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Conrad

(54) **CYCLONIC SURFACE CLEANING APPARATUS WITH EXTERNALLY POSITIONED DIRT CHAMBER**

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(30) **Foreign Application Priority Data**

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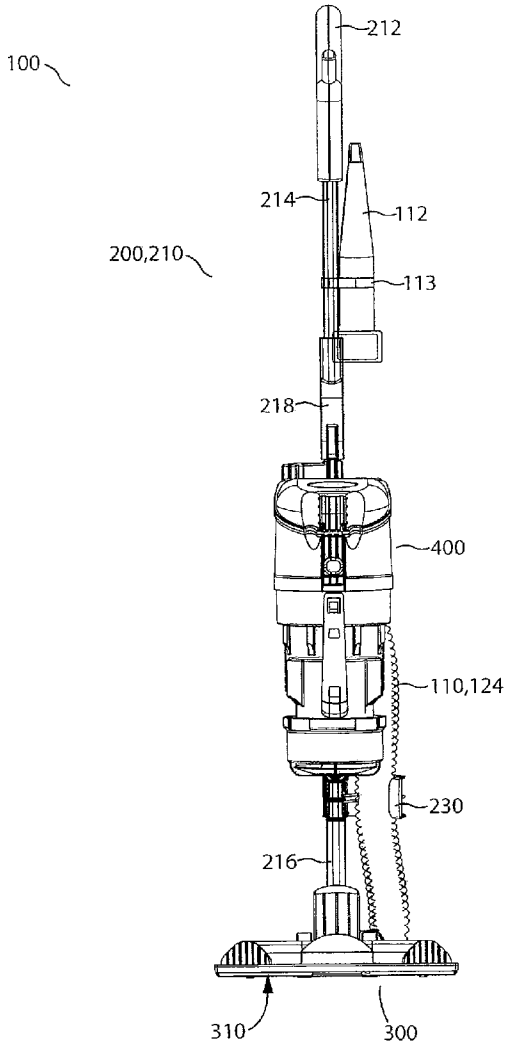
(52) **U.S. Cl.** **15/331**; 15/347

(57) **ABSTRACT**

A surface cleaning apparatus comprises a floor cleaning unit and an upright section comprising a handle drivingly connected to the surface cleaning head. The surface cleaning apparatus also comprises a cyclone mounted on the upright section and positioned in the air flow passage. The cyclone is inverted and/or has an external dirt collection chamber.



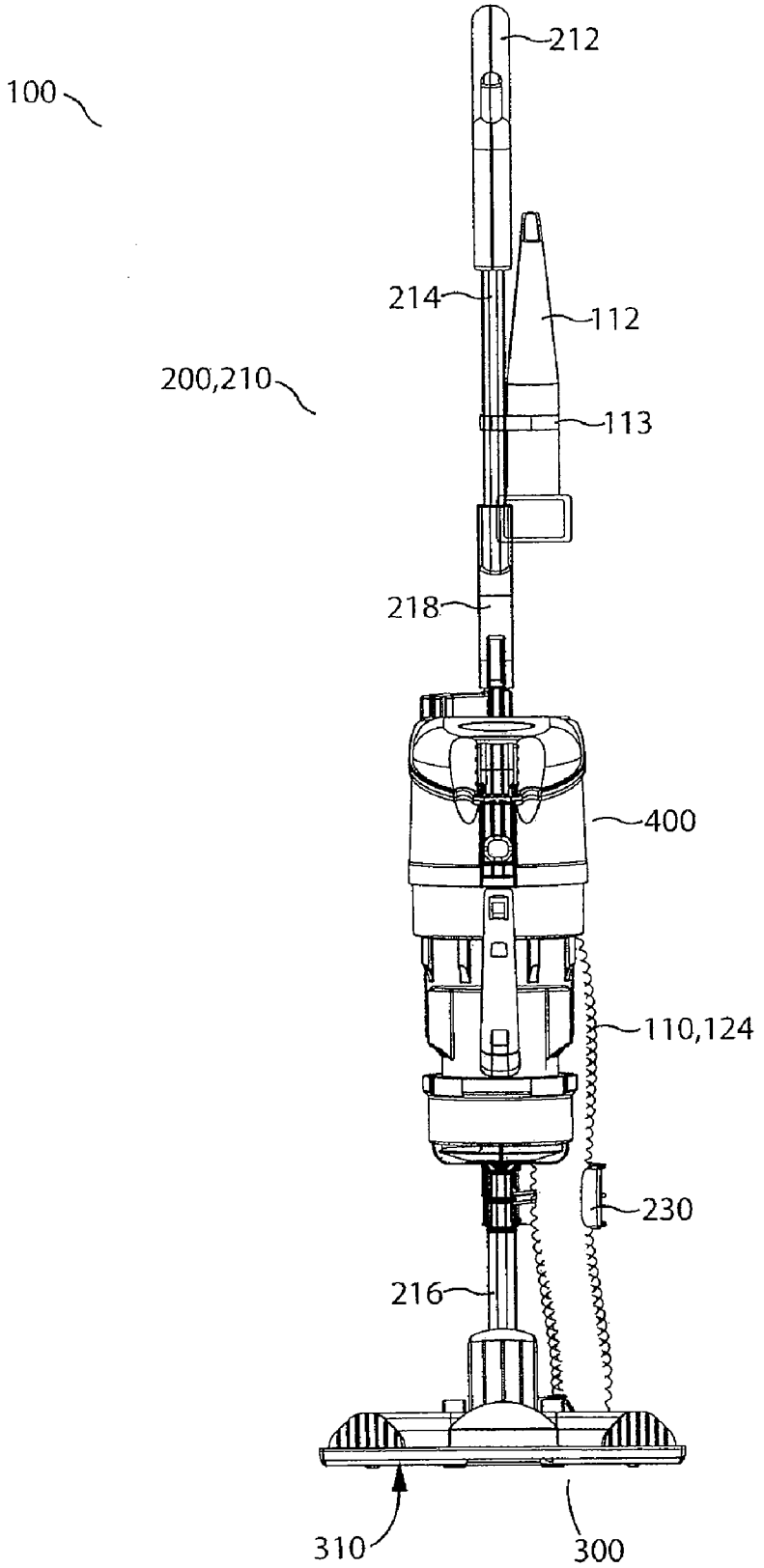


Fig. 1

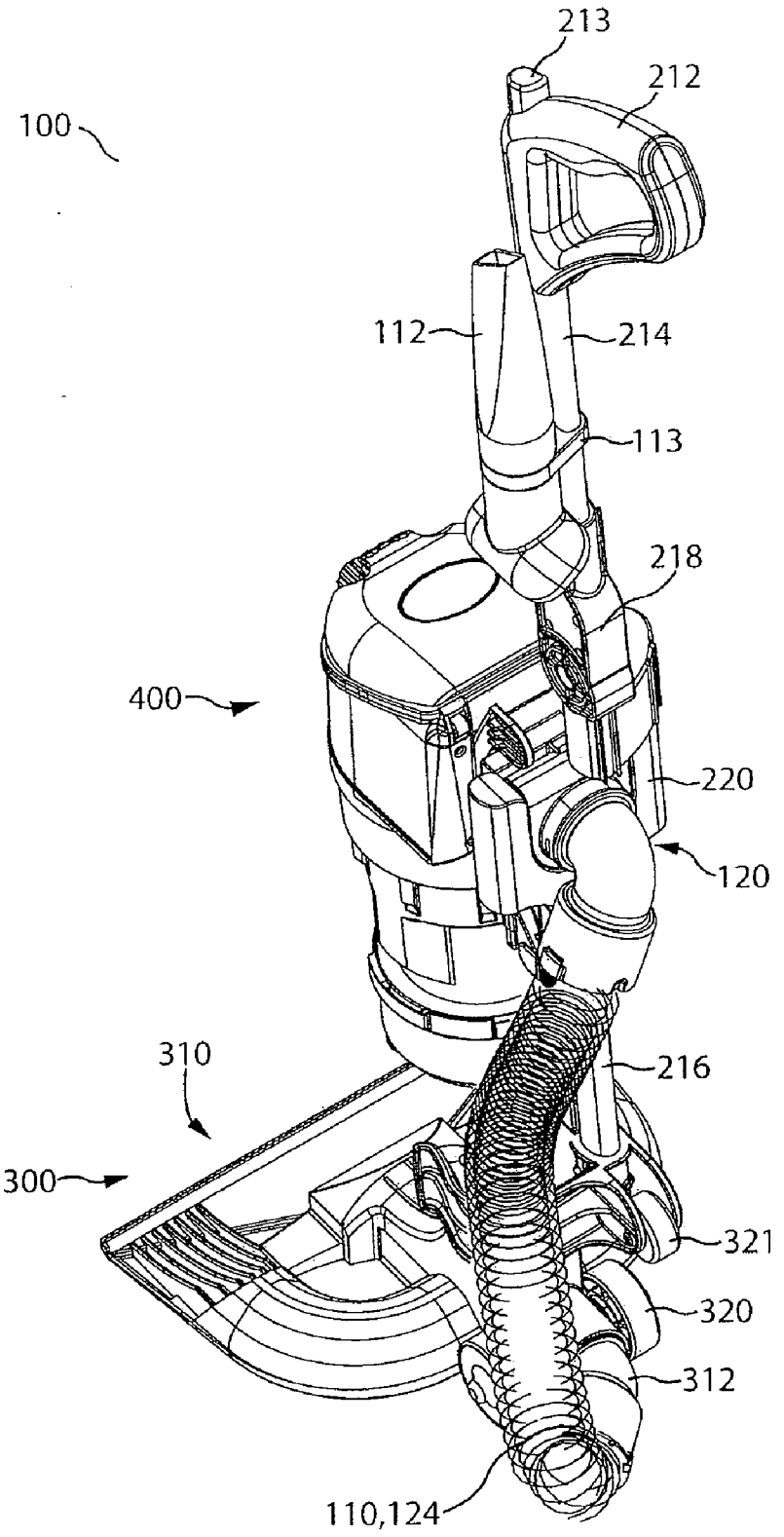

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Fig. 2

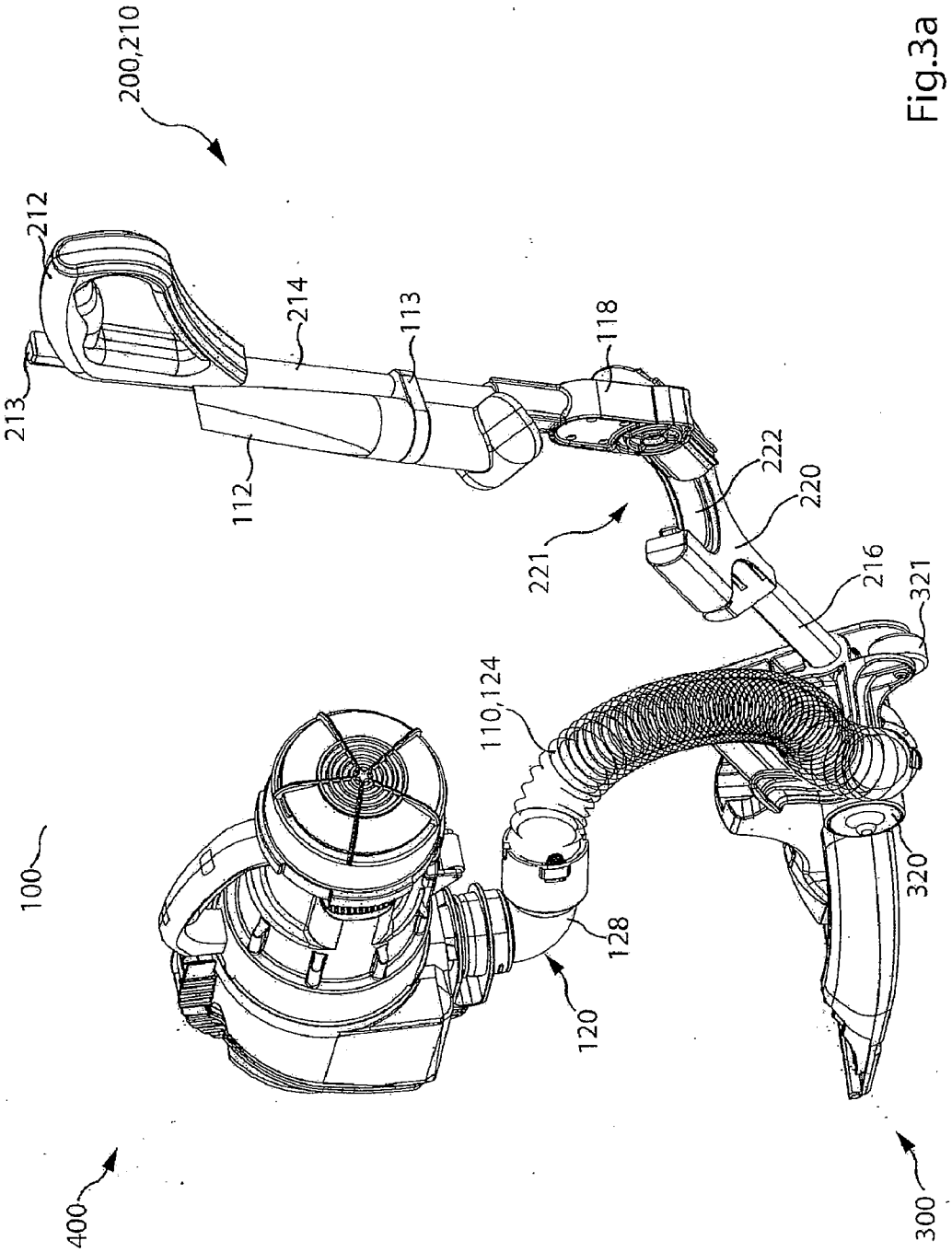
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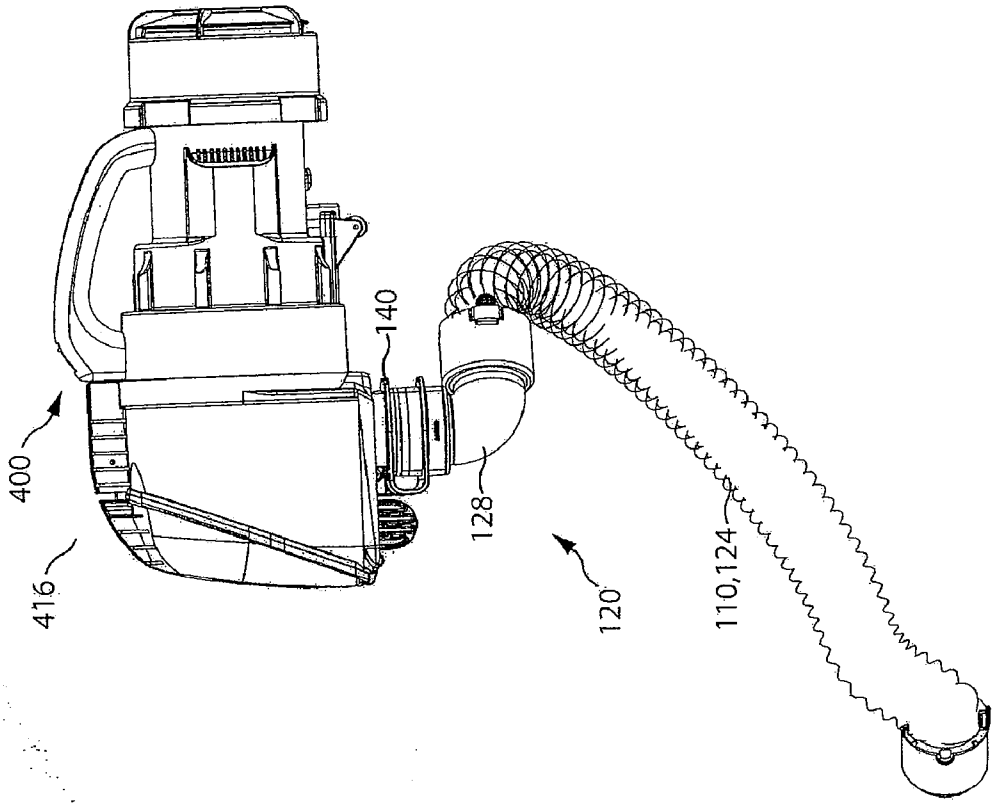
Fig.3a

Fig.3b



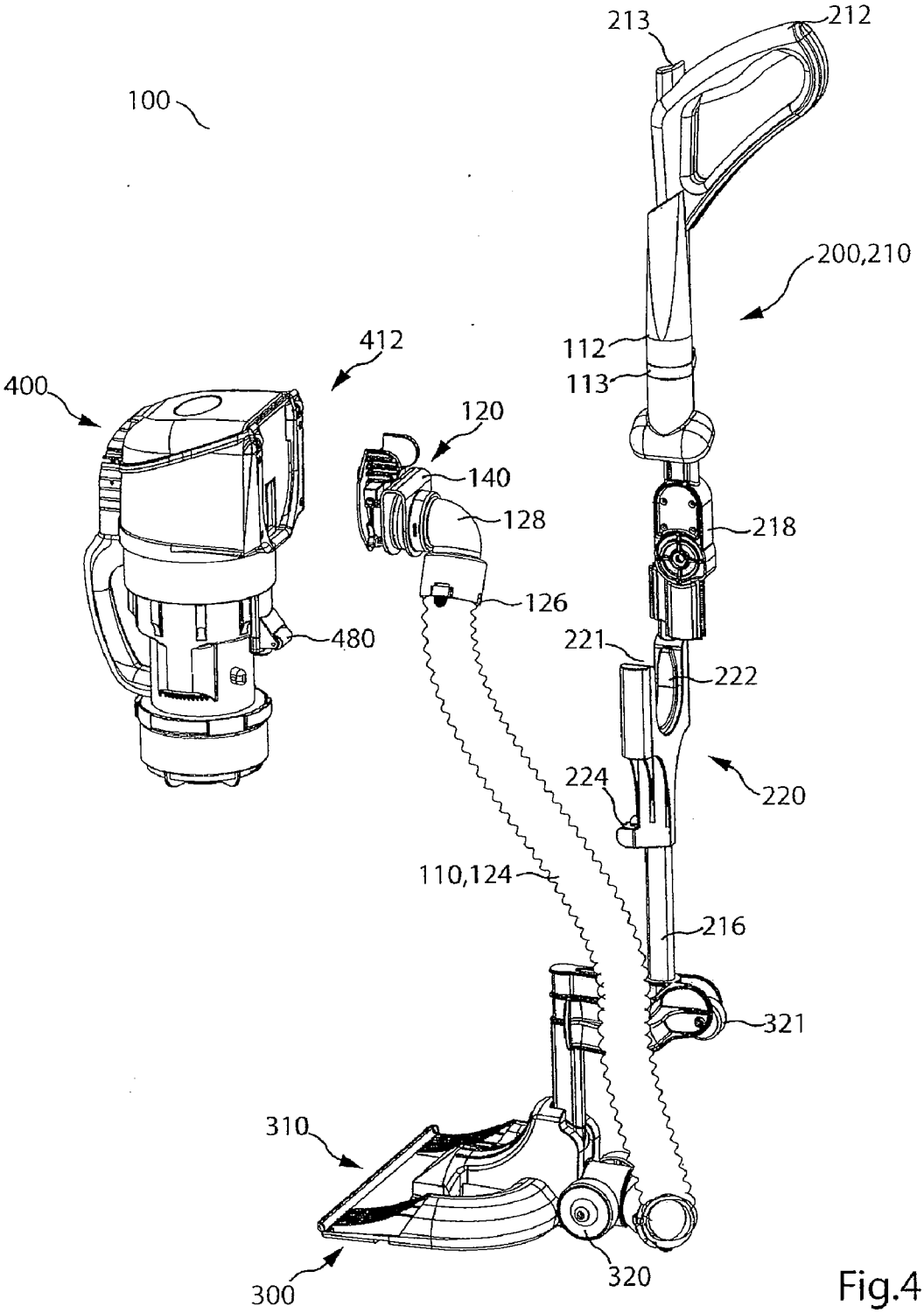

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Fig.4

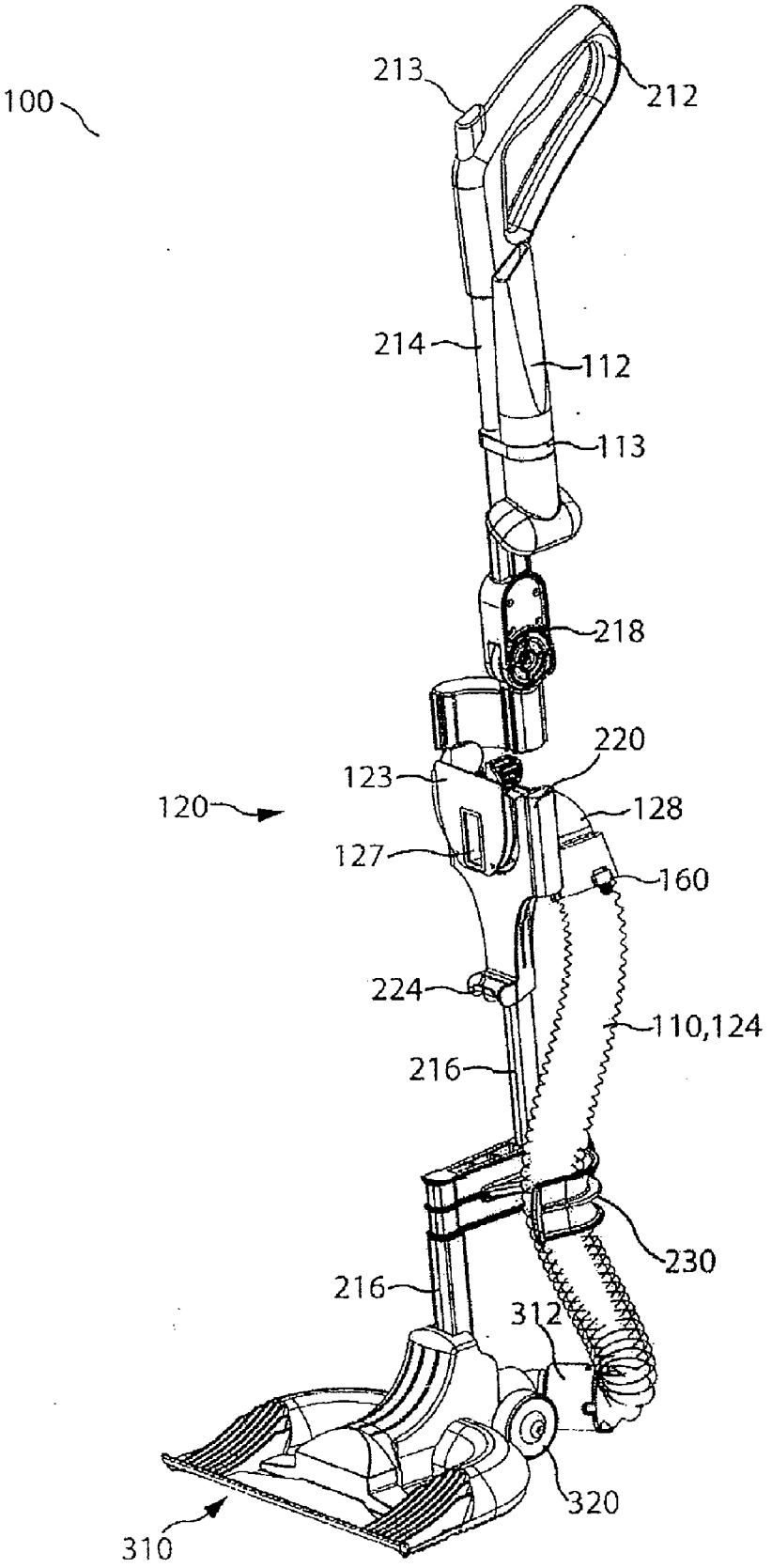
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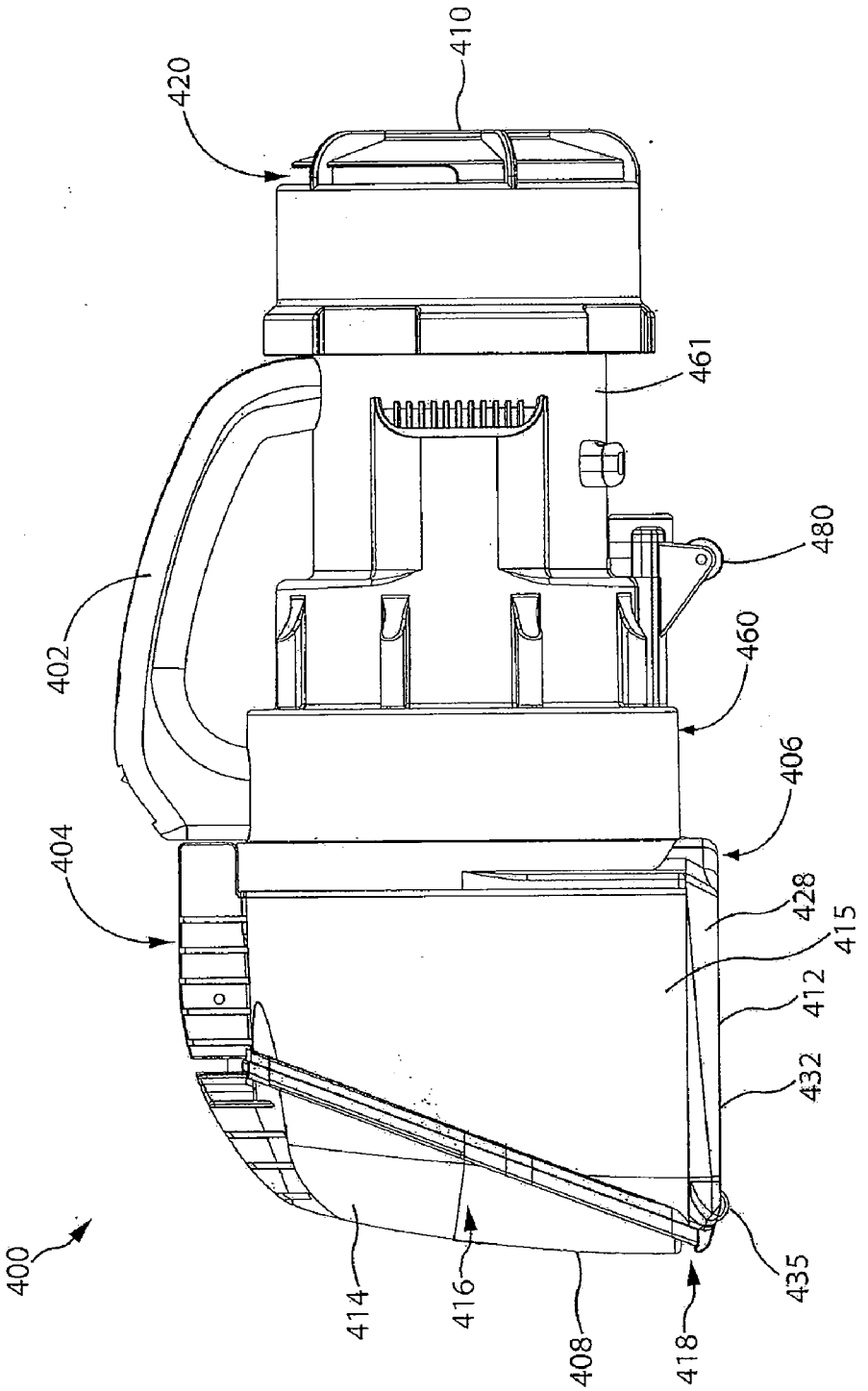
Fig.5

Fig.6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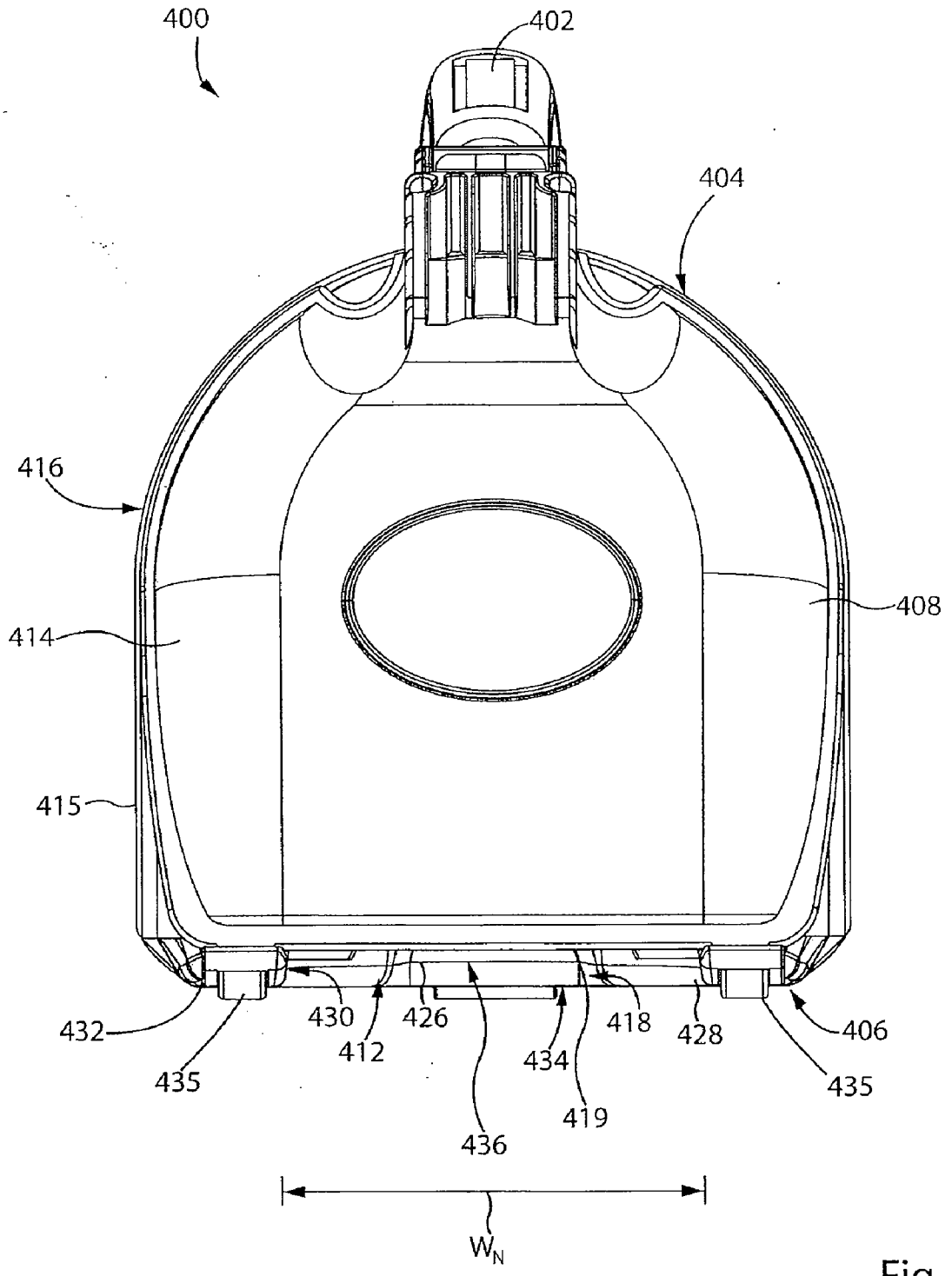
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Fig. 7

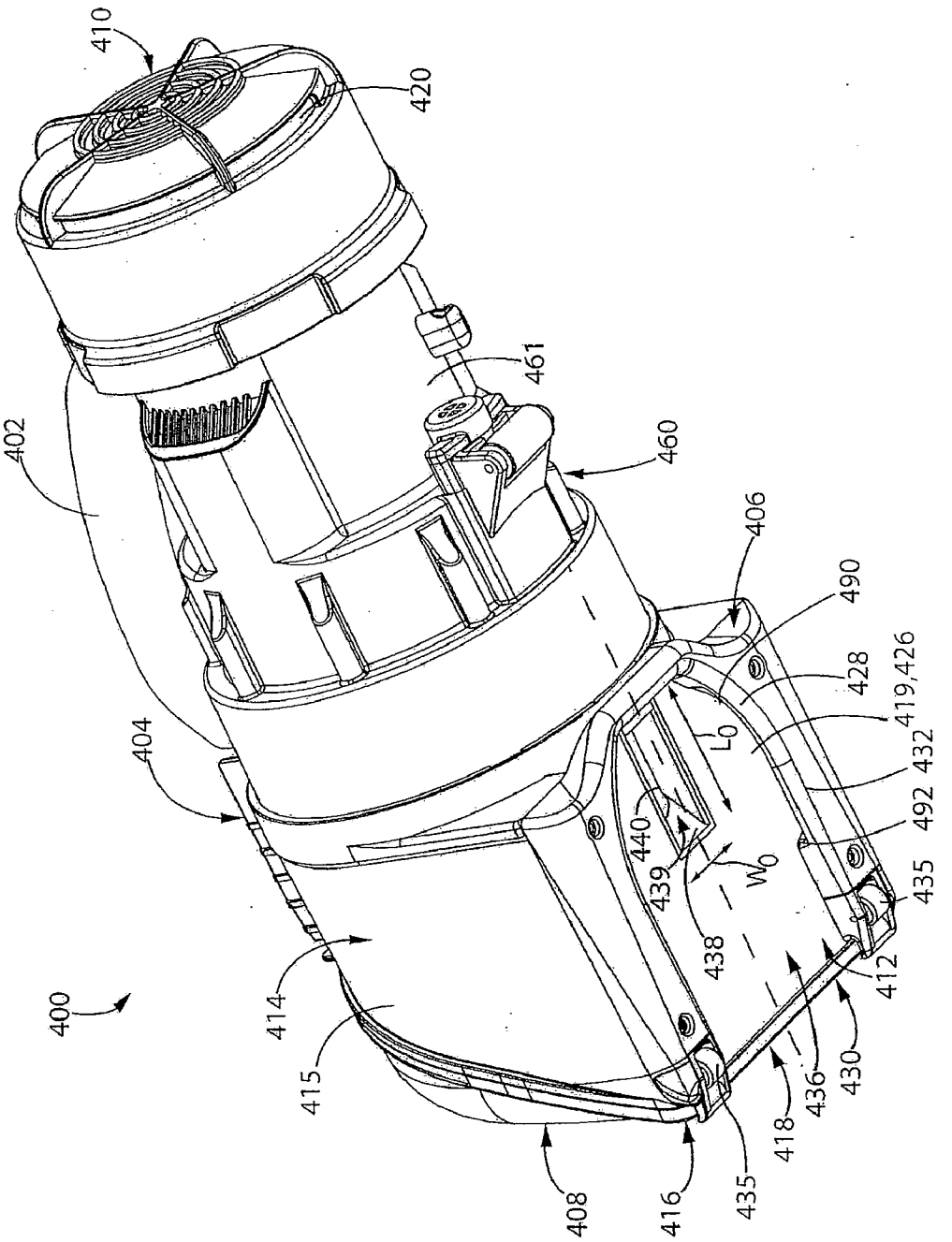
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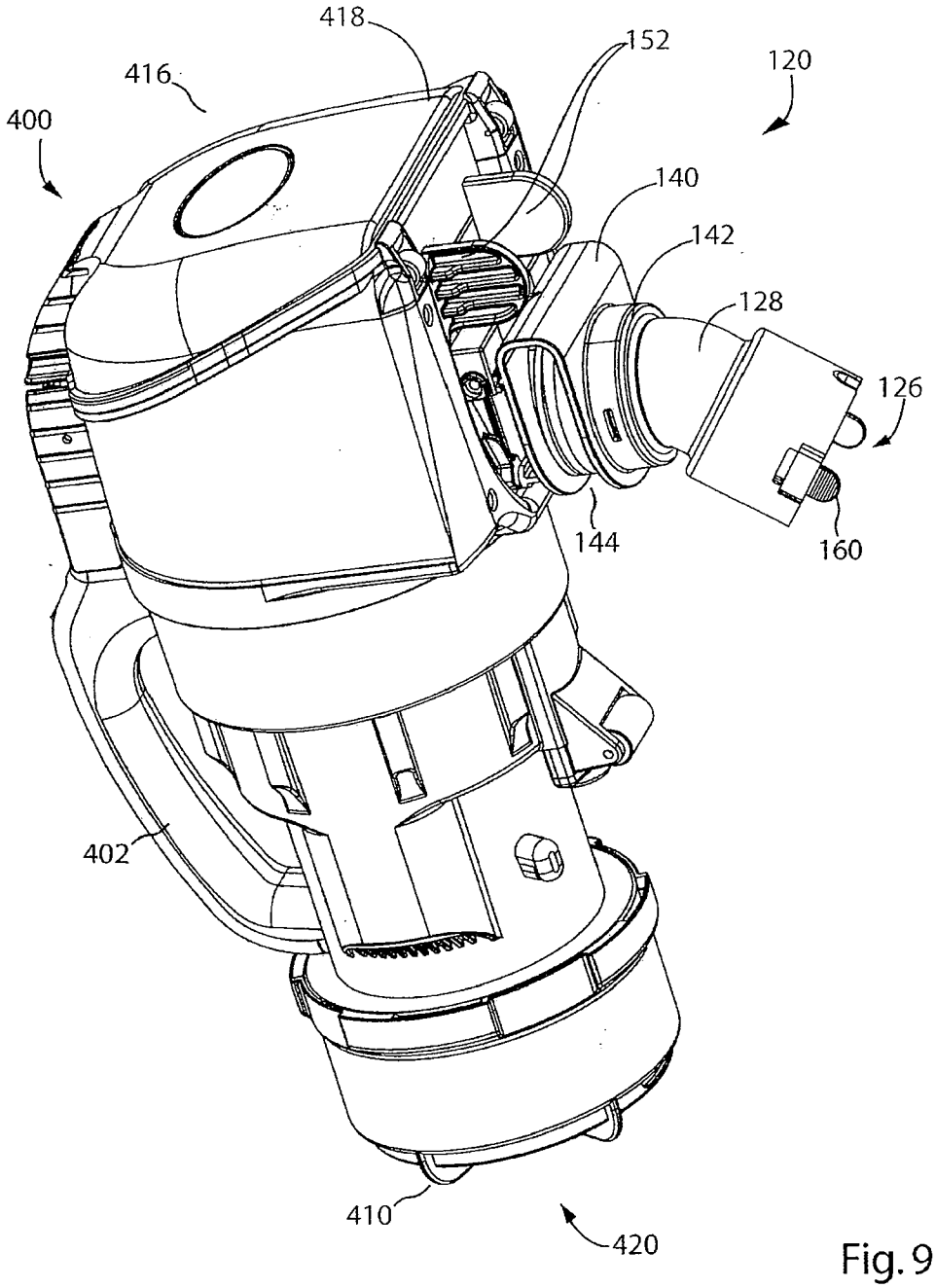
Fig. 8



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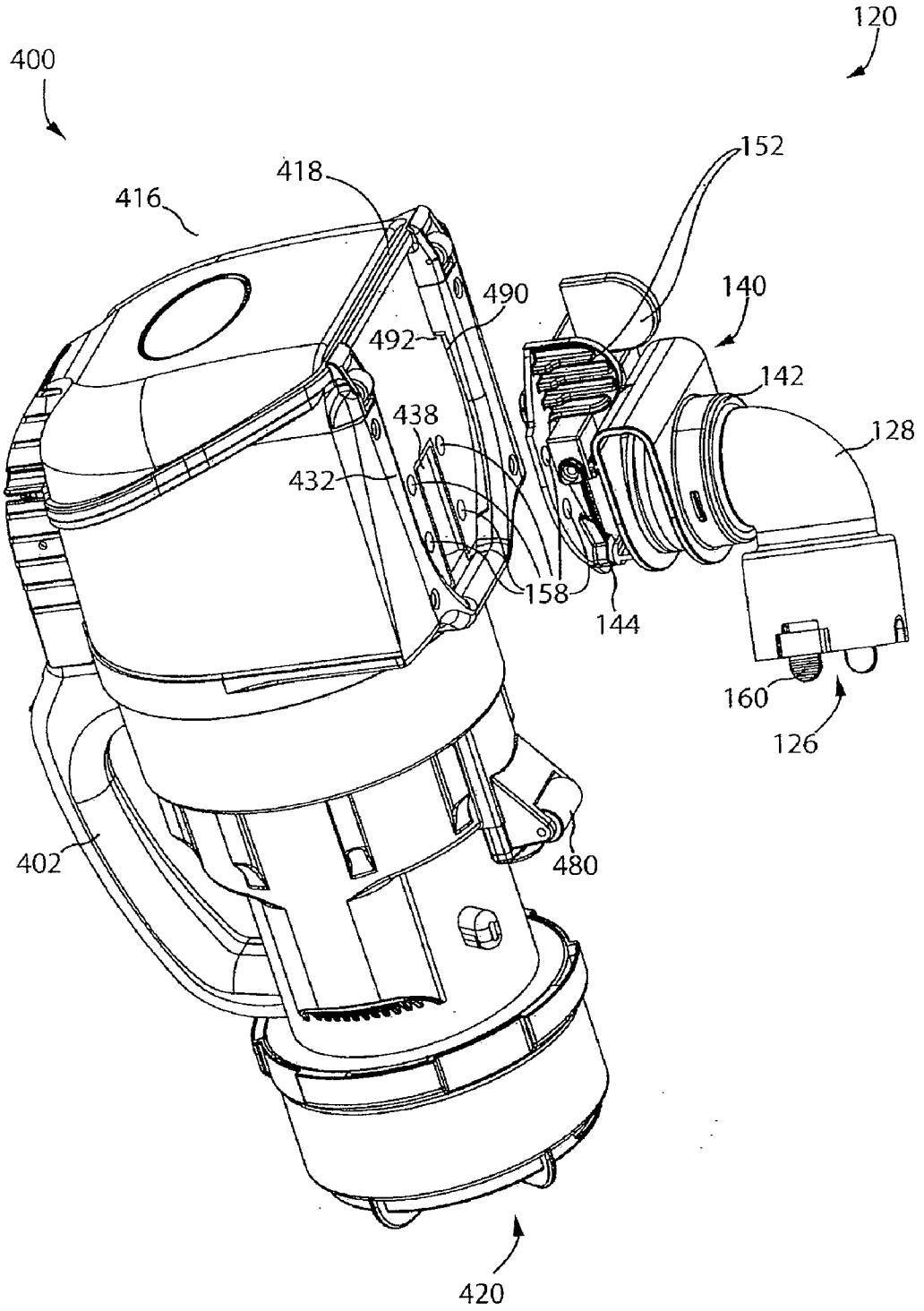
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Fig. 10

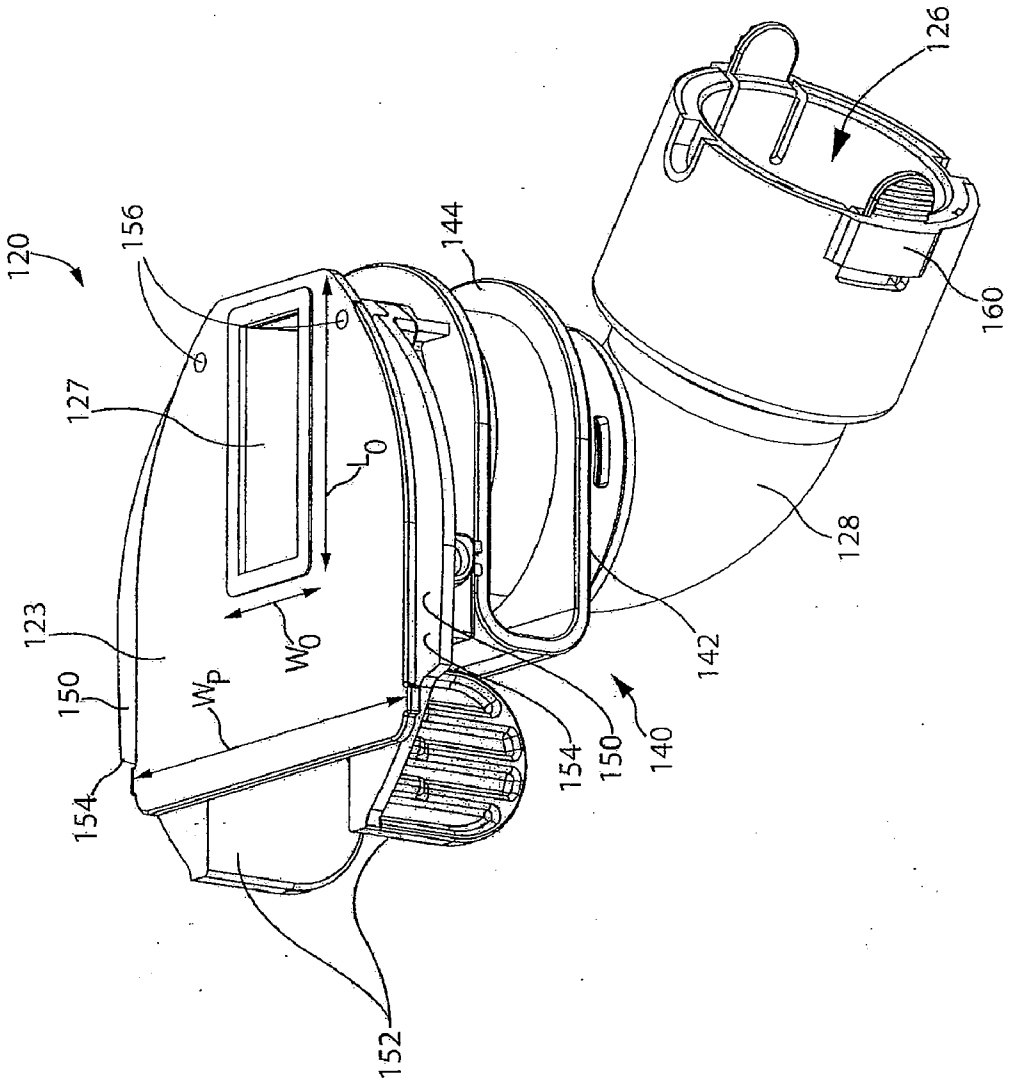
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Fig. 11

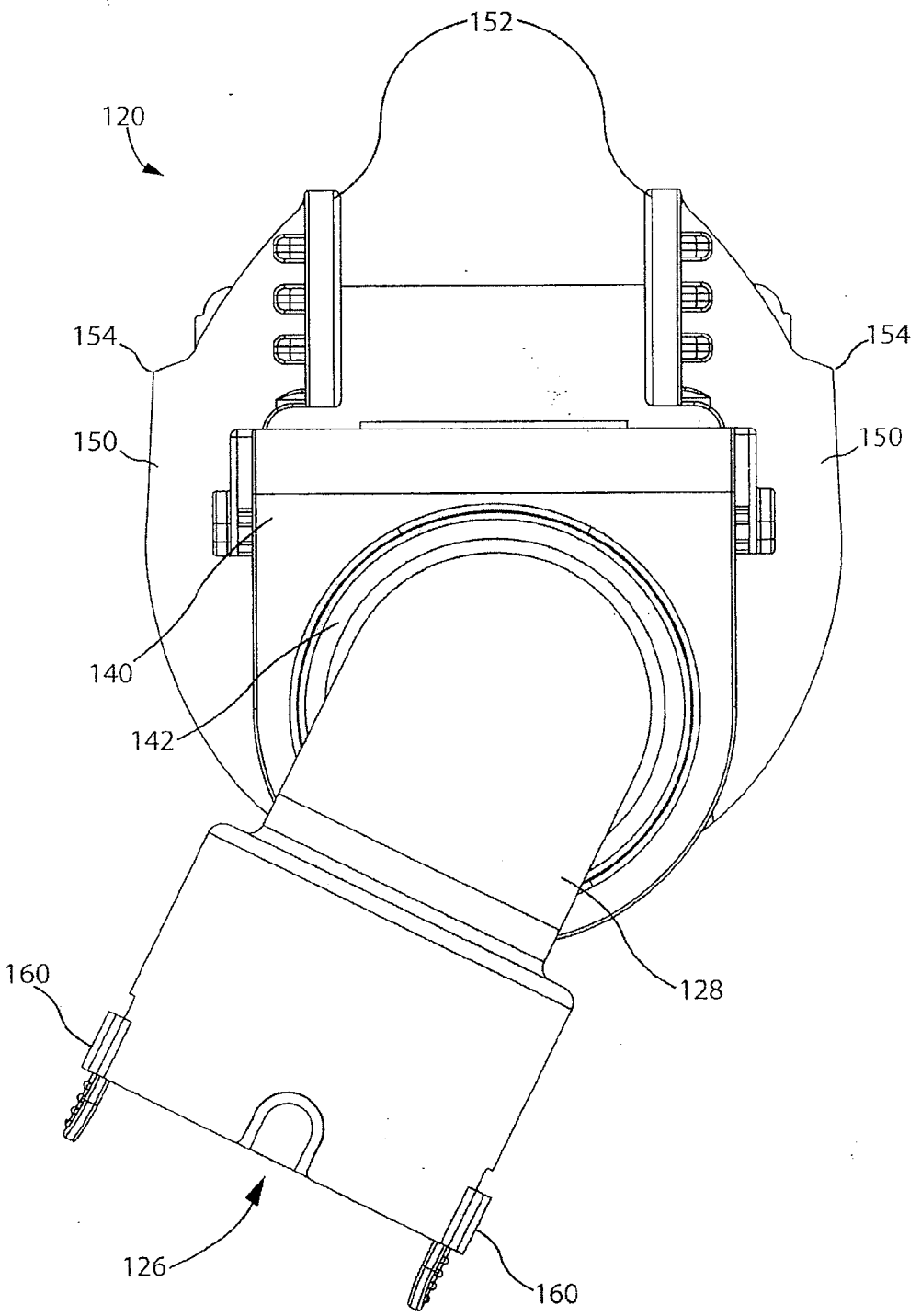
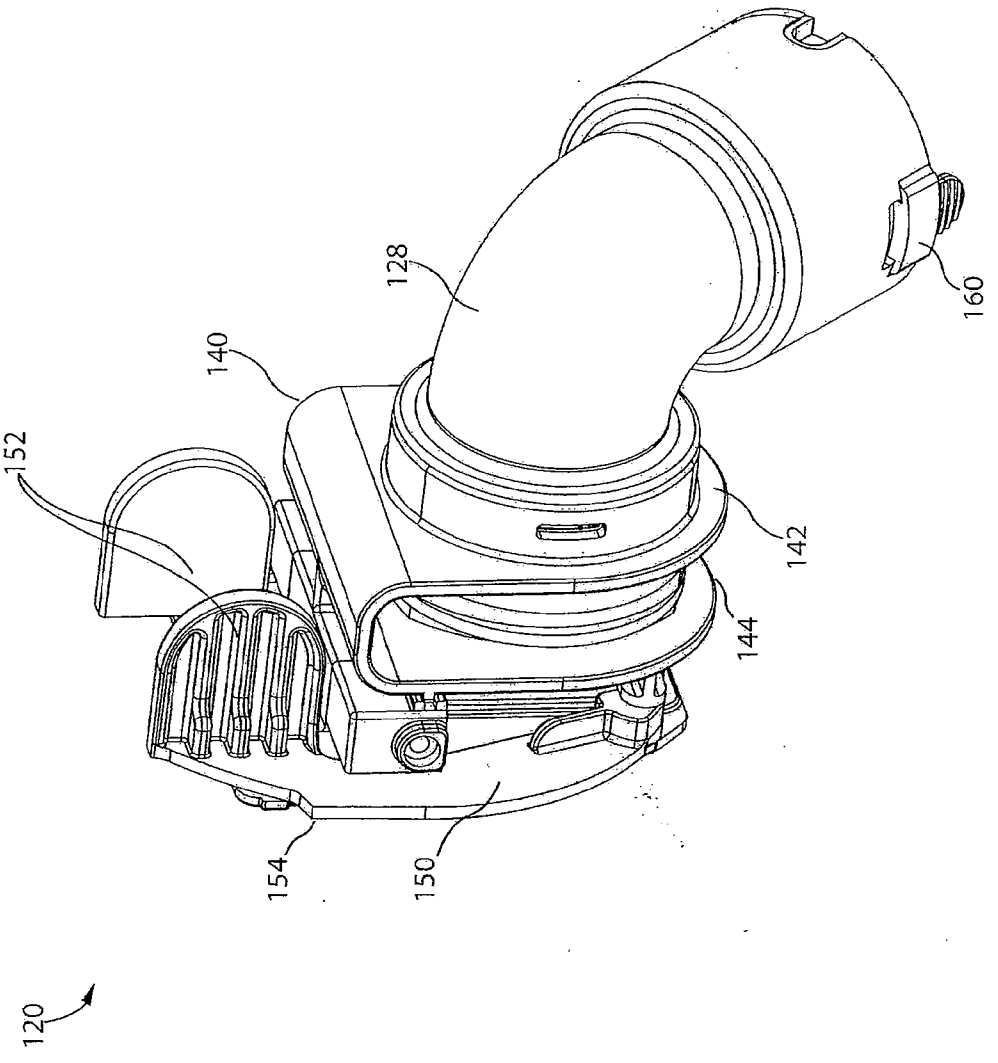


Fig. 12

Fig. 13



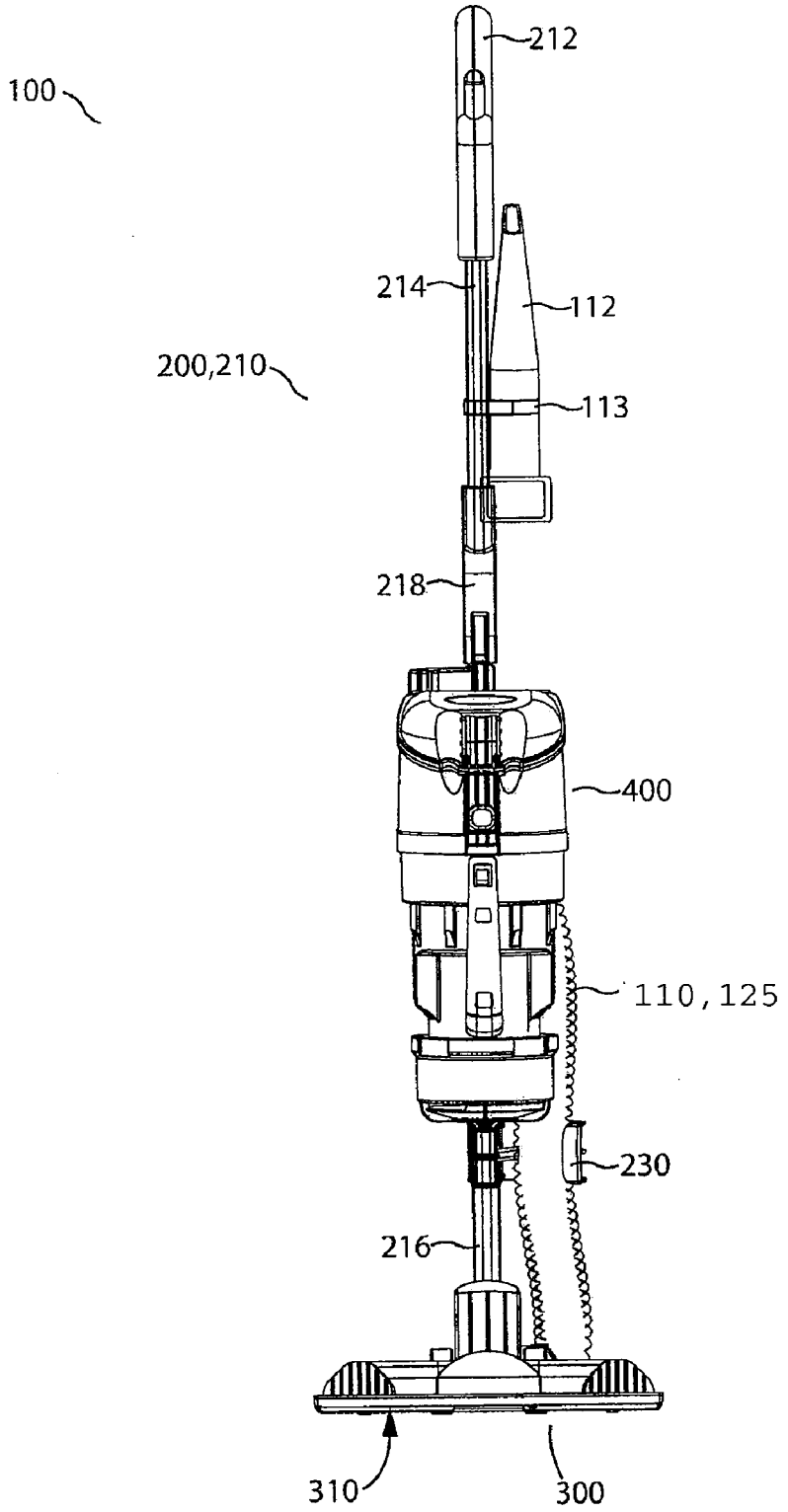


FIG.14

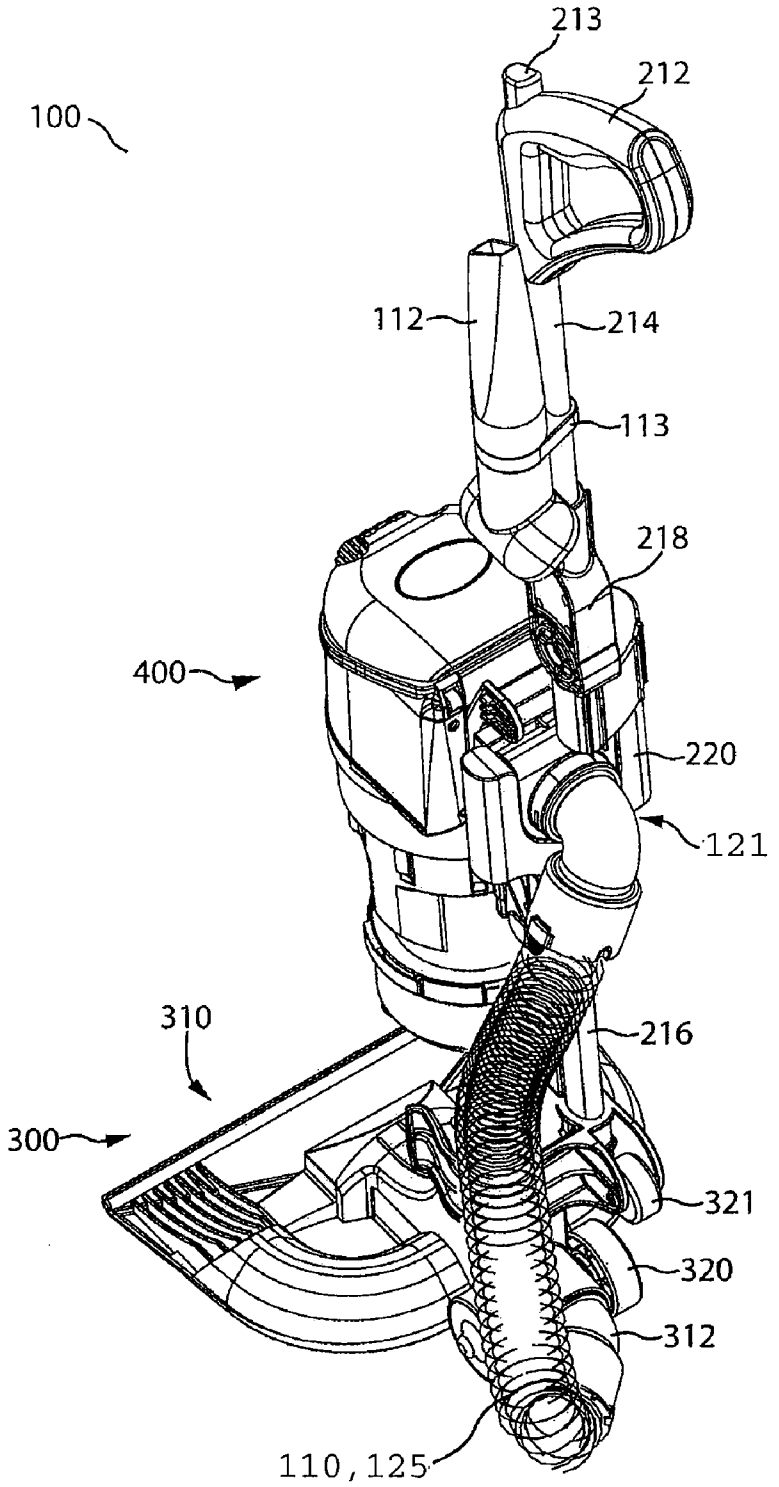

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FIG.15

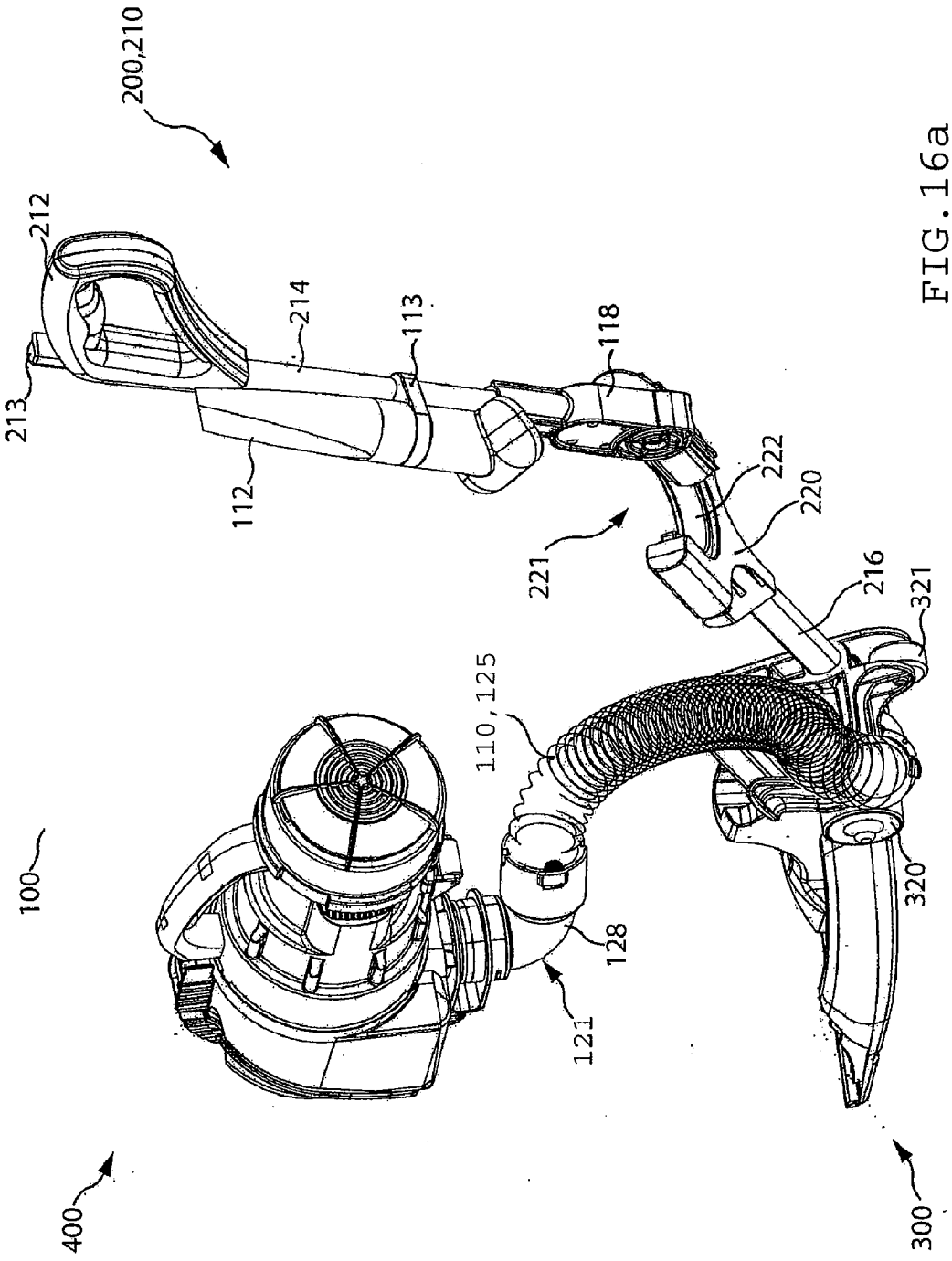
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FIG.16a

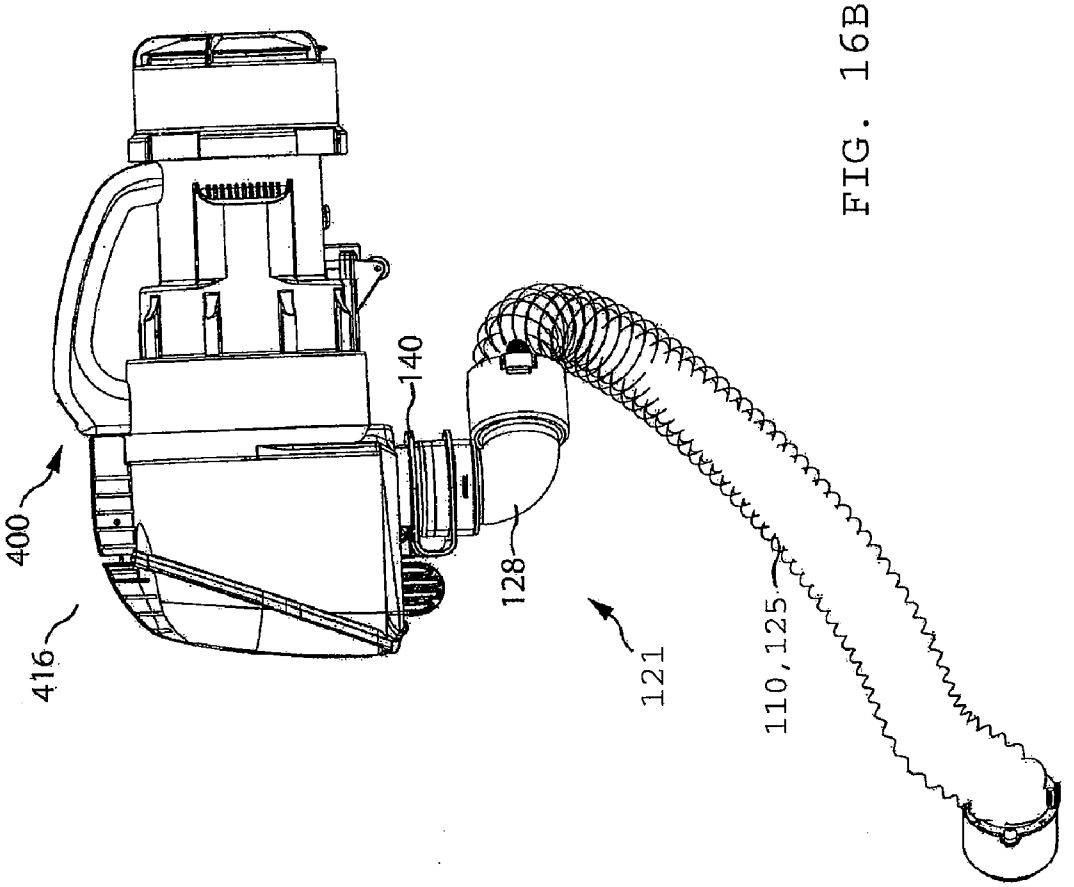

FIG. 16B

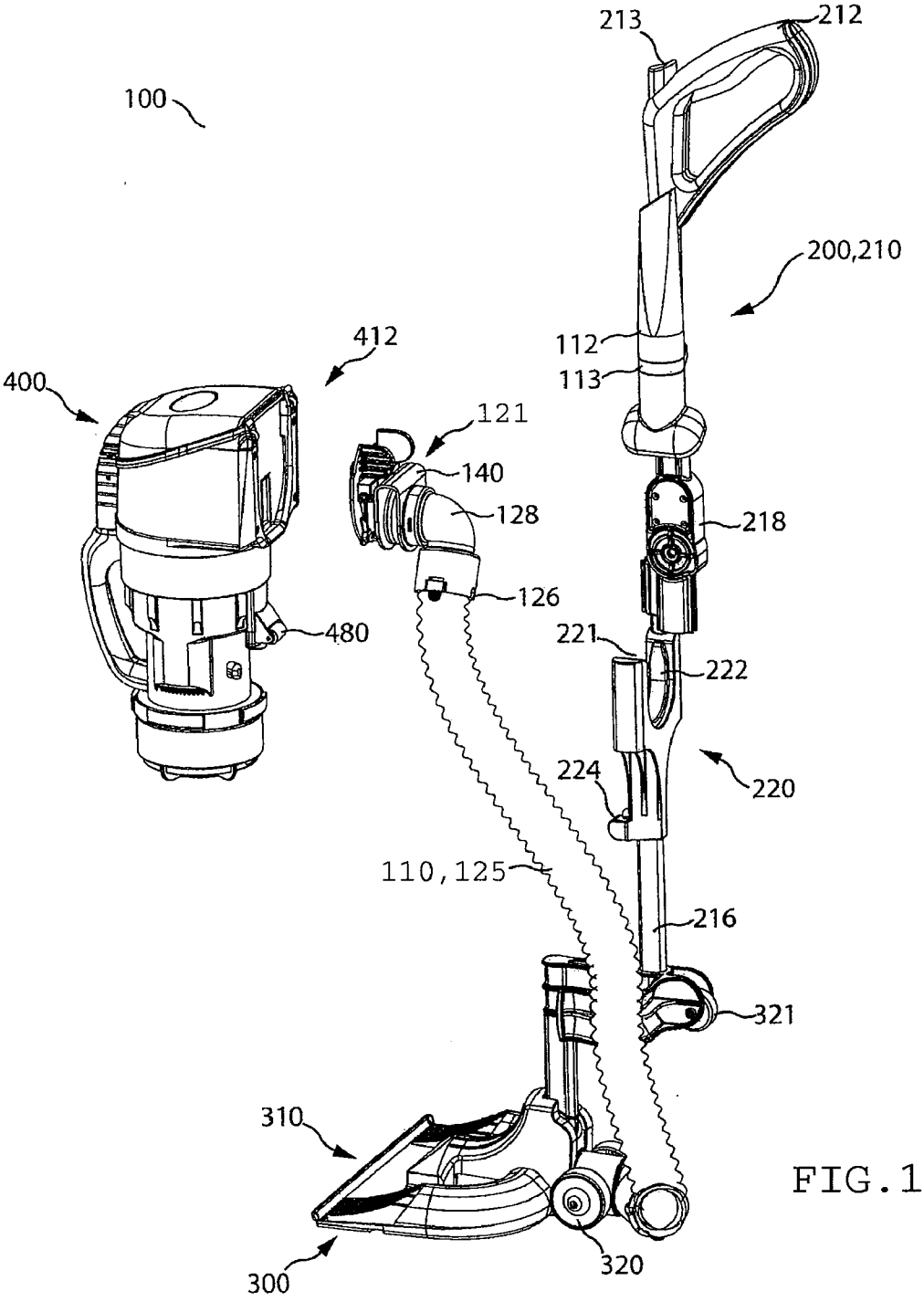
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FIG.17

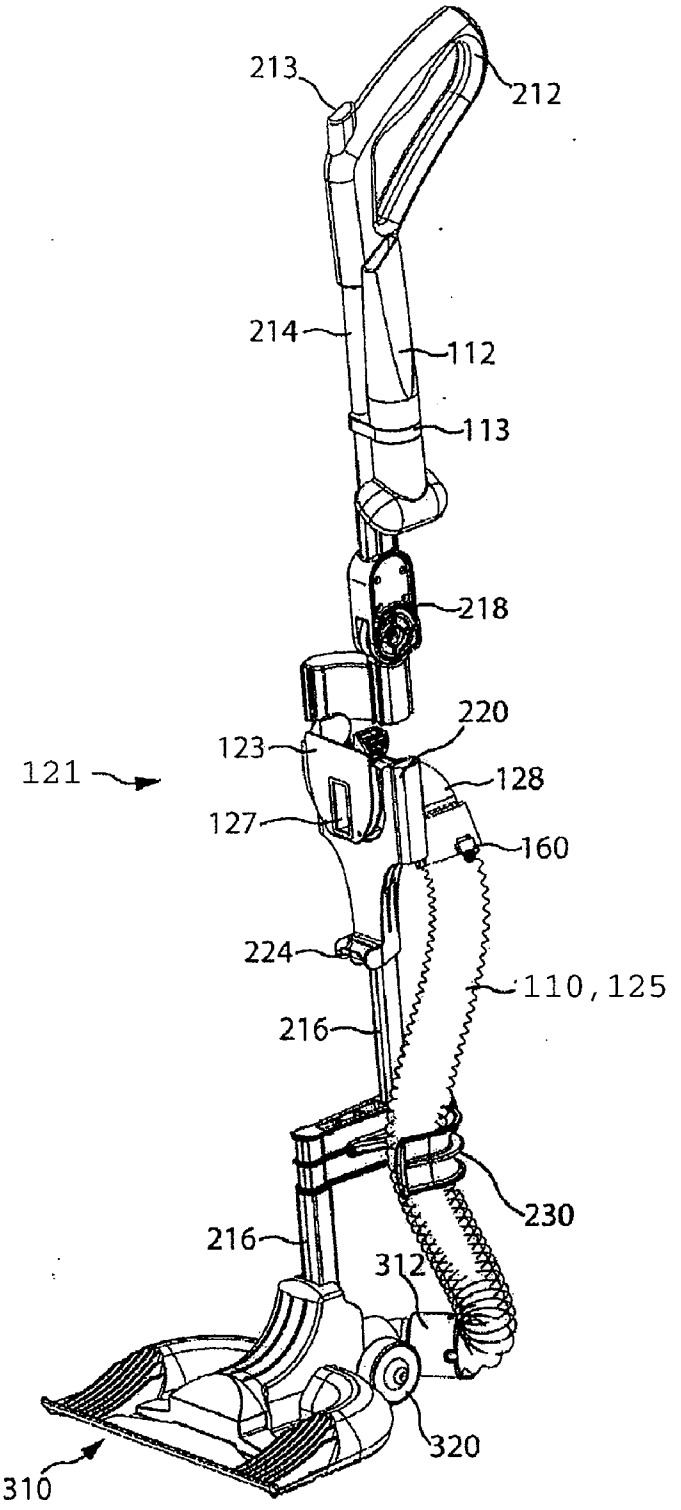
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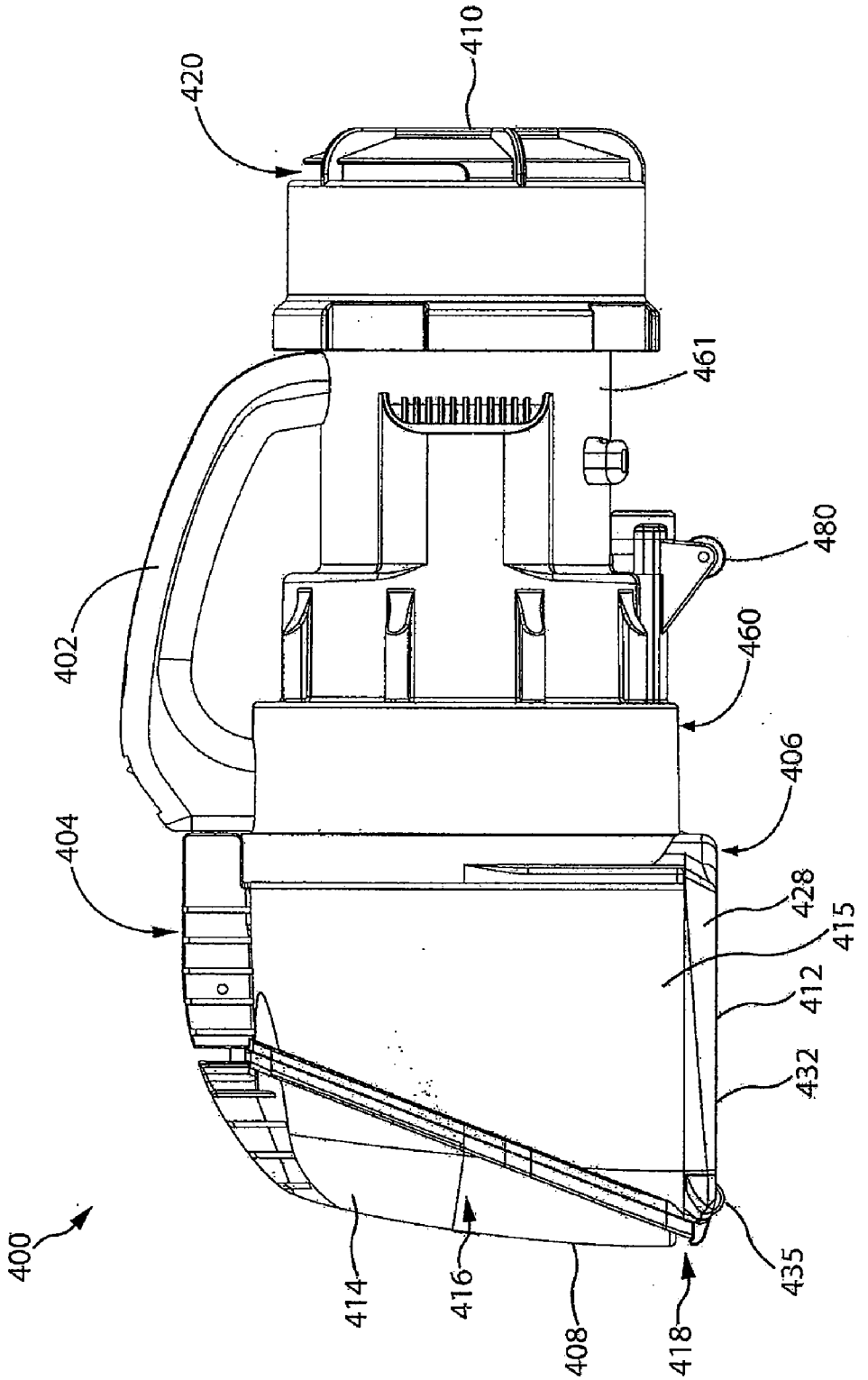
FIG.18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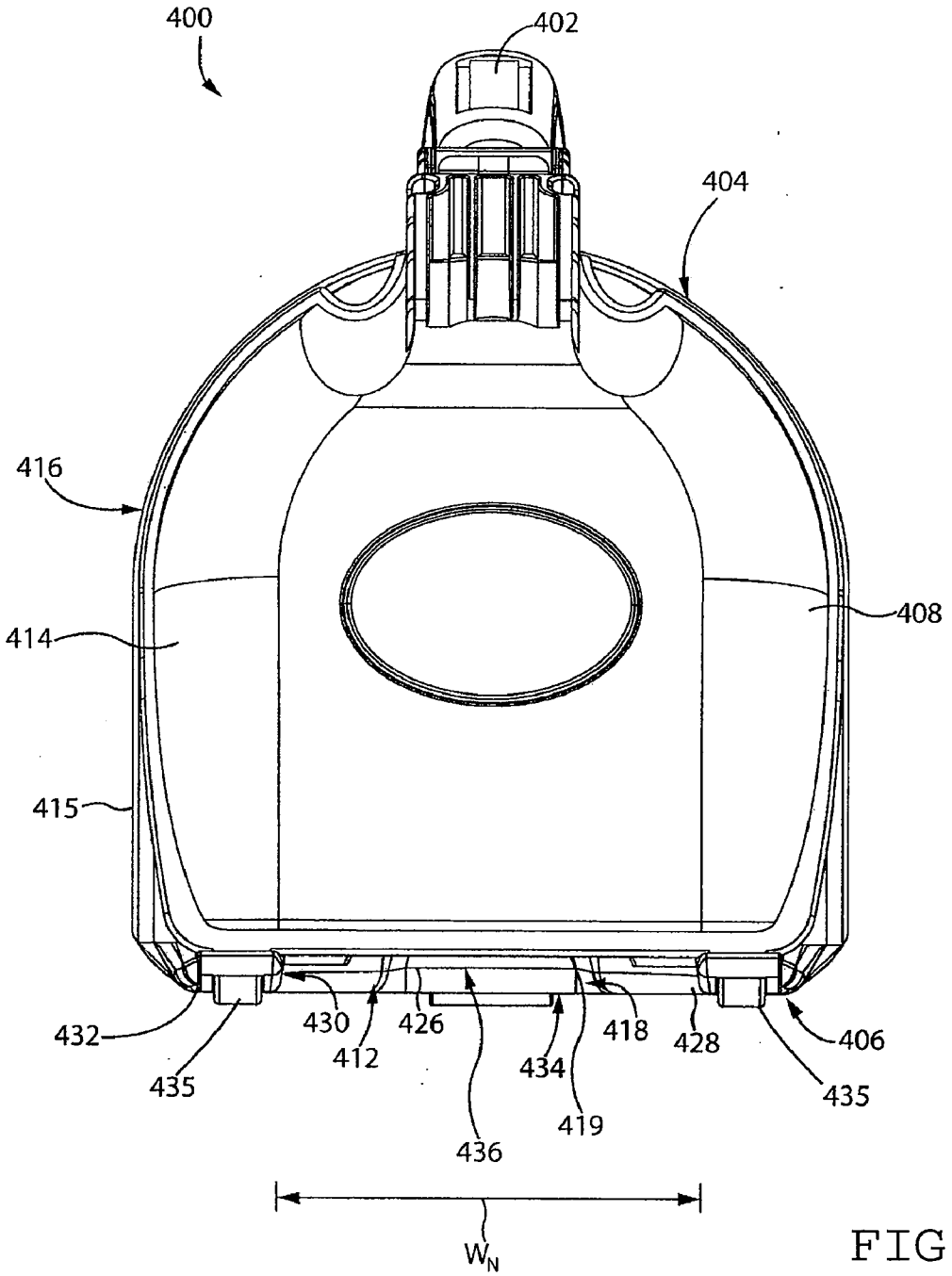
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FIG.20

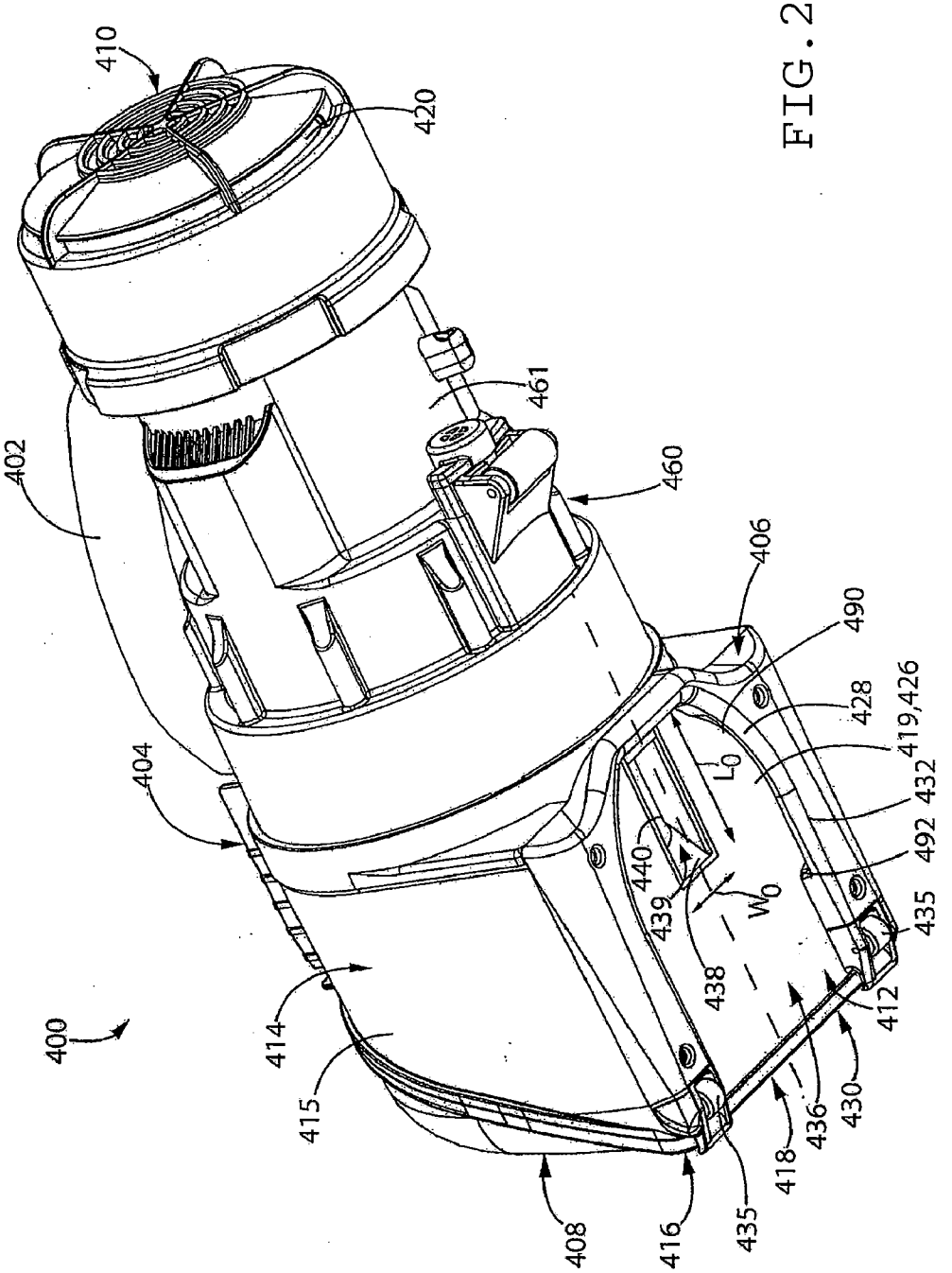
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FIG. 21

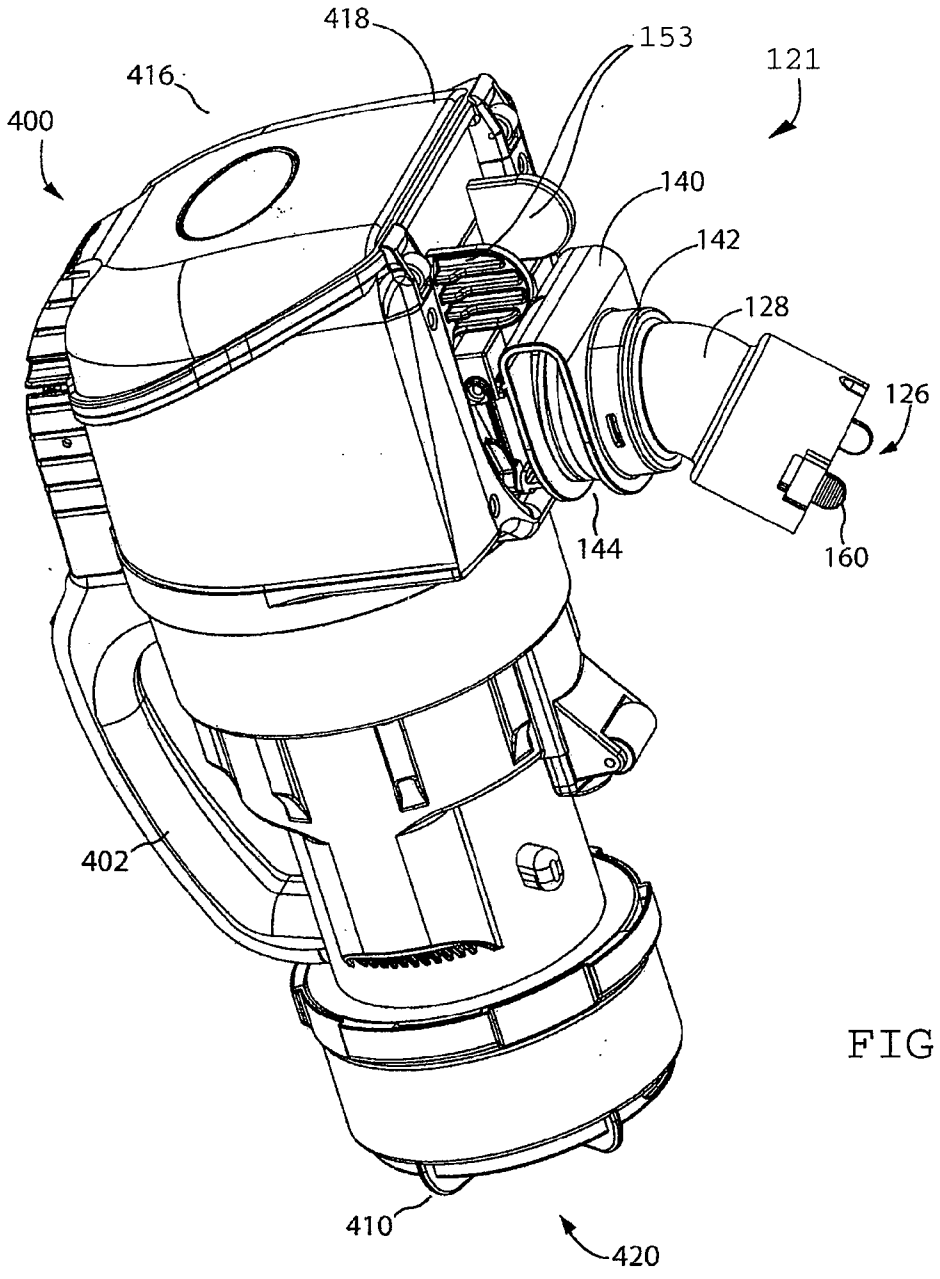

FIG. 22

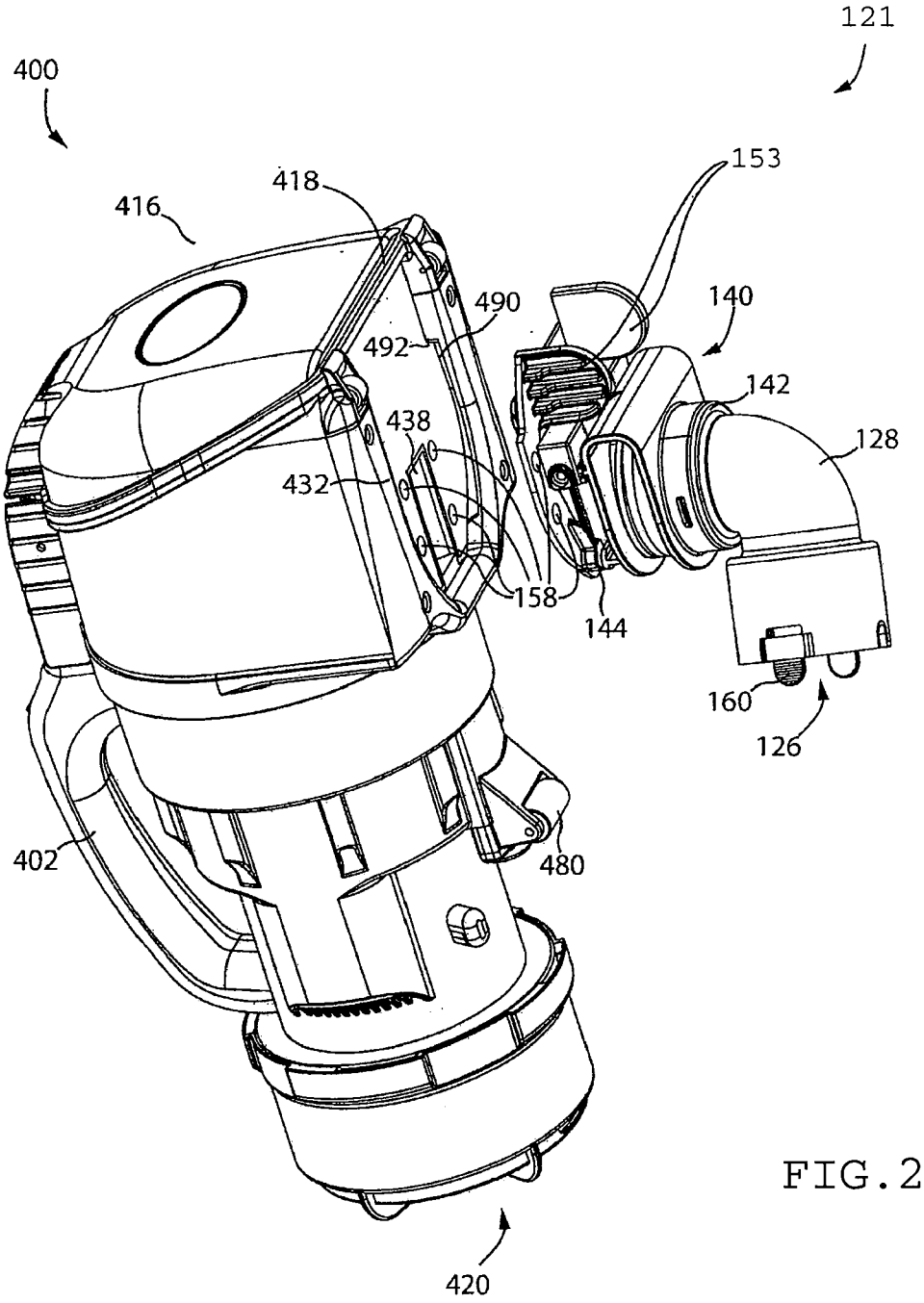
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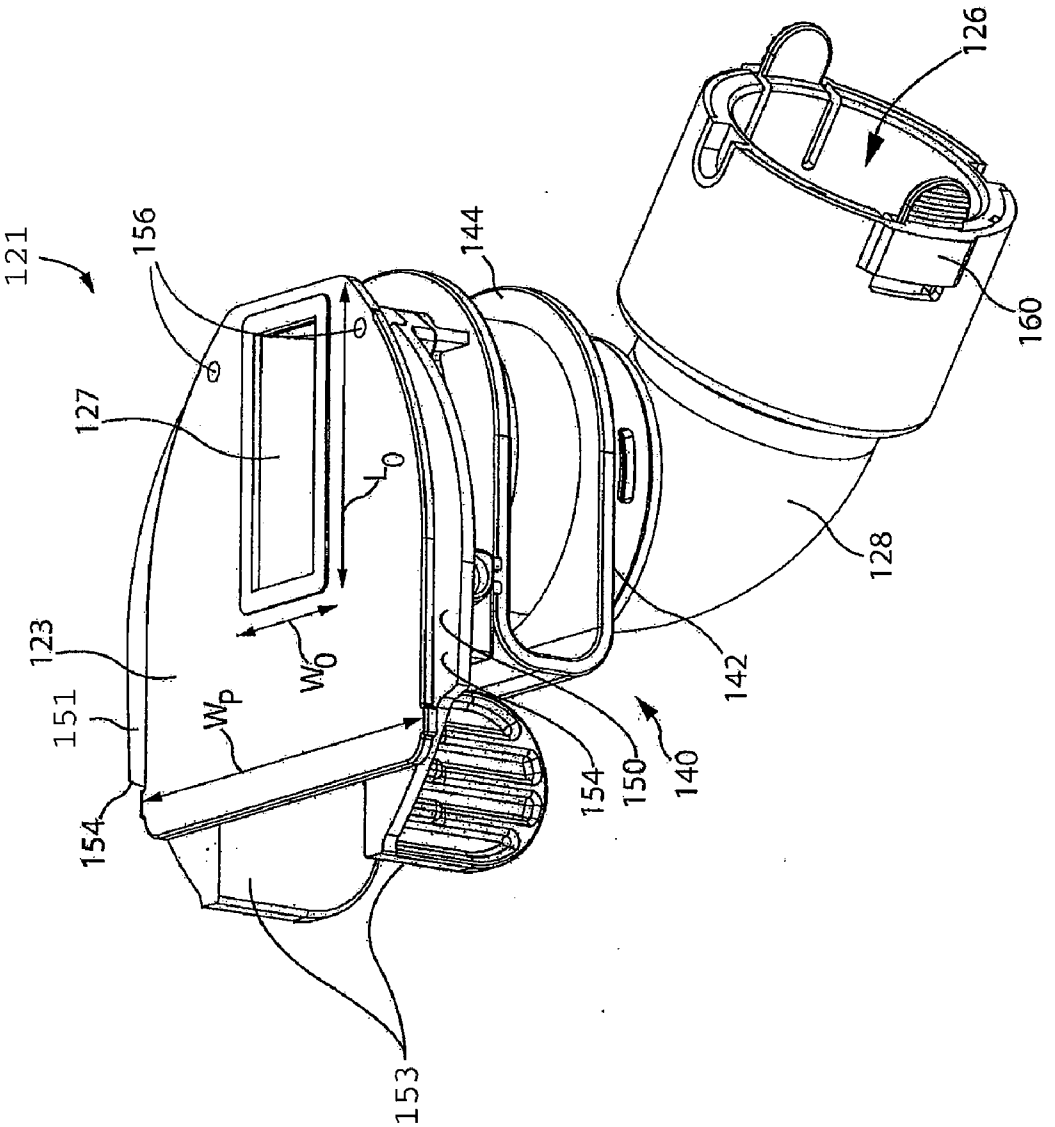
FIG.23

FIG. 24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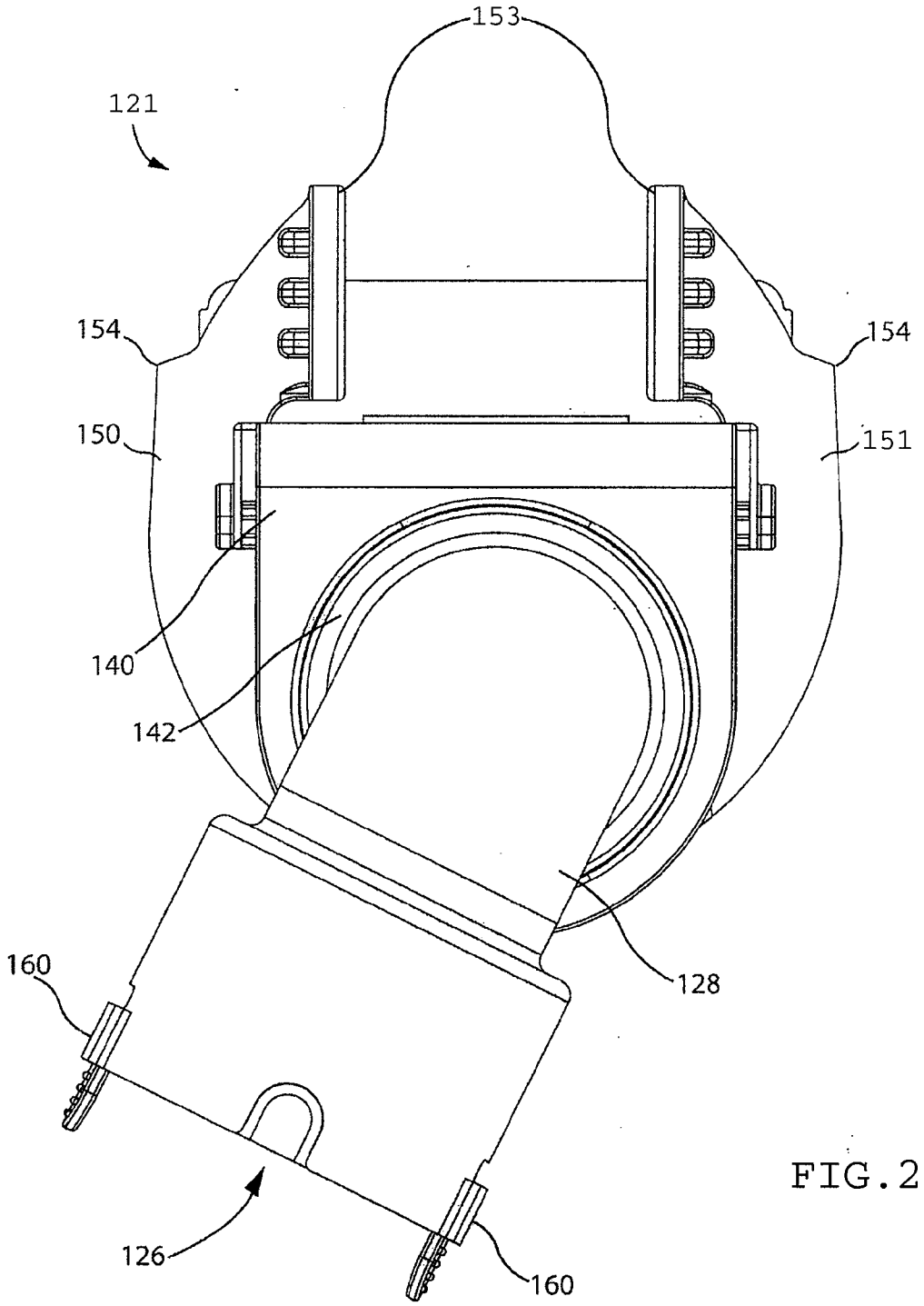
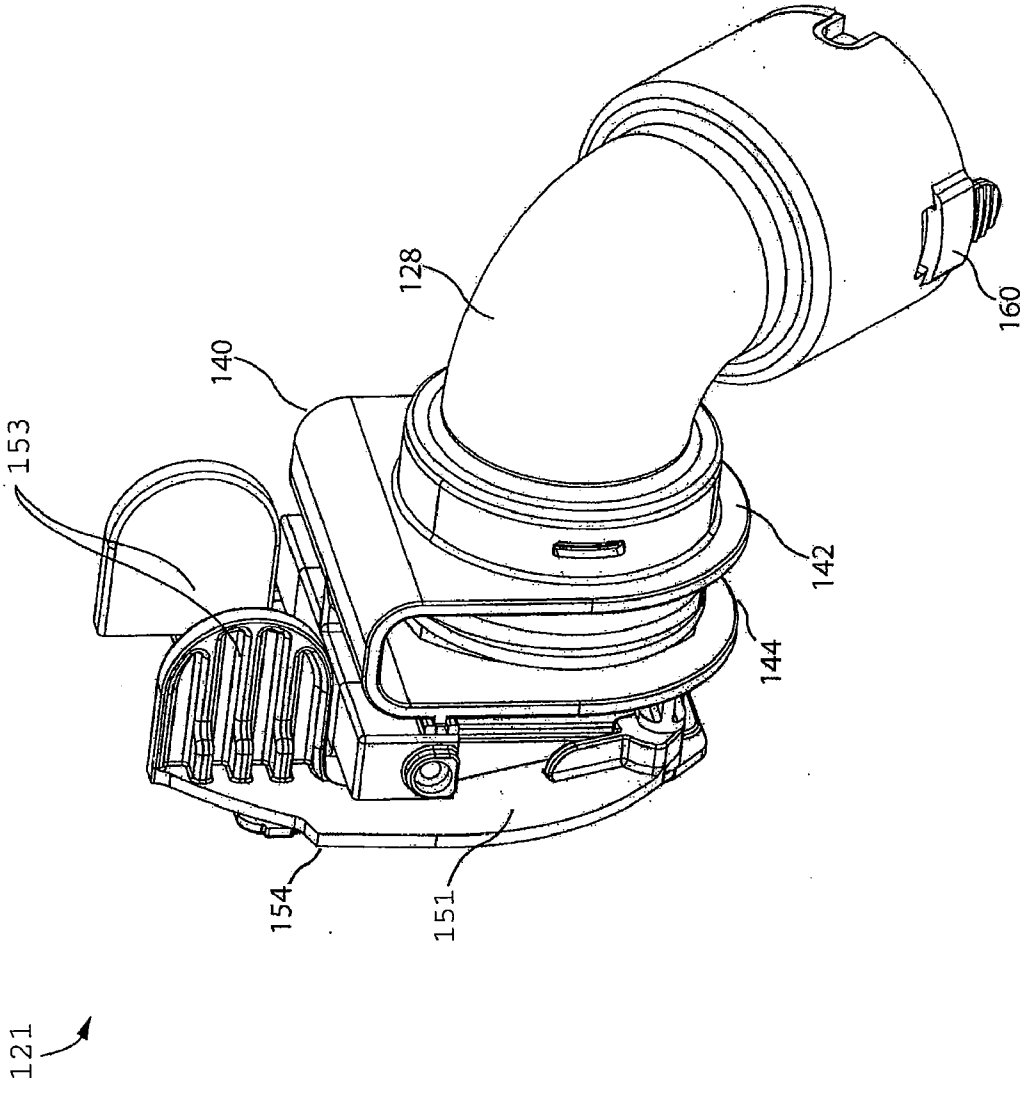


FIG.25

FIG. 26



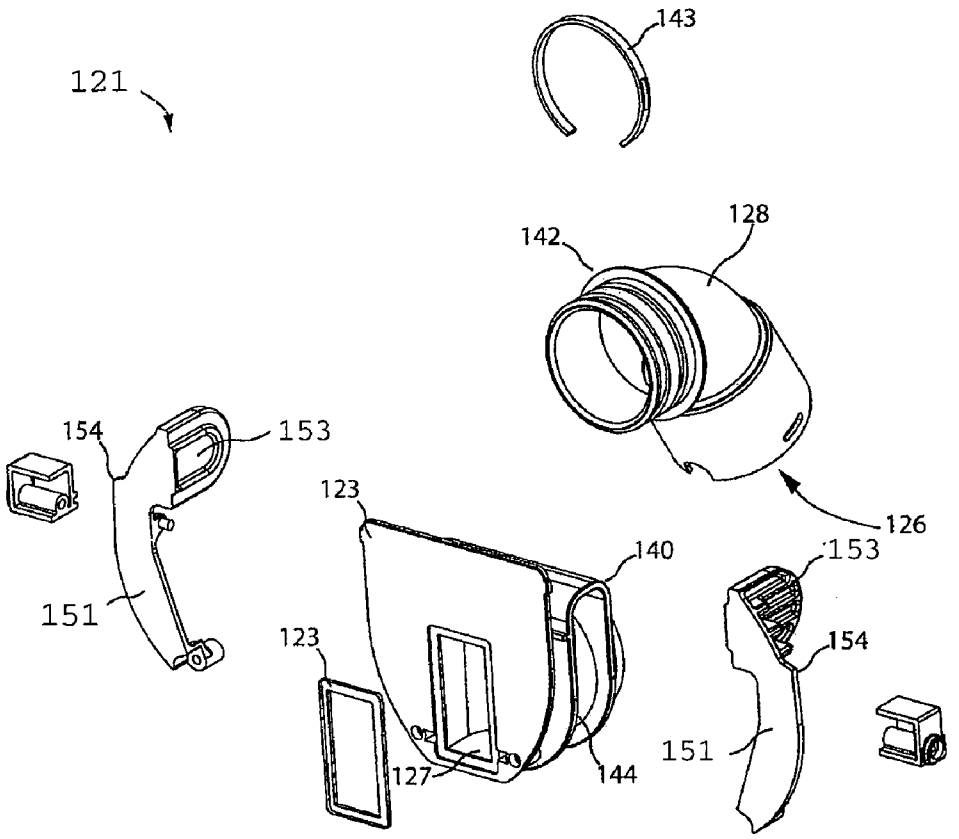


FIG.27

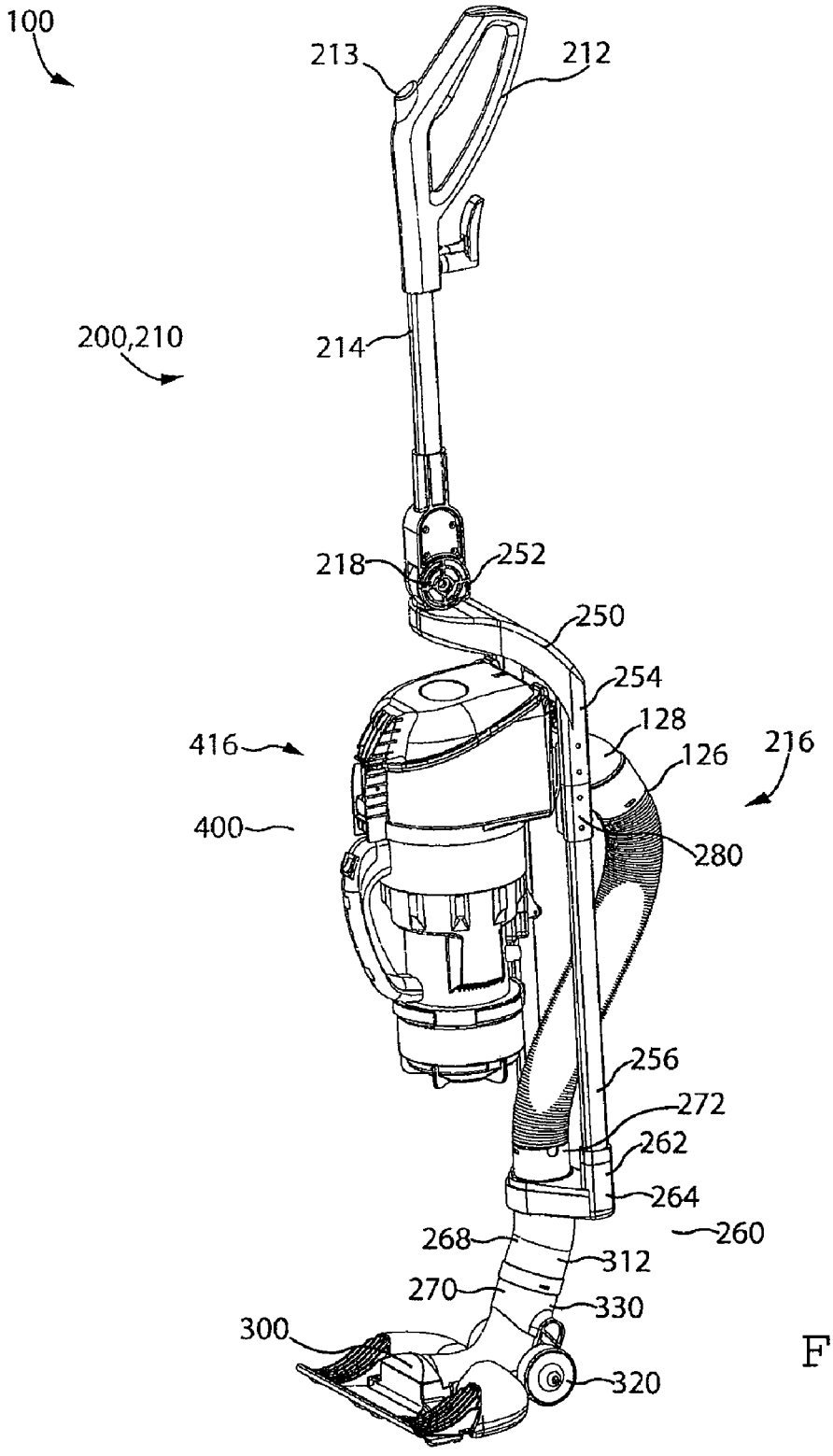

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FIG. 28

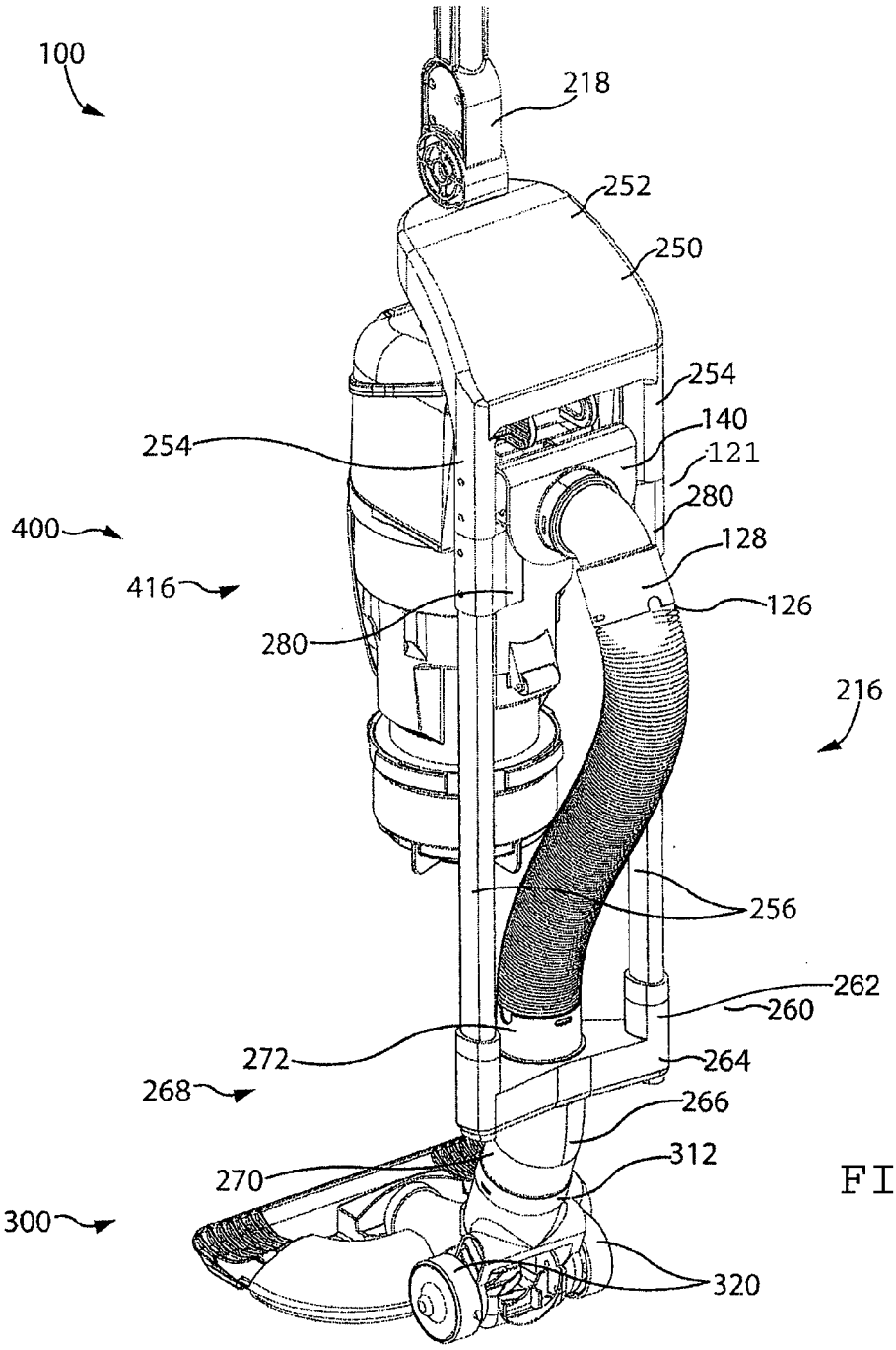
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FIG. 29

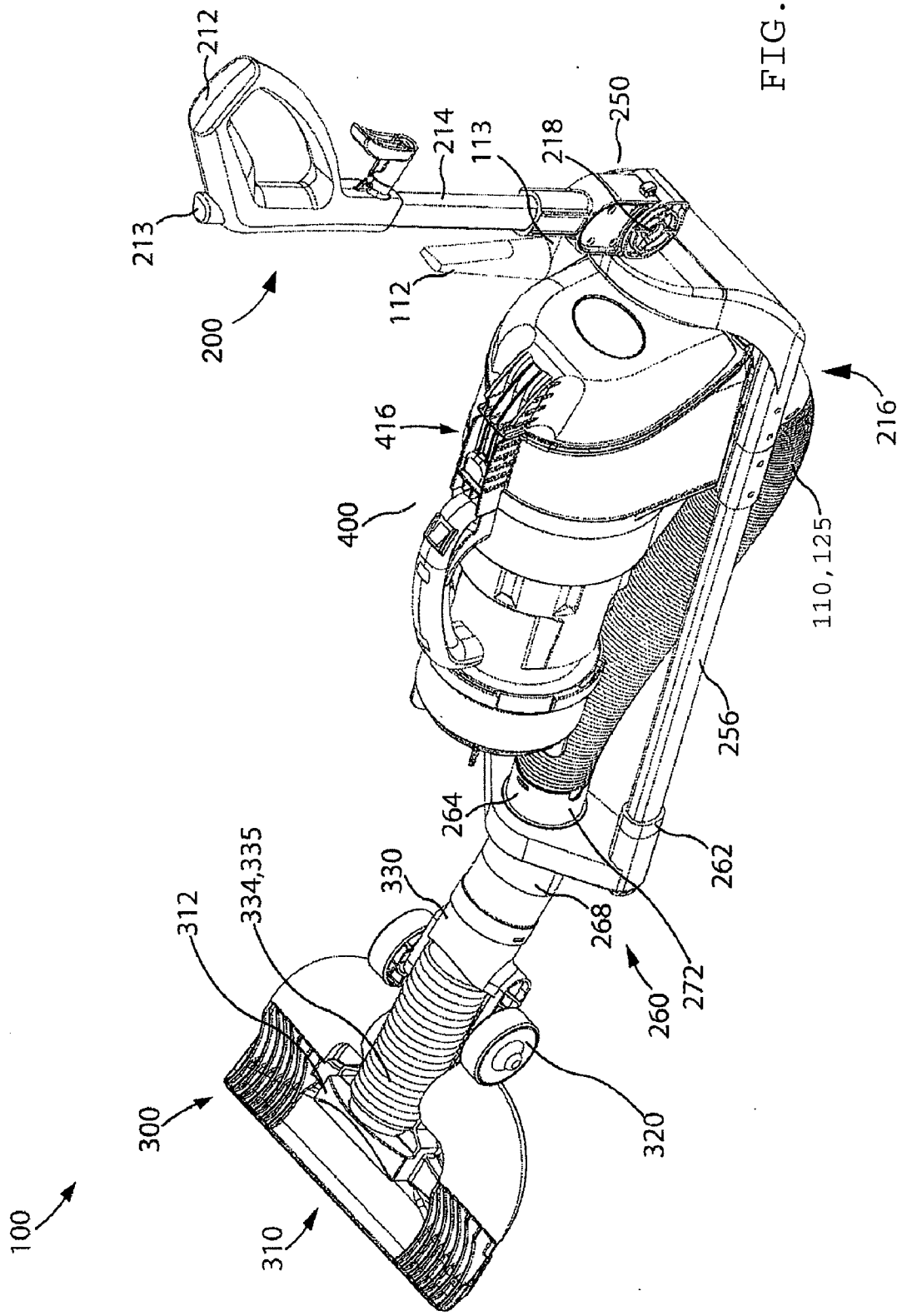
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FIG. 30

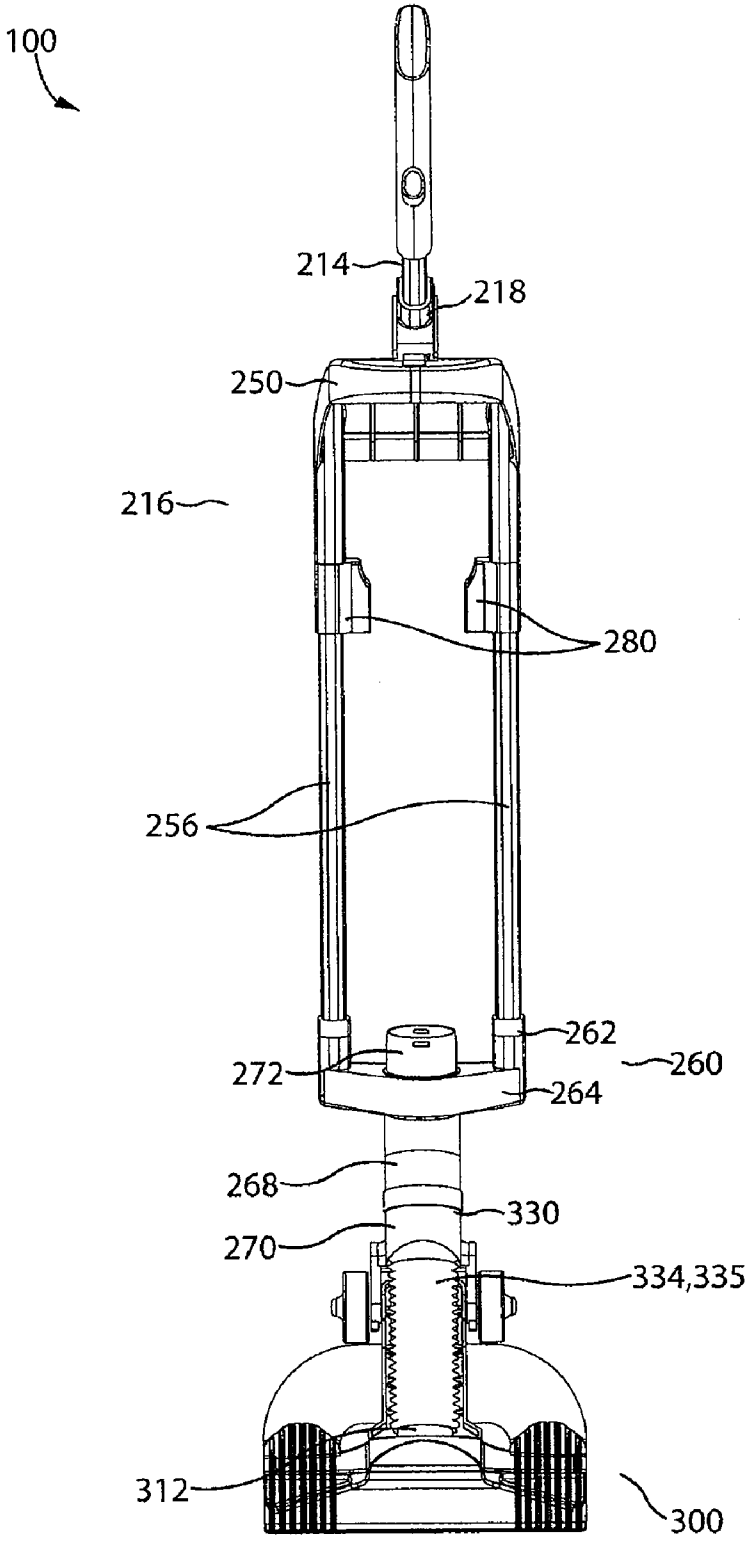
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FIG. 31

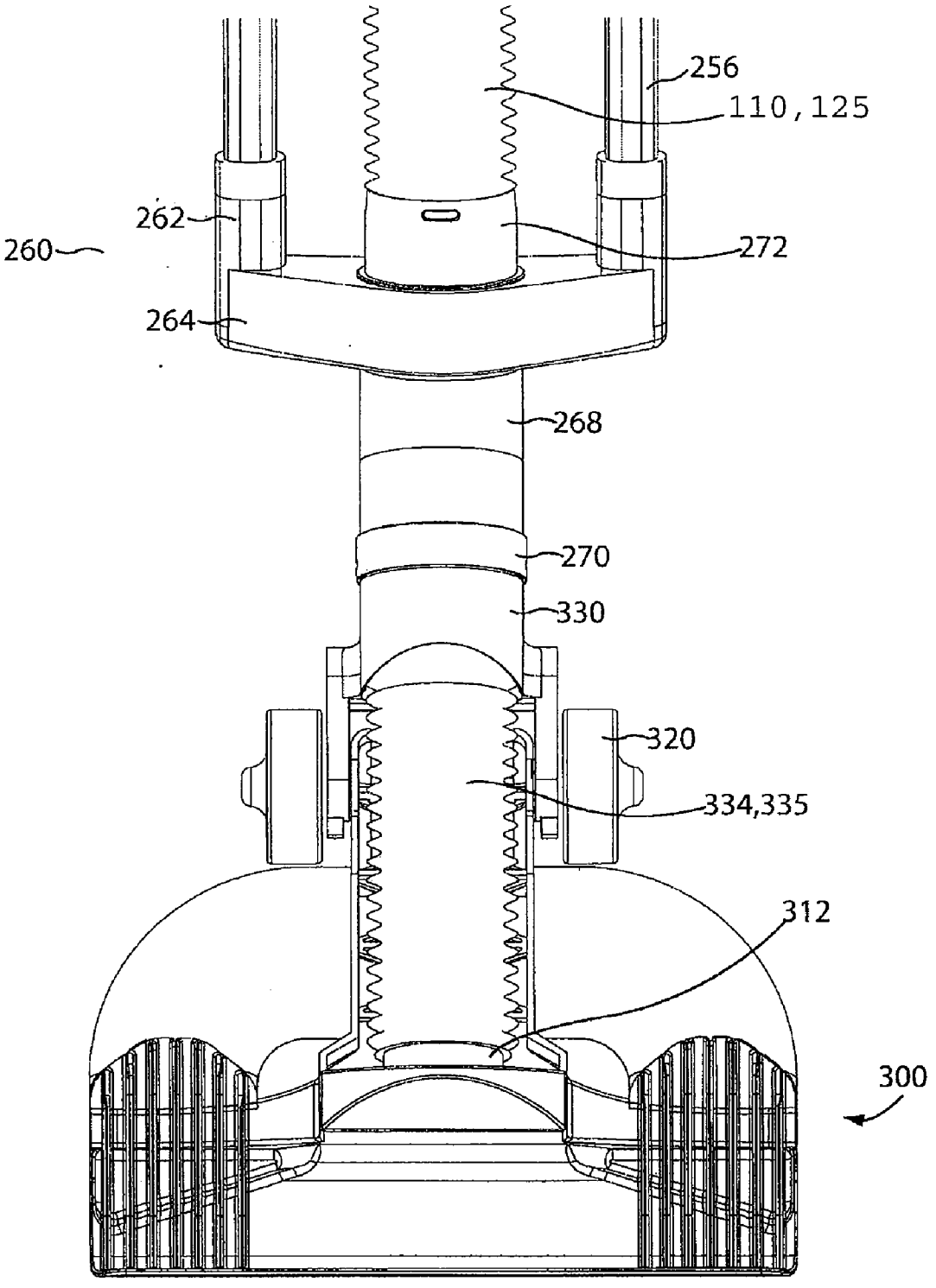

FIG.32

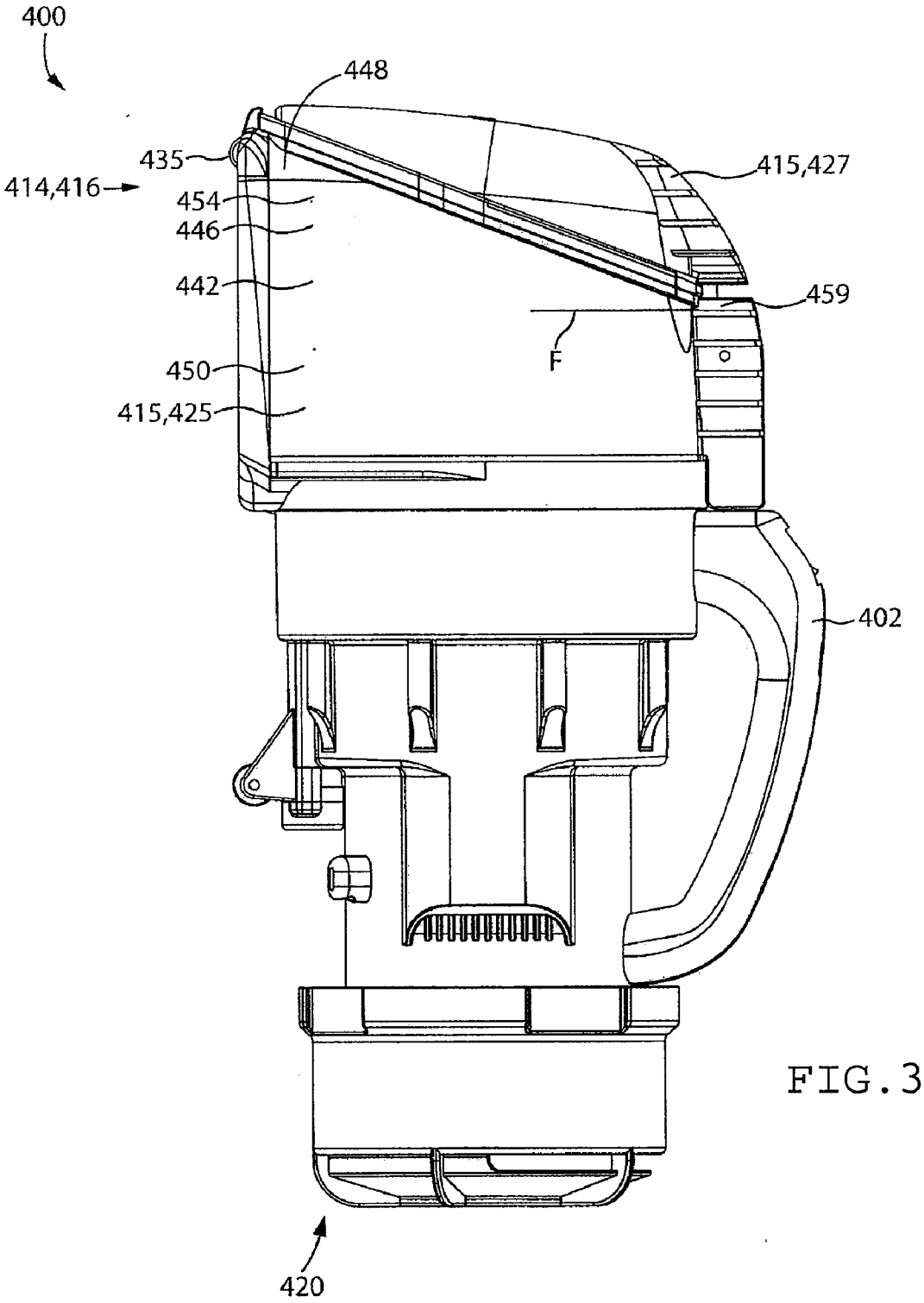

FIG.33

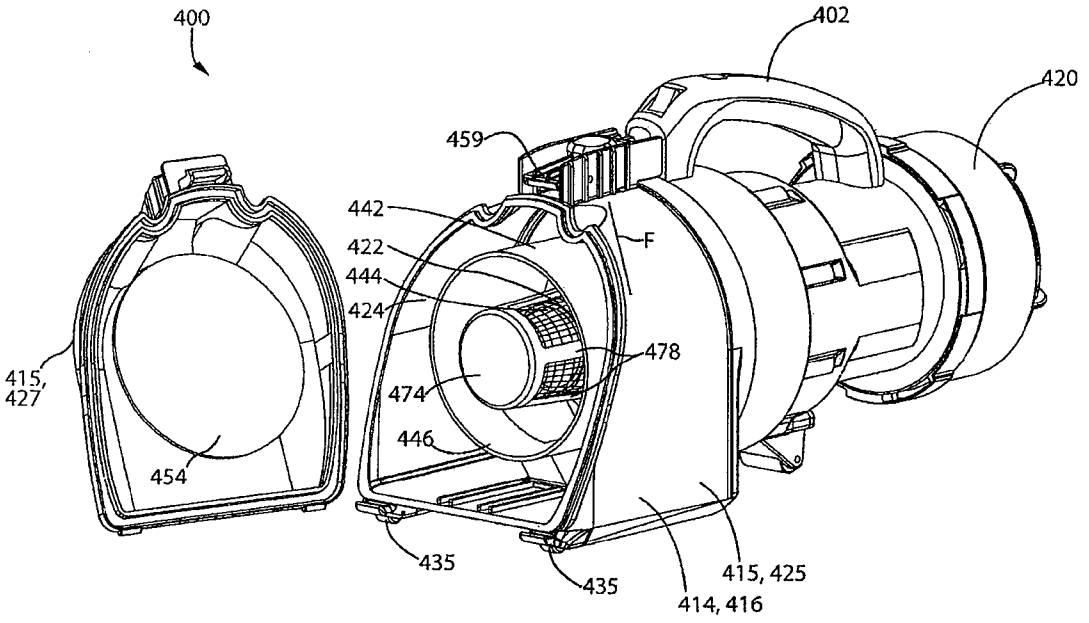
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FIG.34

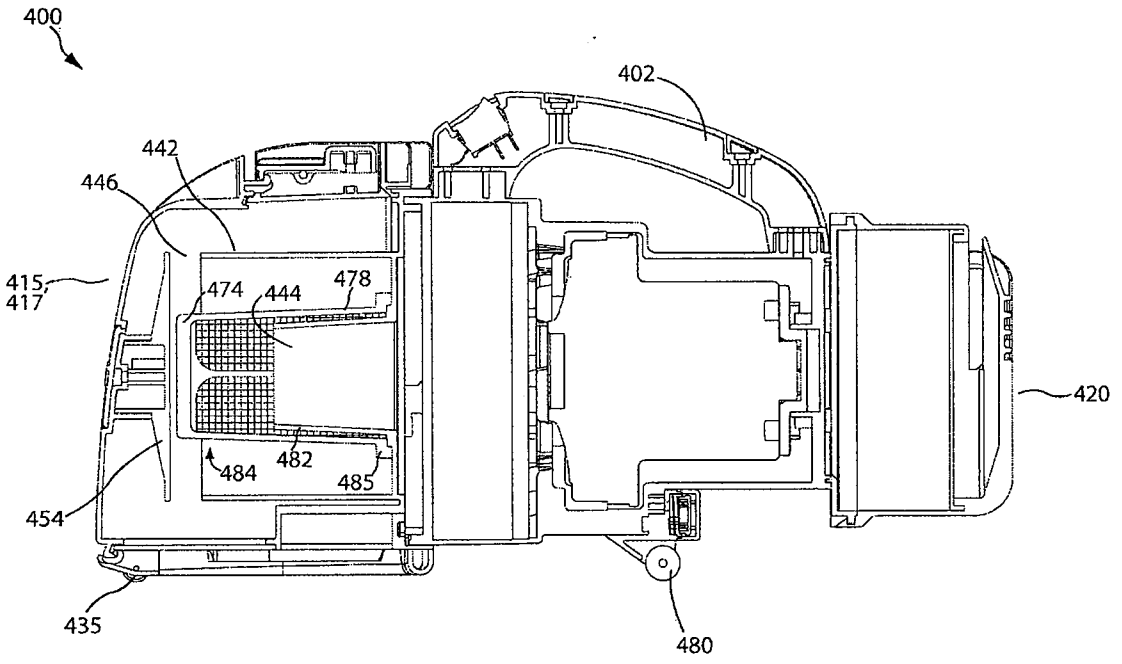

FIG.35

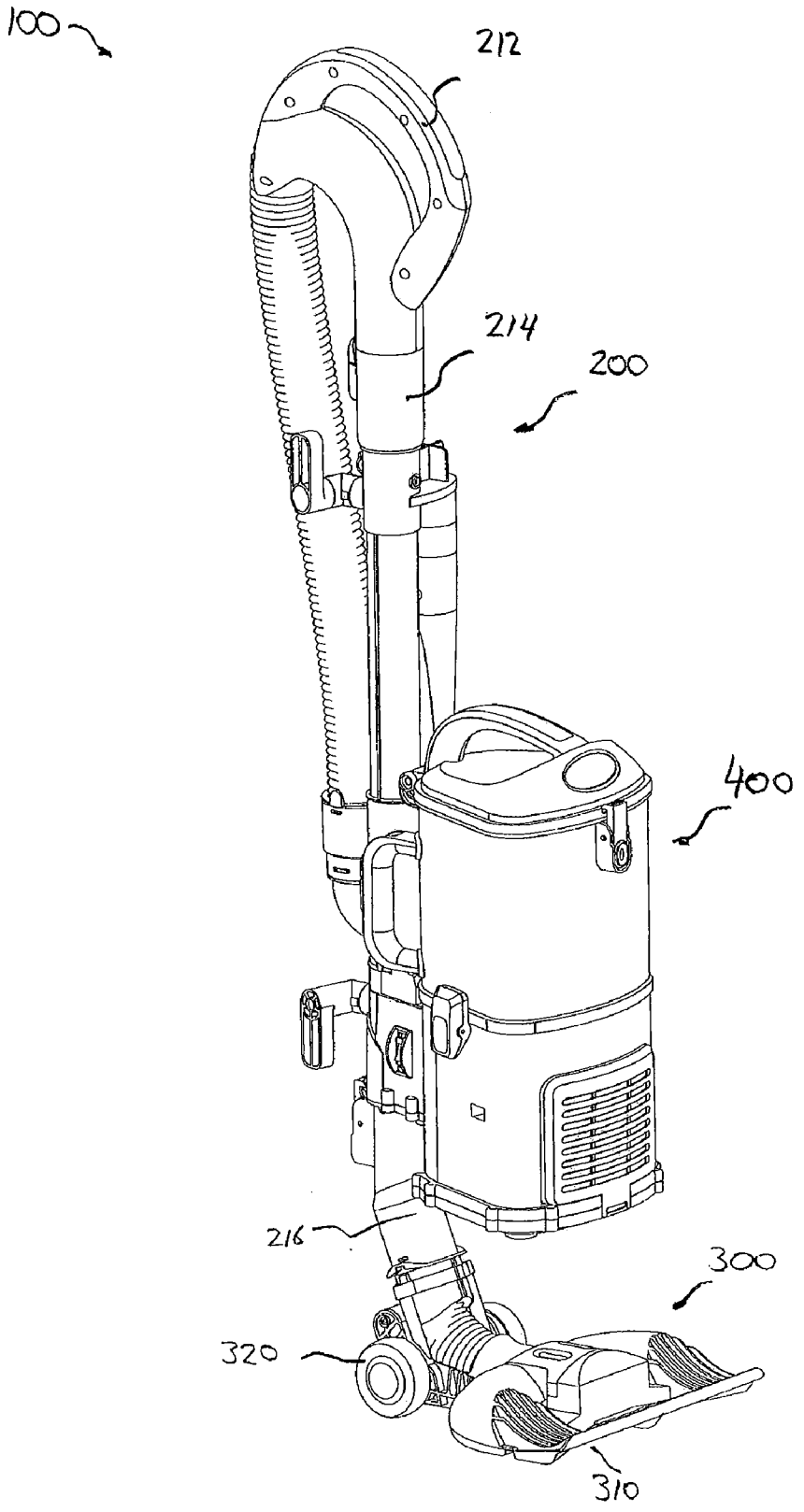

FIG. 36

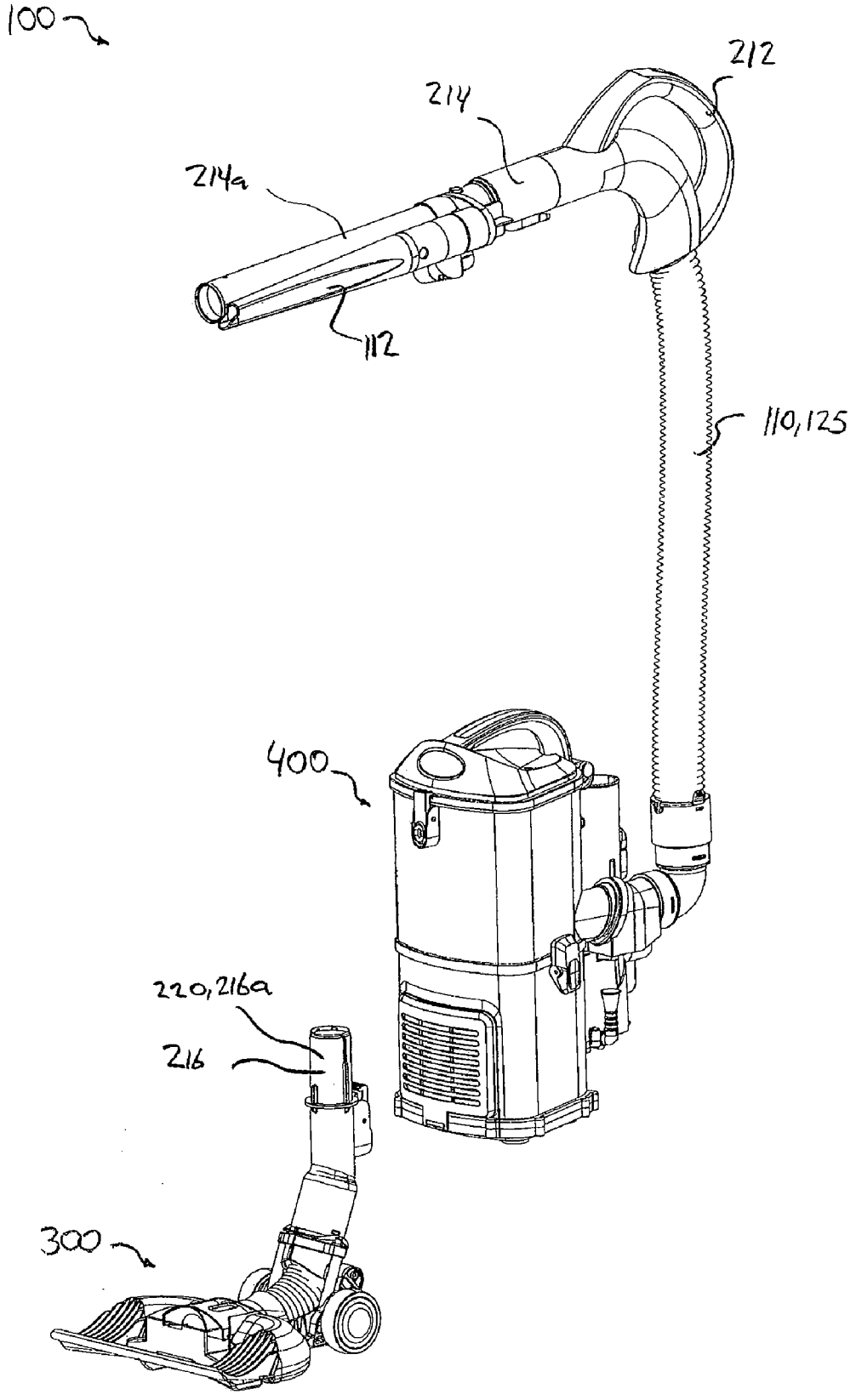

FIG. 37

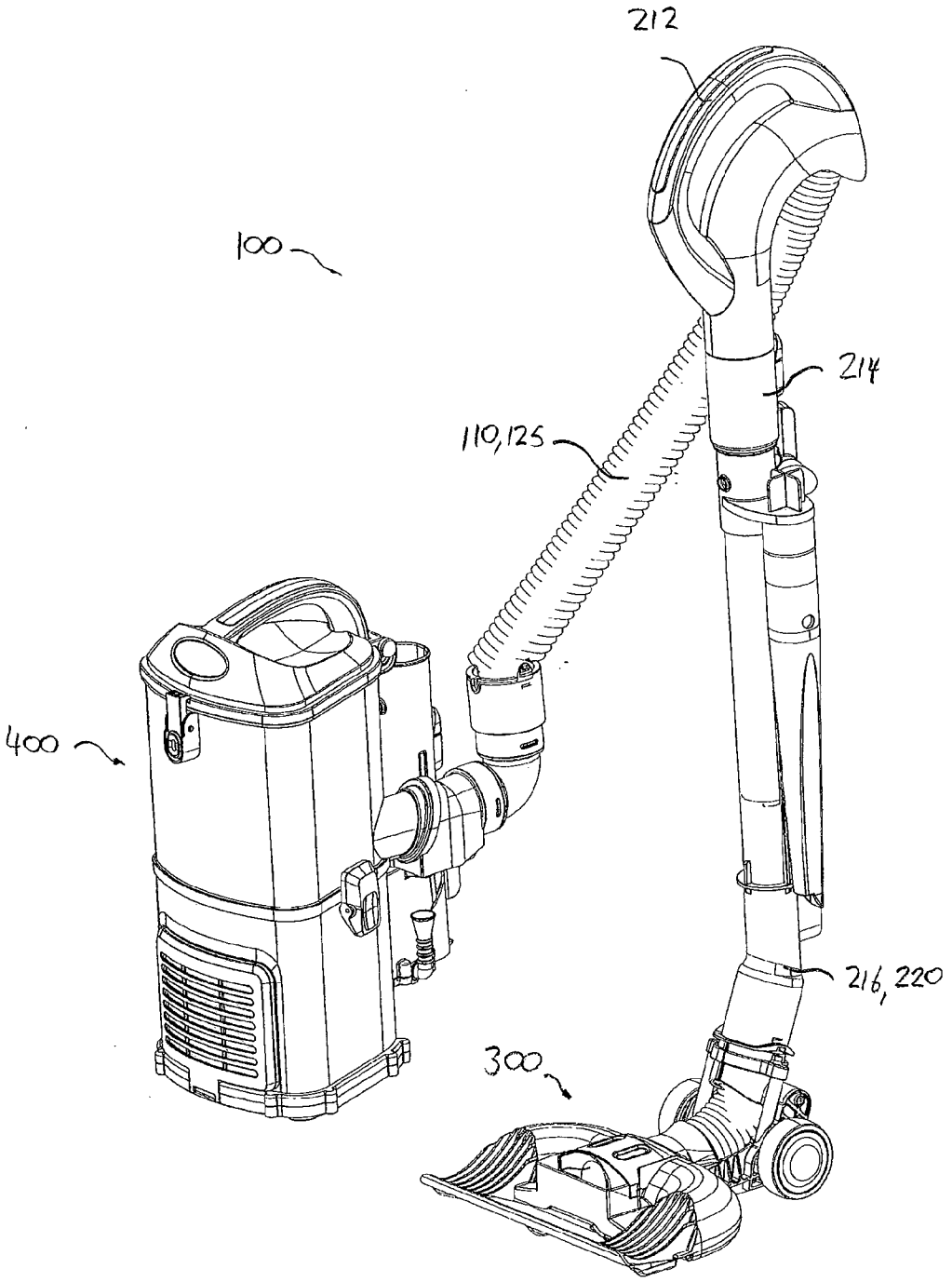

FIG. 38

CYCLONIC SURFACE CLEANING APPARATUS WITH EXTERNALLY POSITIONED DIRT CHAMBER

RELATED APPLICATIONS

[0001] This application is a continuation in part of co-pending U.S. patent application Ser. No. 12/675,540, filed Feb. 26, 2010, which is a national phase entry of International Application PCT/CA2008/001530, filed Aug. 28, 2008 and now published as WO 2009/026709, which claims priority to Canadian patent application 2,599,303, filed Aug. 29, 2007, and also claims the benefit of 35 USC 119 based on the priority of co-pending Canadian patent application 2,659,212, filed Mar. 20, 2009, each of those applications being incorporated herein in their entirety by reference.

FIELD

[0002] This application relates to surface cleaning apparatus, such as vacuum cleaners. In a preferred embodiment, the specification relates to a cyclone unit that comprises a cyclone and a dirt chamber that is external the cyclone and is removably mounted to the surface cleaning apparatus and, preferably, operable when removed from the surface cleaning apparatus. In another embodiment, the specification relates to a cyclone unit that comprises a cyclone and a dirt chamber that is external the cyclone wherein the cyclone and the dirt collection chamber are removable as a closed unit and concurrently openable.

BACKGROUND

[0003] The use of a cyclone, or multiple cyclones connected in parallel or series, is known to be advantageous in the separation of particulate matter from a fluid stream. Currently, many vacuum cleaners, which are sold for residential applications, utilize at least one cyclone as part of the air filtration mechanism.

[0004] U.S. Pat. No. 4,373,228 (Dyson) and 4,826,515 (Dyson) each discloses a cyclonic vacuum cleaner having two cyclonic stages, namely a first stage for separating larger particulate matter from an air stream and a second stage for separating finer particulate matter from the same air stream. Each cyclonic stage comprises a single cyclone having an associated dirt collection region.

[0005] A difficulty experienced with cyclonic separators is the re-entrainment of the separated particulate matter back into the outgoing fluid flow. Deposited particles exposed to a high-speed cyclonic flow have a tendency to be re-entrained. One approach to resolve this issue is to use a plate positioned in a cyclone container to divide the cyclone container into an upper cyclone chamber, which is positioned above the plate, and a lower dirt collection chamber, which is positioned below the plate. See for example Conrad (U.S. Pat. No. 6,221,134). Accordingly, the portion of the cyclone casing below the plate functions as a dirt collection chamber wherein re-entrainment of separated particulate matter is impeded.

SUMMARY

[0006] The following introduction is provided to introduce the reader to the more detailed discussion to follow. The introduction is not intended to limit or define the claims.

[0007] In accordance with a broad aspect of this invention, a filtration apparatus for a surface cleaning apparatus comprises a cyclone and a dirt collection chamber for the cyclone that is separate from the cyclone, and preferably external to the cyclone chamber. The dirt collection chamber is openable and, when opened, material collected therein may be removed. Similarly, the cyclone is openable. When opened, the cyclone chamber preferably has an absence of any member having a larger diameter than the vortex finder. Therefore, when the cyclone is opened, material collected therein may be also removed. For example, a vortex finder with a large diameter shroud, or a deflector disc positioned around a vortex finder or air outlet, are preferably not located in the cyclone when it is opened and therefore do not create an impediment to dirt falling out of the cyclone when a cyclone is opened and positioned with the opening over a garbage can. Preferably, both the cyclone and the dirt collection chamber are openable at the same time. Preferably, the vortex finder is also removed from the cyclone chamber when the cyclone is opened. Preferably the cyclone and the dirt collection chamber are closed when removed from the surface cleaning apparatus such as for emptying.

[0008] An advantage of this design is that, from time to time, material may accumulate in a cyclone. In some embodiments, the cyclone may be configured such that heavier material is collected in the cyclone itself. For example, the cyclone may be inverted and have an upper dirt outlet. Material that is too heavy to be entrained in an air stream and carried upwardly through the cyclone and through the dirt outlet will accumulate in the cyclone. Accordingly, the interior of the cyclone could be used as a dirt collection chamber. By opening the cyclone, material that collects in the cyclone may be removed, e.g., the opened portion of the cyclone may be held over a garbage can and the accumulated material in the cyclone may be poured out.

[0009] If the dirt collection chamber associated with the cyclone is not the bottom of the cyclone casing, but a separate exterior chamber, then by opening the cyclone and the dirt collection chamber during the same emptying operation, e.g., concurrently or sequentially and preferably concurrently, material that collects both may be removed, e.g., the opened portion of the cyclone and the dirt collection chamber may be held over a garbage can and the accumulated material in the cyclone and the dirt collection chamber may be poured out

[0010] According to another broad aspect, a surface cleaning apparatus is provided that comprises an inverted first stage cyclone mounted to an upright section of an upright surface cleaning apparatus, and preferably of a stick vacuum cleaner. When the surface cleaning apparatus is in use, dirt is entrained in an air stream that is drawn into the cyclone, separated by the cyclonic action of the cyclone and then deposited in a dirt chamber. Preferably the dirt chamber is external cyclone so that the accumulation of dirt within the dirt collection chamber may not affect the performance of the cyclone. In a preferred embodiment, the cyclone may have a cylindrical housing or perimeter wall with an upward facing dirt outlet that is surrounded by, e.g., a generally annular shaped dirt collection chamber. In this embodiment, dirt that is separated from the air stream may be ejected from the dirt outlet of the cyclone and fall into, and collect within, the surrounding dirt collection chamber.

[0011] Typically, cyclones have an efficiency to separate particulate matter having a targeted size range. By using the interior of the cyclone as a dirt collection chamber, the cyclone may be designed to separate particulate matter having a smaller targeted size range. The material that is disentrained from the airflow by the cyclone and which exits the

cyclone dirt outlet may accumulate in a separate dirt collection chamber in flow communication with the cyclone dirt outlet. For example, in a preferred embodiment, the cyclone or the cyclonic cleaning stages combined, may achieve a separation efficiency for IEC dirt as specified as IEC 60312, which is representative of household dirt, of 98% of particles that are from 3 to 5 microns and at least 96.5% of particles that are from 1-2 microns. Such a cyclone, while using a relatively high fluid velocity, may result in heavier or larger material remaining in the cyclone.

[0012] Accordingly, for example, a surface cleaning apparatus may include an inverted cyclone having a floor and an upper dirt outlet. A lower air inlet is provided and an air outlet is provided through the floor or a sidewall of the cyclone. In operation, air will enter through the air inlet and cyclone upwardly. Some of the dirt will exit upwardly through the dirt outlet. The air will then travel downwardly and exit the cyclone through the cyclone outlet (e.g., a vortex finder). Some of the dirt will accumulate on the floor of the cyclone. The dirt collection chamber may surround at least a portion of the cyclone and, preferably, all of the cyclone. The dirt collection chamber has a floor on which dirt entering the dirt collection chamber will accumulate. The floor of the cyclone and the floor of the dirt collection chamber, or the top of each, may concurrently or sequentially open so that the dirt collected in the cyclone and the dirt collected in the dirt collection chamber are emptied concurrently. An advantage of this design is that fewer steps are required for a user to empty the dirt collection areas of the vacuum cleaner.

[0013] In some embodiments, the cyclone and the dirt collection chamber are removable when closed, e.g., an openable floor is closed. Accordingly, when the dirt collection chamber is to be emptied, the cyclone and the dirt collection chamber may be removed from the surface cleaning apparatus, e.g., an upright surface cleaning apparatus, and then emptied.0

[0014] In some embodiments, a vortex finder may be provided on the portion of the cyclone that opens. For example, if the cyclone is inverted, the vortex finder may be positioned on the bottom opening floor of the cyclone. Accordingly, when the cyclone is opened, the vortex finder is removed from the cyclone leaving an open cyclone chamber.

[0015] Alternately, or in addition, in some other embodiments, the cyclone may have an interior shroud or screen that may need cleaning from time to time. Accordingly a consumer may use a single step to open the cyclone to access a shroud, filter or screen that requires cleaning or replacement and, at the same time, have access to the dirt collection chamber so as to empty the dirt collection chamber.

[0016] In any embodiment, an upright surface cleaning apparatus may comprise:

[0017] (a) a floor cleaning unit comprising a surface cleaning head having a dirty air inlet, a cleaning head air outlet and an upright section comprising a handle drivingly connected to the surface cleaning head;

[0018] (b) a cyclone unit positioned in the air flow passage, the cyclone unit comprising a cyclone having an air inlet located at a lower end of the cyclone and an air outlet and a dirt outlet provided at an upper end of the cyclone, and a dirt collection chamber exterior to the cyclone and surrounding at least a portion of the cyclone;

[0019] (c) a suction motor positioned in the air flow path; and,

[0020] (d) a surface cleaning unit removably mounted to the handle wherein the surface cleaning unit comprises the cyclone unit and the suction motor.

[0021] In some embodiments, the cyclone and the dirt collection chamber are concurrently openable.

[0022] In some embodiments, the cyclone is positioned interior of the dirt collection chamber.

[0023] In some embodiments, the surface cleaning apparatus further comprises a plate facing the dirt outlet. Preferably, the plate is mounted to an upper end of the cyclone unit.

[0024] In some embodiments, the cyclone is an inverted cyclone having an air inlet and an air outlet at a lower end of the cyclone.

[0025] In some embodiments, the surface cleaning apparatus further comprises a vortex finder that is provided on an openable door of the cyclone.

[0026] In some embodiments, the handle comprises a portion of the air flow path.

[0027] In any embodiment, an upright surface cleaning apparatus may alternately comprise:

[0028] (a) a floor cleaning unit comprising a surface cleaning head having a dirty air inlet, a cleaning head air outlet and an upright section comprising a handle drivingly connected to the surface cleaning head;

[0029] (b) a cyclone unit mounted on the upright section and positioned in the air flow passage, the cyclone unit comprising a cyclone having an air inlet located at a lower end of the cyclone and an air outlet and a dirt outlet provided at an upper end of the cyclone, and a dirt collection chamber exterior to the cyclone and surrounding at least a portion of the cyclone wherein the cyclone unit is removable in a closed configuration; and,

[0030] (c) a suction motor positioned in the air flow path.

[0031] In some embodiments, the surface cleaning apparatus further comprises a surface cleaning unit removably mounted to the handle wherein the surface cleaning unit comprises the cyclone unit and the suction motor.

[0032] In some embodiments, the cyclone and the dirt collection chamber are concurrently openable.

[0033] In some embodiments, the cyclone is positioned interior of the dirt collection chamber.

[0034] In some embodiments, the surface cleaning apparatus further comprises a plate facing the dirt outlet. Preferably the plate is mounted to an upper end of the cyclone unit.

[0035] In some embodiments, the cyclone is an inverted cyclone having an air inlet and an air outlet at a lower end of the cyclone.

[0036] In some embodiments, the surface cleaning apparatus further comprises a vortex finder that is provided on an openable door of the cyclone.

[0037] It will be appreciated by those skilled in the art that any of these alternate embodiments may be used individually or in combination in a single surface cleaning apparatus, as exemplified in a preferred embodiment described herein, or in any particular sub-combination. Accordingly, any two or more alternate embodiments may be used in a single surface cleaning apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] These and other advantages of the instant invention will be more fully and completely understood in conjunction with the following description of the preferred embodiments of the invention in which:

[0039] FIG. **1** is a side elevational view of a preferred embodiment of a vacuum cleaner in accordance with this design wherein the outer casing surrounding the cyclone and forming an outer wall of a dirt collection chamber is optionally transparent;

[0040] FIG. **2** is a perspective view from the front and the right side of the vacuum cleaner of FIG. **1**;

[0041] FIG. **3** is a cross-section along the line **3-3** in FIG. **2**;

[0042] FIG. **4** is a schematic drawing of the vacuum cleaner of FIG. **1** showing the airflow passage therethrough;

[0043] FIG. **5** is a perspective view from the bottom of the vacuum cleaner of FIG. **1** wherein the bottom of the first and second housings is open;

[0044] FIG. **6** is a perspective view of the bottom of the vacuum cleaner of FIG. **1** wherein the first and second housings are closed but an access door is open;

[0045] FIG. **7** is a longitudinal section through an alternate embodiment of a vacuum cleaner in accordance with this invention;

[0046] FIG. **8** is a perspective end view of the vacuum cleaner of FIG. **8** wherein the dirt collection chamber and the cyclone are open;

[0047] FIG. **9** is a perspective cross-section view of a further alternate embodiment of a cyclone and dirt collection chamber in accordance with this invention;

[0048] FIG. **10** is an exploded perspective view of the alternate embodiment shown in FIG. **9**; and,

[0049] FIG. **11** is a perspective view from the bottom of the cyclone and dirt collection chamber shown in FIG. **9** wherein the bottom panel is open;

[0050] FIG. **12** is a cross-section through a further alternate embodiment of a cyclone and dirt collection chamber in accordance with this invention;

[0051] FIG. **13** is a cross-section through the alternate embodiment shown in FIG. **12** wherein the cyclone floor and dirt collection chamber floor are open;

[0052] FIG. **14** is a front elevation view of an example of a vacuum cleaner;

[0053] FIG. **15** is a back perspective view of the vacuum cleaner of FIG. **14** with a portable surface cleaning apparatus mounted to a support structure;

[0054] FIG. **16***a* is a back perspective view of the vacuum cleaner of FIG. **14** with the portable surface cleaning apparatus removed from the support structure and in a position in which it may be carried by hand;

[0055] FIG. **16***b* is a side elevation view of the portable surface cleaning apparatus of FIG. **16***a* wherein the portable surface cleaning apparatus has been removed from the support structure and is in a position in which it may be carried by hand with flexible hose detached from the surface cleaning head;

[0056] FIG. **17** is a partially exploded side perspective view of the vacuum cleaner of FIG. **14** with the portable surface cleaning apparatus removed from air flow communication with the floor cleaning unit;

[0057] FIG. **18** is a front isometric view of the vacuum cleaner of FIG. **14** with the portable surface cleaning apparatus removed;

[0058] FIG. **19** is side elevation view of a hand vacuum cleaner;

[0059] FIG. **20** is a front elevation view of the hand vacuum cleaner of FIG. **19**;

[0060] FIG. **21** is a bottom isometric view the hand vacuum cleaner of FIG. **19**;

[0061] FIG. **22** is a bottom isometric view of the hand vacuum cleaner and an attachment member;

[0062] FIG. **23** is a partially exploded bottom isometric view of the hand vacuum cleaner and an attachment member of FIG. **22**;

[0063] FIG. **24** is a side isometric view of the attachment member of FIG. **22**;

[0064] FIG. **25** is a front elevation view of the attachment member of FIG. **24**;

[0065] FIG. **26** is a side isometric view of the attachment member of FIG. **24**;

[0066] FIG. **27** is a partially exploded isometric view of the attachment member of FIG. **24**;

[0067] FIG. **28** is a front isometric view of an alternate example of a vacuum cleaner with a portable surface cleaning apparatus mounted thereto;

[0068] FIG. **29** is a partial rear isometric view of the vacuum cleaner of FIG. **28**;

[0069] FIG. **30** is a rear isometric view of an alternate example of a vacuum cleaner with a portable surface cleaning apparatus mounted thereto;

[0070] FIG. **31** is a partial front isometric view of the vacuum cleaner of FIG. **30** with the portable surface cleaning apparatus removed;

[0071] FIG. **32** is a partial top view of the surface cleaning head of the vacuum cleaner of FIG. **30**;

[0072] FIG. **33** is a side elevation view of a portable surface cleaning apparatus having a partially transparent dirt chamber;

[0073] FIG. **34** is an isometric view of the portable surface cleaning apparatus of FIG. **33** with the dirt chamber door removed;

[0074] FIG. **35** is a section view of the portable surface cleaning apparatus of FIG. **33**;

[0075] FIG. **36** is a front isometric view of another embodiment of a surface cleaning apparatus;

[0076] FIG. **37** is a front isometric view of the surface cleaning apparatus of FIG. **36** with the portable surface apparatus removed in a first configuration; and

[0077] FIG. **38** is a front isometric view of the surface cleaning apparatus of FIG. **36** with the portable surface apparatus removed in a second configuration.

DETAILED DESCRIPTION

[0078] As shown in FIGS. **1-6**, a surface cleaning apparatus comprises a vacuum cleaner **10** having at least one cyclone and a dirt collection chamber in communication with the cyclone dirt outlet. The filtration apparatus may be of any design or configuration. As exemplified, surface cleaning apparatus **10** has a first housing **12** and a second housing **14**. First housing **12** comprises at least one cyclone **16** and a dirt collection chamber **18** and second housing **14** houses the filtration members and the suction motor. As shown in FIG. **7**, a surface cleaning apparatus **10** has a first cyclonic cleaning stage comprising a single cyclone **150** having a dirt collection chamber **152** and a second cyclonic cleaning stage comprising a plurality of second stage cyclones **154** in parallel.

[0079] As exemplified in FIGS. **1-6**, vacuum cleaner **10** comprises a hand held vacuum cleaner. Accordingly, vacuum cleaner **10** may be provided with handle **54**, which is affixed to lid **32** and lid **58** of second housing **14**. Handle **54** may alternately be affixed to any other portion or portions of vacuum cleaner **10** as is known in the art. Optionally, as exemplified, on/off switch **56** may be provided on handle **54**.

On/off switch **56** may alternately be provided on any other portion of vacuum cleaner **10**. As exemplified in FIG. **3**, suction motor **26** may be positioned in second housing **14**, preferably with a suction fan provided below the electric motor. Clean air outlet **60** is provided downstream from suction motor **26**. An optional post-motor filter may be provided downstream from suction motor **26**, such as in post-motor filter housing **62**, which may be accessible via post motor filter housing door **64**, which could be pivotally mounted to second housing **14**.

[0080] It will be appreciated that, surface cleaning apparatus may be a vacuum cleaner, a carpet extractor, a bare floor cleaner or the like. As exemplified, the surface cleaning apparatus is hand held. However the surface cleaning apparatus may be configured as an upright vacuum cleaner, a stick vacuum cleaner, a canister vacuum cleaner, a backpack or shoulder strap vacuum cleaner or other configuration known in the art. The surface cleaning apparatus may have a single cyclonic cleaning stage, which may be of any construction known in the art, or a plurality of cyclonic cleaning stages, each of which may be of any construction known in the art, e.g. they may comprise a single cyclone or a plurality of cyclones in parallel. For example, as exemplified in FIGS. **14-35**, vacuum cleaner **100** comprises a hand held vacuum cleaner removably mounted on an upright vacuum cleaner.

[0081] In accordance with one aspect of this invention, an openable dirt collection chamber **18** is provided that is in communication with the dirt outlet **28**. Dirt collection chamber **18** has an openable end portion that comprises a wall that is intersected by the longitudinally extending axis of the cyclone. For example, the openable end portion may be floor **44** of cyclone **16** as exemplified in FIGS. **1-6**, impingement member **30** and the floor of dirt collection chamber **18** to which impingement member **30** may be mounted as exemplified in FIGS. **7-8** or opposed wall **164** of dirt collection chamber **18** of FIGS. **12-13** or bottom **66** comprising cyclone floor **42** and dirt collection chamber floor **44** of FIGS. **9-11**. When the end portion is in an open position as exemplified in FIGS. **5**, **8** and **11** and **13**, the cyclone chamber preferably has an absence of any member having a larger diameter than the vortex finder (i.e., the vortex finder and any shroud or screen surrounding the vortex finder) whereby dirt collection chamber **18** and the cyclone **16** may be concurrently emptyable with dirt collection chamber **18**.

[0082] A first embodiment of this invention is shown in FIGS. **1-6**, which exemplifies the use of an inverted cyclone. However, as shown in other embodiments, it will be appreciated that the cyclone **16** may be of any configuration and orientation and need not be inverted (e.g., cyclone **16** may be a horizontally mounted cyclone or a vertically mounted upright cyclone with an upper air inlet, an upper air out and a lower dirt outlet). Accordingly, the reference to "upper" and "lower" and "floor" are for convenience in the following discussion and relate to a preferred embodiment.

[0083] Referring to FIGS. **1-6**, cyclone **16** has a dirt outlet **28** and an impingement surface **30** in dirt collection chamber **18** spaced from and facing dirt outlet **28**. As shown in FIG. **3**, optional impingement surface **30** is preferably spaced a distance D from outlet **28** wherein distance D may be up to 50 mm, preferably from 8 to 30 millimeters and, and more preferably from 12 to 25 millimeters. It will be appreciated that impingement member **30** may be mounted to lid **32** of dirt collection chamber **18** as exemplified. Alternately, impingement member may be mounted to a sidewall of dirt collection chamber **18** and/or cyclone **16**. It will be appreciated that cyclone **16** may be in any particular orientation and/or any particular configuration. As exemplified in FIG. **7**, cyclone **150** may have a longitudinally extending axis A that extends generally horizontally when the surface cleaning apparatus is in use. In such a case, impingement surface **30** may be positioned facing dirt outlet **28** and accordingly, in use, extends generally vertically, (i.e. transverse to longitudinal axis A). Alternately, as shown in FIGS. **12** to **13**, an impingement surface may not be provided.

[0084] As exemplified in FIG. **3**, cyclone **16** is an inverted cyclone. Accordingly, cyclone **16** has a lower air inlet **34** and a lower air outlet **36**. Air inlet **34** is positioned downstream from dirty air inlet **38** of surface cleaning nozzle **40**. Surface cleaning nozzle **40** may be any surface cleaning nozzle known in the art. Air inlet **34** of cyclone **16** may be in airflow communication with surface cleaning nozzle **40** in any manner known in the art. The exact structure of surface cleaning nozzle **40** and the communication passage between surface cleaning nozzle **40** and air inlet **34** will vary depending if the surface cleaning apparatus is an upright vacuum cleaner, canister vacuum cleaner or, as exemplified, a portable hand held vacuum cleaner. In operation, air will enter cyclone **16** through inlet **34** and travel upwardly, as exemplified in FIG. **4**. The air will then travel downwardly to exit cyclone **16** via outlet **36**. As shown in FIG. **4** by the hatched arrows, dirt will exit upwardly through outlet **28** and deposit on dirt collection chamber floor **42**. In addition, some of the heavier particulate matter may not be entrained in the air stream and may be deposited on cyclone floor **44**.

[0085] In this embodiment, cyclone **16** has a longitudinally extending axis that extends through the centre of cyclone **16**. The longitudinal axis is aligned with, and extends through, air outlet **36** and accordingly intersects floor **44** and door **82**. In an alternate embodiment, it will be appreciated that cyclone **16** need not be inverted but may be of any configuration or orientation. As exemplified in FIGS. **7** and **8**, cyclones **150**, **154** may be oriented such that longitudinal axis A of the cyclones extends horizontally when the surface cleaning apparatus is in use. As exemplified in FIG. **7**, cyclone **150** has an impingement member **30** that is generally vertical and faces dirt outlet **28** and is intersected by longitudinal axis A. Alternately, the cyclone may be an upright cyclone (see for example FIGS. **12** to **13**) or a cyclone having a single direction of travel of the air. As exemplified in FIGS. **12** and **13**, cyclone **16** has a longitudinal axis that intersects dirt collection chamber floor **42** and cyclone floor **44**. As exemplified in FIGS. **9-11**, cyclone **16** has a longitudinal axis that intersects cyclone floor **44**.

[0086] As exemplified, cyclone **16** is a frustoconical cyclone having cylindrical portion **46** and frustoconical portion **48**. Alternately, or in addition to the orientation of cyclone **16**, it will be appreciated that cyclone **16** may be cylindrical, entirely frustoconical or any other shape known in the art. As shown in FIGS. **9-13**, cyclone **16** may be closed, i.e. have a portion that closes the dirt outlet end of the cyclone chamber, and is provided with at least one dirt outlet **28**. The dirt exit end may be bowl shaped, e.g., rounded.

[0087] As exemplified in FIG. **3**, outlet **36** of cyclone **16** comprises a vortex finder that extends inwardly into the cyclone chamber defined by cyclone **16**. Outlet **36** preferably comprises a generally cylindrical passage having an inlet **50**

and an outlet **52**. It will be appreciated that, in an alternate embodiment any outlet or vortex finder known in the art for cyclones may be utilized.

[0088] In any embodiment, inlet **50** may be covered by a screen, shroud or filter as is known in the art. However, it is preferred that vortex finder **36** is unobstructed, i.e., no screen, shroud or filter is provided on inlet **50**. Accordingly, as exemplified in FIG. **3**, vortex finder **36** is not surrounded by a screen, shroud or filter and no physical separation member is positioned in the cyclone chamber of cyclone **16**. Accordingly, no filtration or screen member interior of cyclone **16** requires cleaning. Elongate material such as hair or fibre can become adhered to a shroud, requiring the shroud to be manually cleaned. Preferably, a screen is positioned downstream from cyclone **16** and upstream from the pre-motor filter. For example, a screen **78** is preferably provided (see for example FIG. **3**). The material that would otherwise clog a screen or shroud that surrounds inlet **50** may be retained by optional screen **78** which may be larger than a screen in a cyclone chamber.

[0089] While the use of the impingement member is exemplified in a surface cleaning apparatus having side-by-side housings **12**, **14**, it will be appreciated that this design may be used in any vacuum cleaner configuration, such as shown in FIG. **7**. In other embodiments, an impingement member may not be provided. For example, in the example of FIGS. **1-6**, an impingement member may not be provided. See also FIGS. **9-13** wherein an impingement member is not provided.

[0090] In accordance with a preferred embodiment of this invention, dirt collection chamber **18** surrounds at least a portion of and, as exemplified, preferably all of cyclone **16** and is preferably external to the cyclone chamber defined by cyclone **16**. Accordingly, cyclone **16** may be positioned in dirt collection chamber **18** and, preferably, generally centrally therein. An advantage of this design is that the bottom of cyclone **16** (e.g., floor **44**) may be continuous with the bottom of dirt collection chamber **18** (e.g., floor **44**) so that a simplified construction is provided that permits both cyclone **16** and dirt collection chamber **18** to be opened at the same time.

[0091] The following description refers to the embodiment of FIGS. **1-6** wherein the openable end of the dirt collection camber is the dirt collection surface (floor **42**). However, in an alternate embodiment, it will be appreciated that the openable portion need not be the dirt collection surface. For example, if cyclone **16** is mounted horizontally, then the openable portion may be opposed wall **164** of dirt collection chamber **18** facing dirt outlet **28** to which impingement member **30** is attached. In such a case, the dirt collection surface will be a sidewall of dirt collection chamber **18**. Alternately, a lid may be openable.

[0092] In accordance with the preferred embodiment of FIGS. **1-6**, vacuum cleaner **10** is preferably configured such that floor **44** forms an openable end portion of cyclone **16** and floor **42** forms an openable end portion of dirt collection chamber **18**. Floor **44** is a moveable cyclone dirt collection surface and floor **42** is a moveable dirt collection chamber surface. The openable portion of cyclone **16** is accordingly opened when the openable portion of dirt collection chamber **18** is opened. Accordingly, dirt collected on floor **44** of cyclone **16** is emptied at the same time as dirt collected on floor **42** of dirt collection chamber **18**. Accordingly, floor **42** and floor **44** are both moveable and connected to each other whereby both floor **42** and **44** are concurrently moveable such that dirt collection chamber **18** and cyclone **16** are concurrently emptied.

[0093] As exemplified in FIG. **5**, floors **42** and **44** comprise a wall intersecting the longitudinally extending axis of the dirt collection chamber **18** and cyclone **16**. Floors **42** and **44** may comprise a pivoting bottom or end portion of first housing **12** and, alternately, of the filtration apparatus (e.g. housings **12** and **14** of this embodiment). It will be appreciated that in other embodiments, floors **42** and **44** may be otherwise openable and may be removably mounted. For example, they may be slidably, translatably or removably mounted (e.g., by a screw mount, a bayonet mount or a snap fit) to cyclone **16** and dirt collection chamber **18**.

[0094] As exemplified in FIG. **5**, outlet **36** is in some embodiments preferably provided as part of floor **42**, and is preferably integrally molded therewith. Accordingly, when floors **42** and **44** are in the open position, vortex finder **36**, and any shroud or the like mounted thereon, is removed from cyclone **16**. Accordingly, the cyclone chamber has an absence of any member having a larger diameter than the vortex finder therein. Accordingly, the dirt will fall out of collection chamber **16** and cyclone **16** and will fall downwardly off of floors **42** and **44**.

[0095] Accordingly, as seen in FIG. **5**, both cyclone **16** and dirt collection chamber **18** are openable and may be emptied concurrently when floors **42** and **44** are in the open position by holding vacuum cleaner **10** in the upright position (as shown in FIG. **1**).

[0096] It will be appreciated that dirt collection chamber **18** may be spaced from cyclone **16** provided dirt outlet **28** is in communication with dirt collection chamber **18** so that dirt which is disentrained from the fluid flow in cyclone **16** is conveyed to dirt collection chamber **18**. It will be appreciated that floor **42** may open separately from floor **44**, such that cyclone **16** and dirt collection chamber **18** may be individually opened.

[0097] As shown in FIG. **5**, housings **12** and **14** may have a pivoting bottom **66**, which is secured to each of housings **12** and **14** by a pivot **68**. In the closed position exemplified in FIGS. **1** and **4**, pivoting bottom **66** is secured in position by latch **70**. Latch **70** may have a button **72** which, when pressed, causes arm **74** to move outwardly thereby disengaging a flange provided on the bottom end of arm **74** from flange **76** provided on pivoting bottom **66**. A gasket or other sealing member may be provided at the interface of housings **12** and **14** and pivoting bottom **66** to provide an air tight or fluid tight seal. It will be appreciated that bottom **66** may be moveable in any other direction by any other means known in the art and may optionally be removable from housings **12**, **14**. Further, bottom **66** may be moveably secured in position by any other means known in the art and need not be connected to surface cleaning apparatus **10** for relative motion thereto.

[0098] In an alternate embodiment of FIGS. **1-6**, it will be appreciated that only floors **42** and **44** may be pivotally mounted to housing **12**. In such an embodiment, foam filter **20** may remain sealed when cyclone **16** and dirt collection chamber **18** are emptied. In an alternate embodiment, a side-by-side housing design as exemplified in FIG. **1** need not be utilized. In such a case, floor **42** and floor **44** may comprise the entire floor of the filtration assembly, see for example, FIGS. **9-11**.

[0099] If bottom **66** opens both housings **12** and **14**, then it will be appreciated that dirt positioned on the upstream surface of filter **20** will be emptied when bottom **66** is opened.

[0100] In the alternate embodiment of FIGS. **7** and **8**, impingement member **30** is removed from the vicinity of dirt outlet **28** when opposed wall is opened, e.g., by pivoting about pivot pin **66**. As exemplified, impingement member **30** is mounted to support **166** that is preferably mounted to opposed wall **164**. It will be appreciated that impingement member **30** may be otherwise moveably mounted. When opposed wall is opened, the cyclone chamber is opened and both cyclone **150** and dirt collection chamber **152** may be concurrently emptied. In this embodiment, vortex finder **36** remains in position in the cyclone chamber. While a screen may be positioned to overlie inlet end **50** of vortex finder **36**, it will be appreciated that a member having a diameter larger than vortex finder **36** is absent from the interior of cyclone **150** thereby permitting dirt to be unimpeded when cyclone **150** is held open over a garbage can.

[0101] In the alternate embodiment of FIGS. **9-11**, cyclone **16** has a closed end and is opened at the closed dirt outlet end for emptying. As exemplified, in FIGS. **9-11**, cyclone **16** has tangential passage **172** that is in airflow communication with a surface cleaning nozzle (not shown). Tangential passage **172** is connected to air inlet **34** of cyclone **16**. Cyclone **16** has a clean air outlet **36** in floor **44**, similar to the embodiment of FIGS. **1-6**. Cyclone **16** has a closed end wall **174** with at least one dirt outlet **28** in a side wall thereof. Dirt outlet **28** opens to dirt collection chamber **18**. The outer walls of dirt collection chamber **18** are formed from sidewall **186** and end wall **188**. Bottom wall **182** comprises floors **44** and **42**. A gasket **180** may be provided at the interface of dirt collection chamber **18**, cyclone **16** and bottom panel **182** to provide an air tight or fluid tight seal.

[0102] In operation, dirty air enters cyclone **16** tangentially via air inlet **34** and swirls upwardly. Heavier dirt particles fall out of the air stream and are deposited on floor **44** of bottom panel **182**. Some dirt particles will exit cyclone **16** via dirt outlet **28**, fall downwardly in dirt collection chamber **18** and deposit on floor **42** of bottom panel **182**.

[0103] As exemplified in FIGS. **9-11**, bottom panel **182** comprises a wall intersecting the longitudinally extending axis A of dirt collection chamber **18** and cyclone **16**. Accordingly, bottom panel **182** forms the end portion of dirt collection chamber **18** and cyclone **16**. Bottom panel **182** may have a flange **184** connected to a flange **190** on sidewall **186**. Accordingly, bottom panel **182** is rotatably moveable such that cyclone **16** and dirt collection chamber **18** may be opened to empty deposited dirt particles. When bottom panel **182** is in the open position, the cyclone chamber has an absence of any member having a larger diameter than the vortex finder.

[0104] In the alternate embodiment of FIGS. **12-13**, floors **42** and **44** comprise the openable end portion. Cyclone floor **44** is mounted to dirt collection chamber **18**, such as by support **176**. Accordingly, when dirt collection chamber **18** is opened, such as by rotating about pivot **170**, cyclone **16** is also opened.

[0105] In any embodiment as exemplified in FIGS. **1-6**, a filtration member may be provided adjacent outlet **36** and, preferably, in sealing engagement with outlet **52**. Referring to FIG. **3**, filtration member **78** may be positioned on rear surface **84** of floor **44** and overlies outlet **52**. Accordingly, air that exits outlet **36** travels through filtration member **78**. The air then travels through filtration chamber **80** and travels laterally to outlet **86**, which is in air flow communication with headspace **88** below filter **20**. An advantage of such an embodiment is that a screen, shroud or filter need not be provided inside cyclone **16** overlying inlet **52** of vortex finder **36**. Accordingly, if a vortex finder remains in cyclone **16** when it is opened, such as in FIGS. **7-8** and **12-13**, then a large diameter member that may impede dirt from falling out need not be provided in cyclone **16**.

[0106] Preferably, filtration member **78** preferably comprises a screen, such as an open mesh screen, e.g., a wire mesh screen or, alternately, a plastic mesh screen.

[0107] An access door **82** may be provided to permit access to filtration member **78** such that filtration member **78** may be cleaned. Access door may be any door that is movably mounted in overlying relationship to filtration chamber **80**. As exemplified in FIG. **6**, access door **82** is pivotally mounted by pivot **90** to pivoting bottom **66**, and is secured in position by a latch **120**. Latch **120**, for example, may have a button **122** which, when pressed, causes arm **124** to move outwardly thereby disengaging a flange on the bottom end of arm **124** from flange **92** provided on the front end of access door **82**. A sealing gasket or other sealing member known in the art may be utilized to provide an air tight or fluid tight seal for filtration chamber **80**. Any other securing member known in the art may be used. Further, door **82** may be removable and need not be connected to surface cleaning apparatus **10** for relative motion thereto.

[0108] Preferably, filtration member **78** is mounted and, more preferably, movably mounted and, most preferably, removably mounted to access door **82**. As shown in FIG. **6**, filtration member **78** is pivotally mounted to the inner surface of access door **82**. Accordingly, when a user desires to clean filtration member **78**, it may be pivoted in the direction shown by arrow A in FIG. **6** to an open or cleaning position. It will be noticed that access door **82** may be opened independently of pivoting bottom **66**. In an alternate embodiment, it will be appreciated that a pivoting bottom **66** need not be provided.

[0109] Preferably, at least a portion of and, more preferably, all of access door **82** is transparent. Accordingly, a user may lift the vacuum cleaner, invert the vacuum cleaner or tilt the vacuum cleaner on its side to view filtration member **78** and determine whether filtration **78** requires cleaning or, alternately, replacement.

[0110] In accordance with any embodiment of this invention, a series of screening and filtration members may be used in series downstream from the cyclone chamber of cyclone **16**. In accordance with this preferred embodiment, the screening and filtration members comprise a screen **78**, which is preferably positioned adjacent outlet **36**, a foam filter **22** downstream from screen **78**, a felt filter **22** downstream from foam **20** and a HEPA filter **24** downstream from felt filter **22**. Preferably, all of these filters are positioned upstream from suction motor **26**. Alternately, one or more of these filters may be positioned downstream from suction motor **26**. In particular HEPA filter **24** may be downstream from suction motor **26**. Accordingly, a plurality of screening and filtration members, each of which have a finer filtration capacity (e.g. smaller pores) are provided in series in the downstream direction. Optionally, a shroud (e.g. a perforated or apertured plastic cover) may be provided surrounding or overlying inlet **50** of outlet **36**.

[0111] It will be appreciated that the end portion may be openable by any means known in the art. For example, it may be translatable, slidable or removably mounted, such as by a

screw or bayonet mount or a snap fit. Preferably, it is not removably mounted, but remains affixed to the filtration housing when opened, such as by being pivotally mounted as exemplified.

[0112] It will be appreciated that the end portion may be oriented such that it is the lower portion of the dirt collection chamber **18** (e.g. FIGS. **1-6** and **9-13**) and accordingly comprises a dirt collection surface. However, it need not be, provided that it intersects the longitudinal axis of the cyclone (e.g. FIGS. **7-8**).

[0113] It will be appreciated that the end portion may be distal to dirt outlet **28** (e.g., FIGS. **1-6** and **9-11**) or may face dirt outlet **28** (e.g., FIGS. **7-10**).

[0114] FIGS. **14-18** exemplify an upright vacuum cleaner optionally having a removably mounted portable surface cleaning apparatus, optionally a hand vacuum cleaner, wherein the portable surface cleaning apparatus preferably has a nozzle having an open sided air flow chamber. It will be appreciated that the portable surface cleaning apparatus may be of any construction (e.g., a hand vacuum cleaner) and may use any particular air treatment member (e.g., one or more cyclones comprising one or more cyclonic cleaning stages and one or more filters). It will also be appreciated that the upright structure to which the portable surface cleaning apparatus is removably attached may be of any particular design. Further, the floor cleaning unit may alternately, or in addition, use an open sided nozzle and may selectively receive an auxiliary cleaning tool.

[0115] Referring to FIGS. **14** to **18**, a first example of a surface cleaning apparatus **100** is shown. The surface cleaning apparatus **100** is a vacuum cleaner that comprises a floor cleaning unit **200** comprising a surface cleaning head **300** having a support structure **210** pivotally mounted thereto and a portable surface cleaning apparatus **400** that is removably mounted to support structure **210**. Support structure **210** may also be referred to as a handle, a backbone or an upright section.

[0116] In the example shown, the handle **210** has an upper portion **214** and a lower portion **216** that are optionally pivotally connected by a hinge **218**. The handle **210** is attached to the surface cleaning head **300** and a user can move the surface cleaning head **300** along a surface to be cleaned by gripping and maneuvering the handle **210**. Optionally, the lower portion **216** of the handle **210** can be hingedly or pivotally attached to the surface cleaning head **300**, so that the lower portion **216** of the handle **210** can move relative to the surface cleaning head **300** during use. This may enable the user to move the surface cleaning head **300** beneath cabinets, furniture or other obstacles.

[0117] The upper portion **214** of the handle optionally includes a grip **212** that is shaped to be gripped by a user. In the example shown, the grip **212** is at the top, or upper end of the upper portion **214** of the handle **210** and is formed in a closed loop-type shape having surfaces that are rounded to increase user comfort. In other examples, the grip **212** may be of a different configuration or may be located at a different position on the upper portion **214** of the handle **210**.

[0118] In addition to the grip **212**, the upper portion **214** of the handle **210** optionally includes a bracket **113** that supports an auxiliary, or accessory or supplemental cleaning tool **112**. In the example shown, the bracket **113** is configured to hold a single auxiliary cleaning tool **112**, but in other examples the bracket **113** may be configured to hold more than one auxiliary cleaning tool **112**. Also, while shown attached to the upper portion **214**, it is understood that the bracket **113** may be attached to other locations on the surface cleaning apparatus, including the lower portion **216**, the surface cleaning head **300** and/or the hand vacuum **400**.

[0119] In the example shown, the upper and lower portions **214**, **216** have a generally cylindrical or tube-like shape. However, in other examples, the upper and lower portions **214**, **216** may any other type of thin support members having suitable cross-sectional shape including square, rectangular or polygonal. In addition, the upper and lower portions **214**, **216** may be solid or hollow and may be formed from any suitable material, including plastic and metal. In other embodiments, it will be appreciated that handle may be a single unit, e.g., a support rod such that upper and lower portions **214**, **216** are part of the same element. Alternately, upright section **210** may comprise a frame for removably receiving a portable surface cleaning apparatus.

[0120] The upper and lower portions **214**, **216** of the handle **210** are optionally pivotally joined by hinge **218**. When the hinge **218** is in a first position, as shown in FIGS. **14**, **15**, **17** and **18** the upper and lower portions **214**, **216** of the handle **210** are generally aligned with each other. The hinge **218** is retained in this first position by a biasing or locking means so that first portion **214** of the handle **210** remains in a generally vertical aligned with lower portion **216** when not in use and so that movements of the first portion **214** of the handle **210** can be translated to the second portion **216**. In use, the hinge **218** can be unlocked, or released from the first position and can move into a second position, wherein the grip **212** is preferably rotated forwardly.

[0121] In the example shown, the grip **212** comprises a hinge release **213** that can be activated by a user during use of vacuum cleaner **100** to unlock the hinge **218**. When a user activates the hinge release **213**, the retaining or locking means used to secure the hinge **218** in the first position is disengaged, allowing the hinge **218** to rotate or pivot, as shown in FIG. **16***a*. As the hinge **218** rotates, the first portion **214** of the handle **210** can be moved into a plurality of angular positions relative to the second portion **216** handle **210**. Optionally, the hinge **218** may rotate between, and lock into, a given number of set or indexed angular positions. Alternatively, the rotation of the hinge **218** may be continuously variable, after being initially unlocked, allowing for the first portion **214** to be moved into an indefinite number of angular positions relative to the second portion **216** (e.g., freely rotatable).

[0122] In the example of the vacuum cleaner **100** shown, the lower portion **214** of the handle **210** extends from the hinge **218** to the surface cleaning head **300** and optionally comprises the portable surface cleaning apparatus mount **220** for receiving and supporting the hand vacuum **400**. The lower portion **216** also optionally comprises a hose guide **230** for keeping the flexible hose **125** in close proximity to the backbone **200**. When the portable surface cleaning apparatus **400** is detached or removed from the backbone **200** the flexible hose **125** may be removed from the hose guide **230**, as shown in FIG. **16***a*.

[0123] The surface cleaning head **300** serves as a base portion of the vacuum cleaner **100** and is preferably in rolling contact with the surface to be cleaned. When the vacuum cleaner is **100** in an upright position (as exemplified in FIGS. **14**, **15**, **17** and **18**) the surface cleaning head **300** is supported by optional main or rear wheels **320** and/or optional front wheels (not shown). However, when the vacuum cleaner **100** is moved into an angled position during use (as exemplified in

FIG. **16***a*) additional optional support wheel **321** that is provided on upright section **210** may also roll across the surface to be cleaned. In other examples of the vacuum cleaner **100** the surface cleaning head **300** may include a greater or fewer number of wheels.

[0124] The surface cleaning head **300** also comprises a dirty air inlet **310** that is connected in fluid communication with a dirty air outlet **312** by one or more dirty air conduits (not shown). Preferably, the dirty air conduit is an air flow chamber wherein at least a portion of the lower side is open.

[0125] If the upright section includes a suction motor and/or an air treatment unit, then the dirty air outlet **312** may, in turn, be coupled, optionally removably coupled, to the upstream end of the conduit, preferably a flexible hose **125**, that extends from the dirty air outlet **312** of the surface cleaning head **300** to the upright section, such as the attachment member air inlet **126**. The fluid pathway may continue through the attachment member passageway **128**, which terminates in attachment portion air outlet **127**, and through attachment portion air outlet **127** which mates with the opening **438** of the portable cleaning apparatus **400**. The connection between the attachment portion **120** and the portable cleaning apparatus **400** is discussed in greater detail below.

[0126] Mount **220** is preferably configured to removably receive a portion of the portable surface cleaning apparatus and/or an attachment member removably mounted to the portable surface cleaning apparatus. The mount is preferably configured to retain portable surface cleaning apparatus therein under the influence of gravity. Accordingly, a mechanical lock need not be used. In particular, a user may lift the portable surface cleaning apparatus off of upright section **210** without having to press a button or otherwise release a mechanical lock.

[0127] As exemplified in FIGS. **14-18** the mount **220** may be generally U-shaped and may be sized to receive collar **140** or other mounting portion of the attachment member **120**. The inner surface of the mount **220** comprises a protrusion **222** that extends outward from the inner surface of the mount **220** and removably seats within the generally U-shaped channel **144** of the collar **140**. It will be appreciated that mount **220** may comprise more than one member, as exemplified in FIGS. **27-28**.

[0128] The mount **220** may be located in a variety of locations along the length of the second portion **216**. Preferably, the mount **220** is positioned at approximately the waist height of the intended user (e.g., 2.5-3.5 feet above the floor) so that the user can attached or detach the hand vacuum **400** from the backbone **200** without bending over. This may decrease the stress and strain experienced by the user when the user removes the hand vacuum **400** from the backbone **200**.

[0129] When attached to the portable surface cleaning apparatus **400** and seated in the mount **220** (as shown in FIGS. **14** and **15**), the attachment member **120** transfers all or a portion of the load (i.e. the weight) of the hand vacuum **400** to the mount **220**. Another portion of the load of the hand vacuum **400** may be supported by an additional mounting bracket, such as mount bracket **224**, which receives and supports optional rear wheel **480** of the portable surface cleaning apparatus **400**. The surface of the mount bracket **224** may be complimentary to the curved shape of the optional rear wheel **480** so that the optional rear wheel **480** can at least partially nest within mount bracket **224**. In addition to supporting the weight of the portable surface cleaning apparatus **400**, the attachment portion **120** also preferably serves as a fluid conduit establishing a fluid flow connection between the hand vacuum **400** and the airflow conduit **110**, which is preferably a flexible hose **125**.

[0130] Loads placed on the mount **220** (via both the U-shaped opening and/or the mount bracket **224**) are in turn transferred via the lower portion **216** of the handle **210** to the surface cleaning head **300** and ultimately to the floor or other type of surface being cleaned. The mount **220** may be made from any material that can support the weight of the hand vacuum **400**, including plastic and metal.

[0131] In the example of the vacuum cleaner **100** shown, the optional rear wheel **480** of hand vacuum **400** and the attachment member **121** are each preferably freely received by the mount **220** and held in place by gravity. The protrusion **222** that seats within the channel **144** of the attachment member **121** also provides a degree of lateral support, restraining the movement of the attachment member **121** (and therefore the hand vacuum **400**) when the handle **210** is moved from a vertical position to an angled position when in use. Further protrusion **222** may comprise a cam surface to assist in guiding protrusion **222** into channel **144** as the portable surface cleaning apparatus is lowered onto mount **220**. Accordingly, the attachment member **121** and the optional rear wheel **480** are preferably not held in place by clips, straps or any other type of mechanical fastening means.

[0132] The absence of mechanical fasters allows for simple, one-handed removal of the attachment member **121** and the hand vacuum **400** from the mount **220**, without the need to unlock or undo any fasteners. One-handed detachment of the hand vacuum **400** may be advantageous as it allows a user to control and maneuver the backbone **200** with one hand while simultaneously removing the hand vacuum **400** from the mount **220** with the other hand. In use, this may allow a user to frequently attach and detach the portable surface cleaning apparatus **400** from the mount **220** in response to the user's needs, for example navigating around furniture, stairs or other obstacles on the surface to be cleaned.

[0133] While in the preferred example described above the mount **220** is free of fasteners, in another example the mount **220** may be outfitted with fastening devices for retaining the attachment member **121** and the additional wheel **480**. Examples of possible fasteners include clips, snaps, and straps. Magnets may alternately or in addition be used. An advantage of using magnets may assist in holding the portable surface cleaning apparatus on the backbone but still permit one handed removal as no lock need be released.

[0134] Optionally, instead of removing the attachment portion **121** from the mount **220**, the hand vacuum **400** may be decoupled from the attachment portion while the attachment portion is positioned in mount **220**, as shown in FIG. **18**. In an embodiment, it will be appreciated that attachment member **121** may not be removable from mount **220**.

[0135] Referring to FIGS. **28-32** and **36-38**, other examples of the vacuum cleaner **100** are shown. These figures exemplify features of a surface cleaning apparatus that may be used with any embodiment disclosed in herein, either individually or in any particular combination or sub-combination. The features exemplified in these figures include a surface cleaning head, a support structure for an upright or stick vacuum cleaner, and a handle mount for a surface cleaning apparatus.

[0136] In this description, alternate structures for supporting an air treatment unit and/or a suction motor are provided. In one embodiment, as exemplified in FIGS. **28-32**, the sec-

ond portion **216** may include a generally upside down U-shaped wishbone portion **250**. The wishbone **250** is optionally provided with a hinge **218** at the centre of an upper portion of the wishbone **252**, and each prong **254** of the wishbone extends downward, and connects to a rib **256**. The ribs **256** are preferably substantially parallel and cooperate to define an optional mount for receiving a removable surface cleaning unit, such as the split saddle configuration that is exemplified. Optionally, the ribs **256** may be integrally formed with the prongs **254** of the wishbone portion **250**, or they may be separate tubes or rods fastened to the prongs **254** of the wishbone **250**, as shown.

[0137] A preferred mount comprises a pair of generally opposing saddle flanges **280** (one on each rib) that cooperate to provide a mount or a mounting location for the attachment member **121** that is connected to the hand vacuum **400**. Due to the spacing of the ribs **256** and the general curvature of the hand vacuum **400**, the hand vacuum **400** is preferably positioned in front of ribs **256**. The attachment member **121** extends rearward of hand vacuum **400** and may be received on split saddle flanges **280** in a similar manner to mount **220**. Alternately, it will be appreciated that hand vacuum **400** may be partially nest between, or be received between, the ribs **256**.

[0138] As exemplified, to supportingly engage the attachment member **121**, each saddle flange **280** preferably includes a projection or protrusion (not shown) that is received within the channel **142** of the collar **140** (as described in more detail with reference to FIGS. **24-27** below). The generally curved profile of the collar **140** and channel **142** may enable the attachment member **121** (and the associated hand vacuum **400**) to generally self-level or self-register between the ribs **256** when the user initially places the attachment member **121** on the saddle flanges **280**. Like the mount **220** described above, the saddle flanges **280** may include magnets or other fastening devices to secure or retain the attachment member **121**. Optionally, the mount **220** or any other suitable type of mounting hardware may replace the saddle flanges **280** in this example.

[0139] The lower ends of the ribs **256** may be attached to a bracket **260** having a generally opposite configuration than the wishbone. That is, the bracket may include two, upward facing projections **262**, for attaching to the ribs **256**, that are connected by a cross-member **264** to provide a single downward facing coupling point **266**. The spaced apart ribs provide two mounting points. Various such structures may be used.

[0140] Preferably, lower portion **216** is rotatably mounted to the cleaning head. Accordingly, a user may rotate grip **212** clockwise or counterclockwise to assist in steering the cleaning head. Accordingly an advantage of providing a single, downward facing coupling point may be the fact that a single coupling point can be pivotally and rotationally connected to the surface cleaning head **300**. Another advantage is that a narrower rear end may be utilized for the floor cleaning unit.

[0141] Accordingly, as exemplified, the bracket **260** preferably also includes a housing **268**, which is preferably hollow, having a lower opening **270** that connects to the surface cleaning head **300**. As exemplified, housing **268** may be pivotally mounted to surface cleaning head, preferably at about the location of rear wheels **320**, such as by having a portion pivotally mounted to the axle of rear wheels **320**. Optionally, the connection between the lower opening **270** and the surface cleaning head **300** can be a rotatable and pivotal connection. The hollow housing **268** may extend from the lower opening **270**, through the cross-member **264** to define an upper collar **272**.

[0142] Optionally, as in this example, the surface cleaning head **300** includes a hollow conduit member **330** and a second air conduit **334**. As exemplified in FIGS. **30-32**, one example of the second air conduit **334** is a second flexible hose **335**. In the preferred arrangement shown, the dirty air outlet **312** of the surface cleaning head **300** is connected to the second or upstream flexible hose **335** and the second flexible hose **335** extends from the dirty air outlet **312**, through the hollow conduit member **330**, through the hollow housing **268** to the upper collar **272**. The downstream end of the second flexible hose **335** may be fixedly connected to the upper collar **272**, or it may have a fitting that seats upon a surface of the upper collar **272** preventing the second flexible hose **335** from retracting within the hollow housing **268** while leaving the downstream end of the second flexible hose **335** free to extend upward, away from the upper collar **272**.

[0143] The second flexible hose **335** forms part of the continuous airflow passageway that connects the dirty air outlet **312** of the surface cleaning head **300** to the opening **438** on the hand vacuum **400**. To establish the continuous airflow passageway, the downstream end of the second upstream flexible hose **335** may be connected to the upstream end of the downstream flexible hose **125**. The connection between the flexible hose **125** and the downstream end of the second flexible hose **335** is preferably a detachable connection so that the flexible hose **125** can be detached from the surface cleaning head **300** as described above.

[0144] Optionally, the second flexible hose **335** is also an extensible, or stretchable, hose that can extend when pulled on by the user. In some examples, the second flexible hose **335** is a stretch hose and may have a stretched length to non-stretched length ratio of between 2:1-6:1. In examples where the second flexible hose **335** is not stretchable, when a user removes the hand vacuum **400** from its mount during use, the maximum distance that the hand vacuum **400** can be separated from the backbone **200** and the surface cleaning head **300** is determined by the length of the flexible hose **125**. However, in some instances, a user may wish to move the hand vacuum **400** a greater distance from the backbone **200**, for example to pass the surface cleaning head **300** under a bed or other large piece of furniture. When a stretchable second flexible hose **335** is used, the downstream end of the second flexible hose **335** can unseat from the upper collar **272** and extend away from the bracket **260**, whereby some of hose **335** may pass through housing **268** thereby lengthening the airflow conduit connecting the hand vacuum **400** to the surface cleaning head **300** and allowing the hand vacuum **400** to be moved further from the backbone **200** in use. Accordingly, it will be appreciated that some or all of the conduit that may be extended to provide additional length for an air flow passage may be stored on the surface cleaning head **300**.

[0145] It will be appreciated that lower section **216** may be rotatably mounted on cleaning head **300** without hose **335** extending through a housing **268**. Further, a housing **268** may be used even if lower section **216** is not rotatably mounted to cleaning head **300**. Such a housing need not be pivotally mounted to surface cleaning head.

[0146] Preferably, the second flexible hose **335** is also resilient so that it will return to its original, un-stretched length when it is released by the user. The resilience of the second flexible hose **335** may tend to retract the second flexible hose

335 through the hollow housing 268 and the hollow conduit member 330 and may serve to re-seat the downstream end of the second flexible hose 335 on the upper collar 272. In this example, the second flexible hose 335 functions as a variable length air conduit and may reduce the need for a user to add extra hoses or conduit members to the vacuum 100 during use.

[0147] To allow for easy and repeated extension of the second flexible hose 335, the second flexible hose 335 may be sized to freely pass through both the hollow conduit member 330 of the surface cleaning head 300 and the hollow housing 268 of the bracket 260.

[0148] In the example shown in FIG. 28-32, the hollow housing 268 is integral the bracket 260 and also serves as the coupling means that connects the lower portion 216 to the surface cleaning head 300. As shown, the coupling between the lower portion 216 and the surface cleaning head 300 may be the telescoping or overlapping engagement of the lower opening 270 over the surface cleaning head 300 hollow conduit member 330. In other examples, the coupling or attachment between the lower portion 216 and the surface cleaning head 300 may be any type of connection including a threaded connection, clamps or tabs. The connection between the lower portion 216 and the surface cleaning head 300 may be fixed or selectively releasable. An advantage of providing a single, downward facing coupling point 266 may be the fact that a single coupling point 266 can be pivotally and rotationally connected to the surface cleaning head 300. Further, the hollow conduit member 330 may be pivotally connected to the surface cleaning head 300, as exemplified in FIGS. 28-32, and in other examples, the hollow conduit member 330 may be fixedly connected to the surface cleaning head 300, or integrally formed therewith.

[0149] As shown, the hollow housing 268 may be integral with the bracket 260 and provide both a hollow passageway and an attachment point. However, in other examples, the hollow housing 268 may be external the bracket 260 and may be formed from a separate conduit. Similarly, the air flow conduit 110 connecting the attachment member 121 to the second flexible hose 335 may be the flexible hose 125 or any other suitable conduit, including flexible conduits, rigid conduits, conduits integral with the handle and conduits external the handle.

[0150] Optionally, the ribs 256 (or another portion of the second portion 216) may be surrounded by a housing or shell. The housing may provide structural strength to the second portion 216 or it may merely provide an improved aesthetic appearance of the vacuum 100, or both. If a housing is formed around a section of the second portion 216 (or any other section of the handle 210 or backbone 200) the mount for supporting the hand vacuum (for example the mount 220 or the saddle flanges 260) may be within a recess in the housing. Providing a recess in the housing for receiving the hand vacuum may create a more integrated or seamless visual appearance when the hand vacuum is mounted to the backbone 200; it may also improve the rigidity of the backbone 200.

[0151] As exemplified, wishbone portion 250 preferably extends forwardly and provides a mount for upper portion 214 (i.e. the handle) at a forward point of the backbone. Further, passageway 268 extends rearwardly. Accordingly, when hand vacuum 400 is mounted to the backbone, the centre of gravity of the backbone and hand vacuum 400 combined is below a plane P extending from the axle of rear wheel 320 to the upper end of upper portion 214 (as exemplified in FIG. 30), thereby improving maneuverability of surface cleaning head 300. It will be appreciated that other constructions, such as that exemplified in FIGS. 14-18, may be used to position the centre of gravity behind the plane. In the example shown (best exemplified in FIG. 18), the lower portion 216 includes an upper end, that is connected to the hinge 218 such that the upper portion 214 is drivingly connected to the surface cleaning head 300. In this construction the lower end includes a step-back or kinked-back portion 215. The step-back portion 215 enables the mount 220 to be positioned sufficiently behind the rear wheels 320 such that the centre of gravity of the combination of the backbone 200 and the hand vacuum 400 is below the plane P. As a result of this configuration, the vacuum 100 may be more stable when rotated and maneuvered by the user, especially when upper portion 214 is rotated about hinge 218. Specifically, locating the centre of gravity of the combination of the hand vacuum 400 and the backbone 200 below the plane P may tend to reduce the over rotation of the backbone 200 or over-steer of the vacuum 100 in use, and may reduce the strain on a user's arm and wrist.

[0152] It will be appreciated that the dual hose construction (i.e. the flexible hose 125 and the second flexible hose 335 of FIG. 28-32) may be used in combination with any example disclosed herein or by itself in a surface cleaning apparatus. Similarly, the positioning of a removably mounted portable surface cleaning apparatus with a low centre of gravity may be used in combination with any example disclosed herein or by itself in a surface cleaning apparatus.

[0153] Referring now to FIGS. 36-38, another embodiment of a vacuum cleaner 100 includes a portable surface cleaning apparatus 400 removably mounted to the backbone 200, which in this embodiment includes the upper portion 214 and the lower portion 216. Backbone 200 is pivotally connected to the surface cleaning head 300, which includes the dirty air inlet 310 and is rolling supported above the floor by rear wheels 320.

[0154] The portable surface cleaning apparatus 400 is fluidly connected to the surface cleaning head 300 by the air conduit 110 that comprises the substantially rigid upper and lower portions 214, 216 and the flexible hose 125. In this configuration, the vacuum cleaner 100 can be operated in a floor cleaning mode as an upright vacuum cleaner.

[0155] Optionally, as described in detail above, a user can detach the portable surface cleaning apparatus 400 from the backbone 200, as shown in FIGS. 37 and 38, so that the user can hold the portable surface cleaning apparatus 400, or rest it on the ground, separately from the backbone 200 and surface cleaning head 300. To configure the vacuum cleaner 100 in this manner, a user can remove the portable surface cleaning apparatus 400 from the mount portion 220 of the backbone 200.

[0156] In this example, as exemplified in FIG. 37, the mount portion 220 is a generally tubular section 216*a* of the lower portion 216 that is received within a corresponding slot or aperture in the portable surface cleaning apparatus 400. In some examples, the corresponding slot is a generally complimentary, tubular or cylindrical opening in a lower portion of the portable surface cleaning apparatus 400 that is sized and configured to removably receive the tubular section 216*a*. Optionally, as exemplified, both the tubular section 216*a* and the corresponding slot can form part of the air flow passage 110 that communicably links the dirty air inlet 310 to the

portable surface cleaning apparatus **100**. Accordingly, the connection between the tubular section **216***a* and the slot in the portable surface cleaning apparatus **400** can also include a releasable sealing member, for example a rubber o-ring, to provide a generally air-tight connection between the lower portion **216** and the portable surface cleaning apparatus **400**.

[0157] In some examples the portable surface cleaning apparatus **400** is held on the tubular section **216***a* by gravity, and is free from any locking or latching mechanisms. In other examples, the connection between the tubular section **216***a* and the portable surface cleaning apparatus **400** can include a user operable lock or latching mechanism to securely hold the portable surface cleaning apparatus **400** in place when the vacuum cleaner **100** is in use as an upright vacuum cleaning.

[0158] As exemplified in FIGS. **36-38**, the vacuum cleaner **100** can be operated in at least two operating modes when the portable surface cleaning apparatus **400** is removed from the backbone **200**. In one configuration, as exemplified in FIG. **37**, the portable surface cleaning apparatus **400** can be removed from fluid communication with the surface cleaning head **300** and can be operated as an above floor cleaning apparatus. In this configuration the upper portion **214** can be released from portable surface cleaning apparatus **400** and serve as an auxiliary cleaning tool. Optionally, the upper portion **214** can include a rigid cleaning wand portion **214***a* that can be used to extend the cleaning reach of a user. The cleaning wand portion **214***a* can also be configured to receive additional auxiliary cleaning tools **112** as described above. In some examples, the cleaning wand portion **214***a* can be detached from the grip portion **212**, which can then be used to clean surfaces directly, or to support auxiliary cleaning tools **112**.

[0159] In another configuration, as exemplified in FIG. **38**, when the portable surface cleaning apparatus **400** is detached from the backbone **200** the upper portion **214** and be re-connected to the lower portion **216** (for example by sliding over the tubular mount section **216***a*), so that the detached portable surface cleaning apparatus **400** can remain in fluid communication with the surface cleaning head **300**. In this configuration, the backbone **200** of the vacuum cleaner **100** can be maneuvered as an upright vacuum cleaner without the added weight and bulk of the portable surface cleaning apparatus **400**, as explained in greater detail with respect to the previous example with reference to FIG. **16***a*.

[0160] In the previous example the portable surface cleaning apparatus **400** could optionally be detached from the backbone **200** without interrupting the air flow connection between the portable surface cleaning apparatus **400** and the surface cleaning head **300**. In the present example (exemplified in FIGS. **36-38**), detaching the portable surface cleaning apparatus **400** from the backbone **200** temporarily interrupts the air flow passage from the surface cleaning head **300** to the portable surface cleaning apparatus **400**, but the air flow passage can be reestablished by re-configuring the upper and lower portions **214**, **216** as described above.

[0161] Referring now to FIGS. **19-27**, examples of the portable cleaning apparatus **400** and the attachment member **121** of the vacuum **100** are shown in more detail. It will be appreciated that any portable surface cleaning apparatus may be used. Preferably, the portable surface cleaning apparatus uses cyclonic separation. More preferably, the portable surface cleaning apparatus is a hand vacuum cleaner.

[0162] The hand vacuum **400** can be operated as the vacuum suction supply for the vacuum **100** and it can be operated as a stand alone hand vacuum cleaner, that is movable along a surface to be cleaned by gripping and maneuvering handle **402**, when it is removed from, or detached from the backbone **200**. The hand vacuum **400** includes an upper portion **404**, a lower portion **406**, a front **408**, and a rear **410**. In the example shown, maneuvering handle **402** is provided at the upper portion **404**. In alternate examples, maneuvering handle **402** may be provided elsewhere on the vacuum cleaner **400**, for example at the rear **410**.

[0163] In the example shown, the hand vacuum **400** comprises a nozzle **412** and a cyclone unit **414**, which together preferably form a cleaning head portion **416** of the hand vacuum **400**. In the example shown, the cleaning head portion **416** is provided at the front **408** of the hand vacuum **400**.

[0164] Nozzle **412** comprises a dirty air inlet **418**, through which dirty air is drawn into the portable cleaning apparatus **400**, and when used as a hand vacuum cleaner the nozzle **412** directly engages a surface to be cleaned. An airflow passage extends from the dirty air inlet **418** to a clean air outlet **420** of the hand vacuum **400**. In the example shown, clean air outlet **420** is at the rear **410** of the hand vacuum **400**. It will be appreciated that clean air outlet may optionally be connected to a fluid conduit provided in the floor cleaning unit.

[0165] Cyclone unit **414** is provided in the airflow passage, downstream of the dirty air inlet **418**. In the example shown, the cyclone unit **414** comprises one cyclone **422**, and one dirt chamber **424**. In alternate examples, the cyclone unit **410** may include more than one cyclone, and more than one dirt chamber. Further, the cyclones chambers may be arranged in stages, and may be provided in parallel or in sequence. Alternately, or in addition, one or more filters or other dirt separation members may be used.

[0166] In a preferred embodiment, cyclone unit **414** is the first cyclonic cleaning stage of an upright vacuum cleaner and one or more additional cyclonic stages may optionally be provided. Cyclone unit **414** preferably comprises an inverted cyclone and/or a dirt collection chamber that partially or completely surrounds a cyclone chamber.

[0167] Referring to FIGS. **33** and **34**, an example of a cyclone unit **414** is shown in more detail. Within the cyclone unit **414**, the cyclone **422** may be of any configuration and orientation. Preferably, cyclone **422** comprises a chamber wall **442**, which in the example shown, is cylindrical. The cyclone chamber is located inside chamber wall **442**. The cyclone **422** has an air inlet and an air outlet, which, preferably are at the same end of cyclone **422**. Preferably the air inlet and the air outlet are distal to front end of the hand vacuum **400**. The cyclone air inlet and cyclone air outlet may be of any configuration known in the art and the cyclone air outlet may be covered by a screen or shroud or filter as is known in the art.

[0168] The air travels in a cyclonic path in the cyclone, and dirt in the air is separated from the air. The air exits the cyclone via an outlet passage **444**. As exemplified in FIG. **34**, a plate **474** may be provided adjacent outlet passage **444**, spaced from and facing the outlet passage **444**. As exemplified in FIG. **35**, the cyclone outlet passage **444** may comprise a vortex finder **482**, upstream from and in communication with the dirt outlet **446**. As exemplified, the vortex finder is a cylindrical conduit, having an inlet facing the dirt outlet **446**.

[0169] In the example shown, plate **474**, legs **478** and a wire mesh surrounding legs **478** form a shroud **484** that is optionally removably mounted in cyclone **422**.

[0170] Preferably, the shroud **484** is positioned such that air must pass through the openings in the shroud prior to traveling to a downstream component (e.g., a further cyclonic stage or a suction motor). As exemplified, the shroud surrounds the cyclone air outlet, or outlet passage **444**. The shroud **484** may serve to prevent elongate material and larger, lighter dirt from passing through dirt outlet **446**. As exemplified, the shroud **484** surrounds the vortex finder **482**. Legs **478** extend from plate **474**, along vortex finder **482**. As exemplified, the shroud **484** also comprises a ring **485** that is integral with legs **478** and surrounds vortex finder **482**. The ring and legs provide a mount for plate **474**. Optionally, a screen extends from plate **474**, around legs **478**, to ring **485**. Accordingly, the screen is positioned in the air flow path of air exiting the cyclone chamber and entering the vortex finder **482**. It will be appreciated that in alternate embodiments, the shroud may be any other suitable configuration. For example, a plate need not be provided. In another example, the plate may be provided as part of the vortex finder. The shroud screen may be made of a wire mesh. Alternately, shroud **484** may be a molded plastic covering vortex finder **482** and may have a plurality of apertures therein.

[0171] Optionally, the dirt chamber may be internal or external to the cyclone chamber. Preferably, as exemplified in FIGS. **33-35**, the dirt chamber **424** is external the outer cyclone housing **442**, and the dirt that is separated from the air exits the outer cyclone housing **442** via dirt outlet **446**, and enters dirt chamber **424**. In the example shown, the dirt chamber **424** has an outer wall **415** that comprises a first portion **425** and a second portion **427**. The second portion **427** may also be referred to as a door or outlet end wall. Together, the first and second portions **425**, **427** cooperate to define a sealed dirt chamber **424**. As exemplified, the first and second portions **425**, **427** of the dirt chamber outer wall **415** may also form the outer housing, casing or unit wall of the cyclone unit **414**, and more generally of the cleaning head portion **416** of the hand vacuum **400**. In other examples, the first and second portions **425**, **427** of the dirt chamber outer wall, or portions thereof, may be surrounded by a separate housing, casing or wall structure that defines the outer surface of the cyclone unit **414** and the cleaning head portion **416** of the hand vacuum **400**. Also, the dirt chamber **424** may be in communication with the cyclone chamber by any means known in the art. Accordingly, one or more dirt outlets may be provided. Preferably, the dirt outlet is at the end opposed to the air inlet and, preferably, the dirt outlet is at the front end of the hand vacuum **400**.

[0172] In the example shown, the dirt chamber **424** comprises two volumes. A first volume **448** is provided immediately adjacent the dirt outlet **446**, and above the top of the outer cyclone housing **442**, when the hand vacuum **400** is mounted on the backbone **200**. A second volume **450** is the generally annular space formed between the outer cyclone housing **442** and the first portion **425** of the dirt chamber outer wall **415**.

[0173] A separation plate **454** may be provided in the dirt chamber **424**, adjacent the dirt outlet **446**. The separation plate **454** aids in preventing dirt in dirt chamber **424** from re-entering cyclone **422**. Preferably, plate **454** is spaced from dirt outlet **446** and faces dirt outlet **446**. Plate **454** may be mounted by any means to any component in cyclone unit **414**. As exemplified, the separation plate is mounted on an arm, which extends from an inner surface of the front wall **458** of the hand vacuum **400**.

[0174] When the vacuum **100** is used to clean a surface the dirt separated from the dirty air is collected in and retained in the dirt chamber **424**. When the hand vacuum **400** is mounted on the backbone **200**, gravity will urge the dirt toward the bottom the dirt chamber **424** as exemplified in FIG. **33** (that is, toward the air outlet **420** and away from the second portion **427** of the dirt chamber outer wall **415**). As a result of ongoing or extended use of the vacuum **100**, the amount of dirt collected within dirt chamber **424** will increase. As the amount of dirt contained within the dirt chamber **424** increases, the level of dirt within the dirt chamber **424** will rise, relative to the bottom of the dirt chamber **424** as exemplified in FIG. **33**. Over time, the level of dirt within the dirt chamber **424** will approach an optional designated fill line F indicated on at least one side of the first portion **425** of the dirt chamber outer wall **415**.

[0175] The position of the fill line F may be based on the performance characteristics of the cyclone **422** including the height of the cyclone outer surface **442** or other suitable factors. As exemplified in FIG. **33**, the location of the fill line F may be below the top of the cyclone outer housing **442** and the dirt outlet **446** (when the hand vacuum **400** is vertically mounted on the backbone **200**). Locating the fill line F below the dirt outlet **446** may reduce the likelihood of dirt re-entering the outer cyclone housing **442** and fouling the cyclone **422** or otherwise interfering with the operation of the hand vacuum **400**. Optionally, the fill line F may be defined by the edge of the second portion **427** of the dirt chamber wall **415**, instead of a line on the first portion **425**.

[0176] In the example shown in FIGS. **33** and **34**, the first portion **425** of the dirt chamber outer wall **415** is transparent (or at least substantially transparent) to allow a user to see the amount of dirt contained within the dirt chamber **424** without having to open or otherwise access the dirt chamber **424**. When the hand vacuum is mounted on the backbone **200**, a user looking into the dirt chamber **424** may be able to compare the height of the dirt in the dirt chamber **424** to the position of the fill line F to determine if the dirt chamber **424** is "full". Being able to see the amount of dirt in the dirt chamber **424** may enable a user to determine how much capacity remains within the dirt chamber **424**, and accordingly anticipate how much additional cleaning can be completed before the dirt chamber **424** needs to be emptied. While the first portion **425** of the dirt chamber outer wall **415** is preferably transparent to allow a user to see inside the dirt chamber **424**, the outer cyclone housing **442** is preferably opaque to conceal the cyclone **422** and to provide a contrasting background to allow the user to accurately determine the height of the dirt within the dirt chamber **424**.

[0177] Due to the operation of the cyclone **422** and configuration of the dirt outlet **446**, it may impede the operation of the vacuum **100** (and the hand vacuum **400**) if the dirt outlet **446** is substantially blocked or occluded by the accumulated dirt in the dirt chamber **424**. To reduce the chances of the dirt outlet **446** being blocked by dirt the fill line F may be located below the dirt outlet **446** as exemplified. The position of the fill line F may also be based on a maximum volume of the dirt chamber below the fill line F so that when the hand vacuum **400** is operated on its side, as a hand vacuum, the dirt in the dirt chamber **424** will not completely submerge the cyclone outer housing **442** and the dirt outlet **446**. Optionally, the first portion **425** of the dirt chamber outer wall **415** may include a second fill line that is oriented to be read when the hand vacuum **400** is in a sideways orientation. The dirt chamber

424 may also include a plurality of additional indicator lines, such as a half-full line and a quarter-full line.

[0178] Despite the presence of the fill line F indicating the maximum intended capacity of the dirt chamber 424, a user may be tempted to continue to operate the vacuum 100 to collect additional dirt, particularly if it appears that there is additional dirt storage capacity within the dirt chamber 424 above the fill line F, for example dirt chamber volume 448. As described above, filling the dirt chamber 424 above the fill line F can impede the operation of the vacuum 100. Therefore, to deter users from over-filling the dirt chamber 424 (i.e. filling above the fill line F), the second portion 427 of the cyclone unit wall 415 is preferably opaque (or at least substantially opaque) to visually obscure portions of the dirt chamber 424 from the user, as exemplified in FIG. 33. Optionally, the first portion 425 may be partially translucent and partially opaque to further conceal the interior of the dirt chamber 424.

[0179] The second portion 427 of the dirt chamber outer wall 415 abuts the first portion 425 at a joint or juncture. The position of the juncture may be such that the lowest portion of the juncture (when the hand vacuum 400 is vertically mounted on the backbone 200) is proximate the fill line F. Configuring the dirt chamber 424 in this manner may further deter the user from over-filling the dirt chamber 424 because the opaque second portion 427 may create the illusion that the dirt chamber 424 does not extend much above the fill line F.

[0180] This embodiment is particularly preferred. When a user approaches the vacuum cleaner, they may approach it from the front, as seen in FIG. 14. In this orientation, the shortest portion of first portion 425 is visible. Accordingly, if second portion is an openable lip, and is made from a plastic that is less translucent then first portion 415, a user may determine to empty the dirt collection chamber prior to using the vacuum cleaner if the dirt collection appears to be full due to dirt extending all the way up to the lowest portion of lid 427. It will be appreciated that a fill line need not be marked on the dirt collection chamber itself.

[0181] Cyclone unit 414 may be emptied by any means known in the art. For example, one of the ends of the cyclone unit 414 may be openable. The second portion 427 may be a pivotally mounted door to the first portion 425 of the cyclone unit wall 415, such that cyclone unit 414 may be opened, and dirt chamber 424 may be emptied. When second portion 427 is pivoted away from the remainder of the cyclone unit 414, separation plate 454 also preferably pivots away from the remainder of the cyclone unit 414. A securing member such as a latch 459, a screw mount or the like may be provided, which secures second portion 427 to the first portion 425 of the wall 415. In alternate examples, second portion 427 may be removable from cyclone unit wall 415 (As exemplified in FIG. 34) or the opposed end of the cyclone unit 414 may be openable.

[0182] In the example shown, the nozzle 412 is positioned at the lower portion 406 of the portable cleaning apparatus 400. More preferably, as in the example shown, nozzle 412 is positioned at the bottom of the portable cleaning apparatus 400, and is preferably beneath the cyclone unit 414 when used as a hand vacuum cleaner and is between the cyclone unit 414 and the mount 220 when attached to the backbone 200. Further, as in the example shown, the nozzle 412 is preferably fixedly positioned at the lower portion 406 of the portable cleaning apparatus 400. That is, the nozzle 412 is not movable with respect to the remainder of the portable cleaning apparatus 400, and is fixed at the lower portion 106 of the portable cleaning apparatus 400. As shown in FIGS. 20 and 21, nozzle 412 has a width WN and, as shown in FIG. 24, coupling plate 123 has a width Wp that is generally the same as width WN.

[0183] Nozzle 112 exemplifies a particular design for an open sided nozzle. Open sided nozzle 112 has an open side that faces the surface to be cleaned when the nozzle is placed against a surface to be cleaned. Accordingly, nozzle 112 defines an air flow chamber that has an open lower side. In operation, air will flow longitudinally through the air flow chamber to an air exit. It will be appreciated that only part of the nozzle may have an open lower side. Alternately, all of the nozzle, from an air inlet end to the air outlet, may have an open lower side. It will be appreciated that various other design may be used.

[0184] Referring now to FIGS. 21-27, nozzle 412 comprises an upper nozzle wall 426. In the example shown, the upper nozzle wall 426 comprises a portion 419 of a wall 415 of the cyclone unit. Nozzle 412 further preferably comprises a depending wall 428 extending downwardly from the upper nozzle wall 426. The depending wall 428 is generally U-shaped. The height of the depending wall may vary. The open end of the U-shape defines an open side wall 430 of the nozzle 414, and forms the dirty air inlet 418 of the portable cleaning apparatus 400. In the example shown, the open side wall 430 is provided at the front of the nozzle 414 and forms a portion of a flow passage that is in communication with the opening 438. When in use as a hand vacuum, optional wheels 435 are in contact with a surface and the open side wall 430 sits above and is adjacent a hard surface to be cleaned. It will be appreciated that depending wall 428 may be positioned only rearward of opening 438. Alternately, or in addition, depending wall 428 may be provided adjacent the lateral sides of opening 438. The depending walls may be discrete walls or they may be joined together as exemplified. The walls may be continuous or discontinuous.

[0185] In the example shown, the lower end 432 of the depending wall 428 defines an open lower end 434 of the nozzle 414. The open lower end 434 extends to the front 408 of the hand vacuum 400, and merges with the open side 430. In use, the open lower end 434 faces a surface to be cleaned. In the example shown, a plurality of wheels 435 are mounted to the depending wall 428, and extend below the lower end 432 of the depending wall 428. Accordingly, when in use as a hand vacuum, when wheels 435 are in contact with a surface, the lower end 432 of the depending wall 428 is spaced from a surface to be cleaned, and the space between the lower end of the depending wall 428 and the surface to be cleaned form a secondary dirty air inlet to the portable cleaning apparatus 400 when used as a hand vacuum.

[0186] The upper nozzle wall 426, depending wall 428, and open lower end 434 of the nozzle 412 define an airflow chamber 436 of the nozzle. An opening 438 is preferably provided in the upper nozzle wall 426, and is in communication with the airflow chamber 436. When in use as a hand vacuum, the wheels 435 are in contact with a surface, the opening 438 faces a surface to be cleaned, air enters the dirty air inlet 418, passes horizontally through the airflow chamber 436, and passes into the opening 438. Opening 438 is in communication with a cyclone inlet passage 439, which is in communication with a cyclone air inlet 440 of cyclone 422. In some embodiments, opening 438 need not be in upper wall 426.

[0187] Nozzle 412 and attachment member 121 are configured such that attachment member 121 may form part of the

air flow conduit to opening **438** when attachment member **121** is mounted to hand vacuum **400**. For example, when the portable cleaning apparatus **400** is used in combination with the backbone **200** and the surface cleaning head **300**, the opening **438** in the nozzle **412** is in sealed, fluid communication with the air outlet **127** of the attachment member **121**. By way of this connection, a continuous fluid pathway is established between the dirty air input **310** of the surface cleaning head **300** and the opening **438**.

[0188] It will be appreciated that attachment member **121** may be removably mounted to nozzle **412** by any engagement means known in the connecting arts. Further, attachment member may be of any configuration. Attachment member may be part of, or may be connected to, an accessory cleaning tool by any means, such as a flexible hose. The flexible hose may be hose **110** if hose **110** is removably mounted to the floor cleaning unit.

[0189] As exemplified, attachment member **121** is removably engaged with nozzle **412** by the engagement of pivoting arms in slots provided on nozzle **412**. Accordingly, for example, nozzle **412** may also include a slot **490** defining a recess in the depending wall **428** that is adjacent the upper nozzle wall **426**. The slot **490** preferably extends continuously along the U-shaped portion of the nozzle depending wall **428** and may be bounded at each end by corners **492**. The attachment member **121** includes two arms **151** each having a shoulder **154** and being pivotally connected to the coupling plate **123** using pins **156** (alternatively, the arms **151** could be resilient). FIG. **27** is a partially exploded view of the attachment member **121**, illustrating one example of the rotational connection between the coupling **142** and the collar **140**. In the example shown, the coupling **142** comprises a cylindrical body wall that passes through an opening in the collar **140**. Once the coupling **142** had been inserted into the collar **140** it is retained using fastening clip **143**. The combination of the coupling plate **123** and the arms **151** may also be described as connecting portion, mounting portion or nozzle mounting portion of the attachment member **121**.

[0190] In order to assemble the mount on nozzle **412**, coupling plate **123** may be slid into the open end of airflow chamber **436**. Accordingly, when the coupling plate **123** of the attachment portion **121** is slid into the airflow chamber **436**, the arms **151** are pressed together by the nozzle **412** walls until the point when arms **151** are aligned with slot **490** (i.e. when the shoulders **154** are advanced past the corners **492**). When the arms **151** are aligned with the slot **490**, the attachment member **121** is "clicked-in" or locked in place when the arms **151** spread apart and the shoulders **154** of the arms **151** become lodged behind the corners **192** of slot **490**. The arms **151** may be manually separated or the attachment member may include a biasing means (not shown) that biases the arms **151** apart. With the arms **151** in the spread configuration the attachment member **121** cannot be slidingly removed from the nozzle **412**. When a user wishes to detach the attachment means **121** from the nozzle **412** the user may squeeze upstanding tabs **153** together thereby allowing the shoulders **154** to slide past the corners **192**. The mount may alternately be inserted by squeezing upstanding tabs **153** together so that plate **123** may be inserted in chamber **436**.

[0191] When the hand vacuum **400** is coupled to the attachment member **121** the airflow chamber **436** may receive, and be partially filled with the coupling plate **123** of the attachment portion **121**. The coupling plate **123** is preferably shaped to be slidingly received within the airflow chamber **436**.

[0192] Insertion of the coupling plate **123** into the airflow chamber **436** serves to register the air outlet **127** with the nozzle opening **438**. As shown, the air outlet **127** has a width Wo and a length Lo that are preferably the same as the width Wo and a length Lo of the opening **438**. A sealing gasket **123** may provided at the juncture of the openings.

[0193] The attachment member **121** and the nozzle **412** may also include a plurality of magnets **158** that magnetically couple the attachment member **121** to the nozzle **412** to improve the connection between them and ensure that air outlet **127** is properly registered with opening **438**. It will be appreciated that, in an alternate embodiment, only magnets may be used. Other mounting means may be used. For example, a plurality of latches may be used or air outlet **127** may extend into opening **438**.

[0194] Optionally, when the attachment member **121** is coupled to the portable cleaning apparatus **400**, the upstream end of the air conduit **110** (for example hose **125**) can be detached from the surface cleaning head **300** and the combination of the attachment member **120** and the flexible hose **125** (decoupled from the surface cleaning head **300**) can serve as an auxiliary or accessory cleaning tool. The free end of the hose **125** may be maneuvered by the user to clean objects and surfaces that cannot be cleaned using the surface cleaning head **300**. In some examples, the upstream end of the flexible hose **125** may be connected to the auxiliary cleaning tool **112**. Alternatively, the flexible hose **125** may be removed from the attachment member **120** and the auxiliary cleaning tool **112** may be mounted directly to the air inlet **126** of the attachment member **120**. It will be appreciated that tool **112** may have a plate **123** and arms **151** provided at the coupling end thereof.

[0195] Optionally, the attachment member **120** may be removed from the nozzle **412** and the auxiliary cleaning tool **112** may be fitted directly to the nozzle **412**, without the use of a flexible hose **125** or other type intermediate air conduit. In addition to the auxiliary or accessory cleaning tool **112**, the nozzle **412** may be directly connected to any one of a number of cleaning tools that have been provided with the an appropriate attachment member, including wands, brushes, crevasse tools and other hoses.

[0196] Clean air outlet **420** is provided downstream of the cyclone unit **414**, suction motor and optional post-motor filter contained optionally within the cleaner body **460**. Clean air outlet **420** may comprise a plurality of apertures formed in housing **461**. The cleaner body **460** may also contain one or more of a separation plate, a dirt chamber a pre-motor filter and a plurality of connecting fluid conduits or passageways.

[0197] In the example shown, cleaner body **460** is removably mounted to head portion **416**. For example, cleaner body **460** may be entirely removable from head portion **416**, or pivotably mounted to head portion **416**. Accordingly, cleaner body **460** and head portion **416** may be separated in order to provide access to the interior of cleaner body **460** or head portion **416**. This may allow a pre-motor filter to be cleaned, changed, or serviced, or the motor to be cleaned, changed or serviced. Alternately, head portion **416** may be cleaned or serviced. For example, any dirt stuck in the enclosed passages portable cleaning apparatus **400** may be removed. Alternately, a replacement cleaner body **460** or head portion **416** may be provided, and may be mounted to an existing head portion **416** or cleaner body **460**, respectively.

[0198] One or more additional rear wheels **480** may be mounted to housing **461** at lower portion **406**, and may be used in conjunction with wheels **435** when the portable cleaning apparatus **400** is used as a hand vacuum. When the portable cleaning apparatus **400** is attached to the backbone **200** the additional wheel **480** preferably engages with the mount bracket **224** and partially supports the portable cleaning apparatus **400** on the handle **210** as described above.

[0199] Preferably, as exemplified, the portion of the attachment member **120** that is used to mount the attachment member to the backbone may also comprise part of the air flow path from surface cleaning head **300** to hand vacuum cleaner **400**. For example, the attachment member **120** may include a mounting portion or collar **140** that includes a coupling **142** and defines a channel **144**. The collar **140** is connected to the airflow passageway **128**, or alternatively may be connected directly to the air conduit **110**. Optionally, the coupling **142** is a rotatable coupling that allows the airflow passageway **128** to rotate relative to the collar **140**. The upstream end of the airflow passageway **128** defines the air inlet **126**. In operation, the air inlet **126** is preferably coupled to the airflow conduit **110** that extends to the surface cleaning head **300** (the flexible air hose **125** in the example shown). The air inlet **126** is releasably coupled to the flexible air hose by clips **160**. Downstream of the coupling **142** an enclosed airflow passage connects the airflow passage **128** to the air outlet **127**. It will be appreciated that the attachment member **120** need not comprise part of the air flow passage. For example, coupling **142** may be located out of the flow path defined by passageway **128**. Alternately, plate **123** need not have opening **127**. Accordingly, attachment member may have a first part that is secured to hand vacuum **400** and a second distinct part that completes that air flow passage from surface cleaning head **300** to opening **438**.

[0200] The airflow passageway **128** may be flexible or rigid and may be generally straight or may have a curved shape, as shown. Preferably, the curved airflow passageway **128** subtends fewer than **45** degrees.

[0201] It will be appreciated that a construction that uses a dirt collection chamber that partially or completely surrounds a cyclone in an upright surface cleaning apparatus may be used by itself or with any other feature disclosed herein. It will be appreciated that an inverted first stage cyclone in an upright surface cleaning apparatus may be used by itself or with any other feature disclosed herein. In addition, any of the features disclosed herein may be used by themselves, or with any other feature, and may include the construction of the dirt collection chamber to denote a fill line.

[0202] It will also be appreciated that any of the aforementioned embodiments may be used singly or in any particular combination or sub-combination of the remaining features listed above.

[0203] Although the invention has been described in conjunction with specific embodiments thereof, if is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention.

1. An upright surface cleaning apparatus comprising:

(a) a floor cleaning unit comprising a surface cleaning head having a dirty air inlet, a cleaning head air outlet and an upright section comprising a handle drivingly connected to the surface cleaning head;

(b) a cyclone unit positioned in the air flow passage, the cyclone unit comprising a cyclone having an air inlet located at a lower end of the cyclone and an air outlet and a dirt outlet provided at an upper end of the cyclone, and a dirt collection chamber exterior to the cyclone and surrounding at least a portion of the cyclone;

(c) a suction motor positioned in the air flow path; and,

(d) a surface cleaning unit removably mounted to the handle wherein the surface cleaning unit comprises the cyclone unit and the suction motor.

2. The surface cleaning apparatus of claim **1** wherein the cyclone and the dirt collection chamber are concurrently openable.

3. The surface cleaning apparatus of claim **1** wherein the cyclone is positioned interior of the dirt collection chamber.

4. The surface cleaning apparatus of claim **1** further comprising a plate facing the dirt outlet.

5. The surface cleaning apparatus of claim **4** wherein the plate is mounted to an upper end of the cyclone unit.

6. The surface cleaning apparatus of claim **5** wherein the cyclone is an inverted cyclone having an air inlet and an air outlet at a lower end of the cyclone.

7. The surface cleaning apparatus of claim **1** further comprising a vortex finder that is provided on an openable door of the cyclone.

8. The surface cleaning apparatus of claim **1** wherein the handle comprises a portion of the air flow path.

9. An upright surface cleaning apparatus comprising:

(a) a floor cleaning unit comprising a surface cleaning head having a dirty air inlet, a cleaning head air outlet and an upright section comprising a handle drivingly connected to the surface cleaning head;

(b) a cyclone unit mounted on the upright section and positioned in the air flow passage, the cyclone unit comprising a cyclone having an air inlet located at a lower end of the cyclone and an air outlet and a dirt outlet provided at an upper end of the cyclone, and a dirt collection chamber exterior to the cyclone and surrounding at least a portion of the cyclone wherein the cyclone unit is removable in a closed configuration; and,

(c) a suction motor positioned in the air flow path.

10. The surface cleaning apparatus of claim **9** further comprising a surface cleaning unit removably mounted to the handle wherein the surface cleaning unit comprises the cyclone unit and the suction motor.

11. The surface cleaning apparatus of claim **9** wherein the cyclone and the dirt collection chamber are concurrently openable.

12. The surface cleaning apparatus of claim **9** wherein the cyclone is positioned interior of the dirt collection chamber.

13. The surface cleaning apparatus of claim **9** further comprising a plate facing the dirt outlet.

14. The surface cleaning apparatus of claim **13** wherein the plate is mounted to an upper end of the cyclone unit.

15. The surface cleaning apparatus of claim **14** wherein the cyclone is an inverted cyclone having an air inlet and an air outlet at a lower end of the cyclone.

16. The surface cleaning apparatus of claim **9** further comprising a vortex finder that is provided on an openable door of the cyclone.

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