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(12) **United States Patent**
Conrad

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(45) **Date of Patent: Sep. 25, 2018**

(54) **HAND VACUUM CLEANER**

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(21) Appl. No.: **15/597,061**

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(65) **Prior Publication Data**

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(63) Continuation of application No. 14/874,544, filed on Oct. 5, 2015, now Pat. No. 9,826,868, which is a (Continued)

(30) **Foreign Application Priority Data**

Mar. 13, 2009 (CA) 2658372

(51) **Int. Cl.**

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A47L 5/22	(2006.01)
A47L 5/28	(2006.01)
A47L 5/32	(2006.01)
A47L 9/02	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***A47L 5/24*** (2013.01); ***A47L 5/225*** (2013.01); ***A47L 5/28*** (2013.01); ***A47L 5/32*** (2013.01); ***A47L 9/02*** (2013.01); ***A47L 9/106*** (2013.01); ***A47L 9/1608*** (2013.01); ***A47L 9/1666*** (2013.01); ***A47L 9/1683*** (2013.01); ***A47L 9/1691*** (2013.01); ***A47L 9/322*** (2013.01)

(58) **Field of Classification Search**

CPC ... A47L 5/24; A47L 5/225; A47L 5/28; A47L 5/32; A47L 9/322; A47L 9/122; A47L 9/1658; A47L 9/02; A47L 9/1683

See application file for complete search history.

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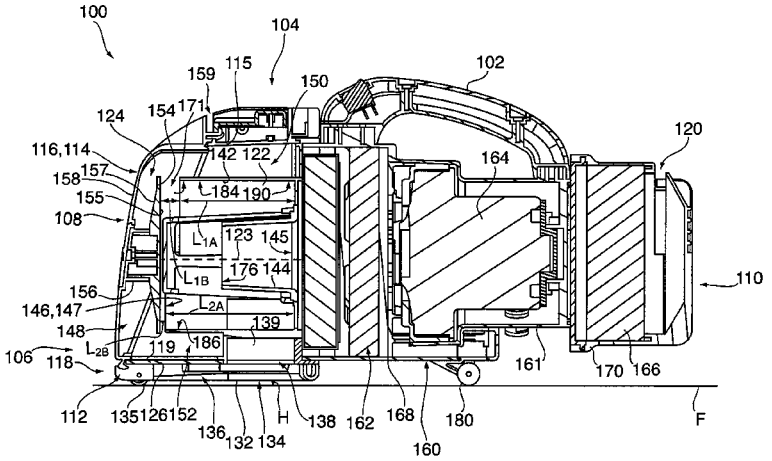
(57) **ABSTRACT**

A hand vacuum cleaner has a cleaner body and a post-motor filter is positioned in the air flow passage downstream from and aligned with the suction motor and, the post-motor filter and the cleaner body are separable.

16 Claims, 10 Drawing Sheets



Related U.S. Application Data

continuation of application No. 13/255,875, filed as application No. PCT/CA2010/000342 on Mar. 9, 2010, now Pat. No. 9,204,769.

(51) **Int. Cl.**

A47L 9/16	(2006.01)
A47L 9/10	(2006.01)
A47L 9/32	(2006.01)

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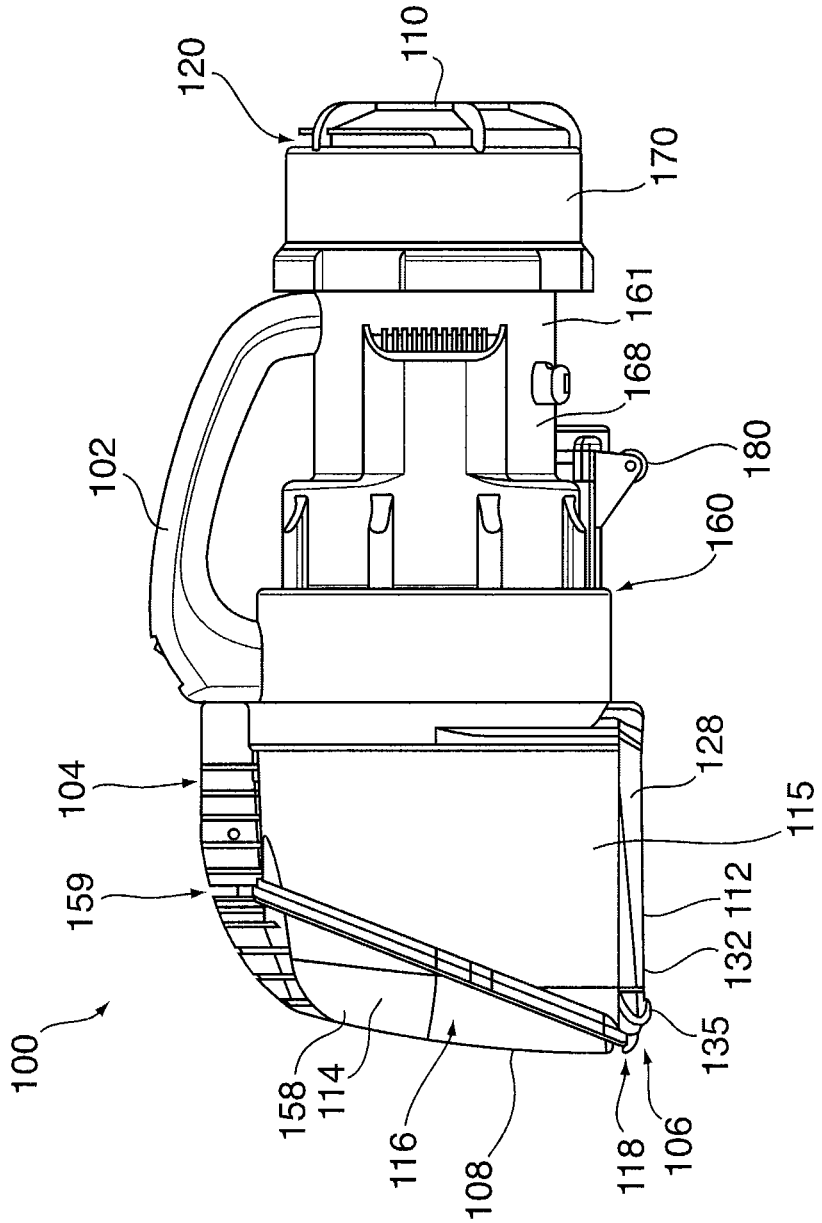
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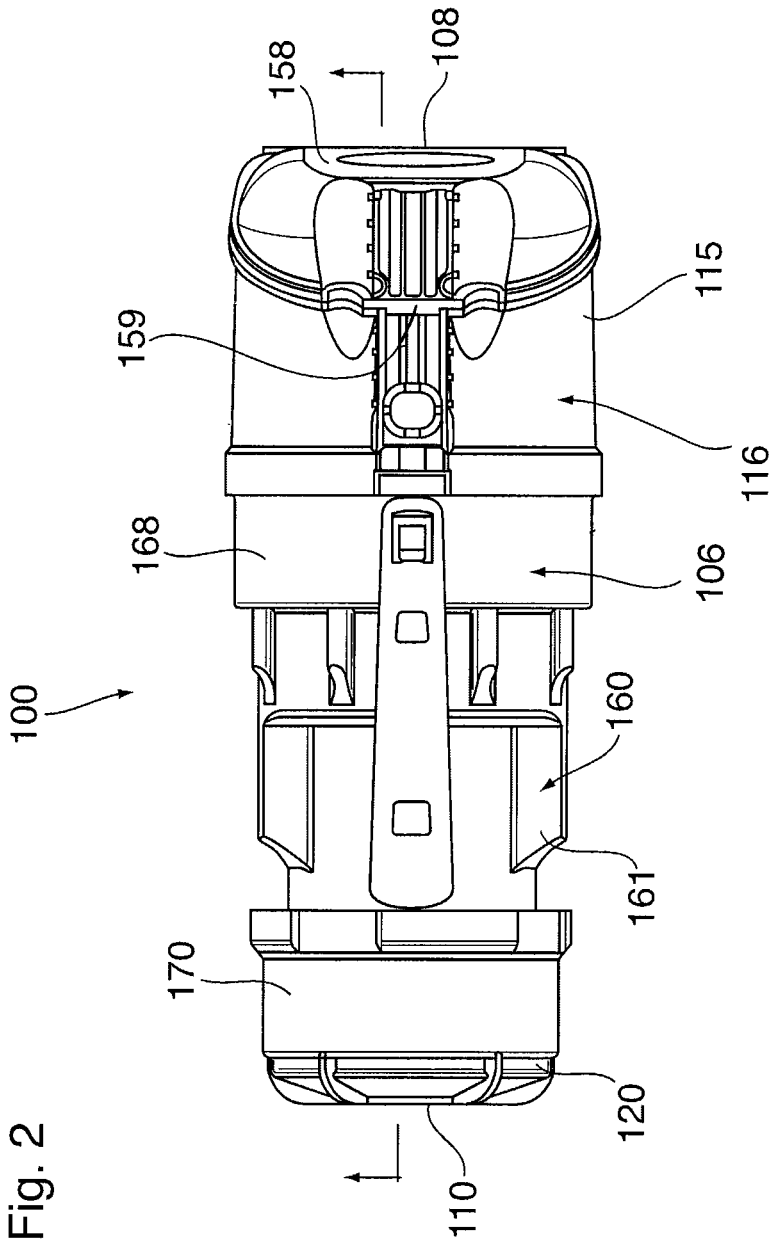
Fig. 1



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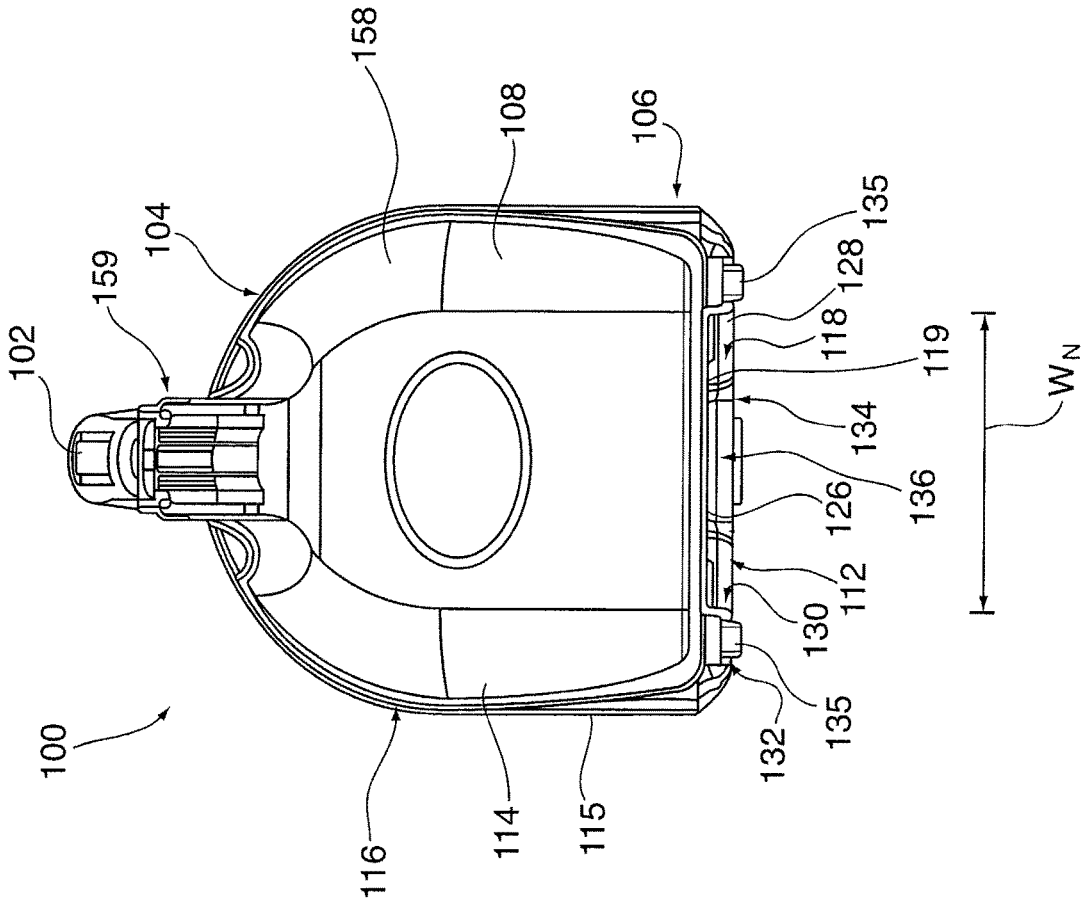
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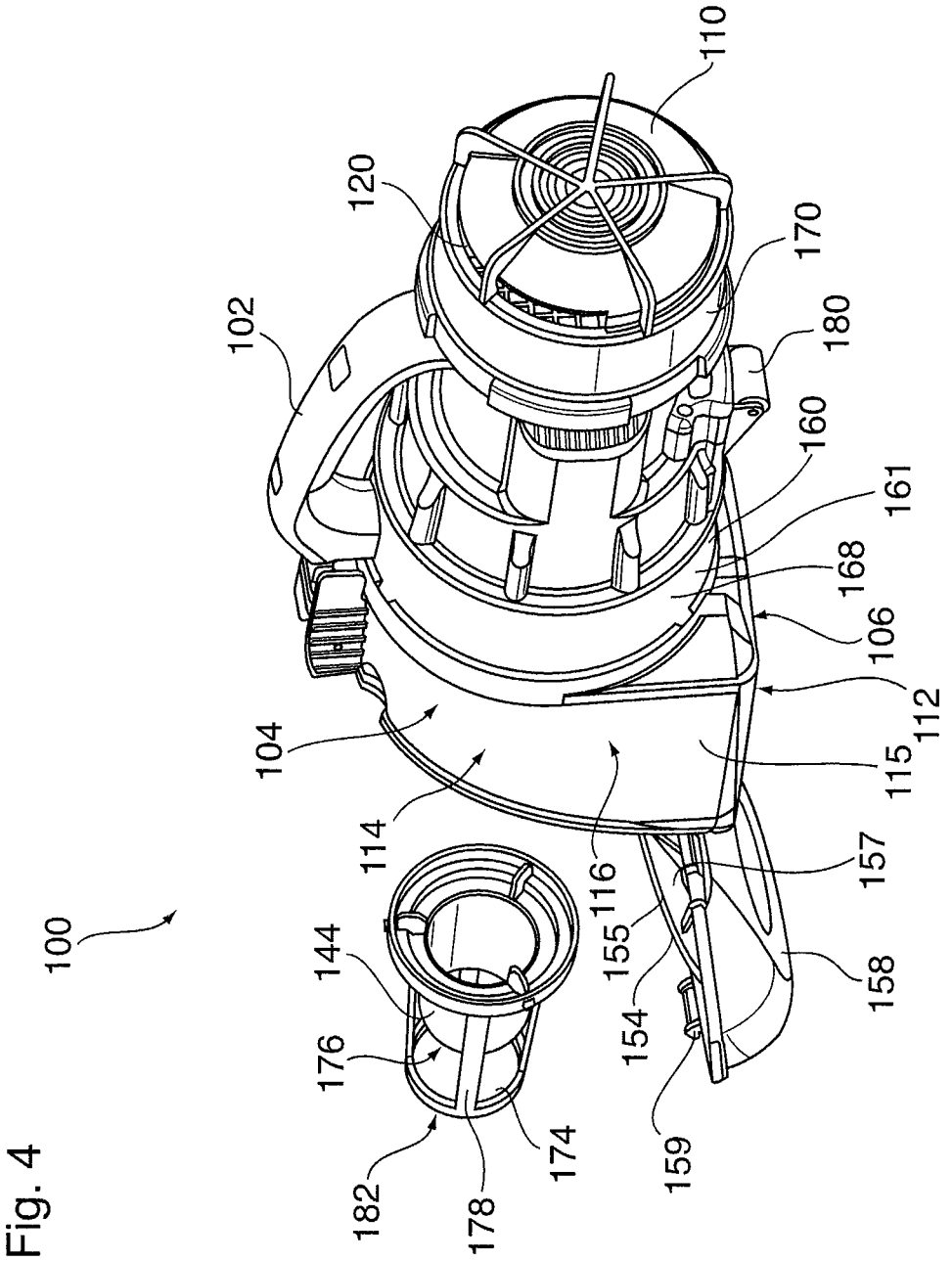
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Fig. 4

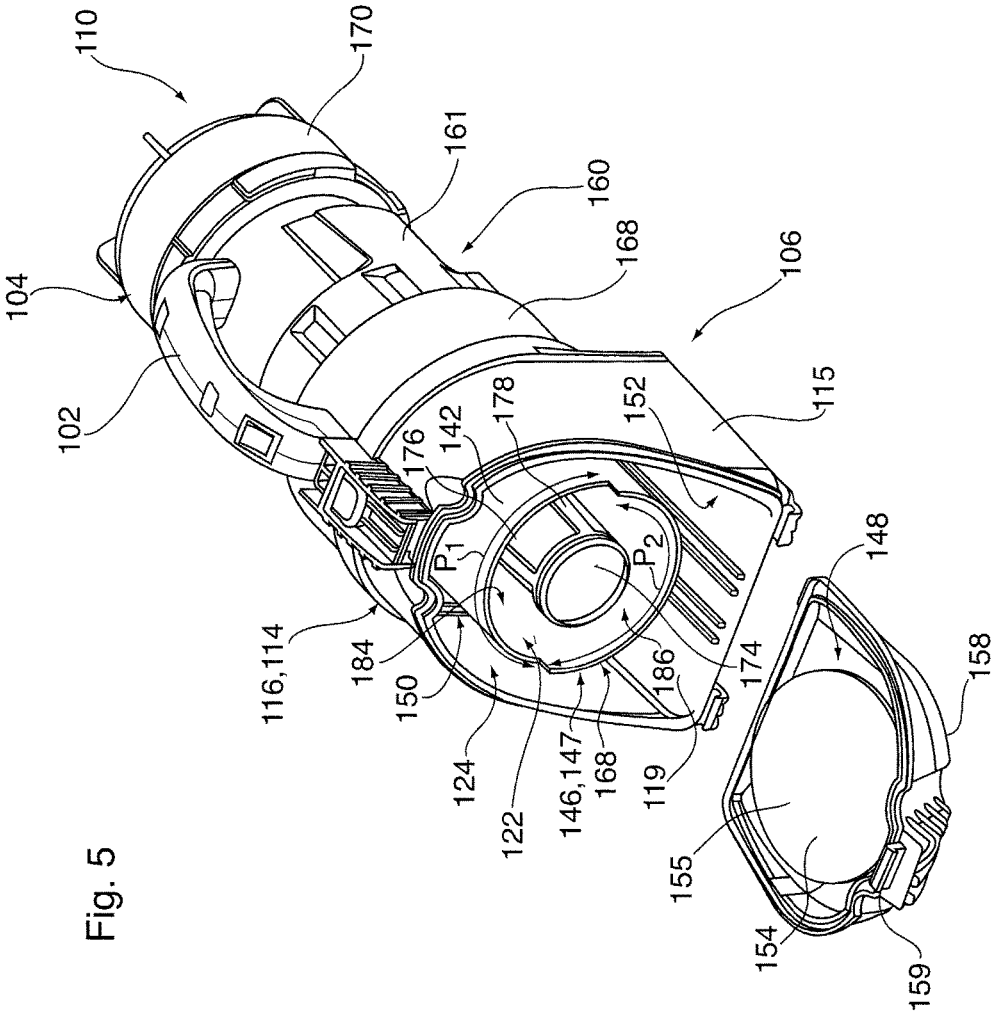
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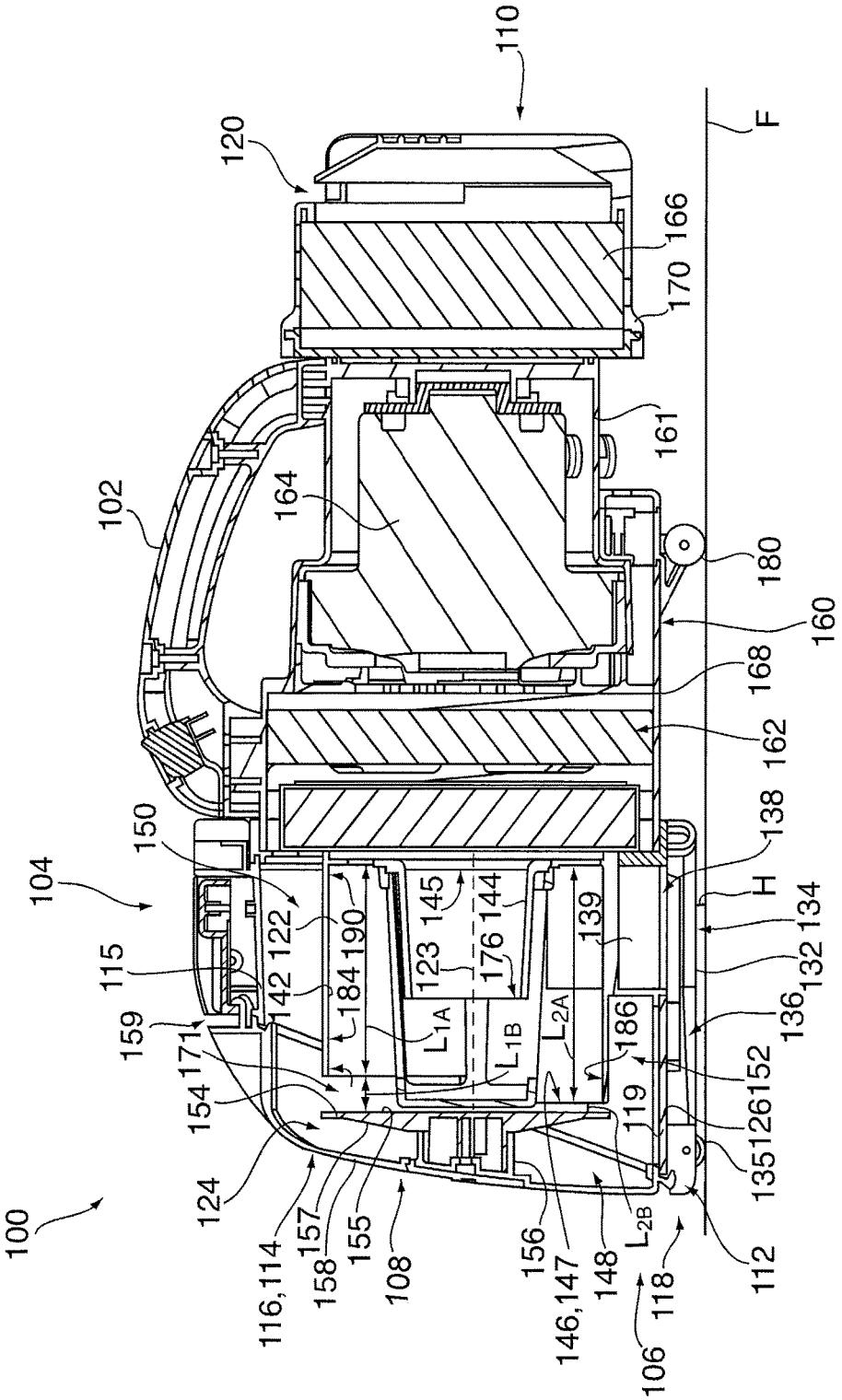
Fig. 5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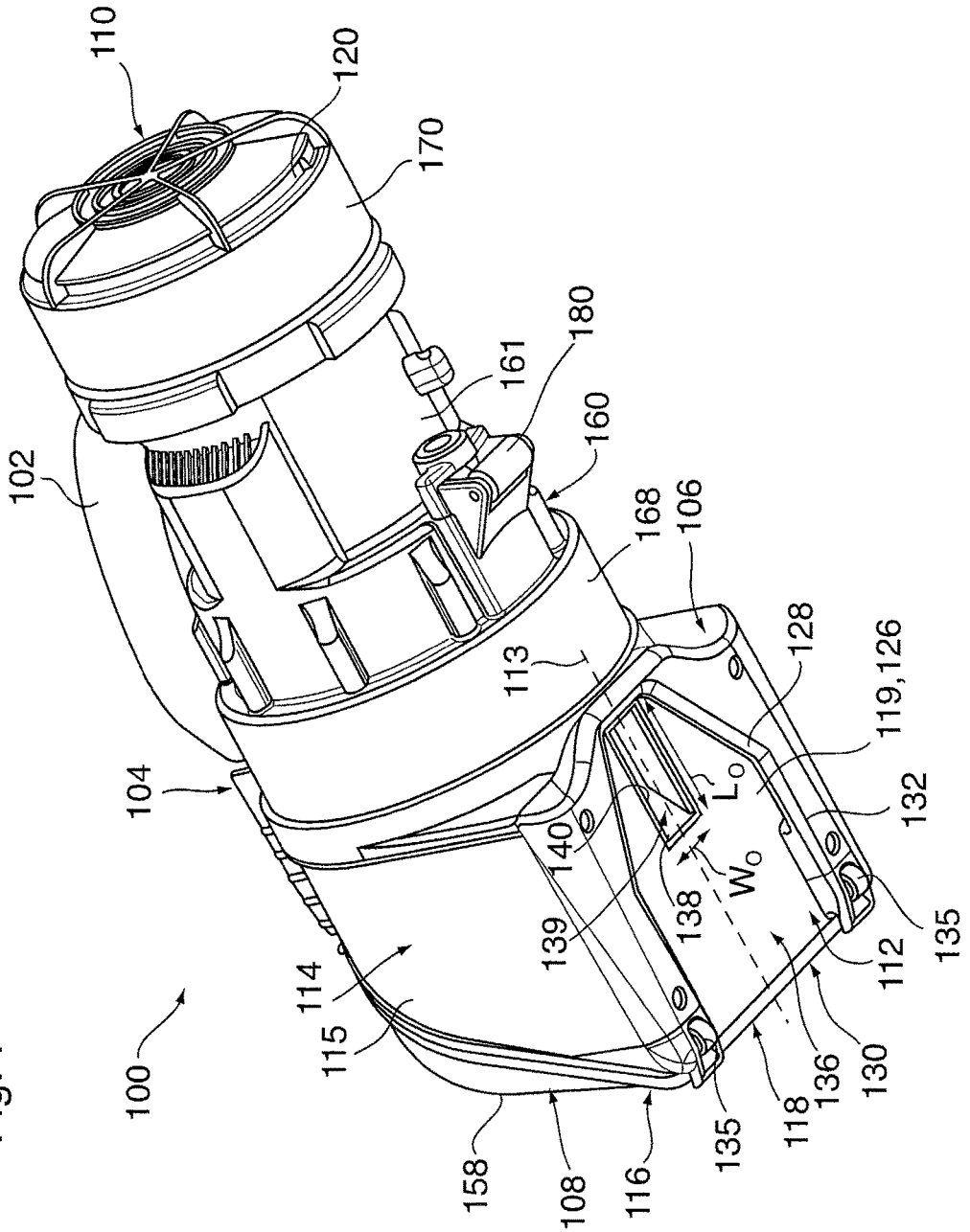
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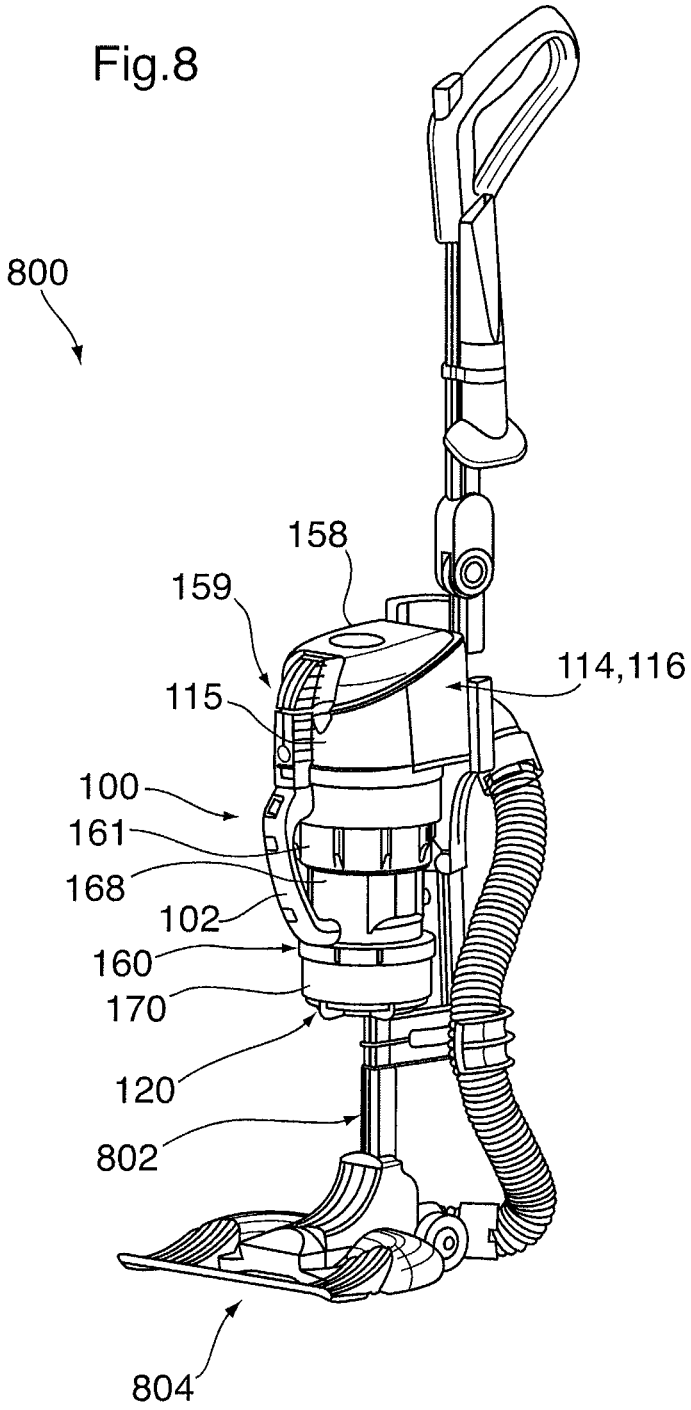
Fig. 7

Fig.8



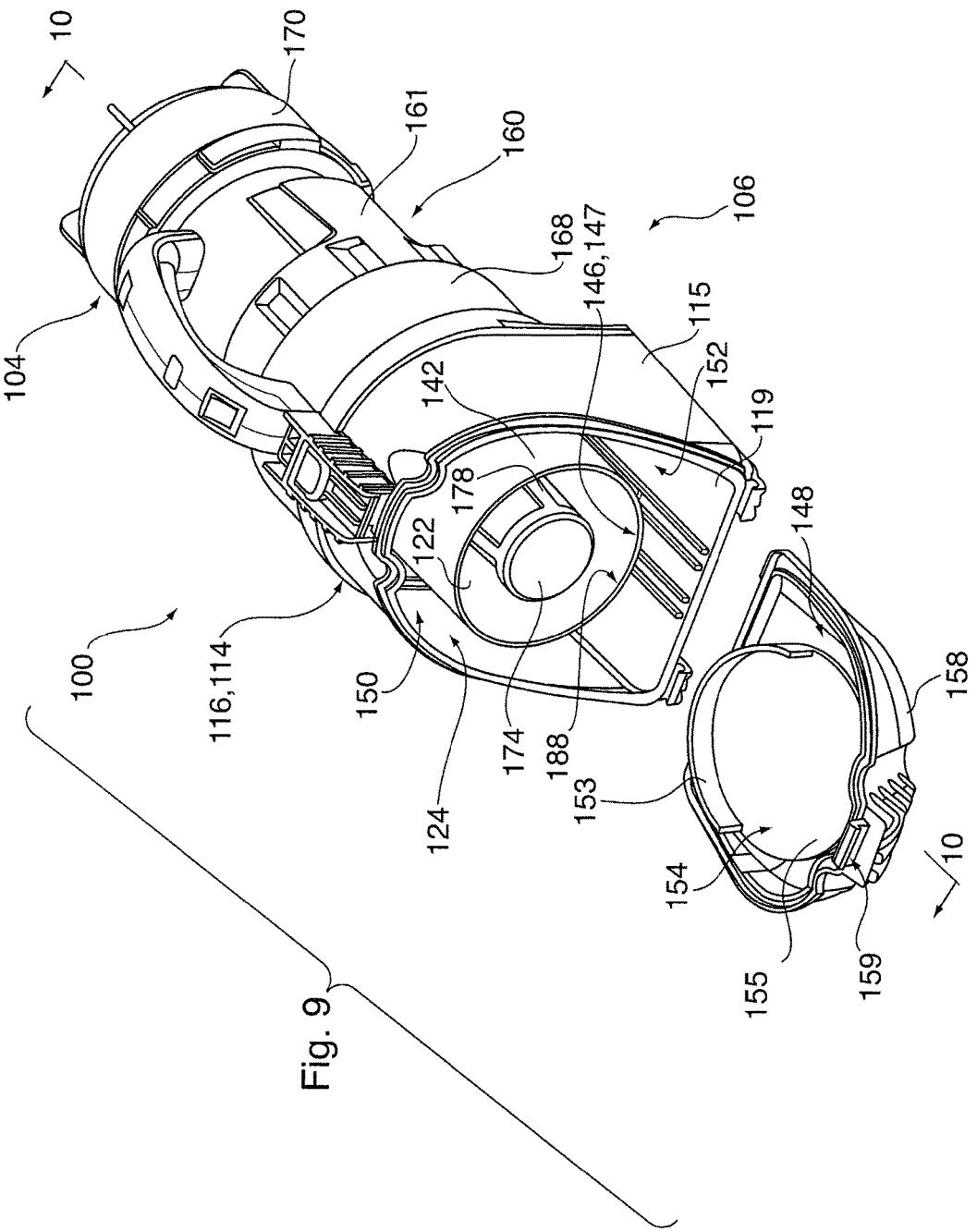

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Fig. 9

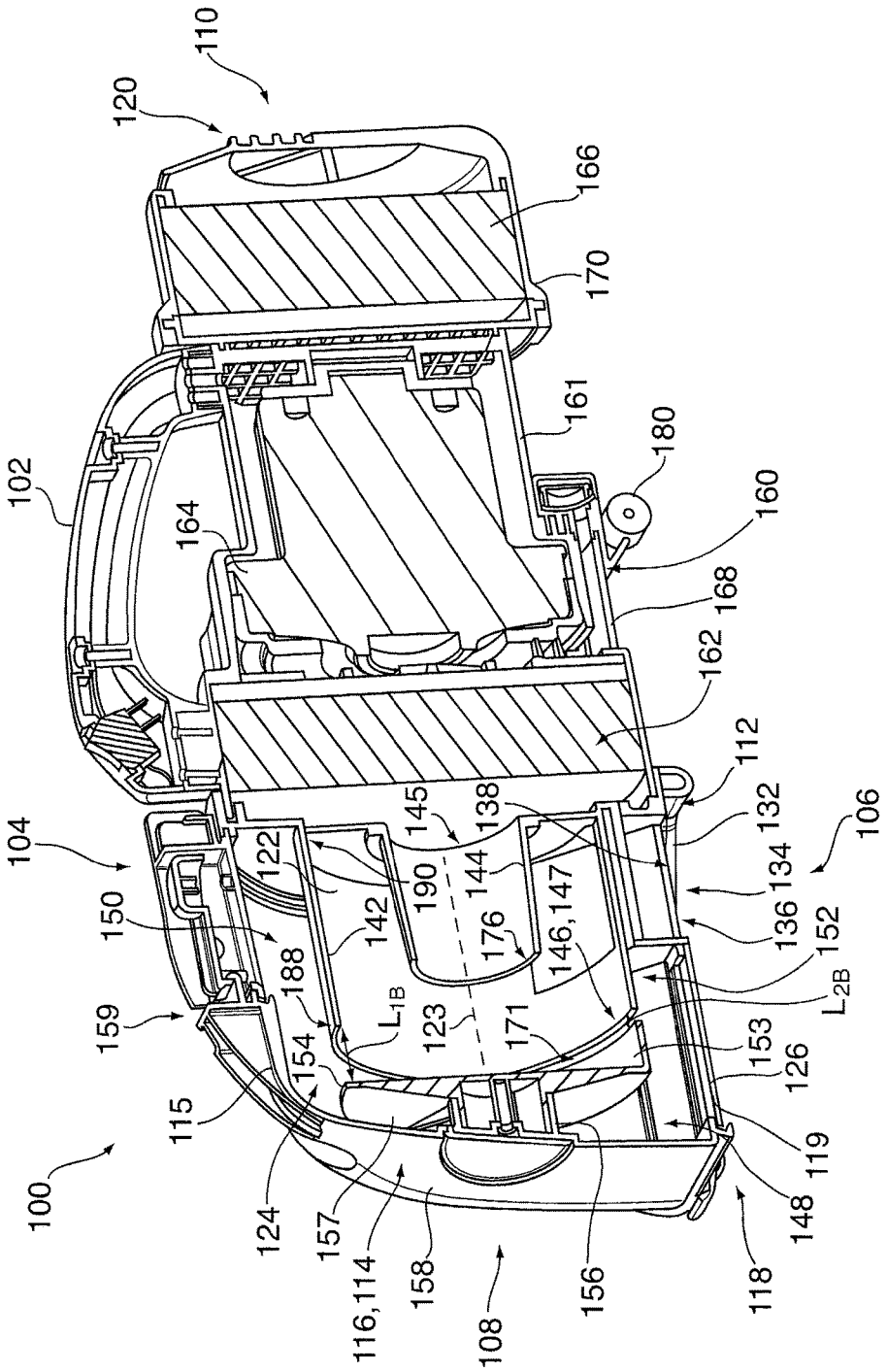
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Fig. 10

HAND VACUUM CLEANER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims benefit under 35 USC 120 as a continuation application of co-pending U.S. patent application Ser. No. 14/874,544 which was filed on Oct. 5, 2015, which itself is a continuation of U.S. patent application Ser. No. 13/255,875, filed on Sep. 9, 2011, now U.S. Pat. No. 9,204,769, issued on Dec. 8, 2015, which itself claims benefit under 35 USC 371 based on co-pending international application No. PCT/CA2010/000342, filed on Mar. 9, 2010, the entirety of which is incorporated herein by reference.

FIELD

The specification relates to surface cleaning apparatuses. More specifically, the specification relates to cyclonic surface cleaning apparatuses.

INTRODUCTION

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

Cyclonic vacuum cleaners utilize one or more cyclones that have an associated dirt collection chamber. The dirt collection chamber may be formed in the bottom of a cyclone chamber. A disc or divider may be positioned in the cyclone casing to divide the cyclone casing into an upper cyclone chamber and a lower dirt collection chamber. In it also known to position a dirt collection chamber exterior to a cyclone casing, such as surrounding the cyclone chamber.

SUMMARY

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.

According to one broad aspect, a surface cleaning apparatus is provided that utilizes a cyclone having an open end, wherein the open end comprises the dirt outlet of the cyclone. A plate, that preferably has a planar surface facing the open end, is positioned facing the open end. For example, the plate may line in a plane that is perpendicular to the longitudinal axis extending through a cyclone chamber and may be spaced from the open end. Accordingly, a gap is provided between the plate and the open and defines a dirt outlet of the cyclone. In accordance with this aspect, the gap has a non uniform length.

For example, the cyclone casing may have a variable length. The portion that have a shorter length define a gap having a increased height. Alternately, or in addition, the plate may be provided with a sidewall on the side of the plate facing the open end of the cyclone. The sidewall may extend part way around the plate. The height of the wall maybe constant or may be variable.

The sidewall is preferably provided on the periphery of the plate. The diameter of the plate is preferably about the same as the diameter of the open end of the cyclone.

In some embodiments, the sidewall of the plate has a constant length. In other embodiments, the sidewall of the plate has a variable length.

In some embodiments, the sidewall of the cyclone has a first end at the open end, the first end has a perimeter, and the gap has a first portion having a first length and a second portion having a second length greater than the first length. The first length and the second length may be constant. Alternately, the first length and the second length may be variable.

In some embodiments, one of the portions extends up to 210° of the perimeter. For example, the second portion may extend up to 210° of the perimeter. In other embodiments, the second portion extends up to 240° of the perimeter.

According to another broad aspect, a surface cleaning apparatus is provided. The surface cleaning apparatus comprises an air flow passage extending from a dirty air inlet to a clean air outlet. A suction motor is positioned in the air flow passage. A cyclone is positioned in the air flow passage. The cyclone comprises an air inlet, an air outlet, an open end, a longitudinal axis and a longitudinally extending sidewall. The side wall has a variable length. A dirt collection chamber is in flow communication with the open end.

In some embodiments, a first portion of the sidewall is longer than a second portion of the sidewall.

In some embodiments, the sidewall has a first end at the open end, the first end has a perimeter, and the first portion comprises up to 240° of the perimeter and the second portion comprises from up to 120° of the perimeter.

In some embodiments, the surface cleaning apparatus further comprises a plate facing the open end. The plate may be spaced from a front end wall of the surface cleaning apparatus. A first portion of the dirt collection chamber may be provided between the plate and the front end wall. Preferably, a second portion of the dirt collection chamber surrounds at least a portion of the cyclone.

According to another broad aspect, another surface cleaning apparatus is provided. The surface cleaning apparatus comprises an air flow passage extending from a dirty air inlet to a clean air outlet. A suction motor is positioned in the air flow passage. A cyclone is positioned in the air flow passage. The cyclone comprises an air inlet, an air outlet, an open end, a longitudinal axis and a longitudinally extending sidewall. A plate is provided having a cyclone side facing the open end. The plate is positioned to define a gap between the plate and the open end of the cyclone. The plate has a plate sidewall extending towards the open end. A dirt collection chamber is in flow communication with the open end.

In some embodiments, the plate sidewall extends part way around the plate. In some embodiments, the sidewall of the plate has a constant length. In other embodiments, the sidewall of the plate has a variable height.

Any of the surface cleaning apparatuses described herein may comprise a portable vacuum cleaner, and preferably, a hand vacuum cleaner. The portable vacuum cleaner may be removably mountable to an upright vacuum cleaner.

It will be appreciated that an embodiment may contain one or more of features set out in the examples.

DRAWINGS

In the detailed description, reference will be made to the following drawings, in which:

FIG. **1** is a side plan view of an example of a hand vacuum cleaner;

FIG. **2** is a top plan view of the hand vacuum cleaner of FIG. **1**;

FIG. **3** is a front plan view of the hand vacuum cleaner of FIG. **1**;

FIG. **4** is a partially exploded rear perspective view of the hand vacuum cleaner of FIG. **1**;

FIG. **5** is a partially exploded front perspective view of the hand vacuum cleaner of FIG. **1**;

FIG. **6** is a cross section taken along line **6-6** in FIG. **2**;

FIG. **7** is a bottom perspective view of the hand vacuum cleaner of FIG. **1**;

FIG. **8** is a perspective illustration of the surface cleaning apparatus of FIG. **1** mounted to an upright vacuum cleaner;

FIG. **9** is a partially exploded front perspective view of an alternate embodiment of a hand vacuum cleaner; and,

FIG. **10** is a cross section taken along line **10-10** in FIG. **9**.

DESCRIPTION OF VARIOUS EXAMPLES

Various apparatuses or methods will be described below to provide an example of each claimed invention. No example described below limits any claimed invention and any claimed invention may cover processes or apparatuses that are not described below. The claimed inventions are not limited to apparatuses or processes having all of the features of any one apparatus or process described below or to features common to multiple or all of the apparatuses described below. It is possible that an apparatus or process described below is not an embodiment of any claimed invention.

Referring to FIGS. **1** to **7**, a first example of a surface cleaning apparatus **100** is shown. Preferably, the surface cleaning apparatus **100** (also referred to herein as cleaner **100** or vacuum cleaner **100**) is a portable vacuum cleaner **100**, such as a hand vacuum cleaner **100** as shown. The hand vacuum cleaner **100** is movable along a surface to be cleaned by gripping and maneuvering handle **102**. In alternate embodiments, the surface cleaning apparatus **100** may be another type of surface cleaning apparatus, such as a stick-vac, an upright vacuum cleaner, or a canister vacuum cleaner.

The exemplified embodiments are hand vacuum cleaners. The design for a cyclone and facing plate having a gap therebetween of non-uniform height may be used in any cyclonic cleaning apparatus. If the feature is used with a portable surface cleaning apparatus such as a hand vacuum cleaner, then the portable surface cleaning apparatus may be of any design. For example, as exemplified, the vacuum cleaner includes an upper portion **104**, a lower portion **106**, a front **108**, and a rear **110**. In the example shown, handle **102** is provided at the upper portion **104**. In alternate examples, handle **102** may be provided elsewhere on the vacuum cleaner **100**, for example at the rear **110** and may be of any design. The vacuum cleaner **100** may be of various configurations (e.g., different positioning and orientation of the cyclone unit and the suction motor and differing cyclone units that may comprise one or more cyclones and one or more filters) and may use any type of nozzle or position of the nozzle.

In the example shown, the vacuum cleaner **100** comprises a nozzle **112**, which may be of any design, and a cyclone unit **114**, which together form a surface cleaning head **116** of the vacuum cleaner **100**. As exemplified, the surface cleaning head **116** is preferably provided at the front **108** of the vacuum cleaner **100**.

Nozzle **112** engages a surface to be cleaned, and comprises a dirty air inlet **118**, through which dirty air is drawn into the vacuum cleaner **100**. An airflow passage extends from the dirty air inlet **118** to a clean air outlet **120** of the cleaner **100**. In the example shown, clean air outlet **120** is at the rear **110** of the cleaner **100**.

Cyclone unit **114** is provided in the airflow passage, downstream of the dirty air inlet **118**. In the example shown, the cyclone unit **114** comprises one cyclone **122** positioned in the airflow passage, and one dirt chamber **124**. In alternate examples, the cyclone unit **110** may include more than one cyclonic stage, wherein each cyclonic stage comprising one or more cyclones and one or more dirt chambers. Accordingly, the cyclones may be arranged in parallel and/or in sequence.

In the example shown, the nozzle **112** is positioned at the lower portion **106** of the vacuum cleaner **100**. Preferably, as exemplified, nozzle **112** is positioned at the bottom of the vacuum cleaner **100**, and, preferably, beneath the cyclone unit **114**. Accordingly, as exemplified, nozzle **112** may be on lower surface **117** of cyclone unit **114**. In a particularly preferred design, the upper wall of the nozzle may be a lower wall of the cyclone unit **114**. As shown in FIG. **6**, dirt chamber **124** surrounds the lower portion of cyclone **122**. Accordingly, the upper wall of nozzle **112** may be part of the lower wall of the dirt chamber. It will be appreciated that if dirt chamber **124** does not extend around the lower portion of cyclone **122**, then the upper wall of nozzle **112** may be part of a lower wall of cyclone **122**.

Preferably, in the example shown, the nozzle **112** is fixedly positioned at the lower portion **106** of the vacuum cleaner **100**. That is, the nozzle **112** is not movable (e.g., rotatable) with respect to the remainder of the vacuum cleaner **100**, and is fixed at the lower portion **106** of the vacuum cleaner **100**.

As shown in FIGS. **3** and **5**, nozzle **112** has a width WN, and cyclone unit **114** has a width WC. In the example shown, WN, and WC are about the same. An advantage of this design is that the nozzle may have a cleaning path that is essentially as wide as the hand vacuum itself.

Preferably, nozzle **112** comprises an airflow chamber wherein at least a portion, and preferably a majority, of the lower surface of the chamber is open. In an alternate design, the nozzle may comprise a lower wall, which closes the lower end. Accordingly, nozzle **112** may be of various design and may be an open sided passage or a closed passage.

Nozzle **112** may also share a common wall with another component of cyclone unit **114**. As exemplified in FIG. **7**, nozzle **112** comprises an upper nozzle wall **126**, which defines a closed upper end of the airflow chamber **136**. In the example shown, the upper nozzle wall **126** comprises a lower portion **119** of a wall **115** of the cyclone unit.

Preferably, one or more depending walls **128** extend downwardly from the upper nozzle wall **126**. The depending wall is preferably generally U-shaped. In one embodiment, depending wall is provided rearward of opening **138**. In other embodiments, depending walls may alternately or in addition be provided on the lateral sides of opening **138**. It is preferred that depending walls are provided on each lateral side of opening **138** and rearward thereof. Further, depending walls **128** may extend a substantial distance to the front end **108** and, preferably, essentially all the way to front end **108**. The depending walls may be continuous to define a single wall as shown, or may be discontinuous. The depending walls are preferably rigid (e.g., integrally molded with cyclone unit **114**). However, they may be flexible (e.g., bristles or rubber) or moveably mounted to cyclone unit **114** (e.g., hingedly mounted).

Preferably, the lower end **132** of depending wall **128** is spaced above the surface being cleaned when the hand vacuum cleaner is placed on a surface to be cleaned. As exemplified in FIG. **6**, when vacuum cleaner **100** is placed on floor F, lower end **132** of depending wall **128** is spaced a distance H above the floor. Preferably distance H is from 0.01 to 0.175 inches, more preferably from 0.04 to 0.08 inches.

The height of the depending wall (between upper nozzle wall **126** and lower end **132**) may vary. In some examples, the depending wall may have a height of between about 0.05 and about 0.875 inches, preferably between about 0.125 and about 0.6 inches and more preferably between about 0.2 and about 0.4 inches. The height of depending wall may vary but is preferably constant.

As exemplified, the open end of the U-shape defines an open side **130** of the nozzle **112**, and forms the dirty air inlet **118** of the cleaner **100**. In the example shown, the open side **130** is provided at the front of the nozzle **112**. In use, when optional wheels **135** are in contact with a surface, the open side **130** sits above and is adjacent a surface to be cleaned (e.g. floor F). Preferably, lower end **132** of depending walls **128** is spaced above floor F. Accordingly, some air may enter nozzle **112** by passing underneath depending wall **132**. In such a case, the primary air entry to nozzle **112** is via open side **130** so that dirty air inlet **118** is the primary air inlet, with a secondary air inlet being under depending wall **128**. In the example shown, the lower end **132** of the depending wall **128** defines an open lower end **134** of the nozzle **112**. The open lower end **134** preferably extends to the front **108** of the cleaner **108**, and merges with the open side **130**.

In use, the exemplified nozzle has an open lower end **134** that faces a surface to be cleaned. In the example shown, a plurality of wheels **135** are mounted to the depending wall **128**, and extend lower than the lower end **132** of the depending wall **128**. Accordingly, in use, when wheels **135** are in contact with a surface, the lower end **132** of the depending wall **128** is spaced from a surface to be cleaned, and the space between the lower end of the depending wall **128** and the surface to be cleaned form a secondary dirty air inlet to the vacuum cleaner **100**. It will be appreciated that wheels **135** are optional. Preferably, wheels **135** are positioned exterior to the airflow path through nozzle **112**, e.g., laterally outwardly from depending wall **128**. Preferably a pair of front wheels **135** is provided. Preferably, the wheels are located adjacent front **108**. Optionally, one or more rear wheels **108** may be provided. In an alternate embodiment, no wheels may be provided.

The upper nozzle wall **126**, depending wall **128**, and open lower end **134** of the nozzle **112** define an open sided airflow chamber **136** of the nozzle. In use, when wheels **135** are in contact with a horizontal surface, the nozzle **112** and the airflow chamber **136** extend generally horizontally, and preferably linearly along a nozzle axis **113** (see FIG. **7**).

An opening **138** is provided in the upper nozzle wall **126**, and is in communication with the airflow chamber **136**. Opening **138** may be of any size and configuration and at various locations in upper nozzle wall **126**. In use, when wheels **135** are in contact with a surface, the opening **138** faces a surface to be cleaned, air enters the dirty air inlet **118**, passes horizontally through the airflow chamber **136**, and passes into the opening **138**. Opening **138** is in communication with a cyclone inlet passage **139**, which is in communication with an air inlet **140** of cyclone **122**.

Referring to FIGS. **5** and **6**, cyclone **122** comprises a longitudinally extending sidewall **142**. In the example shown, the longitudinally extending sidewall **142** is substantially cylindrical. The cyclone chamber is located inside chamber wall **142**. The cyclone **122** extends along a longitudinal axis **123**. Preferably, as shown, axis **123** is parallel to the nozzle axis, and extends generally horizontally when cleaner **100** is in use and wheels **135** are seated on a surface.

Cyclone **122** further comprises an air inlet **140**, and an air outlet **145**. The cyclone air inlet and cyclone air outlet may be of any configuration known in the art. The cyclone **122** further comprises an open end **147**. The open end **147** comprises a dirt outlet **146** of the cyclone **122**.

As exemplified, the cyclone air inlet **140** is defined by an aperture in the chamber wall **142**. As can be seen in FIG. **5**, the inlet passage **139** is at configured such that air enters the cyclone **122** in a tangential flow path, e.g., passage **139** may be arcuate. 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 **144**, which is in communication with outlet **145**. The dirt that is separated from the air exits the cyclone via dirt outlet **146** defined by open end **147**, and enters dirt chamber **124**.

As exemplified in FIG. **6**, a shroud **174** may be provided adjacent outlet passage **144**, spaced from and facing the inlet **176** to outlet passage **144**. Shroud **174** may be mounted to cyclone **122** via legs **178**. In the example shown, shroud **174**, and legs **178** form an assembly **182** that is removably mounted in cyclone **122**. In some examples, a screen may be mounted around legs **178**. Shroud **174** may be of any design.

As noted hereinabove, the open end **147** of the cyclone **122** is in communication with a dirt chamber **124**. In the example shown, dirt chamber **124** comprises two portions. A first portion **148** is provided forwardly of the dirt outlet **146**. A second portion **150** is concentric with the cyclone **122**, and surrounds at least a portion of the cyclone **122**. A lower portion **152** of the second portion **150** is below the cyclone. As exemplified, nozzle **112** is positioned below first portion **148**, and lower portion **152**.

Preferably, the surface cleaning apparatus comprises a plate **154** facing the open end **147** of the cyclone. Preferably, the plate **154** has a cyclone side **155** facing the open end **147**, and a dirt bin side **157** facing front wall **158**. The cyclone side **155** is preferably planar. For example, as exemplified, cyclone side may be oriented to be perpendicular to the cyclone axis **123**. Preferably, plate **123** is spaced for the open end of the cyclone. Preferably, the diameter of plate **154** and the diameter of the open end are about the same. The plate may be slightly smaller and/or slightly larger (e.g., +/−10%).

As shown, plate **154** may be provided in the dirt chamber **124**, and is spaced from a front wall **158** at the front **108** of the cleaner. Accordingly, the first portion **148** of dirt chamber **124** is provided between dirt bin side **157** of plate **154** and a front end wall **158** of the surface cleaning apparatus.

Preferably, the plate is positioned to define a gap **171** between the plate **154** and the open end **147** of the cyclone **122**. More preferably, the gap has a variable length in the direction of the longitudinal axis **123** of the cyclone **122**.

For example, as shown in FIGS. **5** and **6**, the sidewall **142** of cyclone **122** has a variable length. That is, as shown, a first portion **184** of the sidewall **142** is longer than a second portion **186** of the sidewall. Accordingly, in this embodiment, the variable length of the sidewall of the cyclone provides the variable length of the gap.

In the embodiment shown, first portion **184** of the sidewall **142** has a first length L**1**A, and second portion **186** of the sidewall **142** has a second length L**2**A. Accordingly, the gap has a first length L**1**B adjacent the first portion **184** of the sidewall, and a second length L**2**B adjacent the second portion **186** of the sidewall. In the embodiment shown, the second length L**2**A is greater than the first length L**1**A. Accordingly, the first length L**1**B of the gap **171** is greater than the second length L**2**B of the gap **171**.

Preferably, the first length L**1**A of the first portion **184** and the first length L**2**A of the second portion are constant. More preferably, the first length L**1**B of the gap **171** and the second length L**2**B of the gap **171** are constant. In alternate embodi-

ments, however, one or both of the first length L1B of the gap **171** and the second length L2B of the gap **171** may be variable.

In the exemplified embodiment, sidewall **142** has a first end **188** at open end **147**, and a second end **190** opposed to the first end. The first end has a perimeter. Preferably, in embodiments wherein the first length L1A and the second length L2A are constant, one of first portion **184** and second portion **186** extends up to 210° of the perimeter. For example, the first portion **184** may extend up to 210° of the perimeter. For example, as shown, first portion **184** extends for about 180° of the perimeter (indicated by arrow P1) and the second portion **186** extends for about 180° of the perimeter (indicated by arrow P2).

In alternate embodiments, wherein the first length L1A and/or the second length L2B are variable, one of first portion **184** and second portion **186** preferably extends up to 240° of the perimeter. For example, the first portion may comprise 240° of the perimeter, and the second portion may comprise 120° of the perimeter. In such an embodiment, the face of the wall facing the open end of the cyclone may extend upwardly at an angle.

It will be appreciated that in alternate embodiments, a cyclone **122** having a variable length may be useful, even if a plate **154** is not provided.

Alternately or in addition, as exemplified in FIGS. **9** and **10**, the plate **154** may have a plate sidewall **153** extending towards the open end **147**. Preferably, the plate sidewall **153** is at the periphery of the plate. In the embodiment shown, the plate sidewall **153** extends part way around the plate **154**. Accordingly, in this embodiment, the space between the plate sidewall and the open end of the cyclone defines the variable length of the gap, and gap **171** has a first length L1B between the plate **154** and the end **188** of cyclone **122**, and a second length L2B between the sidewall **153** and the end **188** of cyclone **122** that is less than the first length L1B

In some embodiments, as shown, the sidewall **153** of the plate **154** has a constant length.

In a alternate embodiments, the plate sidewall **154** may extend all the way around the plate **154**, and may have a variable length.

Plate **154** may be mounted by any means to any component in cyclone unit **114**. As exemplified, the separation plate is mounted on an arm **156**, which extends from a front wall **158** at the front **108** of the cleaner **100**.

Cyclone unit **114** may be emptied by any means known in the art. For example, one of the ends of the cyclone unit **114** may be openable. As exemplified in FIGS. **4** and **5**, front wall **158** is pivotably mounted to the cyclone unit wall **115**, such that cyclone unit **114** may be opened, and dirt chamber **124** may be emptied. When front wall **158** is pivoted away from the remainder of the cyclone unit **114**, separation plate **154** and arm **156** also pivot away from the remainder of the cyclone unit. A latch **159** is provided, which secures front wall **158** to wall **115**. In alternate examples, front wall **158** may be removable from cyclone unit wall **115** or the opposed end of the cyclone unit **114** may be openable.

The clean air exiting cyclone **122** passes through outlet passage **144**, exits surface cleaning head **116**, and passes into the cleaner body **160**. The air exiting the cyclone may be subjected to one or more treatment stages (e.g., cyclonic and/or filtration). In the example shown, a cleaner body **160** is positioned rearward of the surface cleaning head **116**. The cleaner body comprises a housing **161**, which preferably houses an optional pre-motor filter assembly **162**, a suction motor **164**, and an optional post-motor filter **166**.

In the exemplified embodiments, the vacuum cleaner has a linear configuration. Accordingly, pre-motor filter assembly **162** is preferably provided in the airflow path adjacent and downstream of the outlet passage **144**. Pre-motor filter assembly **162** serves to remove remaining particulate matter from air exiting the cyclone **122**, and may be any type of filter, such as a foam filter. One or more filters may be used, as shown. If the vacuum cleaner is of a non-linear configuration, then pre-motor filter assembly **162** need not be located adjacent outlet passage **144**.

Suction motor **164** is provided in the airflow path preferably adjacent and downstream of the pre-motor filter **162**. The suction motor draws air into the dirty air inlet **118** of the cleaner **100**, through the airflow path past the suction motor **164**, and out of the clean air outlet **120**. The suction motor **164** has a motor axis **165**. In the example shown, the motor axis **165** and the cyclone axis **122** extend in the same direction and are generally parallel. The suction motor **164** may be any type of suction motor. If the vacuum cleaner is of a non-linear configuration, then motor **164** need not be located adjacent pre-motor filter **162**.

Post motor filter **166** is provided in the airflow path downstream of, and preferably adjacent, the suction motor **164**. Post motor filter serves to remove remaining particulate mater from air exiting the cleaner **100**. Post-motor filter **166** may be any type of filter, such as a HEPA filter.

Clean air outlet **120** is provided downstream of post-motor filter **166**. Clean air outlet **120** comprises a plurality of apertures preferably formed in housing **161**.

Preferably, as in the example shown, cleaner body **160** is removably mounted to surface cleaning head **116**. For example, cleaner body **160** may be entirely removable from surface cleaning head **116**, or pivotably mounted to surface cleaning head **116**. Accordingly, cleaner body **160** and surface cleaning head **116** may be separated in order to provide access to the interior of cleaner body **160** or surface cleaning head **116**. This may allow pre-motor filter assembly **162** to be cleaned, changed, or serviced, or motor **164** to be cleaned, changed or serviced. Alternately, or in addition, surface cleaning head **116** may be cleaned or serviced. For example, any dirt stuck in outlet passage **144** may be removed. Alternately, a replacement cleaner body **160** or surface cleaning head **116** may be provided, and may be mounted to an existing surface cleaning head **116** or cleaner body **160**, respectively. If no filter element is fixedly mounted to cleaning head **116**, then cleaning head **116** may be removed and washed with water.

As can be seen in FIG. **6**, housing **161** preferably comprises a first portion **168** housing pre-motor filter assembly **162**, and suction motor **164**, and a second portion **170** housing post-motor filter **166**. Second portion **170** is openable, such as by being removably mounted to first portion **168**, such that post-motor filter **166** may be cleaned, changed, or serviced.

One or more additional rear wheels **180** may be mounted to housing **161**, preferably at lower portion **106**, and may be used in conjunction with wheels **135**. Preferably, a single rear wheel **180** is provided. Preferably, rear wheel **180** is located on a centre line of the vacuum cleaner and rearward of the depending wall **128**.

As mentioned hereinabove, surface cleaning apparatus **100** is a preferably a portable vacuum cleaner **100**, as shown in FIGS. **1** to **7**.

The invention claimed is:

1. A hand vacuum cleaner having an outer surface, the hand vacuum cleaner comprising:

a) an air flow passage extending from a dirty air inlet to a clear air outlet;

b) a hand vacuum cleaner body comprising a handle, a suction motor positioned in the air flow passage, a post-motor filter, a front end, and a rear end spaced apart from the front end in a rearward direction, the suction motor having a suction motor axis of rotation;

c) a cyclone unit positioned in the air flow passage upstream from the suction motor;

d) the post-motor filter provided in a post-motor filter housing, the post-motor filter provided rearward of the suction motor, the post-motor filter housing comprising a sidewall, the post-motor filter housing defining a post-motor filter chamber which contains the post-motor filter, wherein the suction motor axis of rotation extends through the post-motor filter chamber and wherein the post-motor filter housing is removably mounted at the rear end of the hand vacuum cleaner body and

e) the handle having a hand grip portion, the handle being provided on the hand vacuum cleaner forward of the outer surface portion, and wherein a rearward portion of the hand grip portion is positioned forward of a rearward end of the post-motor filter,

wherein the post-motor filter housing forms a rearmost removable portion of the hand vacuum cleaner body through which the suction motor axis of rotation extends, and

wherein the outer surface portion forms a rear portion of the outer surface of the hand vacuum cleaner, and

wherein a finger receiving area is a closed volume having a perimeter wherein the perimeter comprises the hand grip portion and another portion of the hand vacuum cleaner body.

2. The hand vacuum cleaner of claim **1**, wherein the cyclone unit is provided at the front end of the hand vacuum cleaner body and the suction motor axis intersects the cyclone unit.

3. The hand vacuum cleaner of claim **1**, wherein the cyclone unit is movably mounted with respect to the hand vacuum cleaner body.

4. The hand vacuum cleaner of claim **3**, wherein the cyclone unit is removably mounted at the front end of the hand vacuum cleaner body.

5. The hand vacuum cleaner of claim **4**, wherein air exiting the clean air outlet travels in a direction transverse to the suction motor axis.

6. The hand vacuum cleaner of claim **1**, wherein the clean air outlet is provided in the post-motor filter housing.

7. The hand vacuum cleaner of claim **1**, wherein air exiting a header downstream of a pre-motor filter and air entering the post-motor filter housing travels in a flow direction that is parallel to the suction motor axis.

8. The hand vacuum cleaner of claim **1**, further comprising a pre-motor filter in the air flow passage downstream from the cyclone unit and upstream from the suction motor, wherein the pre-motor filter is disposed forward of the suction motor and the suction motor axis intersects the pre-motor filter.

9. The hand vacuum cleaner of claim **1**, wherein the suction motor includes a fan, the fan has a diameter in a direction transverse to the suction motor axis and the diameter of the fan is proximate a diameter of the post-motor filter in the direction transverse to the suction motor axis.

10. The hand vacuum cleaner of claim **1**, wherein a portion of the hand vacuum cleaner body houses a fan of the suction motor, the portion has a diameter in a direction transverse to the suction motor axis and the diameter of the portion is proximate a diameter of the post-motor filter housing in the direction transverse to the suction motor axis.

11. The hand vacuum cleaner of claim **1**, wherein the post-motor filter housing has a rear facing surface that is a rearmost surface of the hand vacuum cleaner body.

12. The hand vacuum cleaner of claim **1**, wherein the post-motor filter comprises a porous filter media and the suction motor axis intersects the porous filter media.

13. The hand vacuum cleaner of claim **1**, wherein the finger receiving area is forward of the post-motor filter and rearward of the cyclone unit.

14. The hand vacuum cleaner of claim **1**, wherein the hand grip portion is forward of a plane that is transverse to the suction motor axis and extends through a rearmost portion of the rearmost removable portion.

15. The hand vacuum cleaner of claim **14**, wherein the handle is located forward of the outer surface portion.

16. The hand vacuum cleaner of claim **1**, wherein a pre-motor filter is positioned in an interior of the hand vacuum cleaner body.

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