术相比具有下列优点：
1．本实用新型将旋风筒体的底部向内凹陷，形成内凹结构，在实现正常旋风分离的同时，相对缩短了旋风筒体的轴向长度，从而相对增大了吸尘器的容尘空间，取得了较好的效果，这对于容尘量相对较小的吸尘器（如手持式吸尘器）具有积极的现实意义。
2. 本实用新型在将旋风筒体的底部向内凹陷的同时，在其内凹壁上设置了过滤网孔，构成过滤网罩，从而防止了上升气流的灰尘夹带，提高了分离效果。
3. 本实用新型在风筒体的外部套设第二过滤网罩，形成两道过滤结构，进一步提高了过滤效果。
4 本实用新型的结构简单，易于制备，适于推广应用。
附图说明
图1是本实用新型实施例一的结构示意图；
图2是本实用新型实施例一的局部分解图；
图3是本实用新型实施例一的局部剖视图。
其中：1、旋风筒体；2. 过滤网孔；3、第二过滤网罩；4、容尘空间。
具体实施方式
下面结合附图及实施例对本实用新型作进一步描述：
实施例一
参见图1~3所示，一种手持式旋风吸尘器，包括旋风筒体1，所述旋风筒体的底部向内凹陷，构成内锥结构，内凹壁上设有过滤网孔2。
所述旋风筒体的外部套设有第二过滤网罩3。所述第二过滤网罩与旋风筒体的结构相同，且两者同轴设置。
所述旋风筒体的侧壁设有复数个通孔，通孔的进气方向与进风方向相反。所述手持式旋风吸尘器还包括把手、壳体，壳体内设有电机风扇单元、容尘空间4等。

Dyson Ex1020
Page 1401

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Suction cleaning device

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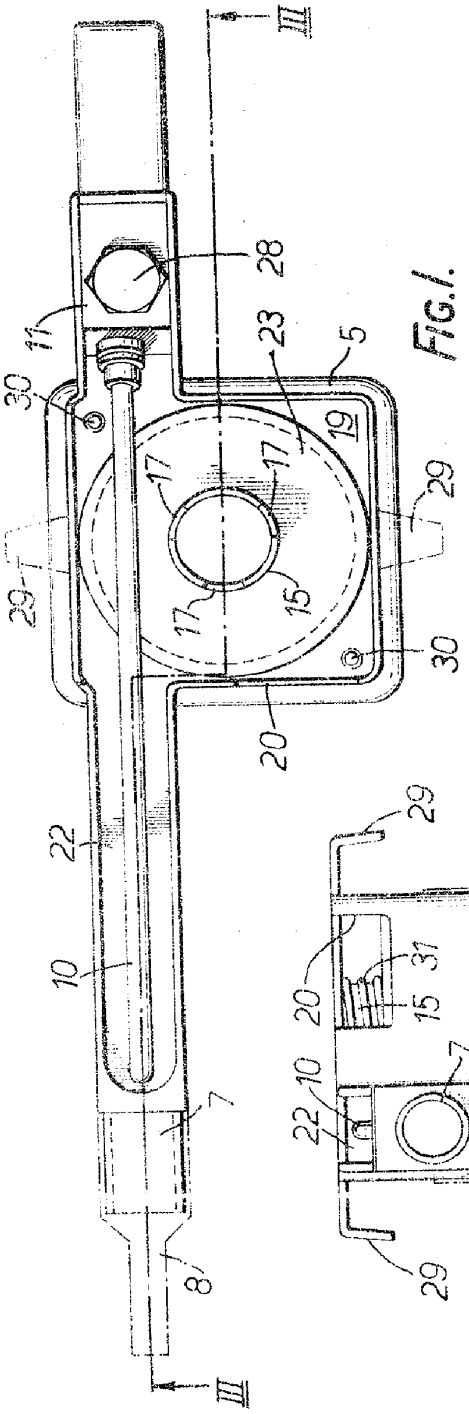

III
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22
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8
III

FIG.1.

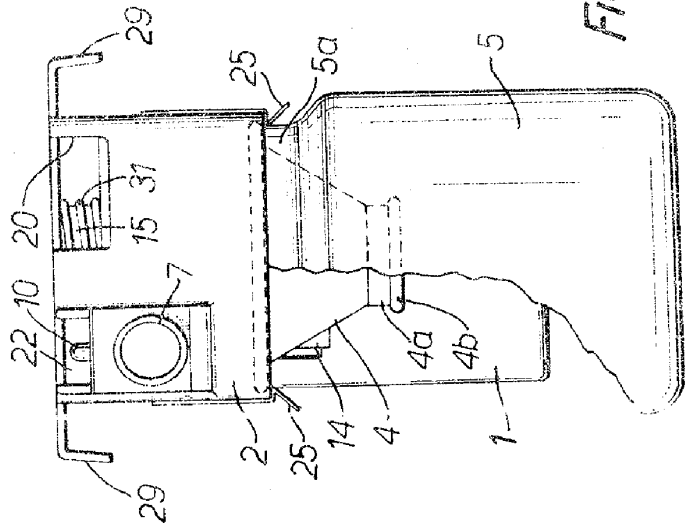

29
25
5a
5
20
31
15
7
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22
4a
4b
14
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2
25
1
29

FIG.2.

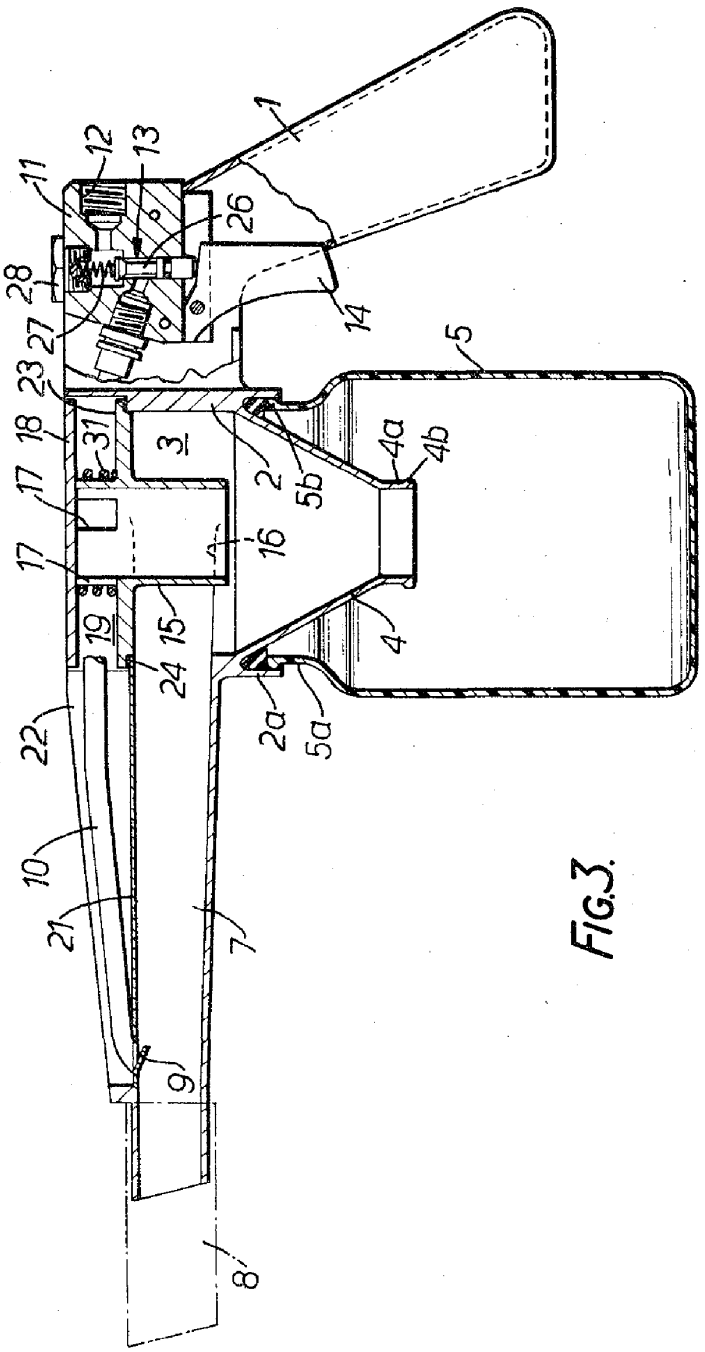

1
11
12
13
26
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14
23
5
18
31
3
2
5b
4a
4b
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16
17
19
15
4
24
2a
5a
22
10
21
7
9
8

FIG.3.

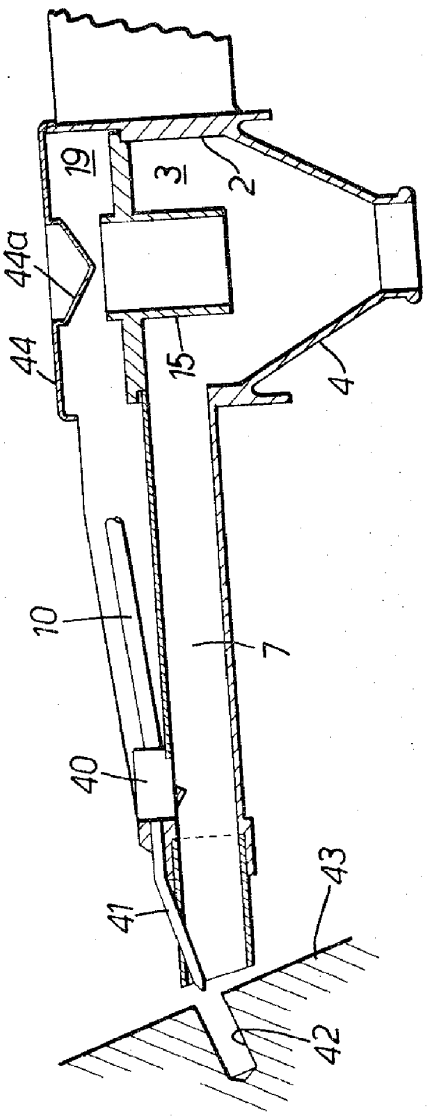


FIG.4.

SPECIFICATION

Suction cleaning device

This invention relates to cleaning devices of the type which employ suction to pick up solid matter which is transported in an air flow to a bag or container in which it collects for disposal.

Devices of this type are not, generally speaking, suitable for workshop use as they do not satisfactorily handle oily metal such as the swarf produced by machine tools. The cleaning out of oily swarf from the T-slots of lathes, milling machines and the like is a common workshop problem. This swarf normally has to be dislodged and brushed out by hand.

The object of the invention is to provide a portable hand-held suction cleaning device which is particularly suitable for workshop use, for example to clear out the T-slots of machine tool slides and tables.

According to the invention a hand-held suction cleaning device has a suction pipe leading to a cyclone separator which exhausts to atmosphere and is disposed above a container for solids which are in use picked up at an inlet end of the pipe and separated out in the separator, and an air inlet connection for coupling to a compressed-air line and which supplies an air jet which discharges into the suction pipe to produce an air flow therealong to the separator with resultant suction at the inlet of the pipe.

Preferably a detachable nozzle at the end of the suction pipe provides the suction inlet, and this nozzle may be one of a range of interchangeable nozzles which are differently shaped to suit a variety of applications. A device in accordance with the invention has in practice proved extremely useful for clearing out machine tool T-slots, and for this purpose an elongated rectangular cross-section nozzle is most suitable.

The device preferably has a pistol-grip handle with an ON/OFF air valve controlling the air jet and operated by a conveniently situated trigger control member. A pre-settable needle valve may also be provided for adjustable throttling of the air flow to the jet, whereby to provide optimum performance for picking up different solid materials. The separator may exhaust at the top and to the side away from the operator, and the container is preferably readily detachable from the separator for emptying when full.

A discharge funnel may be provided below the separator to discharge into the container, and this funnel may have an end section with a lip for attachment of a polythene bag by means of an elastic band in place of the container. This provides ready and safe disposal of contaminated material collected by the device.

An air blast nozzle may be provided which is operable to dislodge solid matter which is subsequently picked up by the suction of the device, for example to dislodge swarf from a blind hole or recess in a component. This air blast nozzle may be concentric with, or otherwise positioned with respect to, a detachable suction nozzle of the device and said ON/OFF air valve may simultaneously supply the air blast nozzle and the suction air jet. Alternatively, the air blast nozzle may have its own air supply controlled along with the suction air jet by a two-position trigger control valve operable to supply the air jet, and thus apply suction, first, and then to apply both an air blast and suction should this be necessary.

A general-purpose suction cleaning device designed with the problem of clearing out the T-slots of machine tools particularly in mind is illustrated, by way of example, together with a modification, in the accompanying drawings and will now be described with reference thereto. In the drawings:

Figure 1 is a plan view of the device;

Figure 2 is a suction-inlet end view, with a container of the device partly cut away;

Figure 3 is a sectional view on the line III–III in Fig. 1; and

Figure 4 is a fragmentary sectional view, on the same section line, showing the modification.

The hand-held device illustrated in Figs. 1 to 3 has a stock 1 (shown partly cut away in Fig. 3) which provides a pistol grip and to which is attached a cyclone separator chamber 3 disposed coaxially above a frusto-conical discharge funnel 4. A detachable circular blow-moulded polythene container 5 has a neck 5a which fits into a bottom skirt 2*a* of the separator 2, the funnel 4 projecting a short distance down into the container 5.

A suction pipe 7 enters the cyclone chamber 3 tangentially at one side of the device, and an interchangeable inlet nozzle 8 (shown in broken lines) is a push fit on the end of the pipe 7. The inlet nozzle shown is of elongated rectangular cross-section, which is particularly suitable for clearing swarf out of T-slots. An air jet nozzle 9, formed by semi-piercing the upper wall of the tube 7 adjacent the inlet end thereof, discharges into the separator 2 with the resultant production of a vacuum at the inlet nozzle 8.

The jet nozzle 9 is supplied by an air supply pipe 10 leading from a valve block 11 at the top of the stock 1. At the block 11 an inlet connection 12 enables the pipe 10 to be connected to a compressed-air line through an ON/OFF valve 13 housed in the block 11. The valve 13 is normally OFF and is actuated, to operate the device, by a trigger control member 14 mounted in the stock 1.

A tubular exhaust outlet pipe 15 mounted centrally of the separator 2 projects upwardly from and downwardly into the chamber 3 to a

level below the port of entry 16 of the tube 7 into the chamber 3. The exhaust pipe 15 has side outlets 17 at an upper level and is capped by a closure plate 18 which closes the top of the pipe 15 and surrounding exhaust chamber 19 which in turn discharges to atmosphere forwardly, and thus away from the operator holding the stock 1, through an air discharge aperture 20.

The stock 1, separator 2, funnel 4 and tube 7 are all provided by an integral die-casr body of aluminium or zinc based alloy. The casting is open at the top above the tube 7 and the separator chamber 3, the casting being closed to form the tube by a closure plate 21 providing said upper wall in which the jet nozzle 9 is formed. The supply pipe 10 to the nozzle 9 passes through the space 22 within the die-cast body above the plate 21 as well as through the chamber 19, and it is encapsulated within the space 22, for example with an epoxy resin. The exhaust pipe 15 is provided by a further die-cast moulding which fits into the body and has an intermediate annular flange 23 which seals against the body through a gasket 24 to form the top of the cyclone separating chamber 3.

The neck 5a of the container 5 has a top lip 5*b* engaged by two spring clips, which are respectively fixed to the sides of the body and act to retain the container. This provides a quick-release attachment for the container 5, and the rim of the container neck 5a seals against a foam rubber sealing ring housed in a recess between the skirt 2a and the funnel 4. The frusto-conical funnel 4 has a short cyclindrical extension at its lower end with a lip 4*b* to retain an elastic band which can be used to secure a disposable polythene bag to the funnel in lieu of the container 5. This simplifies the disposal of contaminated material which can be thrown away with the bag.

The valve 13 comprises a simple poppet valve member 26 which is directly displaceable off its seating in the block 11 (which is shown sectioned in Fig. 3) by the trigger member 14 which is pivoted to the block 11. The valve member 26 is urged to the closed position, as shown, by a valve spring 27 an abutment for which is provided by a closure plug 28 screwed into the block 11. This plug seals off an aperture through which the valve member 26 and the spring 27 are fitted.

To use the device the operator actuates the trigger member 14, thus starting the air flow along the tube 7 into the cyclone chamber 3. Swarf or other solid matter to be collected can then be picked up by the suction at the nozzle 8, and transported by the air stream along the tube 7 to the chamber 3. In that chamber a normal centrifugal cyclone separation occurs, the solid matter which is separated out falling down the funnel 4 into the container 5 which can be detached and emptied when full, or into a disposable polythene bag fixed to the extension 4a when preferred. The air discharges to atmosphere from the chamber 3 through the pipe 15 and chamber 19.

As shown the pistol grip is offset to said one side of the central section line II–II and line with the tube 7 to improve balance, and as a modification (not shown) the air jet 9 may be positioned on the vertical centre line of the tube 7. As a further modification (aga not shown) the air jet may be provided by a drilling, which may be divergent, in a connecting piece mounted at the end of the tub 7 and on to which the interchangeable nozz such as 8 fit.

At the sides of the device the closure plat 18 has projecting angled lugs 29 (see Fig. 2 These enable the device to be hung up out the way when not in use. The closure plate 18 is shown in ghost broken outline in Fig. to show how the pipe 10 passes through th chamber 19 to the valve block 11. The plat 18 is held in place by two screws at 30, an it retains a spring 31 which holds the flange 23 in sealing engagement with the gasket 2 The bottom end inlet of the exhaust pipe 15 is positioned at the bottom of the cyclone separator chamber 3, and the exhaust discharge path through the exhaust chamber 1 prevents any possibility of non-separated so ids being exhausted to atmosphere. Any sol which may enter the pipe 15 will collect in the chamber 19. Removal of the plate 18 enables the chamber 19 to be cleaned out, and also the moulding 15, 23 to be remove for cleaning of the device as a whole and should the chamber 3 become clogged with swarf.

In the modification of Fig. 4 the air suppl pipe 10 supplies an air distribution block 4 which in turn supplies a forwardly directed blast nozzle 41 as well as the suction air jet nozzle 9. The interchangeable inlet suction nozzle 8 is cut away to allow the nozzle 41 project within the cross-sectional area of th suction nozzle 8. Fig. 4 illustrates how the modified device is used to remove swarf fr a blind hole 42 in a component 43. The device is positioned so that when the trigge operated ON/OFF valve is actuated the air blast from the nozzle 41 dislodges the swa in the bore 42, the dislodged swarf then being picked up by the suction nozzle 8 an transported along the suction pipe 7 to the cyclone chamber 3.

The device as modified in Fig. 4 also has top cover 44 which replaces the closure pl 18 of Figs. 1 to 3 and is in the form of a l pressing. This pressing has an indentation 44a to assist the air flow and for location the spring 31. The exhaust pipe 15 projec only a short distance upwardly into the exhaust chamber 19, terminating well below top cover 44 so that slotting of the pipe 1 not now necessary.

Dyson Ex1020
Page 1407

CLAIMS

1. A hand-held suction cleaning device having a suction pipe leading to a cyclone separator which exhausts to atmosphere and is disposed above a container for solids which are in use picked up at an inlet end of the pipe and separated out in the separator, and an air inlet connection for coupling to a compressed air line and which supplies an air jet which discharges into the suction pipe to produce an air flow therealong to the separator with resultant suction at the inlet end of the pipe.

2. A device according to claim 1, wherein a detachable nozzle at the inlet end of the pipe provides the suction inlet.

3. A device according to claim 2, wherein said nozzle is one of a range of interchangeable nozzles differently shaped to suit a variety of applications.

4. A device according to claim 2 or 3, wherein said nozzle, or one of said range thereof, is of elongated rectangular cross-section as suited to clearing out the T-slots of a slide or table of a machine tool.

5. A device according to any one of the preceding claims, wherein a discharge funnel below the separator discharges into the container.

6. A device according to claim 5, wherein said funnel has an end section with a lip to retain an elastic band by means of which a disposable polythene bag can be secured to the funnel in place of the container.

7. A device according to any one of the preceding claims, wherein the device has a pistol-grip handle, an ON/OFF air valve to control the air jet and a trigger control member for operation of the air valve.

8. A device according to any one of the preceding claims, wherein a pre-settable needle valve is provided for adjustable throttling of the air flow to said air jet.

9. A device according to any one of the preceding claims, wherein said separator has an annular chamber into which the suction pipe feeds tangentially and which exhausts to atmosphere through an exhaust pipe positioned centrally of the chamber, said exhaust pipe having an inlet at the bottom of the separator chamber and an outlet above the chamber.

10. A device according to claim 9, wherein said exhaust pipe outlet discharges into an exhaust chamber disposed above the separator chamber and which in turn discharges to atmosphere away from an operator when holding the device.

11. A device according to claim 9 or 10, wherein the separator chamber is formed within a main body moulding to which the container is detachably secured, and the exhaust pipe is provided by a removable moulding which includes an intermediate flange which forms the top wall of the separator chamber.

12. A device according to claim 11, wherein the removable moulding is held in position within the body moulding by a top closure plate which provides the top of said exhaust chamber and is detachable for cleaning the exhaust chamber and removal of the exhaust pipe moulding.

13. A device according to any one of the preceding claims, wherein said air jet issues from a nozzle in the wall of the suction pipe adjacent the inlet end thereof.

14. A device according to any one of the preceding claims, wherein an air blast nozzle of the device is positioned to produce an air blast operative to dislodge material to be picked up at the inlet end of the suction pipe.

15. A device according to claims 7 and 14, wherein said ON/OFF valve supplies both the suction air jet and the air blast nozzle.

16. A hand-held suction cleaning device constructed and arranged substantially as herein particularly described with reference to and as illustrated in Figs. 1 to 3 of the accompanying drawings, or modified as shown in Fig. 4 of the accompanying drawings.

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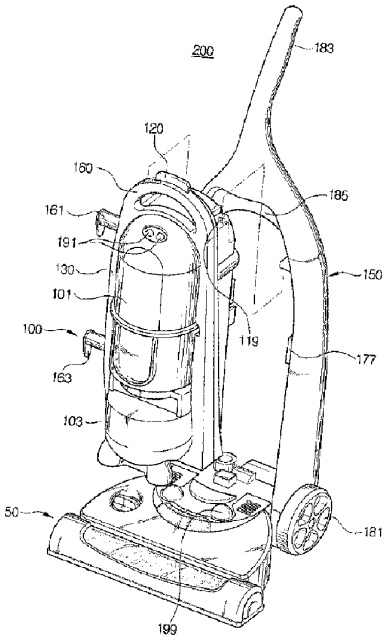
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(54) ASPIRATEUR MULTIFONCTIONS
(54) A MULTIFUNCTION VACUUM CLEANER

(57)

A multifunction vacuum cleaner, in which a main body is removably connected to a frame portion, comprises a nozzle assembly for suctioning in an air including dusts or dirt on a cleaning area, a main body having a cyclone dust collector for centrifugally separating the dusts or dirt from the sucked air, a dust receptacle for collecting the separated dusts or dirt, a main body frame having an upper casing and a lower casing, a button operation portion formed on an upper part of the main body frame, and a connecting projection integrally formed with the button operation portion and moving elastically, and a frame portion which is pivotably connected with the nozzle assembly, and having a connecting groove to correspond to the connecting projection. The main body of the vacuum cleaner is removably mounted in the frame portion. As a result, the main body can be conveniently connected with or separate from the frame portion.



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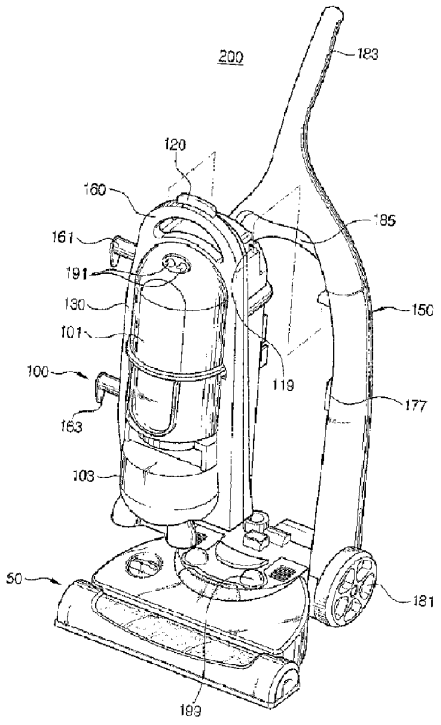
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(54) Titre : ASPIRATEUR MULTIFONCTIONS
(54) Title: A MULTIFUNCTION VACUUM CLEANER



(57) Abrégé/Abstract:
A multifunction vacuum cleaner, in which a main body is removably connected to a frame portion, comprises a nozzle assembly for suctioning in an air including dusts or dirt on a cleaning area, a main body having a cyclone dust collector for centrifugally separating the dusts or dirt from the sucked air, a dust receptacle for collecting the separated dusts or dirt, a main body frame

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(57) Abrégé(suite)/Abstract(continued):
having an upper casing and a lower casing, a button operation portion formed on an upper part of the main body frame, and a connecting projection integrally formed with the button operation portion and moving elastically, and a frame portion which is pivotably connected with the nozzle assembly, and having a connecting groove to correspond to the connecting projection. The main body of the vacuum cleaner is removably mounted in the frame portion. As a result, the main body can be conveniently connected with or separate from the frame portion.

Dyson Ex1020
Page 1411

ABSTRACT OF THE DISCLOSURE

A multifunction vacuum cleaner, in which a main body is removably connected to a frame portion, comprises a nozzle assembly for suctioning in an air including dusts or dirt on a cleaning area, a main body having a cyclone dust collector for centrifugally separating the dusts or dirt from the sucked air, a dust receptacle for collecting the separated dusts or dirt, a main body frame having an upper casing and a lower casing, a button operation portion formed on an upper part of the main body frame, and a connecting projection integrally formed with the button operation portion and moving elastically, and a frame portion which is pivotably connected with the nozzle assembly, and having a connecting groove to correspond to the connecting projection. The main body of the vacuum cleaner is removably mounted in the frame portion. As a result, the main body can be conveniently connected with or separate from the frame portion.

A MULTIFUNCTION VACUUM CLEANER

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates generally to a vacuum cleaner, and more particularly, to a vacuum cleaner for multi purpose use in which the main body of the cleaner is removably mounted in the frame portion.

2. Description of the Related Art

A general upright vacuum cleaner cleans a wide area such as a floor or a carpet, by forcibly suctioning dust and dirt entrained within air that is drawn in by suction force generated inside the main body of the vacuum cleaner.

As shown in Fig. 1, a general conventional vacuum cleaner comprises a nozzle assembly 12 mounted in the bottom part of the main body 11 of the vacuum cleaner to move along an area to be cleaned, such as a floor or carpet. Inside the main body 11, an upper part comprising a dust collecting chamber (not shown) includes a dust bag (not shown in Fig. 1), and a lower part includes a motor driving chamber 30 where a motor is mounted. The dust collecting chamber is shut by a dust cover 10, as shown.

Above the main body 11 is mounted a handle portion 13 for pushing or pulling the vacuum cleaner, including the nozzle assembly 12 over the surface to be cleaned. On one side of the main body 11, an on/off switch 15 is disposed.

In the above structure, when the motor is driven by manipulation of the on/off switch 15, a strong suction force is generated in the nozzle assembly 12, and thereby air, including entrained dust and dirt, is removed from the area to be cleaned around the nozzle assembly 12 and is suctioned into the main body 11.

The air drawn into the nozzle 12 passes through the dust bag in the dust collecting chamber of the main body 11 and the motor driving chamber 30, through a grill unit mounted between the dust collecting chamber and the motor driving chamber 30. Here, the dust entrained in the air is collected in the dust bag, and the air is discharged to the outside through a discharging grill 40, after passing through the motor driving chamber 30.

After the cleaning work has been completed, if the dust collecting chamber becomes filled with a predetermined amount of dust, a user can separate the dust cover 10 and replace the full dust bag with a new dust bag to continue use of the vacuum cleaner.

However, the above-described structure of a general upright vacuum cleaner has several problems, such as the following.

General upright vacuum cleaners are usually used for cleaning a wide area such

Dyson Ex1020
Page 1414

as a floor or a carpet. Therefore, when the area to be cleaned is narrow or has obstacles, such as a projection or a doorsill, conventional upright vacuum cleaners are inefficient to use.

Further, the main body portion of general conventional upright vacuum cleaners is not removable. As a result, upright vacuum cleaners comprising an integral dust collector are somewhat bulky.

Still further, for cleaning a narrow area or an area having obstacles, a user needs to additionally prepare and have ready a variety of auxiliary brushes or accessories for a vacuum cleaner, or is required to buy a separate small vacuum cleaner, which becomes quite uneconomical.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a vacuum cleaner for multifunction use to overcome the above problems, of which the main body of the cleaner is removably mounted in the frame portion.

Another object of the present invention is to provide a multifunction vacuum cleaner of an improved structure, of which the main body of the cleaner is easy to attach to or separate from the frame portion.

Yet another object of the present invention is to provide a multifunction vacuum cleaner which is compact and economical.

In order to achieve the above-described objects, there is provided a multifunction vacuum cleaner according to the present invention, which is removably connected to a frame portion, and comprises a nozzle assembly for drawing in air, including entrained dust or dirt, from as area or surface to be cleaned, a main body having a cyclone dust collector for centrifugally separating the dust or dirt from the air drawn into the cyclone dust collector, a dust receptacle for collecting the separated dusts or dirt, a main body frame having an upper casing and a lower casing, a button operation portion formed on an upper part of the main body frame, and a connecting projection, integrally formed with the button operation portion, capable of moving together with the button operation portion, and a frame portion pivotably connected with the nozzle assembly, and having a connecting groove capable of receiving the connecting projection therein.

The button operation portion further comprises a button operation portion body which is essentially semicircular, a biasing member for biasing the button operation portion body toward a desired position, a pressing button integrally formed with the button operation portion body at a top part thereof, and a guide extended from one side of the button operation portion.

The main body frame comprises a biasing member supporting portion for supporting the biasing member, a guide groove for guiding movement of the guide, and an opening through which the connecting projection protrudes, whereby the button operation portion moves in the main body as the pressing button of the button operation portion is depressed.

Additionally, the main body preferably comprises a handle portion allowing a user to grab on the upper part, and the handle portion is shaped to correspond to the shape of the button operation portion and has a hollow portion therein.

Here, it is preferable that the main body comprises on one of its sides, a first rotatable cord holder for winding therearound and holding a power cord of the vacuum cleaner, and a stationary second cord holder formed at a predetermined distance from the first cord holder. Further, the main body comprises a communicating member disposed at a bottom part of the main body for fluidly communicating with the nozzle assembly.

In addition, it is also preferable that the main body further comprises a flexible hose capable of being connected to the communicating member, a hose supporting member for supporting the flexible hose, and a discharging grill through which the clean air is discharged. It is preferable that the flexible hose is removably connected to the communicating member, and when removed, capable of being connected with an auxiliary

accessory on one end thereof.

In addition, it is preferable that the main body comprises an on/off switch located at a front side of the main body, and the frame portion has at least one supporter formed on at least one side thereof to provide support to the main body when it is mounted therein. Here, each supporter may include a mounting guide on one side of the supporter for the mounting of accessories for use with the vacuum cleaner.

The connecting groove preferably has a slanted part for easier insertion of the main body into the frame portion. It is preferable that the frame portion comprises wheels on both sides of the bottom thereof, which are disposed for use with the frame portion to permit easier motion of the vacuum cleaner over the area or surface to be cleaned.

The frame portion has a frame handle portion extending upward from the top of the frame portion, and a handle recess corresponding to the button operation portion of the main body.

In another embodiment, a multifunction vacuum cleaner for cleaning a surface according to the present invention comprises a nozzle assembly for drawing in air, including entrained dust or dirt, from the surface, a main body having a cyclone dust collector for centrifugally separating the dust or dirt from the air drawn into the cyclone dust collector, a dust receptacle for collecting the separated dust or dirt separated in the

cyclone dust collector, a main body frame, a button operation portion including a connecting projection capable of moving together with the button operation portion, and a frame portion, pivotably connected with the nozzle assembly, having a connecting groove capable of receiving the connecting projection therein.

The button operation portion may further comprise an essentially semicircular button operation portion body, a biasing member for biasing the button operation portion toward a desired position, a pressing button integrally formed with the button operation portion body disposed at a top part thereof, and a guide extended from one side of the button operation portion.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when read with regard to the following description, appended claims, and accompanying drawings wherein:

Fig. 1 is a perspective view of a conventional upright vacuum cleaner;

Fig. 2 is a perspective view showing the structure of a multifunction vacuum cleaner according to the present invention having a main body removable from a frame portion;

Dyson Ex1020
Page 1419

Fig. 3 is a partially exploded, perspective view of a button operation portion of the multifunction vacuum cleaner according to the present invention;

Fig. 4A is a perspective view showing a connecting projection of the main body Fig. 4B is a perspective detail view of a connecting groove of a frame portion of the multifunction vacuum cleaner according to the present invention; and

Fig. 5 is a rear view of the main body of the multifunction vacuum cleaner according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, preferred embodiments of a cyclone type vacuum cleaner according to the present invention will be described in detail with reference to the accompanying drawings.

Fig. 2 is a perspective view showing the structure of a multifunction vacuum cleaner according to a preferred embodiment of the present invention having a main body removable from a frame portion.

Referring to Fig. 2, the vacuum cleaner comprises a nozzle assembly 50, a main body 100 fluidly communicating with the nozzle assembly 50, and a frame portion 150 which is pivotably connected with the nozzle assembly and capable of pivoting in relation

Dyson Ex1020
Page 1420

to the nozzle assembly 50. The main body 100 is removably connected within the frame portion 150.

The nozzle assembly 50 has a suction port (not shown) in a bottom surface thereof for drawing in air and entrained dust therethrough, and a seating support 199 formed on the upper part for mounting of the main body 100 into the frame portion 150 in a secure manner.

The main body 100 comprises a main body frame 130, preferably surrounding the other elements of the main body, such as a cyclone dust collector 101 for centrifugally separating dust from the air drawn into the cyclone dust collector 101, and a dust receptacle 103, which is removable, for collecting the separated dust.

The cyclone dust collector 101 is a general dust collector which separates dust from the air by centrifugal force in a cyclone stream. The dust receptacle 103 is also a general dust receptacle for collecting the dust separated in the cyclone dust collector 101. Dust receptacle 103 is removable from the main body frame 130.

Fig. 3 is a partially exploded perspective view of a button operation portion 120 of the multifunction vacuum cleaner according to the present invention. As shown in Figs. 2 and 3, the main body frame 130 comprises an upper casing 105, a lower casing 107 for connection to the upper casing 105, and the button operation portion 120 formed on an

Dyson Ex1020
Page 1421

upper part of the main body frame 130 and sandwiched between the upper casing 105 and the lower casing 107.

The button operation portion 120 comprises a button operation portion body 111 which is semicircular, a biasing member 113 disposed to cooperate with the button operation portion body 111, a pressing button 115, preferably integrally formed with the button operation portion body 111 adjacent the top portion thereof, a guide 117 extended from one side of the button operation portion 120, and at least one connecting projection 119 integrally formed with the button operation portion 120, to move in conjunction with the button operation portion 120.

If the pressing button 115 of the button operation portion 120 is depressed, the connecting projection 119, which is integrally formed therewith, accordingly moves in a downward direction. Contrarily, if the pressing force is removed from the pressing button 115, the button operation portion 120 reverts to the initial position above the main body frame 130 by the recovery force of a biasing member 113. The biasing member 113 is preferably configured as a spring, such as a coil spring, as shown.

In addition, the main body frame 130 may comprise a biasing member supporting portion 133 for supporting the biasing member 113, a guide groove 131 for guiding movement of the guide 117, and an opening 135 for the connecting projection 119 to

Dyson Ex1020
Page 1422

protrude therethrough.

Accordingly, by depressing the button 115 of the button operation portion 120, the button operation portion 120 moves as a whole within the main body 100 and is elastically biased to return to the normal position during operation of the vacuum cleaner.

Further, the main body 100 of the vacuum cleaner comprises a handle portion 160 (Fig. 2) permitting the user to grab the upper part of the main body 100. The handle portion 160 has a hollow portion therein shaped and configured to correspond to the button operation portion 120. Accordingly, the main body 100 is easily separated from the frame portion 150 by simply depressing the pressing button 115 of the button operation portion 120 as the user grabs the handle portion 160.

Fig. 4A is a perspective view showing a connecting projection of the main body and Fig. 4B is a detail perspective view of a connecting groove formed on a frame portion of the multifunction vacuum cleaner according to the present invention. Fig. 5 is a rear view of the main body of the multifunction vacuum cleaner according to the present invention.

Referring to Figs. 4A, 4B and 5, on the main body 100 adjacent a flank thereof, a rotatable first cord holder 161 is provided for winding and holding a cord 205 of the vacuum cleaner 200 thereon, and a second cord holder 163, is disposed at a predetermined

Dyson Ex1020
Page 1423

distance from the first cord holder 161.

With the first and second cord holders 161, 163, a user can retain the cord 205 attached to the main body 100 in a handy and compact manner.

A connecting member 165 fluidly communicating with the nozzle assembly 50 is formed at a bottom part of the main body 100. On the rear side of the main body 100 are formed a flexible hose 167 to be connected to the connecting member 165, a hose supporting member 169 to support the flexible hose 167, and a discharging grill 195 for discharging the air after it has been separated from dust and debris.

In using the main body 100 alone, when separated from the frame portion 150, an end of the flexible hose 167 can be separated from the connecting member 165 so as to permit attachment thereof to auxiliary brushes or other accessories.

Further, an on/off switch 191 is formed on a side of the main body 100 to enable the user to turn the vacuum cleaner on and off. Generally, the on/off switch is preferably formed on an upper part of a front side of the main body 100, as shown in Fig. 4A.

Referring to Figs. 2, 4A and 4B, the frame portion 150 where the main body 100 is removably mounted will be described hereinafter.

Since at least one connecting groove 171 is formed on one side of the frame portion 150 to correspond to each connecting projection 119, the main body 100 can be

Dyson Ex1020
Page 1424

removably mounted into the frame portion 150. It is preferable that respectively two connecting projections 119 and connecting projection grooves 171, correspondingly disposed to the connecting projections 119, are formed to connect securely to each other.

Additionally, supporters 177 are formed on both sides of the frame portion 150 to support the main body 100 after it is mounted within the frame portion 150.

A mounting guide 179 is formed on one side of the supporter 177 for mounting of the accessories of the vacuum cleaner thereon. Therefore, when the main body 100 is separated from the frame portion 150, because the auxiliary brushes or other accessories do not have to be connected on the main body 100, the main body 100 can be used without carrying the unnecessary weight of the auxiliary brushes or other accessories.

The connecting groove 171 may be partially slanted with respect to the frame portion 150 so that the main body 100 is easily connected with the frame portion 150 along the slant of the connecting projection groove 171. Further, on both sides of the bottom of the frame portion 150, wheels 181 are formed to permit the frame and vacuum cleaner to move along an area to be cleaned.

In addition, a frame handle portion 183 is formed extending upwardly from the top of the frame portion 150, and a handle recess 185, is formed in the frame portion 150 to correspond with the position of the button operation portion 120 of the main body 100.

Dyson Ex1020
Page 1425

Due to the presence of the handle recess 185, the user can depress the button operation portion 120 more easily.

Hereinafter, the operation of the vacuum cleaner according to the present invention, in which the main body is removably mounted into the frame, will be described.

Through manipulation of the on/off switch 191, power is supplied to the vacuum cleaner. Accordingly, a motor (not shown) in the main body 100 is driven, subsequently generating a strong suction force at the nozzle assembly 50, which is fluidly communicated with the main body 100. By the suction force, dust and dirt located on the area to be cleaned is drawn through the suction port (not shown) of the nozzle assembly 50 and the flexible hose 169, and then to the main body 100.

The dust is centrifugally separated from the air drawn into and passing through the cyclone dust collector 101 of the main body 100. The filtered air is discharged through the discharging grill 195, which is on the rear side of the main body 100, as shown in Fig. 5.

The separated dust and dirt is collected in the dust receptacle 103 of the main body 100. When the collected dust fills the dust receptacle 103 to a predetermined amount, the user may separate the dust receptacle 103 to empty the dust receptacle 103 and then remount the dust receptacle into the main body 100.

For a narrow area to be cleaned or if there is an obstacle, such as a doorsill, in the

Dyson Ex1020
Page 1426

way of the free movement of the nozzle 50, the user can separate the main body 100 from the frame portion 150 by depressing the button operation portion 120 of the handle portion 160 and thereby causing the at least one connecting projection 119, which is integrally formed with the button operation portion 120, to withdraw from the connecting groove 171 of the frame portion 150.

Then, the biasing member 113 disposed in the button operation portion 120 is compressed. The biasing member 113 returns the button operation portion 120 to the initial position automatically, after the main body 100 is separated form the frame portion 150.

When separating the main body 100 from the frame portion 150, the direction of separating the main body 100 and the direction of pressing the button operation portion 120 usually make a right angle. That is, the user can separate the main body 100 from the frame portion 150 by pulling the handle portion 160 in a direction perpendicular to the direction of pressing the button operation portion 120 and so remove the main body 100 to clean in a narrow space.

After separating the main body 100 from the frame portion 150, the user can separate an end of the flexible hose 167 from the connecting member 165 to enable the attachment of general auxiliary brushes or other accessories to clean a desired area, such as bedclothes or a narrow space.

Dyson Ex1020
Page 1427

After the cleaning work in the narrow space has been completed, the user reconnects the flexible hose 167 to the connecting member 165 of the main body 100, and connect the main body 100 to the frame portion 150 by taking the handle portion 160 and inserting the bottom thereof into the bottom part of the frame portion 150.

More specifically, as the main body 100 is pushed toward the frame portion 150, with its bottom part being affixed onto the seating portion 199, the connecting projection 119 of the button operation portion 120 is slid along the slanted surface of frame portion 150 and then hooked in the connecting groove 171 of the frame portion 150.

At this time, the biasing member 113 in the button operation portion 120 biases the connecting projection 119 toward the normal position, so that the button operation portion 120 is elastically connected into the connecting groove 171 of the frame portion 150. Further, the main body 100 is naturally connected to the frame portion 150 by gravity acting on the weight of the main body 100, and is securely fixed by the supporter 177.

As described hereinbefore, according to the present invention, when the area to be cleaned is narrow or there is a doorsill or other obstruction on the floor, the user can separate the main body 100 of the vacuum cleaner 200 from the frame portion 150 and so, use it more conveniently. Moreover, it is economical since the user does not have to purchase an additional smaller size vacuum cleaner.

Dyson Ex1020
Page 1428

Further, it is convenient to a user since the vacuum cleaner according to the present invention can be used depending on the user's choice such as whether the user will use the vacuum cleaner with the main body 100 being connected to the frame portion 150 or being separated from the frame portion 150.

In addition, the main body 100 can be separated easily by the button operation portion 120 located on the top of the main body 100 of the vacuum cleaner, and can be easily connected due to its own weight. Also, the vacuum cleaner according to the present invention has a more rigid structure. Accordingly, the user can connect or separate the main body 100 of the vacuum cleaner 200 easily.

While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

Dyson Ex1020
Page 1429

WHAT IS CLAIMED IS:

1. A multifunction vacuum cleaner comprising:

a nozzle assembly for drawing in air, including entrained dust or dirt, from an area to be cleaned;

a main body having a cyclone dust collector for centrifugally separating the dust or dirt from the air drawn into the cyclone dust collector, a dust receptacle for collecting the separated dust or dirt separated in the cyclone dust collector, a main body frame having an upper casing and a lower casing, a button operation portion formed on an upper part of the main body frame, and a connecting projection, integrally formed with the button operation portion, capable of moving together with the button operation portion; and

a frame portion, pivotably connected with the nozzle assembly, and having a connecting groove capable of receiving the connecting projection therein.

2. The multifunction vacuum cleaner of claim 1, wherein the button operation portion further comprises:

a button operation portion body which is semicircular;

a biasing member for biasing the button operation portion body toward a desired position;

Dyson Ex1020
Page 1430

a pressing button integrally formed with the button operation portion body at a top part thereof; and

a guide extended from one side of the button operation portion.

3. The multifunction vacuum cleaner of claim 2, wherein the main body frame comprises a biasing member supporting portion for supporting the biasing member, a guide groove for guiding movement of the guide, and an opening through which the connecting projection protrudes, whereby the button operation portion moves in the main body as the pressing button of the button operation portion is depressed.

4. The multifunction vacuum cleaner of claim 1, the main body comprises a handle portion to permit a user to grab on the upper part.

5. The multifunction vacuum cleaner of claim 4, the handle portion is shaped to corresponding to the shape of the button operation portion and includes a hollow recess therein.

Dyson Ex1020
Page 1431

6. The multifunction vacuum cleaner of claim 1, wherein the main body further comprises on one side thereof:

a rotatable first cord holder for winding therearound and holding a power cord of the vacuum cleaner; and

a stationary second cord holder formed at a predetermined distance from the first cord holder.

7. The multifunction vacuum cleaner of claim 1, wherein the main body further comprises a communicating member disposed at a bottom part of the main body for fluidly communicating with the nozzle assembly.

8. The multifunction vacuum cleaner of claim 7, wherein the main body includes a rear portion, and further comprises:

a flexible hose capable of being connected to the communicating member;

a hose supporting member for supporting the flexible hose; and

a discharging grill through which clean air is discharged.

Dyson Ex1020
Page 1432

9. The multifunction vacuum cleaner of claim 8, wherein the flexible hose is removably connected to the communicating member, and when removed, capable of being connected with an auxiliary accessory on one end thereof.

10. The multifunction vacuum cleaner of claim 1, wherein the main body further comprises an on/off switch located at a front side of the main body.

11. The multifunction vacuum cleaner of claim 1, wherein the frame portion further includes at least one supporter formed on at least one side thereof to provide support for the main body when it is mounted therein.

12. The multifunction vacuum cleaner of claim 11, wherein each supporter has a mounting guide on one side of the supporter for the mounting of accessories for use with the vacuum cleaner.

13. The multifunction vacuum cleaner of claim 1, wherein the connecting groove further includes a slanted part for easier insertion of the main body into the frame portion.

Dyson Ex1020
Page 1433

14. The multifunction vacuum cleaner of claim 1, wherein the frame portion further comprises wheels on both sides of the bottom thereof to permit easier motion of the vacuum cleaner over the area to be cleaned.

15. The multifunction vacuum cleaner of claim 1, wherein the frame portion has a frame handle portion extending upwardly from the top of the frame portion, and a handle recess corresponding to the button operation portion of the main body.

16. A multifunction vacuum cleaner for cleaning a surface comprising:

a nozzle assembly for drawing in air, including entrained dust or dirt, from the surface;

a main body having a cyclone dust collector for centrifugally separating the dust or dirt from the air drawn into the cyclone dust collector, a dust receptacle for collecting the separated dust or dirt separated in the cyclone dust collector, a main body frame, a button operation portion including a connecting projection capable of moving together with the button operation portion; and

a frame portion, pivotably connected with the nozzle assembly, and having a connecting groove capable of receiving the connecting projection therein.

Dyson Ex1020
Page 1434

17. The multifunction vacuum cleaner of claim 16, wherein the button operation portion further comprises:

an essentially semicircular button operation portion body;

a biasing member for biasing the button operation portion toward a desired position;

a pressing button integrally formed with the button operation portion body disposed at a top part thereof; and

a guide extended from one side of the button operation portion.

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Ottawa, Canada
Patent Agents

FIG. 1

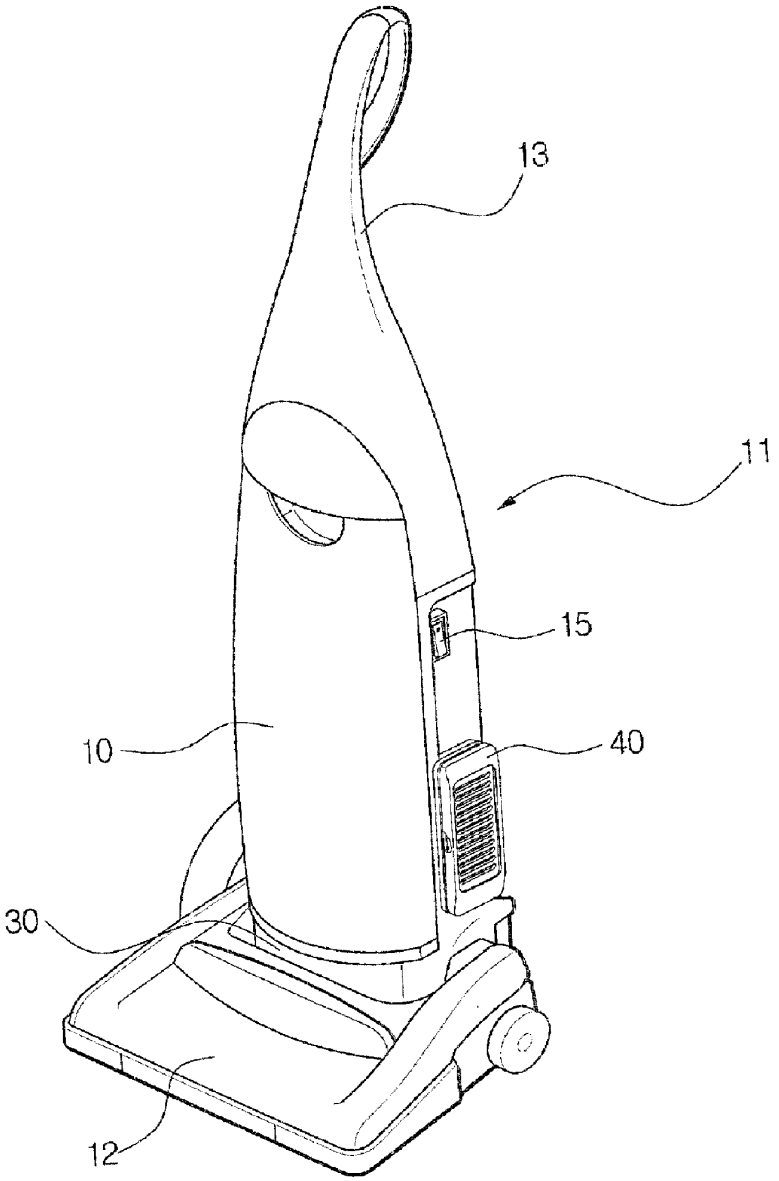


FIG. 2

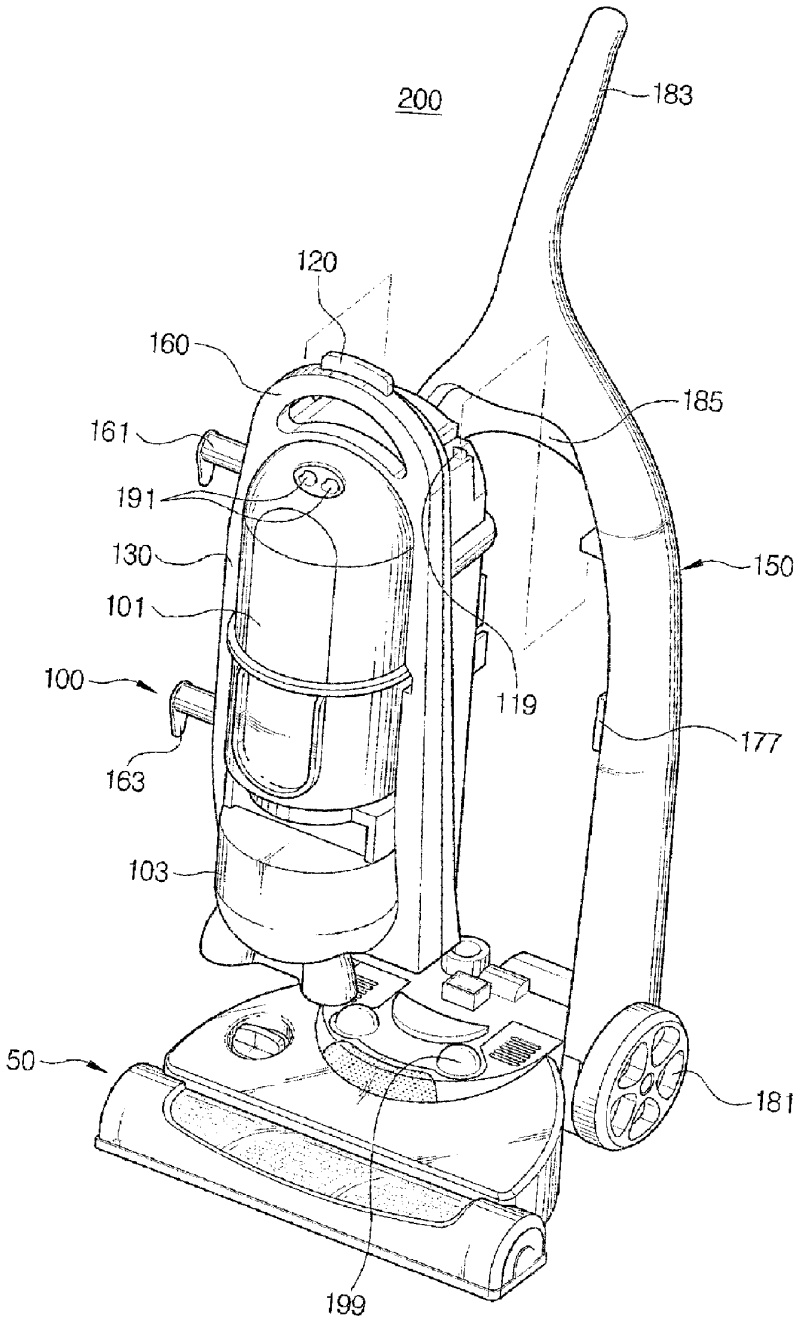

200
183
120
160
185
161
191
130
150
101
100
119
177
163
103
50
181
199

FIG. 3

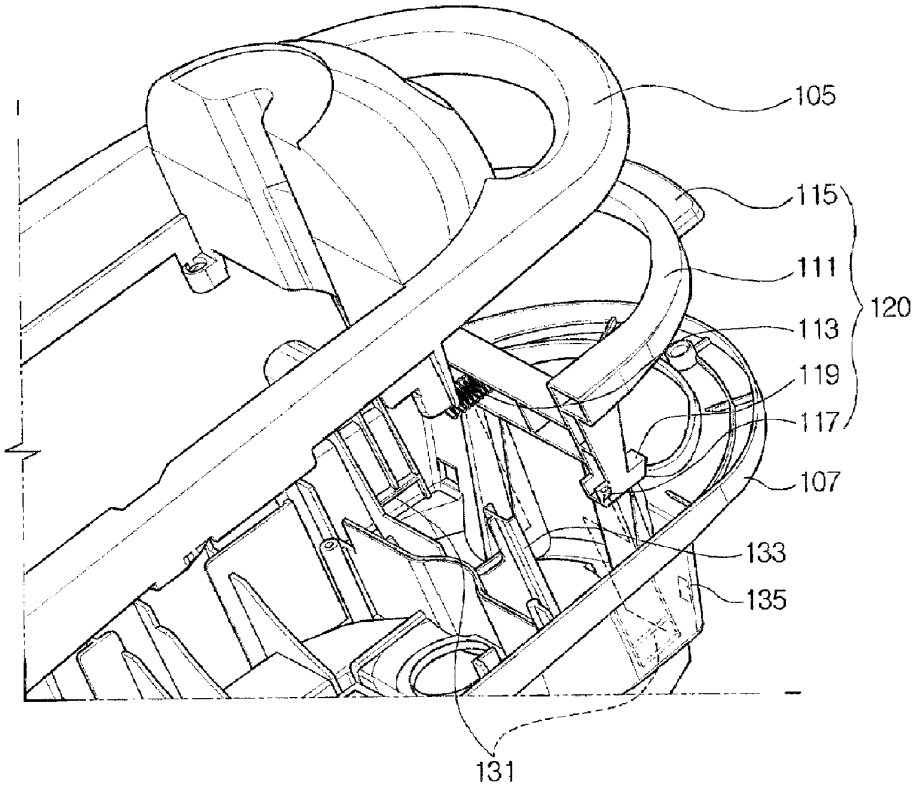


FIG. 4A

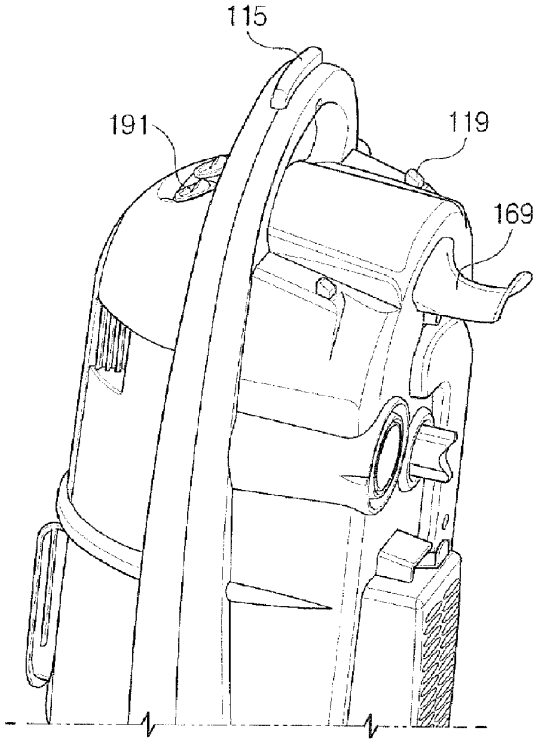


FIG. 4B

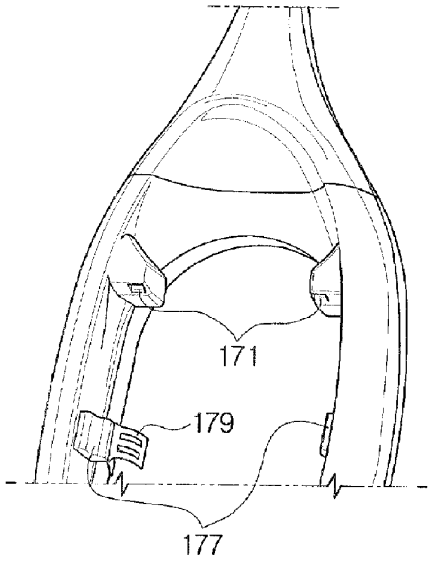
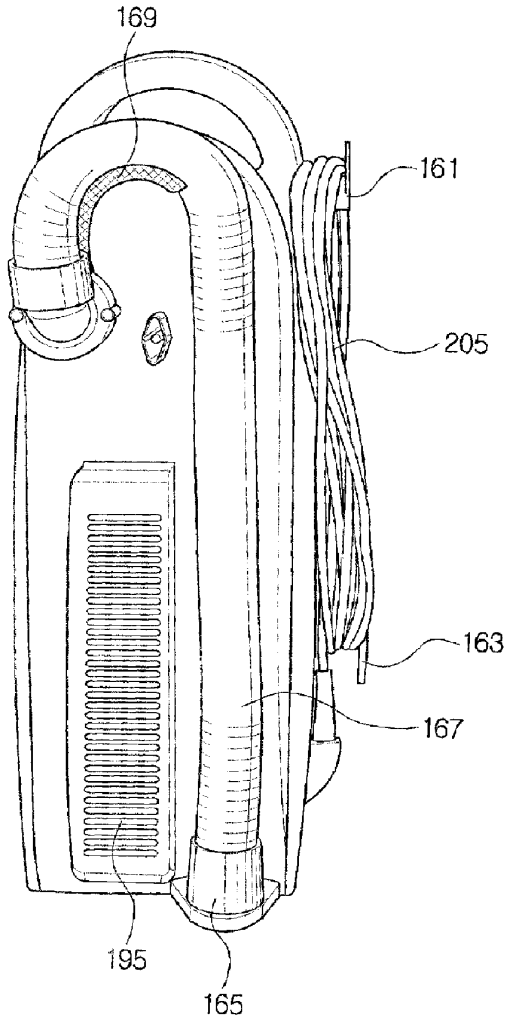


FIG. 5



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 10452-113	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/CA2007/000380	International filing date *(day/month/year)* 09 March 2007 (09.03.2007)	Priority date *(day/month/year)* 10 March 2006 (10.03.2006)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant GBD CORP.		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☒	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 16 September 2008 (16.09.2008)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Athina Nickitas-Etienne e-mail: pt04.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
BERESKIN & PARR
P.O. Box 401
40 King Street West
TORONTO, Ontario
Canada, M5H 3Y2

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* 24 July 2007 (24-07-2007)

Applicant's or agent's file reference
10452-113

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA2007/000380	09 March 2007 (09-03-2007)	10 March 2006 (10-03-2006)

International Patent Classification (IPC) or both national classification and IPC
IPC: ***B04C 5/185*** (2006.01) , ***A47L 9/16*** (2006.01) , ***B04C 5/04*** (2006.01) , ***B07B 7/08*** (2006.01)

Applicant
GBD CORP. ET AL

1. This opinion contains indications relating to the following items :

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [X] Box No. VII Certain defects in the international application
- [X] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**
If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/CA	Date of completion of this opinion	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	16 July 2007 (16-07-2007)	Pierre Cuerrier 819-997-4379

Dyson Ex1020
Page 1442

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CA2007/000380

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   [X] the international application in the language in which it was filed

   [ ] a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of :

   a. type of material

      [ ] a sequence listing

      [ ] table(s) related to the sequence listing

   b. format of material

      [ ] on paper

      [ ] in electronic form

   c. time of filing/furnishing

      [ ] contained in the international application as filed.

      [ ] filed together with the international application in electronic form

      [ ] furnished subsequently to this Authority for the purposes of search.

4. [ ] In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments :

Dyson Ex1020
Page 1443

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	2-3, 5-6, 10-14, 20, 23-27, 30-43	YES
	Claims	1, 4, 7-9, 15, 16-19, 21-22, 28-29	NO
Inventive step (IS)	Claims	2-3, 5-6, 20, 39	YES
	Claims	1, 4, 7-15, 16-19, 21-29, 30-38, 40-43	NO
Industrial applicability (IA)	Claims	1-43	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1 = WO 06/026,414 A2 (ARNOLD, A. et al.)
D2 = CA 1,218,962 (BOADWAY, J.)
D3 = US 2003/0159411 A1 (HANSEN, S. et al.)

D1 discloses a cyclonic separation device for a vacuum cleaner comprising a dirty air inlet (204), a handle (203), a cyclone separator having an outer wall (15), a fluid inlet (24) downstream from the dirty air inlet and a fluid outlet (31), a plate (36) having a cyclone chamber surface and positioned to substantially divide the cyclone separator into a cyclone chamber (19) and a dirt collection chamber (20), a passage extending between the cyclone chamber and the dirt collection chamber, the passage configured such that dirt travels at least outwardly as the dirt travels through the passage (Figures 9 and 10), and an air flow motor (206). The plate (36) comprises a disc positioned adjacent the cyclone chamber end of the dirt collection chamber and the dirt collection chamber extends under at least a portion of the disc (see Figures 9, 10 and 13). D1 discloses a flow director (29) positioned above the plate (36), an annular dirt collection region collinear with the cyclone chamber, a tube (31) having an inlet and extending along the axis of the cyclone chamber to a position below the fluid inlet and having an end that is spaced from the plate (36). The bottom (104) of the dirt collection chamber is openable via a hinge (107).

Claims 1, 4, 7, 8, 9, 15, 16, 19, 21, 22, 28 and 29 do not comply with PCT Article 33(2). D1 disclosed the claimed subject matter before the claim date. Also, claims 1, 4, 7, 8, 9, 15, 16, 19, 21, 22, 28 and 29 do not comply with PCT Article 33(3) for lacking an inventive step.

Claims 10, 23 and 36 define a screen in covering relation to the inlet of the air flow tube. D3 (paragraph [0055]) teaches the use of a screen element to cover a fluid outlet in a similar context. Claims 10, 23 and 36 therefore lack inventive ingenuity having regard to D1 in view of D3 (PCT Article 33(3)).

D2 discloses a cyclone of traditional design equipped with a blunt cone plate (14) which allows the boundary layer material to leave without the inner fluid by blocking the vortex while permitting the boundary layer fluid with its content of heavy material to leak away through a gap between the end (15) of the cyclone cone (13) and the blunt cone plate (14). The cyclone separator has an outwardly extending portion (see Fig. 2) such that the outer perimeter of the dirt collection chamber is larger than the outer perimeter of the cyclone chamber. Furthermore, the blunt cone plate (14) is positioned below the outwardly extending portion and the dirt collection chamber extends under at least a portion of the blunt cone plate.

Claims 16, 17, 18 and 19 do not comply with PCT Article 33(2). D1 disclosed the claimed subject matter before the claim date. Also, claims 16, 17, 18 and 19 do not comply with PCT Article 33(3) for lacking an inventive step.

Claims 11-14, 24-27 and 30-33 define relative dimensions of the passage as it relates to the diameter adjacent the fluid inlet. These dimensions could have easily been determined by a technician skilled in the art through routine experimentation. Claims 11-14, 24-27, 30-35, 37-38 and 40-43 therefore lack inventive ingenuity having regard to either D1 or D2 in view of general knowledge in the art (PCT Article 33(3)).

The industrial applicability of claims 1-43 is clear (PCT Article 33(4)).

Dyson Ex1020
Page 1444

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted :

The drawings and/or the description do not comply with Rule 11.13(l) of the PCT. Reference signs not mentioned in the description shall not appear in the drawing, and vice versa. Reference characters 10, 12 and 13 (all on page 39) do not seem to appear in the drawings.

The drawings and/or the description do not comply with Rule 11.13 of the PCT. Reference character 27e on Fig. 6e should probably read 27a (see page 54, line 6 and pag 56, line 7). Also, in Fig. 7b, one of the occurrences of reference character 59 should be replaced by reference character 60 (see page 55, line 10).

The description does not comply with PCT Article 6. A statement, such as found on page 77, which implies that the protection sought may be expanded to cover the "spirit" of the invention, should be removed.

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made :

Claims 16 and 30 are broader in scope than the teaching of the description. To comply with Article 6 of the PCT the claims must specify that the cyclone separator is used in a surface cleaning apparatus.

Claims 3, 18 and 37 are unclear and do not comply with Article 6 of the PCT. The expression "outwardly extending portion" (claim 3, line 3) lacks a proper antecedent basis with respect to claims 1, 16 and 30-33, respectively.

Claim 37 does not comply with Article 6 of the PCT. The claim shall be clear and concise. Claim 37 depends upon itself.

In claims 3, 18 and 37, the word "then" should read "than".

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2007/000380

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***B04C 5/185*** (2006.01) , ***A47L 9/16*** (2006.01) , ***B04C 5/04*** (2006.01) , ***B07B 7/08*** (2006.01)
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)
IPC[8]: B04C, A47L, B07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Delphion, Canadian Patents Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 06/026,414 A2 (ARNOLD, A. et al.) 9 March 2006 (09-03-2006) * Abstract, page 13, line 15 - page 16, line 3, claims, figs. 9, 10, 13 *	1, 4, 7- 9, 11-15, 16, 19, 21, 22, 24-29, 30-33, 35, 40-43
Y		10, 23, 36
X	CA 1,218,962 A1 (BOADWAY, J) 10 March 1987 (10-03-1987) * Page 8, line 19 - page 10, line 19, Fig. 2 *	16-19, 24-27, 30-35, 37-38
Y	US 2003/0159411 A1 (HANSEN, S. et al.) 28 August 2003 (28-08-2003) * the whole document *	10, 23, 36

[ ] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 May 2007 (14-05-2007)	24 July 2007 (24-07-2007)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Pierre Cuerrier 819- 997-4379

Dyson Ex1020
Page 1447

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2007/000380

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
WO2006026414 A2	09-03-2006	US20060207231 A1	21-09-2006
		US20060042206 A1	02-03-2006
		US20060042206 A1	02-03-2006
CA1218962 A1	10-03-1987	US4842145 A	27-06-1989
		US4712867 A	15-12-1987
		US4389307 A	21-06-1983
		EP068792 A2	05-01-1983
		DE3279026 C0	20-10-1988
US20030159411 A1	28-08-2003	US20050125940 A1	16-06-2005
		US20050125939 A1	16-06-2005
		US20040216263 A1	04-11-2004
		US20020011050 A1	31-01-2002
		US7188388 B1	13-03-2007

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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BERESKIN & PARR

PCT

To:

BERESKIN & PARR
40 King Street West
40th Floor
Toronto, Ontario
M5H 3Y2
CANADA

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	26.10.2001
Applicant's or agent's file reference: 10452-30	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00873	26/07/2000	27/07/1999

Applicant: G.B.D. CORPORATION et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Riebel, O Tel.+49 89 2399-2967

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
10452-30		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00873	26/07/2000	27/07/1999
International Patent Classification (IPC) or national classification and IPC B04C5/181		
Applicant G.B.D. CORPORATION et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 10 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26/02/2001	26.10.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Mayer, R Telephone No. +49 89 2399 2094

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA00/00873

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-28	as originally filed			

Claims, No.:

1-55	as received on	16/07/2001	with letter of	13/07/2001

Drawings, sheets:

1/15-15/15	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1,20,25,39,47
Inventive step (IS)	Yes:	Claims	
	No:	Claims	2-19,21-24,26-38, 40-46,47-55
Industrial applicability (IA)	Yes:	Claims	1-55
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Item V:

1. Independent claims 1, 20,25,39,47 are not consider novel:

1.1 US-A-4486207 discloses a separator with a cyclone chamber, means for introducing and removing, separation means 121 having holes 124 so that particles pass therethrough to particle receiving means 126 (see figures 7,8 and the corresponding text). Consequently, all the features of claim 1 are disclosed.

1.2 All the features of claims 20, 25 and 39 are also known from US-A-4486207 for the same reasons as given in paragraph 1.1.

1.3 All the features of claims 1, 20, 25 and 39 are also known from WO-A-98/43721 (fig. 5), DE-C-875134 (Abb. 1), US-A-2981369 (fig. 3), DE-C-4232382 (fig. 1) and US-A-3988132 (fig. 1).

1.4 WO-A-98/43721 discloses a vacuum cleaner comprising all the features of claim 47 (see figures 1,5 and the corresponding text).

2. Having regard to the dependent claims, the features of these claims, insofar as they are not known from the documents cited in the Search Report for the same purpose as in your application, are generally known to a person skilled in the art, and, therefore, do not add an inventive step to the claims from which they depend.

3. The industrial applicability is obvious.

Item VII:

The description is adapted to the claim, and the prior art known from US-A-4486207, WO-A-98/43721, DE-C-875134, US-A-2981369, DE-C-4232382 nd US-A-3988132 is not cited in the description.

Item VIII:

Independent claims 1, 25 and 39 are not concise as required by Article 6 since each one defines a separator and repeats much of the content of the others. Therefore, it is appropriate to have a single independent claim defining separator.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
BERESKIN & PARR
P.O. Box 401
40 King Street West
TORONTO, Ontario
Canada, M5H 3Y2

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* 21 April 2008 (21-04-2008)

Applicant's or agent's file reference
10452-179

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA2007/002211	11 December 2007 (11-12-2007)	12 December 2006 (12-12-2006)

International Patent Classification (IPC) or both national classification and IPC
IPC: ***A47L 9/00*** (2006.01), ***A47L 11/30*** (2006.01), ***A47L 9/10*** (2006.01), ***A47L 9/16*** (2006.01)

Applicant
GBD CORP. ET AL

1. This opinion contains indications relating to the following items :

[X]	Box No. I	Basis of the opinion
[ ]	Box No. II	Priority
[ ]	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
[ ]	Box No. IV	Lack of unity of invention
[X]	Box No. V	Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
[ ]	Box No. VI	Certain documents cited
[ ]	Box No. VII	Certain defects in the international application
[ ]	Box No. VIII	Certain observations on the international application

2. **FURTHER ACTION**
If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

dd ent July 01/08 NK

3. For further details, see notes to Form PCT/ISA/220.

dd ent Oct 12/08 NK

Name and mailing address of the ISA/CA	Date of completion of this opinion	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	15 April 2008 (15-04-2008)	Siavash Mohajer 819- 934-3466

Dyson Ex1020
Page 1454

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CA2007/002211

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   [X] the international application in the language in which it was filed

   [ ] a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of :

   a. type of material

      [ ] a sequence listing

      [ ] table(s) related to the sequence listing

   b. format of material

      [ ] on paper

      [ ] in electronic form

   c. time of filing/furnishing

      [ ] contained in the international application as filed.

      [ ] filed together with the international application in electronic form

      [ ] furnished subsequently to this Authority for the purposes of search.

4. [ ] In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments :

Dyson Ex1020
Page 1455

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	2-4, 7, 8, 10-13, 16-18, 21, and 23-26	YES
	Claims	1, 5, 6, 9, 14, 15, 19, 20, and 22	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-26	NO
Industrial applicability (IA)	Claims	1-26	YES
	Claims	None	NO

2. Citations and explanations :

D1: EP 0 489 468 A1 (WEISTRA, M.) 10 JUNE 1992 (10.06.1992)
D2: US 2006/0207055 A1 (IVARSSON, B. et al.) 21 SEPTEMBER 2006 (21.09.2006)

D1 disclosed a surface cleaning apparatus comprising a fluid flow path extending from a dirt inlet (15) to a clean fluid outlet (19) and a fluid flow motor (4) positioned in the fluid flow path (col. 3, line 56 - col. 4, line 1); a cyclonic cleaning stage (3) provided in the fluid flow path and comprising a cyclone chamber (10); at least one dirt chamber (5b) in fluid communication with the cyclone chamber and positioned below the cyclone chamber (figs. 1, 3, and 4), the dirt chamber having an upper portion proximate the cyclone chamber, a lower portion, a central axis extending vertically between the upper portion and the lower portion, and a dirt chamber inlet (11) spaced from the central axis (figs. 1 and 4).

D2 disclosed an upright vacuum comprising a plurality of cyclones in parallel (paragraphs 007-009).

Novelty:
Claims 2-4, 7, 8, 10-13, 16-18, 21, and 23-26 are novel and do comply with Article 33(2) of the PCT. Document D1 is considered the closest prior art. The subject matter of claims 2-4 and 16-18 differ from D1 in that although off-center, D1 does not teach or fairly suggest the relative location of the dirt chamber inlet with respect to dirt chamber. With regards to claims 7 and 21, D1 fails to disclose a plate positioned inside the dirt chamber. With regards to claims 8 and 23, D1 does not disclose a perimeter on the upper portion of the dirt chamber. With regards to claims 10-13, D1 fails to disclose the shape and size of the applicant's apparatus. With regards to claims 24-26, D1 fails to disclose a combination of cyclonic stages either in parallel or series.

Claims 1, 5, 6, 9, 14, 15, 19, 20, and 22 are not novel and do not comply with Article 33(2) of the PCT. D1 disclosed the subject matter of claims 1, 14, and 15. With regards to claims 5, 6, 19, 20, and 22, it can be seen in figures 1 and 4 that the cyclonic cleaning stage comprises a dirt outlet positioned at the dirt chamber inlet (11), which is defined in an upper surface of the dirt chamber. Additionally, the dirt chamber inlet is created by an opening in a plate that is adjacent to the cyclonic cleaning stage and the dirt chamber. With regards to claim 9, it can be seen from figures 1 and 4 that the longitudinal axis of the cyclone chamber is spaced apart from the central axis of the dirt chamber.

Inventive Step:

Since claims 1, 5, 6, 9, 14, 15, 19, 20, and 22 are not novel, they also do not involve an inventive step. As such, they do not comply with Article 33(3) of the PCT.

Claims 2-4, 8, 10-13, 16-18, 23, and 24 do not comply with Article 33(3) of the PCT. The subject matter of these claims would have been obvious to a person skilled in the art or science to which they pertain, having regard to D1 in view of common knowledge in the art. Claims 2-4, 8, 10-13, 16-18, and 23 merely recite design features and do not involve an inventive step over D1. The problems solved by said claims would have been obvious to a person skilled in the art having prior knowledge of D1. With regards to claim 24, it would have been obvious to a person skilled in the art to create multiple cyclonic stages in an iterative way to further filter dirty air. Multiple instances of the alleged invention can be connected together to achieve this.

Continued in Supplemental Box on page 4...

Dyson Ex1020
Page 1456

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of : Box No. V

Claims 7, 21, 25, and 26 do not comply with Article 33(3) of the PCT. The subject matter of these claims would have been obvious to a person skilled in the art or science to which they pertain, having regard to D1 in view of D2. D1 disclosed the subject matter of the above claims with the exception of the plate being located inside the dirt chamber and multiple cyclones being connected together in parallel. D2 disclosed both of these features. The structure (112, 118, 104') acts as the plate of claims 7 and 21 and is located inside the dirt chamber. Therefore, it would have been obvious for a person skilled in the art having prior knowledge of D1 and D2 to arrive at the subject matter of the above claims.

Industrial Applicability:
The subject matter of claims 1-26 is considered to be industrially applicable and thus complies with the requirements of Article 33(4) of the PCT.

PATENT COOPERATION TREATY

359

From the INTERNATIONAL SEARCHING AUTHORITY

To:
BERESKIN & PARR
P.O. Box 401
40 King Street West
TORONTO, Ontario
Canada, M5H 3Y2

RECEIVED
APR 29 2008
BERESKIN & PARR

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing *(day/month/year)*	21 April 2008 (21-04-2008)
Applicant's or agent's file reference 10452-179	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/CA2007/002211	International filing date *(day/month/year)* 11 December 2007 (11-12-2007)

Applicant
GBD CORP. ET AL

OO ea to June 21/08 NR

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19 :
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46) :

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that :

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for the international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer Carole Millaire 819- 994-6587

Form PCT/ISA/220 (October 2005) *(See notes on accompanying sheet)*

NOTES TO FROM PCT/ISA/220

These Notes are intended to give instructions concerning the filing of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*, a publication of WIPO.

In these Notes, "Article," "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Volume I/A, Annexes B1 and B2).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide,* Volume I/A, paragraph 296).

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Preliminary Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)) :

The amendments must be submitted with a letter.
The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").
The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

Dyson Ex1020
Page 1459

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

(i) the claim is unchanged;
(ii) the claim is cancelled;
(iii) the claim is new;
(iv) the claim replaces one or more claims as filed;
(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter :

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under Article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments and any accompanying statement, under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the time of filing the amendments (and any statement) with the International Bureau, also file with the International Preliminary Examining Authority a copy of such amendments (and of any statement) and, where required, a translation of such amendments for the procedure before that Authority (see Rules 55.3(a) and 62.2, first sentence). For further information, see the Notes to the demand form (PCT/IPEA/401).

If a demand for international preliminary examination is made, the written opinion of the International Searching Authority will, except in certain cases where the International Preliminary Examining Authority did not act as International Searching Authority and where it has notified the International Bureau under Rule 66.1*bis*(b), be considered to be a written opinion of the International Preliminary Examining Authority. If a demand is made, the applicant may submit to the International Preliminary Examining Authority a reply to the written opinion together, where appropriate, with amendments before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later (Rule 43*bis*.1(c)).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, upon entry into the national phase, a translation of the claims as amended under Article 19 may have to furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see the *PCT Applicant's Guide*, Volume II.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 10452-179	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below
International application No. **PCT/CA2007/002211**	International filing date *(day/month/year)* 11 December 2007 (11-12-2007)	(Earliest)Priority date *(day/month/year)* 12 December 2006 (12-12-2006)
Applicant GBD CORP. ET AL		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

[X] the international application in the language in which it was filed

[ ] a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I

2. [ ] **Certain claims were found unsearchable** (see Box No. II)

3. [ ] **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title**,

[X] the text is approved as submitted by the applicant

[ ] the text has been established by this Authority to read as follows :

5. With regard to the **abstract**,

[X] the text is approved as submitted by the applicant

[ ] the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 2b

[ ] as suggested by the applicant

[X] as selected by this Authority, because the applicant failed to suggest a figure

[ ] as selected by this Authority, because this figure better characterizes the invention

b. [ ] none of the figures is to be published with the abstract

Dyson Ex1020
Page 1461

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2007/002211

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***A47L 9/00*** (2006.01) , ***A47L 11/30*** (2006.01) , ***A47L 9/10*** (2006.01) , ***A47L 9/16*** (2006.01)
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)
IPC (2006.01): A47L/all, B01D 45/all,
USC: 55/all, 15/all

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Delphion, Canadian Patent Database, WEST (cyclone, dirt chamber, axis, off-center OR offset, inlet)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 0 489 468 A1 (WEISTRA, M.) 10 JUNE 1992 (10.06.1992) *Entire Document*	1-6, 8-20, and 22-24 7, 21, 25, and 26
Y	US 2006/0207055 A1 (IVARSSON, B. et al) 21 SEPTEMBER 2006 (21.09.2006) *Paragraphs 007-009 & Figure 1, 4, 6, and 7*	7, 21, 25, and 26
A	US 5,287,591 A (RENCH, G. et al) 22 FEBRUARY 1994 (22.02.1994) *Figures 1 & 3*	1-26
A	US 5,307,538 A (RENCH, G. et al) 03 MAY 1994 (03.05.1994) *Figures 1 & 3*	1-26
A	US 5,363,535 A (RENCH, G. et al) 15 NOVEMBER 1994 (15.11.1994) *Figures 1 & 3*	1-26
A	US 3,543,325 A (HAMRICK, J.) 01 DECEMBER 1970 (01.12.1970) *Figure 8*	1-26

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 March 2008 (18-03-2008)	21 April 2008 (21-04-2008)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer Siavash Mohajer 819- 934-3466

Dyson Ex1020
Page 1462

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,523,936 A (DISANZA, W.) 18 JUNE 1985 (18.06.1985) *Figure 2*	1-26

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2007/002211

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
EP0489468 A1	10-06-1992	JP6052749U U	19-07-1994
		NL9002668 A	01-07-1992
		US5135552 A	04-08-1992
US2006207055 A1	21-09-2006	AU2006227345 A1	28-09-2006
		EP1874171 A2	09-01-2008
		WO2006102147 A2	28-09-2006
US5287591 A	22-02-1994	EP0734217 A1	02-10-1996
		JP9506529T T	30-06-1997
		US5363535 A	15-11-1994
		WO9516382 A1	22-06-1995
US5307538 A	03-05-1994	AT163521T T	15-03-1998
		DE69224666D D1	09-04-1998
		DE69224666T T2	25-06-1998
		DK634905T T3	07-12-1998
		EP0634905 A1	25-01-1995
		JP7505312T T	15-06-1995
		WO9319659 A1	14-10-1993
US5363535 A	15-11-1994	US5287591 A	22-02-1994
US3543325 A	01-12-1970	NONE	
US4523936 A	18-06-1985	AU580078B B2	22-12-1988
		AU4485985 A	30-01-1986
		CA1252395 A1	11-04-1989
		DK163027B B	13-01-1992
		GB2162086 A	29-01-1986
		USRE32788E E	22-11-1988

Dyson Ex1020
Page 1464

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

RECEIVED
OCT 26 2015
BERESKIN & PARR LLP
LOCATION | DELIVER TO
593

To:

BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
Scotia Plaza
40 King Street West, 40th Floor
TORONTO, Ontario
Canada, M5H 3Y2

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing *(day/month/year)*	19 October 2015 (19-10-2015)
Applicant's or agent's file reference P46581PC00 - 10452	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/CA2015/050661**	International filing date *(day/month/year)* 15 July 2015 (15-07-2015)

Applicant
OMACHRON INTELLECTUAL PROPERTY INC.

1. ☑ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46).

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 & 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the any request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Within **19 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 819-953-2476	Authorized officer Jean-Luc Robert (819) 639-5169

Form PCT/ISA/220 (July 2014)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P46581PC00	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below
International application No. **PCT/CA2015/050661**	International filing date *(day/month/year)* 15 July 2015 (15-07-2015)	(Earliest)Priority date *(day/month/year)* 18 July 2014 (18-07-2014)
Applicant OMACHRON INTELLECTUAL PROPERTY INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 7 sheets.

☑ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of

☑ the international application in the language in which it was filed.

☐ a translation of the international application into which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☑ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☑ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☑ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 9

☐ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☑ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

Dyson Ex1020
Page 1466

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2015/050661

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

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

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

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

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

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

This International Searching Authority found multiple inventions in this international application, as follows:

Group A, Claims 1-20: A hand carryable surface cleaning apparatus comprising a cyclone bin having an air outlet provided at an upper end of the cyclone bin assembly.
Group B, Claims 21- 40: A hand carryable surface cleaning apparatus comprising a locking mechanism selectively securing the cyclone bin assembly to the body of the apparatus comprising an actuator on a cyclone bin assembly.
Group C, Claims 41- 60: A hand carryable surface cleaning apparatus comprising a suction motor oriented at an angle to a vertical and horizontal axis.
Group D: Claims 61-83 A hand carryable surface cleaning apparatus comprising a dirt collection chamber extending under at least a portion of a suction motor.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☑ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos.:

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

Remark on Protest

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

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

☐ No protest accompanied the payment of additional search fees.

Dyson Ex1020
Page 1467

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2015/050661

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***A47L 5/24*** (2006.01), ***A47L 5/26*** (2006.01), ***A47L 5/30*** (2006.01), ***A47L 9/16*** (2006.01)

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)
IPC: A47L (2006.01), A47L 5/* (2006.01), A47L 9/* (2006.01), A47L 5/24 (2006.01), A47L 9/16 (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Questel-Orbit. Keywords: bin, chamber, container, receptacle, cyclon*, hand, held, portable, latch*, lock*, actuator, motor, angl*, inclin*, recess*, cavity, above, over, under, below, seal*

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO2008088278A2, (BESKOW, J. et al.) 24 July 2008 (24-07-2008) *whole document*	1-20, 41-46, 57, 59, 61, 67, 72-75, and 81-83
X	US20120222260A1, (CONRAD, W. E.) 06 September 2012 (06-12-2012) *whole document*	1-3, 10
X	WO0217766A2, (MURPHY, J. S. et al.) 07 March 2002 (07-03-2002) *whole document*	1-4, 10-13, 17, 18
A	EP2308360A2, (WAI, L. Y.) 13 April 2011 (13-04-2011) *whole document*	

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search	Date of mailing of the international search report
10 September 2015 (10-09-2015)	19 October 2015 (19-10-2015)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Shawn De Salvo (819) 934-4270

Dyson Ex1020
Page 1468

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP1594386A1, (MIEFALK, H. et al.) 16 November 2005 (16-11-2005) *whole document*	
A	CA2484587A1, (MOONEY, P. W.) 15 April 2005 (15-04-2005) *whole document*	
A	CN202932850U, (WANG, W.) 15 May 2013 (15-05-2013) *whole document*	
A	GB2508035A, (WILSON, H. G.) 21 May 2014 (21-05-2014) *whole document*	

Dyson Ex1020
Page 1469

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
WO2008088278A2	24 July 2008 (24-07-2008)	WO2008088278A2	24 July 2008 (24-07-2008)
		WO2008088278A3	04 September 2008 (04-09-2008)
		CN101448447A	03 June 2009 (03-06-2009)
		CN101448447B	27 June 2012 (27-06-2012)
		CN101460083A	17 June 2009 (17-06-2009)
		CN101460083B	13 August 2014 (13-08-2014)
		CN101583302A	18 November 2009 (18-11-2009)
		CN101583302B	23 January 2013 (23-01-2013)
		CN102283611A	21 December 2011 (21-12-2011)
		CN102283611B	16 July 2014 (16-07-2014)
		CN102302349A	04 January 2012 (04-01-2012)
		CN102302350A	04 January 2012 (04-01-2012)
		EP2007264A1	31 December 2008 (31-12-2008)
		EP2012838A1	14 January 2009 (14-01-2009)
		EP2012838A4	22 September 2010 (22-09-2010)
		EP2012838B1	19 June 2013 (19-06-2013)
		EP2111144A2	28 October 2009 (28-10-2009)
		EP2111144A4	02 March 2011 (02-03-2011)
		EP2111144B1	10 December 2014 (10-12-2014)
		ES2531518T3	16 March 2015 (16-03-2015)
		SE0700143L	20 July 2008 (20-07-2008)
		SE531125C2	23 December 2008 (23-12-2008)
		US2010083459A1	08 April 2010 (08-04-2010)
		US7882593B2	08 February 2011 (08-02-2011)
		US2010017997A1	28 January 2010 (28-01-2010)
		US8151411B2	10 April 2012 (10-04-2012)
		US2010242209A1	30 September 2010 (30-09-2010)
		US8302251B2	06 November 2012 (06-11-2012)
		US2010024154A1	04 February 2010 (04-02-2010)
		US8424154B2	23 April 2013 (23-04-2013)
		US2008040883A1	21 February 2008 (21-02-2008)
		WO2007117196A1	18 October 2007 (18-10-2007)
		WO2007117197A1	18 October 2007 (18-10-2007)
US2012222260A1	06 September 2012 (06-09-2012)	US2012222260A1	06 September 2012 (06-09-2012)
		US8689396B2	08 April 2014 (08-04-2014)
		US2012222249A1	06 September 2012 (06-09-2012)
		US8567008B2	29 October 2013 (29-10-2013)
		US2012222250A1	06 September 2012 (06-09-2012)
		US8601641B2	10 December 2013 (10-12-2013)
		US2012222236A1	06 September 2012 (06-09-2012)
		US8646146B2	11 February 2014 (11-02-2014)
		US2012222237A1	06 September 2012 (06-09-2012)
		US8683644B2	01 April 2014 (01-04-2014)
		US2012222251A1	06 September 2012 (06-09-2012)
		US2012222259A1	06 September 2012 (06-09-2012)
		WO2012119221A1	13 September 2012 (13-09-2012)

Dyson Ex1020
Page 1470

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
WO0217766A2	07 March 2002 (07-03-2002)	WO0217766A2	07 March 2002 (07-03-2002)
		WO0217766A3	13 February 2003 (13-02-2003)
		AU8859001A	13 March 2002 (13-03-2002)
		AU2001288590B2	21 September 2006 (21-09-2006)
		CA2420598A1	07 March 2002 (07-03-2002)
		CA2420598C	21 October 2008 (21-10-2008)
		DE60116336D1	02 February 2006 (02-02-2006)
		DE60116336T2	31 August 2006 (31-08-2006)
		EP1315442A2	04 June 2003 (04-06-2003)
		EP1315442B1	28 December 2005 (28-12-2005)
		US2002026775A1	07 March 2002 (07-03-2002)
		US6712868B2	30 March 2004 (30-03-2004)
		US2004163201A1	26 August 2004 (26-08-2004)
		US7052523B2	30 May 2006 (30-05-2006)
EP2308360A2	13 April 2011 (13-04-2011)	EP2308360A2	13 April 2011 (13-04-2011)
		EP2308360A3	26 February 2014 (26-02-2014)
		EP2308360B1	24 June 2015 (24-06-2015)
		CN102038464A	04 May 2011 (04-05-2011)
		CN102038464B	25 December 2013 (25-12-2013)
		HK1153359A1	16 May 2014 (16-05-2014)
		JP2011078757A	21 April 2011 (21-04-2011)
		JP5649390B2	07 January 2015 (07-01-2015)
		US7789922B1	07 September 2010 (07-09-2010)
		US2010257825A1	14 October 2010 (14-10-2010)
		US8167964B2	01 May 2012 (01-05-2012)
EP1594386A1	16 November 2005 (16-11-2005)	EP1594386A1	16 November 2005 (16-11-2005)
		EP1594386B1	15 April 2009 (15-04-2009)
		AT428340T	15 May 2009 (15-05-2009)
		AT503414T	15 April 2011 (15-04-2011)
		AT538708T	15 January 2012 (15-01-2012)
		BRPI0407257A	31 January 2006 (31-01-2006)
		BRPI0407257B1	03 February 2015 (03-02-2015)
		DE202004021292U1	31 June 2007 (21-06-2007)
		DE602004020587D1	28 May 2009 (28-05-2009)
		DE602004032069D1	12 May 2011 (12-05-2011)
		EP1969988A2	17 September 2008 (17-09-2008)
		EP1969988A3	21 January 2009 (21-01-2009)
		EP1969988B1	30 March 2011 (30-03-2011)
		EP2201881A1	30 June 2010 (30-06-2010)
		EP2201881B1	28 December 2011 (28-12-2011)
		ES2310163T1	01 January 2009 (01-01-2009)
		ES2310163T3	22 August 2011 (22-08-2011)
		ES2325535T3	08 September 2009 (08-09-2009)
		ES2380732T3	17 May 2012 (17-05-2012)
		SE0300355D0	10 February 2003 (10-02-2003)
		US2007271724A1	29 November 2007 (29-11-2007)
		US8225456B2	24 July 2012 (24-07-2012)
		US2013031742A1	07 February 2013 (07-02-2013)
		US8607406B2	17 December 2013 (17-12-2013)
		WO2004069021A1	19 August 2004 (19-08-2004)

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
CA2484587A1	15 April 2005 (15-04-2005)	CA2484587A1	15 April 2005 (15-04-2005)
		CA2484587C	25 January 2011 (25-01-2011)
		AT437599T	15 August 2009 (15-08-2009)
		AU2004220716A1	05 May 2005 (05-05-2005)
		AU2004220716B2	12 May 2011 (12-05-2011)
		AU2011201938A1	19 May 2011 (19-05-2011)
		AU2011201938B2	09 February 2012 (09-02-2012)
		CN1626025A	15 June 2005 (15-06-2005)
		CN1626025B	13 April 2011 (13-04-2011)
		CN101822506A	08 September 2010 (08-09-2010)
		DE602004022234D1	10 September 2009 (10-09-2009)
		EP1523916A2	20 April 2005 (20-04-2005)
		EP1523916A3	26 April 2006 (26-04-2006)
		EP1523916B1	29 July 2009 (29-07-2009)
		EP1958560A1	20 August 2008 (20-08-2008)
		EP1958560B1	10 April 2013 (10-04-2013)
		NZ535942A	30 November 2006 (30-11-2006)
		NZ544120A	31 August 2007 (31-08-2007)
		NZ544121A	31 May 2007 (31-05-2007)
		US2009144931A1	11 June 2009 (11-06-2009)
		US7845046B2	07 December 2010 (07-12-2010)
		US2011030164A1	10 February 2011 (10-02-2011)
		US8549704B2	08 October 2013 (08-10-2013)
		US2005081321A1	21 April 2005 (21-04-2005)
CN202932850U	15 May 2013 (15-05-2013)	None	
GB2508035A	21 May 2014 (21-05-2014)	GB201220884D0	02 January 2013 (02-01-2013)
		GB2508035B	11 March 2015 (11-03-2015)
		AU2013249441A1	28 May 2015 (28-05-2015)
		CN103860103A	18 June 2014 (18-06-2014)
		JP2014100572A	05 June 2014 (05-06-2014)
		KR20150082575A	15 July 2015 (15-07-2015)
		US2014137383A1	22 May 2014 (22-05-2014)
		US8925145B2	06 January 2015 (06-01-2015)
		WO2014080179A1	30 May 2014 (30-05-2014)

Dyson Ex1020
Page 1472

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
Scotia Plaza
40 King Street West, 40th Floor
TORONTO, Ontario
Canada, M5H 3Y2

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	19 October 2015 (19-10-2015)
Applicant's or agent's file reference P46581PC00	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA2015/050661	15 July 2015 (15-07-2015)	18 July 2014 (18-07-2014)

International Patent Classification (IPC) or both national classification and IPC
IPC: ***A47L 5/24*** (2006.01), ***A47L 5/26*** (2006.01), ***A47L 5/30*** (2006.01), ***A47L 9/16*** (2006.01)

Applicant
OMACHRON INTELLECTUAL PROPERTY INC.

1. This opinion contains indications relating to the following items:

- ☑ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☑ Box No. IV Lack of unity of invention
- ☑ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

dd May 18/16 DA

Name and mailing address of the ISA/CA	Date of completion of this opinion	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	14 October 2015 (14-10-2015)	Shawn De Salvo (819) 934-4270

Dyson Ex1020
Page 1473

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CA2015/050661

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☑ the international application in the language in which it was filed.

☐ a translation of the international application into which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. IV Lack of unity of invention

1. ☐ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:

   ☐ paid additional fees

   ☐ paid additional fees under protest and, where applicable, the protest fee

   ☐ paid additional fees under protest but the applicable protest fee was not paid

   ☐ not paid additional fees

2. ☑ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☑ not complied with for the following reasons:

WO2008088278A2, (BESKOW, J. et al.) 24 July 2008 (24-07-2008) discloses a hand carryable surface cleaning apparatus 1 comprising a body 19 housing a suction motor 33 and comprising a dirty air inlet 9; a cyclone bin assembly 7 removably mounted to the body, the bin assembly comprising a cyclone bin assembly air inlet 22 in fluid communication with the dirty air inlet 9 when the cyclone bin assembly is mounted to the body, the cyclone bin assembly 7 comprising a cyclone bin assembly air inlet 22 provided at an upper end of the cyclone bin assembly 7, a cyclone chamber 21 and a dirt collection chamber; an air flow path extending from the dirty air inlet 9 to a clean air outlet 37 and including the suction motor 33 and the cyclone chamber 21, wherein the cyclone bin assembly 7 is partially nested in the body when the cyclone bin assembly is mounted to the body.

In view of WO2008088278A2, there are no features common to all the claims which could form a single inventive concept. The claims therefore must be directed to multiple alleged inventions as follows

Group A, Claims 1-20: A hand carryable surface cleaning apparatus comprising a cyclone bin having an air outlet provided at an upper end of the cyclone bin assembly.

Group B, Claims 21- 40: A hand carryable surface cleaning apparatus comprising a locking mechanism selectively securing the cyclone bin assembly to the body of the apparatus comprising an actuator on a cyclone bin assembly.

Group C, Claims 41- 60: A hand carryable surface cleaning apparatus comprising a suction motor oriented at an angle to a vertical and horizontal axis.

Group D: Claims 61-83 A hand carryable surface cleaning apparatus comprising a dirt collection chamber extending under at least a portion of a suction motor.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

   ☑ all parts.

   ☐ the parts relating to claim Nos.

Dyson Ex1020
Page 1475

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	21-40, 47-56, 58, 60, 62-66, 68-71 and 76-80	YES
	Claims	1-20, 41-46, 57, 59, 61, 67, 72-75, and 81-83	NO
Inventive step (IS)	Claims	21-40, 47-56, 58, 60, 62-66, 68-71 and 76-80	YES
	Claims	1-20, 41-46, 57, 59, 61, 67, 72-75, and 81-83	NO
Industrial applicability (IA)	Claims	1-83	YES
	Claims	NONE	NO

2. Citations and explanations:

D1: WO2008088278A2, (BESKOW, J. et al.) 24 July 2008 (24-07-2008)
D2: US2012022260A1, (CONRAD, W. E.) 06 September 2012 (06-12-2012)
D3: WO0217766A2, (MURPHY, J. S. et al.) 07 March 2002 (07-03-2002)

NOVELTY (N)

Group A: Claims 1-20

Claims 1-20 are not novel and therefore do not comply with PCT Article 33(2).

Regarding claims 1 and 13 document D1 discloses a hand carryable surface cleaning apparatus 1 comprising a body 19 housing a suction motor 33 and comprising a dirty air inlet 9; a cyclone bin assembly 7 removably mounted to the body, the bin assembly comprising a cyclone bin assembly air inlet 22 in fluid communication with the dirty air inlet 9 when the cyclone bin assembly is mounted to the body,the cyclone bin assembly 7 comprising a cyclone bin assembly air inlet 22 provided at an upper end of the cyclone bin assembly 7, a cyclone chamber 21 and a dirt collection chamber; an air flow path extending from the dirty air inlet 9 to a clean air outlet 37 and including the suction motor 33 and the cyclone chamber 21, wherein the cyclone bin assembly 7 is partially nested in the body when the cyclone bin assembly is mounted to the body.

With regard to the additional features of claim 2, D1 discloses a recess provided in the lower side of the body 19 in which the cyclone bin assembly (D) is received.

With regard to the additional features of claim 3, D1 discloses an entire length of the cyclone bin assembly 7 received in the recess 60.

With regard to the additional features of claim 4, D1 discloses a cyclone bin assembly air inlet 22 is provided at an upper end of the cyclone bin assembly 7.

With regard to the additional features of claims 5 and 8, D1 discloses a cyclone bin assembly air outlet is provided at an upper end of the cyclone bin assembly 7.

With regard to the additional features of claims 6, 9 and 16, D1 discloses an upper portion of the cyclone bin assembly 7 received in the recess and a pre motor screen 31 positioned above the recess.

With regard to the additional features of claim 7, D1 discloses a recess provided in the lower side of the body 19 in which entirety of the cyclone bin assembly 7 is received and an cyclone bin assembly air inlet 22 is provide at an upper end of the cyclone bin assembly 7.

[X] Continued in Supplemental Box

Dyson Ex1020
Page 1476

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: BoX V

With regard to the additional features of claim 10, D1 discloses the body 19 comprises a conduit 18 extending from a dirty air inlet 9 to a conduit air outlet 20, the conduit extending linearly.

With regard to the additional features of claims 11 and 17, D1 discloses the body 19 comprises a conduit 18 extending from a dirty air inlet 9 to a conduit air outlet 20, the outlet 20 extending at an angle to the direction of airflow through the conduit and the cyclone bin assembly air inlet 22 extends in a mating angle.

With regard to the additional features of claims 12 and 18, D1 discloses the body 19 has a carry handle and the carry handle remains with the body 19 when the cyclone bin assembly 7 is removed.

With regard to the additional features of claim 14, D1 discloses the cyclone bin assembly air outlet is provided at an upper end of the cyclone bin assembly.

With regard to the additional features of claim 15, D1 discloses the cyclone bin assembly is removable as a sealed unit other than the cyclone bin assembly air inlet 22 and the cyclone bin assembly air outlet.

Regarding claims 1-3 and 10, document D2 discloses a hand carryable surface cleaning apparatus 100 comprising a body 112 housing a suction motor 114 and comprising a dirty air inlet 102; a cyclone bin assembly 110 removably mounted to the body, the bin assembly comprising a cyclone bin assembly air inlet 128 in fluid communication with the dirty air inlet 102 when the cyclone bin assembly is mounted to the body, a cyclone chamber 118 and a dirt collection chamber 120; an air flow path extending from the dirty air inlet 102 to a clean air outlet 104 and including the suction motor 114 and the cyclone chamber 118, wherein the cyclone bin assembly 110 is partially nested in the body when the cyclone bin assembly is mounted to the body. A recess extends into the lower half of the body 112 in which the cyclone bin assembly is received. The entirety of the cyclone bin assembly 110, including an upper portion, is received in the recess. a conduit 108 extending from the dirty air inlet 102 to a conduit air outlet 130.

Regarding claims 1-4, 10-13, 17, and 18, document D3 discloses a hand carryable surface cleaning apparatus (A) comprising a body (B) housing a suction motor (G) and comprising a dirty air inlet 104; a cyclone bin assembly (D) removably mounted to the body, the bin assembly comprising a cyclone bin assembly air inlet 110 in fluid communication with the dirty air inlet 104 when the cyclone bin assembly is mounted to the body, a cyclone chamber (F) and a dirt collection chamber 30; an air flow path extending from the dirty air inlet 104 to a clean air outlet 22 and including the suction motor (G) and the cyclone chamber (F), wherein the cyclone bin assembly (D) is partially nested in the body when the cyclone bin assembly is mounted to the body.
A recess 60 provided in the lower side of the body (B) in which the cyclone bin assembly (D) is received. An upper portion of the cyclone bin assembly (D) received in the recess 60. A cyclone bin assembly air inlet 110 is provide at an upper end of the cyclone bin assembly (D). The body (B) having a conduit 102 extending from the dirty air inlet 104 to a conduit air outlet 110 wherein the conduit extends linearly. The conduit air outlet 108 extends at an angle to the direction of airflow through the conduit and the cyclone bin assembly air inlet 110 extends at a mating angle. The body (B) has a handle 80 which remains with the body (B) when the cyclone bin assembly (D) is removed.

Therefore, claims 1-20 are not novel.

Group B: Claims 21-40

Claims 21-40 are novel and therefore comply with PCT Article 33(2). Document D1 is considered to represent the closest prior art. However, none of the cited documents discloses a locking mechanism comprising an actuator disposed on the cyclone bin assembly. Claims 21-40 are therefore novel.

Group C: Claims 41-60

Claims 41-46, 57 and 59 are not novel and therefore do not comply with PCT Article 33(2).

Regarding claim 41, document D1 discloses a hand carryable surface cleaning apparatus 1 comprising a body 19 housing a suction motor 33 and comprising a handle; a cyclone bin assembly 7 mounted to the body 19; an air flow path extending from a dirty air inlet 19 to a clean air outlet 37 and including the suction motor 33 and the cyclone bin assembly 7, wherein the suction motor is oriented at an angle to a vertical axis and a horizontal axis.

[X] Continued in Supplemental Box

Dyson Ex1020
Page 1477

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of: Box V

With regard to the additional features of claim 42, D1 discloses the suction motor 33 is forward of the handle.

With regard to the additional features of claim 43, D1 discloses the suction motor extends at an angle of about 5 degrees to 45 degrees to the vertical axis.

With regard to the additional features of claims 44 and 46, D1 discloses the handle oriented at an angle to the vertical axis and the horizontal axis.

With regard to the additional features of claim 45, D1 discloses the motor and handle are generally parallel.

With regard to the additional features of claim 57, D1 discloses handle provided at a rear end of the body 19.

With regard to the additional features of claim 59, D1 discloses the cyclone bin assembly 7 comprises a dirt collection chamber which extends under the suction motor.

Therefore, claims 41-46, 57 and 59 are not novel

Claims 47-50 are novel and therefore comply with PCT Article 33(2). Document D1 is considered to represent the closest prior art. However, none of the cited documents discloses a centre of gravity below and upper end of the cyclone bin assembly. Claims 47-50 are therefore novel.

Claims 51-55 are novel and therefore comply with PCT Article 33(2). Document D1 is considered to represent the closest prior art. However, none of the cited documents discloses a pre-motor filter positioned above the suction motor. Claims 51-55 are therefore novel.

Claims 56 and 58 are novel and therefore comply with PCT Article 33(2). Document D1 is considered to represent the closest prior art. However, none of the cited documents discloses a handle mounted to the upper and lower portions of the body. Claims 56 and 58 are therefore novel.

Claim 60 is novel and therefore complies with PCT Article 33(2). Document D1 is considered to represent the closest prior art. However, none of the cited documents disclose a cyclone bin assembly having a base on which the hand carryable surface cleaning apparatus can stand. Claim 60 is therefore novel.

Group D: Claims 61-80

Claims 61, 67, 72-75, and 81-83 are not novel and therefore do not comply with PCT Article 33(2).

Regarding claims 61 and 81, document D1 discloses a hand carryable surface cleaning apparatus 1 comprising a body 19 housing a suction motor 33 oriented forwardly, a cyclone bin assembly 7 mounted to the body 19 and comprising a cyclone chamber 21 and a dirt collection chamber, wherein the dirt collection chamber extends under a portion of the suction motor; and air flow path extending from a dirty air inlet 19 to a clean air outlet 37 and including the suction motor 33 and the cyclone bin assembly 7.

With regard to the additional features of claim 67, D1 discloses the dirt collection chamber extends forwardly of the cyclone chamber.

With regard to the additional features of claim 72, D1 discloses a pre-motor filter 31 positioned in a pre-motor filter chamber 30 and air exits upwardly from the cyclone bin assembly 7 to the pre-motor filter chamber 30.

With regard to the additional features of claim 73, D1 discloses the cyclone bin assembly 7 is removable as a sealed unit other than the cyclone bin assembly air inlet 22 and the cyclone bin assembly air outlet.

[X] Continued in Supplemental Box

Dyson Ex1020
Page 1478

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Box V

With regard to the additional features of claim 74 and 75, D1 discloses the body 19 is provided with a handle and the suction motor is positioned forward of the handle. The handle is orientated as an angle to the vertical and horizontal axes.

With regard to the additional features of claim 82, D1 discloses the suction motor 33 oriented at an angle to the vertical and horizontal axes.

With regard to the additional features of claim 83, D1 discloses the suction motor 33 positioned between the handle and the cyclone bin assembly.

Therefore, claims 61, 67, 72-75, and 81-83 are not novel

Claims 62-66, 68-71, and 76-80 are novel and therefore comply with PCT Article 33(2). Document D1 is considered to represent the closest prior art. However, none of the cited documents discloses the dirt collection chamber extending rearward of the cyclone chamber; the dirt collection chamber comprises a stand; the center of gravity of the hand carryable surface cleaning apparatus is positioned below an upper end of the cyclone pin assembly; or the handle mounted to upper and lower portions of the body. Claims 68-71, and 76-80 are therefore novel.

INVENSTIVE STEP (IS)

Group A: Claims 1-20

Claims 1-20 do not involve an inventive step and therefore do not comply with PCT Article 33(3). Given the above novelty objection, claims 1-20 do not involve an inventive step.

Group B: Claims 21-40

Claims 21-40 involve an inventive step and therefore comply with PCT Article 33(3). A locking mechanism comprising an actuator disposed on the cyclone bin assembly is not obvious to a person skilled in the art from the cited documents, when taken individually or in any combination. Claims 21-40 therefore involve an inventive step.

Group C: Claims 41-60

Claims 41-46, 57 and 59 do not involve an inventive step and therefore do not comply with PCT Article 33(3). Given the above novelty objection, claims 41-46, 57 and 59 do not involve an inventive step.

Claims 47-56, 58, and 60 involve an inventive step and therefore comply with PCT Article 33(3). A centre of gravity below and upper end of the cyclone bin assembly; a pre-motor filter positioned above the suction motor; a handle mounted to the upper and lower portions of the body or a cyclone bin assembly having a base on which the hand carryable surface cleaning apparatus can stand is not obvious to a person skilled in the art from the cited documents, when taken individually or in any combination. Claims 47-56, 58, and 60 therefore involve an inventive step.

Group D: Claims 61-83

Claims 61, 67, 72-75, and 81-83 do not involve an inventive step and therefore do not comply with PCT Article 33(3). Given the above novelty objection, claims 61, 67, 72-75, and 81-83 do not involve an inventive step.

Claims 68-71 and 76-80 involve an inventive step and therefore comply with PCT Article 33(3). the dirt collection chamber extending rearward of the cyclone chamber; the dirt collection chamber comprises a stand; the center of gravity of the hand carryable surface cleaning apparatus is positioned below an upper end of the cyclone pin assembly; or the handle mounted to upper and lower portions of the body. is not obvious to a person skilled in the art from the cited documents, when taken individually or in any combination. Claims 68-71 and 76-80 therefore involve an inventive step.

INDUSTRIAL APPLICABILITY (IA)

The subject matter of claims 1-83 is considered to be industrially applicable and thus complies with the requirements of PCT Article 33(4).

Dyson Ex1020
Page 1479

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:

BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
Scotia Plaza
40 King Street West, 40th Floor
TORONTO, Ontario
Canada, M5H 3Y2

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BERESKIN & PARR LLP
LOCATION | DELIVERED TO
593 | 595

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing *(day/month/year)*	26 May 2014 (26-05-2014)
Applicant's or agent's file reference P39194PC00 — 10152	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/CA2014/000133**	International filing date *(day/month/year)* 24 February 2014 (24-02-2014)
Applicant G.B.D. CORP. ET AL.	

Advent July 2e, 2014 ns

1. ☑ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 8270

For more detailed instructions, see PCT Applicant's Guide, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the any request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters

Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 819-953-2476	Authorized officer Jean-Luc Robert (819) 953-0756

Form PCT/ISA/220 (July 2010)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below
P39194PC00		
International application No.	International filing date *(day/month/year)*	(Earliest)Priority date *(day/month/year)*
PCT/CA2014/000133	24 February 2014 (24-02-2014)	01 March 2013 (01-03-2013)
Applicant		
G,B,D, CORP. ET AL		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 5 sheets.

☑ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☑ the international application in the language in which it was filed.

☐ a translation of the international application into which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☑ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☑ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 6

☐ as suggested by the applicant.

☑ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

Dyson Ex1020
Page 1481

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2014/000133

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***A47L 9/28*** (2006.01), ***A47L 5/24*** (2006.01), ***A47L 5/36*** (2006.01), ***A47L 9/16*** (2006.01)

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)
A47L 9/28 (2006.01), ***A47L 5/24*** (2006.01), ***A47L 5/36*** (2006.01), ***A47L 9/16*** (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Databases: Google, Google Patents, Total Patent, Canadian Patent database
Keywords: wheel base portable clean unit suction motor fluid flow path AC DC power vacuum removable battery cord first second dirty inlet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
XY	US7113847B2 (CHMURA ET AL.), 26 September 2006 (26-09-2006) - claim 3; fig.1-3, 5; col.5, lines 38-47; col.9, lines 3-30	12-18, 41-42
Y	US8146201B2 (CONRAD), 03 April 2012 (03-04-2012) - claim 35; fig.11, 13-14; col.1, lines 15-24; col.2, lines 11-13, 24-27; - col.3, lines 61-64; col.4, lines 1-10;	12-18
XY	US7377007B2 (BEST), 27 May 2008 (27-05-2008) - abstract; fig.1-10B; col.2, lines 26-28; col.3, lines 28-31; col.7, lines 42-63	12-18, 19-26, 32-33, 36-38, 41-42

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 23 May 2014 (23-05-2014)	Date of mailing of the international search report 26 May 2014 (26-05-2014)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer Allan Tam (819) 953-3444

Dyson Ex1020
Page 1482

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**** Continued in Extra Sheet ****

Dyson Ex1020
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		WO2005084511A8	26 May 2006 (26-05-2006)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.
Scotia Plaza
40 King Street West, 40th Floor
TORONTO, Ontario
Canada, M5H 3Y2

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day month year)*	26 May 2014 (26-05-2014)
Applicant's or agent's file reference P39194PC00	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day month year)*	Priority date *(day month year)*
PCT/CA2014/000133	24 February 2014 (24-02-2014)	01 March 2013 (01-03-2013)

International Patent Classification (IPC) or both national classification and IPC
IPC: ***A47L 9/28*** (2006.01), ***A47L 5/24*** (2006.01), ***A47L 5/36*** (2006.01), ***A47L 9/16*** (2006.01)

Applicant
G.B.D. CORP. ET AL.

1. This opinion contains indications relating to the following items:

- ☑ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☑ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☑ Box No. VIII Certain observations on the international application

dident Jan 1, 2015 ns

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/CA	Date of completion of this opinion	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	23 May 2014 (23-05-2014)	Allan Tam (819) 953-3444

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CA2014/000133

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☑ the international application in the language in which it was filed.

☐ a translation of the international application into which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

a. (means)

☐ on paper

☐ in electronic form

b. (time)

☐ in the international application as filed.

☐ together with the international application in electronic form.

☐ subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-11, 12-18, 27-31, 34-35, 39-40	YES
	Claims	19-26, 32-33, 36-38, 41-42	NO
Inventive step (IS)	Claims	1-11, 27-31, 34-35, 39-40	YES
	Claims	12-18, 19-26, 32-33, 36-38, 41-42	NO
Industrial applicability (IA)	Claims	1-42	YES
	Claims	NONE	NO

2. Citations and explanations:

D1: US7113847B2, 26 September 2006 (26-09-2006)
- D1 is directed to a robotic vacuum with a removable portable vacuum and may be powered by a portable power source or standard power cord

D2: US8146201B2, 03 April 2012 (03-04-2012)
- D2 is directed to a surface cleaning apparatus with a cyclonic stage and removable wheeled base

D3: US7377007B2, 27 May 2008 (27-05-2008)
- D3 is directed to a vacuum cleaner with detachable vacuum module, cyclone separator and portable or corded power sources.

Novelty

Claims 1-11, 27-31, 34-35, 39-40 are novel and **do comply with Article 33(2) of the PCT**. Documents D1, D2, and D3 are considered to be the closest prior art. The subject matter of these claims differs from the prior art in that D1-D3 do not disclose: "a wheeled base comprising an AC suction motor" nor a "second dirty fluid inlet".

Claims 12-18 are novel and **do comply with Article 33(2) of the PCT**. Document D1 is considered to be the closest prior art. The subject matter of these claims differs from the prior art in that D1 does not disclose: "cyclonic separation stage".

Claims 19-26, 32-33, 36-38, and 41-42 are not novel and **do not comply with Article 33(2) of the PCT**.

With respect to independent claim 19, D3 discloses:

Claim 19 describes a surface cleaning apparatus comprising:

a) a wheeled based [D3: fig.2, ref 14, 32];
b) a portable cleaning unit removably mounted on the wheeled base and comprising at least one cyclonic separation stage and a suction motor [D3: fig 1-2, 5, ref 48; abstract; col.2, lines 26-28];
c) a first fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus [D3: fig.5, ref 78, 80, inlet and outlet]
the first fluid flow path comprising an upstream portion that extends from the dirty fluid inlet to the at least one cyclonic separation stage and the at least one cyclonic separation stage and the suction motor are positioned in the first fluid flow path [D3: fig.3, hose 58, motor 68, cyclonic separator 48];
d) wherein the cyclonic separation stage comprises a cyclone chamber and a material collection chamber, the material collection chamber is removable from the portable cleaning unit while the portable cleaning unit is mounted on the wheeled base [D3: fig 3-4, cyclonic separator 48, dirt cup 50, col.3, lines 28-31, dirt cup removably mounted to portable cleaning module].

Dependent claims 20-26, 32-33, and 36-38 are considered to provide implementation details and design choices without adding any subject matter distinguishable over the prior art found in D3 and in light of the common general knowledge in the art.

****** Continued in Supplemental Box ******

Dyson Ex1020
Page 1488

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 40 and 42 do not comply with Rule 6.2(a) of the PCT. Reference is made to the description for completeness and clarity, rather than claiming the subject matter in explicit terms.

Dyson Ex1020
Page 1489

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of: V

Novelty (cont.)

With respect to claim 41, D1 discloses:

Claim 41 describes a surface cleaning apparatus comprising:

a) a wheeled base connectable to a source of AC current [D1: fig.5, col.9, lines 3-30];
b) a portable cleaning unit removably mounted on the wheeled base [D1: fig.3, 5, ref.20] [D2: fig.13-14, col.2, lines 11-13]and comprising a first energy storage member and a suction motor [D1: fig.2-3, 5, "blower"], the portable cleaning unit operable on DC current supplied by the first energy storage member [D1: fig.3, 5, ref.56; col.5, lines 46-47] when the portable cleaning unit is removed from the wheeled base [D1: col.5, lines 38-45];
c) the portable cleaning unit electrically connectable to the wheeled base when mounted to the wheeled base whereby the suction motor is operable on AC current supplied by the source when the portable cleaning unit is mounted on the wheeled base base [D1: col.9, lines 22-25, vacuum may be power by "standard utility power via the power cord...", fig. 5 etc.];
d) a fluid flow path extending from a dirty fluid inlet to a clean air outlet of the surface cleaning apparatus and comprising the suction motor [D1: fig. 2].

Similarly, D3 is also considered to disclose the subject matter of claim 41: [D3: fig.8, col.7, lines 42-63, plug 101 provides power to motor 106 in foot assembly 14], [D3: fig.1-2, 5, ref.48; abstract; col.2, lines 26-28], [D3: fig.5, ref.78, 80, inlet and outlet].

Dependent claim 42 is considered to provide implementation details and design choices without adding any subject matter distinguishable over the prior art found in D1 and D3 and in light of the common general knowledge in the art.

Inventive Step

Claims 12-18, 19-26, 32-33, 36-38, and 41-42 **do not comply with Article 33(3) of the PCT**. The subject matter of these claims do not involve an inventive step in view of D1-D3 and in light of common general knowledge in the art.

Given the above objections, claims 19-26, 32-33, 36-38, and 41-42 are also considered to lack an inventive step in light of the described prior art and thus fail to comply with Article 33(3) of the PCT.

With respect to Independent claim 12, D1 describes.

Claim 12 describes a surface cleaning apparatus comprising:

a) a wheeled based connectable to a source of current [D1: fig.5, col.9, lines 3-30],
b) a portable cleaning unit removably mounted on the wheeled base [D1: fig.3, 5, ref.20],
a first energy storage member [D1: fig.3, 5, ref.56; col.5, lines 46-47],
a portable cleaning unit suction motor that is operable on DC power [D1: col.5, lines 38-45],
c) a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus [D1: fig.2, ref 30, 40, claim 3],
d) wherein the portable cleaning unit suction motor is operable on DC power when removed from the wheeled base and is operable on power provided by the wheeled base when mounted on the wheeled base [D1: fig.2, 3, 5].

D1 does not explicitly describe a "cyclonic separation stage" however such techniques of dirt separation are well known to a person skilled in the art as exemplified in D2 and D3 [D2: col.2, lines 24-27] [D3: fig.1, 5, ref. 48]

Dependent claims 13-18 are considered to provide implementation details and design choices without adding any subject matter distinguishable over the prior art found in D1-3 and in light of the common general knowledge in the art.

Industrial Applicability

The subject matter of claims 1-42 is considered to be industrially applicable and thus **complies with the requirements of Article 33(4) of the PCT**.

Dyson Ex1020
Page 1490

Electronic Acknowledgement Receipt

EFS ID:	24386958
Application Number:	14875381
International Application Number:	
Confirmation Number:	2483
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Customer Number:	1059
Filer:	Philip C. Mendes da Costa/Snezana Lisowsky
Filer Authorized By:	Philip C. Mendes da Costa
Attorney Docket Number:	10452-P39194US04
Receipt Date:	16-DEC-2015
Filing Date:	05-OCT-2015
Time Stamp:	18:48:13
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	CN202932850U_U-English.pdf	212222 8957ecb9e6b09375a120184 3126a1494132d7e45	no	2

Warnings:	
Information:	

2	Foreign Reference	F2_8_GB2035787.pdf	397845 b17bf376d84473a1741de15313fae8f19eb39e0d	no	7
Warnings:					
Information:					
3	Foreign Reference	F2_9_CA2450450.pdf	878997 32bb7a4c494c1e3a64847f43e353d98b5682bd95	no	32
Warnings:					
Information:					
4	Non Patent Literature	NPL1.pdf	296864 e3fa2c770d13aeb6c0e2ba238a869b361be85879	no	8
Warnings:					
Information:					
5	Non Patent Literature	NPL2.PDF	1107756 569c1db0fb170266cf76ef149aa227562c3dbb61	no	7
Warnings:					
Information:					
6	Non Patent Literature	NPL3_CN.pdf	1463720 2d71773df5dac3803abfe44a76c6c76c4648cd36	no	6
Warnings:					
Information:					
7	Non Patent Literature	NPL4.pdf	287089 719818bdc55bab94a8314f826b812874cc86bf88	no	9
Warnings:					
Information:					
8	Non Patent Literature	NPL5.pdf	314927 8ab1715cbfc0d9ffa7e14aae3c4f2619a0d9393f	no	8
Warnings:					
Information:					
9	Non Patent Literature	NPL6.PDF	404289 f32ddc72ccefc1d43e96ecc792b7e078363471f8	no	10
Warnings:					
Information:					
10	Non Patent Literature	NPL7_cordless.pdf	1011752 4ad8bfd72e3adb8c9135b0f886d9a60837ec49e9	no	14
Warnings:					
Information:					

11	Non Patent Literature	NPL8_Makita.pdf	9452553 65ab8c67583ebb915bea221b3d820c3ac8e81339	no	32
Warnings:					
Information:					
12	Non Patent Literature	NPL9_EPO.pdf	566454 5337de44848688319a6d1ef79d9554050612c5b2	no	6
Warnings:					
Information:					
13	Non Patent Literature	NPL10_EPO.pdf	1215759 a5746ffc4d3f00876264a52bd911fad85157b3d7	no	7
Warnings:					
Information:					
14	Non Patent Literature	NPL11_iprp.pdf	422507 f91b9c6a0ca653e2f70d409766aef362bcf19806	no	5
Warnings:					
Information:					
15	Non Patent Literature	NPL12.pdf	85139 6417122ae22c3f1c8e006086dcf302bc964447b2	no	2
Warnings:					
Information:					
16	Non Patent Literature	NPL13.pdf	608162 d2243905dd296336400717cb82bbaaf5940f2bf4	no	11
Warnings:					
Information:					
17	Non Patent Literature	NPL14_ISR.pdf	19123704 487371b2ef680ce5144bd2327764a2a9d624c882	no	15
Warnings:					
Information:					
18	Non Patent Literature	NPL15.pdf	230997 6ed3969757098020960732045bfcaf26e7c6fb46	no	7
Warnings:					
Information:					
19	Non Patent Literature	NPL16.pdf	233599 c0d807236b2089eeb357671af6359d9f964a3b1d	no	7
Warnings:					
Information:					

20	Non Patent Literature	NPL17_Shark_Manual.pdf	1024647 46f9ec0fb5a1838290eaccdcbca10e3f8023cd8b	no	14
Warnings:					
Information:					
21	Non Patent Literature	NPL18_000133ISR.pdf	4218247 31dc8ddf197684b4b9bba0e94b958e39f33e235a	no	11
Warnings:					
Information:					
22	Non Patent Literature	NPL19_OA_901_2011.pdf	155706 1e5cf277c2f7fe1eafcc685165aae0b79887f9e4	no	5
Warnings:					
Information:					
23	Non Patent Literature	NPL20_OA_901_2010.pdf	245982 40c18e63796444f6875a9c1cb5b46afd6d834c54	no	7
Warnings:					
Information:					
		Total Files Size (in bytes):	43958917		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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1059 e 2016-01-25

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2 CANADA

Paper No.

Application No.:	**14/875,381**	**Date Mailed:**	**2016-01-25** **PAPER**
First Named Inventor:	Wayne Ernest Conrad	Examiner:	MCDONALD, SHANTESE L
Attorney Docket No.:	10452-P39194US04	Art Unit:	3723
Confirmation No.:	2483	Filing Date:	10/05/2015

Please find attached an Office communication concerning this application or proceeding.

Commissioner for Patents

PTO-90c (Rev.08-06)

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04

CONFIRMATION NO. 2483

1059
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40th Floor
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CANADA

PUBLICATION NOTICE



Title:SURFACE CLEANING APPARATUS

Publication No.US-2016-0066755-A1
Publication Date:03/10/2016

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

1059 7590 05/05/2016

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EXAMINER	
MCDONALD, SHANTESE L	

ART UNIT	PAPER NUMBER
3723	

MAIL DATE	DELIVERY MODE
05/05/2016	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 14/875,381	Applicant(s) CONRAD, WAYNE ERNEST	
	Examiner SHANTESE MCDONALD	Art Unit 3723	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10/5/15*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-21 and 23-32* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-10,13,15-17,19-21,23-29,31 and 32* is/are rejected.

8)☐ Claim(s) *11,12,14,18 and 30* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *12/16/15*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

Claims 1,5-10,13,15-17,19,20,23-25,27-29,31 and 32 rejected under 35 U.S.C. 102(a)(1) as being anticipated by Best.

Best teaches a surface cleaning apparatus comprising a base, 14, comprising or connectable to a power cord, 100, (col .7, lines 42-53), a portable cleaning unit, 16, removable from a position in which the portable cleaning unit is supported by the base and comprising at least one cyclonic separation stage, 48, a first energy storage member, 104, and a portable cleaning unit suction motor, 64, and a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus, wherein the energy storage member may be charged when the portable

cleaning unit is supported on the base, wherein the power cord provides AC current to the base and the base provides current to the portable cleaning unit when the portable cleaning unit is supported by the base, wherein the base provides DC current to the portable cleaning unit when the portable cleaning unit is supported provides AC current to the base when connected to the base and the base provides current to the portable cleaning unit when the portable cleaning unit is supported by the base, wherein the base provides DC current to the portable cleaning unit when the portable cleaning unit is supported by the base, (col. 7, lines 49-67), wherein the portable cleaning unit is powered solely by the first energy storage member when the portable cleaning unit is removed from the position in which the portable cleaning unit is supported by the base, wherein the first energy storage member comprises batteries, (col. 8, lines 1-61), and a second storage member, 102, located in the base.

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole

> would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 2-4,21 and 26 are rejected under 35 U.S.C. 103 as being unpatentable over Best in view of Cochran et al.

Best teaches all the limitations of the claims except for the portable cleaning unit further comprises a power cord, the power cord is removably electrically connected to the portable cleaning unit, the power cord being removably electrically connected to the base. Cochran et al. teaches a portable cleaning unit with a removable power cord, (pp0050). It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide the tool of Best with the portable cleaning unit having a removably electrically connected power cord, as taught by Cochran et al., in order to provide an alternate power source. It would have been further obvious to provide the tool with the power cord being removable attachable to the base, as a matter of design choice, and since it is old and well known to provide a detachable power cord to an electric apparatus.

Allowable Subject Matter

Claims 11,12,14,18 and 30 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Weaver et al. was cited to show another example of a surface cleaning apparatus.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SHANTESE MCDONALD whose telephone number is (571)272-4486. The examiner can normally be reached on 8:00 a.m. - 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Joseph Hail can be reached on (571) 272-4485. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/S.L.M./

May 2, 2016

/Joseph J Hail/
Supervisory Patent Examiner, Art Unit 3723

Notice of References Cited	Application/Control No. 14/875,381	Applicant(s)/Patent Under Reexamination CONRAD, WAYNE ERNEST	
	Examiner SHANTESE MCDONALD	Art Unit 3723	Page 1 of 1

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Application Number	14875381
Filing Date	2015-10-05
First Named Inventor	CONRAD, Wayne E.
Art Unit	3723
Examiner Name	N/A
Attorney Docket Number	10452-P39194US04

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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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	Attorney Docket Number	10452-P39194US04	

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Philip C. Mendes da Costa/	Date (YYYY-MM-DD)	2015-12-16
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Attorney Docket Number	10452-P39194US04

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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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	Attorney Docket Number	10452-P39194US04	

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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05
	First Named Inventor	CONRAD, Wayne E.
(Not for submission under 37 CFR 1.99)	Art Unit	3723
	Examiner Name	N/A
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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	Examiner Name	N/A
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
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	Art Unit	3723	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

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Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

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Receipt date: 12/16/2015	Application Number	14875381 14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05
	First Named Inventor	CONRAD, Wayne E.
(Not for submission under 37 CFR 1.99)	Art Unit	3723
	Examiner Name	N/A
	Attorney Docket Number	10452-P39194US04

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NON-PATENT LITERATURE DOCUMENTS **Remove**

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
/S.M./	1	International Preliminary Report on Patentability, dated September 16, 2008 for International application No.PCT/CA2007/000380	
	2	Supplementary European Search Report, dated June 16, 2009, as received on the corresponding EP application No. 07719394.4	
	3	A copy of the Office Action received in connection to the corresponding Chinese Patent Application No. 200880126486.6 dated MAR 23 2012	
	4	A copy of the Office Action received in connection to the corresponding US Patent Application No. 12720901 dated JUNE 10 2011	
	5	A copy of the Office Action received in connection to the related Chinese Patent Application No. 00813438.3 issued July 11, 2003	
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	8	MAKITA BCL180 USER MANUAL	
/S.M./	9	European COMMUNICATION pursuant to Article 94(3) on European Patent Application No. 04078261.7, dated April 24, 2012	

Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

/S.M./	10	European COMMUNICATION pursuant to Article 94(3) on European Patent Application No. 04078261.7, dated February 26, 2010	
	11	International Preliminary Examination Report on International application No. PCT/CA00/00873, dated October 26, 2001	
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	14	International Search Report and Written Opinion received in connection to international patent application No. PCT/CA2015/050661, mailed on October 19, 2015	
	15	United States Office Action, dated Feb. 16, 2011, for U.S. application no. 11/953,292.	
	16	United States Office Action, dated Jul. 22, 2010, for U.S. application no. 11/953,292.	
	17	Euro-Pro Shark Cordless Hand Vac Owner's Manual, published in 2002	
	18	International Search Report and Written Opinion received in connection to international patent application no. PCT/CA2014/000133, mailed on May 26, 2014.	
	19	Office Action, issued in United States Patent Application No. 12/720,901, dated June 10, 2011	
/S.M./	20	Office Action, issued in United States Patent Application No. 12/720,901, dated November 26, 2010	

Receipt date: 12/16/2015	Application Number	14875381 14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05
	First Named Inventor	CONRAD, Wayne E.
(Not for submission under 37 CFR 1.99)	Art Unit	3723
	Examiner Name	N/A
	Attorney Docket Number	10452-P39194US04

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EXAMINER SIGNATURE

Examiner Signature	/Shantese Mcdonald/	Date Considered	05/02/2016

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2015-10-05	
	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Philip C. Mendes da Costa/	Date (YYYY-MM-DD)	2015-12-16
Name/Print	Philip C. Mendes da Costa	Registration Number	33106

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14875381	CONRAD, WAYNE ERNEST
	Examiner	Art Unit
	SHANTESE MCDONALD	3723

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
15	329,.353,410	5/2/2016	/SLM/

SEARCH NOTES		
Search Notes	Date	Examiner
class 15	5/2/2016	/SLM/

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Appl. No	:	14/875,381	Confirmation No.:	2483
Applicant	:	Omachron Intellectual Property Inc.		
Filed	:	October 5, 2015		
Title	:	SURFACE CLEANING APPARATUS		
TC./A.U.	:	3723		
Examiner	:	MCDONALD, Shantese L.		
Docket No.	:	10452-P39194US04		
Customer No.	:	001059		

Mail Stop Amendments
Honorable Commissioner for Patents
P. O. Box 1450
Alexandria, Virginia 22313–1450

July 29, 2016

AMENDMENT

Sir:

In response to the office action of May 5, 2016 please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims, which begins on page 2 of this paper.

Remarks/Arguments begin on page 9 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A surface cleaning apparatus comprising:

a) a base comprising or connectable to a power cord;

b) a portable cleaning unit removable from a position in which the portable cleaning unit is supported by the base and comprising at least one cyclonic separation stage, a first energy storage member and a portable cleaning unit suction motor; and,

c) a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus,

wherein the energy storage member may be charged when the portable cleaning unit is supported by the base

and wherein the base further comprises a suction motor which is used to provide motive power through the fluid flow path when the surface cleaning unit is switched on and when the portable cleaning unit is mounted on the base.

2. (Original) The surface cleaning apparatus of claim 1 wherein the portable cleaning unit further comprises a power cord.

3. (Original) The surface cleaning apparatus of claim 1, wherein the power cord is removably electrically connected to the portable cleaning unit.

4. (Previously Presented) The surface cleaning apparatus of claim 3 wherein the power cord is also removably electrically connected to the base.

5. (Previously Presented) The surface cleaning apparatus of claim 4 wherein the power cord provides AC current to the base and the base provides current to the portable cleaning unit when the portable cleaning unit is supported by the base.

6. (Previously Presented) The surface cleaning apparatus of claim 5 wherein the base provides DC current to the portable cleaning unit when the portable cleaning unit is supported by the base.

7. (Previously Presented) The surface cleaning apparatus of claim 1 further comprising a power cord electrically connected to the base and wherein the power cord provides AC current to the base when connected to the base and the base provides current to the portable cleaning unit when the portable cleaning unit is supported by the base.

8. (Previously Presented) The surface cleaning apparatus of claim 7 wherein the base provides DC current to the portable cleaning unit when the portable cleaning unit is supported by the base.

9. (Previously Presented) The surface cleaning apparatus of claim 1 wherein the portable cleaning unit is powered solely by the first energy storage member when the portable cleaning unit is removed from the position in which the portable cleaning unit is supported by the base.

10. (Original) The surface cleaning apparatus of claim 1 wherein the first energy storage member comprises batteries.

11. (Cancelled).

12. (Currently Amended) The surface cleaning apparatus of claim [[1]]1 wherein the suction motor in the portable cleaning unit is not used to provide motive power to move fluid through the fluid flow path when the surface cleaning unit is switched on and when the portable cleaning unit is supported by ~~to~~ the base.

13. (Cancelled).

14. (Currently Amended) [[The]] a surface cleaning apparatus ~~of claim 13~~ comprising:

a) a base comprising or connectable to a power cord;

b) a portable cleaning unit removable from a position in which the portable cleaning unit is supported by the base and comprising at least one cyclonic separation stage, a first energy storage member and a portable cleaning unit suction motor; and,

c) a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus,

wherein the base further comprises a second energy storage member,

and wherein the first ~~second~~ energy storage member may be charged by ~~charges~~ the second ~~first~~ energy storage member when the portable cleaning unit is supported by the base.

15. (Original) The surface cleaning apparatus of claim 1 wherein the portable cleaning unit suction motor is a DC motor.

16. (Previously Presented) The surface cleaning apparatus of claim 15 wherein the base further comprises or is electrically connectable to a power cord, the base further comprises a circuit that receives AC current and outputs DC current and the portable cleaning unit is powered by DC current when the portable cleaning unit is supported by the base.

17. (Currently Amended) A surface cleaning apparatus comprising:

a) a base;

b) a portable cleaning unit removable from a position in which the portable cleaning unit is supported by the base and comprising at least one cyclonic separation stage, an energy storage member and a portable cleaning unit suction motor; and,

c) a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus,

wherein the base further comprises a portion of the fluid flow path and has a base suction motor provided in the portion of the fluid flow path and the base suction motor is used to provide motive power through the fluid flow path when the surface cleaning unit is switched on and when the portable cleaning unit is mounted on the base ~~the portable cleaning comprises or is electrically connectable to a power cord whereby the portable cleaning unit suction motor may be powered by the energy storage member or power supplied by the power cord~~.

18. (Cancelled).

19. (Currently Amended) The surface cleaning apparatus of claim 17 wherein the portable cleaning unit comprises or is electrically connectable to a power cord whereby the portable cleaning unit suction motor may be powered by the energy storage member or power supplied by the power cord and the power cord or an alternate power cord provides AC current to the base and the base provides current to the portable cleaning unit when the portable cleaning unit is supported by the base.

20. (Previously Presented) The surface cleaning apparatus of claim 19 wherein the base provides DC current to the portable cleaning unit when the portable cleaning unit is supported by the base.

21. (Currently Amended) The surface cleaning apparatus of claim 17 wherein the portable cleaning unit comprises or is electrically connectable to a power cord whereby the portable cleaning unit suction motor may be powered by the energy storage member or power supplied by the power cord and the power cord is electrically connectable to the portable cleaning unit and the base.

22. (Cancelled).

23. (Previously Presented) The surface cleaning apparatus of claim 1 wherein the base comprises a surface cleaning head.

24. (Previously Presented) The surface cleaning apparatus of claim 17 wherein the base comprises a surface cleaning head.

25. (Currently Amended) A surface cleaning apparatus comprising:

a) a portable cleaning unit removable from a remainder of the surface cleaning unit and comprising at least one cyclonic separation stage, a first energy storage member and a portable cleaning unit suction motor;

b) the remainder of the surface cleaning apparatus comprising or connectable to a power cord; and,

c) a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus,

wherein the base further comprises a portion of the fluid flow path and has a base suction motor provided in the portion of the fluid flow path and the base suction motor is used to provide motive power through the fluid flow path when the surface cleaning unit is switched on and when the portable cleaning unit is mounted on the base ~~the energy storage member may be charged when the portable cleaning unit is supported by the remainder of the surface cleaning apparatus~~.

26. (Previously Presented) The surface cleaning apparatus of claim 25 wherein the power cord is removably electrically connected to the portable cleaning unit.

27. (Previously Presented) The surface cleaning apparatus of claim 25 wherein the power cord provides AC current to the remainder of the surface cleaning apparatus and the remainder of the surface cleaning apparatus provides current to the portable cleaning unit when the portable cleaning unit is supported by the remainder of the surface cleaning apparatus.

28. (Previously Presented) The surface cleaning apparatus of claim 27 wherein the remainder of the surface cleaning apparatus provides DC current to the portable cleaning unit when the portable cleaning unit is supported by the remainder of the surface cleaning apparatus.

29. (Currently Amended) A surface cleaning apparatus comprising:

a) a portable cleaning unit removable from a remainder of the surface cleaning apparatus and comprising at least one cyclonic separation stage, an energy storage member and a portable cleaning unit suction motor; and,

c) a fluid flow path extending from a first dirty fluid inlet to a clean air outlet of the surface cleaning apparatus,

wherein ~~the portable cleaning comprises or is electrically connectable to a power cord whereby the portable cleaning unit suction motor may be powered by the energy storage member or power supplied by the power cord~~

wherein the remainder of the surface cleaning apparatus further comprises a portion of the fluid flow path and has a suction motor provided in the portion of the fluid flow path and which is used to provide motive power through the fluid flow path when the surface cleaning unit is switched on and when the portable cleaning unit is mounted on the base

30. (Cancelled).

31. (Currently Amended) The surface cleaning apparatus of claim 29 wherein the portable cleaning comprises or is electrically connectable to a power cord whereby the portable cleaning unit suction motor may be powered by the energy storage member or power supplied by the power cord and the power cord or an alternate power cord provides AC current to the remainder of the surface cleaning apparatus and the remainder of the surface cleaning apparatus provides current to the portable cleaning unit when the portable cleaning unit is supported by remainder of the surface cleaning apparatus.

32. (Previously Presented) The surface cleaning apparatus of claim 31 wherein the remainder of the surface cleaning apparatus provides DC current to the portable cleaning unit when the portable cleaning unit is supported by the remainder of the surface cleaning apparatus.

REMARKS/ARGUMENTS

This is response to the Office Action dated May 5, 2016. Therefore, this response is timely filed.

Status of the Claims

Claim 1 has been amended by adding the subject matter of claim 11 thereto. Claim 11 has accordingly been cancelled without prejudice.

Claim 12 has been amended to depend from claim 1 as claim 11 was cancelled.

Claim 14 was converted to an independent claim by adding the subject matter of claim 1 thereto.

Claim 17 was amended by deleting the reference to the power cord and adding the subject matter of cancelled claim 11 thereto.

Claims 19 and 21 were amended by adding the power cord thereto.

Claims 25 was amended by deleting the reference to the energy storage member and adding the subject matter of cancelled claim 11 thereto.

Claims 29 was amended by deleting the reference to the power cord and adding the subject matter of cancelled claim 11 thereto.

The application now contains 27 claims including 5 independent claims. The Applicant has already paid for 4 independent claims in excess of 3. The Applicant encloses herewith the requisite fees under 37 CFR 1.16(i) and 37 CFR 1.16(h) which are due in conjunction with the filing of 1 additional independent claim in excess of 4.

The Applicant believes that no other additional fees are due; However, should any additional fees be required, the Commissioner is authorized to charge any such deficiencies necessary for entry of this amendment, including any claim fees and/or extension fees from our Deposit Account no. 022095.

Discussion of the Allowable Subject Matter

The Examiner advised that claims 11, 12, 14 18 and 30 contain allowable subject matter. The subject matter of claim 11 has been included in independent claims 1, 17, 25 and 29. Claim 14 has been converted to an independent claim. Therefore, it is submitted that each independent claim is allowable.

Discussion of the Rejections under 35 USC 102

The Examiner rejected claims 1, 5-10, 13, 15-17, 19, 20, 23-25, 27-29, 31 and 32 under 35 U.S.C. 102(a) in view of Best. The Applicant notes that claim 11 was not rejected as being anticipated by Best. Claims 1, 17, 25 and 29 now contain the subject matter of claim 11. Therefore it is submitted that the claims on file are not anticipated by Best.

Discussion of the Rejections under 35 USC 103

The Examiner rejected claims 2-4, 21 and 26 under 35 U.S.C. 102(a) in view of Best in view of Cochran et al.

The rest of the rejected claims depend from an allowable base claim and further define additional technical features of the present invention. In view of the patentability of claim 1, 17 and 25 and in further view of the additional technical features, applicant respectfully submits that the dependent claims are patentable over the prior art.

Although applicant has not addressed all the issues of the dependent claims, applicant respectfully submits that applicant does not necessarily agree with the characterization and assessments of the dependent claims made by the Examiner, and applicant believes that each claim is patentable on its own merits. Applicant respectfully submits that the dependent claims incorporate by reference all the limitations of the claim to which they refer and include their own patentable features, and are therefore in condition for allowance. Therefore applicant respectfully requests the withdrawal of all claim rejections and prompts allowance of the claims.

Conclusion

In light of the applicant's amendments to the claims and the foregoing Remarks, it is respectfully submitted that the present application is in condition for allowance. Should the Examiner have any remaining concerns which might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number appearing below.

No Disclaimers or Disavowals

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to peruse at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that applicant has made any disclaimers or disavowals of any subject matter supported by the present specification.

If additional fees are required, please charge the fees to our Deposit Account No. 02-2095.

Respectfully submitted,

BERESKIN & PARR LLP/
S.E.N.C.R.L., s.r.l.

By _____
Philip C. Mendes da Costa
Reg. No. 33,106
Tel: 416-957-1695

Attachments

Attach Figure

Dyson Ex1020
Page 1561

Annotated Sheet Showing Changes

Attach Figure

Dyson Ex1020
Page 1562

Electronic Acknowledgement Receipt

EFS ID:	26494975
Application Number:	14875381
International Application Number:	
Confirmation Number:	2483
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Customer Number:	1059
Filer:	Philip C. Mendes da Costa/Nakita D'souza
Filer Authorized By:	Philip C. Mendes da Costa
Attorney Docket Number:	10452-P39194US04
Receipt Date:	29-JUL-2016
Filing Date:	05-OCT-2015
Time Stamp:	14:09:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		P39194US04US_Response_2016_07_29.pdf	173196 0e39886372ab6ced76385da94c2f47ae279062b7	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	8
	Applicant Arguments/Remarks Made in an Amendment	9	14
Warnings:			
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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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1059 7590 11/18/2016

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TORONTO, ON M5H 3Y2
CANADA

EXAMINER
MCDONALD, SHANTESE L

ART UNIT	PAPER NUMBER
3723	

DATE MAILED: 11/18/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

TITLE OF INVENTION: SURFACE CLEANING APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	02/21/2017

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

1059 7590 11/18/2016
BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2
CANADA

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

TITLE OF INVENTION: SURFACE CLEANING APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	02/21/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
MCDONALD, SHANTESE L	3723	015-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29
  NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27
  NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status.
  NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Dyson Ex1020
Page 1566

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

1059 7590 11/18/2016

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2
CANADA

EXAMINER	
MCDONALD, SHANTESE L	
ART UNIT	PAPER NUMBER
3723	

DATE MAILED: 11/18/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Dyson Ex1020
Page 1567

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/875,381	Applicant(s) CONRAD, WAYNE ERNEST	
	Examiner SHANTESE MCDONALD	Art Unit 3723	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☐ This communication is responsive to *an amendment filed 7/29/16*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-10,12,14-17,19-21,23-29,31 and 32*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

REASONS FOR ALLOWANCE

The following is an examiner's statement of reasons for allowance: the limitation of wherein the base further comprises a suction motor which is used to provided motive power through the fluid flow path when the surface cleaning unit is switched on and when the portable cleaning unit is mounted on the base, was not found in the prior art..

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SHANTESE MCDONALD whose telephone number is (571)272-4486. The examiner can normally be reached on 8:00 a.m. - 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Joseph Hail can be reached on (571) 272-4485. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/S.L.M./
November 14, 2016

/Joseph J Hail/
Supervisory Patent Examiner, Art Unit 3723

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 2483

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/875,381	10/05/2015	015	3723	10452-P39194US04

APPLICANTS
Omachron Intellectual Property Inc., Hampton, CANADA;

INVENTORS
Wayne Ernest Conrad, Hampton, CANADA;

**** CONTINUING DATA ***************************
This application is a CON of 13/782,217 03/01/2013 PAT 9192269
which is a CIP of 13/720,754 12/19/2012 PAT 8752239
which is a DIV of 11/954,331 12/12/2007 PAT 8359705
which claims benefit of 60/870,175 12/15/2006
and claims benefit of 60/884,767 01/12/2007

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
10/19/2015

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /SHANTESE L MCDONALD/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CANADA	18	31	4

ADDRESS

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2
CANADA

TITLE

SURFACE CLEANING APPARATUS

FILING FEE RECEIVED		
2900	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14875381	CONRAD, WAYNE ERNEST
	Examiner	Art Unit
	SHANTESE MCDONALD	3723

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
15	329,.353,410	5/2/2016	/SLM/
same as above		11/14/2016	/SLM/

SEARCH NOTES		
Search Notes	Date	Examiner
class 15	5/2/2016	/SLM/
same as above	11/14/2016	/SLM/

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
see search notes		11/14/2016	/SLM/

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14875381	CONRAD, WAYNE ERNEST
	Examiner	**Art Unit**
	SHANTESE MCDONALD	3723

CPC						
Symbol					**Type**	**Version**
A47L		9	/	1641	F	2013-01-01
A47L		5	/	225	I	2013-01-01
A47L		9	/	1683	I	2013-01-01
A47L		9	/	322	I	2013-01-01
A47L		5	/	24	I	2013-01-01
A47L		5	/	36	I	2013-01-01
A47L		9	/	16	I	2013-01-01
A47L		9	/	2868	I	2013-01-01
A47L		9	/	2884	I	2013-01-01
A47L		9	/	009	I	2013-01-01
			/			
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

/SHANTESE MCDONALD/ Examiner.Art Unit 3723	11/14/2016	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/JOSEPH J HAIL/ Supervisory Patent Examiner.Art Unit 3723	11/14/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14875381	CONRAD, WAYNE ERNEST
	Examiner	**Art Unit**
	SHANTESE MCDONALD	3723

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION									
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED				
15	329	A	4	7	L	9 / 00 (2006.01.01)					

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
15	353	410			

/SHANTESE MCDONALD/ Examiner.Art Unit 3723	11/14/2016	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/JOSEPH J HAIL/ Supervisory Patent Examiner.Art Unit 3723	11/14/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14875381	CONRAD, WAYNE ERNEST
	Examiner	**Art Unit**
	SHANTESE MCDONALD	3723

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	18	20												
2	2	19	21												
3	3	14	23												
4	4	20	24												
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10	10	26	31												
11	12	27	32												
15	14														
12	15														
13	16														
16	17														
17	19														

/SHANTESE MCDONALD/ Examiner.Art Unit 3723	11/14/2016	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/JOSEPH J HAIL/ Supervisory Patent Examiner.Art Unit 3723	11/14/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	9242	(surface with cleaning with apparatus).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/14 08:37
L2	60	l1 and (portable with cleaning with unit).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/14 08:38
L3	20	l2 and (fluid with flow with path).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/14 08:38
L4	7	l3 and (energy with storage with member).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/14 08:39
L5	6	l4 and (base with suction with motor).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/14 08:39

11/ 14/ 2016 8:40:32 AM

DEJ

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

OPAP DEC 08 2016 PATENT & TRADEMARK OFFICE

1059 7590 11/18/2016
BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2
CANADA

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

TITLE OF INVENTION: SURFACE CLEANING APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	02/21/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
MCDONALD, SHANTESE L	3723	015-329000

12/09/2016 INTEFSW 00002558 14875381
01 FC:1501 960.00 DA

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Philip C. Mendes da Costa
2 Bereskin & Parr LLP/ S.E.N.C.R.L., s.r.l.
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Omachron Intellectual Property Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Hampton, Ontario, Canada

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 022095 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
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NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Philip C. Mendes da Costa/ Date December 8, 2016
Typed or printed name Philip C. Mendes da Costa Registration No. 33106

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

1059 7590 11/18/2016
BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2
CANADA

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Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

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EXAMINER	ART UNIT	CLASS-SUBCLASS
MCDONALD, SHANTESE L	3723	015-329000

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1 Philip C. Mendes da Costa
2 Bereskin & Parr LLP/
3 S.E.N.C.R.L., s.r.l.

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(B) RESIDENCE: (CITY and STATE OR COUNTRY): Hampton, Ontario, Canada

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Authorized Signature /Philip C. Mendes da Costa/ Date December 8, 2016
Typed or printed name Philip C. Mendes da Costa Registration No. 33106

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Acknowledgement Receipt

EFS ID:	27737353
Application Number:	14875381
International Application Number:	
Confirmation Number:	2483
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Customer Number:	1059
Filer:	Philip C. Mendes da Costa/Snezana Lisowsky
Filer Authorized By:	Philip C. Mendes da Costa
Attorney Docket Number:	10452-P39194US04
Receipt Date:	08-DEC-2016
Filing Date:	05-OCT-2015
Time Stamp:	15:28:16
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	P39194US04_Commissioner_reIssueFee_2016_12_08.pdf	146155 4037b9ce3bbe85350d9ba965922a50d34f08ed93	no	1
Warnings:					

Information:					
2	Issue Fee Payment (PTO-85B)	P39194US04_14875381_IssueFeePayment.pdf	87519 f04078aaf6729c66aff6680fd1014cc28bf84b7c	no	1
Warnings:					
Information:					
			Total Files Size (in bytes):	233674	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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Bereskin & Parr
INTELLECTUAL PROPERTY LAW

Appl. No	:	14/875,381
Applicant	:	Omachron Intellectual Property Inc.
Filed	:	October 5, 2015
Title	:	SURFACE CLEANING APPARATUS
TC./A.U.	:	3723
Examiner	:	MCDONALD, Shantese L.
Docket No.	:	10452-P39194US04
Customer No.	:	001059

Date: December 8, 2016
Confirmation No.: 2483

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Accordingly, please charge the government fee of $960.00 (Utility Issue Fee) to our deposit account No. **022095**. Please also charge any deficiency or credit any overpayment to this account.

Respectfully submitted,

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.

By P. mendes da Costa
Philip C. Mendes da Costa
Reg. No. 33,106
Tel: 416-957-1695

Bereskin & Parr LLP
Scotia Plaza, 40 King Street West, 40th Floor, Toronto, Ontario, Canada M5H 3Y2
Tel: 416.364.7311 Fax: 416.361.1398 www.bereskinparr.com
TORONTO MISSISSAUGA WATERLOO MONTRÉAL

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14/875,381	10/05/2015	Wayne Ernest Conrad	10452-P39194US04	2483

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Authorized Signature /Philip C. Mendes da Costa/ Date December 8, 2016
Typed or printed name Philip C. Mendes da Costa Registration No. 33106

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal

Application Number:	14875381
Filing Date:	05-Oct-2015
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Filer:	Philip C. Mendes da Costa/Snezana Lisowsky
Attorney Docket Number:	10452-P39194US04

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt	
EFS ID:	27737889
Application Number:	14875381
International Application Number:	
Confirmation Number:	2483
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Customer Number:	1059
Filer:	Philip C. Mendes da Costa/Snezana Lisowsky
Filer Authorized By:	Philip C. Mendes da Costa
Attorney Docket Number:	10452-P39194US04
Receipt Date:	08-DEC-2016
Filing Date:	05-OCT-2015
Time Stamp:	15:53:13
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$960
RAM confirmation Number	120916INTEFSW00002558022095
Deposit Account	022095
Authorized User	Snezana Lisowsky
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	P39194US04_Commissioner_reIssueFee_2016_12_08.pdf	146155 4037b9ce3bbe85350d9ba965922a50d34f08ed93	no	1
Warnings:					
Information:					
2	Issue Fee Payment (PTO-85B)	P39194US04_14875381_IssueFeePayment.pdf	87519 f04078aaf6729c66aff6680fd1014cc28bf84b7c	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30641 6f8b422b499304b45d571c56fda7baa324adae5e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	264315		

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Bereskin & Parr
INTELLECTUAL PROPERTY LAW

Appl. No	:	14/875,381
Applicant	:	Omachron Intellectual Property Inc.
Filed	:	October 5, 2015
Title	:	SURFACE CLEANING APPARATUS
TC./A.U.	:	3723
Examiner	:	MCDONALD, Shantese L.
Docket No.	:	10452-P39194US04
Customer No.	:	001059

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By P. mendes da Costa
Philip C. Mendes da Costa
Reg. No. 33,106
Tel: 416-957-1695

Bereskin & Parr LLP
Scotia Plaza, 40 King Street West, 40th Floor, Toronto, Ontario, Canada M5H 3Y2
Tel: 416.364.7311 Fax: 416.361.1398 www.bereskinparr.com
TORONTO MISSISSAUGA WATERLOO MONTRÉAL

Receipt date: 12/16/2015	Application Number	14875381	14875381 - GAU: 3723
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2015-10-05	
(Not for submission under 37 CFR 1.99)	First Named Inventor	CONRAD, Wayne E.	
	Art Unit	3723	
	Examiner Name	N/A	
	Attorney Docket Number	10452-P39194US04	

/S.M./	130	2731102	A	1956-01-17	JAMES WILLIAM S	
	131	2678110	A	1954-05-11	MADSEN WALTER M.	
	132	2542634	A	1951-02-20	DAVIS ARCHIBALD H. et al.	
	133	2152114	A	1939-03-28	TONGEREN HERMANNUS VAN	
	134	2015464	A	1935-09-24	CAMILLE SAINT	
	135	1937765	A	1933-12-05	LEATHERS WARD	
	136	1898608	A	1933-02-21	ALEXANDER WILLIAM	
	137	1797812	A	1931-03-24	WARING HORACE	
	138	1600762	A	1926-09-21	HAWLEY CHARLES GILBERT	
	139	0911258	A	1909-02-02	RICHARD GOTTHILF NEUMANN	
/S.M./	140	D303173	S	1989-08-29	Miyamoto, et al. ~~MASAKATA ET AL~~.	

Change(s) applied to document.
/KD/
12/9/2016

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/875,381	01/17/2017	9545181	10452-P39194US04	2483

1059 7590 12/28/2016

BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.
40 KING STREET WEST
40th Floor
TORONTO, ON M5H 3Y2
CANADA

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Wayne Ernest Conrad, Hampton, CANADA;
Omachron Intellectual Property Inc., Hampton, CANADA;

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PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,545,181

APPLICATION NO.: 14/875,381

ISSUE DATE : January 17, 2017

INVENTOR(S) : Wayne Ernest Conrad

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Claim 16, column 21, line 17, “wherein the base further comprises a portion of the fluid path” should read -- wherein the base further comprises a portion of the fluid flow path --

Claim 21, column 22, line 6, “when the portable cleaning unit is mounted to the base.” should read-- when the portable cleaning unit is mounted on the base. --

Claim 27, line 4, “by remainder” should read -- by the remainder --

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Bereskin & Parr LLP/S.E.N.C.R.L., s.r.l.
40 King Street West, 40th Floor
Toronto, Ontario M5H 3Y2, Canada

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Bereskin & Parr
INTELLECTUAL PROPERTY LAW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent No.:	9,545,181
Patentee:	Omachron Intellectual Property Inc.
Issued :	January 17, 2017
Title:	SURFACE CLEANING APPARATUS
Docket No.:	10452-P39194US04
Customer No.:	01059

Date: March 3, 2017

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CERTIFICATE OF CORRECTION OF PATENT FOR PTO MISTAKE (37 C.F.R. § 1.322(a))

1. Attached is PTO/SB/44 in a form suitable for printing.

2. The exact page and line number of the errors and the corrections that are required are as follows:

   Claim 16, column 21, line 17, "wherein the base further comprises a portion of the fluid path" should read "wherein the base further comprises a portion of the fluid flow path";

   Claim 21, column 22, line 6, "when the portable cleaning unit is mounted to the base." should read "when the portable cleaning unit is mounted on the base.";

   Claim 27, line 4, "by remainder" should read "by the remainder".

3. Please send the Certificate to:

   Name: Philip C. Mendes da Costa
   Address: Bereskin & Parr LLP/S.E.N.C.R.L., s.r.l.
   40 King Street West, 40th Floor
   Toronto, Ontario, M5H 3Y2, Canada

   Respectfully submitted,

   BERESKIN & PARR LLP/S.E.N.C.R.L., s.r.l.

   By /Philip C. Mendes da Costa /
   Philip C. Mendes da Costa
   Reg. No. 33,106
   Tel: 416-957-1695

Electronic Acknowledgement Receipt

EFS ID:	28522904
Application Number:	14875381
International Application Number:	
Confirmation Number:	2483
Title of Invention:	SURFACE CLEANING APPARATUS
First Named Inventor/Applicant Name:	Wayne Ernest Conrad
Customer Number:	1059
Filer:	Philip C. Mendes da Costa/Snezana Lisowsky
Filer Authorized By:	Philip C. Mendes da Costa
Attorney Docket Number:	10452-P39194US04
Receipt Date:	03-MAR-2017
Filing Date:	05-OCT-2015
Time Stamp:	05:06:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	10452_P39194US04_Certificate_Correction_20170303.pdf	164595 4600fdcec3ae8758b4750406d1bcffbca2be3889	no	2

Warnings:

Information:					
2	Request for Certificate of Correction	Request_for_Certificate_Correction_2017_03_03.pdf	139946 f7d45acba47eedd26e0d1ceb9d170a502d75efeb	no	1
Warnings:					
Information:					
			Total Files Size (in bytes):	304541	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,545,181 B2
APPLICATION NO. : 14/875381
DATED : January 17, 2017
INVENTOR(S) : Wayne Ernest Conrad

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Claim 16, Column 21, Line 17, "wherein the base further comprises a portion of the fluid path" should read -- wherein the base further comprises a portion of the fluid flow path --

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Claim 27, Column 22, Line 4, "by remainder" should read -- by the remainder --

Signed and Sealed this
Tenth Day of April, 2018

Andrei Iancu
Director of the United States Patent and Trademark Office