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Conrad

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(54) **SURFACE CLEANING APPARATUS**

(71) Applicant: **Omachron Intellectual Property Inc.**, Hampton (CA)

(72) Inventor: **Wayne Ernest Conrad**, Hampton (CA)

(73) Assignee: **Omachron Intellectual Property Inc.**, Hampton, Ontario (CA)

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This patent is subject to a terminal disclaimer.

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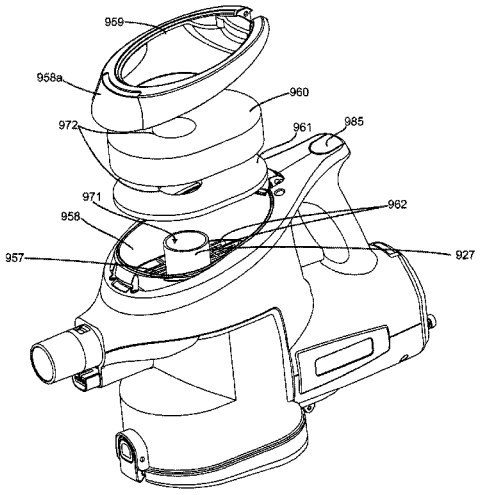
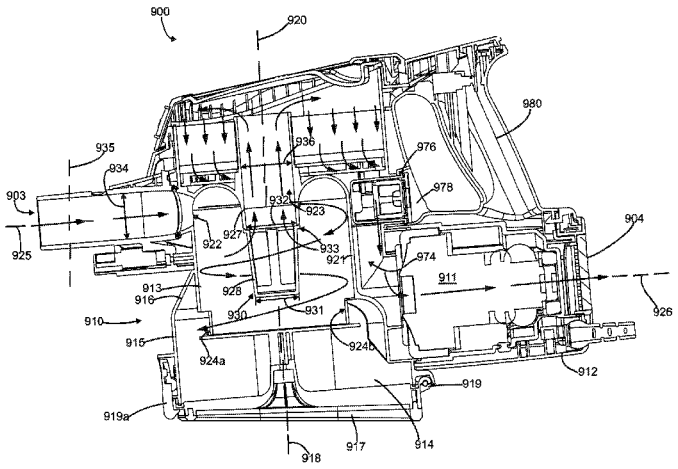
Primary Examiner — Joseph J Hail
Assistant Examiner — J Stephen Taylor
(74) *Attorney, Agent, or Firm* — Philip C. Mendes da Costa; Bereskin & Parr LLP/S.E.N.C.R.L., s.r.l.

(57) **ABSTRACT**

A hand carriable surface cleaning apparatus, such as a cyclonic hand vacuum cleaner, is provided wherein a conduit is in communication with the cyclone air outlet. The conduit extends through the porous pre-motor filter media and is in communication with the upstream side of the porous pre-motor filter media.

19 Claims, 54 Drawing Sheets





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continuation-in-part of application No. 14/994,495, filed on Jan. 13, 2016, now abandoned, which is a continuation of application No. 13/039,376, filed on Mar. 3, 2011, now Pat. No. 9,265,395, which is a continuation-in-part of application No. 12/722,705, filed on Mar. 12, 2010, now Pat. No. 8,578,555, application No. 15/184,954, which is a continuation of application No. 14/932,816, filed on Nov. 4, 2015, now Pat. No. 9,693,666, which is a continuation of application No. 13/040,676, filed on Mar. 4, 2011, now Pat. No. 9,211,044.

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(58) **Field of Classification Search**

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See application file for complete search history.

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* cited by examiner

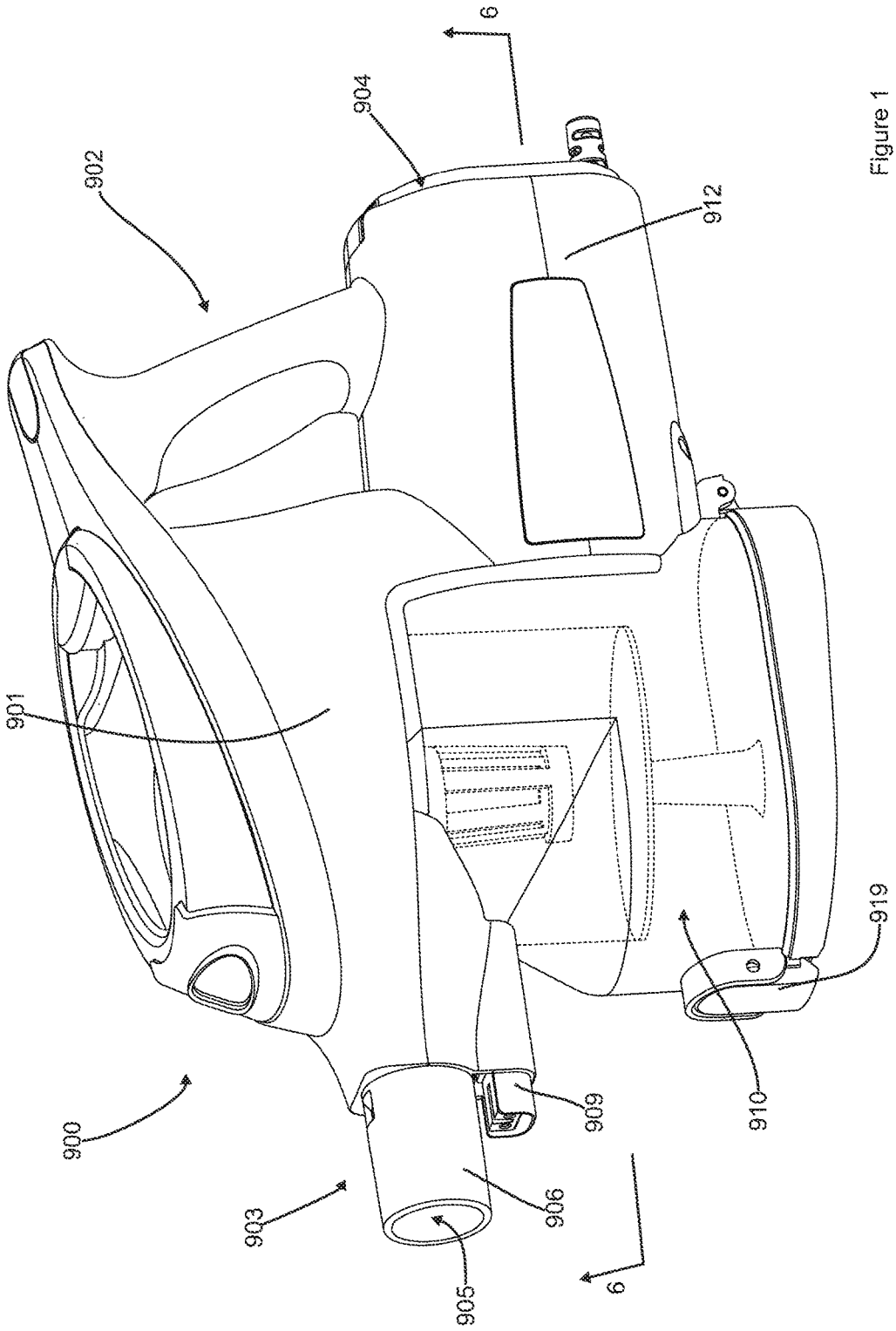
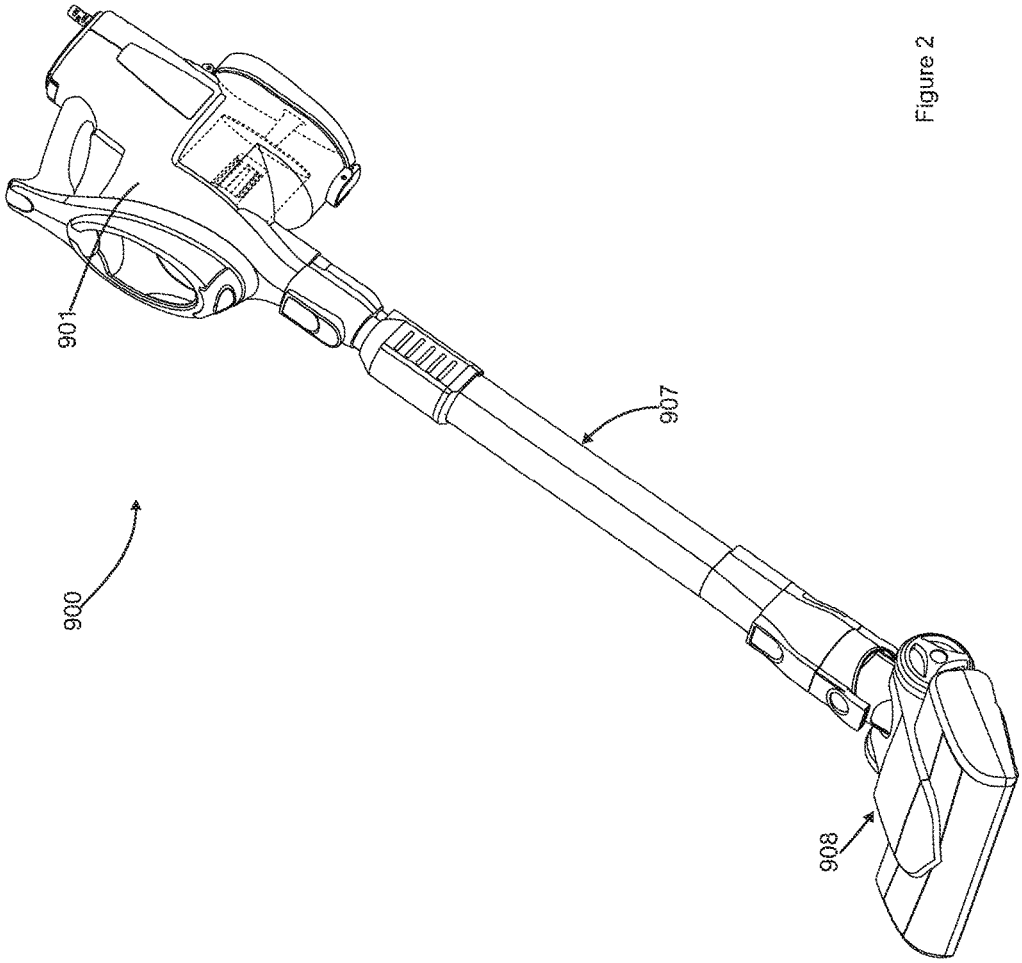


Figure 1



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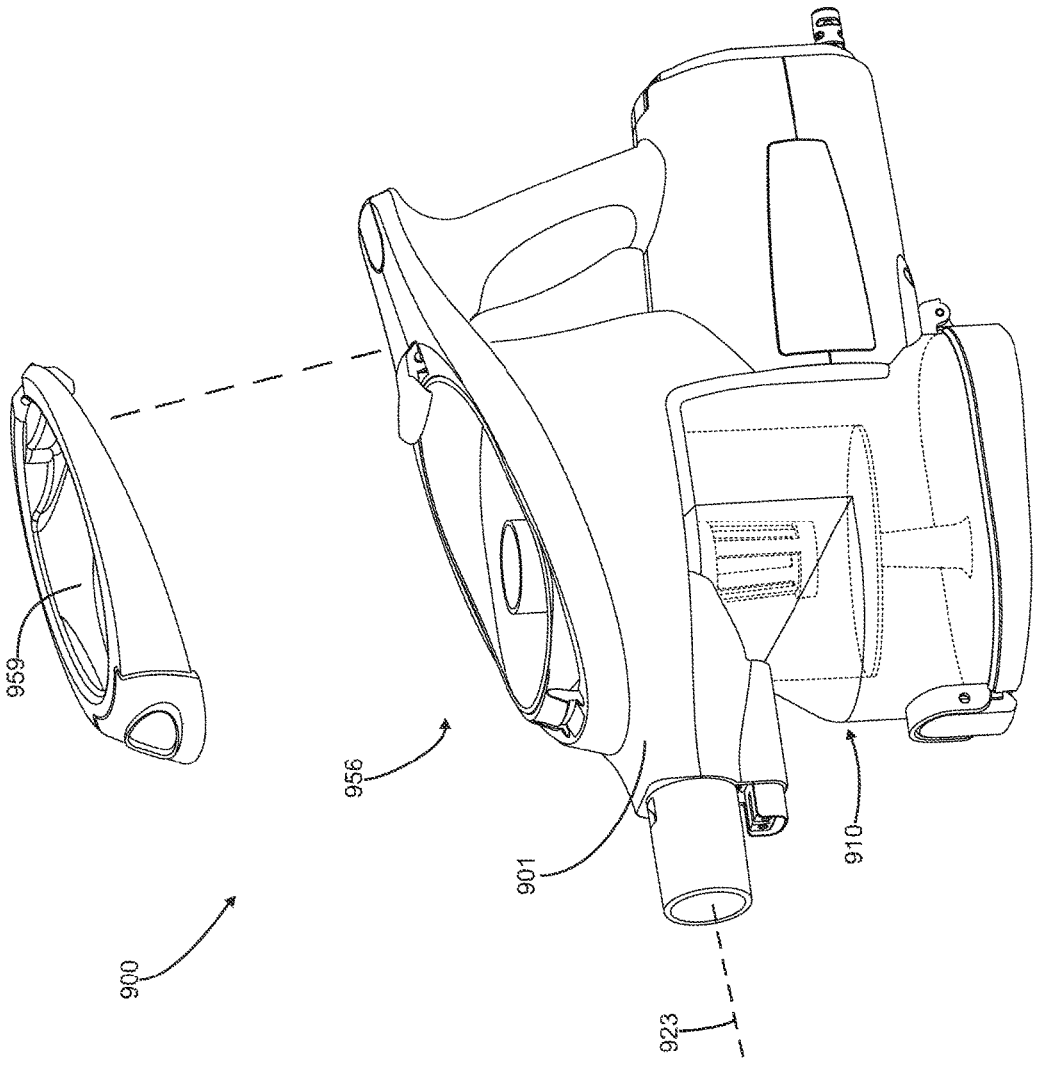

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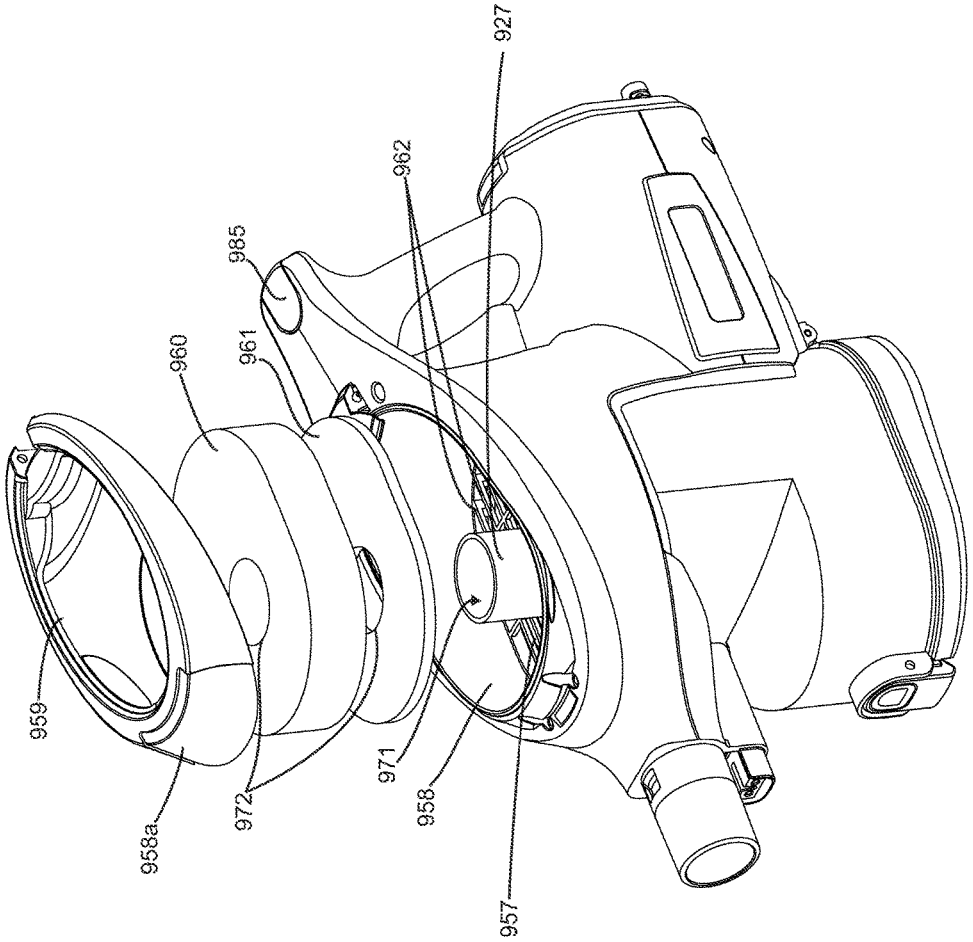

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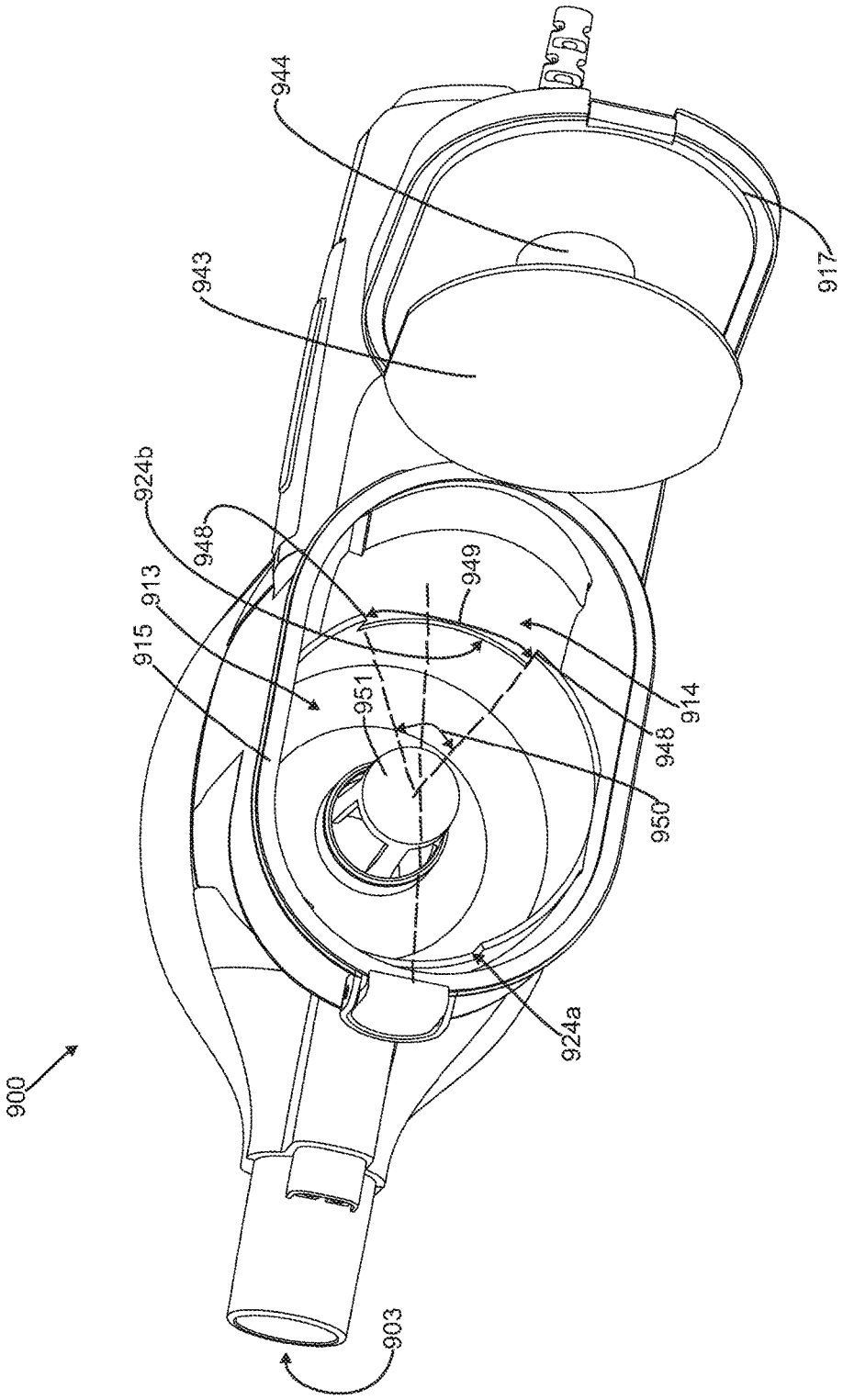

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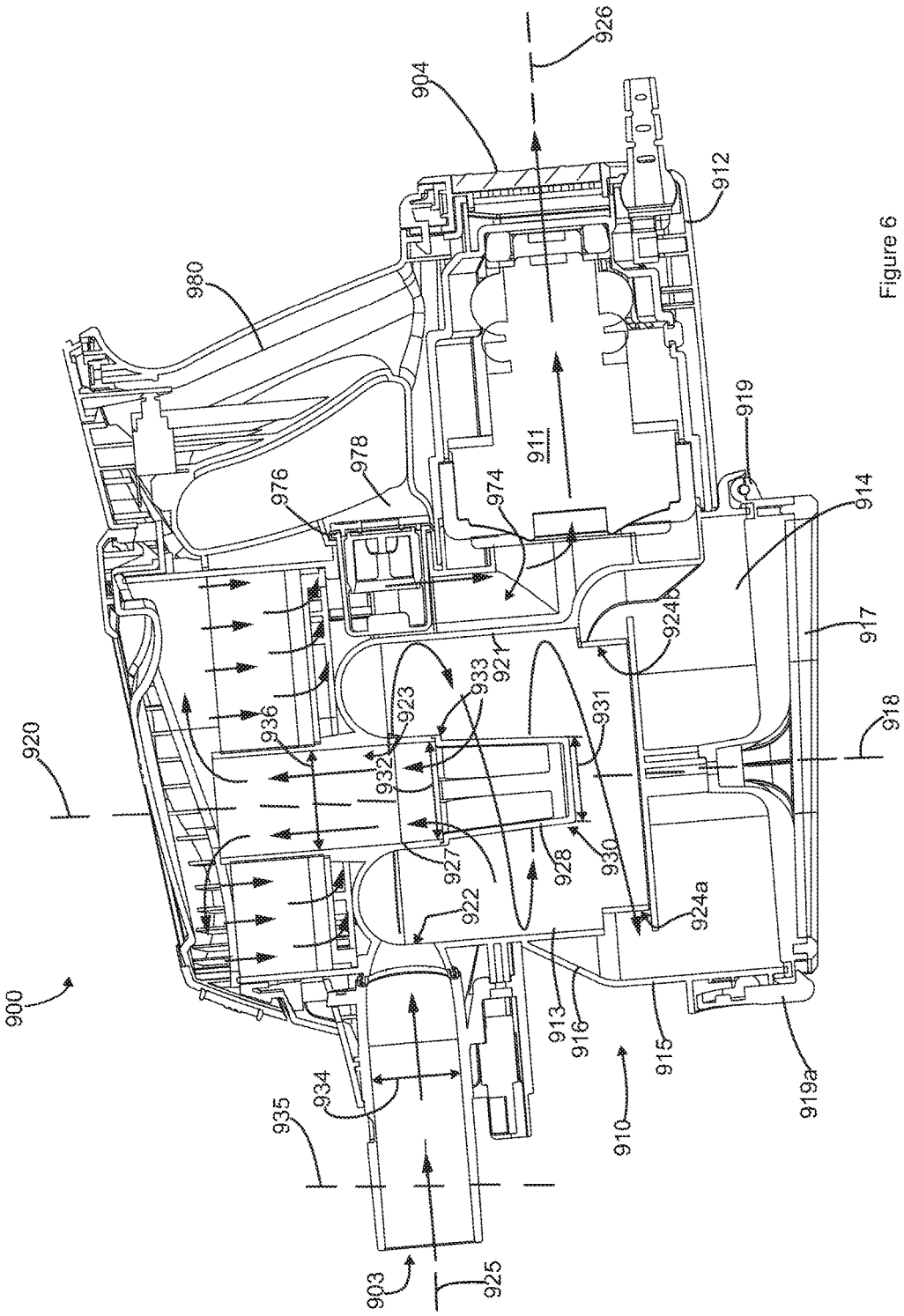
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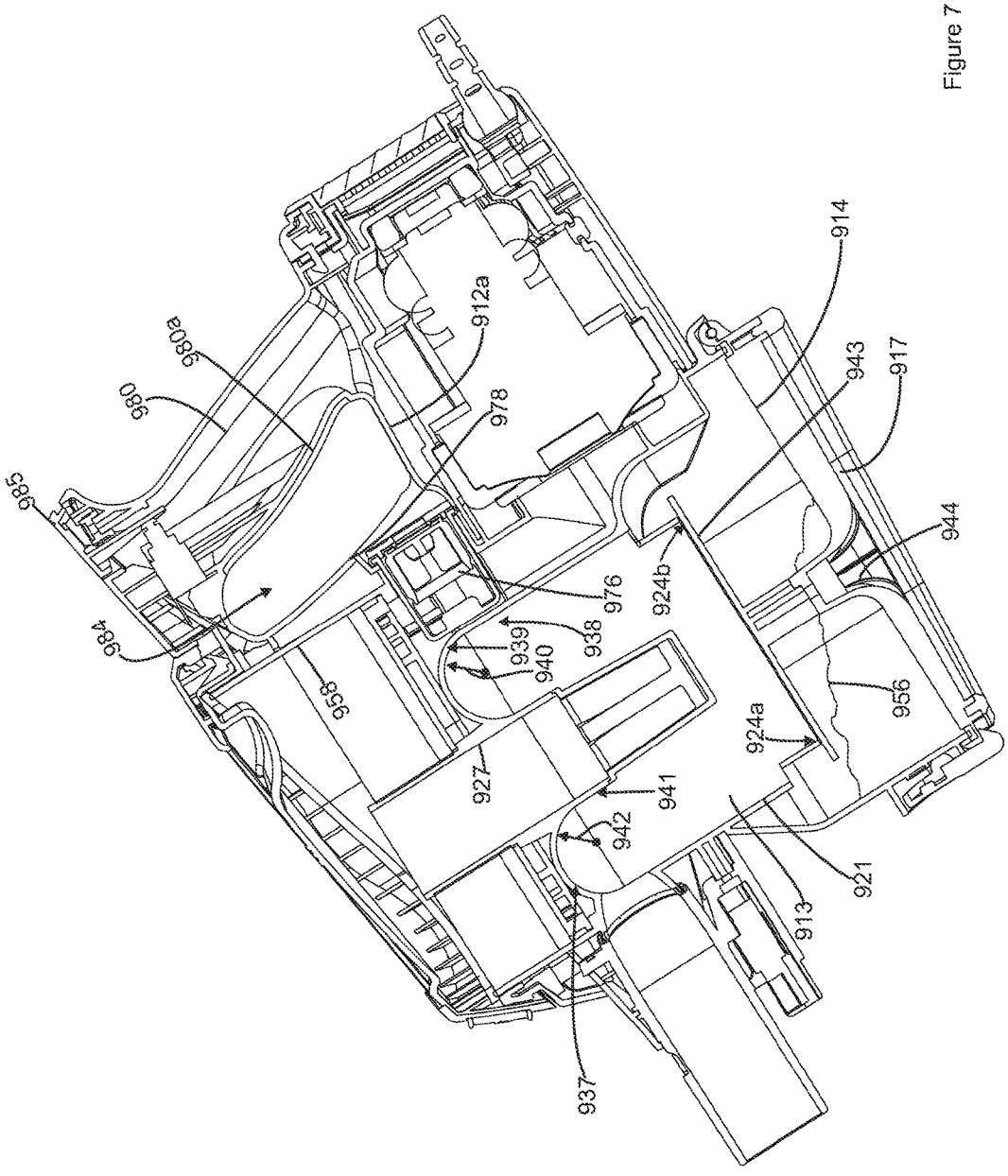
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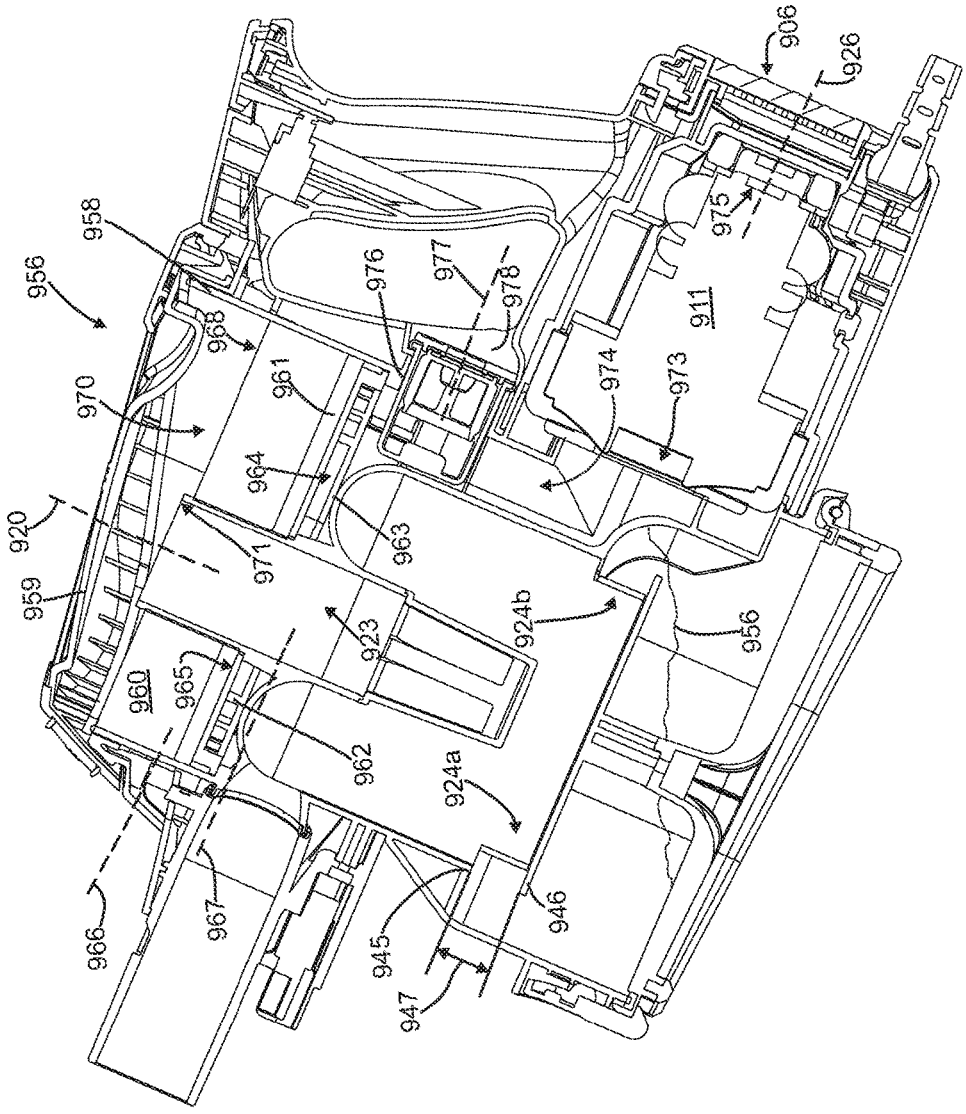
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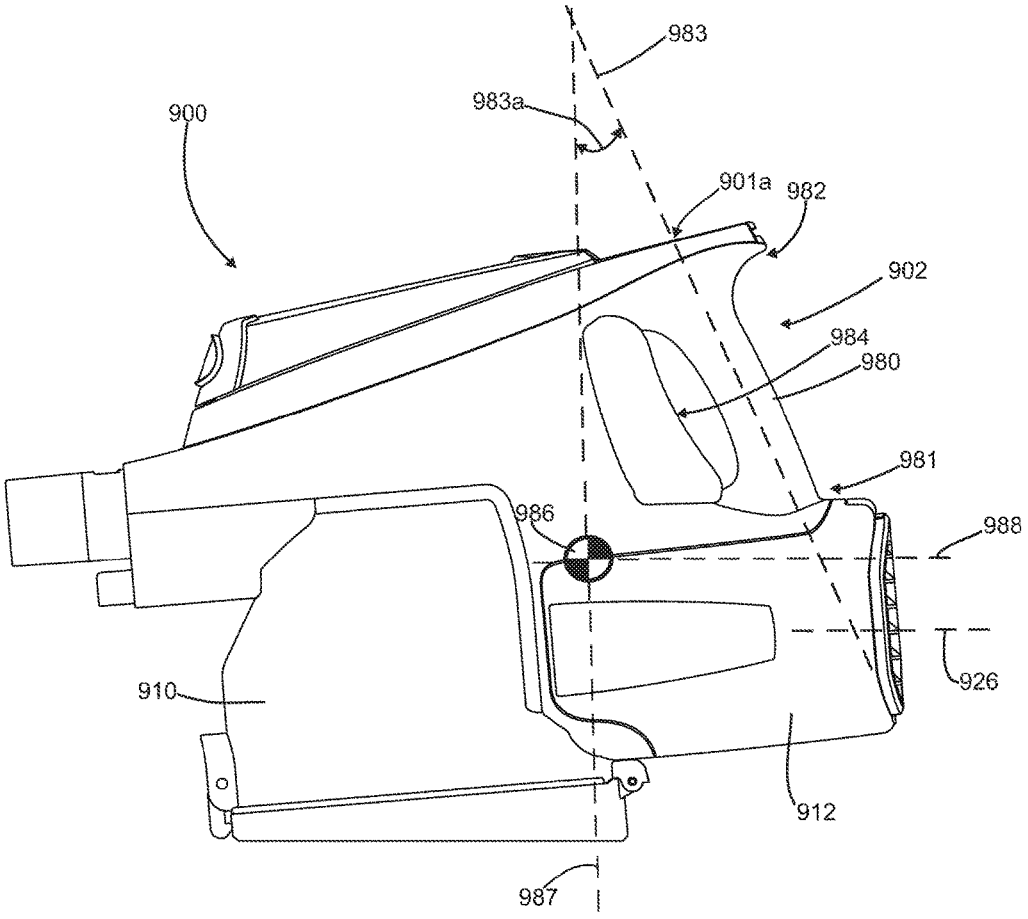

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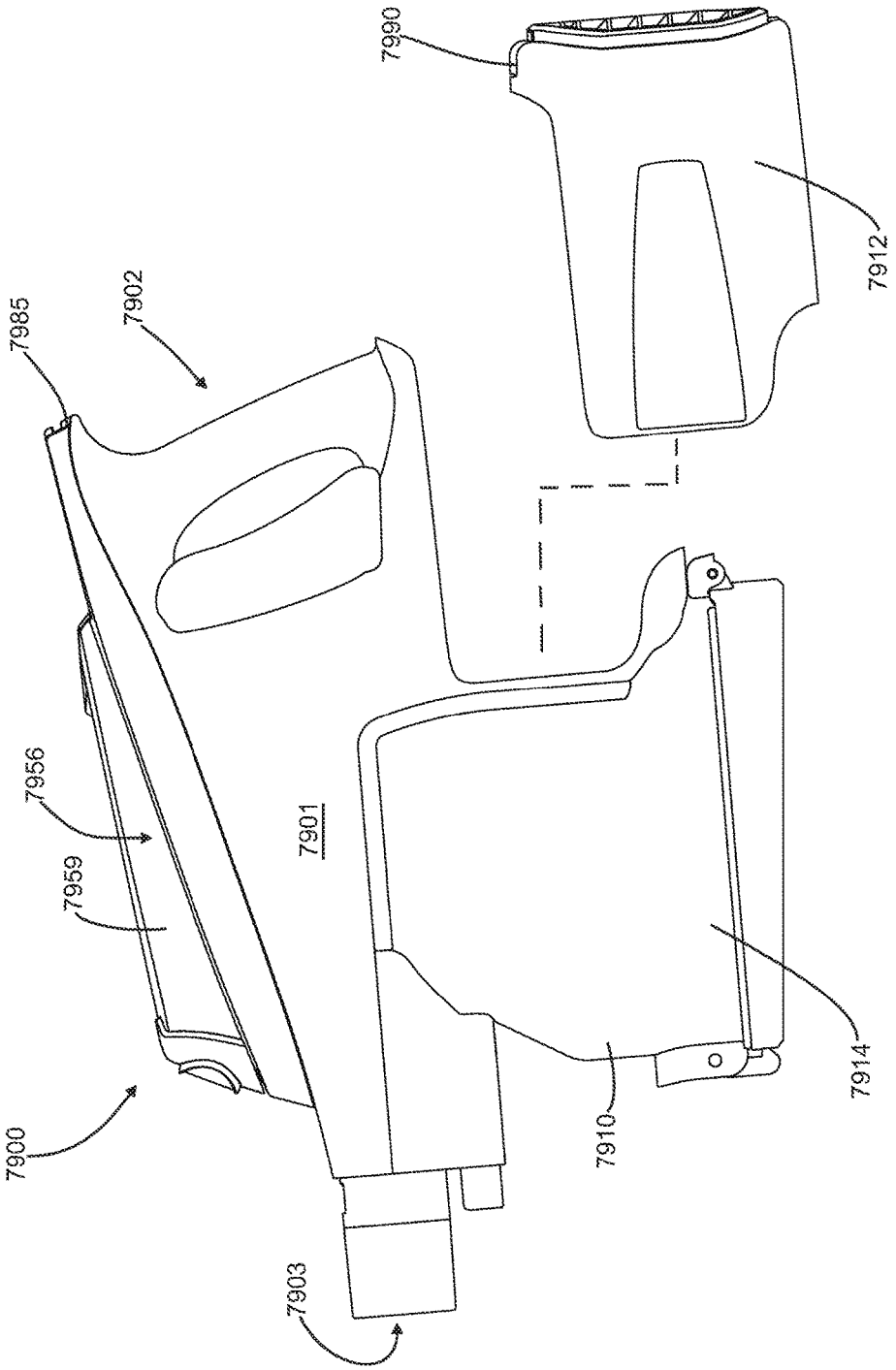

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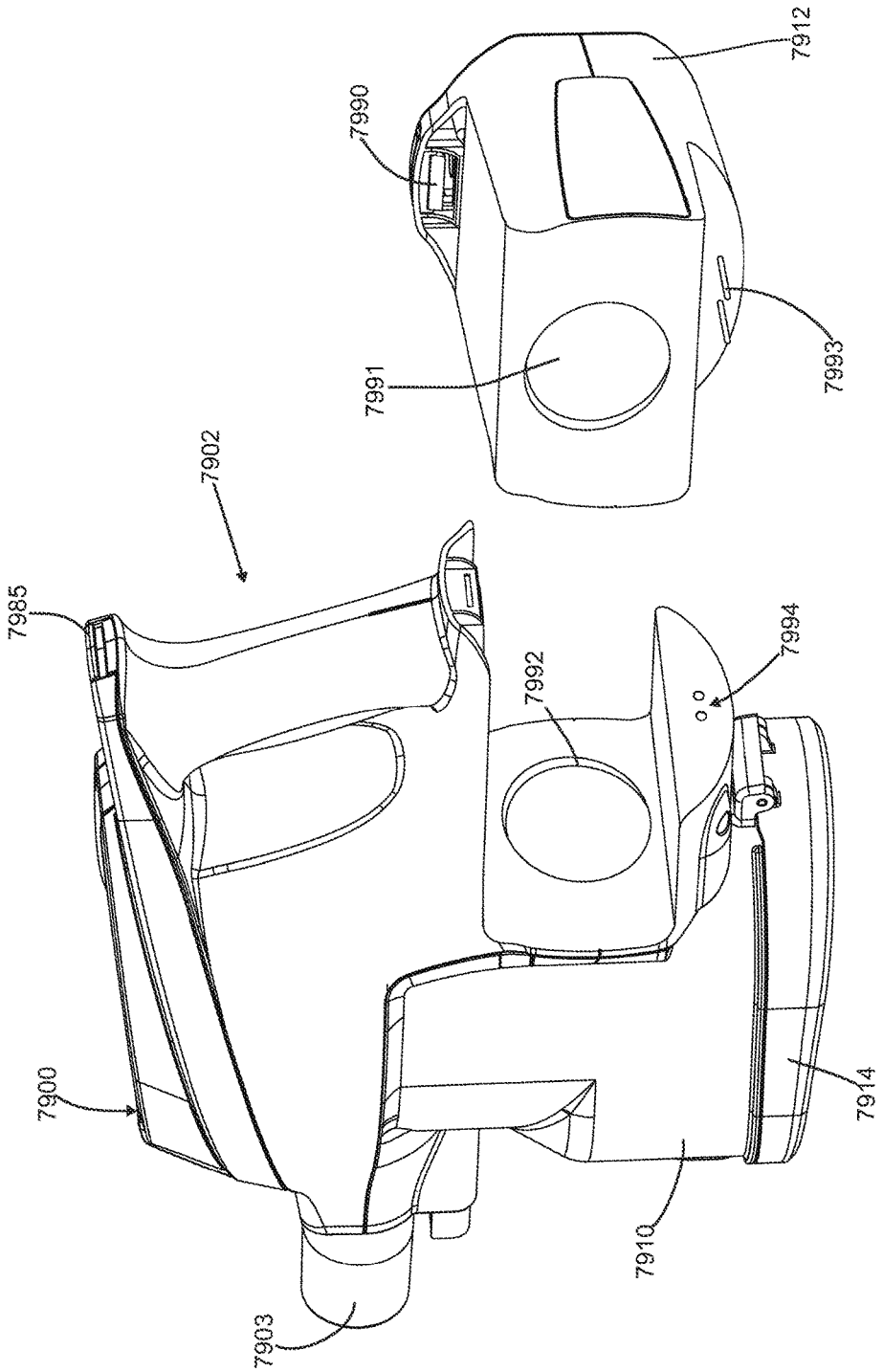

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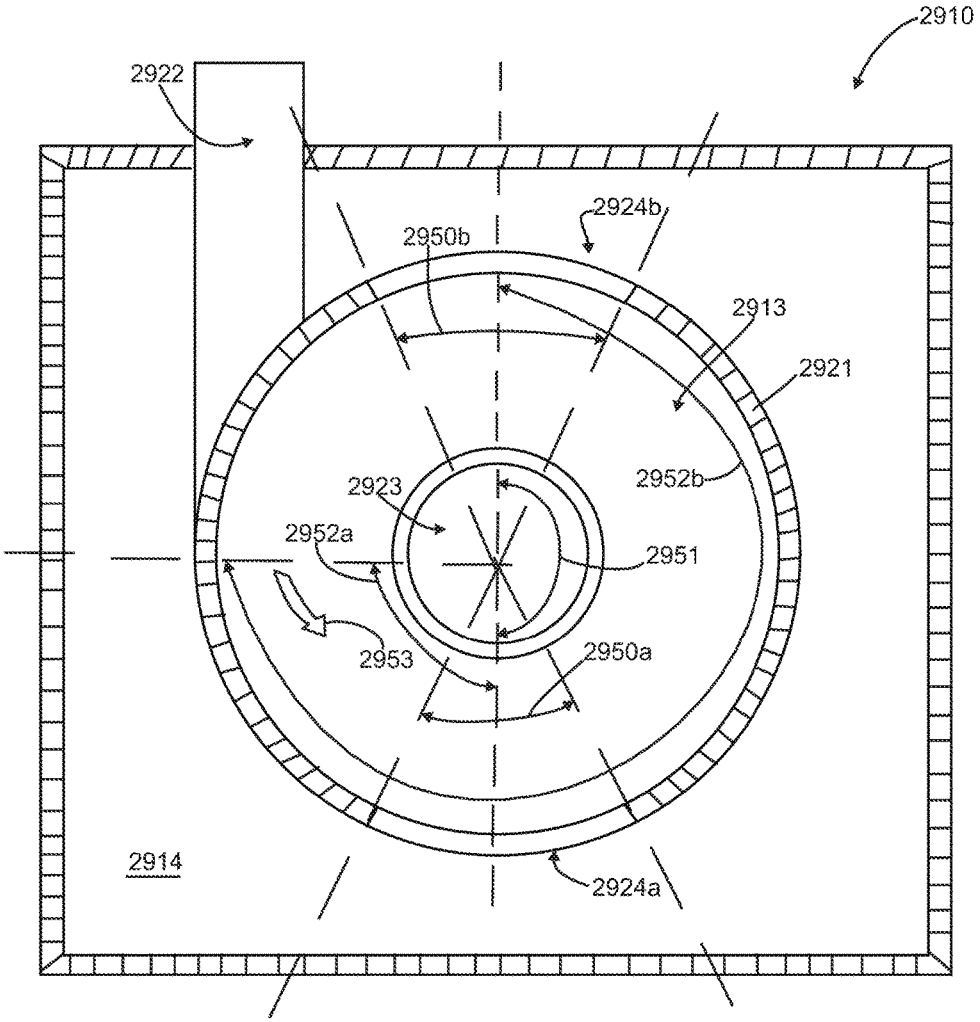
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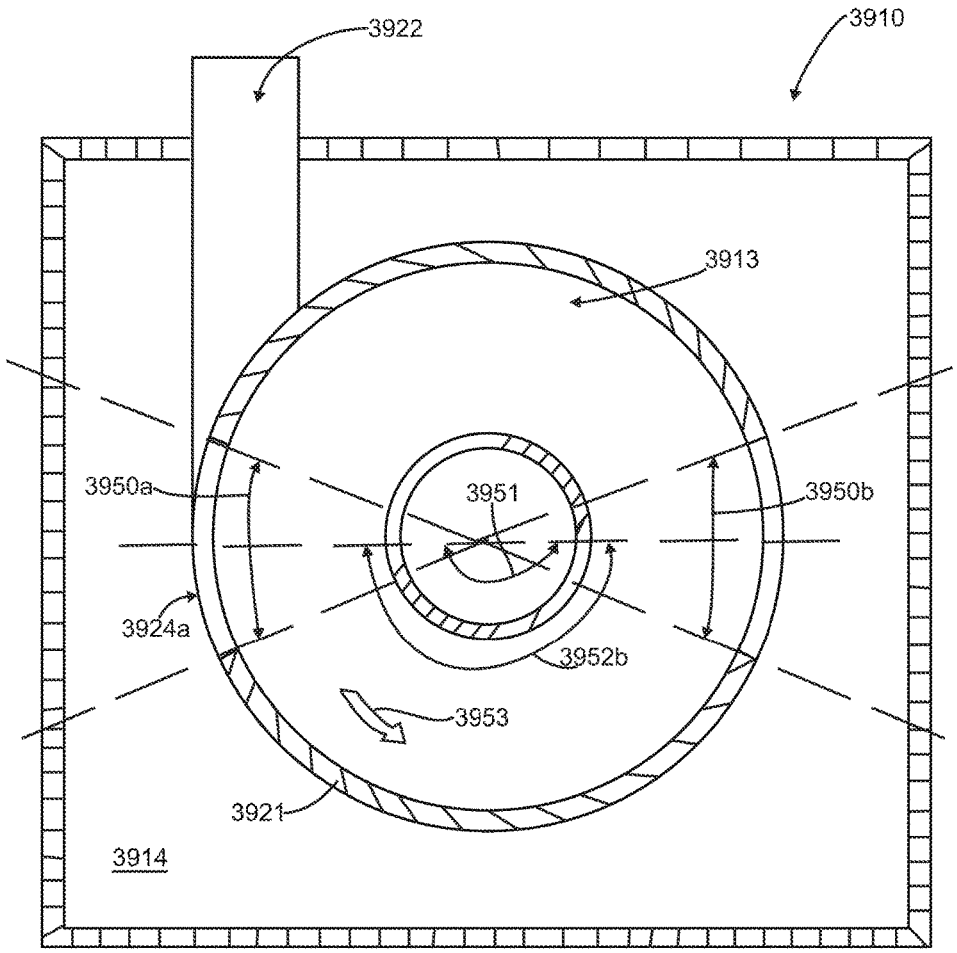

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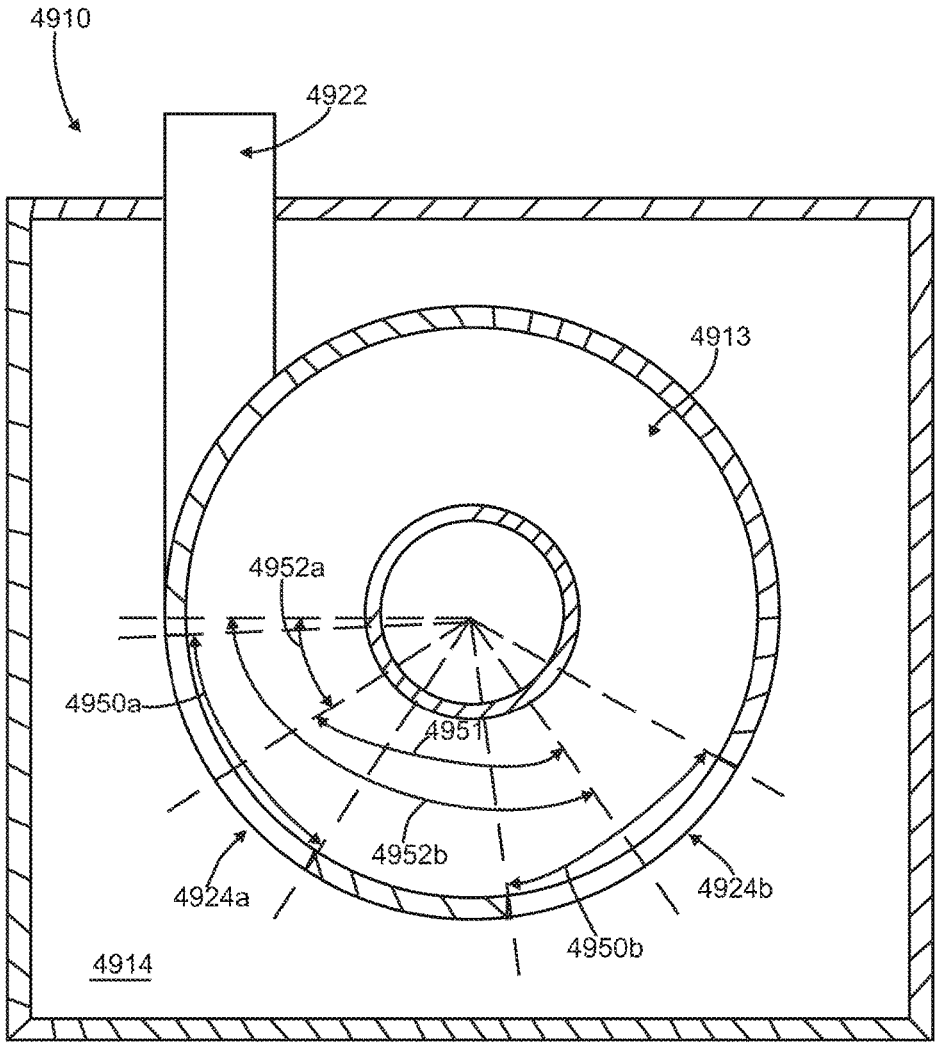
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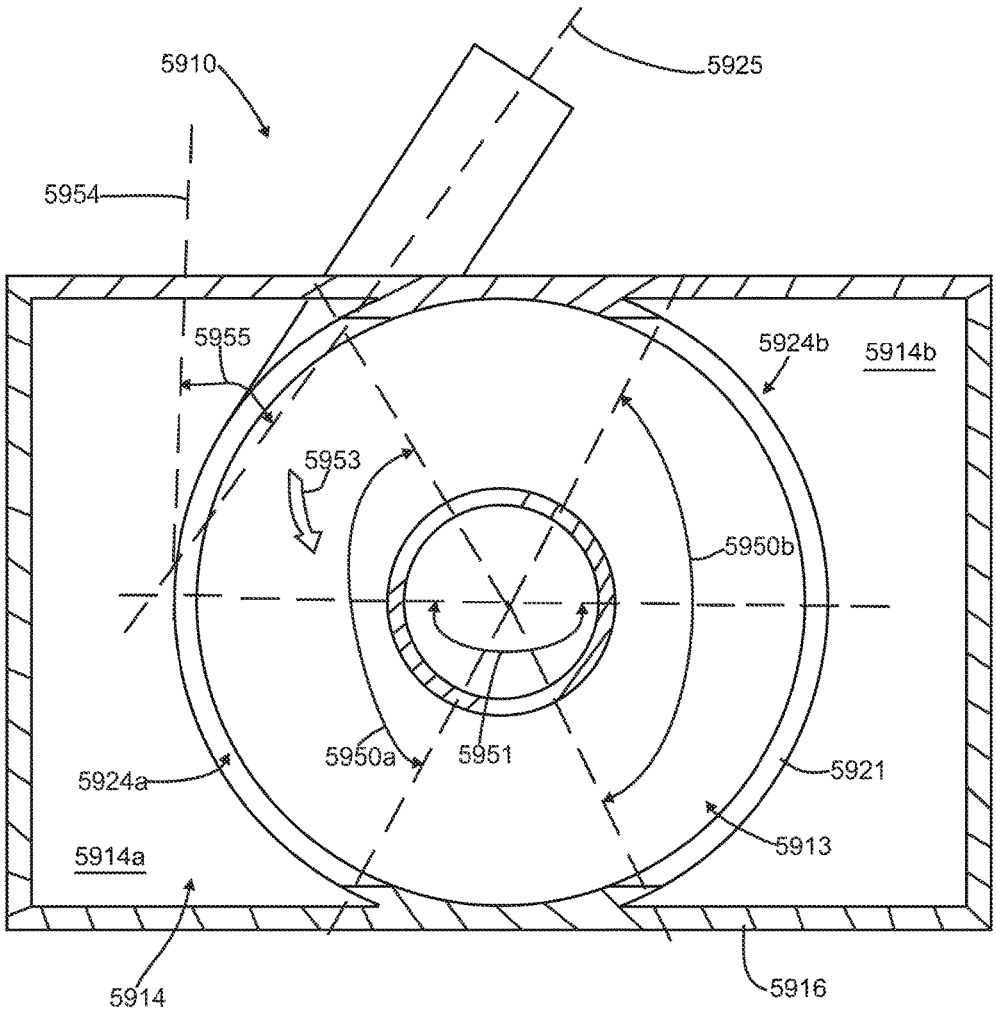
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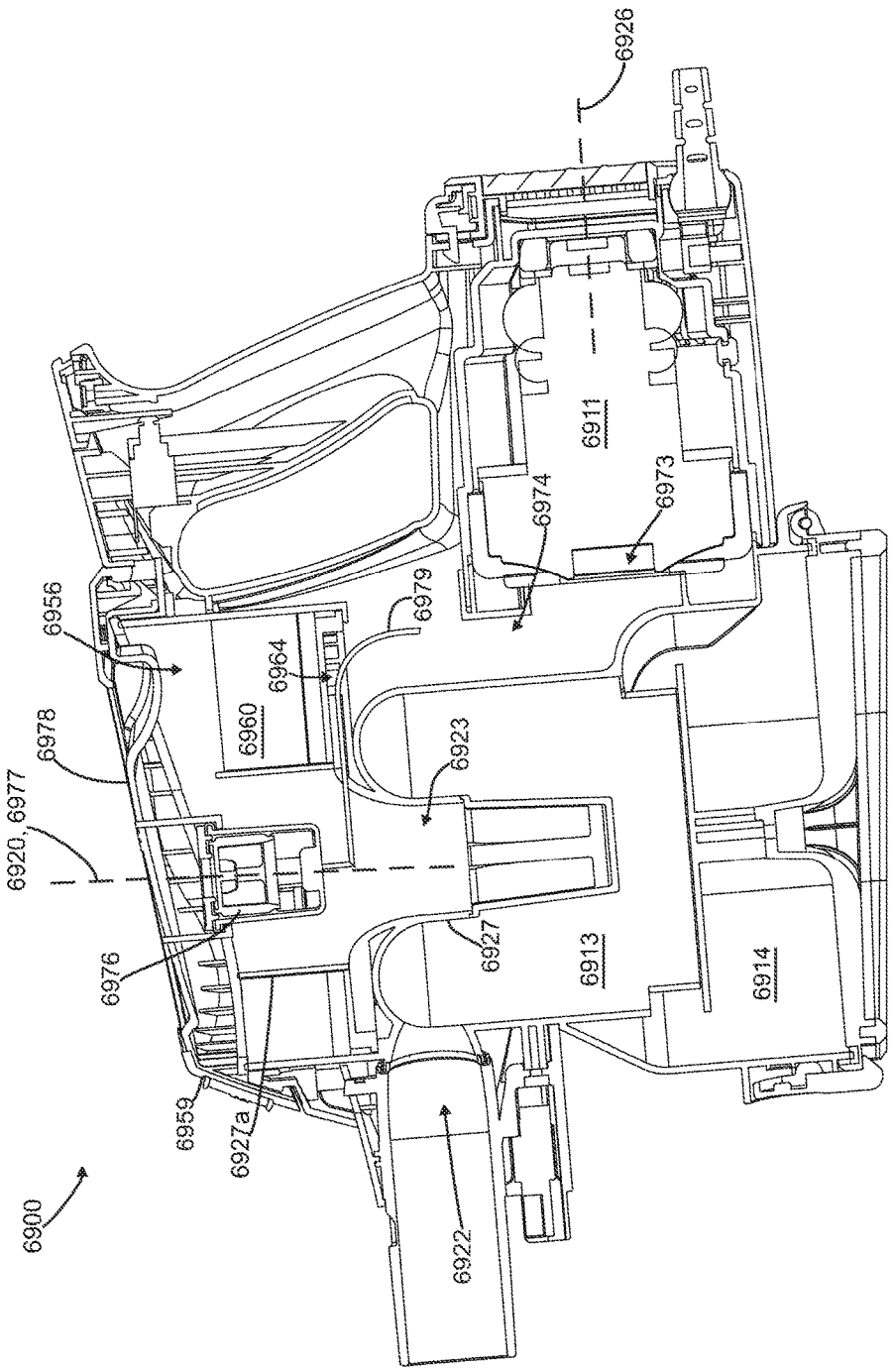
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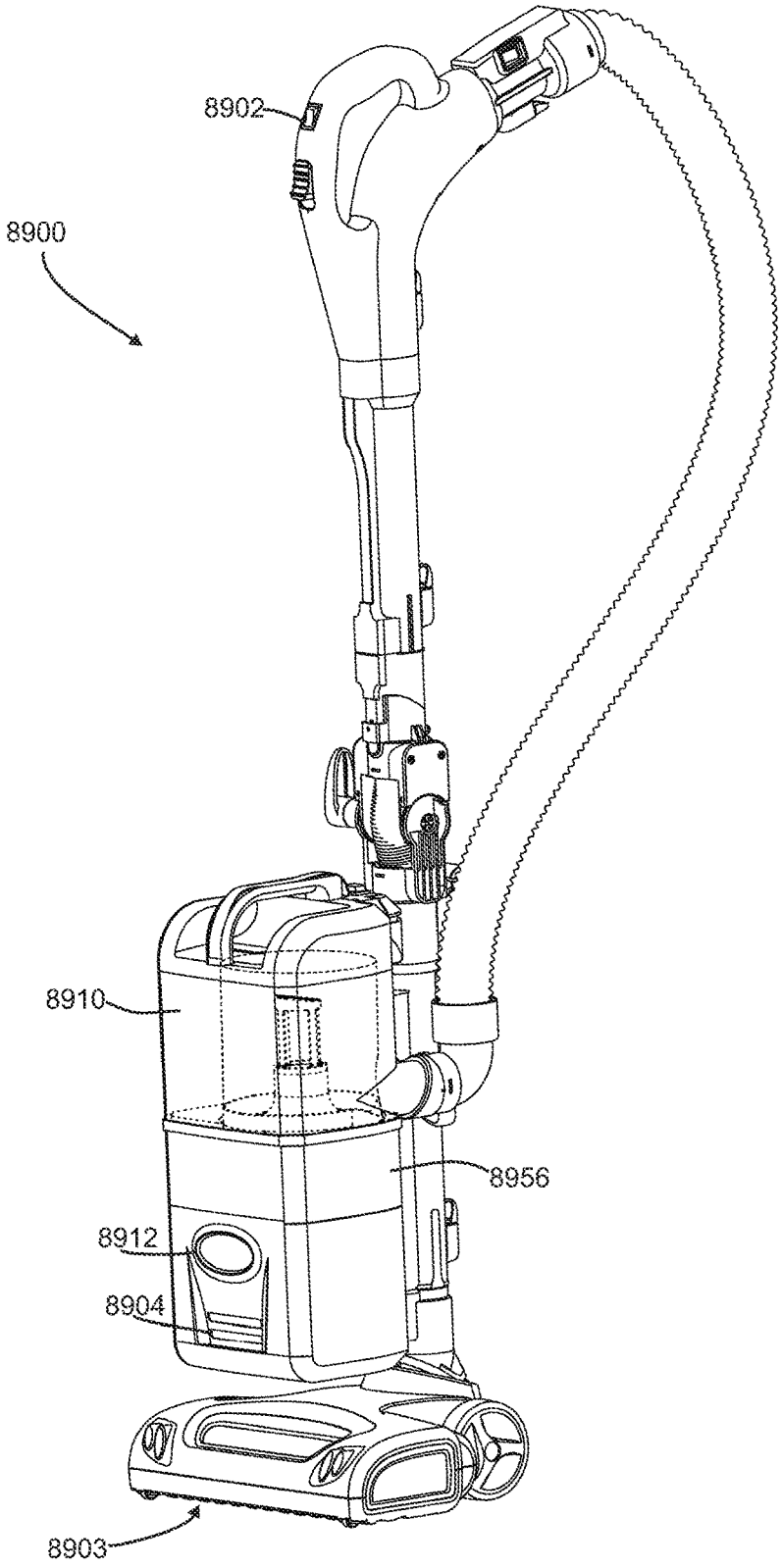
Figure 16



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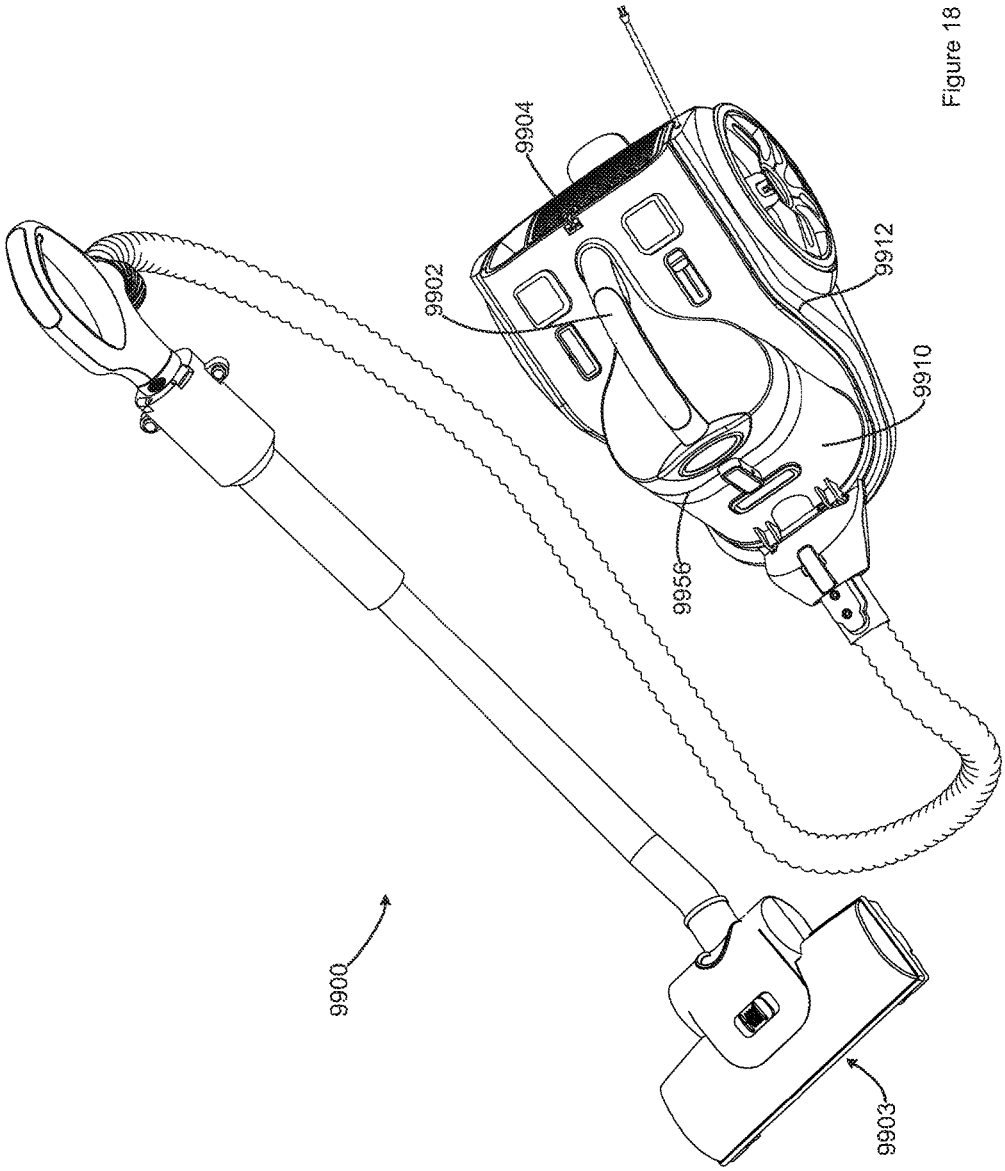

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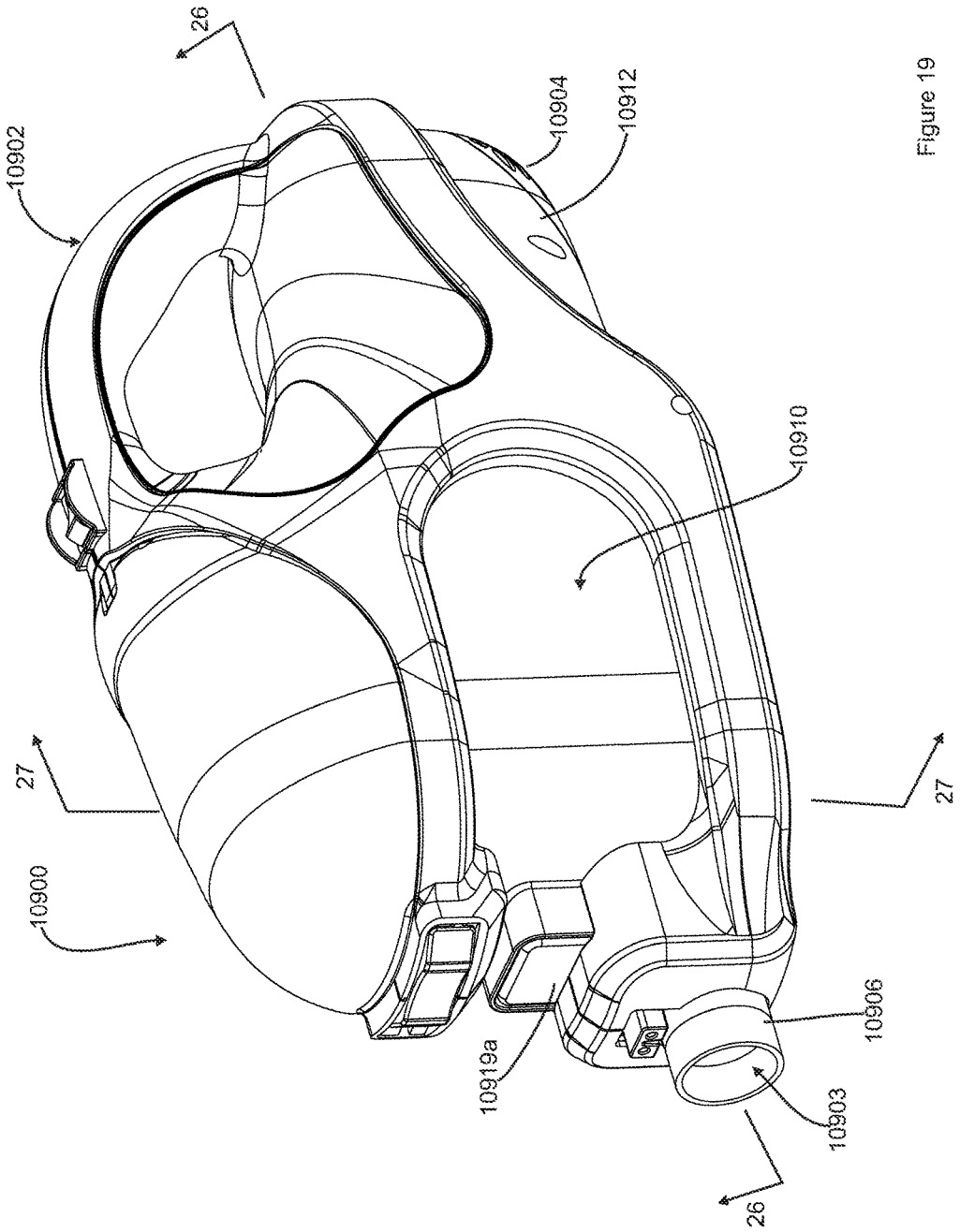

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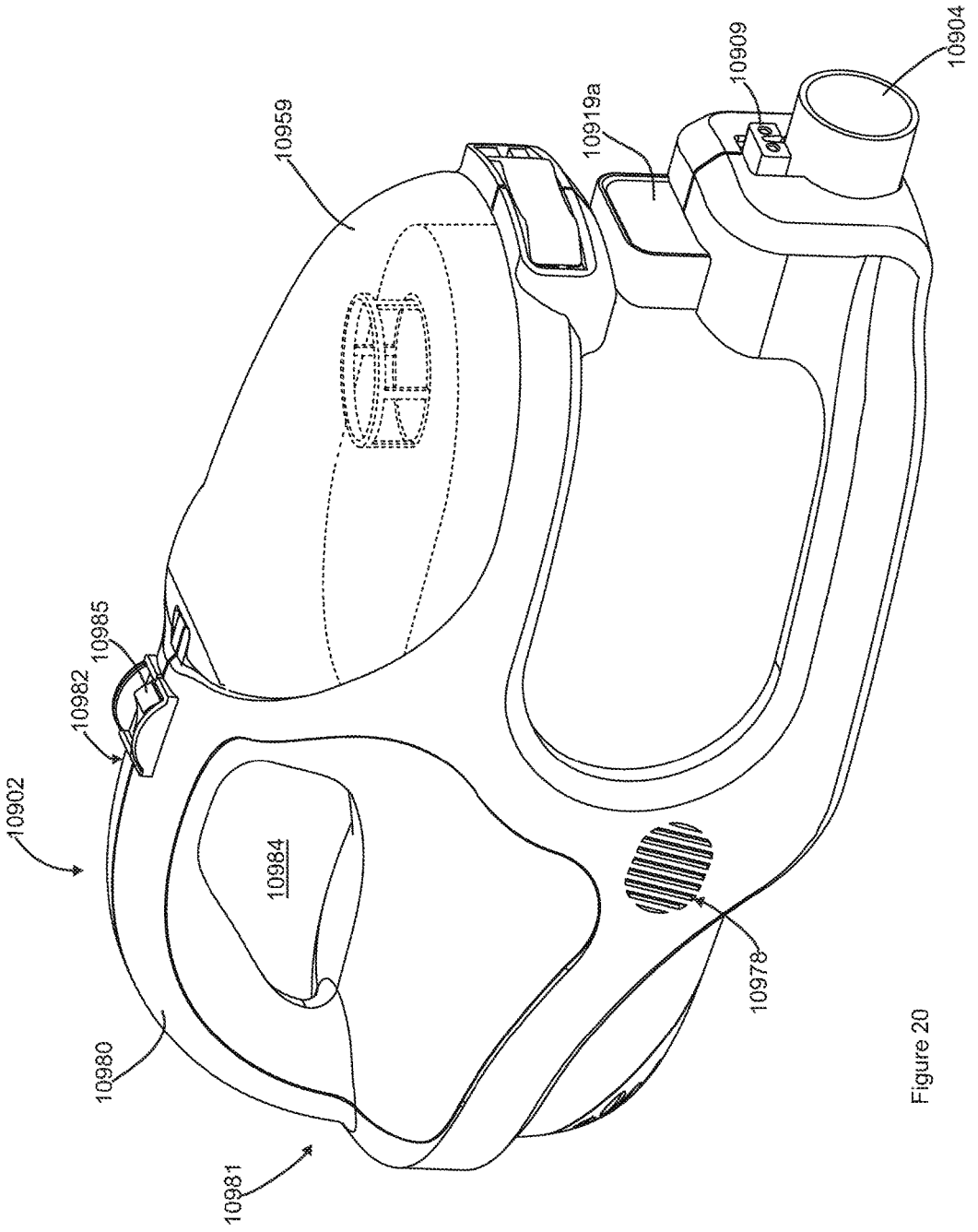
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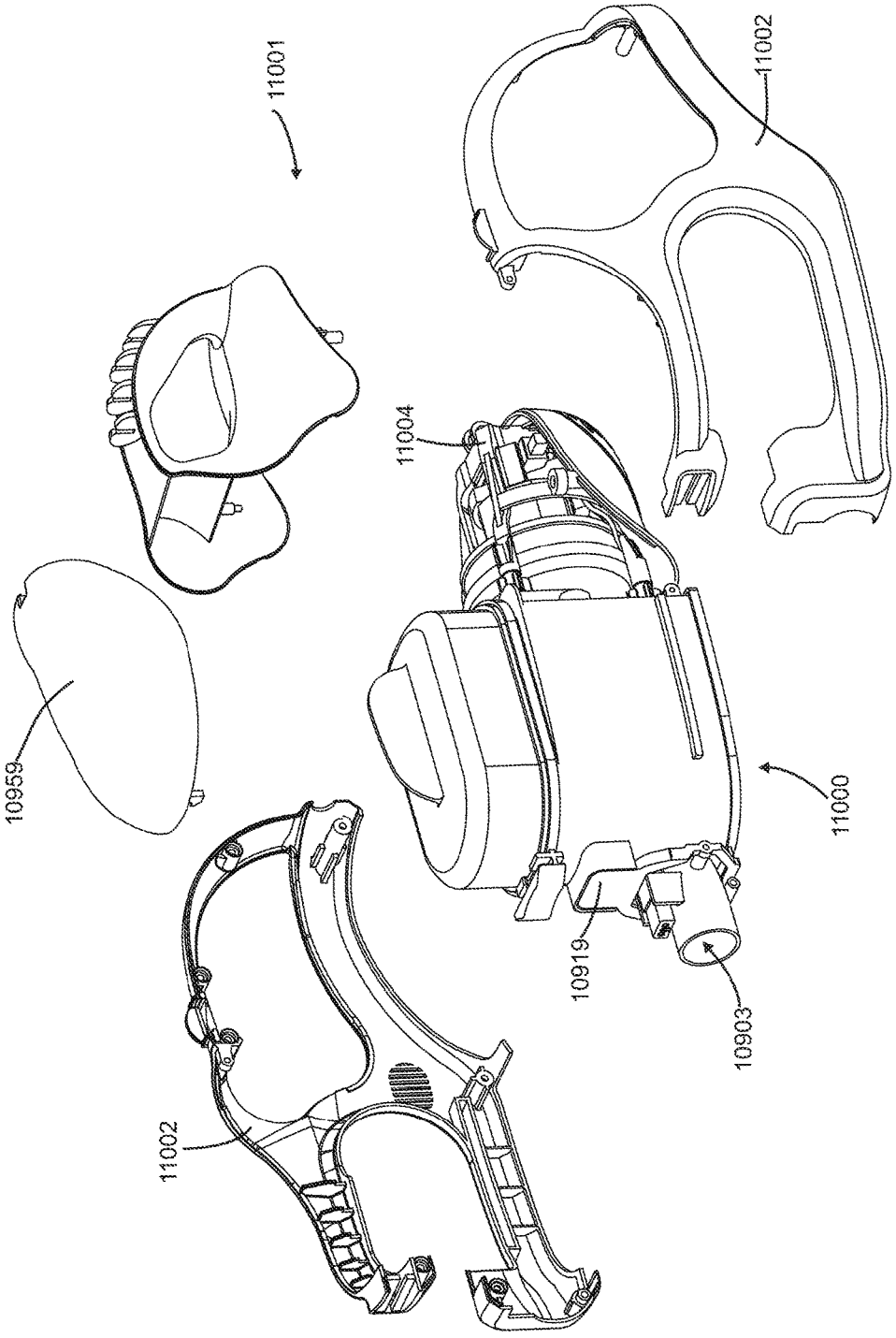

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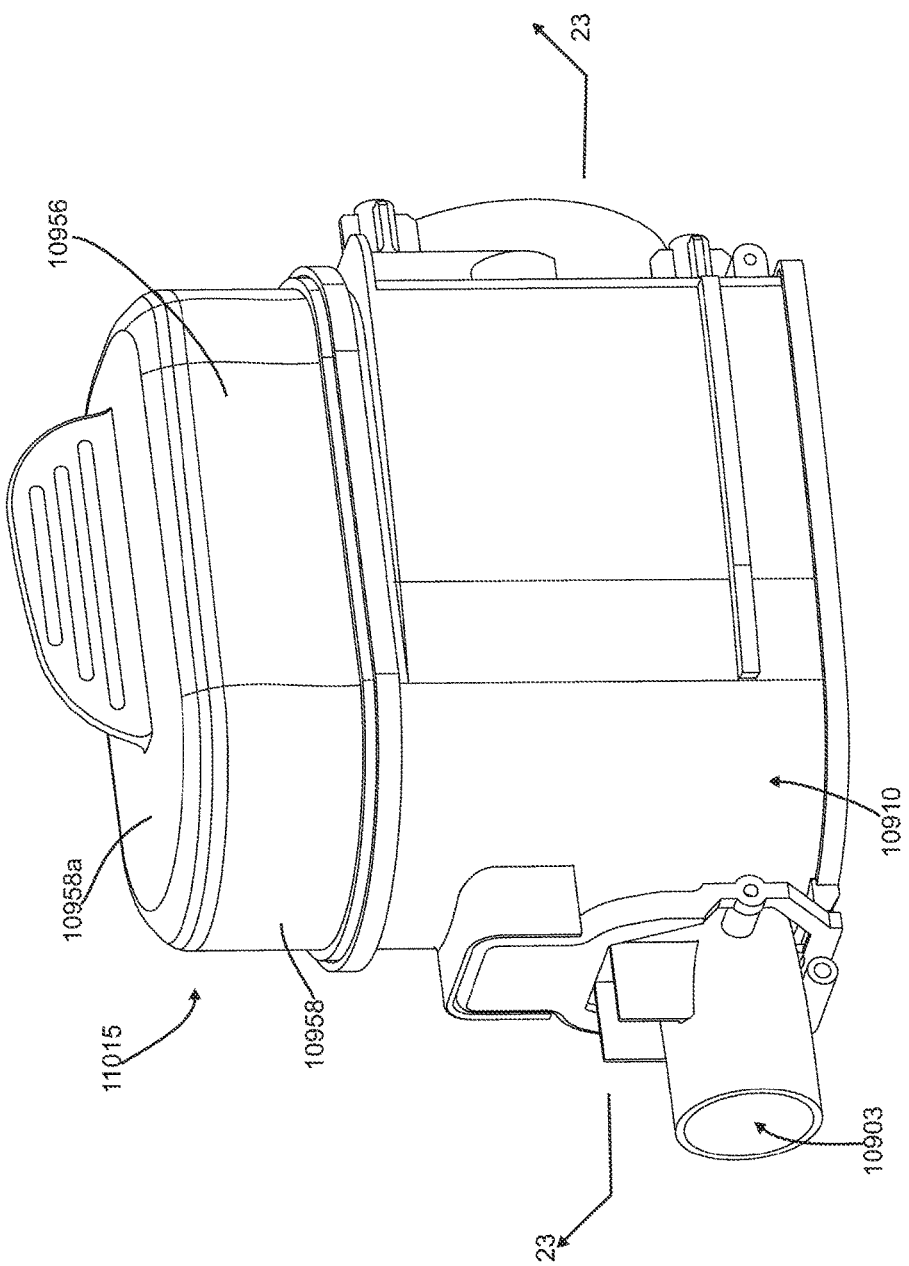

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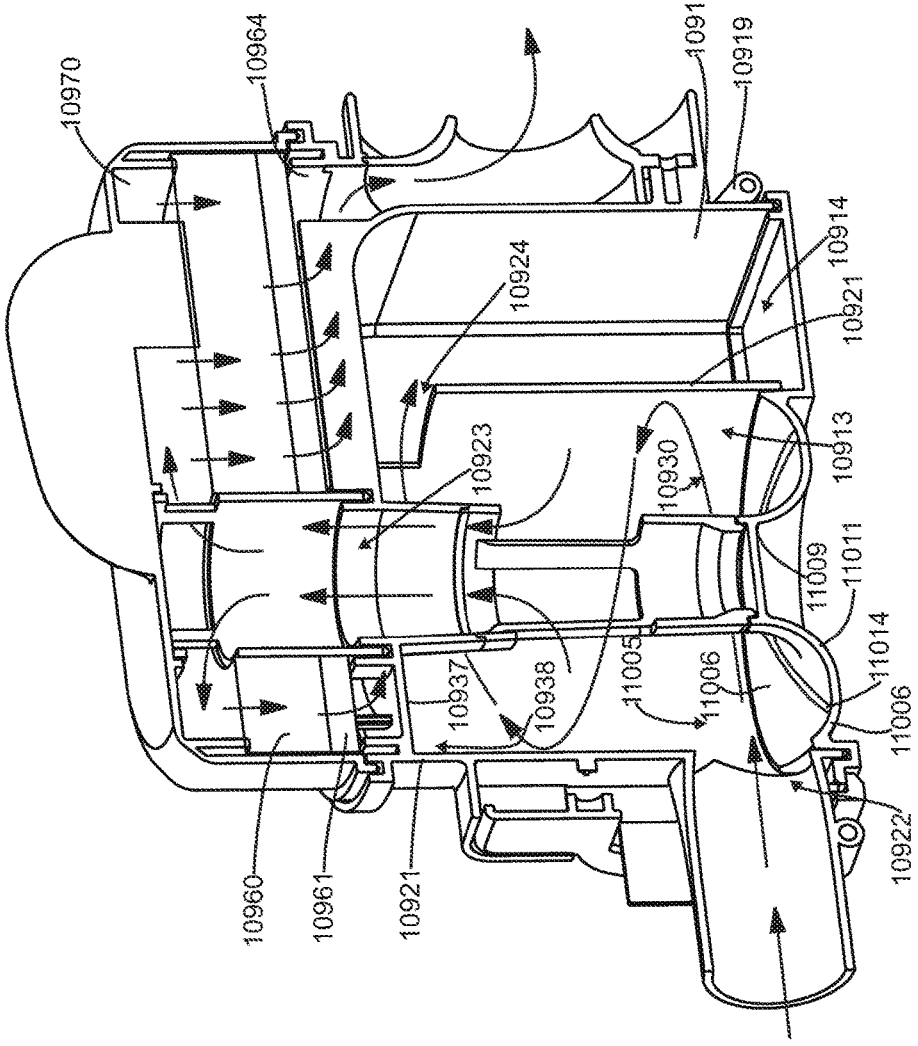
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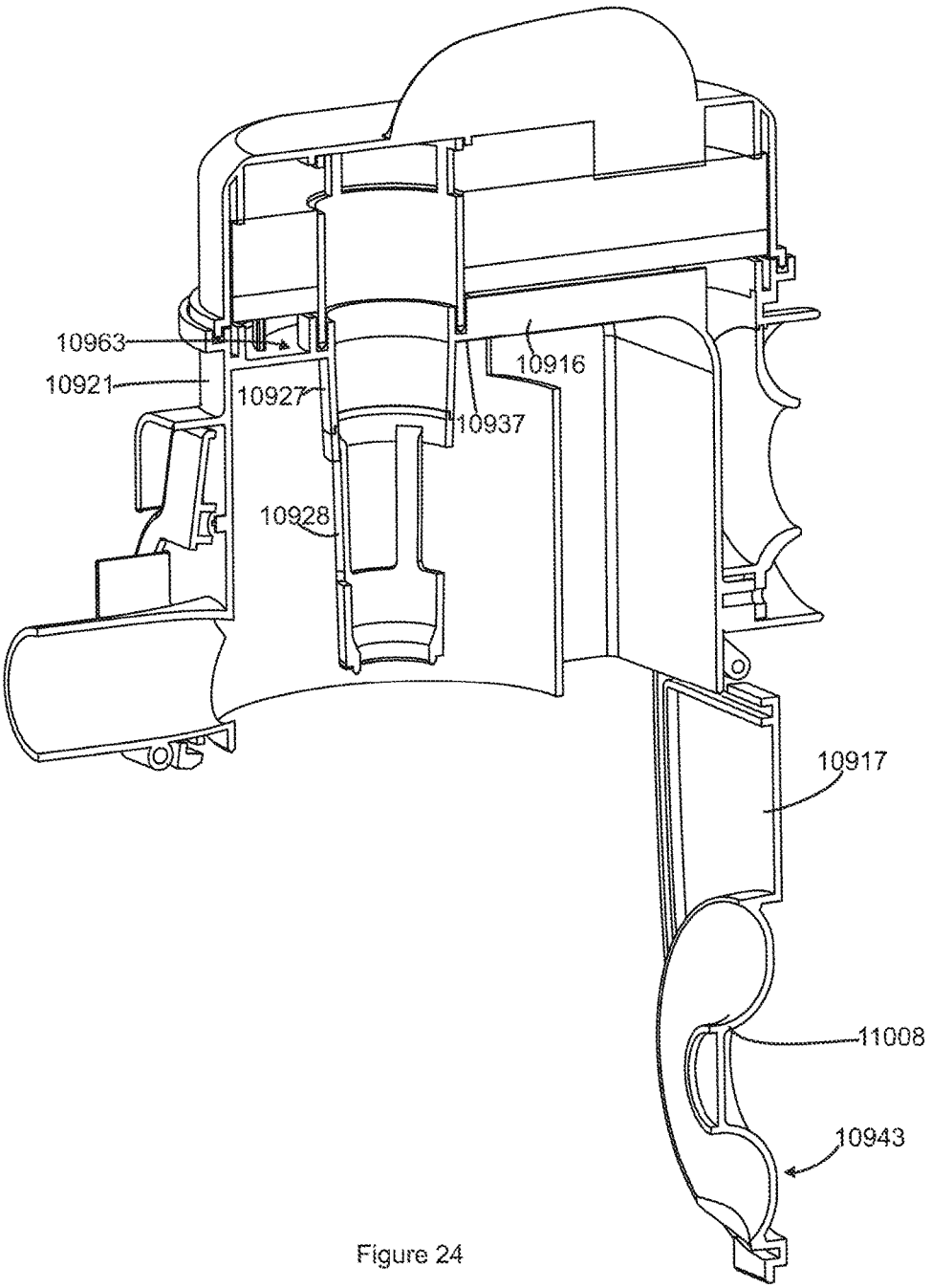

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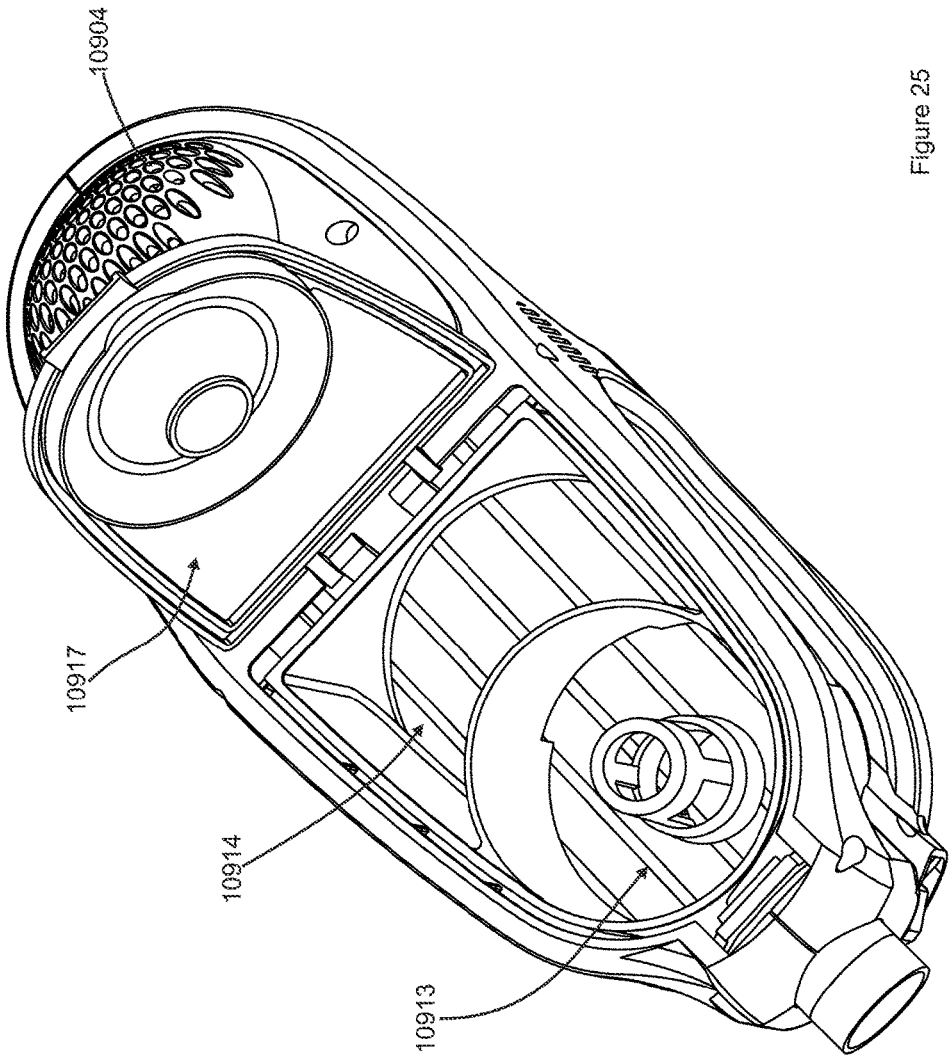

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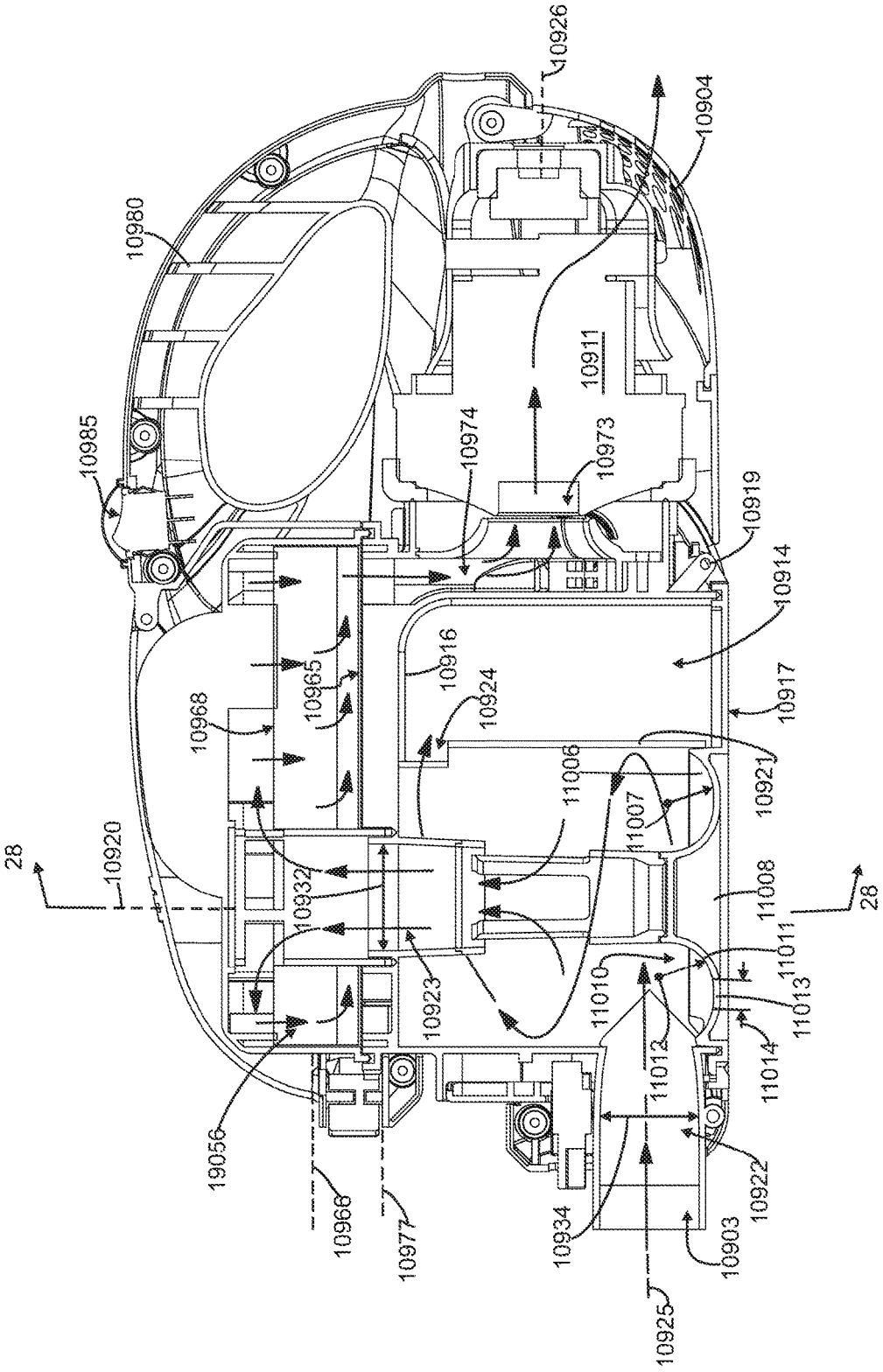
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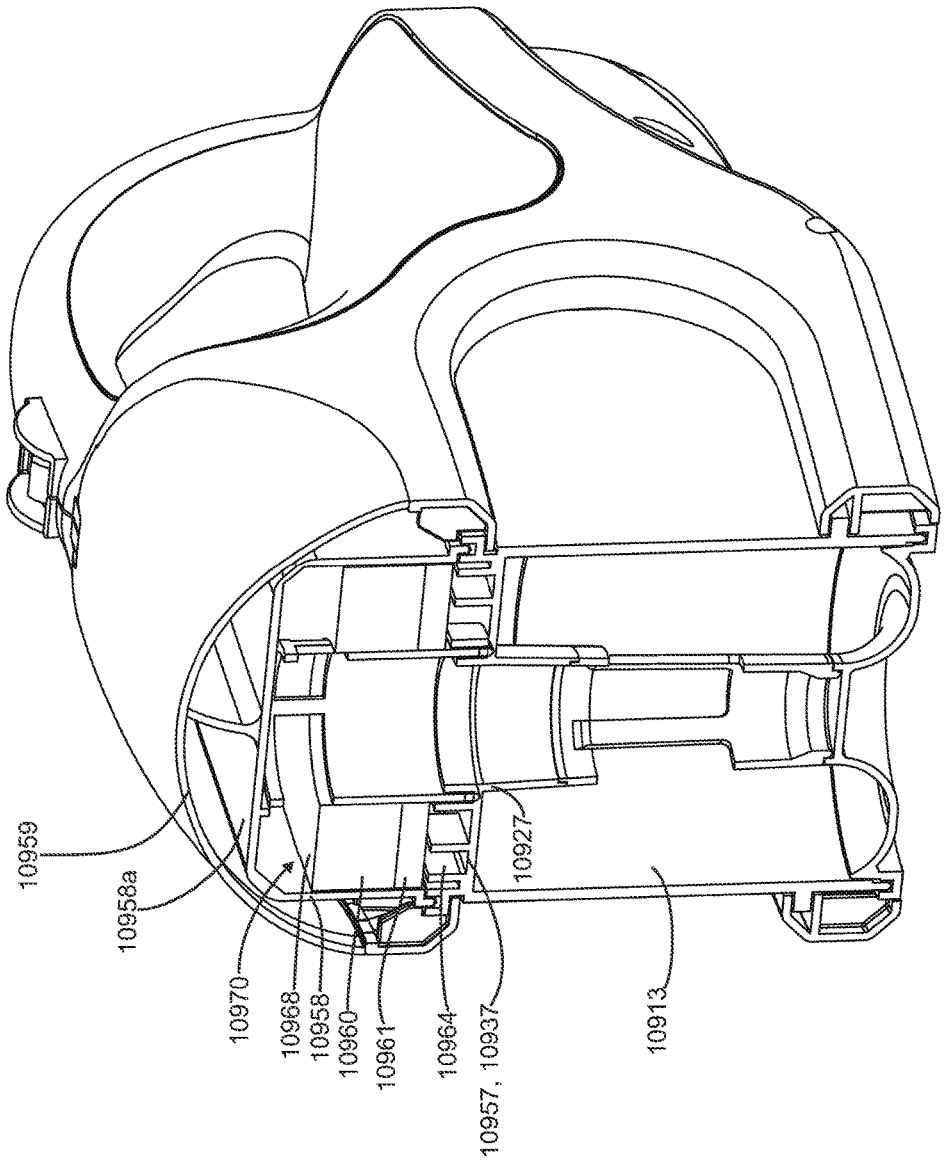
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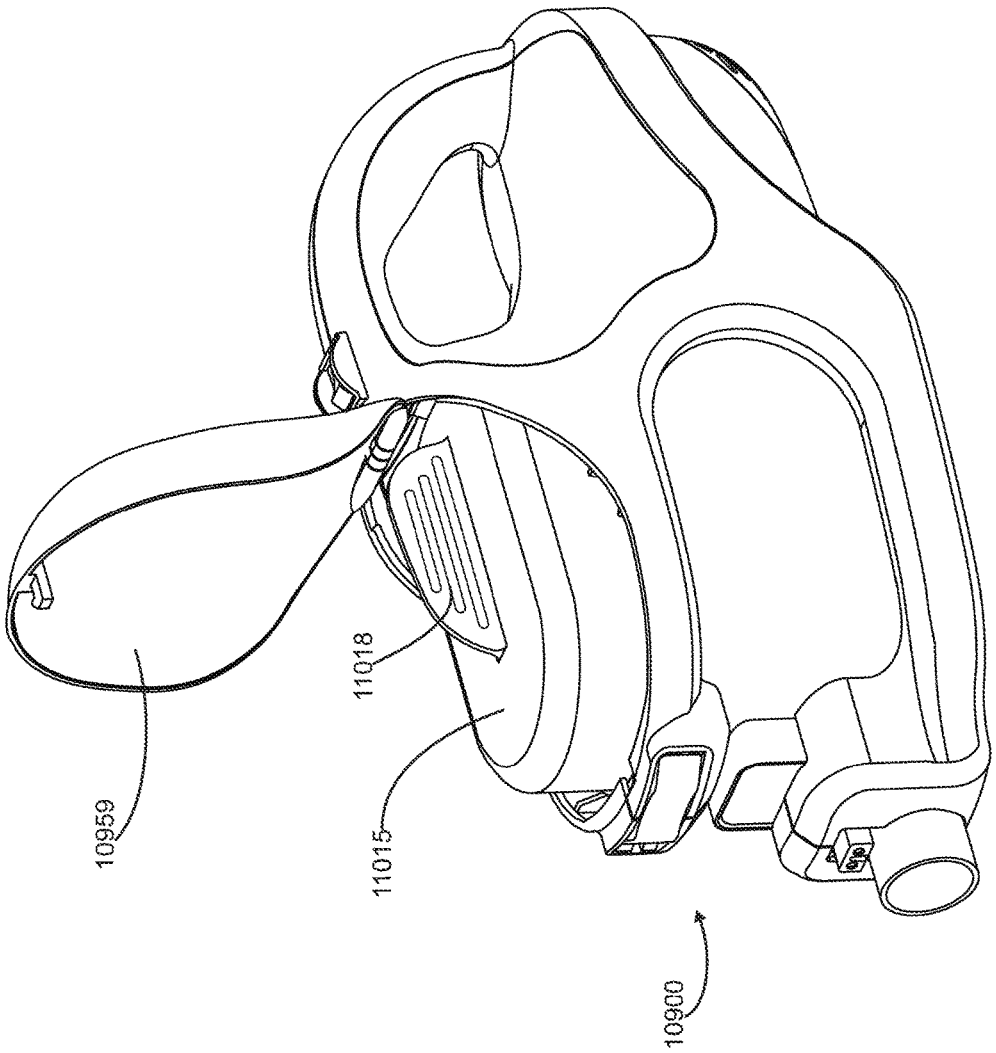

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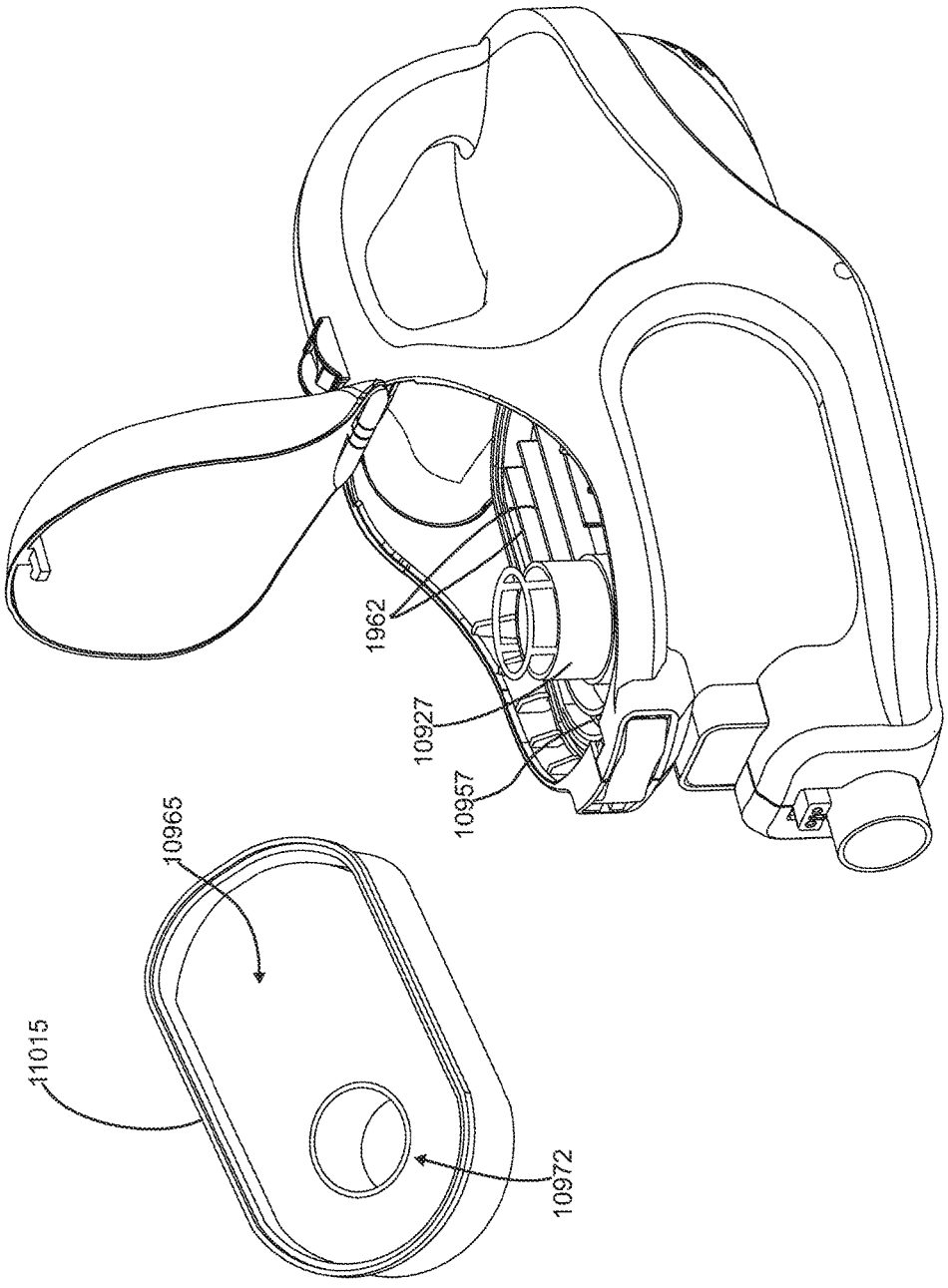

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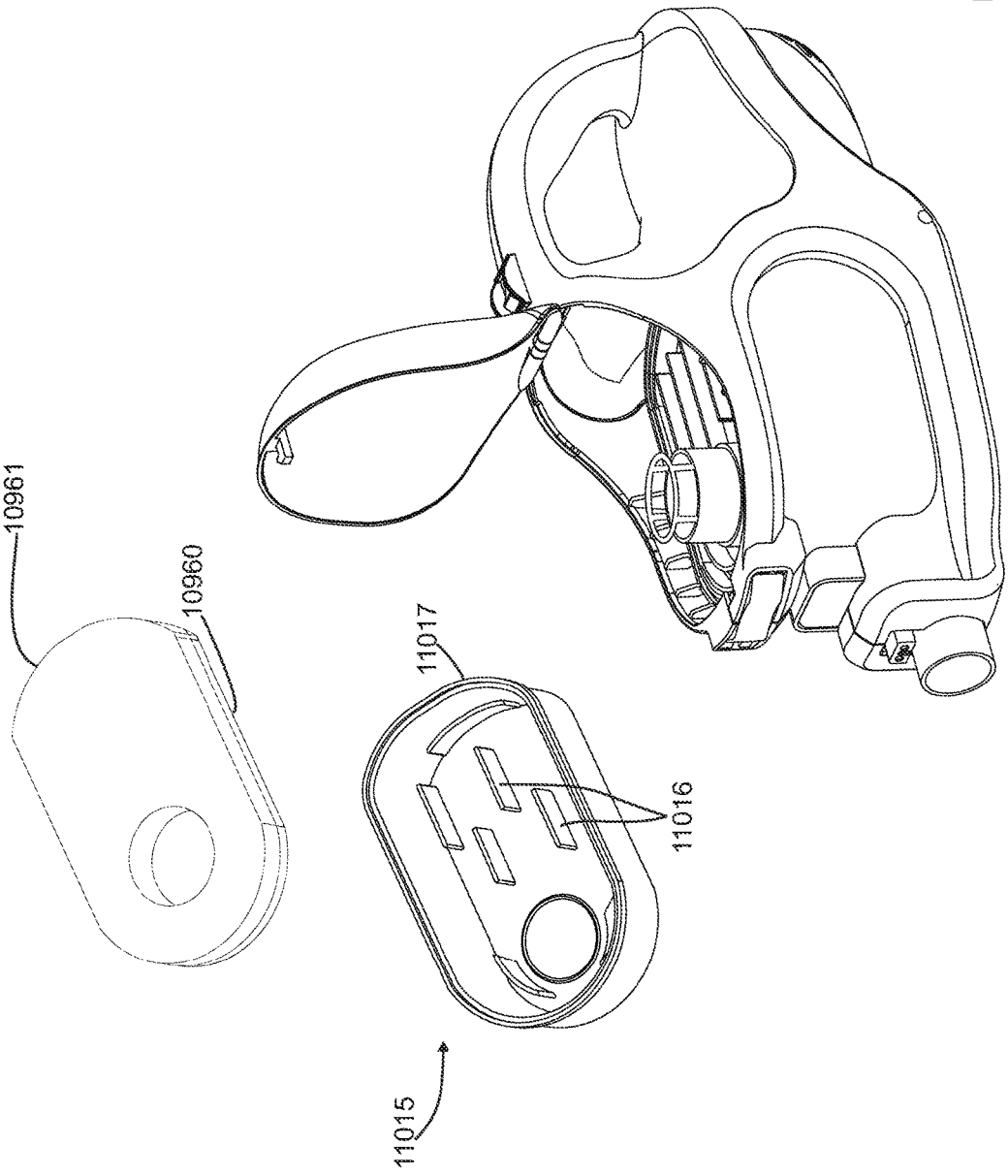

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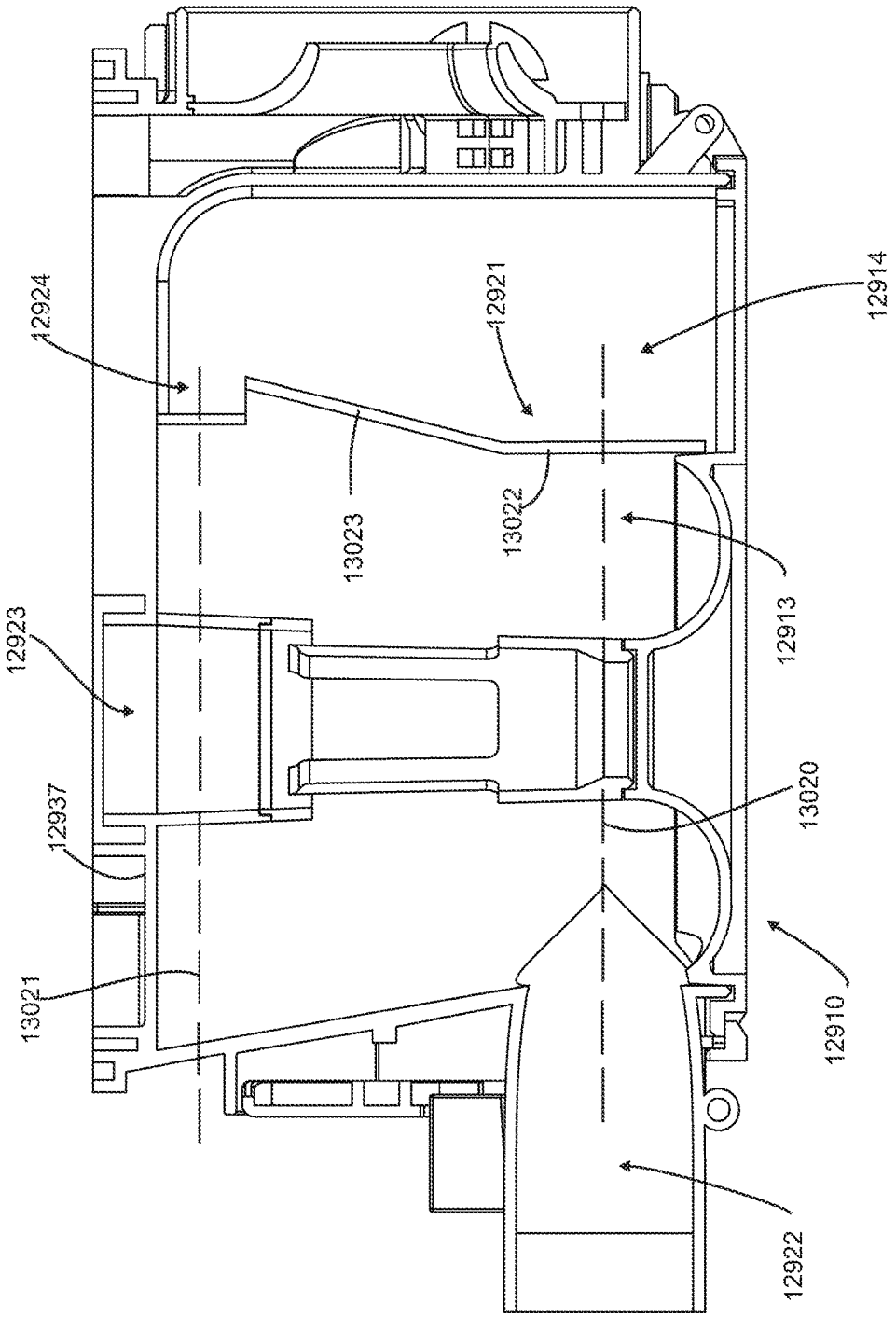
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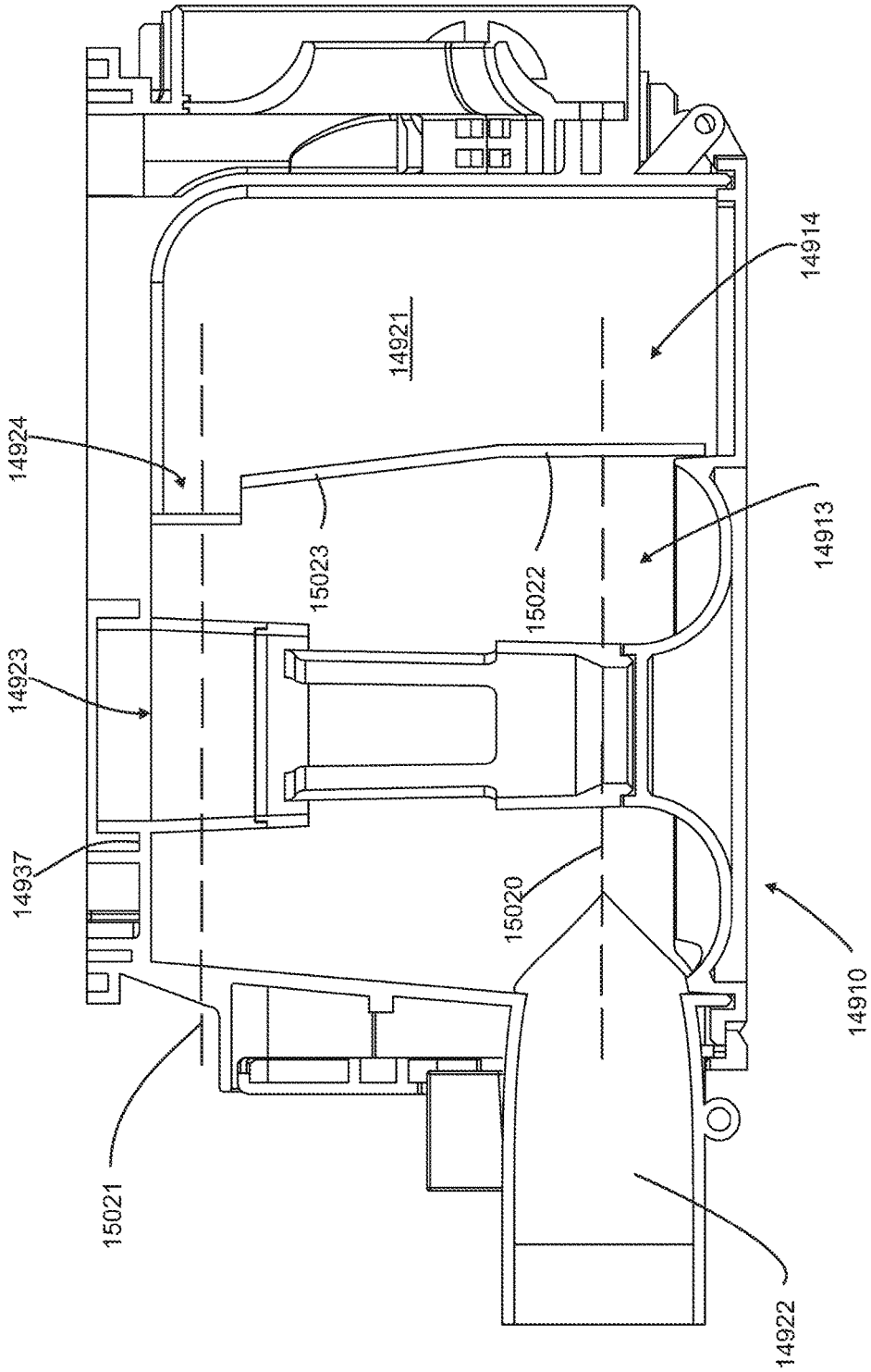
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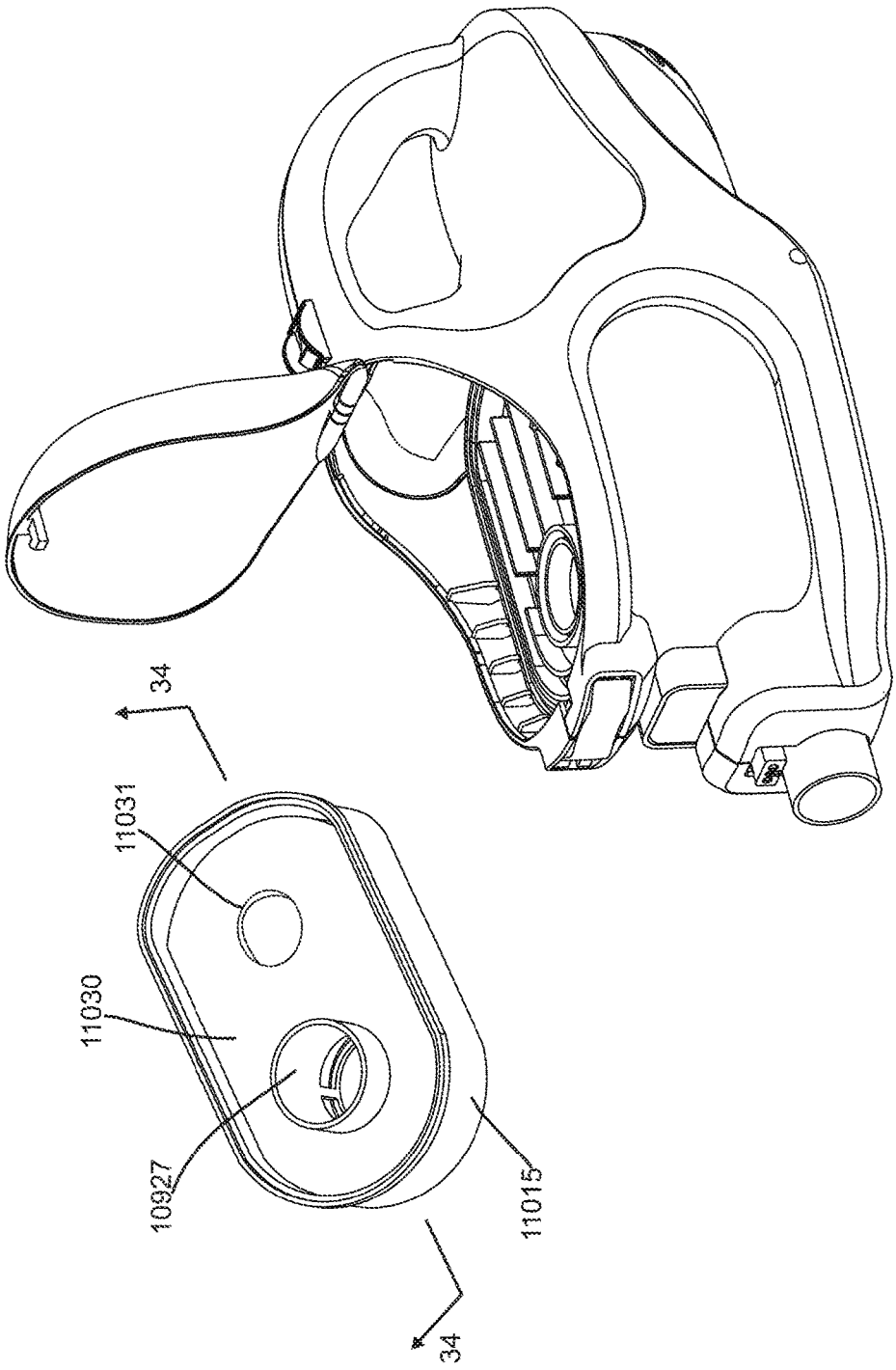

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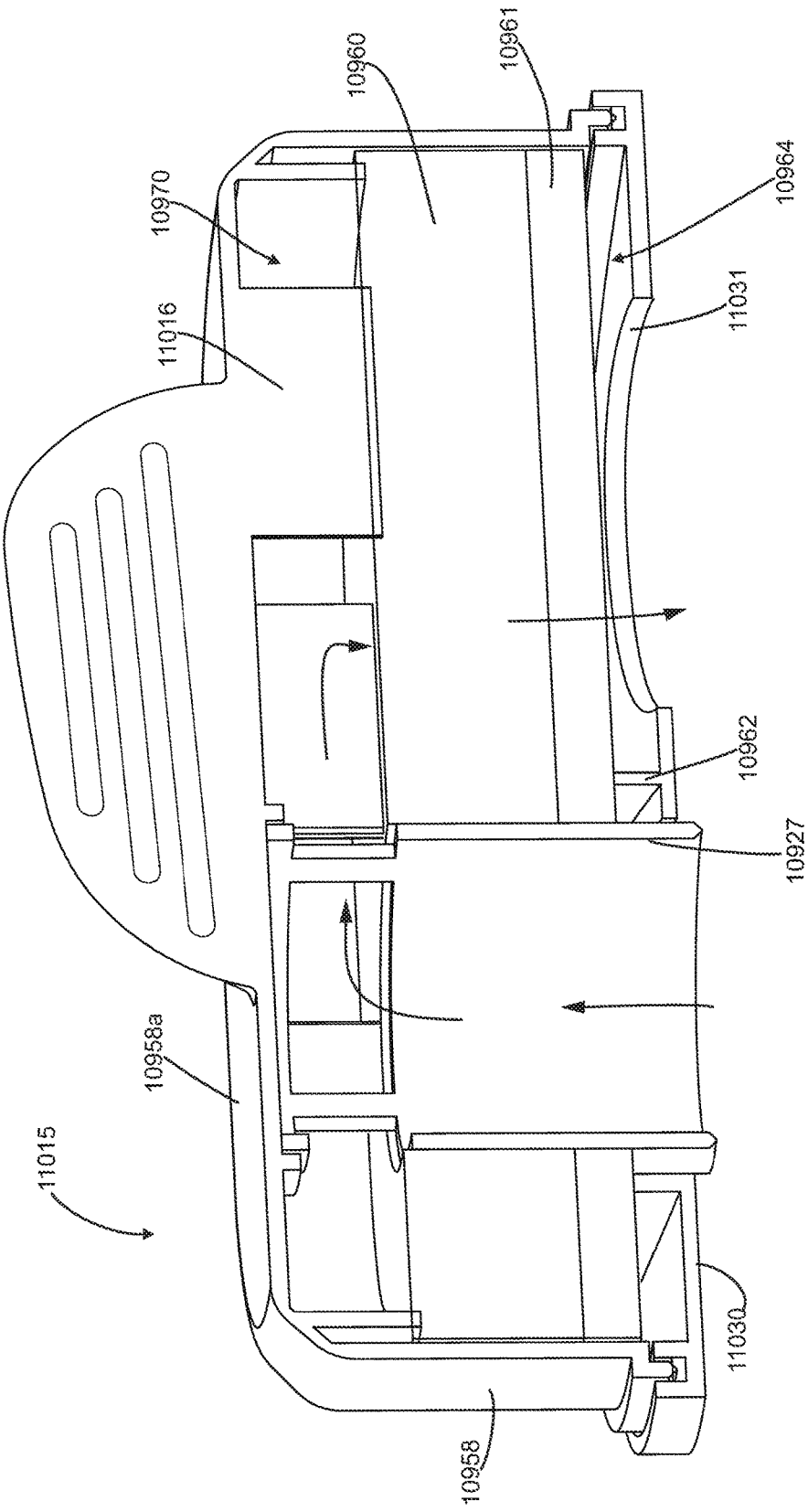
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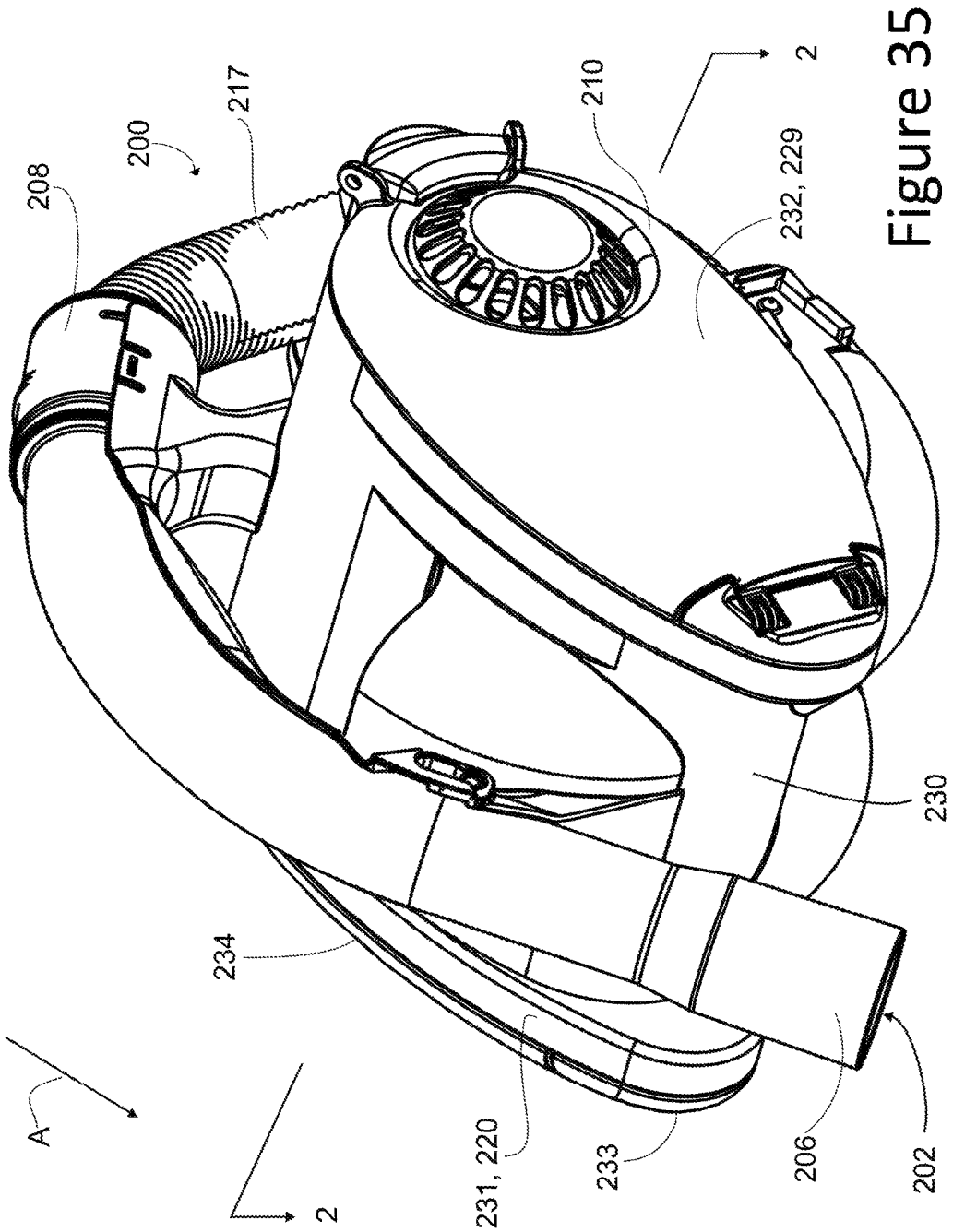

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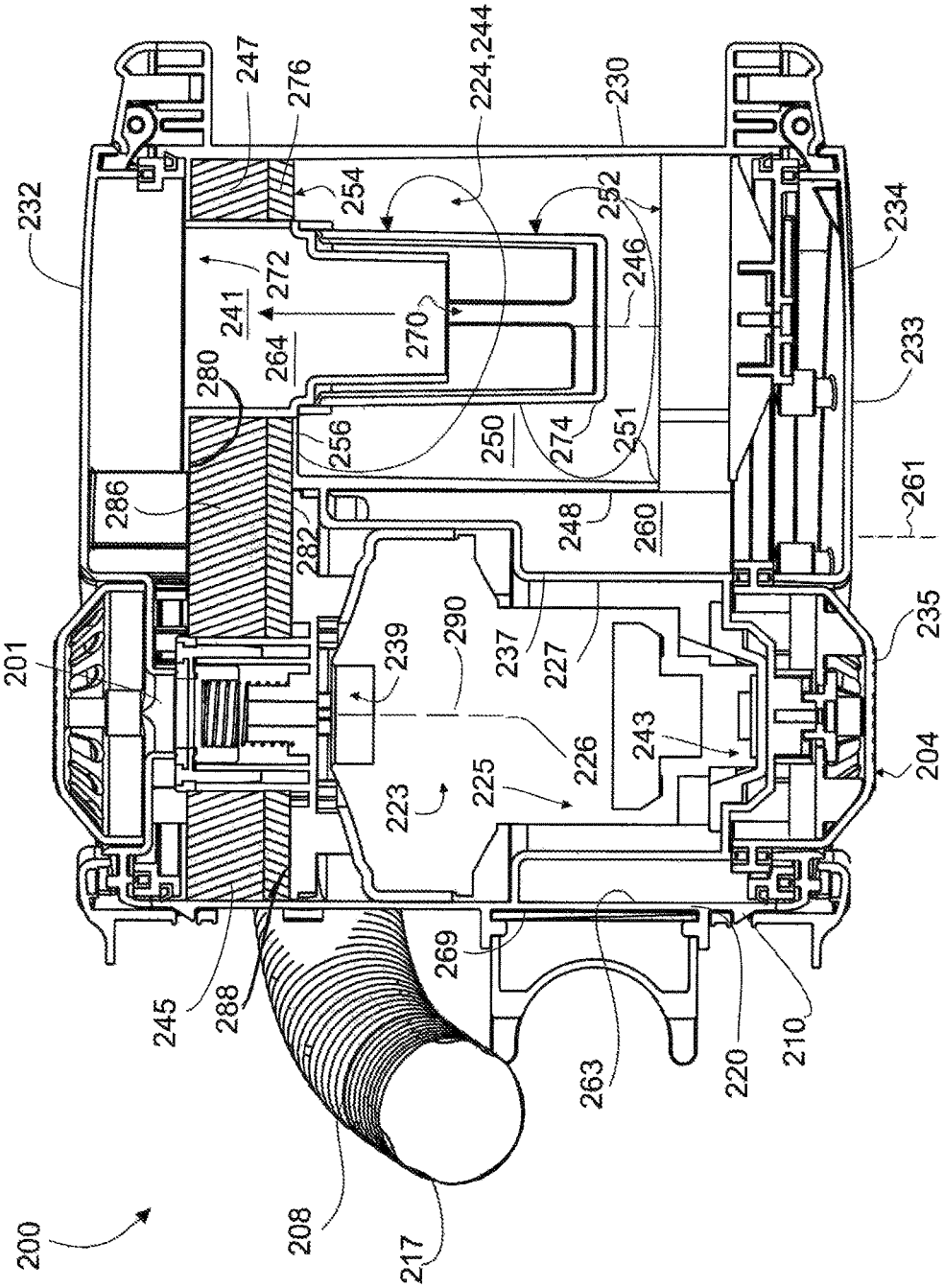
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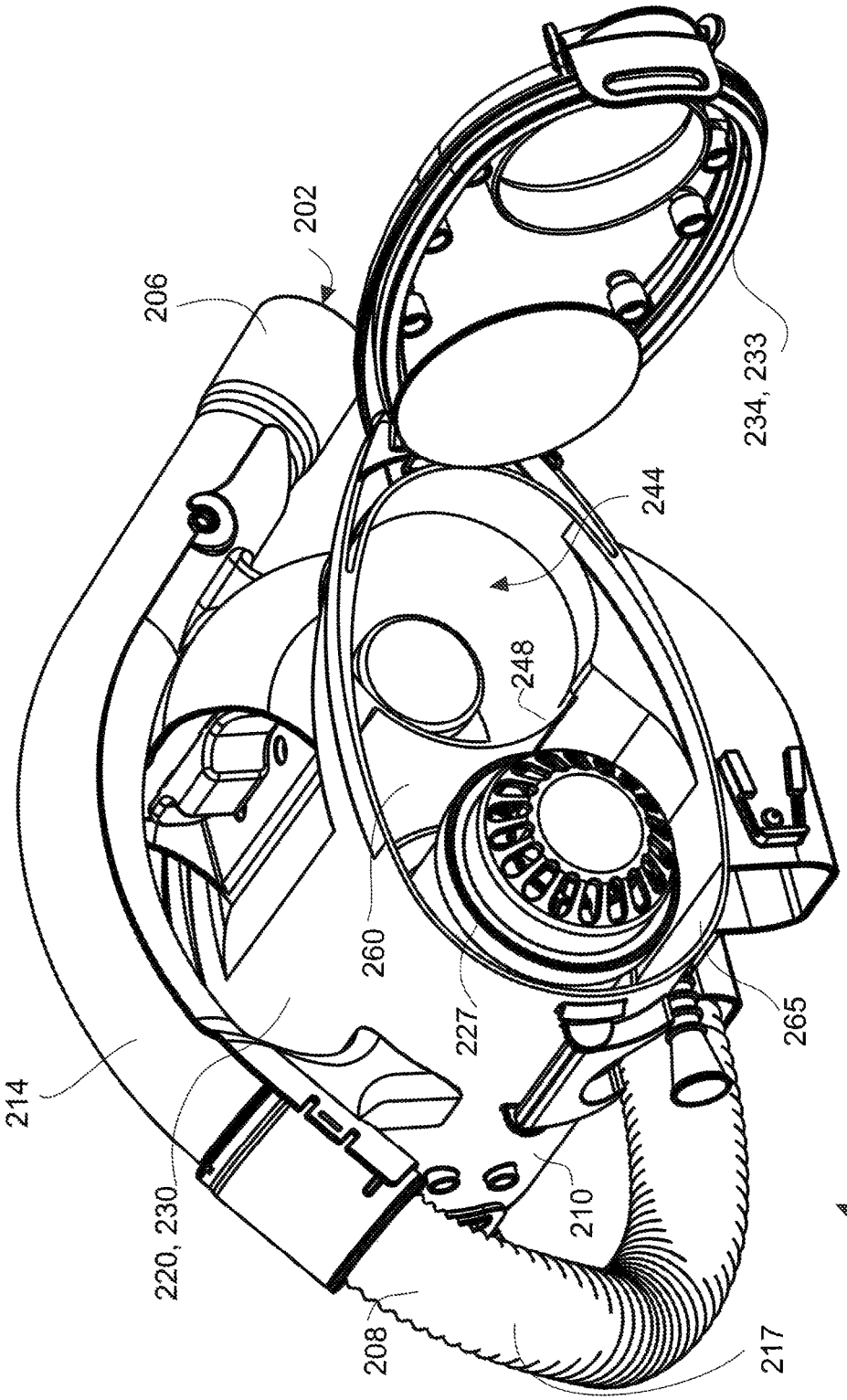

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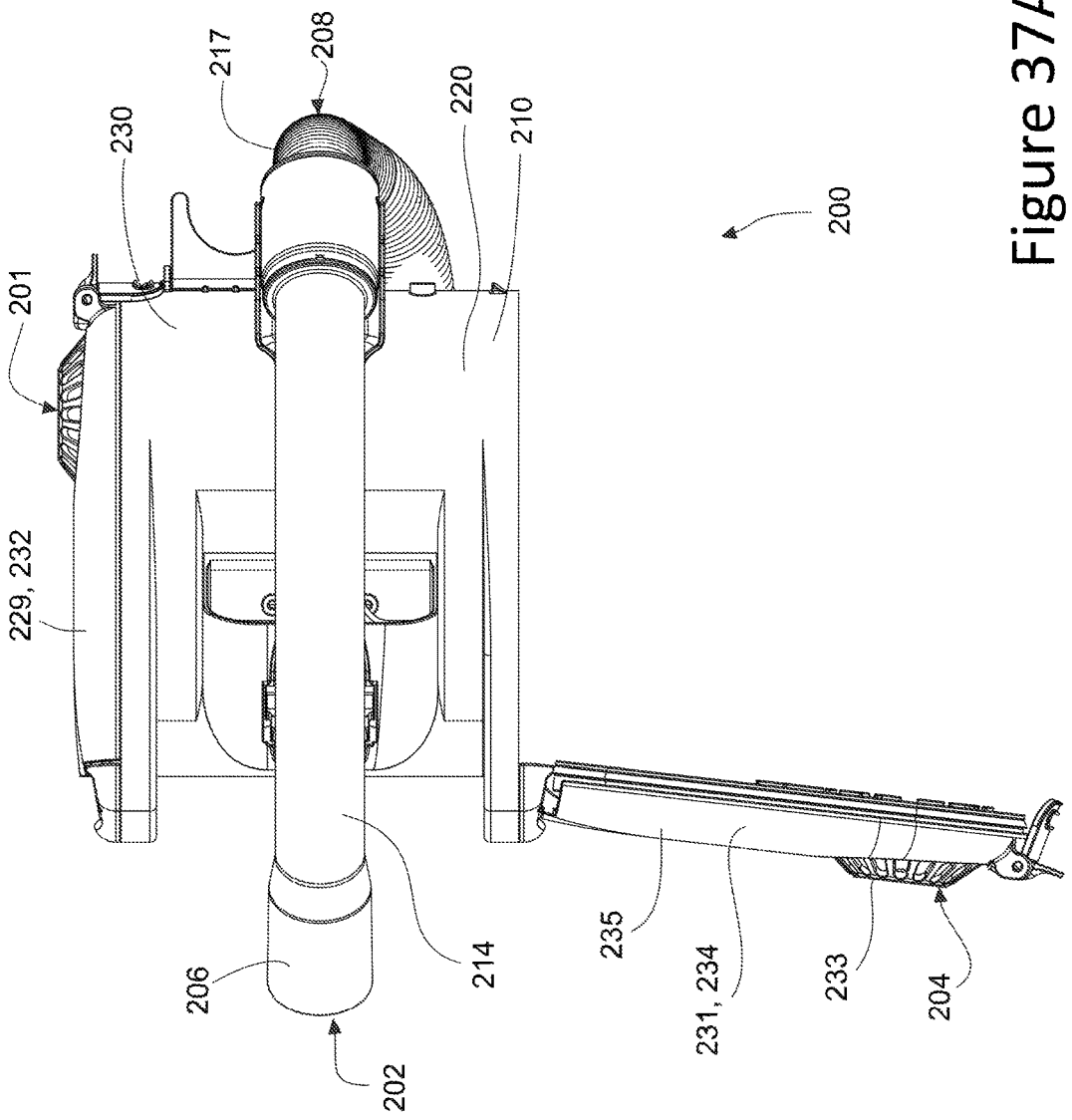
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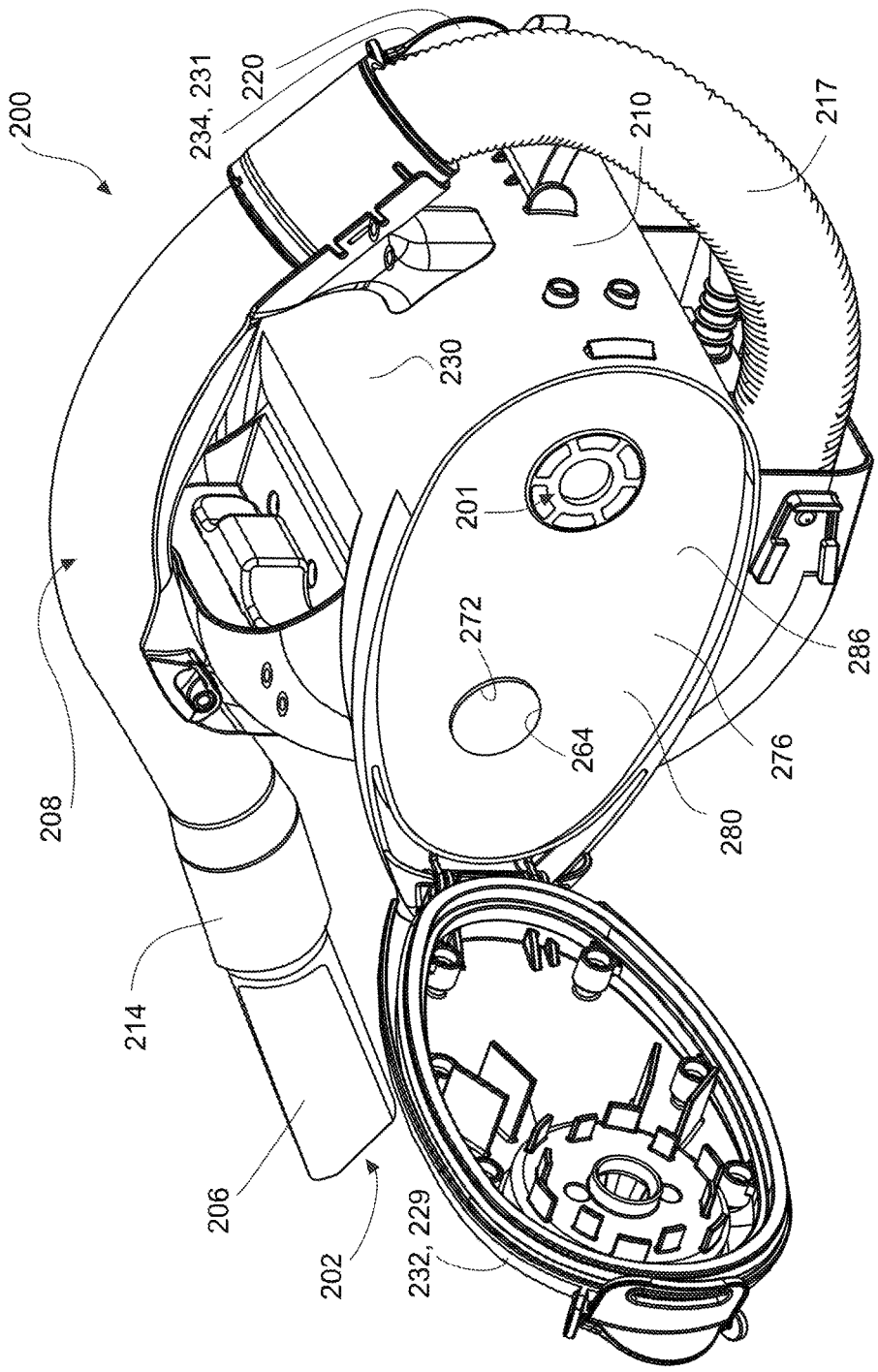
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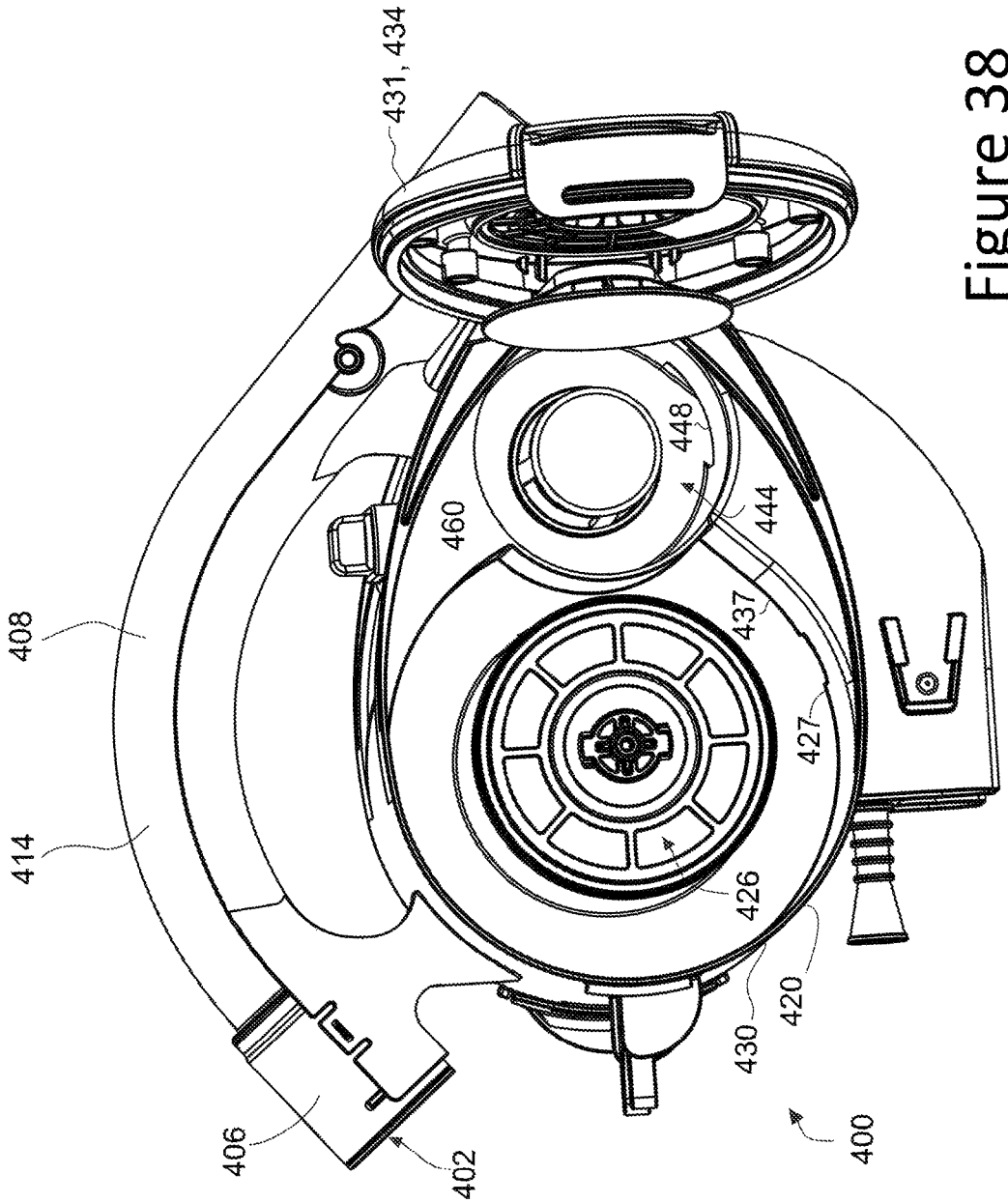

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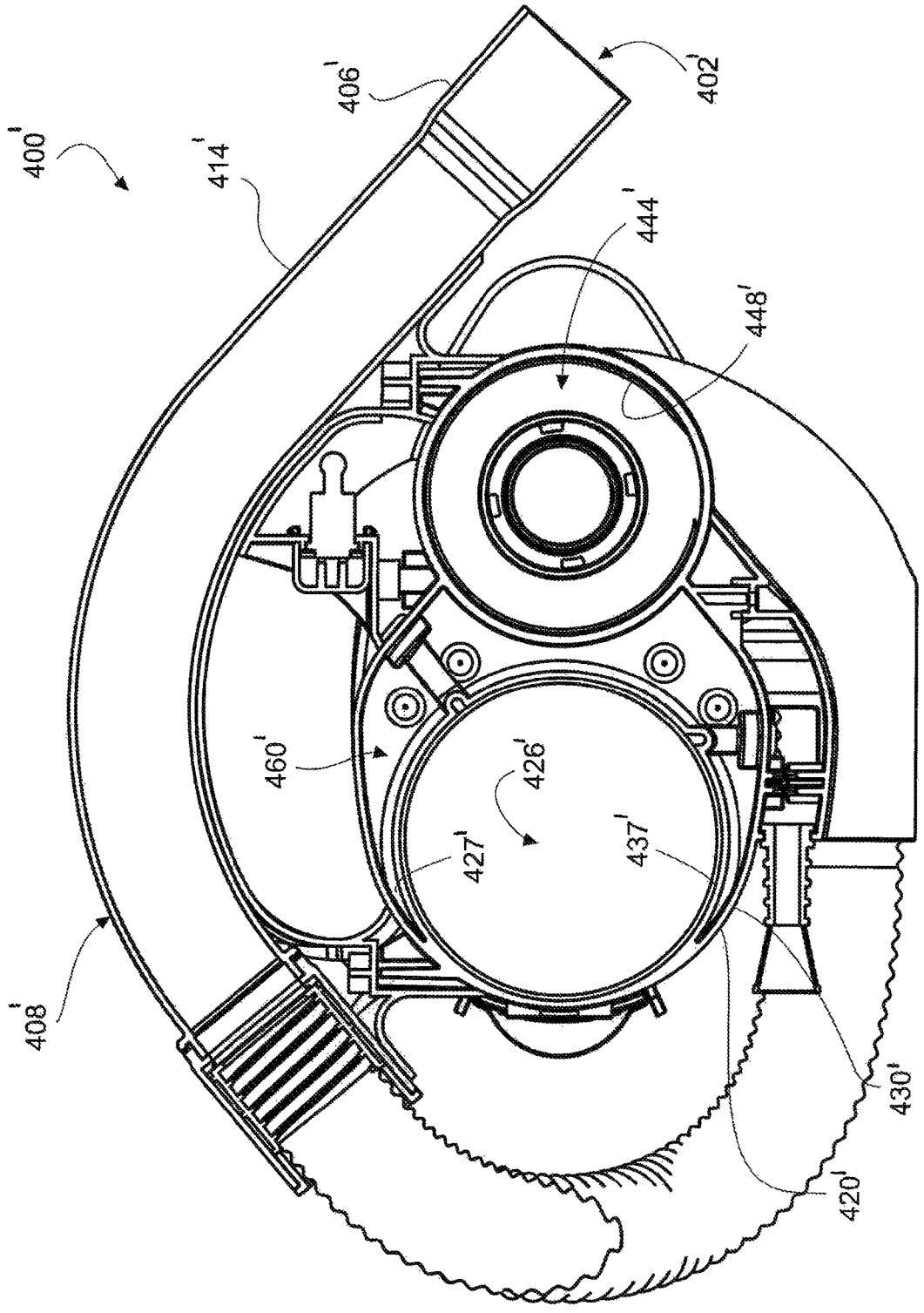

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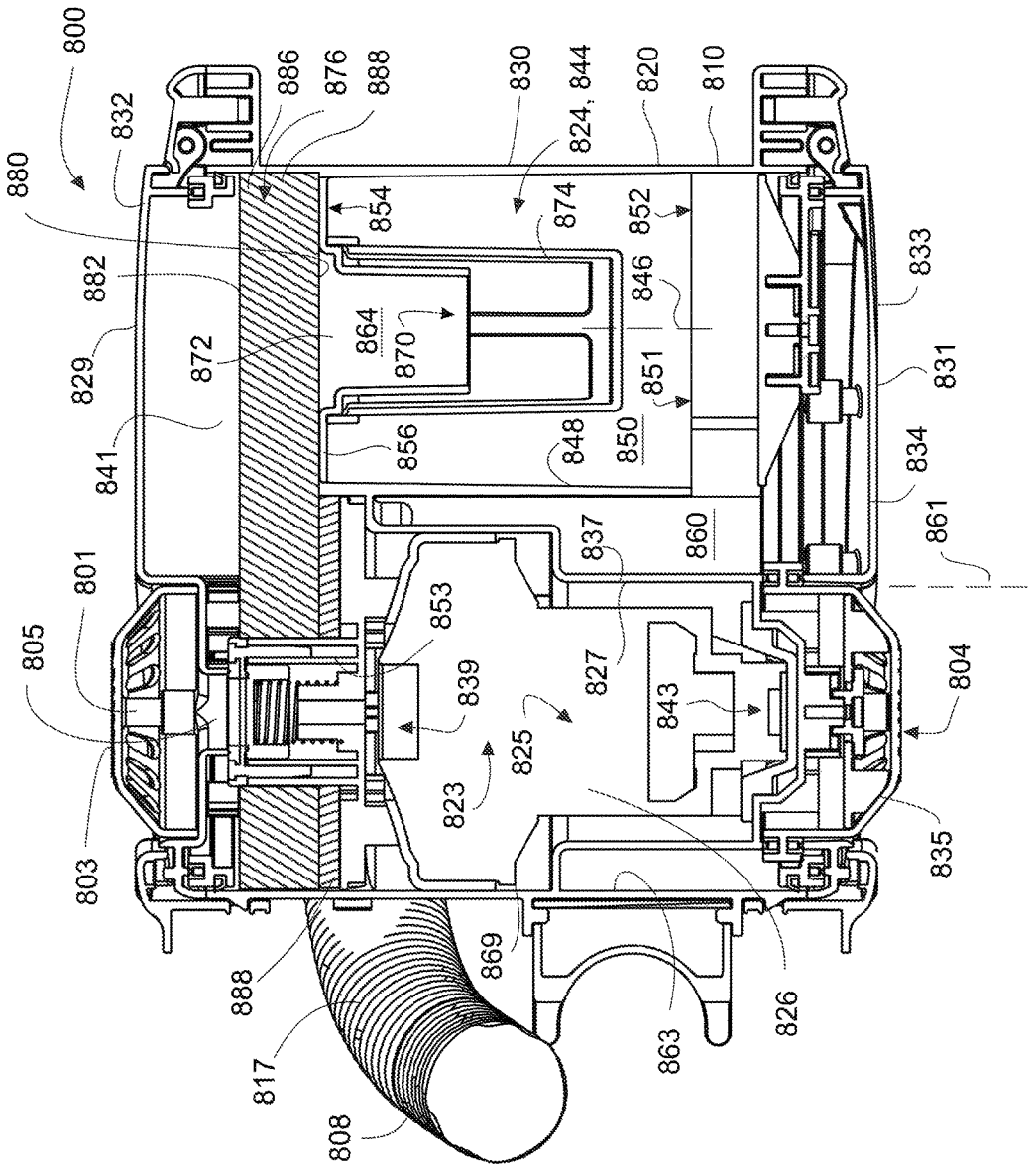
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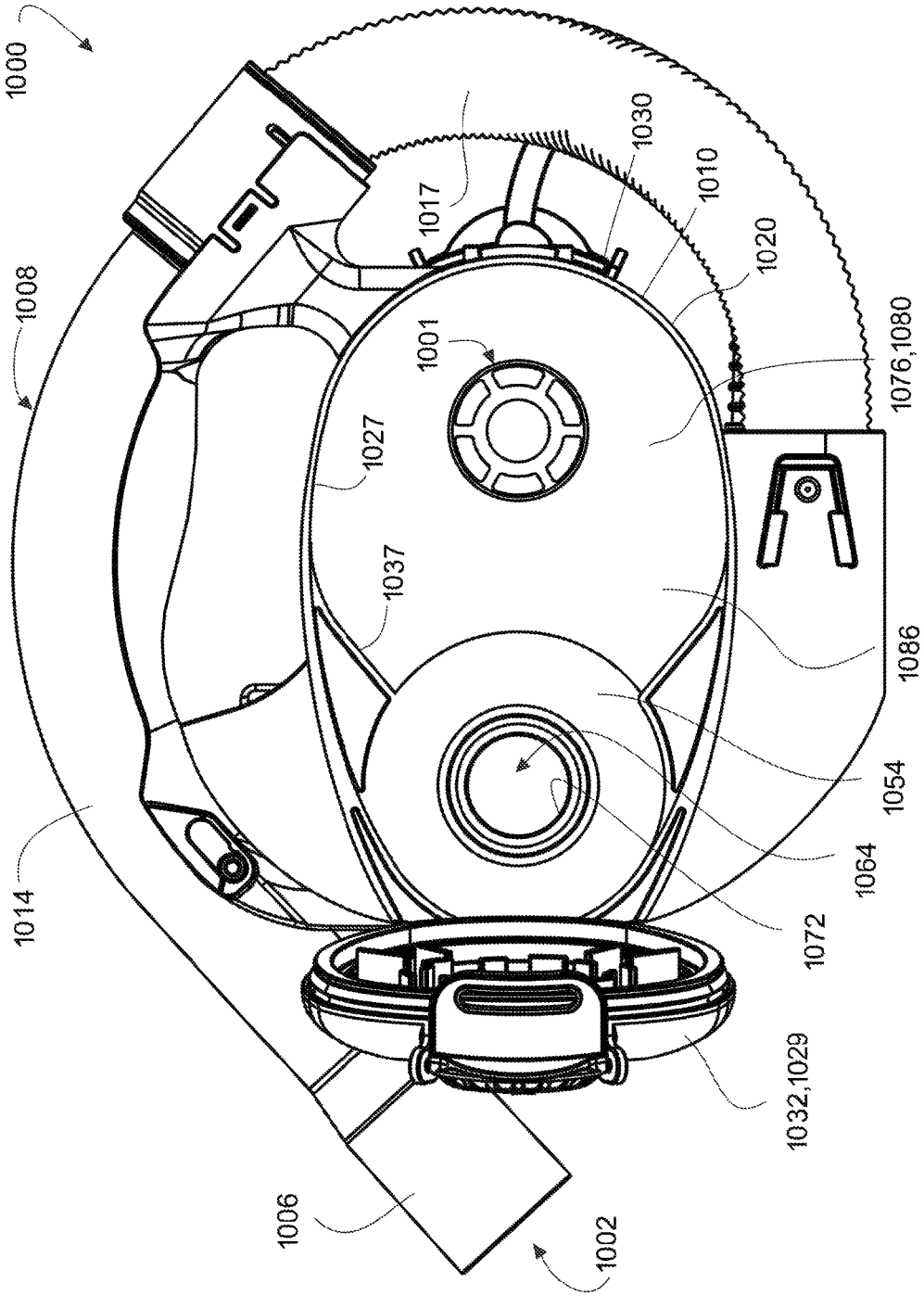
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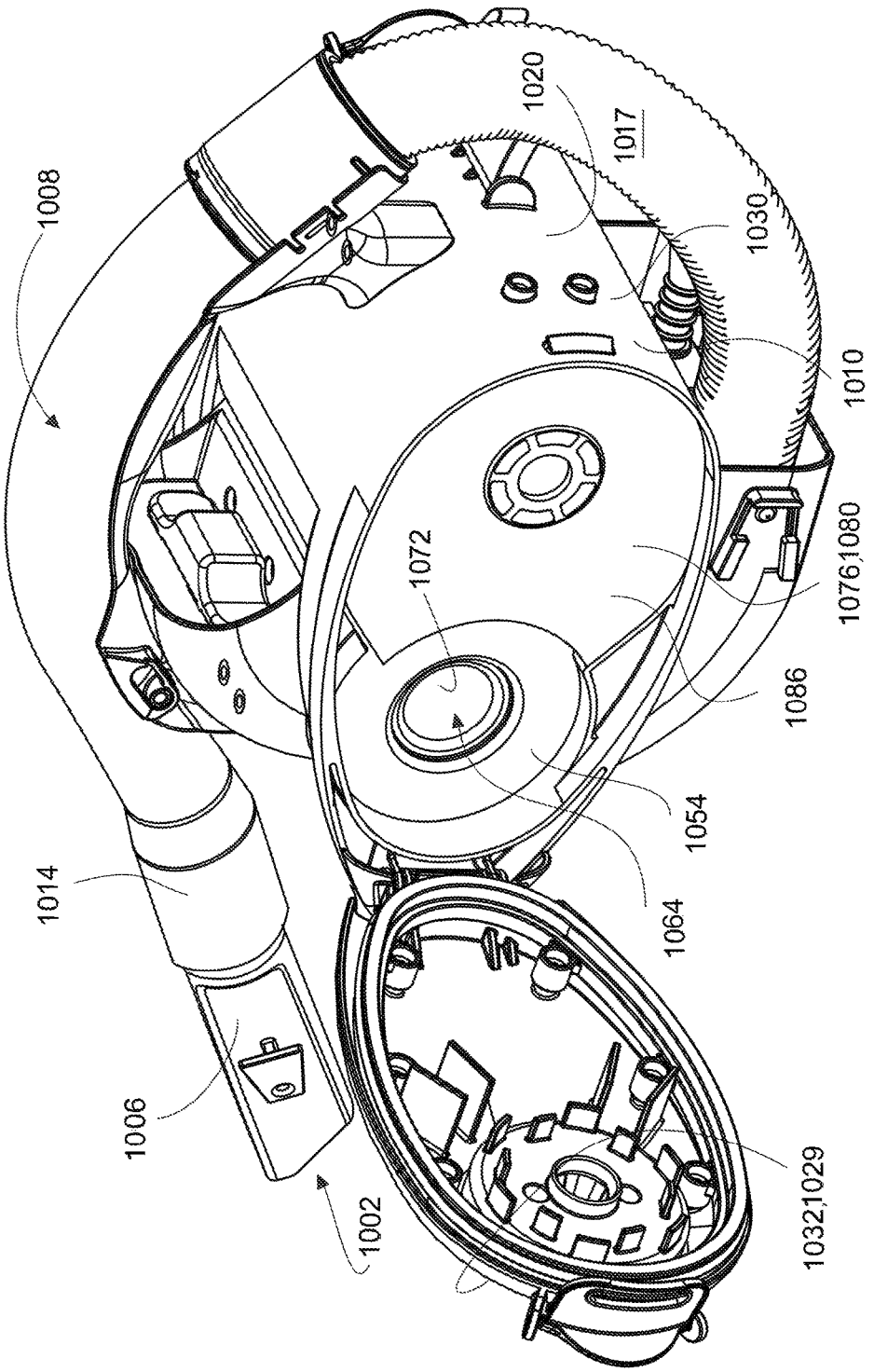
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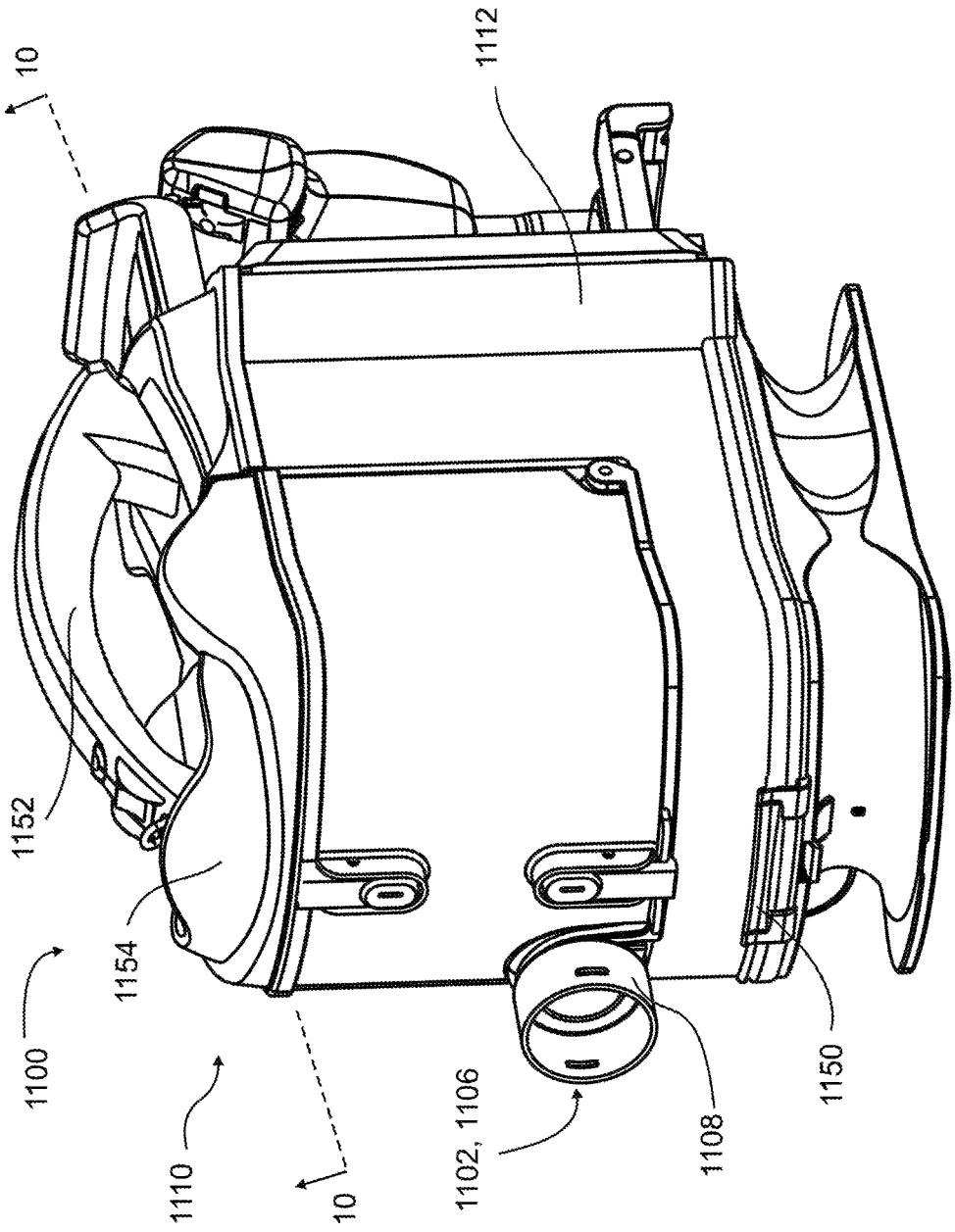

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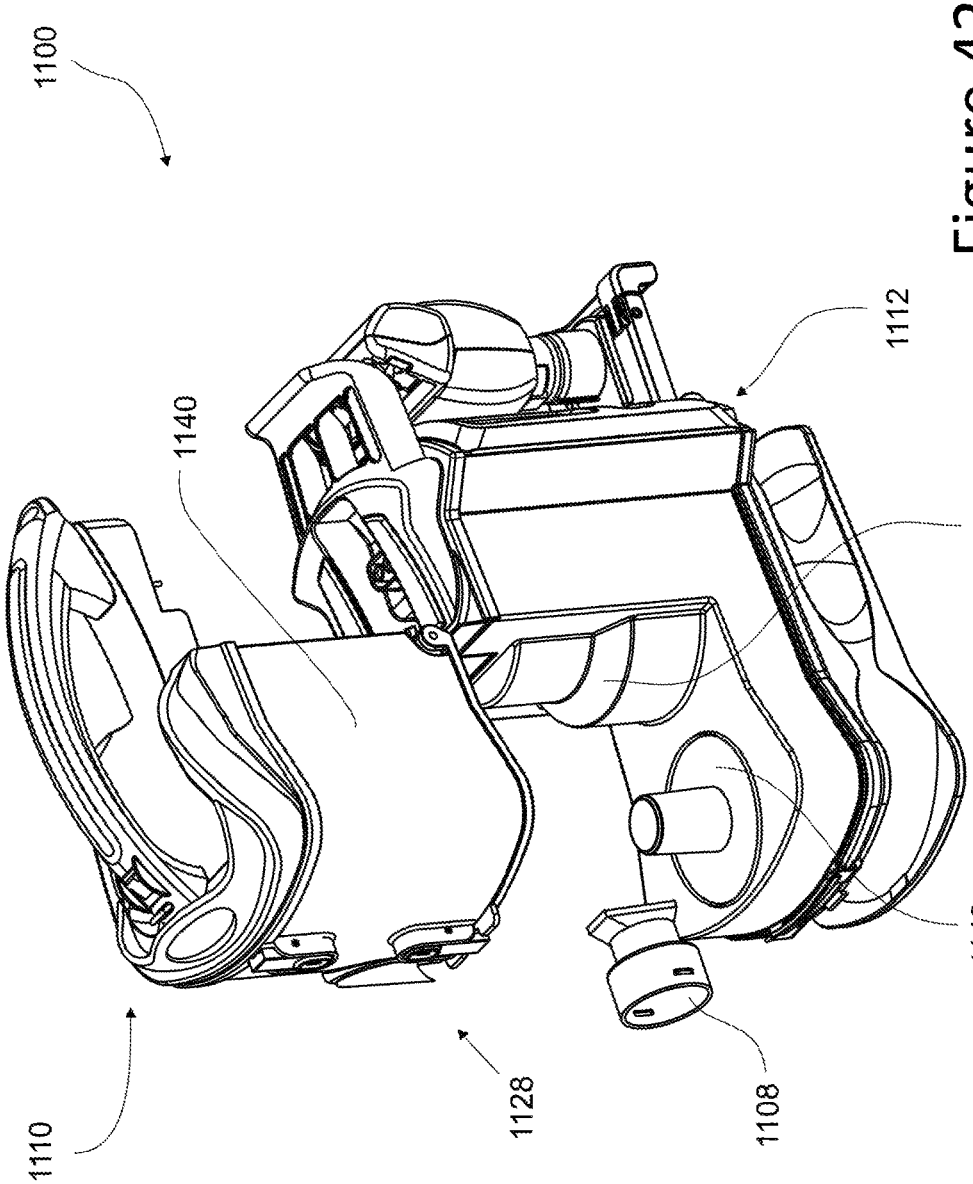

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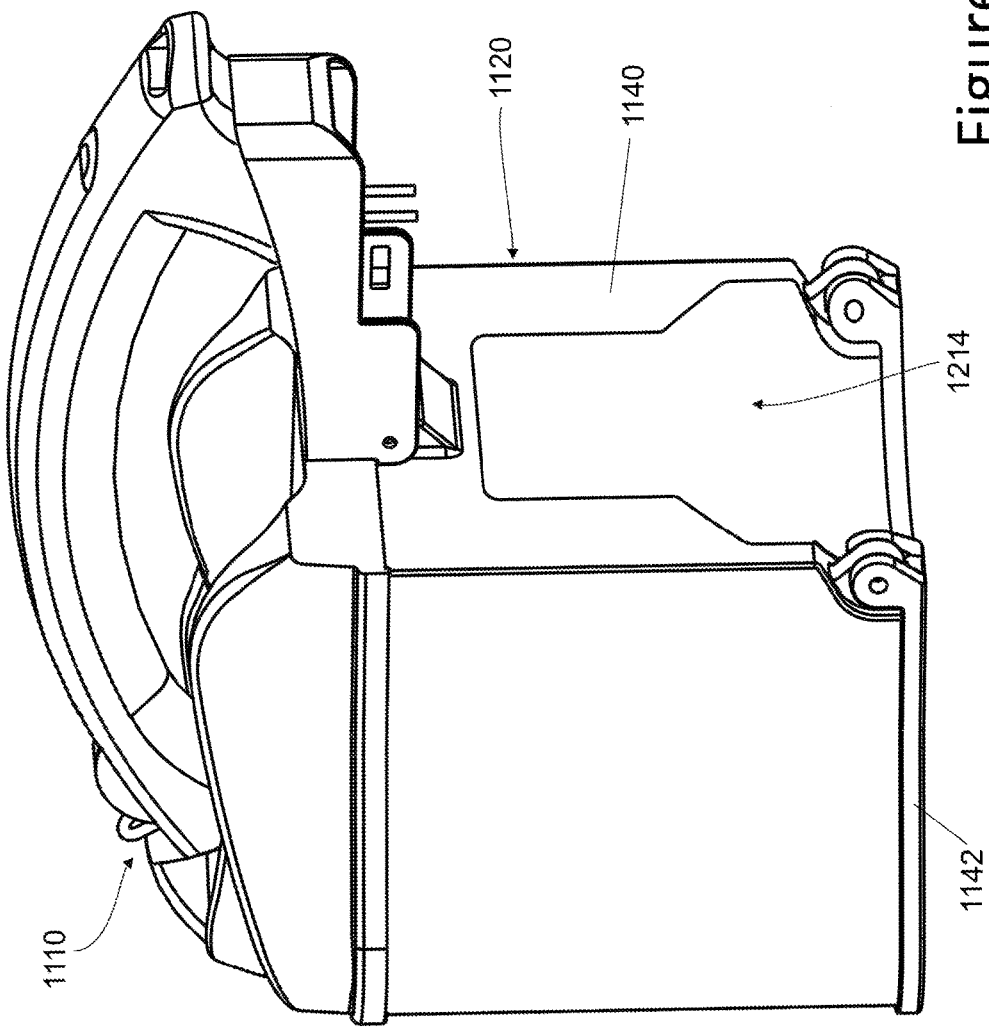
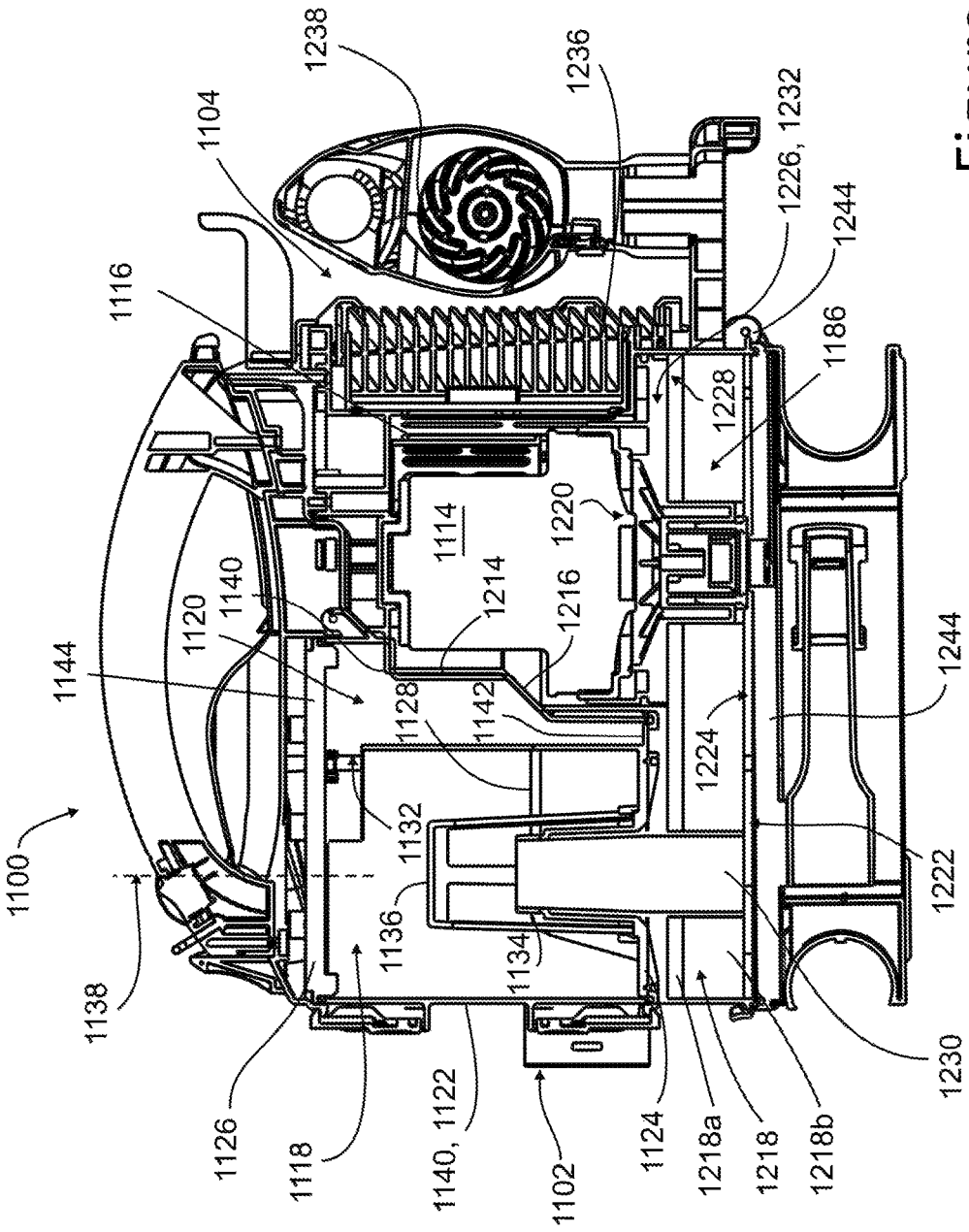


Figure 43


1100
1102
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1142
1144
1186
1214
1216
1218
1218a
1218b
1220
1222
1224
1226, 1232
1228
1230
1236
1238
1244

Figure 44

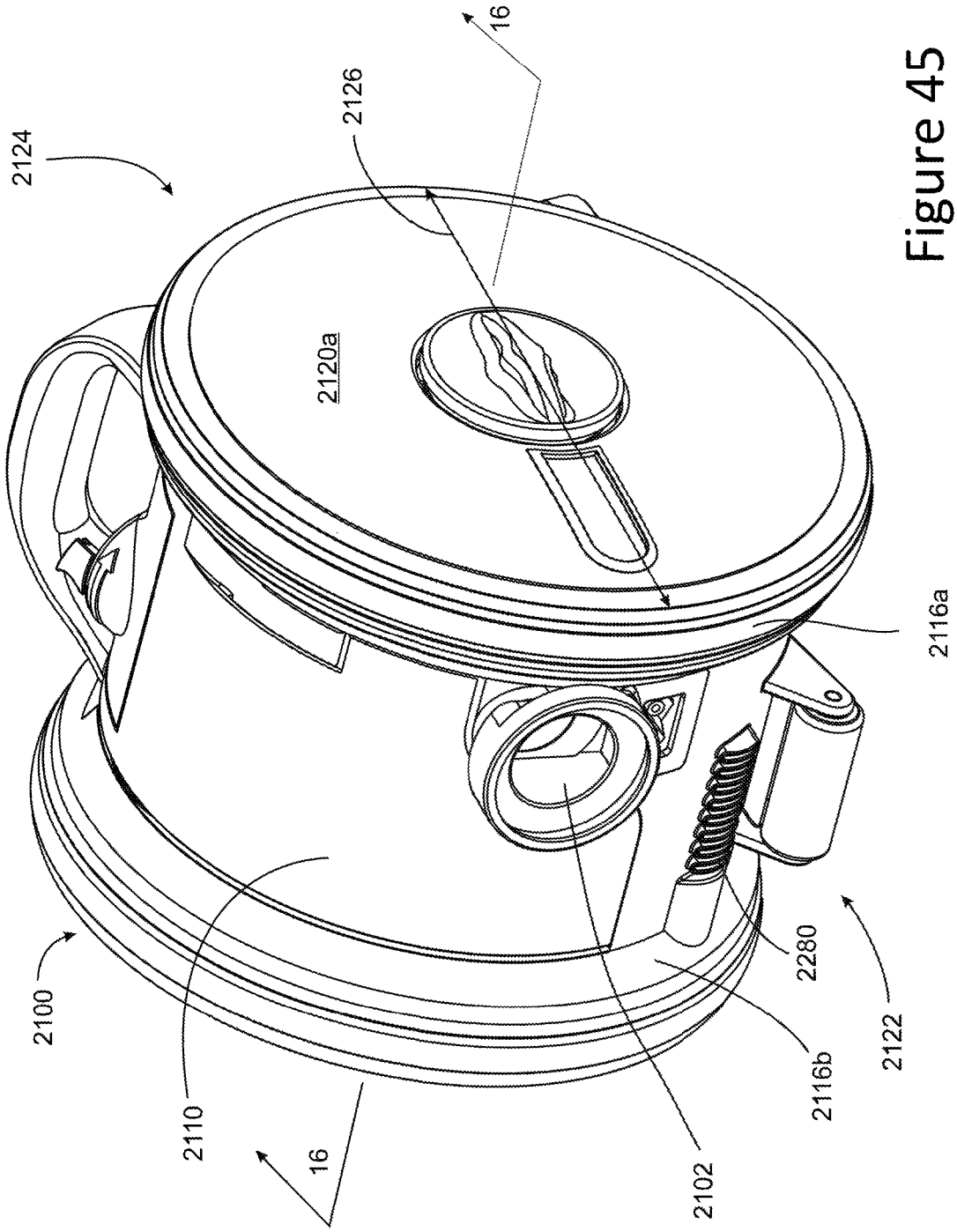
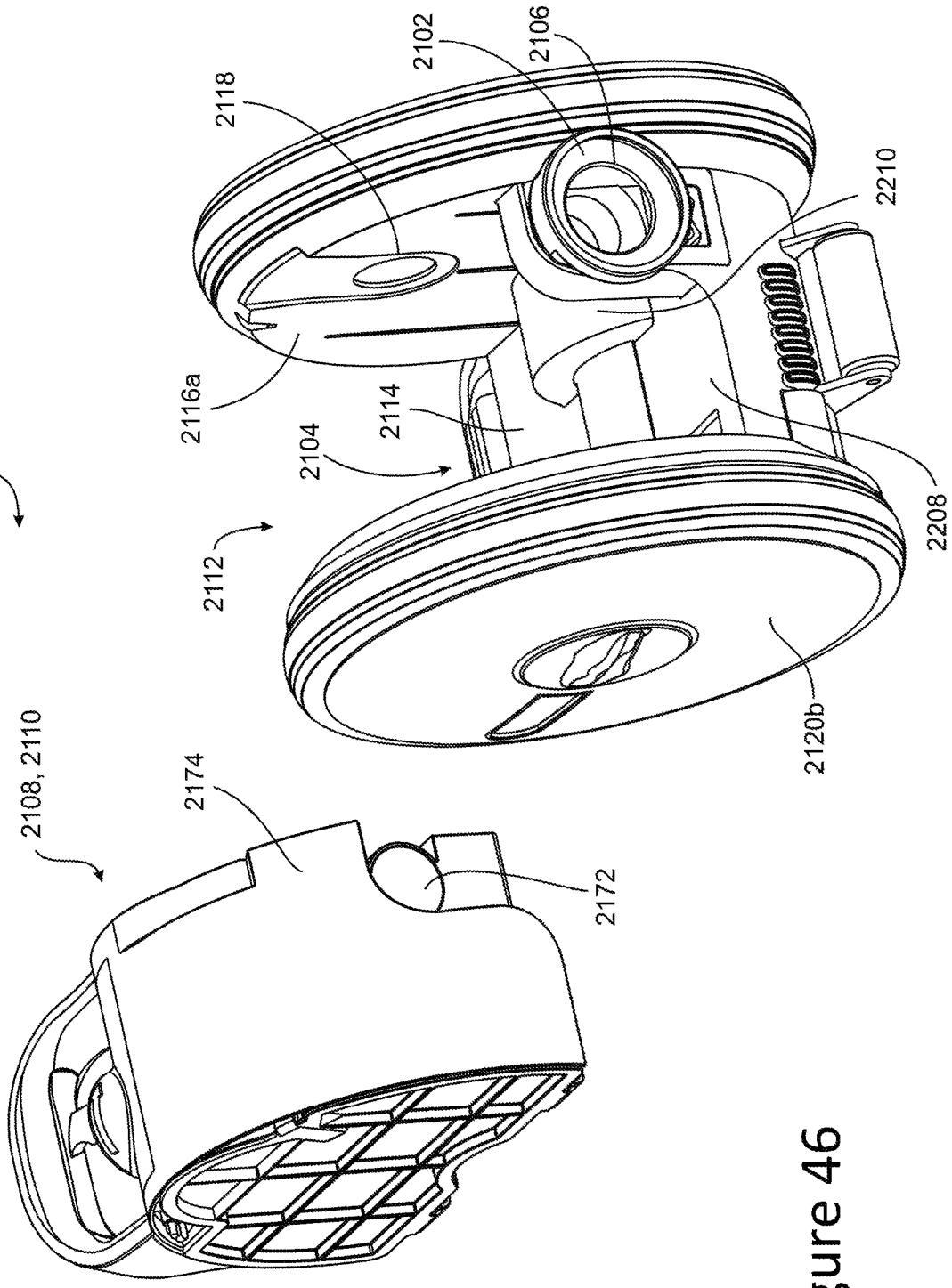


Figure 45


2100
2102
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2210
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2114
2104
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2112
2120b
2108, 2110
2174
2172

Figure 46

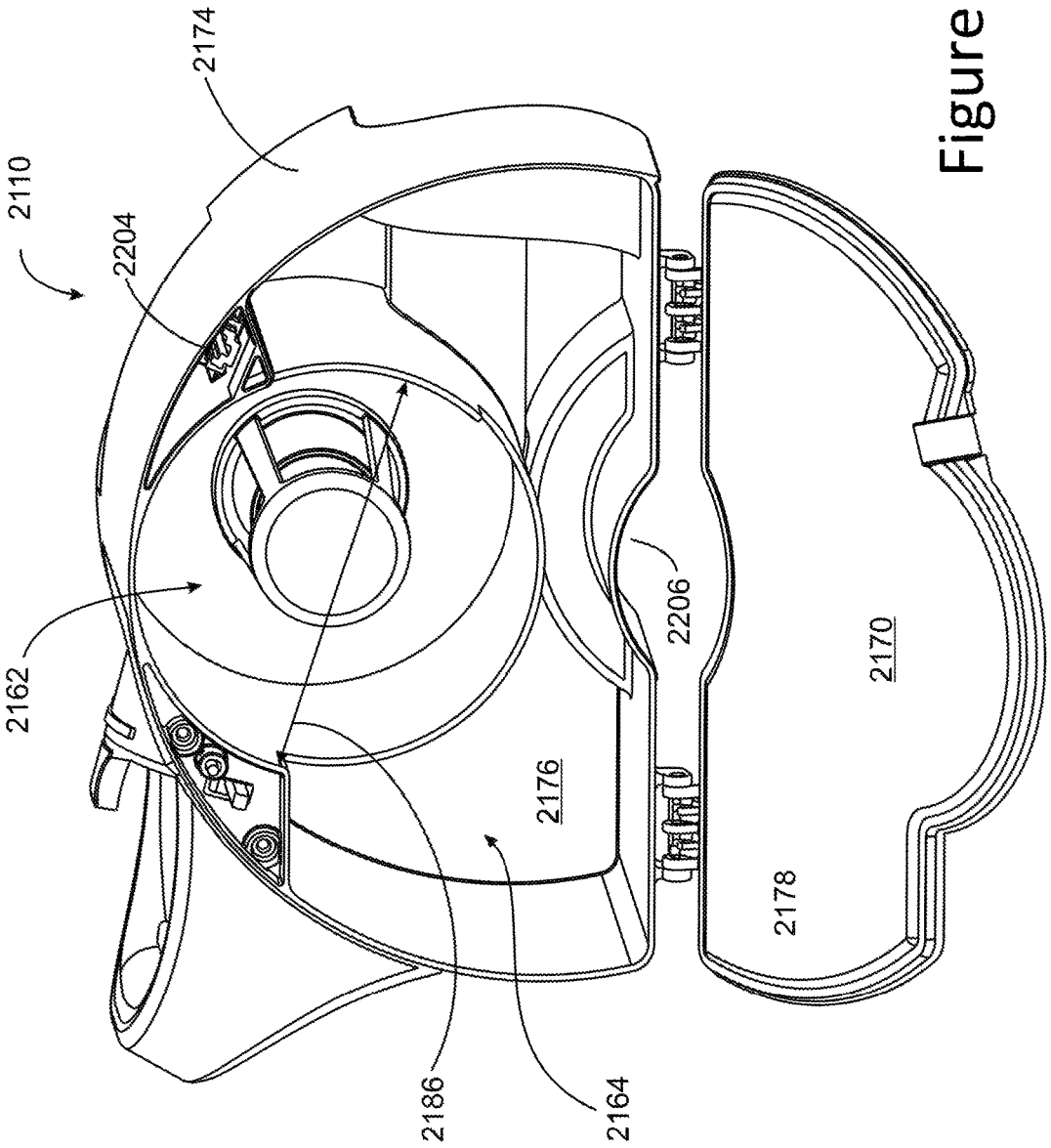


Figure 47

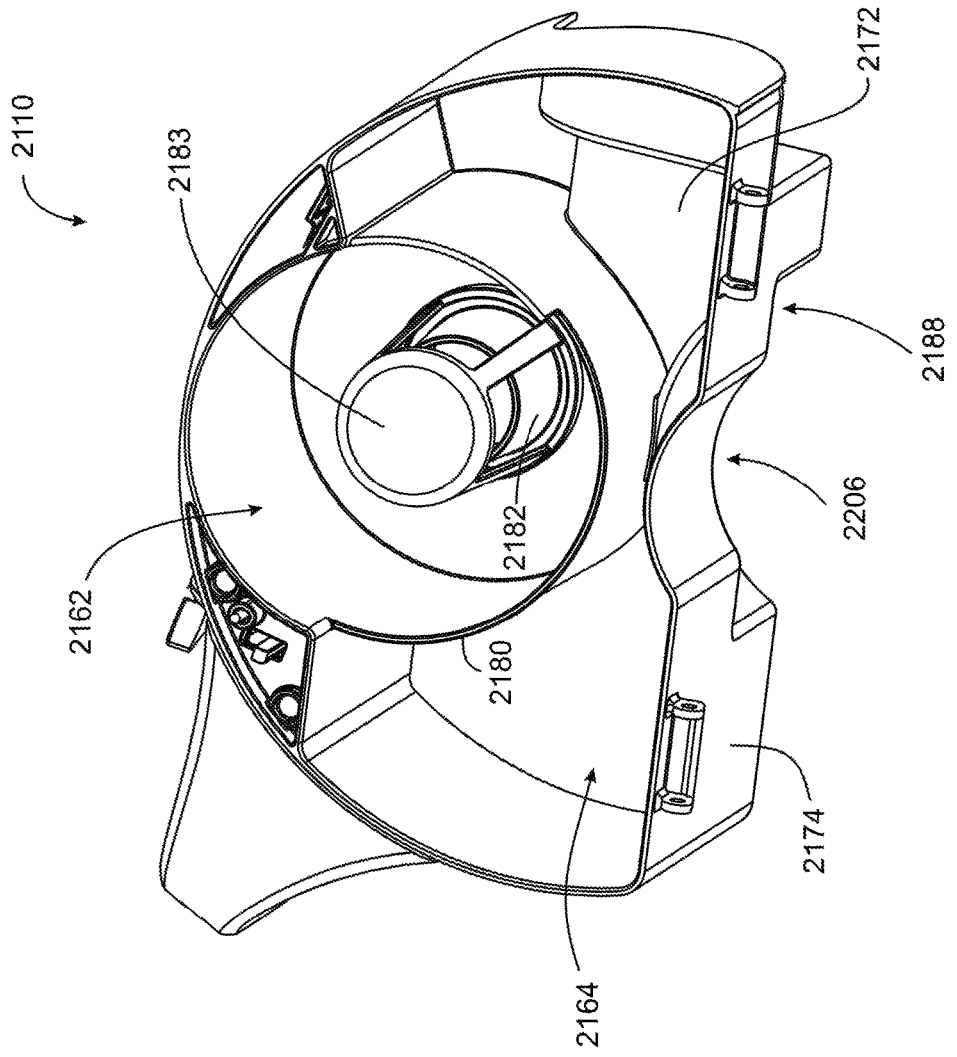


Figure 48

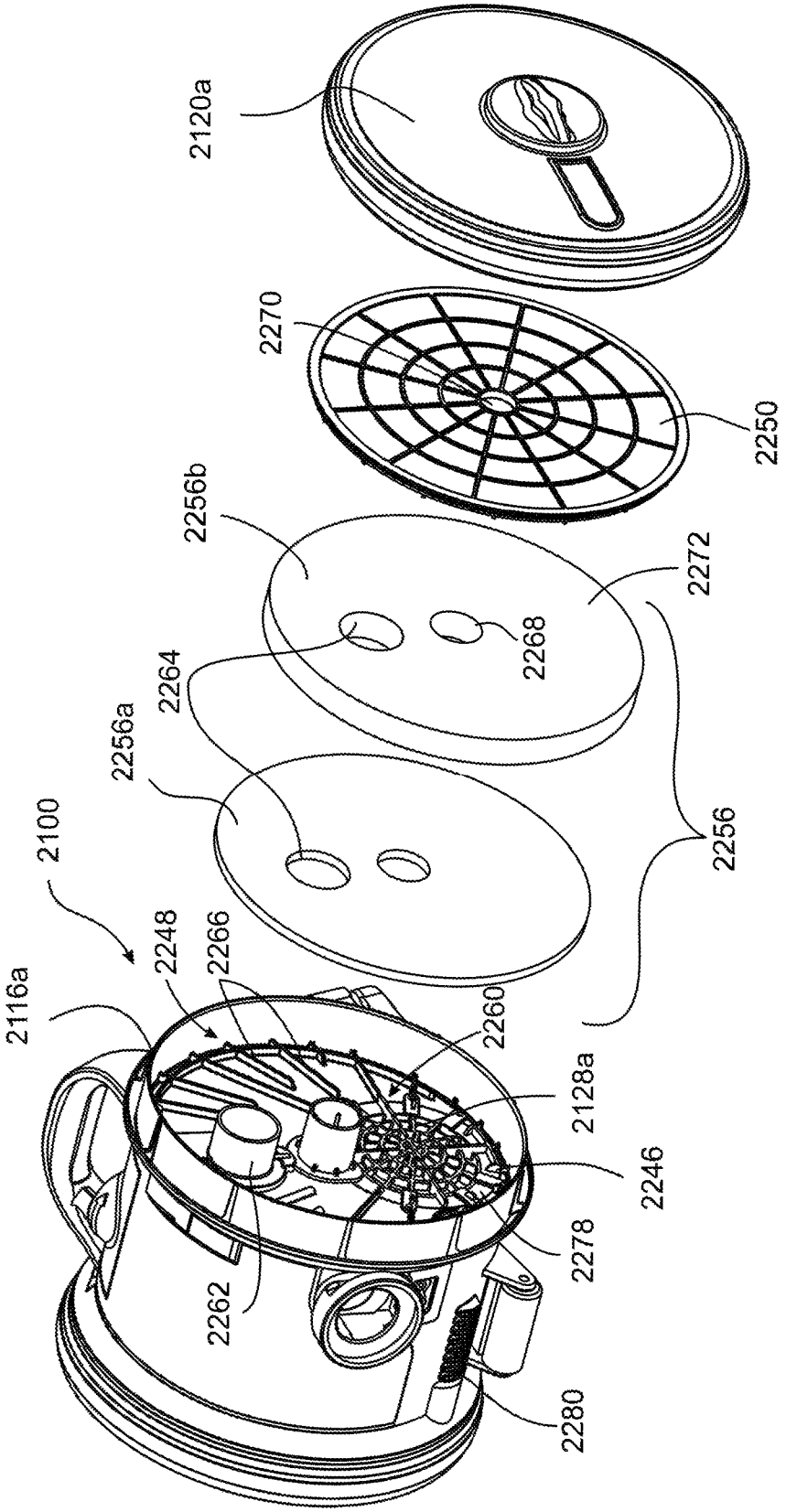
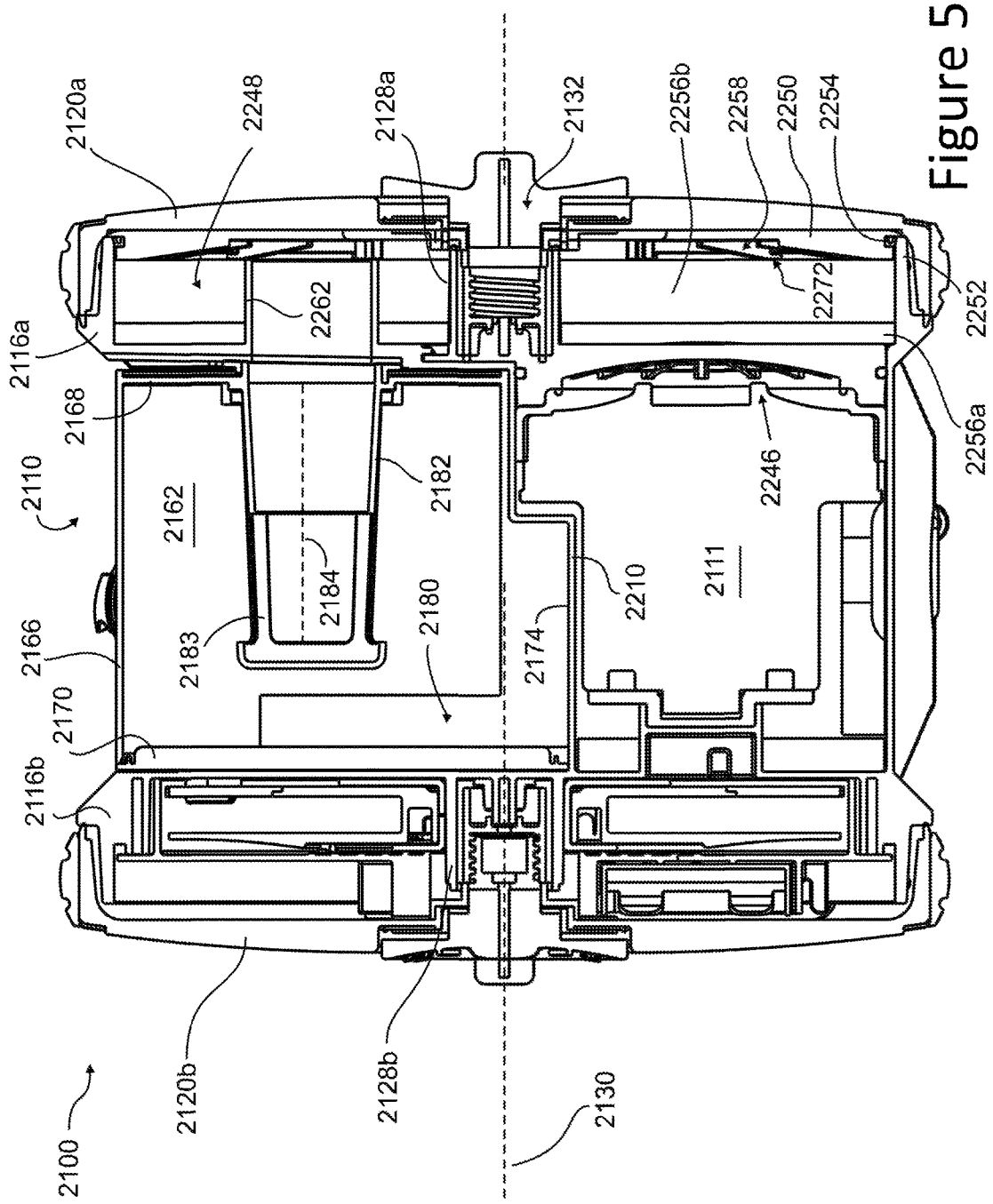

2120a
2270
2250
2256b
2272
2268
2264
2256a
2256
2100
2248
2266
2116a
2260
2128a
2246
2278
2262
2280

Figure 49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2256b
2258
2250
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2272
2252
2262
2116a
2168
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2162
2182
2246
2256a
2184
2183
2180
2210
2111
2174
2166
2170
2116b
2120b
2128b
2130
2100

Figure 50

SURFACE CLEANING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is:

a continuation of U.S. patent application Ser. No. 13/779,405, filed on Feb. 27, 2013; now U.S. Pat. No. 9,433,332, and,

a continuation-in-part of U.S. patent application Ser. No. 14/994,495, filed on Jan. 13, 2016, now abandoned, which is a continuation of U.S. patent application Ser. No. 13/039,376, filed on Mar. 3, 2011, now U.S. Pat. No. 9,265,395, which is a continuation in part of U.S. patent application Ser. No. 12/722,705, filed Mar. 12, 2010, now U.S. Pat. No. 8,578,555; and

a continuation of U.S. patent application Ser. No. 14/932,816 filed on Nov. 4, 2015, now U.S. Pat. No. 9,693,666, which is a continuation of U.S. patent application Ser. No. 13/040,676, filed on Mar. 4, 2011, now U.S. Pat. No. 9,211,044,

the entirety of each of which is incorporated herein by reference.

FIELD

The specification relates to surface cleaning apparatus. In a preferred embodiment, the surface cleaning apparatus comprises a portable surface cleaning apparatus, such as a hand vacuum cleaner or a pod.

BACKGROUND OF THE INVENTION

The following is not an admission that anything discussed below is part of the prior art or part of the common general knowledge of a person skilled in the art.

Various types of surface cleaning apparatus are known. Surface cleaning apparatus include vacuum cleaners. Currently, a vacuum cleaner typically uses at least one cyclonic cleaning stage. More recently, cyclonic hand vacuum cleaners have been developed. See for example, U.S. Pat. No. 7,931,716 and US 2010/0229328. Each of these discloses a hand vacuum cleaner which includes a cyclonic cleaning stage. U.S. Pat. No. 7,931,716 discloses a cyclonic cleaning stage utilizing two cyclonic cleaning stages wherein both cyclonic stages have cyclone axis that extends vertically. US 2010/0229328 discloses a cyclonic hand vacuum cleaner wherein the cyclone axis extends horizontally and is co-axial with the suction motor. In addition, hand carriable (e.g., pod style) cyclonic vacuum cleaners are also known (see U.S. Pat. No. 8,146,201).

BRIEF SUMMARY OF THE INVENTION

This summary is intended to introduce the reader to the more detailed description that follows and not to limit or define any claimed or as yet unclaimed invention. One or more inventions may reside in any combination or sub-combination of the elements or process steps disclosed in any part of this document including its claims and figures.

According to one broad aspect, a pod or other hand carriable surface cleaning apparatus, such as a vacuum cleaner, is provided utilizing at least one cyclone stage wherein the cyclone chamber has two dirt outlets which are preferably positioned front and rear. An advantage of this design is that the dirt carrying capacity of the vacuum cleaner may be increased. For example, if the vacuum cleaner is being used and is tilted upwardly, the dirt in the dirt collection chamber will tend to move rearwardly. The amount of dirt in the dirt collection chamber may be below the fill line. However, when the vacuum cleaner is tilted upwardly, movement of the dirt rearwardly may cause the dirt in the dirt collection chamber to extend above the fill line and could potentially block a rearwardly positioned dirt outlet. The provision of a second spaced apart (preferably forwardly positioned) dirt outlet may provide an alternate dirt outlet which may be used in such a situation. Similarly, the hand vacuum cleaner may be tilted forwardly. In such a case, the dirt in the dirt collection chamber may move forwardly blocking a forward dirt outlet. However, the provision of a second spaced apart (preferably rearwardly positioned) dirt outlet may provide an alternate dirt outlet which may be used in such a situation. Accordingly, provision of different dirt outlets may allow the vacuum cleaner to continue to function despite the vacuum cleaner being operated at an angle to the horizontal. It will be appreciated that such a design is usable in hand vacuum cleaners, pod vacuum cleaners or other vacuum cleaners or surface cleaning apparatus which are meant to be carried by a hand or shoulder strap or the like (which may be referred to as hand carriable surface cleaning apparatus).

It will be appreciated that in a preferred embodiment, the dirt outlets are positioned adjacent the forward end and the rearward end of the cyclone chamber or cyclone chambers. However, it will be appreciated that displacing the dirt outlets from being exactly forward or rearward will still increase the dirt capacity of the hand carriable surface cleaning apparatus when operated at an angle to the horizontal.

The cyclone chamber may be of any particular design. Preferably, the cyclone chamber has the dirt outlet provided at a lower end. For example, the vacuum cleaner may have an upper air inlet and an upper air outlet. The dirt outlets may be provided in the sidewall at or close to the lower end wall of the cyclone chamber. Accordingly, the dirt outlets may be defined by cutouts or slots provided in the sidewall of the cyclone chamber. However, it will be appreciated that the dual dirt outlet design may be utilized with other cyclone constructions such as an inverted cyclone (e.g., the air inlet and air outlet are provided at a lower end and the dirt outlets are provided at an upper end of the cyclone chamber).

Each of the dirt outlets may be the same size. However, in a preferred embodiment, one of the dirt outlets is larger than the other. In addition, the positioning of the dirt outlets with respect to the position of the cyclone air inlet may vary. For example, one or both of the dirt outlets may have a radial extent of 15-135°; preferably 30-105° and, still more preferably, 60-75°. One of the dirt outlets may be positioned at the same radial position on the sidewall of the cyclone chamber as the cyclone air inlet. For example, if the dirt outlet is at the lower end of a cyclone chamber and the air inlet is at the upper end, one of the dirt outlets may be positioned directly below the air inlet such that the radial displacement around the sidewall of the cyclone chamber from the air inlet may be less than 10 degrees. In such an embodiment, it is preferred that the opposed dirt outlet is larger and may be twice as large (e.g., its angular extent may be twice that of the slot which is aligned with the air inlet).

It will also be appreciated that the hand carriable surface cleaning apparatus may be mountable on a base, such as a wheeled base or an upper portion of an upright surface cleaning apparatus. In such a case, the hand carriable surface cleaning apparatus may function as the air treatment mem-

ber of an upright surface cleaning apparatus or a canister style surface cleaning apparatus.

In another embodiment, an improved air flow path for a hand carriable surface cleaning apparatus and, preferably, a hand vacuum cleaner or hand surface cleaning apparatus, is provided. In accordance with this embodiment, the suction motor inlet is positioned below the upper end of the cyclone chamber and preferably at a position between the upper and lower ends of the cyclone chamber or a cyclone bin assembly (e.g., a cyclone bin assembly which includes a cyclone chamber and a dirt collection chamber, wherein the dirt collection chamber may be positioned below the cyclone chamber). According to such an embodiment, the air may enter the cyclone chamber, either at the upper end or the lower end of the cyclone chamber, and exit the cyclone chamber via an air outlet positioned in the upper end wall of the cyclone chamber. The air may then travel through a pre-motor filter. The pre-motor filter is preferably positioned above the cyclone chamber. The air exiting the cyclone chamber may either travel upwardly through the pre-motor filter and then travel downwardly via a conduit provided through the pre-motor filter or at a position that is laterally spaced (e.g., rearwardly) from the pre-motor filter. Alternately, the air exiting the cyclone chamber may pass via a conduit through the pre-motor filter and then travel downwardly through the pre-motor filter before travelling laterally (e.g., rearwardly). A conduit may then extend downwardly from the downstream side of the pre-motor filter (e.g., adjacent the cyclone chamber and/or an exterior dirt collection chamber of the cyclone chamber) to the suction motor inlet. This down flow conduit may be spaced from the cyclone chamber and dirt collection chamber or it may share a common wall with one or both thereof.

An advantage of this design is that the pre-motor filter may be accessible for cleaning or replacement by opening a panel on the upper portion of the hand carriable surface cleaning apparatus. Concurrently, the hand carriable surface cleaning apparatus may be emptiable by opening a bottom door. The bottom door may open the cyclone chamber, the dirt collection chamber, and, preferably, both simultaneously. Accordingly, the surface cleaning apparatus is provided in a hand carriable configuration wherein a bottom opening door and an upper opening pre-motor filter chamber is provided.

It will be appreciated by a person skilled in the art that any of the features of the air flow passage discussed herein may not be utilized with the dual dirt outlet design disclosed herein, but may be used by itself or in combination with any other feature disclosed herein.

In another embodiment, a hand carriable surface cleaning apparatus is provided wherein the suction motor is positioned horizontally (e.g., transverse to the vertical axis of the cyclone) and located between the upper and lower ends of the cyclone chamber or a cyclone bin assembly (preferably at or proximate a midpoint of the cyclone or cyclone bin assembly). A handle is provided which extends upwardly from the suction motor housing and is secured to an upper portion of the hand carriable surface cleaning apparatus. For example, a lower end of the handle may be provided on an upper surface of the suction motor housing. The upper end of the handle may extend to the pre-motor filter housing or a bridging portion which extends rearwardly from the pre-motor filter housing. The handle is preferably positioned so as to be rearward of the centre of gravity of the hand vacuum cleaner. Preferably, the centre of gravity is also located below the lower end of the handle. The handle may also be angled forwardly such that a vertical line extending upwardly from the center of gravity may pass through an upper portion of the handle (preferably a bridging portion extending between the pre-motor filter housing and the upper portion of the handle). An advantage of this design is that the hand carriable surface cleaning apparatus has improved ergonomics. The hand vacuum cleaner may impart a downward force of less than two pounds, preferably less than one pound, and preferably essentially no downward force on the hand of the user when the user holds the hand carriable surface cleaning apparatus horizontally disposed.

It will be appreciated by a person skilled in the art that any of the features of the ergonomic design of the hand vacuum cleaner discussed herein may not be utilized with the dual dirt outlet design disclosed herein, but may be used by itself or in combination with any other feature disclosed herein.

In accordance with another embodiment, a hand carriable surface cleaning apparatus is provided wherein the dirt collection chamber is removable with the handle of the surface cleaning apparatus for emptying. An advantage of this design is that a user need not carry the entire hand carriable surface cleaning apparatus to a garbage can or the like for emptying the dirt collection chamber. Instead, the user may be able to manipulate a lighter portion while emptying the dirt collection chamber. In addition, utilizing the handle of the hand carriable surface cleaning apparatus provides an easy way for a user to transport and hold the dirt collection chamber while it is being emptied. In addition, as the dirt collection chamber has been removed from the suction motor, the dirt collection chamber may be washed or otherwise cleaned once removed from the suction motor. It will be appreciated that the dirt collection chamber may be a lower portion of the cyclone chamber or a separate chamber in communication with a dirt outlet of the cyclone chamber. Preferably, if the dirt collection chamber is exterior to the cyclone chamber, then the cyclone chamber and dirt collection chamber may be removable with the handle as a unit (e.g., a cyclone bin assembly). It will be appreciated by a person skilled in the art that any of the features of the removable dirt collection chamber and handle assembly discussed herein may not be utilized with the dual dirt outlet design disclosed herein, but may be used by itself or in combination with any other feature disclosed herein.

In accordance with another embodiment, a bleed valve is provided downstream of the cyclone chamber. For example, the air exiting the cyclone chamber may travel upwardly via a conduit (which may be an extension of the vortex finder) through the pre-motor filters so that the upper side of the pre-motor filter is the upstream or dirty side of the pre-motor filter. In such a construction, the bleed valve may be positioned in the up flow conduit and connect with an air flow passage on the downstream side of the pre-motor filter (e.g., a downstream header of the pre-motor filter). Accordingly, the bleed valve may be positioned so as to draw bleed air in through a port on the upper side of the pre-motor filter housing and convey the bleed air through the up flow conduit from the cyclone chamber to a position downstream of the pre-motor filter. An advantage of this design is that the bleed valve is positioned at a location which will not be blocked during operation of the hand vacuum cleaner and does not require another passage through the pre-motor filter (which would reduce the cross sectional area of the upstream surface area of the pre-motor filter). In an alternate embodiment, it will be appreciated that the bleed valve could be exterior to the up flow conduit and may pass through the pre-motor filter.

In another embodiment, the bleed valve could be provided on a rearward surface of the surface cleaning apparatus. For

example, the bleed valve could be position coaxial with, and above, the suction motor housing. Accordingly, bleed air could travel essentially forwardly through the bleed valve into the down flow conduit adjacent to the cyclone chamber/dirt collection chamber and then rearwardly into the suction motor. In an alternate embodiment, the bleed valve could be radially spaced around the hand vacuum cleaner but still communicate with the down flow passage.

It will be appreciated by a person skilled in the art that any of the features of the bleed valve discussed herein may not be used with the dual dirt outlet design disclosed herein, but may be used by itself or in combination with any other feature disclosed herein.

In another embodiment, the hand carriable surface cleaning apparatus has a cyclone chamber with a vertically extending axis and the pre-motor filter is positioned above the cyclone chamber and is preferably positioned so as to extend perpendicular to the axis of the cyclone. Accordingly, the air exiting the cyclone chamber may travel upwardly to the pre-motor filter. In such an embodiment, the lower side of the pre-motor filter may be the upstream side or alternately, the upper side may be the upstream side of the pre-motor filter (if a conduit such as the vortex finder extends through the pre-motor filter). An advantage of this design is that a header may be provided and the air will tend to distribute itself radially outwardly over the entire upstream surface of the pre-motor filter.

It will be appreciated by those skilled in the art that any of the features of the positioning of the pre-motor filter discussed herein may not be utilized with the dual dirt outlet design disclosed herein, but may be used by itself or in combination with any other feature disclosed herein.

In another embodiment, a pod or other hand carriable surface cleaning apparatus may be provided with a porous pre-motor filter media that is positioned above, laterally from or below the cyclone chamber and the vortex finder or an extension thereof may extend through the porous pre-motor filter media to the upstream side of the porous pre-motor filter media. The porous pre-motor filter media may be essentially coaxial with the vortex finder (e.g., the porous pre-motor filter media may overlie the cyclone chamber and be essentially centered above the cyclone chamber). It will be appreciated by those skilled in the art that any of the features of a porous pre-motor filter media with a conduit therethrough disclosed herein may not be utilized with the dual dirt outlet discussed herein, but may be used by itself or in combination with any other feature disclosed herein.

In one embodiment there is provided a hand carriable surface cleaning apparatus having a front end, a rear end and comprising:

(a) a dirty fluid inlet;

(b) a cyclone bin assembly comprising a cyclone chamber downstream of the dirty fluid inlet, the cyclone chamber comprising a lower end, an upper end, a cyclone axis, an air inlet and an air outlet at the upper end;

(c) a porous pre-motor filter media comprising an upstream side and a downstream side,

(d) a conduit in communication with the cyclone air outlet, extending through the porous pre-motor filter media and in communication with the upstream side of the porous pre-motor filter media;

(e) a suction motor positioned downstream of the porous pre-motor filter media and rearward of the cyclone bin assembly;

(f) an air flow path extending from the porous pre-motor filter media to the suction motor; and,

(g) a clean air outlet downstream of the suction motor.

In some embodiments, the porous pre-motor filter media may be positioned above the cyclone chamber and the upstream side is spaced further from the cyclone chamber than the downstream side.

In some embodiments, the cyclone air outlet may comprise a vortex finder and the conduit comprises an extension of the vortex finder.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise a downstream header on the downstream side of the porous pre-motor filter media. The air flow path may extend downstream from the downstream header.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise an upstream header on the upstream side of the porous pre-motor filter media. The upstream header may be openable.

In some embodiments, at least a portion of the upstream header may be transparent.

In some embodiments, the suction motor may have a suction motor inlet that is positioned between the lower and upper ends of the cyclone bin assembly.

In some embodiments, the suction motor may have a motor axis that is generally perpendicular to the cyclone axis.

In some embodiments, the suction motor may have a motor axis that is generally perpendicular to the cyclone axis.

In some embodiments, the air inlet may be provided at the upper end and the dirt outlet is provided at the lower end and a dirt collection chamber is positioned below the cyclone chamber.

In some embodiments, the air flow path motor may have a portion that is exterior to and extends part way along an exterior wall of the cyclone chamber to a suction motor inlet.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise a dirt collection chamber positioned exterior to the cyclone chamber. The air flow path may have a portion that extends part way along an exterior wall of the dirt collection chamber to a suction motor inlet.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise a handle, a suction motor housing and a porous pre-motor filter media housing positioned above the cyclone chamber. The handle may extend between the suction motor housing and the porous pre-motor filter media housing.

In some embodiments, the porous pre-motor filter media housing may be openable.

In some embodiments, the suction motor may have a motor axis that is generally perpendicular to the cyclone axis.

In some embodiments, the handle may have a suction motor housing end that is spaced rearward of the cyclone bin assembly and below the porous pre-motor filter media housing and a porous pre-motor filter media end that is spaced above and forward of the suction motor end of the handle.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise an opening having a perimeter. The perimeter may comprise portions of the handle, the pre-motor filer housing and the suction motor housing.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise a handle. A portion of the handle may be placed rearward of a centre of gravity of the hand carriable surface cleaning apparatus.

In some embodiments, the hand carriable surface cleaning apparatus may further comprise a bleed valve having an inlet end in the air flow path.

In some embodiments, the bleed valve may have an axis that is generally parallel to an axis of the suction motor.

According to another aspect, a hand surface cleaning apparatus is provided that may be operable for an enhanced period of time without a significant reduction is air flow into the dirty air inlet. In accordance with this aspect, a pre-motor filter with enhanced surface area transverse to the direction of air flow is provided.

Typically, a surface cleaning apparatus such as a hand vacuum cleaner has a pre-motor filter and a post motor filter. The post motor filter may be a HEPA filter. In such a case, the air discharged from the clean air outlet of the unit may be comparable to that discharged from a full size vacuum cleaner. As the HEPA filter is used, the air flow through the unit will decrease and the suction provided by the unit will decrease. This can impact upon the cleaning performance achieved by the vacuum cleaner. To counter this, a larger suction motor may be provided. However, that would increase the hand weight of the unit. A pre-motor filter reduces the level of entrained dirt that will reach the HEPA filter. However, the filter will become clogged with use. Increasing the surface area of the upstream side of the pre-motor filter extends the lifetime of the pre-motor filter and may therefore enhance the life of a post motor filter.

The pre-motor filter may have an enhanced surface area of its upstream side by configuring the pre-motor filter to have a larger upstream surface area then that of the suction motor inlet end. A pre-motor filter may be positioned in the suction motor casing and may therefore have a diameter that is about the same as the diameter of the fan of the suction motor. By configuring the pre-motor filter to overlie part of one or more additional components of the unit, the surface area of the upstream side is increased.

For example, a suction motor may be positioned beside a cyclone chamber and extend in the same direction of the cyclone chamber. Accordingly, one end of a cyclone chamber may be adjacent the inlet end of the suction motor (e.g., positioned in about the same plane). The pre-motor filter (preferably a foam filter and more preferably a foam filter with a felt filter downstream thereof) may be configured to overlie part or all of the cyclone chamber as well as part or all of the suction motor. Alternately, or in addition, the pre-motor filter may overlie part of the open volume between the suction motor and the cyclone chamber. If the dirt collection chamber is exterior to the cyclone chamber, e.g., it is positioned to occupy some of the open volume, then the pre-motor filter may alternately or in addition overlie part or all of the dirt collection chamber. Accordingly, a pre-motor filter with an enhanced surface area of the upstream side may be provided without substantially increasing the size of the unit. A filter with an enhanced size may be provided by providing a filter that overlies part or all of two or more of the suction motor, the dirt collection chamber and the cyclone chamber.

According to this aspect, a surface cleaning apparatus is provided. The hand surface cleaning apparatus comprises an air flow passage extending from a dirty air inlet to a clean air outlet. A suction motor is positioned in the air flow path and has an inlet end and an outlet end. At least one cyclone chamber is positioned in the air flow path and has an associated dirt collection chamber, a cyclone air inlet and a cyclone air outlet. A pre-motor filter is positioned downstream of the cyclone chamber and upstream of the suction motor. The pre-motor filter has an upstream side and a downstream side. The pre-motor filter overlies at least a portion of the suction motor and the cyclone chamber.

The cyclone chamber and the suction motor may be positioned side by side and may have generally parallel longitudinal axes.

The pre-motor filter may overlie at least half of the suction motor and the cyclone chamber. The pre-motor filter may overlie at least 75% of the suction motor and the cyclone chamber.

The pre-motor filter may have a portion that is centered over the suction motor and a portion that overlies at least half of the cyclone chamber.

The upstream side of the pre-motor filter may face the cyclone air outlet and an inlet duct of the suction motor may extend through the pre-motor filter to the downstream side of the pre-motor filter.

The cyclone air outlet may extend through the pre-motor filter to the upstream side of the pre-motor filter, and the inlet end of the suction motor may face the downstream side of the pre-motor filter.

The hand surface cleaning apparatus may further comprising an openable door positioned at a side of the hand vacuum cleaner having the cyclone air outlet and the inlet end of the suction motor. The upstream side of the pre-motor filter may be visible when the door is opened.

The pre-motor filter may be mounted to at least one of the cyclone chamber and the suction motor and the pre-motor filter may remain in position when the door is opened.

The pre-motor filter may be spaced from the door and a chamber may be provided between the pre-motor filter and the door.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The drawings included herewith are for illustrating various examples of articles, methods, and apparatuses of the teaching of the present specification and are not intended to limit the scope of what is taught in any way.

In the drawings:

FIG. **1** is a perspective view of an example of a hand held surface cleaning apparatus;

FIG. **2** is a perspective view of the surface cleaning apparatus of FIG. **1** attached to a cleaning tool;

FIG. **3** is a partially exploded perspective view of the surface cleaning apparatus of FIG. **1**;

FIG. **4** is another partially exploded perspective view of the surface cleaning apparatus of FIG. **1**;

FIG. **5** is bottom perspective view of the surface cleaning apparatus of FIG. **1** with the bottom door in an open position;

FIG. **6** is a cross sectional view of the surface cleaning apparatus of FIG. **1**, taken along line **6-6** in FIG. **1**;

FIG. **7** is the cross sectional view of FIG. **6** with the surface cleaning apparatus tilted forward;

FIG. **8** is the cross sectional view of FIG. **6** with the surface cleaning apparatus tilted backward;

FIG. **9** is a side view of the surface cleaning apparatus of FIG. **1**;

FIG. **10** is a side view of another embodiment of a surface cleaning apparatus with the cyclone bin assembly and handle removed for emptying;

FIG. **11** is a rear perspective view of the surface cleaning apparatus of FIG. **10**;

FIG. **12** is a schematic top plan representation of an example of a cyclone bin assembly;

FIG. **13** is a schematic top plan representation of another example of a cyclone bin assembly;

FIG. **14** is a schematic top plan representation of another example of a cyclone bin assembly;

FIG. **15** is a schematic top plan representation of another example of a cyclone bin assembly;

FIG. **16** is a cross sectional view of another embodiment of a surface cleaning apparatus;

FIG. **17** is a perspective view of another embodiment of a surface cleaning apparatus;

FIG. **18** is a perspective view of another embodiment of a surface cleaning apparatus;

FIG. **19** is a perspective view from the front of another embodiment of a surface cleaning apparatus;

FIG. **20** is another perspective view from the rear of the surface cleaning apparatus of FIG. **19**;

FIG. **21** is a partially exploded perspective view of the surface cleaning apparatus of FIG. **19**;

FIG. **22** is a perspective view of a portion of the surface cleaning apparatus of FIG. **19**;

FIG. **23** is a cross sectional view of the FIG. **22**, taken along line **23-23** in FIG. **22**;

FIG. **24** is the cross sectional view of FIG. **23** with a bottom door in an open position;

FIG. **25** is a bottom perspective view of the surface cleaning apparatus of FIG. **19**;

FIG. **26** is a cross sectional view of the surface cleaning apparatus of FIG. **19**, taken along line **26-26** in FIG. **19**;

FIG. **27** is a cross sectional view taken along line **27-27** in FIG. **19**;

FIG. **28** is a perspective view of the surface cleaning apparatus of FIG. **19** with a cover open;

FIG. **29** is the perspective view of FIG. **28** with a filter cartridge removed;

FIG. **30** is the perspective view of FIG. **29** with a filter removed from the filter cartridge;

FIG. **31** is a cross sectional view of a portion of another embodiment of a surface cleaning apparatus;

FIG. **32** is a cross sectional view of a portion of another embodiment of a surface cleaning apparatus;

FIG. **33** is the perspective view of FIG. **29** with a different embodiment of a filter cartridge; and,

FIG. **34** is a cross sectional view of the filter cartridge taken along line **34-34** in FIG. **33** with the filter cartridge in the surface cleaning apparatus.

FIG. **35** is a perspective illustration of an embodiment of a surface cleaning apparatus;

FIG. **36** is a cross section taken along line **2-2** in FIG. **35**;

FIG. **37** is a perspective illustration of the surface cleaning apparatus of FIG. **34**, showing a second openable door in an open configuration;

FIG. **37**A is a side plan view of the surface cleaning apparatus of FIG. **34**, showing a second openable door in an open configuration;

FIG. **37**B is a perspective illustration of the surface cleaning apparatus of FIG. **35** showing a first openable door in an open configuration;

FIG. **38** is a plan view of an alternate embodiment of a surface cleaning apparatus, showing a second openable door in an open configuration;

FIG. **38**B is a plan view of another alternate embodiment of a surface cleaning apparatus, showing a second openable door in an open configuration;

FIG. **39** is a cross section taken along the same line **2-2** through an alternate embodiment of a surface cleaning apparatus;

FIG. **40**A is a plan view of an alternate embodiment of a surface cleaning apparatus, showing a first openable door in an open configuration;

FIG. **40**B is a perspective illustration of the surface cleaning apparatus of FIG. **40**A;

FIG. **41** is a perspective illustration of an alternate embodiment of a surface cleaning apparatus;

FIG. **42** is a perspective illustration of the surface cleaning apparatus of FIG. **41**, with its cyclone bin assembly removed;

FIG. **43** is a perspective illustration of the cyclone bin assembly of FIG. **42**;

FIG. **44** is a section view taken along line **10-10** in FIG. **41**;

FIG. **45** is a perspective illustration of an alternate embodiment of a surface cleaning apparatus;

FIG. **46** is a perspective illustration of the surface cleaning apparatus of FIG. **45**, with its cyclone bin assembly removed;

FIG. **47** is a perspective illustration of the cyclone bin assembly of FIG. **45**, with one end wall in an open configuration;

FIG. **48** is a perspective illustration of the cyclone bin assembly of FIG. **47**, with the one end wall removed;

FIG. **49** is a partially exploded view of the surface cleaning apparatus of FIG. **45**; and

FIG. **50** is a section view taken along line **16-16** in FIG. **45**.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1**, an embodiment of a surface cleaning apparatus **900** is shown. In the embodiment illustrated, the surface cleaning apparatus **900** is a hand carriable or hand-held vacuum cleaner. It will be appreciated that surface cleaning apparatus **900** could be carried by a hand of a user, a shoulder strap or the like and could be in the form of a pod or other portable surface cleaning apparatus. Surface cleaning apparatus **900** could be a vacuum cleaner, an extractor or the like. All such surface cleaning apparatus are referred to herein as a hand carriable surface cleaning apparatus. Optionally, surface cleaning apparatus **900** could be removably mounted on a base so as to form, for example, an upright vacuum cleaner, a canister vacuum cleaner, a stick vac, a wet-dry vacuum cleaner and the like. Power can be supplied to the surface cleaning apparatus **900** by an electrical cord (not shown) that can be connected to a standard wall electrical outlet. Alternatively, or in addition, the power source for the surface cleaning apparatus can be an onboard energy storage device, including, for example, one or more batteries.

The surface cleaning apparatus **900** comprises a main body **901** having a handle **902**, a dirty air inlet **903**, a clean air outlet **904** (see for example FIG. **6**) and an air flow path extending therebetween. In the embodiment shown, the dirty air inlet **903** is the inlet end **905** of connector **906**. Optionally, the inlet end can be used to directly clean a surface. Alternatively, the inlet end **905** can be connected to the downstream end of any suitable hose, cleaning tool or accessory, including, for example a wand **907** that is pivotally connected to a surface cleaning head **908** (FIG. **2**), a nozzle and a flexible suction hose. In the configuration illustrated in FIG. **2**, the surface cleaning apparatus **900** can be used to clean a floor or other surface in a manner analogous to conventional upright-style vacuum cleaners.

Referring again to FIG. **1**, the connector **906** may be any suitable connector that is operable to connect to, and preferably detachably connect to, a hose, cleaning tool or other accessory. Optionally, in addition to providing an air flow

connection, the connector **906** may also include an electrical connection. Providing an electrical connection may allow cleaning tools and accessories that are coupled to the connector to be powered by the surface cleaning apparatus **900**. For example, the surface cleaning unit **900** can be used to provide both power and suction to a surface cleaning head, or other suitable tool. In the illustrated embodiment, the connector **906** includes an electrical coupling in the form of a female socket member **909**, and a corresponding male prong member may be provided on the hose, cleaning tool and/or accessory that is connected to inlet end **905**. Providing the female socket **909** on the electrified side of the electrical coupling may help prevent a user from inadvertently contacting the electrical contacts. In other embodiments, socket member **909** may include male connectors. In such a case, it is preferred that the male connectors are de-energized when exposed (i.e., they are not plugged into a female connector).

From the dirty air inlet **903**, the air flow path extends through an air treatment member. The air treatment member may be any suitable member that can treat the air in a desired manner, including, for example, removing dirt particles and debris from the air. In the illustrated example, the air treatment member includes a cyclone bin assembly **910**. Alternatively, the air treatment member can comprise a bag, a filter or other air treating means. In the illustrated embodiment, the cyclone bin assembly forms part of the main body **901** of the surface cleaning apparatus. A suction motor **911** (see FIG. **6**) is mounted within a motor housing **912** portion of the main body **901** and is in fluid communication with the cyclone bin assembly **910**. In this configuration, the suction motor **911** is downstream from the cyclone bin assembly **910** and the clean air outlet **904** is downstream from the suction motor **911**.

Cyclone Bin Assembly

The following is a description of a cyclone and a cyclone bin assembly that may be used by itself in any surface cleaning apparatus or in any combination or sub-combination with any other feature or features disclosed herein.

Referring to FIGS. **5** and **6**, in the illustrated embodiment, the cyclone bin assembly **910** includes a cyclone chamber **913** and a dirt collection chamber **914**. The cyclone chamber **913** and the dirt collection chamber **914** may be of any suitable configuration.

In the illustrated embodiment the dirt collection chamber **914** is positioned outside or exterior to and substantially below the cyclone chamber **913**. Preferably, a least a portion, if not all, of the dirt collection chamber is below the cyclone chamber. The dirt collection chamber **914** comprises a sidewall **915**, a first end wall **916** and an opposed second end wall **917**. The dirt collection chamber **914** extends along a dirt collection axis **918**.

The dirt collection chamber **914** may be emptyable by any means known in the art and is preferably openable concurrently with the cyclone chamber **913**. Preferably, the second dirt collection chamber end wall **917** is moveably (e.g., pivotally) connected to e.g., the dirt collection chamber sidewall **915**, for example using hinge **919**. In this configuration, the second dirt collection chamber end wall **917** functions as an openable door to empty the dirt collection chamber **914** and can be opened as shown in FIG. **5** to empty dirt and debris from the interior of the dirt collection chamber **914**. The second dirt collection chamber end wall **917** can be retained in the closed position by any means known in the art, such as by a releasable latch **919***a*. In the illustrated example, the hinge **919** is provided on a back edge of the end wall **917** and the latch **919***a* is provided at the front of the end wall **917** so that the door swings backwardly when opened. Alternatively, the hinge and latch may be in different positions, and the door may open in a different direction or manner. Optionally, instead of being pivotal or openable, the end wall may be removable.

In the embodiment shown, the cyclone chamber **913** extends along a cyclone axis **920** and is bounded by a sidewall **921**. The cyclone chamber **913** includes an air inlet **922** and an air outlet **923** and two dirt outlets **924***a* and **924***b* in communication with the dirt collection chamber **914**. The air inlet, air outlet and dirt outlets may be of any design known in the art. Preferably, the air inlet **922** is generally tangentially oriented relative to the sidewall **921**, so that air entering the cyclone chamber **913** will tend to swirl and circulate within the cyclone chamber **913**, thereby disentraining dirt and debris from the air flow, before leaving the chamber via the air outlet **923**. The air inlet **922** extends along an inlet axis **925** that may be generally perpendicular to the cyclone axis **920**, and in the illustrated example is generally parallel to and offset above a suction motor axis **926**.

In the illustrated example, the cyclone air outlet **923** comprises a conduit member or vortex finder **927**. Optionally, a screen **928** can be positioned over the vortex finder **927** to help filter lint, fluff and other fine debris. Preferably, the screen **928** can be removable. Optionally, the screen **928** can be tapered such that the distal, inner or free end **930** of the screen **928** has a smaller diameter **931** than the diameter **932** at the base **933** of the screen **928** and/or the air inlet **922**.

Optionally, the screen **928** can be configured so that the diameter **931** of the free end **930** of the screen is between about 60% and about 100% of the diameter **932** of the base **933** of the screen **928** and/or the air inlet **922**, and may be between about 60%-90%, about 70-80% and preferably is between about 63-67% of the base diameter **932** and/or the air inlet **922**.

The air inlet **922** has an inlet diameter **934**, and a related inlet flow cross-sectional area (measure in a plane **935** perpendicular to the inlet axis **925**). Preferably, the air outlet **923** is sized so that the diameter **936** of the air outlet **923**, and therefore the corresponding flow area of the air outlet, is the same as the diameter **934** of the air inlet **922**. Alternatively, the air outlet diameter **936** may be between about 50% and about 150%, and between about 85-115% of the air inlet diameter **934**.

In the example illustrated the cyclone bin assembly **910** and the cyclone chamber **913** are arranged in a generally vertical, inverted cyclone configuration. In this configuration, the air inlet **922** and the air outlet **923** are provided toward the upper end of the cyclone chamber **913**. Alternatively, the cyclone bin assembly **910** and cyclone chamber **913** can be provided in another orientation, including, for example, as a horizontal cyclone or in other configurations, e.g., with the dirt collection chamber beside the cyclone chamber and/or with the inlet and outlets at differing positions.

Optionally, some or all of the sidewall **921** can coincide with portions of the external sidewalls of the cyclone bin assembly **910** and the dirt collection chamber sidewall **915** (see FIGS. **5** and **6**). This may help reduce the overall size of the cyclone bin assembly. Alternative, the sidewall **921** may be distinct from the sidewalls. In alternative embodiments, the cyclone chamber **915** may include only a single dirt outlet **924**, or more than two dirt outlets.

Referring to FIG. **7**, in the illustrated embodiment, the cyclone chamber **913** includes a first or upper end wall **937**. The end wall **937** is connected to the upper end of the

sidewall **921** to enclose the upper end of the cyclone chamber **913**. In the illustrated example, a juncture **938** between the end wall **937** and the side wall **921** includes a curved surface **939**. The radius **940** of the curved surface **939** may be selected to be similar to the radius (i.e. half of the diameter **934**) of the air inlet **922**, and optionally may be selected so that the juncture surface **939** has the same radius as the air inlet.

Optionally, the juncture **941** between the end wall **937** and the vortex finder **927** may also be curved, and preferably is sized to have a radius **942** that is similar to or is the same as the radius **940** of the juncture between the end wall **937** and the sidewall **921**. Providing curved surfaces at one or both of the junctures **938**, **941** may help reduce backpressure and may help improve cyclone efficiency. Optionally, the upper end wall **937** of the cyclone chamber **913** can be openable or removable to allow access to the interior of the cyclone chamber **913** from above.

Referring also to FIG. **5**, a deflector or arrestor plate **943** may be positioned at the lower end of the cyclone chamber **913**, at the interface between the cyclone chamber **913** and the dirt collection chamber **917**. The arrestor plate **943** is preferably sized to cover substantially all of the lower end of the cyclone chamber **913**, and to abut the lower end of the cyclone sidewall **921** to form a lower end wall of the cyclone chamber. When the arrestor plate **943** abuts the lower ends of the sidewall **921** it helps define the gaps or slots that form the dirt outlets **924***a*, **924***b*. In this configuration, the dirt outlet slots **924***a*, **924***b* are bound on three sides by the cyclone chamber sidewall **921** and on a fourth side by the arrestor plate **943**. Alternatively, the dirt outlet slots **924***a*, **924***b* may be entirely bounded by the sidewall **921** and may be spaced apart from the arrestor plate **943**. In the illustrated example the dirt outlets **924***a*, **924***b* are vertically spaced apart from the air inlet **922** and air outlet **923** and are positioned at the opposite, lower end of the cyclone chamber **913**.

In the illustrated embodiment, the arrestor plate **943** forms the bottom of the cyclone chamber and may be of any suitable configuration. Optionally the arrestor plate **943** may be fixed in its position adjacent the sidewall **921**, or may be moveable or openable. Providing an openable arrestor plate **943** may help facilitate emptying of the cyclone chamber **913**. Optionally, the arrestor plate **943** may be openable concurrently with another portion of the surface cleaning apparatus, including, for example, the dirt collection chamber **917**.

In the illustrated embodiment, the arrestor plate **943** is mounted to and supported spaced from the openable wall **917** by a support member **944**. The support member **944** may be of any suitable configuration and may be formed from any suitable material that is capable of supporting the arrestor plate **943** and resisting stresses exerted on the arrestor plate **943** by the air flow in the cyclone chamber or dirt particles exiting the cyclone chamber **913**. In this configuration, the arrestor plate **943** is openable concurrently with the end wall **917**, so that opening the end wall **917** simultaneously opens the dirt collection chamber **914** and the cyclone chamber **913**. Alternatively, the arrestor plate **943** may be mounted to the sidewall **921** (or other portion of the surface cleaning apparatus) and need not open in unison with the end wall **917**.

Referring to FIG. **8**, each dirt outlet **924***a* and **924***b* is a slot that includes an upper edge **945** and a lower edge **946** spaced apart from each other by a slot height **947**, measured axially. The slot height **947** may be any suitable distance, including for example, between 1 mm and 49 mm or more, and preferably is between about 3 mm and about 25 mm. Each slot **924***a*, **924***b* also includes two side edges **948** (FIG. **5**) spaced apart by a slot width **949**, measured along the perimeter of the cyclone chamber sidewall **921**. Each slot width may be between about 5% and about 50% of the perimeter of the cyclone chamber sidewall **921**, and preferably may be between about 10% and about 35% and may be about 25%. In the illustrated embodiment the cyclone chamber sidewall **921** is circular in axial cross-sectional shape, and the angle **950** (FIG. **5**) subtended by the dirt outlet **924***b* may between about 20° and about 180°, and may be between about 35° and 125°, and between about 45° and 90°. In the illustrated embodiment the angle **951** between the dirt outlets **924***a* and **924***b*, measured from the centre line of the slots (FIG. **5**) is 180°. Optionally, the dirt outlets **924***a*, **924***b* may be generally identical. Alternatively, the dirt outlets **924***a* and **924***b* may be of different configurations (i.e. may have different heights and/or widths). Optionally, slot **924***a*, which is at the same end as the cyclone air inlet, is smaller than the opposed dirt outlet **924***b* and may be about half the size.

Referring to FIG. **12**, a cross-sectional schematic representation of an alternate embodiment of a cyclone bin assembly **2910** is shown. The cyclone bin assembly **2910** is generally similar to cyclone bin assembly **910** and analogous features are indicated using like reference characters indexed by 2000. This schematic illustrates a top view of an example of a circular cyclone chamber **2913** positioned within a generally square dirt collection chamber **2914**. The cyclone chamber **2913** includes a tangential air inlet **2922** and an air outlet **2923**. Two dirt outlets **2924***a* and **2924***b* are provided in the cyclone chamber sidewall **2921**. The angle **2951** between the dirt outlets **2924***a*, **2924***b* is about 180°. In this embodiment, the angle **2952** between the air inlet **2922** (measured from the point of tangential intersection between the air inlet and the cyclone chamber sidewall **2921**) and the first dirt slot **2924***a*, in the direction of air circulation (arrow **2953**), is approximately 90°, and the angle **2952***b* between the air inlet **2922** and the second dirt slot **2924***b* is about 270°. Alternatively, angles **2952***a* and **2952***b* may be different.

In the illustrated configuration, each slot subtends an angle **2950***a*, **2950***b* that is about 45°, the leading edge (in the direction of air circulation) of dirt slot **2924***a* is aligned with the leading edge of dirt slot **2924***b*, and the trailing edge (in the direction of air circulation) of dirt slot **2924***a* is aligned with the trailing edge of dirt slot **2924***b*.

Referring to FIG. **13**, a cross-sectional schematic representation of another alternate embodiment of a cyclone bin assembly **3910** is shown. Cyclone bin assembly **3910** is generally similar to cyclone bin assembly **910**, and analogous features are identified using like reference characters indexed by 3000. This embodiment is similar to the embodiment of FIG. **12**, except that the position of the dirt outlets **3924***a* and **3924***b* has been shifted by 90° relative to the air inlet **3922**. In this configuration, the angle **3951** between the dirt outlets **3924***a*, **3924***b* remains 180°, but the angle between the dirt outlet **3924***a* and the air inlet is 0° and the angle **3952***b* between the dirt outlet **3924***b* and the air inlet is 1800.

Referring to FIG. **14**, a cross-sectional schematic representation of another alternate embodiment of a cyclone bin assembly is shown. Cyclone bin assembly **4910** is generally similar to cyclone bin assembly **910**, and analogous features are identified using like reference characters indexed by 4000. In this example, the individual dirt slots **4924***a* and **4924***b* have the same configuration as the slots illustrated in

FIGS. **12** and **13**, but are positioned differently. In this configuration, the first dirt slot **4924***a* is positioned generally adjacent the air inlet **4922**, and the angle **4952***a* between the air inlet **4922** and the first dirt slot **4924***a* is about 30° downstream from the air inlet, and the angle **4952***b* between the first dirt slot and the second dirt slot **4924***b* is about 90°. In this configuration, both dirt slots **4924***a* and **4924***b* are positioned on the same side of the cyclone chamber **4913** (i.e. within 180° of each other).

Referring to FIG. **15**, a cross-sectional schematic representation of another alternate embodiment of a cyclone bin assembly is shown. Cyclone bin assembly **5910** is generally similar to cyclone bin assembly **910**, and analogous features are identified using like reference characters indexed by 5000. In this example, the dirt slots **5924***a* and **5924***b* are opposite each other (i.e. the angle **5951** is about 180°) but each dirt slot **5942***a* and **5924***b* is much wider than the other illustrated examples, such that the angles **5950***a* and **5950***b* subtended by each dirt slot is about 150°. In this configuration, the dirt slots **5942***a* and **5924***b* represent more than 50% of the total perimeter of the cyclone chamber **5913**. Also in this embodiment, portions of the cyclone chamber sidewall **5921** are coincident with the dirt collection chamber sidewalls **5916**. Optionally, if the cyclone chamber walls **5921** extend the entire height of the dirt collection chamber **5914**, in this configuration the cyclone chamber **5913** may sub-divide the dirt collection chamber **5914** into two different portions **5914***a* and **5914***b*, separated by the cyclone chamber **5913**. Each dirt collection region **5914***a* and **5914***b* is in communication with a respective one of the dirt slots **5942***a* and **5924***b*. Also, in this illustrated embodiment, the air inlet axis **5925** is not tangentially oriented (i.e. is not parallel to a tangential plane **5954**). Instead, the air inlet **5922** is arranged at an angle **5955**, relative to the tangential plane **5954**. This may alter the characteristics of the air flow entering the cyclone chamber.

Referring again to FIG. **7**, in the illustrated embodiment the dirt outlets **924***a* and **924***b* are arranged generally opposite each other, are arranged at approximately 180° from each other (measured as a centre-to-centre angle **951** in FIG. **5**). In this configuration, dirt outlet **924***a* is positioned at the front of the cyclone chamber **913** (e.g. in a portion of the sidewall that is located toward the connector and air inlet) and the dirt outlet **924***b* is positioned at the back of the cyclone chamber **913**. When the surface cleaning apparatus **900** is in use, dirt and debris may accumulate within the dirt collection chamber **914** and when the surface cleaning apparatus is manipulated by a user, dirt within the dirt collection **914** chamber may tend to shift and may collect toward the lowest portion of the dirt collection **914** chamber due to gravity. For example, when the surface cleaning apparatus is tipper forward, so that the connector is angled downward and the handle is lifted (FIG. **7**), dirt **956** may tend to collect toward the front of the dirt collection chamber **914**. If the level of the dirt **956** is sufficiently high it may partially or completely block the front dirt outlet **924***a* as illustrated. In this configuration the first dirt outlet **924***a* may be blocked, but the rear dirt outlet **924***b* remains free. Similarly, if the surface cleaning apparatus is tipped rearward, the dirt may tend to collect in a rear portion of the dirt collection chamber (FIG. **8**) and may partially or completely block the rear dirt outlet **924***b*. In this configuration the rear dirt outlet **924***b* is blocked, but the front dirt outlet **924***a* is free. Providing two dirt outlets **924***a* and **924***b* on opposite sides of the cyclone chamber may help ensure that at least one outlet **924***a* and **924***b* remains free and unblocked to allow dirt to exit the cyclone chamber **913** even if the surface cleaning apparatus **900** is tilted forward or backward. Alternatively, instead of being provided toward the front and back of the cyclone chamber, the dirt slots may be positioned in other locations. For example, the cyclone chamber may be configured to have a rear dirt outlet and a side dirt outlet, or two side outlets provided toward the left and right sides of the cyclone chamber.

Pre-Motor Filter

Optionally, one or more pre-motor filters may be placed in the air flow path between the cyclone bin assembly and the suction motor. Alternatively, or in addition, one or more post-motor filters may be provided downstream from the suction motor. The following is a description of a pre-motor filter housing construction that may be used by itself in any surface cleaning apparatus or in any combination or sub-combination with any other feature or features disclosed herein.

Reference is now made to FIGS. **3**, **36**, **39**, **40**A, **44**, and **49**, which illustrate surface cleaning apparatus **900**, **200**, **800**, **1000**, **1100**, and **2100**, respectively in accordance with several embodiments. In the illustrated embodiments, a pre-motor filter chamber or housing **956**, **241**, **841**, **1041**, **1186**, **2248** is provided as a portion of the body or main housing **901**, **220**, **820**, **1020**, **1112**, **2112** of the surface cleaning apparatus **900**, **200**, **800**, **1000**, **1100**, and **2100**, respectively. Pre-motor filter chamber **956** of apparatus **900** is positioned above the cyclone bin assembly **910**. Pre-motor filter chamber **241**, **841**, **1041**, **2248** of apparatus **200**, **800**, **1000**, **2100** is positioned laterally of the cyclone bin assembly **262**, **862**, **1062**, **2110**. Pre-motor filter chamber **1186** of apparatus **1100** is positioned below cyclone bin assembly **1110**. In all cases, the longitudinal axis of the cyclone chamber extends through the pre-motor filter chamber. Referring also to FIG. **4**, the pre-motor filter chamber **956**, **241**, **841**, **1041**, **1186**, **2248** is bounded by a bottom wall **957**, a sidewall **958** and an upper wall **958***a*. In the illustrated example the upper wall **958***a* is provided by an upper cover **959**. Preferably, at least one of the bottom wall, sidewall and upper cover are openable to allow access to the interior of the pre-motor filter chamber. In the illustrated embodiments, a panel such as the upper cover **959** (see e.g., FIG. **3**) or the side panel (see e.g., FIG. **37**) is removable to provide access to the interior of the chamber **956**, the panel may be removable or it may be pivotally openable or otherwise moveably coupled to the main body.

One or more filters may be positioned within the pre-motor filter chamber **956** to filter fine particles from the air stream exiting the air outlet, before it flows into inlet of the suction motor. The filters may be of any suitable configuration and formed from any suitable materials. In the illustrated embodiment, a foam filter **960** and a downstream felt filter **961** are positioned within the pre-motor filter chamber **956**.

In the illustrated example of FIG. **4**, the bottom wall **957** includes a plurality of upstanding support ribs **962** to support the filters **960**, **961** positioned within the chamber **956**. The support ribs **962** may hold the filters **960**, **961** above the surface **963** of the bottom wall **957** to define a lower header or headspace **964**, to allow for air to flow laterally between the bottom surface **965** of filter **961** and the bottom wall **957**. In the illustrated embodiment, the lower or downstream headspace **964** is defined between the outer surface **965** of the felt **961** and the surface **963** of the bottom wall **957**. See also the embodiment of FIG. **25**.

To help reduce the overall size of the surface cleaning apparatus, in the illustrated embodiment the pre-motor filter chamber **956**, and the filters therein **960**, **961**, is positioned

above the cyclone chamber **913** and covers the upper end of the cyclone chamber **913**. In this configuration, a plane **966** containing the foam filter **960** is generally parallel and spaced above a plane **967** containing the air outlet **923** of the cyclone chamber **913**, and both planes **966**, **967** are generally perpendicular to the cyclone axis **920**. Arranging the filters in this configuration results in the upstream side of the pre-motor filter (in this example the upper side **968** of the foam filter **960**) being spaced further apart from the cyclone chamber **913** than the downstream side of the pre-motor filter (in this example the lower surface **965** of the felt filter **961**). Alternatively, in other embodiments, the pre-motor filter chamber may cover only a portion of the upper end of the cyclone chamber and/or may be laterally spaced apart from the cyclone chamber and/or may be inclined with respect to plane **967**. Similar configurations may be used when the filter is positioned laterally from the cyclone chamber as exemplified in FIGS. **36** and **49** or below the cyclone chamber as exemplified in FIG. **44**.

In the illustrated embodiment, the pre-motor filter chamber or downstream header **956** is configured so that the upstream side **968** of the foam filter **960** is provided toward the top of the chamber, and air flows generally downwardly through the filters. In this configuration, the upper cover **959** is shaped so that when it is closed (FIG. **8**) an upper or upstream headspace or header **970** is provided between the inner surface of the upper cover **959** and the upstream side **968** of the foam filter **960**. To provide air flow communication between the cyclone air outlet **923** and the upstream headspace **970**, it is preferred that the vortex finder **927** or an extension thereof extends through the pre-motor filters and preferably extends into the interior of the pre-motor filter chamber **956**, through the filters **960**, **961** therein, and has an outlet end **971** that is located within the upstream head space **970** and above filters **960**, **961**. To accommodate the extension of the vortex finder **927**, each filter includes a correspondingly shaped conduit aperture **972** (FIG. **4**). Similarly, as exemplified in FIGS. **36** and **49**, the upstream side of the foam filter may be provided toward the outer lateral side of the pre-motor filter chamber and the air may flow laterally inwardly through the pre-motor filter (see e.g., air outlet **264** of FIG. **36**) or the upstream side of the foam filter may be provided toward the bottom of the pre-motor filter chamber and the air may flow upwardly through the pre-motor filter (see e.g., air outlet **1230** of FIG. **44**). It will be appreciated that other flow paths may be used to connect vortex finder **927** in air communication with upstream headspace **970**.

When the surface cleaning apparatus is in use, air exiting the cyclone chamber **913** may flow into the upstream head space **956** via the vortex finder **927**. See also air outlet **264** of FIG. **36** and air outlet **1230** of FIG. **44**). Within the upstream headspace the air can flow laterally across the upstream surface **968** of the foam filter **960**, and down through the filters **960**, **961** into the downstream head space **964**.

In this configuration, the upper side **988** of the foam filter **960** is exposed to the dirty air exiting the cyclone air outlet **923**, and may become dirty or soiled during use. Optionally, the upper cover **959** may include at least one transparent region overlying the upper side **968** of the filter **960**. For example, some or all of the upper cover may be formed from a transparent material (such as plastic) or one or more windows may be provided within the upper cover member. Providing a transparent region allows a user to visually inspect the condition of the upstream side **698** of the filter **960** without having to open the upper cover **959**. Alternatively, the upper cover **959** need not include any type of transparent portion or inspection region, and a user may inspect the upstream side **968** of the filter **960** when the upper cover **959** is opened or removed.

Alternatively, the pre-motor filter may be provided laterally from the vortex finder. For example, referring to FIG. **16**, a cross sectional view of another embodiment of a surface cleaning apparatus **6900** is shown. Apparatus **6900** is similar to apparatus **900**, and analogous features are identified using like reference numerals indexed by 6000. In this embodiment, the pre-motor filter **6960** is spaced laterally from the vortex finder **6927**. An extension **6927***a* of the vortex finder extends above the top of filter **6960** to define a dirt collection area, which may be emptied when the lid is opened and the surface cleaning apparatus is inverted.

A more detailed discussion of the embodiments of FIGS. **36**, **39**, **40**A, **44**, and **49** follows the discussion of the embodiment of FIG. **3**.

Downflow Conduit

Optionally, the inlet of the suction motor is positioned along the length of one side (preferably the rear side) of the cyclone bin assembly. The following is a description of a flow path that may be used by itself in any surface cleaning apparatus or in any combination or sub-combination with any other feature or features disclosed herein.

The suction motor preferably has an axis that is generally perpendicular to the cyclone axis and has an air inlet between the upper end and lower end of the cyclone bin assembly and preferably, between the upper end and the lower end of the cyclone chamber. Accordingly, from the downstream head space **964**, the air may flow to the inlet **973** of the suction motor **911** via an internal air conduit **974** formed within the body **901**. Air may be drawn through the suction motor **911** and then be exhausted from a motor outlet **975**, and expelled via the clear air outlet **904** (see also FIG. **6**).

In the illustrated embodiment, the internal air conduit **974** is formed within the main body **901** and is external the cyclone chamber **913** and the dirt collection chamber **914** and is partially bounded by an exterior surface of the cyclone chamber sidewall **921** and an exterior surface of the dirt collection chamber sidewall **915**. The air conduit **974** extends generally vertically between the pre-motor filter chamber **956** and the suction motor **911**, and is positioned laterally intermediate the suction motor **911** and the cyclone chamber **913**. The suction motor **911** is positioned at an elevation where its air inlet **973** is vertically between the upper and lower ends of the cyclone chamber **913**, and the motor axis **926** passes through the cyclone chamber **913** (above the dirt collection chamber—see FIG. **6**). In the illustrated embodiment the inlet axis **925** intersects the air conduit **974** and is positioned below and does not intersect the pre-motor filter chamber **956**.

The internal air conduit **974** may extend downwardly at an angle to the vertical. It may or may not be bounded on one side by the sidewall of the cyclone chamber and/or the dirt collection chamber.

Bleed Valve

Optionally, a bleed valve **976** may be provided to supply bleed air to the suction motor inlet **973** in case of a clog in the air flow path upstream from the suction motor **911**. When the surface cleaning apparatus is in use, the air flow path may become clogged or otherwise blocked in a number of different ways, including, for example if a cleaning wand and/or suction hose becomes blocked with debris, if the cyclone chamber becomes fouled with debris and/or if the pre-motor filters are soiled to an extent that it significantly

impedes airflow through the filters. Preferably the bleed valve **976** can be positioned and configured to supply bleed air into the airflow path at a location that is upstream from the suction motor inlet **973** and downstream from the likely clog or blockage locations.

The following is a description of the positioning and orientation of a bleed valve that may be used by itself in any surface cleaning apparatus or in any combination or sub-combination with any other feature or features disclosed herein.

For example, the bleed valve **976** may be positioned to supply bleed air to the air flow path **974** between the pre-motor filter chamber **956** and the suction motor inlet **973**. The bleed valve **976** may be any suitable valve, including a pressure sensitive valve that is opened automatically when there is a blockage in the air flow path upstream from the suction motor **911**.

In the illustrated embodiment, the bleed valve **976** extends along a valve axis **977** that is generally parallel to the suction motor axis **926**, and is generally orthogonal to the cyclone axis **920**. To provide outside air, a port **978** is provided in the main body **901**, in air flow communication with the inlet end of the bleed valve **976**. The outlet end of the bleed valve is in communication with the air conduit **974**.

In the illustrated embodiment, the bleed valve **976** is located at an elevation between the pre-motor filter chamber **956** and the suction motor **911**, partially laterally underlies the pre-motor filter chamber **956** (and the filters **960**, **961** therein) and partially laterally overlies the suction motor **911** and its housing **912**. Alternatively, the bleed valve **976** may be located at a different elevation (for example below the suction motor and/or in line with or above the pre-motor filter chamber) and need not laterally overlap the suction motor, pre-motor filter chambers or the filters therein.

Alternatively, instead of extending laterally through the main body of the surface cleaning apparatus, the bleed valve may be provided in a different location. Referring to FIG. **16**, a cross sectional view of another embodiment of a surface cleaning apparatus **6900** is shown. Apparatus **6900** is similar to apparatus **900**, and analogous features are identified using like reference numerals indexed by 6000. In this embodiment, the bleed valve **6976** is positioned within the pre-motor filter chamber **6956** and is generally vertically oriented, along axis **6977**. In the illustrated example, the bleed valve **6976** is generally co-axial with the cyclone chamber **6913**. To supply outside air to the bleed valve, a port **6978** is provided in the upper cover **6959** of the pre-motor filter housing **6956** and is in air flow communication with the inlet end of the bleed valve **6976**. The outlet end of the bleed valve **6976** is in air flow communication with the air conduit **6974** via a conduit **6979** or optionally via the downstream headspace **6964**, to supply the outside air to the suction motor in the event that the pre-motor filters are blocked. The conduit **6979** can be any suitable conduit and can be sized to supply a desired quantity of air to the suction motor **6911**.

Handle

Optionally, the surface cleaning apparatus may be provided with one or more handles to allow a user to grasp and manipulate the surface cleaning apparatus. Each handle may have one or more grip portions and may be configured to allow the user to grasp the handle in one or more configurations and/or orientations. Providing a generally upright or pistol-grip style handle may allow a user to grasp the surface cleaning apparatus while keeping his/her wrist in a comfortable, ergonomic position.

The following is a description of the positioning and orientation of a handle that may be used by itself in any surface cleaning apparatus or in any combination or sub-combination with any other feature or features disclosed herein.

Referring to FIG. **9**, in the illustrated embodiment, handle **902** is configured as a generally upright handle and includes a grip portion **980** that is configured as a pistol-grip style handle. The handle **902** has a first or bottom end **981** that is adjacent the suction motor housing **912** (e.g., the upper surface thereof) and a second or upper end **982** that is spaced above from the lower end **981**. The upper end **981** of the handle may be adjacent the rear side wall of the housing of the pre-motor filter chamber **956** or may be attached to bridge portion that extends rearwardly from the pre-motor filter housing.

The hand grip portion **980** may extend along a handle axis **983**. In the illustrated embodiment, the handle axis **983** is inclined slightly forwardly, and forms and angle **983***a*, relative to a vertical axis. The angle **983***a* can be any suitable angle, and preferably is between about 0-45°, and may be between about 20-35°. The handle axis **983** intersects the cyclone axis, the suction motor axis **926** and suction motor housing **912** and a bridge portion **901***a* of the main body that is an extension of the pre-motor filter housing **956**.

When grasping the hand grip portion **980**, a user's fingers may pass through an opening **984** in front of the hand grip portion **980**. In the illustrated embodiment, the perimeter of the opening **984** is formed by an upper portion **912***a* (FIG. **7**) of the suction motor housing **912**, the front surface **980***a* of the hand grip portion **980**, a rear portion of the pre-motor filter chamber sidewall **958** and connecting portions of the main body. Optionally, the air inlet port for the bleed valve **976** may be formed in one of the surfaces forming the perimeter of the handle opening **984**.

Preferably, the primary on/off power switch for the surface cleaning apparatus is positioned proximate the handle **902**, so that a user may turn the vacuum cleaner on or off while holding it by the handle **902**. Referring to FIGS. **4** and **7**, in the illustrated embodiment, the primary power switch **985** is provided on the upper end of the handle **902** and is configured so that it can be pressed by the thumb of a user while holding the hand grip portion **980**. The hand grip portion **980** can include an internal passage for routing electrical wires or mechanical linkages to provide communication between the primary power switch and the electrical circuit powering the suction motor **911**. Optionally, the primary power switch **985** can be positioned so that it is intersected by the handle axis **9083**. Alternatively, the primary power switch **985** may be provided at another suitable location.

Optionally, the handle **902** can be positioned so that the hand weight of the surface cleaning apparatus when held in a horizontally disposed position (e.g., axis **988** is horizontal) is less than 2 lbs, preferably less than 1 lbs and more preferably about 0 lbs, thereby reducing the stress on a user's wrist. Accordingly, the user may experience only a slight down force even though the motor is below the handle. The handle **902** may accordingly be positioned so that it is behind the centre of gravity of the surface cleaning apparatus. Preferably, the handle may also be configured so that all or a portion of it (e.g., the portion gripped by a user) is located at a higher elevation than the centre of gravity.

Positioning the handle behind and optionally above the centre of gravity may result in the surface cleaning apparatus tending to tip forwardly when being held horizontally by a user. This may tend to rotate the front of the surface cleaning

apparatus downwardly when the surface cleaning apparatus is in use and may allow at least a portion of the weight of the surface cleaning apparatus to be carried by a surface cleaning head (or other tool) that rollingly contacts the floor.

For example, referring to FIG. **9**, in the embodiment illustrated, the centre of gravity **986** is located in a vertical plane **987** that is forward of the handle and horizontal plane **988** that lies below the lower end **981** of the handle **902**. In the illustrated embodiment the handle axis **983** does not intersect the centre of gravity of the surface cleaning apparatus.

Detachable Motor Housing

The following is a description of detachable motor housing may be used by itself in any surface cleaning apparatus or in any combination or sub-combination with any other feature or features disclosed herein.

Optionally, the suction motor and at least a portion of its surrounding motor housing may be detachable from the main body of the surface cleaning apparatus. Referring to FIGS. **10** and **11**, an alternate embodiment of a surface cleaning apparatus **7900** is shown. Apparatus **7900** is generally similar to apparatus **900** and analogous features are identified using like reference characters indexed by 7000. In this embodiment the suction motor housing **7912** can be detachably connected to the main body **7901**, so that the suction motor housing **7912**, and the suction motor therein, can be separated from the cyclone bin assembly **7910**, handle **7902** and, preferably, pre-motor filter housing **7956**. The suction motor and related electrical components may form a significant portion of the weight of the surface cleaning apparatus **7900**. Separating the suction motor housing **7912** from the main body **7901** may allow a user to manipulate the main body **7901** and empty the dirt collection chamber **7914** and cyclone **7913** using the handle **7902** without having to carry around the extra weight of the suction motor.

The detachable suction motor housing module **7912** may removably coupled to the main body **7901** using any suitable attachment mechanisms. In the illustrated embodiment the attachment mechanism is a latch **7990** that can be triggered by a user. In this embodiment, the suction motor module **7912** includes an air inlet port **7991** that is configured to be coupled to a reciprocal air outlet port **7992** on the main body **7901**. The ports **7991**, **7992** may be of any compatible configurations, and one or more seals or gasket members may be provided at their interface to help provide an air-tight connection.

If the primary on/off switch **7985** is provided on the main body portion (as described above) in addition to the air flow connection, the suction motor module **7912** also includes at least one control/electrical connection that is configured to mate with a corresponding control port on the main body **7901**. In the illustrated example, the on/off switch **7985** on the main body **7901** is an electrical switch, and the control connection between the suction motor module **7912** and the main body includes mating electrical connectors (e.g., male prongs **7993** and a female electrical socket **7994**) to supply electricity to the switch **7985**. Alternatively, primary on/off switch **7985** may be a mechanical switch that is connected to the suction motor module via a mechanical linkage. In such a configuration, the control connection can include a mechanical linkage to translate movements of the on/off switch to open and close an electrical circuit in the suction motor housing. Alternatively, control signals may be transmitted wireless (e.g. via radio signal) or in any other suitable manner between the on/off switch and the suction motor housing. In such configurations, the suction motor module and the main body need not include a physical control connection.

Optionally, the surface cleaning apparatus **7900** can be configured so that most or all of the electrical components are located within the suction motor housing **7912**. In such a configuration, when the motor housing **7912** is separated from the main body **7901**, substantially all of the components remaining in the main body **7901** may be washed without exposing the suction motor and other electrical components to water or other cleaning materials. This may help prevent inadvertent damage to the electrical components when washing the surface cleaning apparatus **7900**.

The Surface Cleaning Apparatus

Optionally, instead of a hand-held or carriable surface cleaning apparatus, the surface cleaning apparatus may be an upright-style surface cleaning apparatus or a canister-style cleaning apparatus that includes a cyclone bin assembly having some or all of the features described herein. Referring to FIG. **17**, an alternate embodiment of a surface cleaning apparatus **8900** is shown. Apparatus **8900** includes a dirty air inlet **8903**, a clean air outlet **8904** and a cyclone bin assembly **8910** mounted to a suction motor housing **8912**. A pre-motor filter chamber **8956** is defined between the cyclone bin assembly **8910** and the motor housing **8912**. The cyclone bin assembly **8910**, suction motor housing **8912** and pre-motor filter chamber **8956** may include some or all of the features described herein, alone or in combination with each other.

Referring to FIG. **18**, an alternate embodiment of a surface cleaning apparatus **9900** is shown. Apparatus **9900** includes a dirty air inlet **9903**, a clean air outlet **9904** and a cyclone bin assembly **9910** mounted to a suction motor housing **9912**. A pre-motor filter chamber **9956** is defined between the cyclone bin assembly **9910** and the motor housing **9912**. The cyclone bin assembly **9910**, suction motor housing **9912** and pre-motor filter chamber **9956** may include some or all of the features described herein, alone or in combination with each other.

Alternate Hand Carriable Surface Cleaning Apparatus

The following description exemplifies a number of the features disclosed herein in an alternate construction for a hand carriable surface cleaning apparatus. Referring to FIG. **19**, another embodiment of a hand carriable surface cleaning apparatus **10900** is shown. The surface cleaning apparatus **10900** is similar to surface cleaning apparatus **900**, and like features are indicated using analogous reference numbers indexed by 10,000.

The surface cleaning apparatus **900** includes a main body **10901** having a handle **10902**, a dirty air inlet **10903**, a clean air outlet **10904** (see for example FIG. **26**) and an air flow path extending therebetween. In the embodiment shown, the dirty air inlet **10903** is the inlet end of connector **10906**. Optionally, the inlet end **10905** can be used to directly clean a surface. Alternatively, the inlet end can be connected to the downstream end of any suitable cleaning tool or accessory, including, for example a wand, a nozzle and a flexible suction hose.

The connector **10906** may be any suitable connector that is operable to connect to, and preferably detachably connect to, a cleaning tool or other accessory. Optionally, in addition to provide an air flow connection, the connector may also include an electrical connection **10909** (FIG. **20**). Providing an electrical connection **10909** may allow cleaning tools and accessories that are coupled to the connector **10906** to be powered by the surface cleaning apparatus **10900**. For example, the surface cleaning unit **10900** can be used to

provide both power and suction to a surface cleaning head, or other suitable tool. In the illustrated embodiment, the connector **10909** includes an electrical coupling in the form of a female socket member, and a corresponding male prong member may be provided on the cleaning tools and/or accessories. Providing the female socket on the electrified side of the electrical coupling may help prevent a user from inadvertently contacting the electrical contacts.

Referring to FIG. **21**, a construction technique that may be used by itself or with any other feature disclosed herein is exemplified. In this embodiment, the main body portion **10901** of the surface cleaning apparatus includes a core cleaning unit **11000** and an outer shell **11001**. In the illustrated example, the core cleaning unit **11000** is a generally, self-contained functional unit that includes the dirty air inlet **10903**, air treatment member **10910**, pre-motor filter chamber **10956**, suction motor **10911** and clean air outlet **10904**. The outer shell includes mating side panels **11002**, the handle portion **11003** of the surface cleaning apparatus (including the primary power switch **10985**) and an openable pre-motor filter chamber cover **10959**. When the outer shell **11001** is assembled around the core cleaning unit **11000** the exposed outer surfaces of the surface cleaning apparatus **10900** are formed from a combination of portions of the core cleaning unit **11000** and the outer shell **11001**. For example, the external suction motor housing **10912** and handle **10902** are provided by the outer shell **11001**, whereas the shell is shaped so that portions of the cyclone bin assembly **10910** sidewalls remain visible in the assembled configuration. If these portions are at least partially transparent, they can allow a user to see into the dirt collection chamber **10914** to determine if the dirt collection chamber **10914** is getting full.

From the dirty air inlet **10903**, the air flow path extends through the cyclone bin assembly **10910** which forms part of the main body of the surface cleaning apparatus. A suction motor **10911** (see FIG. **26**) is mounted within a motor housing frame **11004** (FIG. **21**) of the core cleaning unit **11000** and is in fluid communication with the cyclone bin assembly **10910**. In this configuration, the suction motor **10911** is downstream from the cyclone bin assembly **10910** and the clean air outlet **10904** is downstream from the suction motor **10911**.

Referring to FIGS. **23** and **26**, a uniflow cyclone and/or a cyclone with rounded junctures, and/or a cyclone with an insert member any of which may be used by itself or with any other feature disclosed herein is exemplified. In the illustrated embodiment, the cyclone bin assembly **10901** includes a cyclone chamber **10913** and a dirt collection chamber **10914**. The dirt collection chamber **10914** comprises a sidewall **10915**, a first end wall **10916** and an opposing second end wall **10917**. The dirt collection chamber **10914** may be emptyable by any means known in the art and is preferably openable concurrently with the cyclone chamber **10913**. Preferably, the second dirt collection chamber end wall **10917** is pivotally connected to the dirt collection chamber sidewall by hinge **10919**. The second dirt collection chamber end wall **10913** functions as an openable door to empty the dirt collection chamber **10914** and can be opened (FIGS. **24** and **25**) to empty dirt and debris from the interior of the dirt collection chamber **10914**. The second dirt collection chamber end wall **10917** can be retained in the closed position by any means known in the art, such as by a releasable latch **10919***a*. In the illustrated example, the hinge **10919** is provided on a back edge of the end wall **10917** and the latch **10919***a* is provided at the front of the end wall **10917** so that the door swings backwardly when opened. Alternatively, the hinge **10919** and latch **10919***a* may be in different positions, and the door **10917** may open in a different direction or manner. Optionally, instead of being openable, the end wall **10917** may be removable.

In the embodiment shown, the cyclone chamber **10913** extends along a cyclone axis **10920** and is bounded by a sidewall **10921**. The cyclone chamber **10913** includes an air inlet **10922** and an air outlet **10923** that is in fluid connection downstream from the air inlet **10922** and one dirt outlet **10924** in communication with the dirt collection chamber **10914**. In this embodiment, the dirt collection chamber **10914** is positioned adjacent the cyclone chamber **10913** and at least partially surrounds the cyclone chamber **10913** in a side-by-side configuration.

Preferably, the air inlet **10922** is generally tangentially oriented relative to the sidewall **10921**, so that air entering the cyclone chamber will tend to swirl and circulate within the cyclone chamber **10913**, thereby dis-entraining dirt and debris from the air flow, before leaving the chamber via the air outlet **10923**. The air inlet **10922** extends along an inlet axis **10925** that is generally perpendicular to the cyclone axis **10920**, and in the illustrated example is generally parallel to and offset above the suction motor axis **10926**.

In the illustrated example, the cyclone air outlet **10923** includes a vortex finder **10927**. Optionally, a screen **10928** can be positioned over the vortex finder **10927** to help filter lint, fluff and other fine debris. Preferably, the screen **10928** can be removable.

The air inlet **10922** has an inlet diameter **10934**, and a related inlet flow cross-sectional area (measure in a plane perpendicular to the inlet axis). Preferably, the air outlet **10923** is sized so that the diameter **10932** of the air outlet **10923**, and therefore the corresponding flow area of the air outlet **10923**, is the same as the diameter of the air inlet. Alternatively, the air outlet diameter **10932** may be between about 50% and about 150%, and between about 85-115% of the air inlet diameter **10925**.

In the example illustrated the cyclone bin assembly **10910**, and the cyclone chamber **10913** are arranged in a generally vertical, uniflow cyclone configuration. In a uniflow cyclone, the air inlet is located toward one end of the cyclone chamber and the air outlet is provided toward the other end of the cyclone chamber. In this configuration, air enters one end of the cyclone chamber and generally exits via the other end of the cyclone chamber, as opposed to the cyclone chamber illustrated in the embodiment of FIGS. **1** to **18**, in which air enters and exits the cyclone chamber via the same end. In the illustrated example, the air inlet **10922** is provided toward the lower end of the cyclone chamber **10913** and the air outlet **10923** is provided toward the upper end of the cyclone chamber **10913**, such that air flows into the bottom of the cyclone chamber **10913** and exits at the top of the cyclone chamber **10913**. Alternatively, the locations of the air inlet and outlet can be reversed.

Optionally, instead of a vertical configuration, the cyclone bin assembly **10910** and cyclone chamber **10913** can be provided in another orientation, including, for example, as a horizontal cyclone.

Optionally, some or all of the cyclone sidewall **10921** can coincide with portions of the external sidewalls of the cyclone bin assembly **10910** and the dirt collection chamber sidewall **10915**. Referring to FIG. **23**, in the illustrated embodiment the front portion of the cyclone chamber sidewall **10921** is coincident with the outer sidewall of the cyclone bin assembly **10910**, and the rear portion of the cyclone sidewall **10921** helps separate the cyclone chamber **10913** from the dirt collection chamber **10914**. This may

help reduce the overall size of the cyclone bin assembly **10910**. Alternative, the sidewall **10921** may be distinct from the sidewalls **10915**. In alternative embodiments, the cyclone chamber **10913** may include only two dirt outlets **10924**, or more than two dirt outlets.

In the illustrated embodiment, the cyclone chamber **10913** includes a first or upper end wall **10937** (FIG. **23**) and a second or lower end wall **10943**. The upper end wall **10937** is connected to the upper end of the sidewall **10921**. In the illustrated example, a juncture **10938** between the end wall **10937** and the side wall **10921** is a relatively sharp corner that does not include any type of angled or radiused surface. In contrast, the lower end wall **10943** meets the lower end of the cyclone sidewall **10921** at a juncture **11005** that includes a curved juncture surface **11006** (see also FIG. **27**). The radius **11007** of the curved surface **11006** may be selected based on the radius of the air inlet (e.g. half of the diameter **10934**), and optionally may be the selected so that the juncture surface **11006** has the same radius as the air inlet **10922**.

The curved juncture surface can be provided as a portion of the sidewall or as a portion of the endwall. In the illustrated embodiment, the curved juncture surface **11006** is provided as part of an insert member **11008** that is provided on the bottom end wall and extends upward into the interior of the cyclone chamber **10913**. The insert member also includes an upwardly extending projection member **11009** that extends into the interior of the cyclone chamber and engages the distal end **10930** of the screen (FIG. **23**). Together, the vortex finder **10927**, screen **10928** and projection member **11009** form a generally continuous internal column member that extends between the first and second end walls **10937** and **10943** of the cyclone chamber **10910**. Providing the projection member **11009** may help direct air flow within the cyclone chamber, and may help support and/or stabilize the distal end **10930** of the screen **10928**.

Optionally, the juncture **11010** between the end wall **10943** and the projection member **11009** may include a curved surface **11011** (see FIGS. **23** and **26**), and preferably is sized so that the surface **11011** has a radius **11012** that is the same as radius **11007**. Providing curved surfaces **11006** and **11011** at the junctures between the end wall **10943** and the sidewall **10921**, may help reduce backpressure and may help improve cyclone efficiency. Preferably, the two curved juncture surfaces **11006** and **11011** are separated by a generally flat, planar transition surface **11013**, having a width **11014**. Providing a flat transition surface **11013** may help improve air flow, and/or reduce back pressure to help improve cyclone efficiency.

In the illustrated embodiment, the second end wall **10943** of the cyclone chamber **10913**, and the insert member **11008** provided thereon, is integral with the openable bottom door **10917** that provides the bottom wall of the dirt collection chamber **10914**. In this configuration, opening the door simultaneously opens the cyclone chamber **10913** and the dirt collection chamber **10914** (see for example FIGS. **24** and **25**) for emptying.

In the illustrated embodiment, the dirt outlet **10924** is in the form of a slot having bottom and side edges provided by the cyclone chamber sidewall **10921**, and a top edge provided by the upper end wall **10937**. Alternatively, all four edges of the slot **10924** may be provided by the cyclone chamber sidewall **10921**. The dirt slot **10924** is positioned at the back of the cyclone chamber **10921** and is generally opposite the air inlet **10922**. In the illustrated embodiment, the upper wall **10937** of the cyclone chamber is integral with the upper wall **10916** (FIGS. **23** and **26**) of the dirt collection chamber **10914**.

Optionally, one or more pre-motor filters may be placed in the air flow path between the cyclone bin assembly **10910** and the suction motor **10911**. Alternatively, or in addition, one or more post-motor filters may be provided downstream from the suction motor.

Referring to FIG. **27**, a filter housing construction that may be used by itself or with any other feature disclosed herein is exemplified. In the illustrated embodiment a pre-motor filter chamber or housing **10956** is provided between the upper walls **10937**, **10916** of the cyclone **10913** and dirt collection chambers **10914** and the openable cover **10959**. In this configuration, the bottom wall **10957** of the pre-motor filter chamber **10956** is integral with the upper walls **10937**, **10916** of the cyclone **10913** and dirt collection chambers **10914**, and the upper wall **10958***a* and sidewall **10958** of the pre-motor filter chamber **10956** are provided via a filter cartridge housing **11015** (see also FIG. **28**). The filter cartridge housing **11015** is separate from the openable cover **10959**. One or more filters may be positioned within the pre-motor filter chamber to filter fine particles from the air stream exiting the air outlet, before it flows into inlet of the suction motor. The filters may be of any suitable configuration and formed from any suitable materials. In the illustrated embodiment, a foam filter **10960** and a felt filter **10961** (FIG. **30**) are positioned within the pre-motor filter chamber **10956**.

Referring to FIGS. **27-30**, the filter cartridge is a generally dome shaped member that includes a upper wall **10958***a* and a sidewall **10958** extending downwardly from the upper wall to surround the pre-motor filters **10960**, **10961**. The pre-motor filters **10960**, **10961** are shaped to fit within the cartridge member **11015**, and when inserted within the cartridge member (FIG. **29**) the downstream side **10965** of the felt filter **10961** forms the bottom surface of the filter cartridge **11015**. When the filter cartridge **11015** is inserted in its use position (FIG. **28**) the downstream side **10965** of the pre-motor filter rests on the support ribs **10962** (see FIG. **29**) on the bottom wall **10957**, and the downstream headspace **10964** (FIG. **27**) is defined between the downstream side **10965** of the filter **10961** and the bottom wall **10957**.

In this embodiment, the upstream headspace **10970** (FIG. **27**) is provided between the upstream side **10968** of the pre-motor filter **10960** and the upper wall **10958***a* of the cartridge housing **11015** (instead of being formed by the cover **10959**). To provide air into the upstream headspace **1970**, the vortex finder **10927** projects upwardly from the bottom wall **10957** and the filters **10960** and **10961** are provided with a corresponding aperture **10972** to receive the vortex finder **10927**. Preferably, a plurality of spacing ribs **11016** (FIG. **30**) are provided on the inner surface of the upper wall **10958***a* to keep the upstream surface **10968** of the filter **10960** spaced apart from the inner surface of the upper wall **10958***a* to maintain the upstream headspace **10970**.

The lower rim **11017** of the filter cartridge **11015** housing is configured to seal against the bottom wall **10957** (for example via snap fit or by using any type of suitable gasket or sealing member) to provide a generally air tight pre-motor filter chamber **10956**. The sealed chamber **10956** is then covered by openable chamber cover **10959**. As the filter cartridge housing **11015** provides a sufficiently air tight connection to the bottom wall, the chamber cover **10959** need not be air tight. Preferably, at least a portion of both the chamber cover **10959** and the filter cartridge **11015** housing is transparent so that a user can inspect the upstream side

10968 of the pre-motor filter 10960 without having to remove it from the chamber 10956. Optionally, both the chamber cover 10959 and filter cartridge housing 11015 may be formed from transparent plastic.

When a user wishes to remove, clean, change or otherwise access the pre-motor filter 10960, 10961 he/she may open the chamber cover 10959 (FIG. 30) to expose the filter cartridge housing 11015. The user may then detach the filter cartridge housing 11015 and separate it from the bottom wall 10957. Preferably, the pre-motor filters 10960, 10961 are snugly received within the filter cartridge housing 11015 (or otherwise retained therein) so that the filters 10960, 10961 are removed with the filter cartridge housing 11015 and remain inside the filter cartridge housing 11015 until removed by a user. In this embodiment, the dirty, upstream side 10968 of the filter 10960 remains enclosed by the filter cartridge housing 11015 when separated from the core cleaning unit 11000, and only the relatively clearer downstream side 10965 of the filter 10961 is exposed. This may help prevent dirt on the upstream side 10968 of the filter 10960 from spilling or from otherwise contacting the user. When at a desired location, for example at a trash receptacle or a sink, a user can grasp the clean, downstream side 10965 of the filter and remove it from the filter cartridge housing 11015. The upstream side 10968 of the filter can then be cleaned and inspected as desired.

To assist a user, the upper side 1958*a* of the filter cartridge housing 11015 may be provided with a grip member, for example the flange 11018 in the illustrated embodiment (FIG. 28), which may allow a user to firmly grasp and manipulate the filter cartridge housing 11015. The grip member 11018 may be of any suitable configuration and optionally may be provided on other portions of the filter cartridge housing (for example as a ridge or groove in the sidewall). Alternatively, the filter cartridge housing 11015 need not include a separate grip member.

To help reduce the overall size of the surface cleaning apparatus, in the illustrated embodiment the pre-motor filter chamber 10956, and the filters therein, is positioned above the cyclone chamber 10913 and covers the upper end of the cyclone chamber 10913. In this configuration, a plane 10966 (FIG. 26) containing the foam filter 10960 is generally parallel and spaced above a plane 10977 containing the air outlet 10923 of the cyclone chamber 10913, and both planes 10966, 10967 are generally perpendicular to the cyclone axis 10920. Arranging the filters 10960, 10961 in this configuration results in the upstream side of the pre-motor filter (in this example the upper side 10968 of the foam filter 10960) being spaced further apart from the cyclone chamber 10913 than the downstream side of the pre-motor filter (in this example the lower surface 10965 of the felt filter 10961). Alternatively, in other embodiments, the pre-motor filter chamber 10956 may cover only a portion of the upper end of the cyclone chamber and/or may be laterally spaced apart from the cyclone chamber.

When the surface cleaning apparatus is in use, air exiting the cyclone chamber 10913 can flow into the upstream head space 10970 via the vortex finder 10927. Within the upstream headspace 10970 the air can flow laterally across the upstream surface 10968 of the foam filter 10960, and down through the filters into the downstream head space 10964. From the downstream head space 10964, the air can flow to the inlet 10973 of the suction motor via an internal air conduit 10974 (FIG. 26) formed within the body 10901. In the illustrated embodiment, the internal air conduit 10974 is formed within the main body 10901 and is external the cyclone chamber 10913 and the dirt collection chamber 10914 and is partially bounded by an exterior surface exterior surface of the dirt collection chamber sidewall 10915. The air conduit 10974 extends generally vertically between the pre-motor filter chamber 10956 and the suction motor 10911, and is positioned laterally intermediate the suction motor 10911 and the cyclone chamber 10913. The suction motor 10911 is positioned at an elevation where its air inlet 10973 is vertically between the upper and lower ends of the cyclone chamber 10913, and the motor axis passes 10926 through the cyclone chamber 10913 and the dirt collection chamber 10914.

Optionally, the cartridge member 11015 can be provided with a bottom cover 11030 to encase the filters 10960 and 10961 and to provide a self-contained pre-motor filter chamber 10956. Referring to FIGS. 33 and 34, in such a configuration, the bottom cover 11030 may provide the bottom wall 10957 of the pre-motor filter chamber 10956, and may be provided with internal ribs 10962 to support the filters 10960, 10961 and to provide the downstream headspace 10964. An outlet port 11031 provided in the bottom cover 11030 allows air to exit the cartridge enclosure 11015 and flow into conduit 10974. Providing a sealed cartridge may help further contain dirt within the cartridge prior to emptying, and may help keep the filters 10960 and 10961 in position.

Referring to FIG. 20, in the illustrated embodiment, handle 10902 has a first or bottom end 10981 that is adjacent the suction motor housing 10912, a second or upper end 10982 that is spaced above from the lower end 1981 and a grip portion 10980 extending therebetween. When grasping the hand grip portion 10980, a user's fingers may pass through an opening 10984.

Referring to FIG. 31, a sectional view of an alternate embodiment cyclone bin assembly portion 12910 of a core cleaning unit 13000 that may be used by itself or with any other feature disclosed herein is exemplified. The cyclone bin assembly 12910 is similar to bin assembly 10910, and like features are identified using like reference numerals indexed by 2000. The cyclone bin assembly 12910 is illustrated in isolation with the outer shell, filter cartridge member and the suction motor removed. In this embodiment the cyclone chamber 12913 is flared such that the cross-sectional area taken in a plane 13020 that passes through the air inlet 12922 (toward the bottom of the cyclone chamber 12913) is smaller than the cross-sectional area taken in a plane 13021 that passes through the dirt outlet 12924, and is smaller than the cross-section area of the upper end wall 12937 of the cyclone chamber 12913 (which includes the air outlet 12923). In this configuration, the cyclone chamber sidewall 12921 includes a vertical portion 13022 and a generally frusto-conical portion 13023 positioned above the vertical portion 13022. In this embodiment the volume of the cyclone chamber 12913 increases toward the top to the cyclone chamber, which may help improve cyclone efficiency and/or may help dis-entrained dirt exit via the dirt outlet.

Referring to FIG. 32, a sectional view of an alternate embodiment cyclone bin assembly 14910 portion of the core cleaning unit 15000 that may be used by itself or with any other feature disclosed herein is exemplified. The cyclone bin assembly 14910 is similar to cyclone bin assembly 10910, and like elements are represented using analogous reference numbers indexed by 4000. The cyclone bin assembly 14910 is illustrated in isolation with the outer shell, filter cartridge member and the suction motor removed. In this embodiment the cyclone chamber 14913 is tapered such that the cross-sectional area taken in a plane 15020 that passes

through the air inlet **14922** (toward the bottom of the cyclone chamber **14913**) is larger than the cross-sectional area taken in a plane **15021** that passes through the dirt outlet **14924**, and is larger than the cross-section area of the upper end wall **14937** of the cyclone chamber **14913** (which includes the air outlet **14923**). In this configuration, the cyclone chamber sidewall **14921** includes a vertical portion **15022** and a generally inwardly-tapering frusto-conical portion **15023** positioned above the vertical portion. In this embodiment the volume of the cyclone chamber **14913** decreases toward the top to the cyclone chamber, which may help improve cyclone efficiency and/or may help dis-entrained dirt exit via the dirt outlet.

Another Alternate Hand Carriable Surface Cleaning Apparatus

Referring to FIG. **35**, an embodiment of a surface cleaning apparatus **200** is shown. In this embodiment the surface cleaning apparatus **200** is a hand operable surface cleaning apparatus. The surface cleaning apparatus **200** is usable in a forward direction of motion, indicated by arrow A in FIG. **35**.

Referring to FIG. **36**, the surface cleaning apparatus **200** has a dirty air inlet **202**, a clean air outlet **204** (shown in FIG. **36**), and an air flow passage extending therebetween. In the embodiment shown, the dirty air inlet **202** is provided in a nozzle **206**. From the dirty air inlet **202**, the airflow passage extends through the nozzle **206**, and through an air conduit **208**, to a suction and filtration unit **210**. The clean air outlet **204** is provided in the suction and filtration unit **110**. In the embodiment shown, the air conduit **108** includes a wand **214**, and a hose **217**.

Referring now to FIGS. **35** and **36**, the suction and filtration unit **210** includes a main housing **220**. A filtration member **224** is provided in the main housing **220**, and the filtration member **224** is positioned in the airflow passage downstream of the dirty air inlet **202**, for removing particulate matter from air flowing through the airflow passage.

A suction motor **226** is also provided in the main housing **220**, downstream of the filtration member **224**, for drawing air through the airflow passage. The suction motor **226** may be any suitable type of suction motor. In the embodiment shown, the suction motor **226** includes a fan **223**, and a motor **225**.

In the embodiment shown, the filtration member **224** and suction motor **226** are positioned side-by-side. Further, the filtration member **224** extends along an axis **246**, and the suction motor extends along an axis **290**, and the axes **246**, **290** are generally parallel. Further, the filtration member **224** and suction motor **226** are each positioned transverse to the forward direction of motion (indicated by arrow A in FIG. **34**) of the hand surface cleaning apparatus **100**.

Referring to FIG. **35**, in the embodiment shown, the main housing **220** includes a central wall **230**, a first side wall **232**, and a second side wall **234**. The first side wall **232** is pivotally mounted to the central wall **230**, and serves as a first openable door **229**. The second sidewall **234** has a first portion **233** adjacent the filtration member **224**, and a second portion **235** adjacent the suction motor **226**. The second sidewall **234** is pivotally mounted to the central wall **230**, and serves as a second openable door **231**. Further, the second portion **235** is removable from the first portion **233**.

Referring to FIG. **36**, an interior wall **237** extends within the main housing **220** to separate the suction motor **226** from the filtration member **224**, so that fluid communication between the filtration member **224** and the suction motor **226** may generally only occur between a filtration member air outlet **264**, and a suction motor air inlet end **239**, as will be described in further detail hereinbelow. The interior wall **237** generally surrounds the suction motor **226** to form a motor housing **227**, and is integral with the central wall **230**, so that a portion **269** of the motor housing **227** forms part of the housing **220**.

Referring to FIG. **36**, in the embodiment shown, the filtration member **224** is a cyclone **244**. In alternate embodiments, the filtration member **224** may be, for example, a filter, such as a filter bag or a foam filter. In further alternate embodiments, the filtration member **224** may include a plurality of cyclone chambers, or a plurality of cyclonic stages.

The cyclone **244** may be of any suitable configuration. The cyclone **244** includes a cyclone wall **248** (also referred to as an outer wall **248**), which is integral with the central wall **230**, and together with the central wall **230** defines a cyclone chamber **250**. That is, a portion of the cyclone wall **248** forms part of the housing **220**. A first end **251** of the cyclone wall **148**, which is positioned towards the second sidewall **234**, defines an opening **252**, and an opposed second end **254** of the cyclone wall includes a second end wall **256**. The cyclone wall **248** is positioned in the main housing **220** such that it is spaced from the second sidewall **234**.

The open first end **252** of the cyclone serves as a dirt outlet for the cyclone **244**. Material that is separated form air in the cyclone travels from the dirt outlet to an associated dirt collection chamber **260**. Together, the cyclone **244** and dirt collection chamber **260** may be referred to as a cyclone bin assembly **262**.

Referring to FIGS. **36** and **37**, at least a portion of the dirt chamber **260** is preferably positioned in an open volume within the main housing **220**. In the embodiment shown, the entire dirt chamber **260** is within an open volume within the main housing **220**. The dirt collection chamber **260** is preferably within the main housing **220**, exterior to the cyclone **244** and the suction motor **226**. The dirt collection chamber extends along a longitudinal axis **261**. The longitudinal axis **261** is preferably parallel to the suction motor axis **290**.

Referring to FIGS. **36** and **37**, at least a portion of the dirt collection chamber **260** is preferably positioned between the cyclone **244** and the suction motor **226**. More preferably, at least a portion of the dirt collection chamber **260** surrounds at least a portion of the suction motor **226** and the suction motor housing **227**. For example, the dirt collection chamber **260** may surround all of the suction motor **226**, or only a portion of the suction motor **226**, and/or all of the suction motor housing **227**, or only a portion of the suction motor housing **227**. As seen most clearly in FIG. **36**, in the embodiment shown, the dirt collection chamber **260** fully surround the motor **225** of suction motor **226** and the portion suction motor housing **227** that houses the motor **225**.

The dirt collection chamber **260** further preferably surrounds at least a portion of the cyclone. For example, in the embodiment shown, dirt collection chamber **260** extends around approximately one quarter of the cyclone **244**. In alternate embodiments, the dirt collection chamber **260** may fully surround the cyclone **244**.

In an alternate embodiment of a surface cleaning apparatus **400** shown in FIG. **38**, wherein like reference numerals are used to refer to like features as in FIGS. **35** to **37**, with the first digit incremented to 4, the dirt collection chamber **460** partially surrounds the motor **425** of suction motor **426** and the portion suction motor housing **427** that houses the motor **425**. Further, the dirt collection chamber **460** partially surrounds the cyclone **444**. Particularly, the dirt collection

chamber **460** surrounds approximately three quarters of the cyclone **444**. In another alternate embodiment of a surface cleaning apparatus **400'** shown in FIG. **39**, wherein like reference numerals are used to refer to like features as in FIG. **38**, with a prime (') after the reference number, similarly to the embodiment of FIG. **38**, the dirt collection chamber **460'** partially surrounds the motor **425'** of suction motor **426'** and the portion suction motor housing **427'** that houses the motor **425'**. Further, the dirt collection chamber **460'** partially surrounds the cyclone **444'**. Particularly, the dirt collection chamber **460'** surrounds approximately one quarter of the cyclone **444'**.

Referring to FIG. **36**, the dirt collection chamber **260** has an outer wall **263**, and a portion **265** of the outer wall **263** preferably forms part of the main housing **220**.

The cyclone **244** further includes a cyclone air inlet (not shown), and a cyclone air outlet **264**. The cyclone air inlet extends from a first end that is in communication with the hose **217** through the central wall **230** of the filtration member main housing **220**, to a second end that is in communication with the cyclone chamber **250**. The cyclone air outlet **264** extends along the axis **246**, from a first end **270** that is positioned within the cyclone chamber **250**, through the lower wall **256**, and to a second end **272** (also referred to herein as an outlet **272** of the cyclone air outlet **264**) that is in communication with a chamber **241** adjacent the first sidewall **232** of the suction and filtration unit **210**. A screen **274** is preferably mounted over the first end **270** of the cyclone air outlet.

In use, air flows from the hose **217** into the cyclone chamber **250** through the cyclone air inlet. In the cyclone chamber **250**, the air flows within the cyclone wall **248** in a cyclonic pattern, and particulate matter is separated from the air. The particulate matter exits the cyclone chamber **250** through the open first end **252**, and settles in the dirt collection chamber **260**. The air exits the cyclone chamber **250** through the cyclone air outlet **264**, and enters the chamber **241**.

The dirt collection chamber **260** may be emptied in any suitable manner. Referring to FIG. **37**A, in the embodiment shown, the second side wall **234** is pivotally openable, so that the dirt collection chamber **260** may be opened.

Referring still to FIG. **36**, the surface cleaning apparatus includes a pre-motor filter **276** positioned downstream of the cyclone **244** and upstream of the suction motor **226**. The pre-motor filter **276** is preferably housed in the chamber **241**, is snugly received within the central wall **230**, overlies the suction motor **226** and the cyclone **244**, and spaced from the first openable door **229**. In the embodiment shown, the pre-motor filter **276** overlies the all of the suction motor **226** and the cyclone **244**. In alternate embodiments, the pre-motor filter may overlie only a portion of the suction motor **226** and the cyclone **244**. Preferably, the pre-motor filter **276** overlies at least half of the suction motor **226** and the cyclone chamber **250**, and more preferably, at least 75% of the suction motor **226** and the cyclone chamber **250**. More preferably, the pre-motor filter **276** overlies at least half of the suction motor **226** and the cyclone **244**, and more preferably, at least 75% of the suction motor **226** and the cyclone **244**. Most preferably, as shown, the pre-motor filter has a portion **245** that is centered over the suction motor **226** and a portion **247** that overlies at least half of the cyclone **244**. In the embodiment shown, the portion **247** overlies all of the cyclone **244**.

The pre-motor filter has an upstream side **280** that faces the first sidewall **232** of the main housing **220**, and an opposed downstream side **282** that faces the second sidewall **234** of the main housing **220**. The pre-motor filter **276** may be any suitable type of filter. Preferably, the pre-motor filter includes a foam layer **286** and a felt layer **288**.

Referring still to FIG. **36**, the cyclone air outlet **264** extends through the pre-motor filter **276**, so that air exiting the cyclone **244** is in contact with the upstream side **280** of the pre-motor filter **286**.

The air then passes through the pre-motor filter **276**, towards a suction motor inlet end **239** that faces the downstream side **282** of the pre-motor filter **276**. From the suction motor inlet **239**, the air passes towards a suction motor outlet end **243**, and out of the clean air outlet **204**.

Preferably, as shown in FIG. **37**B, when the first openable door **229** is open, the upstream side **280** of the pre-motor **276** is visible. By opening the openable door **229**, the pre-motor filter may optionally be removed, replaced, or cleaned. Further, the pre-motor filter **276** is preferably mounted to at least one of the cyclone **244** and the suction motor **226**, and the pre-motor filter **276** remains in position when the first openable door **229** is opened. For example, as shown, the pre-motor filter **276** is frictionally mounted to the cyclone air outlet **264**.

Referring still to FIG. **36**, the surface cleaning apparatus further includes a bleed valve **201**. The bleed valve **201** allows air to flow from the suction motor inlet **239** to the clean air outlet **204** so that the suction motor **226** does not burn out if a clog occurs.

Referring to FIGS. **38** and **39**, a further alternate surface cleaning apparatus **400** is shown. The surface cleaning apparatus is similar to the surface cleaning apparatus **200**, and like numerals in the surface cleaning apparatus **800** will be used to describe like features as in the surface cleaning apparatus **200**, with the first digit incremented to 8.

In the surface cleaning apparatus **800**, the cyclone air outlet **864** does not extend through the pre-motor filter **876**. The upstream side **880** of the pre-motor filter **876** faces towards the second sidewall **834** of the housing **820** and faces the cyclone air outlet **864**, and the downstream side **882** of the pre-motor filter **876** faces the first sidewall **834**. Air passes out of the second end **872** of the cyclone air outlet **864**, through the pre-motor filter, and into the chamber **841**.

The suction motor **826** has a suction motor inlet duct **853** that extends through the pre-motor filter **876** to the downstream side **882** of the pre-motor filter **876**.

In this embodiment, the bleed valve **801** is provided in the openable door, and has an air outlet **805** that is within the chamber **841**, so that it is in communication with the suction motor air inlet end **839**.

When the openable door is open, the suction motor inlet **839** is visible, and the downstream side **882** of the pre-motor filter **876** is visible.

Referring to FIGS. **40**A and **408**, a further alternate surface cleaning apparatus **1000** is shown. The surface cleaning apparatus is similar to the surface cleaning apparatus **200**, and like numerals in the surface cleaning apparatus **1000** will be used to describe like features as in the surface cleaning apparatus **200**, with the first digit incremented to 9.

In the surface cleaning apparatus **1000**, the pre motor filter **1076** overlies only the motor (not shown) and the motor housing **1027**, and does not overlie the cyclone **1044**. The cyclone outlet **1064** is in communication with the upstream side **1080** of the pre motor filter **1076**, which faces towards the first side **1032** of the housing **1020**. The downstream side of the pre motor filter **1076** faces the motor inlet end (not shown) and the second side **1034** of the housing **1020**. A bleed valve **1001** extends through the pre motor filter **1076**.

Another Alternate Hand Carriable Surface Cleaning Apparatus

Referring to FIGS. **41-44**, a further alternate surface cleaning apparatus **1100** is shown. In the embodiment illustrated, the surface cleaning apparatus **1100** is a hand operable surface cleaning apparatus. In alternate embodiments, the surface cleaning apparatus may be another suitable type of surface cleaning apparatus, including, for example, an upright vacuum cleaner, a canister vacuum cleaner, a stick vacuum cleaner, a wet-dry vacuum cleaner and a carpet extractor.

Referring to FIG. **44**, the surface cleaning apparatus **1100** has a dirty air inlet **1102**, a clean air outlet **1104** and an airflow passage extending therebetween. In the embodiment shown, the dirty air inlet **1102** is the air inlet **1106** of a suction hose connector **1108** that can be connected to the downstream end of, e.g., a flexible suction hose or other type of cleaning accessory tool, including, for example, a wand and a nozzle. From the dirty air inlet **1102**, the airflow passage extends through an air treatment member that can treat the air in a desired manner, including for example removing dirt particles and debris from the air. In the illustrated example, the air treatment member comprises a cyclone bin assembly **1110**. The cyclone bin assembly **1110** is mounted on a body **1112**. Alternatively, or in addition, the air treatment member can comprise a bag, a filter or other air treating means. A suction motor **1114** that is mounted within the body **1112** and is in fluid communication with the cyclone bin assembly **1110**.

The clean air outlet **1104**, which is in fluid communication with an outlet of the suction motor **1114**, is provided in the body **1112**. In the illustrated example, the dirty air inlet **1102** is located toward the front of the surface cleaning apparatus **1100**, and the clear air outlet **1104** is located toward the rear.

In the illustrated example, cyclone bin assembly **1110** includes a cyclone chamber **1118** and a dirt collection chamber **1120**. The cyclone chamber **1118** is bounded by a sidewall **1122**, a first end wall **1124** and a second end wall **1126** that are configured to provide an inverted cyclone configuration. A tangential air inlet **1128** is provided in the sidewall of the cyclone chamber **1118** and is in fluid communication with the air outlet of the hose connector **1108**. Air flowing into the cyclone chamber **1118** via the tangential air inlet **1128** can circulate around the interior of the cyclone chamber **1118** and dirt particles and other debris can become disentrained from the circulating air.

A slot **1132** formed between the sidewall **1122** and the second end wall **1126** serves as a cyclone dirt outlet **1132**. Debris separated from the air flow in the cyclone chamber **1118** can travel from the cyclone chamber **1118**, through the dirt outlet **1132** to the dirt collection chamber **1120**.

Air can exit the cyclone chamber **1118** via an air outlet. In the illustrated example, the cyclone air outlet includes a vortex finder **1134**. Optionally, a removable screen **1136** can be positioned over the vortex finder **1134**. The cyclone chamber **1118** extends along a longitudinal cyclone axis **1138**. In the example illustrated, the longitudinal cyclone axis **1138** is aligned with the orientation of the vortex finder **1134**.

The dirt collection chamber **1120** comprises a sidewall **1140**, a first end wall **1142** and an opposing second end wall **1144**. In the illustrated example, at least a portion of the dirt collection chamber sidewall **1140** is integral with a portion of the cyclone chamber sidewall **1122**, and at least a portion of the first cyclone end wall **1124** is integral with a portion of the first dirt collection chamber end wall **1142**.

Referring to FIG. **42**, the cyclone bin assembly **1110** is optionally detachably connected to the body **1112**. In the example illustrated, the cyclone bin assembly **1110** is detachably mounted on a platform **1148**. A releasable latch **1150** can be used to secure a front edge of the cyclone bin assembly **1110** to the body **1112**.

Referring to FIG. **41**, a handle **1152** is provided on the top of the cyclone bin assembly **1110**. The handle **1152** is configured to be grasped by a user. When the cyclone bin assembly **1110** is mounted on the body **1112**, the handle **1152** can be used to manipulate the surface cleaning apparatus **1100**. When the cyclone bin assembly **1110** is removed from the body **1112**, the handle **1152** can be used to carry the cyclone bin assembly **110**, for example to position the cyclone bin assembly **1110** above a waste receptacle for emptying. In the illustrated example, the handle **1152** is integral with a lid **1154** of the cyclone bin assembly **110**.

Referring to FIGS. **43** and **44**, the dirt collection chamber sidewall **1140** comprises a recess **1214** that is shaped to receive a corresponding portion of the body **1112**. In the illustrated example, the recess **1214** is shaped to receive a portion of the motor housing **1216** surrounding the suction motor **1114**. In this example, at least a portion of the dirt collection chamber **1120** is positioned between the cyclone chamber **1118** and the suction motor **1114**. Preferably, at least a portion of the dirt collection chamber **1120** surrounds at least a portion of the suction motor **1114** and, if a suction motor housing is provided, the suction motor housing **1216**. In the illustrated example, the dirt collection chamber **1120** surrounds only a portion of the motor housing **1216**. The shape of the recess **1214** is preferably selected to correspond to the shape of the suction motor housing **1216** so as to maximize the size of the dirt collection chamber for the foot print of the vacuum cleaner. Configuring the dirt collection chamber **1120** to at least partially surround the suction motor housing **216** may help reduce the overall length of the surface cleaning apparatus **1100**, and/or may help increase the capacity of the dirt collection chamber **1120**.

Referring to FIG. **44**, the dirt collection chamber **1120** also surrounds at least a portion of the cyclone chamber **1118**. Optionally, the dirt collection chamber **1120** can be configured to completely surround the cyclone chamber **1118**.

Air exiting the cyclone chamber **1118** flows to a suction motor **1114** inlet via a filter chamber **1186**. The filter chamber **1186** is provided downstream from the cyclone air outlet. In the illustrated example, the filter chamber **1186** extends over substantially the entire lower portion of the body **1112** and overlies substantially all of the cyclone chamber **1118**, dirt collection chamber **1120** and suction motor **1114**.

A pre-motor filter **1218** is provided in the filter chamber **1186** to filter the air before it enters the suction motor inlet **1220**. The pre-motor filter **1218** is sized to cover the entire area of the filter chamber **1186**, and overlies substantially all of the cyclone chamber **1118**, dirt collection chamber **1120** and suction motor **1114**. Preferably, the cross sectional area (in the direction of air flow) of the pre-motor filter **1218** is greater than the cross sectional area of the cyclone chamber **1118** and the suction motor **1114**. In the illustrated example, the pre-motor filter **1218** comprises first and second pre-motor filters **1218***a*, **1218***b*. The filter chamber **1186** comprises an air inlet chamber **1222** on the upstream side **1224** of the pre-motor filter **1218**, and an air outlet chamber **1226** on the downstream side **1228** of the pre-motor filter **1218**. Air can travel from the air inlet chamber **1222** to the air outlet chamber **1226** by flowing through the air-permeable

pre-motor filter **1218**. It will be appreciated that the larger the cross sectional area of the upstream face of the filter, the greater the capacity of the filter to filter particulates without the filter becoming clogged. Accordingly, it is preferred to make pre-motor filter **1218** as large as possible. Accordingly, it is preferred that filter chamber **1186** is as large as possible (i.e. it overlies all of an end face of the cyclone chamber, dirt collection chamber and suction motor) and that the pre-motor filter **1218** extends over the full transverse extent of filter chamber **1186**. It will be appreciated that the filter chamber **1186** may overlie only a portion of the end face of the cyclone chamber, dirt collection chamber and suction motor but may still provide a larger upstream surface area then is the filter only overlied the cyclone chamber.

The lower side of the air filtration chamber comprises a filtration chamber end wall **1244**. Optionally, the first end wall **1244** of the filter chamber **1186** can be openable to allow a user to access the pre-motor filter **1218**. In the illustrated example, the filter chamber end wall **1244** is pivotally connected to the body **1112** by a hinge **1246** and can pivot to an open position. The releasable latch **1150** can be used to secure in a closed position. The latch **1150** can connect the filter chamber end wall **1244** to the cyclone bin assembly **1110**. As exemplified and discussed hereafter, the upstream side of pre-motor filter **1218** is visible when filter chamber end wall **1244** is in the open position and accordingly, a user may readily detect if the pre-motor filter **1218** requires cleaning or changing.

The air inlet chamber **1222** is fluidly connected to the cyclone chamber air outlet by an inlet conduit **1230** that extends through the pre-motor filter **1218**. In the illustrated example the inlet conduit **1230** comprises an extension of a vortex finder insert. The air outlet chamber **1226** is in fluid communication with the inlet **1220** of the suction motor **1114**. The pre-motor filter **1218** may be supported by a plurality of support ribs **1232** extending through the air outlet chamber **1226**. Gaps or cutouts can be provided in the ribs **1232** to allow air to circulate within the air outlet chamber **1226** and flow toward the suction motor inlet **1220**. From the suction motor inlet **1220**, the air is drawn through the suction motor **1114** and ejected via a suction motor outlet **1116**. Optionally, a post-motor filter **1236** (for example a HEPA filter) can be provided downstream from the suction motor outlet **1116**, between the suction motor outlet **1116** and the clean air outlet **1104**. A detachable grill **1238** can be used to retain the post-motor filter **1236** in position, and allow a user to access the post-motor filter **1236** for inspection or replacement.

Another Alternate Hand Carriable Surface Cleaning Apparatus

Referring to FIGS. **45** to **50**, another embodiment of a surface cleaning apparatus **2100** is shown. In the embodiment illustrated, the surface cleaning apparatus **2100** is a canister vacuum cleaner. The surface cleaning apparatus **2100** has a dirty air inlet **2102**, a clean air outlet **2104** and an airflow passage extending therebetween. In the embodiment shown, the dirty air inlet **2102** is the air inlet of a suction hose connector **2106** that can be connected to the downstream end of a flexible suction hose or other type of cleaning accessory tool, including, for example, a surface cleaning head, a wand and a nozzle. From the dirty air inlet **2102**, the airflow passage extends through an air treatment member **2108** that can treat the air in a desired manner, including for example removing dirt particles and debris from the air. In the illustrated example, the air treatment member **2108** comprises a cyclone bin assembly **2110**. Alternatively, or in addition, the air treatment member **2108** can comprise a bag, a filter or other air treating means. A suction motor **2111** (FIG. **50**) is mounted within a body **2112** of the surface cleaning apparatus **2100** and is in fluid communication with the cyclone bin assembly **2110**. In the illustrated example, the body **2112** of the surface cleaning apparatus **2100** is a rollable, canister-type body that comprises a platform **2114** and two opposing sidewalls **2116***a*, **2116***b* that cooperate to define a central cavity **2118**. The surface cleaning apparatus **2100** also comprises two main side wheels **2120***a*, **2120***b*, rotatably coupled to the sidewalls **2116***a* and **2116***b*, respectively.

The clean air outlet **2104**, which is in fluid communication with an outlet of the suction motor **2111**, is provided in the body **2112**. In the illustrated example, the dirty air inlet **2102** is located toward the front **2122** of the surface cleaning apparatus **2100**, and the clear air outlet is located toward the rear **2124**.

In the illustrated example, the body sidewalls **2116***a, b* are generally circular and cover substantially the entire side faces of the surface cleaning apparatus **2100**. One main side wheel **2120***a*, **2120***b* is coupled to the outer face of each body sidewall **2116***a* and **2116***b*, respectively. Optionally, the side wheels **2120***a*, **2120***b* may have a larger diameter **2126** than the body sidewalls **2116***a, b* and can completely cover the outer faces of the sidewalls **2116***a, b*. Referring to FIG. **50**, each side wheel **2120***a, b* is rotatably supported by a corresponding axle **2128***a*, **2128***b*, which extends from the body sidewalls **2116***a* and **2116***b*, respectively. The main side wheels **2120***a* and **2120***b* are rotatable about a primary axis of rotation **2130**. In the illustrated example, the primary axis of rotation **2130** passes through the cyclone bin assembly **2110**.

Optionally, at least one of the side wheels **120***a, b* can be detachable from the body **2112**. Referring to FIG. **49**, in the illustrated example side wheel **2120***a* is detachably coupled to its corresponding axles **2128***a* by a threaded hub assembly **2132***a*, and can be removed from the body **2112**. Removing the side wheel **2120***a* from the body **112**, or otherwise positioning them in an open configuration, may allow a user to access a variety of components located in compartments between the side wheels **120***a* and **120***b* and the corresponding sidewalls **116***a* and **116***b*, as explained in greater detail below.

FIGS. **46**, **47**, **48** and **50** illustrated an example of a cyclone bin assembly **2110** includes a cyclone chamber **2162** and a dirt collection chamber **2164** in accordance with one embodiment. The cyclone bin assembly **2110** is detachably mounted in the cavity **2118**, laterally between the sidewalls **2116***a*, **2116***b* and side wheels **2120***a*, **2120***b*. Positioning the cyclone bin assembly **2110** in the cavity **2118**, between the body sidewalls **2116***a*, **2116***b* may help protect the cyclone bin assembly **2110** from side impacts, for example if the surface cleaning apparatus **2100** contacts a piece of furniture or other obstacle. Preferably, the body sidewalls **2116***a*, **2116***b* have a larger cross-sectional area than the cyclone bin assembly **2110**. More preferably, the transverse faces of the cyclone bin assembly **2110** are entirely covered by the body sidewalls **2116***a*, **2116***b*.

In the illustrated example, the cyclone chamber **2162** is bounded by a sidewall **2166**, a first end wall **2168** and a second end wall **2170**. A tangential air inlet **2172** is provided in the sidewall of the cyclone chamber **2162** and is in fluid communication with the dirty air inlet **2102**. Air flowing into the cyclone chamber **2162** via the air inlet can circulate around the interior of the cyclone chamber **2162** and dirt particles and other debris can become disentrained from the circulating air.

A slot **2180** formed between the sidewall **2166** and the second end wall **2170** serves as a cyclone dirt outlet **2180**. Debris separated from the air flow in the cyclone chamber **2162** can travel from the cyclone chamber **2162**, through the dirt outlet **2180** to the dirt collection chamber **2164**.

Air can exit the cyclone chamber **2162** via an air outlet. In the illustrated example, the cyclone air outlet includes a vortex finder **2182**. Optionally, a removable screen **2183** can be positioned over the vortex finder **2182**. The cyclone chamber **2162** extends along a longitudinal cyclone axis **2184**. In the example illustrated, the longitudinal cyclone axis is aligned with the orientation of the vortex finder **2182** and is generally transverse to the direction of movement of the surface cleaning apparatus **2100**. The cyclone chamber **2162** has a generally circular cross sectional shape (taken in a plane perpendicular to the cyclone axis) and has a cyclone diameter **2186**.

The dirt collection chamber **2164** comprises a sidewall **2174**, a first end wall **2176** and an opposing second end wall **2178**. In the illustrated example, at least a portion of the dirt collection chamber sidewall **2174** is integral with a portion of the cyclone chamber sidewall **2166**, and at least a portion of the first cyclone end wall **2168** is integral with a portion of the first dirt collection chamber end wall **2176**.

Referring to FIGS. **46** and **48**, a lower surface **2188** of the cyclone bin assembly **2110** is configured to rest on the platform **2114**, and the first and second end walls **2168**, **2170** of the cyclone bin assembly **2110** are shaped to engage the inner surfaces of the body sidewalls **2116***a*, **2116***b*, respectively. The upper portion of the cyclone bin (as viewed when installed in the cavity **2118**) can have a radius of curvature that generally corresponds to the radius of curvature of the body sidewalls **2116***a*, **2116***b* and the side wheels **2120***a*, **2120***b*. Matching the curvature of the cyclone bin assembly **2110** with the curvature of the side wheels **120***a*, **120***b* may help facilitate mounting of the cyclone bin assembly **2110** within the body **2112**, so that the walls of the cyclone bin assembly **2110** do not extend radially beyond the body sidewalls **2116***a*. **1216***b* or main side wheels **2120***a*, **2120***b*.

Referring to FIG. **47**, the second dirt collection chamber end wall **2178** is preferably pivotally connected to the dirt collection chamber sidewall **2174**. The second dirt collection chamber end wall **2178** can be opened to empty dirt and debris from the interior of the dirt collection chamber **2164**. Optionally, the second cyclone end wall **2170** is integral with and is openable with the second dirt collection chamber end wall **2178**. Opening the second cyclone end wall **2170** can allow dirt and debris to be emptied from the cyclone chamber **2162**. The second dirt collection chamber sidewall **2178** can be retained in the closed position by a releasable latch **2204**. Optionally, the screen **2183** and/or the vortex finder **2182** can be removable from the cyclone chamber **2162** and can be removed when the second dirt collection chamber end wall **2178** is open.

Referring to FIGS. **47** and **48**, the dirt collection chamber sidewall **2174** comprises a recess **2206** that is shaped to receive a corresponding portion of the body **2112**. Referring to FIG. **46**, in the illustrated example, the platform **2114** comprises a generally planar bearing surface **2208** for supporting the cyclone bin assembly **2110**. The platform **2114** also comprises at least a portion of the suction motor housing **2210** surrounding the suction motor **2111**. In this example, the recess **2206** in the dirt collection chamber sidewall **2174** is shaped to receive the portion of the motor housing **2210** projecting above the planar bearing surface **2208**.

Preferably, at least a portion of the dirt collection chamber **2164** surrounds at least a portion of the suction motor **2111** and the suction motor housing **2210**. In this example, at least a portion of the dirt collection chamber **2164** is positioned between the cyclone chamber **2162** and the suction motor housing **2210** (and the suction motor **2111** therein). Configuring the dirt collection chamber **2164** to at least partially surround the suction motor housing **2210** may help reduce the overall size of the surface cleaning apparatus **2100**, and/or may help increase the capacity of the dirt collection chamber **2164**. The dirt collection chamber **2164** also surrounds at least a portion of the cyclone chamber **2162**.

Referring to FIGS. **49** and **50**, air exiting the cyclone chamber **2162** flows to a suction motor inlet **2246** via a filter chamber **2248**. The filter chamber **2248** is provided downstream from the cyclone air outlet. In the illustrated example, the filter chamber **2248** comprises a recessed chamber in the body sidewall **2116***a* that is enclosed by an openable seal plate **2250**. A sealing gasket **2254** is provided at the interface between an annular rim **2252** of the sidewall **2116***a* and the seal plate **2250** to help provide an air-tight filter chamber **2248**. In the illustrated example, the filter chamber **2248** extends over substantially the entire sidewall **2116***a* and overlies substantially all of the transverse cross sectional area of cyclone chamber **2162**, dirt collection chamber **2164** and suction motor **2111**.

A pre-motor filter **2256** is provided in the filter chamber **2248** to filter the air before it enters the suction motor inlet. The pre-motor filter **2256** is sized to cover substantially the entire area of the filter chamber **2248**, and overlies substantially all of the transverse cross sectional area of the cyclone chamber **2162**, dirt collection chamber **2164** and suction motor **2111**. In the illustrated example, the pre-motor filter **2256** comprises first and second pre-motor filters **2256***a*, **2256***b*. The filter chamber **2248** comprises an air inlet chamber **2258** on the upstream side of the pre-motor filter **256**, and an air outlet chamber **2260** on the downstream side of the pre-motor filter **2256**. Air can travel from the air inlet chamber **2258** to the air outlet chamber **2260** by flowing through the pre-motor filter **2256**.

The air inlet chamber **2258** is fluidly connected to the vortex finder **2182** by an inlet conduit **2262** that extends through a first aperture **2264** in the pre-motor filter **2256**. The air outlet chamber **2260** is in fluid communication with the inlet **2246** of the suction motor **2111**. The pre-motor filter **2256** can be supported by a plurality of support ribs **2266** extending from the sidewall **2116***a* into the air outlet chamber **2260**. Cutouts can be provided in the ribs to allow air to circulate within the air outlet chamber **2266** and flow toward the suction motor inlet **2246**.

In the illustrated example, the axle **2128***a* for supporting the side wheel extends through the air filter chamber **2248**, a second aperture **2268** in the pre-motor filter **2256** and through an axle aperture **2270** in the seal plate **2250**. The axle aperture **2270** in the seal plate **2250** is configured to provide an air-tight seal against the axle **2128***a*. Optionally, a sealing gasket can be provided at the interface between the seal plate **2250** and the axle **2128***a*. In this configuration the pre-motor filter **2256** surrounds the axle **2128***a*.

In the illustrated example, the seal plate **2250** is removable, when the side wheel **2120***a* is detached, to allow a user to access the pre-motor filter **2256**. Alternatively, instead of being removable, the seal plate **2250** can be movably attached to the body **2112**, for example pivotally connected to the sidewall **2116***a*, such that the seal plate **2250** can be opened without being completely detached from the body **2112**.

Preferably, the seal plate **2250** is transparent, or at least partially transparent. Providing a transparent seal plate **2250** may help facilitate visual inspection of the upstream side **2272** of the pre-motor filter **2256** while the seal plate **2250** is in place. When the seal plate **2250** is removed, the pre-motor filter **2256** may be removed, for example for cleaning or replacement.

A bleed valve is provided to supply clean air to the suction motor inlet. In the illustrated example a bleed valve air outlet **2278** is in fluid communication with the air outlet chamber **2260** and can introduce clean air into the air outlet chamber **2260** downstream from the pre-motor filter **2256**. Air introduced by the bleed valve can flow through the cutouts in the supporting ribs **2266**, as described above. The bleed valve may be a pressure sensitive valve that is opened when there is a blockage in the air flow path upstream from the suction motor **2111**. In the illustrated example, the bleed valve is parallel with the suction motor **2111**. A bleed valve inlet **2280** (see also FIG. **45**) is provided toward the front of the body **2112**.

It will be appreciated that, in one embodiment, the enhanced dirt collection chamber construction may be used by itself without the enhanced filter chamber design. Alternately, both the enhanced dirt collection chamber construction and the enhanced filter chamber design may be used concurrently as exemplified herein. It will also be appreciated that the cyclone chamber may be of any design and configuration. When either of the enhanced dirt collection chamber construction and/or the enhanced filter chamber design are used, the vacuum cleaner may be of any design and the dirt collection chamber may or may not be removably mounted from the vacuum cleaner.

What has been described above has been intended to be illustrative of the invention and non-limiting and it will be understood by persons skilled in the art that other variants and modifications may be made without departing from the scope of the invention as defined in the claims appended hereto. The scope of the claims should not be limited by the preferred embodiments and examples, but should be given the broadest interpretation consistent with the description as a whole.

What is claimed is:

1. A hand carriable surface cleaning apparatus having a front end, a rear end and comprising:

(a) a dirty fluid inlet;

(b) a cyclone bin assembly comprising a cyclone chamber downstream of the dirty fluid inlet, the cyclone chamber comprising a lower end, an upper end, a cyclone axis, an air inlet and an air outlet at the upper end;

(c) a porous pre-motor filter media comprising an upstream side and a downstream side, wherein the upstream side is on an opposed side of the pre-motor filter media from the downstream side,

(d) a conduit in communication with the cyclone air outlet, extending through the porous pre-motor filter media and in communication with the upstream side of the porous pre-motor filter media;

(e) a suction motor positioned downstream of the porous pre-motor filter media and rearward of the cyclone bin assembly;

(f) an air flow path extending from the porous pre-motor filter media to the suction motor;

(g) a clean air outlet downstream of the suction motor; and

(h) a downstream header on the downstream side of the porous pre-motor filter media and an upstream header on the upstream side of the porous pre-motor filter media;

wherein the cyclone air outlet comprises a vortex finder and the conduit comprises an extension of the vortex finder.

2. The hand carriable surface cleaning apparatus of claim **1** wherein the porous pre-motor filter media is positioned above the cyclone chamber and the upstream side is spaced further from the cyclone chamber than the downstream side.

3. The hand carriable surface cleaning apparatus of claim **1** wherein the air flow path extends downstream from the downstream header.

4. The hand carriable surface cleaning apparatus of claim **2** wherein the upstream header is openable.

5. The hand carriable surface cleaning apparatus of claim **4** wherein at least a portion of the upstream header is transparent.

6. The hand carriable surface cleaning apparatus of claim **1** wherein the suction motor has a suction motor inlet that is positioned between the lower and upper ends of the cyclone bin assembly.

7. The hand carriable surface cleaning apparatus of claim **6** wherein the suction motor has a motor axis that is generally perpendicular to the cyclone axis.

8. The hand carriable surface cleaning apparatus of claim **1** wherein the suction motor has a motor axis that is generally perpendicular to the cyclone axis.

9. The hand carriable surface cleaning apparatus of claim **1** wherein the air inlet is provided at the upper end and a dirt outlet is provided at the lower end and a dirt collection chamber is positioned below the cyclone chamber.

10. The hand carriable surface cleaning apparatus of claim **1** wherein the air flow path has a portion that is exterior to and extends part way along an exterior wall of the cyclone chamber to a suction motor inlet.

11. The hand carriable surface cleaning apparatus of claim **1** further comprising a dirt collection chamber positioned exterior to the cyclone chamber, the air flow path has a portion that extends part way along an exterior wall of the dirt collection chamber to a suction motor inlet.

12. The hand carriable surface cleaning apparatus of claim **1** further comprising a handle, a suction motor housing and a porous pre-motor filter media housing positioned above the cyclone chamber, the handle extending between the suction motor housing and the porous pre-motor filter media housing.

13. The hand carriable surface cleaning apparatus of claim **12** wherein the porous pre-motor filter media housing is openable.

14. The hand carriable surface cleaning apparatus of claim **12** wherein the suction motor has a motor axis that is generally perpendicular to the cyclone axis.

15. The hand carriable surface cleaning apparatus of claim **12** wherein the handle has a suction motor housing end that is spaced rearward of the cyclone bin assembly and below the porous pre-motor filter media housing and a porous pre-motor filter media end that is spaced above and forward of the suction motor end of the handle.

16. The hand carriable surface cleaning apparatus of claim **12** further comprising an opening having a perimeter and the perimeter comprises portions of the handle, the pre-motor filter housing and the suction motor housing.

17. The hand carriable surface cleaning apparatus of claim **1** further comprising a handle, wherein a portion of the handle is placed rearward of a centre of gravity of the hand carriable surface cleaning apparatus.

18. The hand carriable surface cleaning apparatus of claim **1** further comprising a bleed valve having an inlet end in the air flow path.

19. The hand carriable surface cleaning apparatus of claim 18 wherein the bleed valve has an axis that is generally parallel to an axis of the suction motor.

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