



US 20070163075A1

(19) **United States**(12) **Patent Application Publication**
Butler et al.(10) **Pub. No.: US 2007/0163075 A1**(43) **Pub. Date: Jul. 19, 2007**(54) **STAIR CLEANING VACUUM CLEANER**

(57)

ABSTRACT(76) Inventors: **Dennis Clark Butler**, Saybrook, IL
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WASHINGTON, DC 20006-1109 (US)(21) Appl. No.: **11/332,400**(22) Filed: **Jan. 17, 2006****Publication Classification**(51) **Int. Cl.****A47L 9/32** (2006.01)**A47L 9/10** (2006.01)(52) **U.S. Cl.** **15/410; 15/350**

A vacuum cleaner having a generally elongated housing having a first housing end and a second housing end, a rear grip located at the first housing end, and an air inlet located at the second housing end. A vacuum fan and a motor are located within the housing and the motor is adapted to drive the vacuum fan to draw a working air flow into the air inlet. A dirt receptacle is operatively associated with the housing and adapted to remove particles from the working air flow. The vacuum cleaner also includes one or more foregrips located on the housing between the rear grip and the air inlet. In various aspects, the foregrips are adapted to: provide a user with multiple hand positions around the perimeter of the housing; simultaneously grasp the rear grip and the one or more foregrips and clean staircase surfaces while remaining substantially upright; and/or hold and operate the vacuum cleaner when the housing is rotated about its longitudinal axis at a first angular position and at a second angular position, the first angular position being approximately 90 degrees or more from the second angular position.

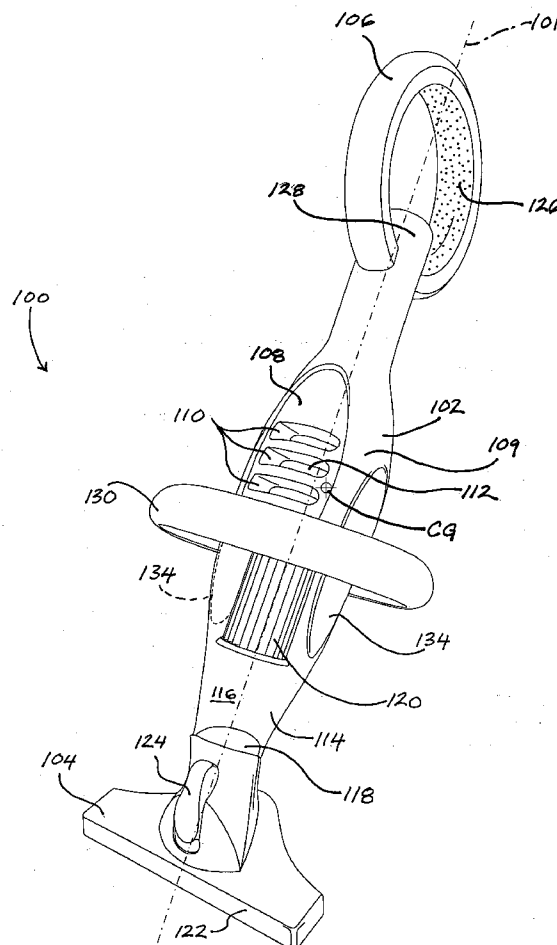


Fig. 1

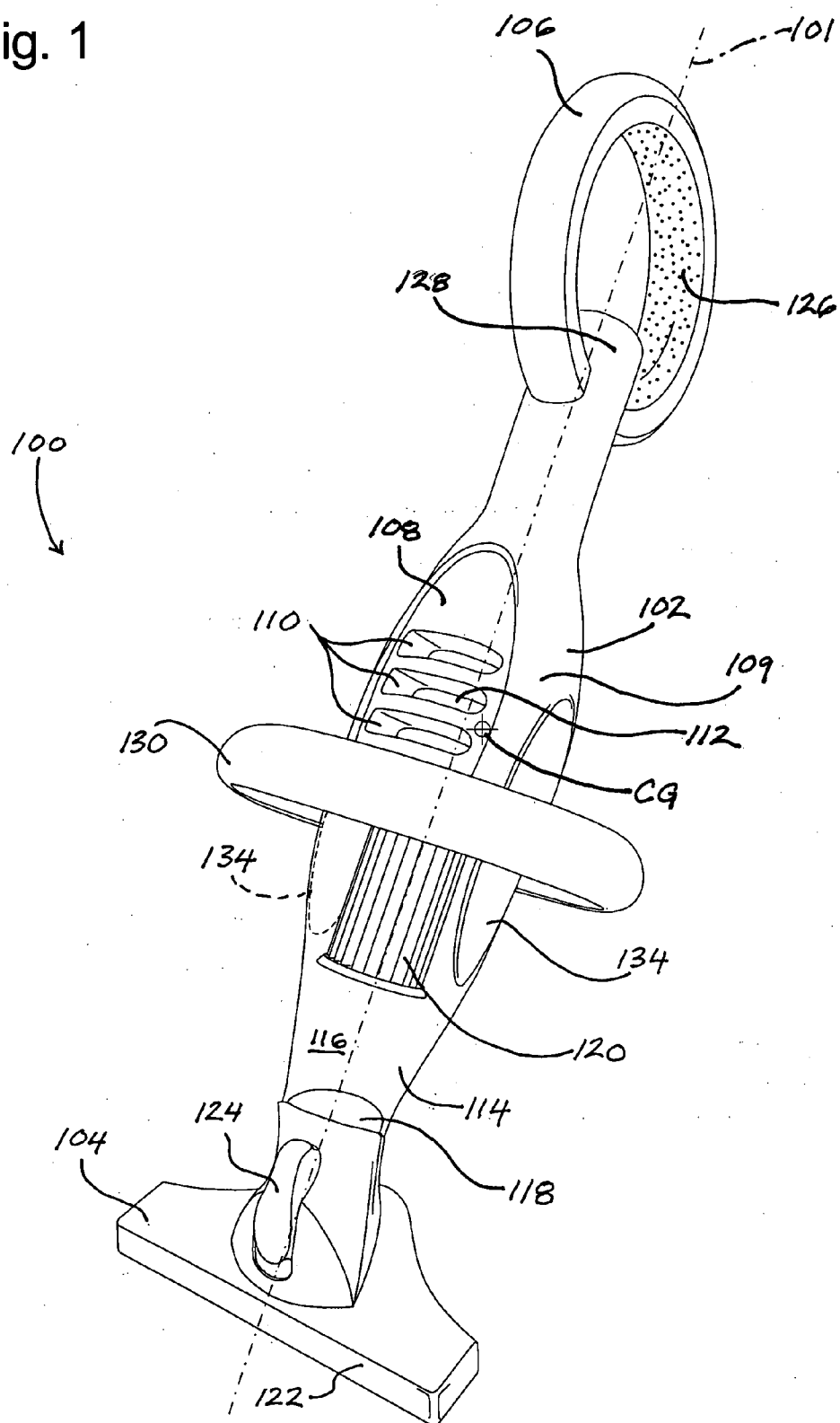


Fig. 2A

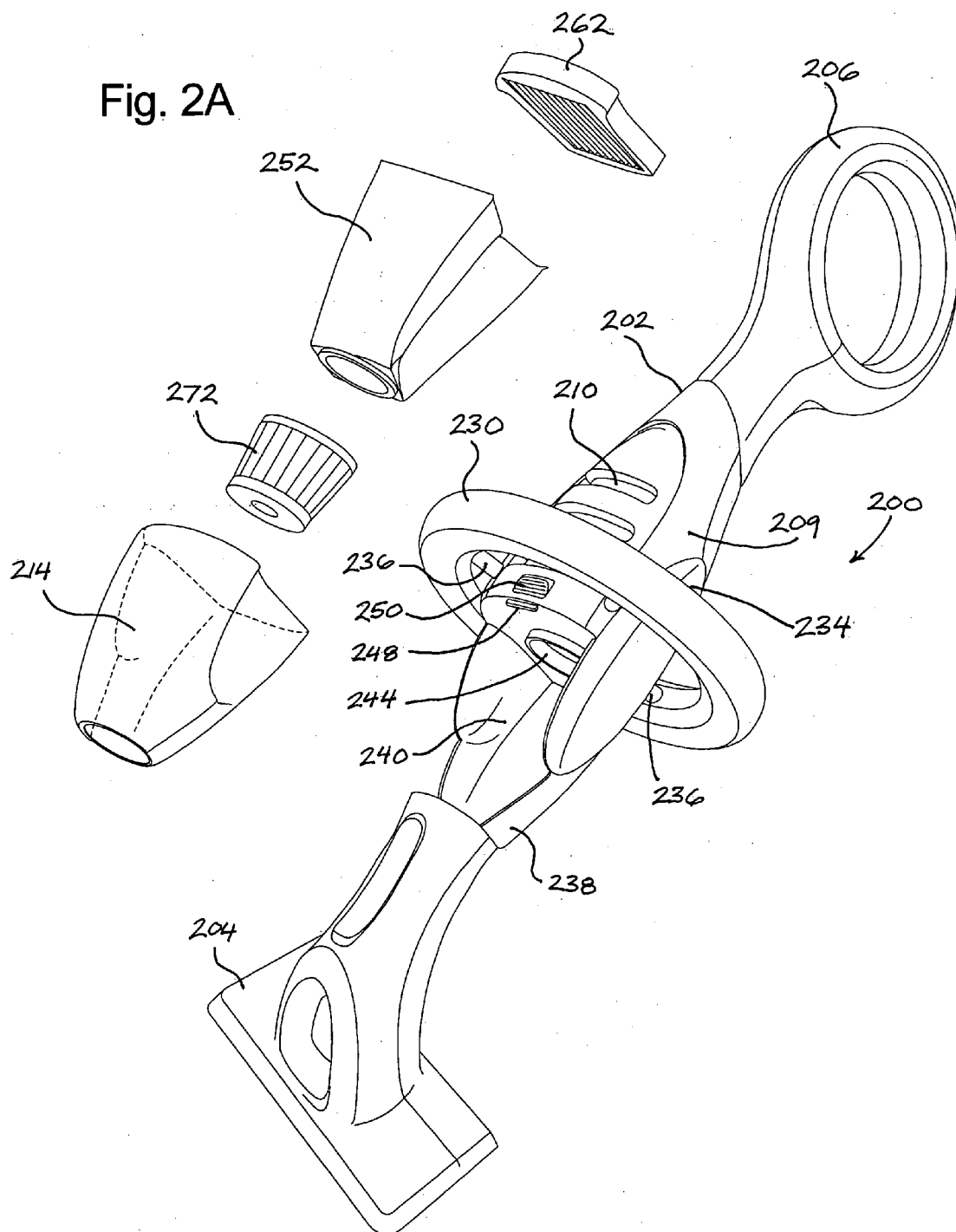


Fig. 2B

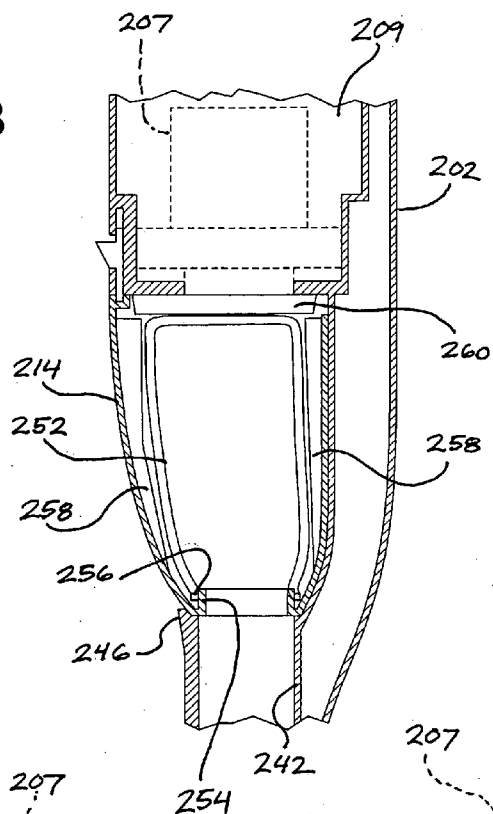


Fig. 2C

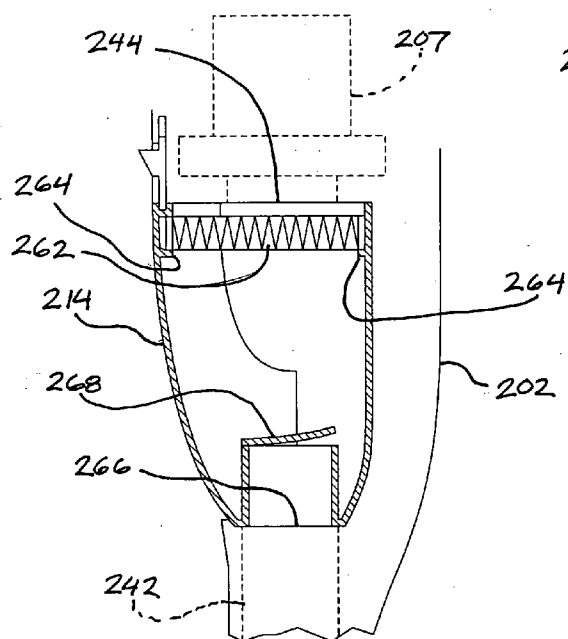


Fig. 2D

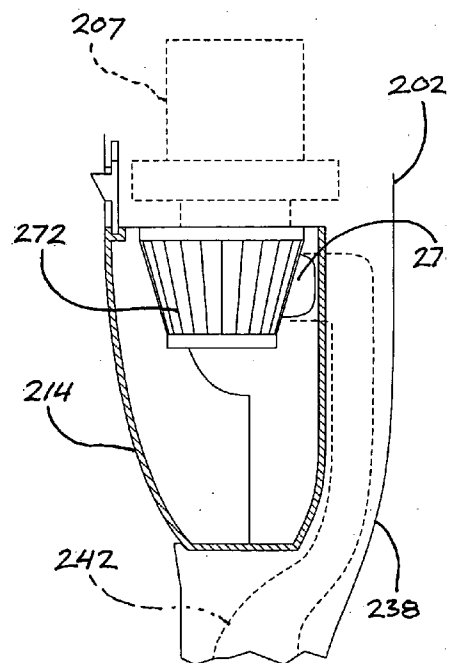


Fig. 4

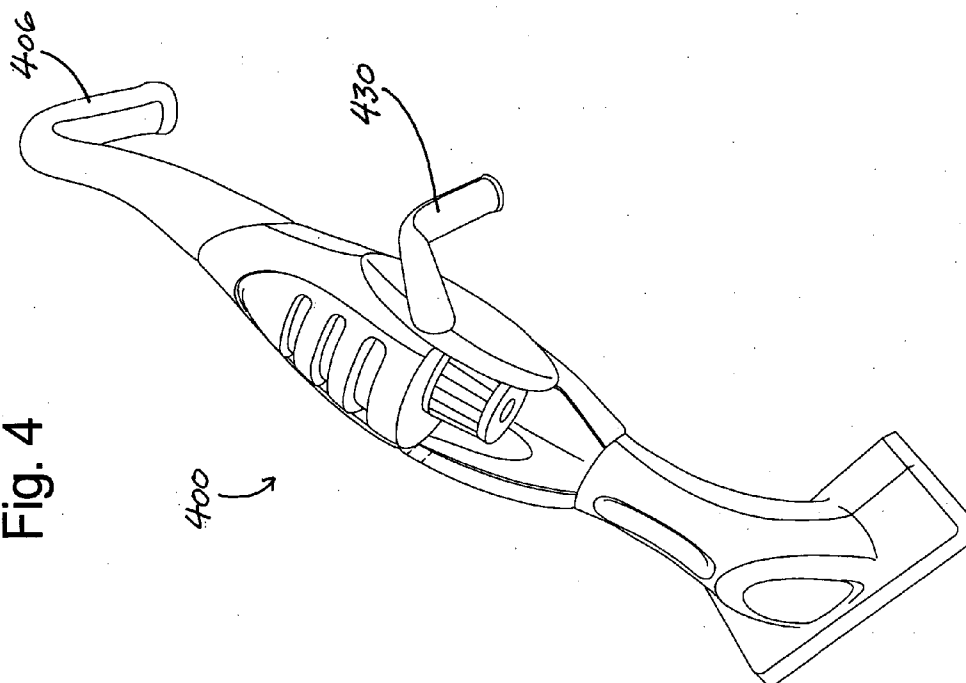


Fig. 3

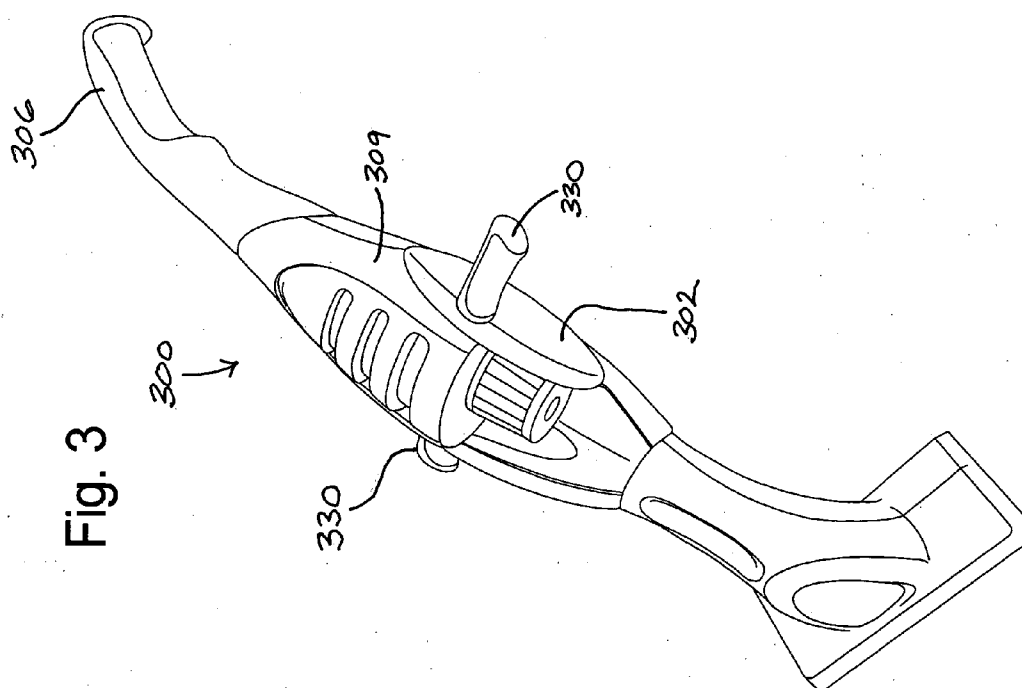


Fig. 5

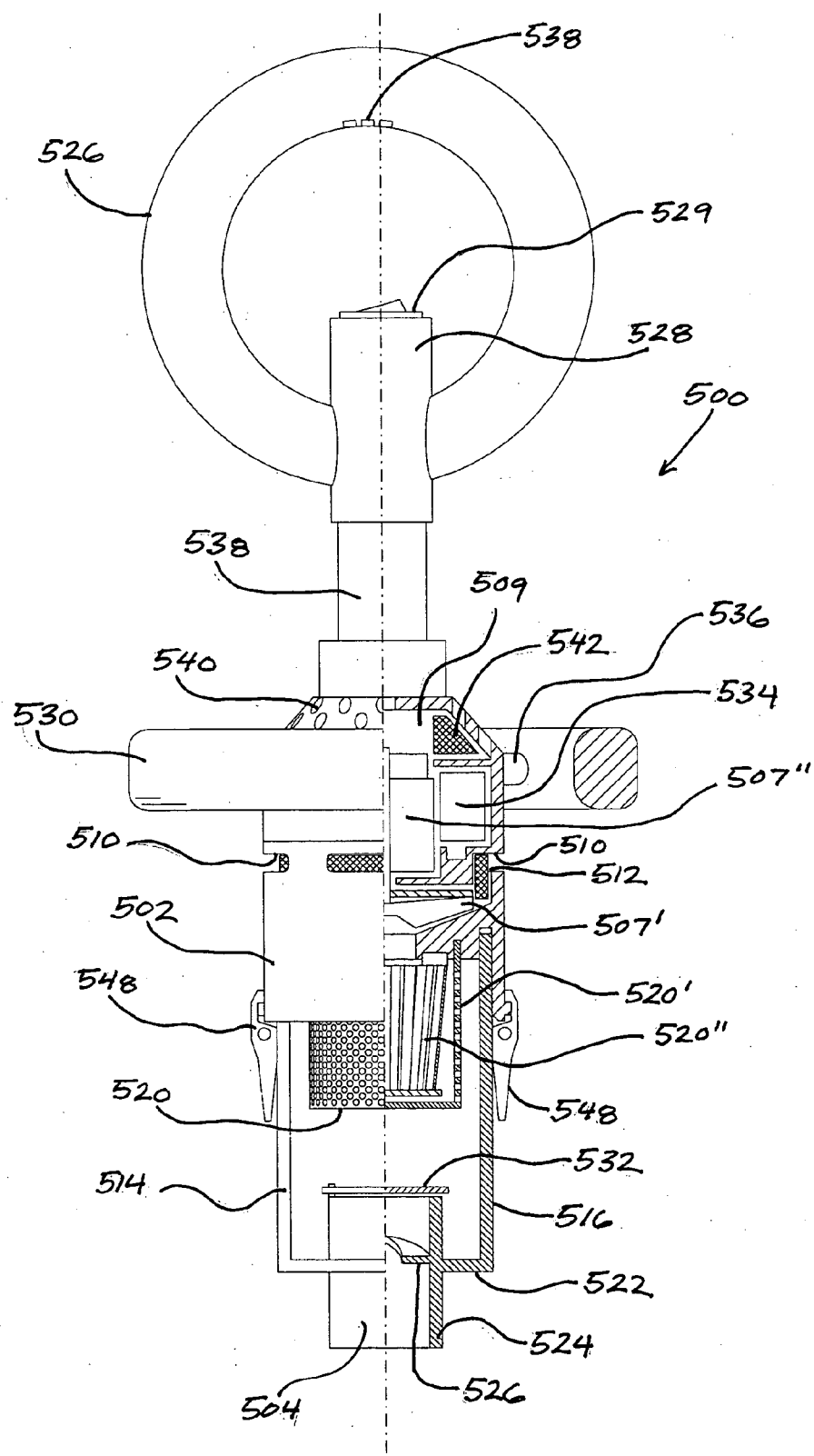


Fig. 6

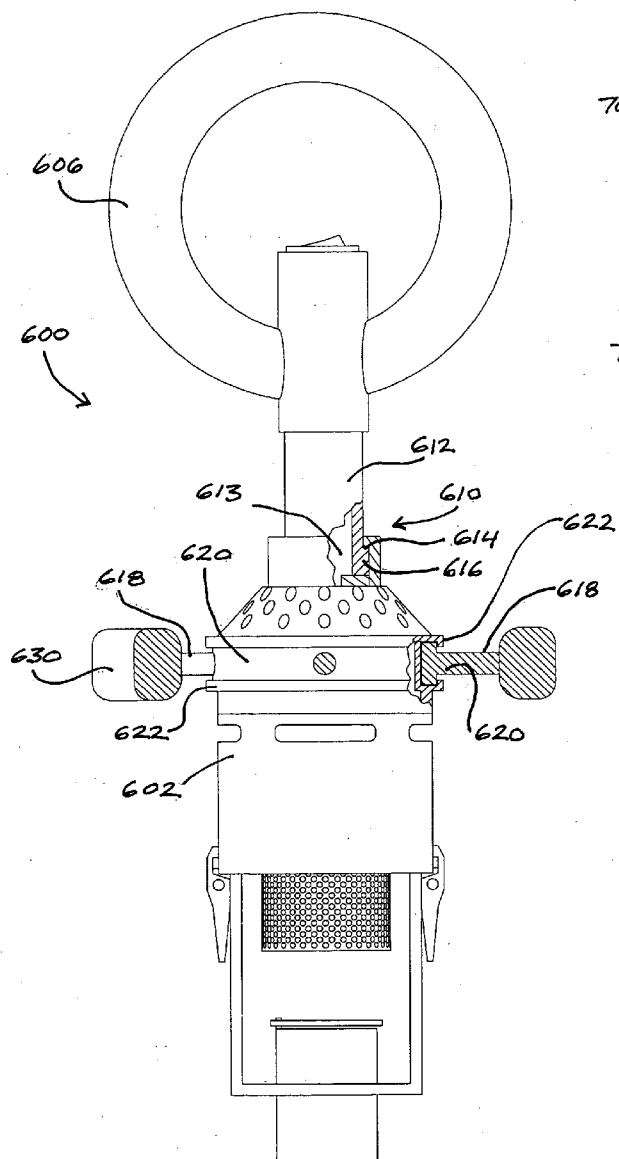


Fig. 7

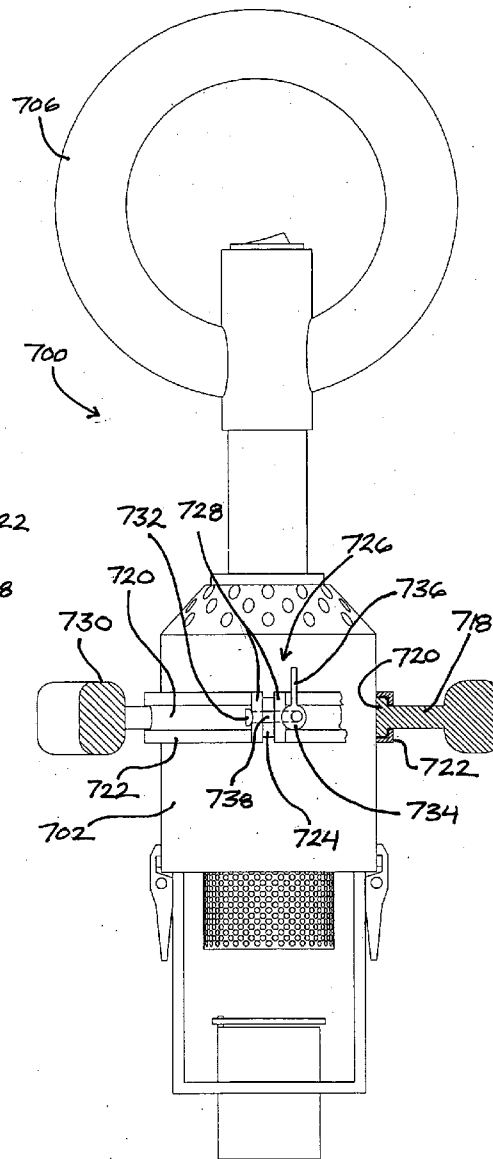


Fig. 8

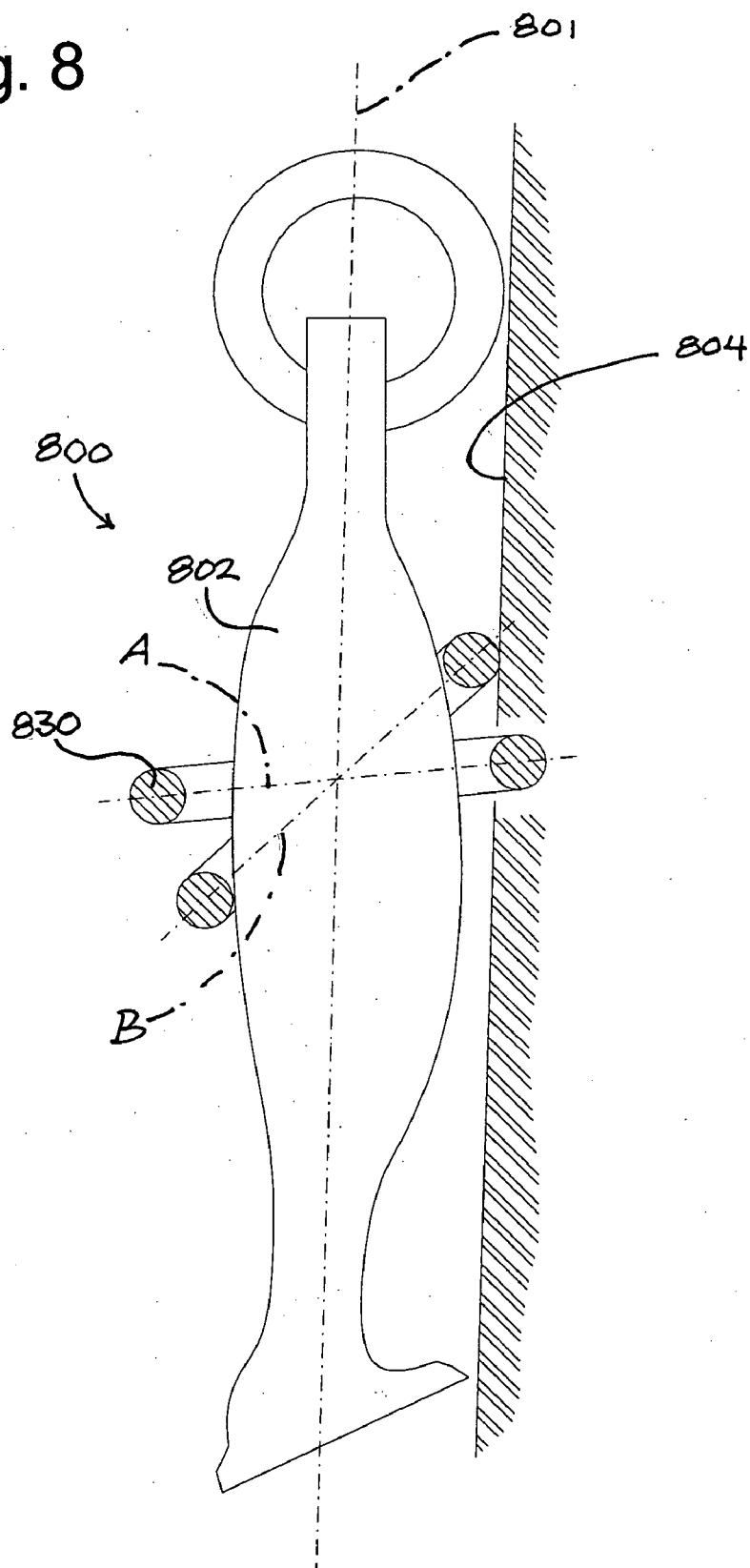


Fig. 9A

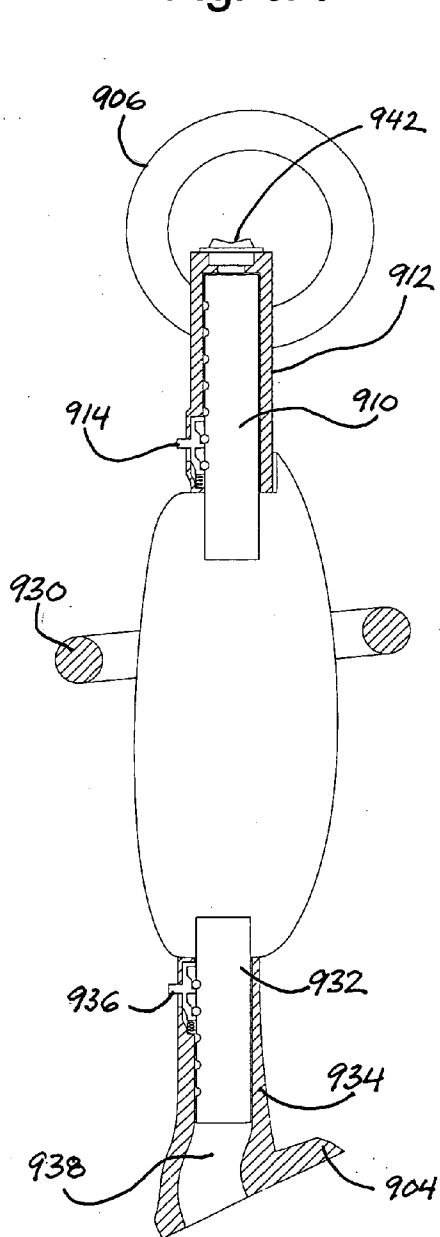


Fig. 9B

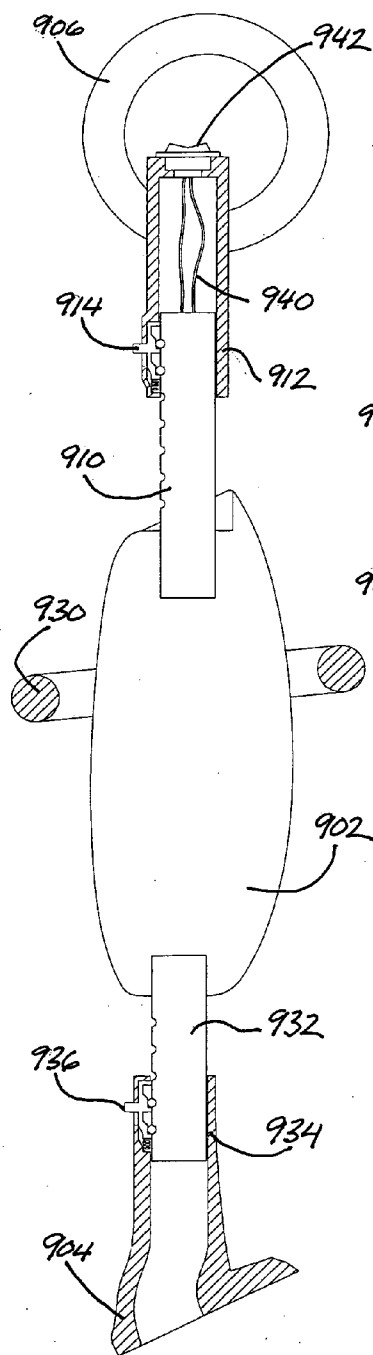


Fig. 9C

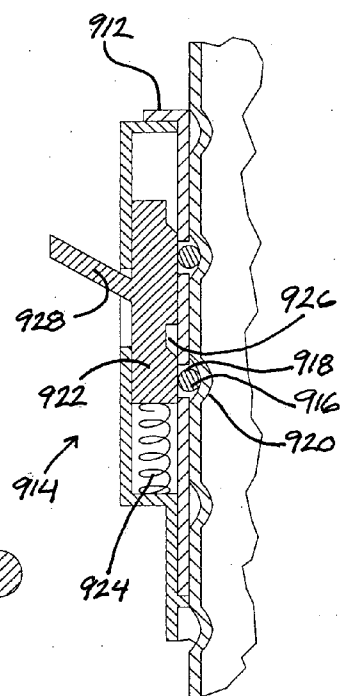
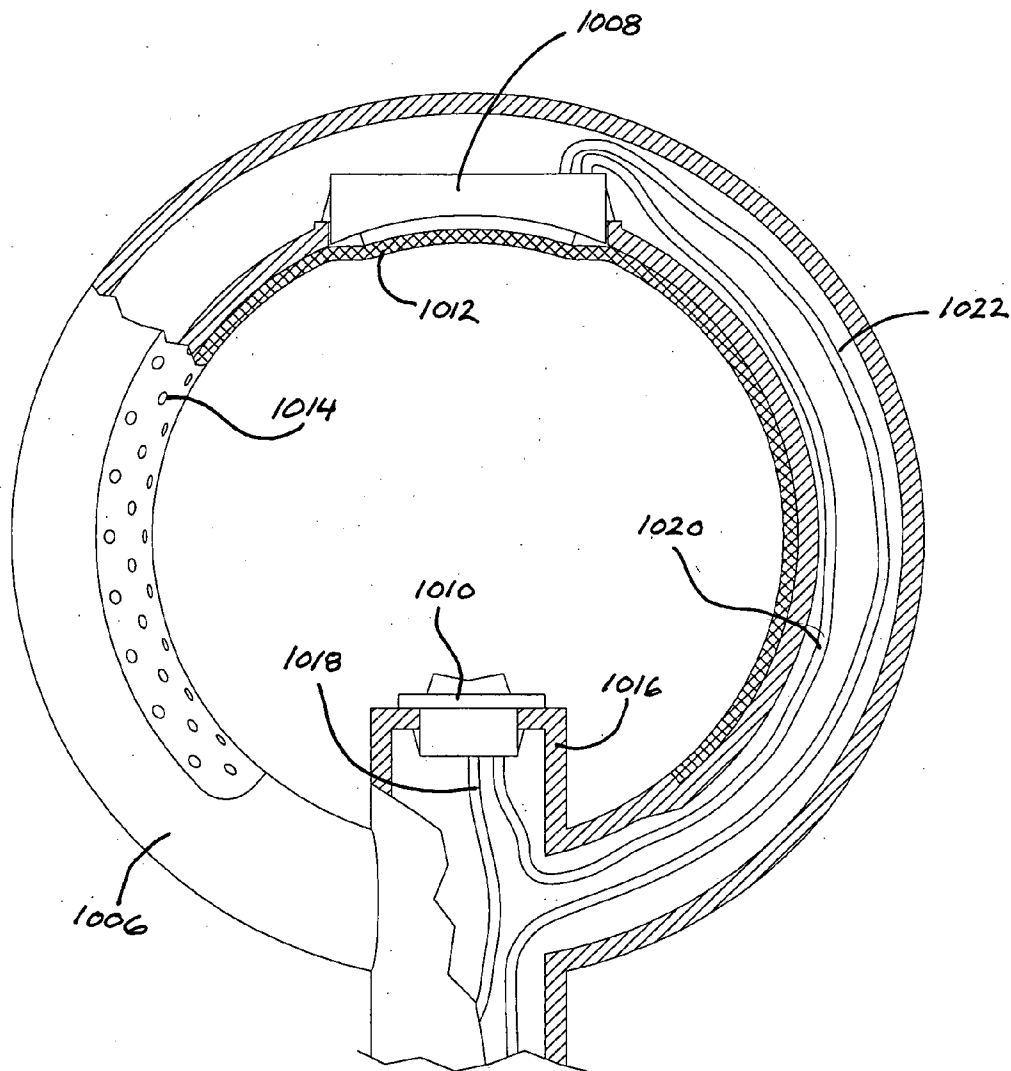


Fig. 10



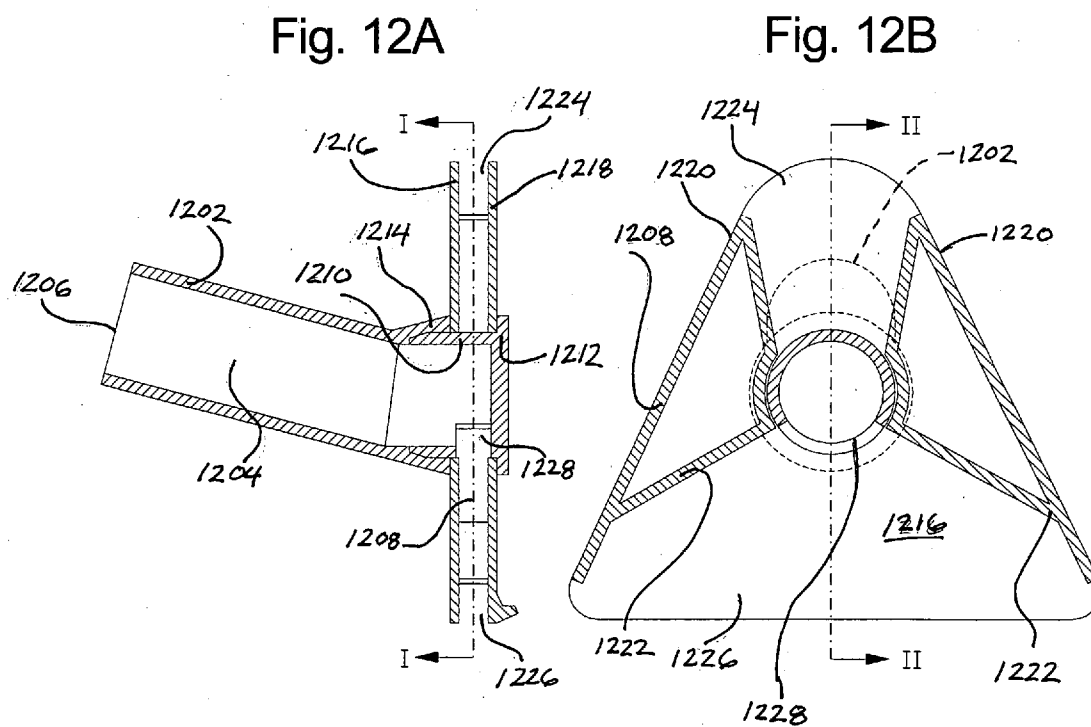
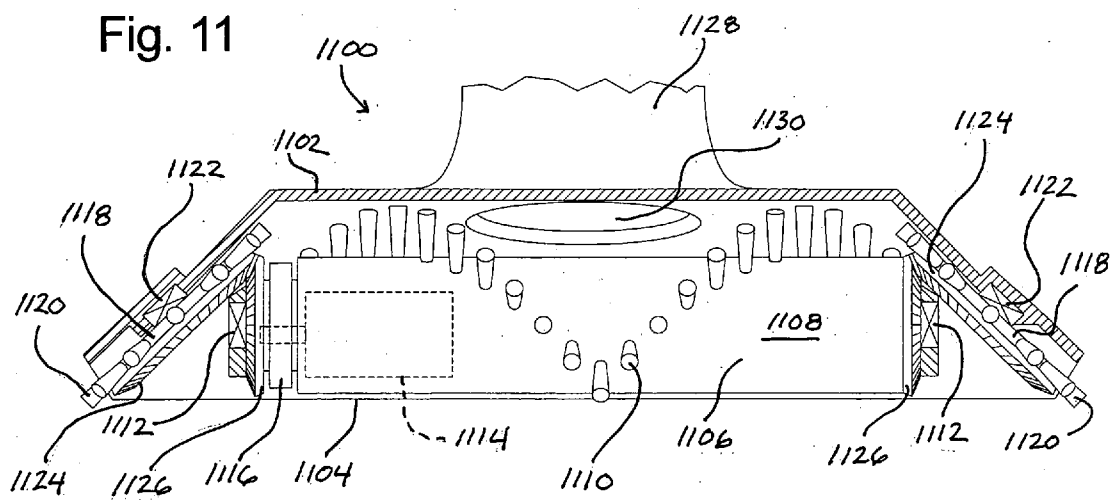


Fig. 13

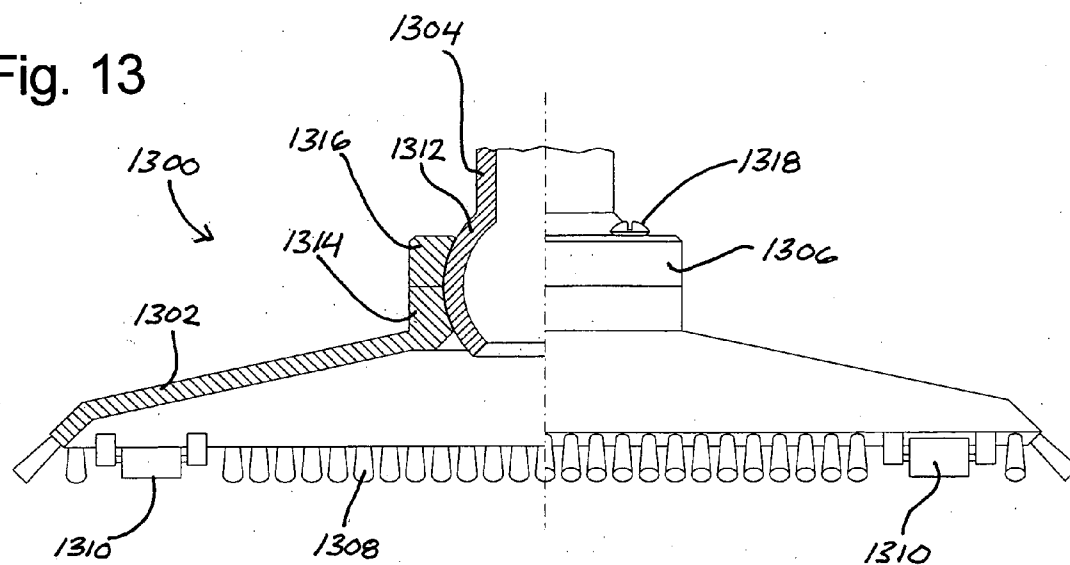
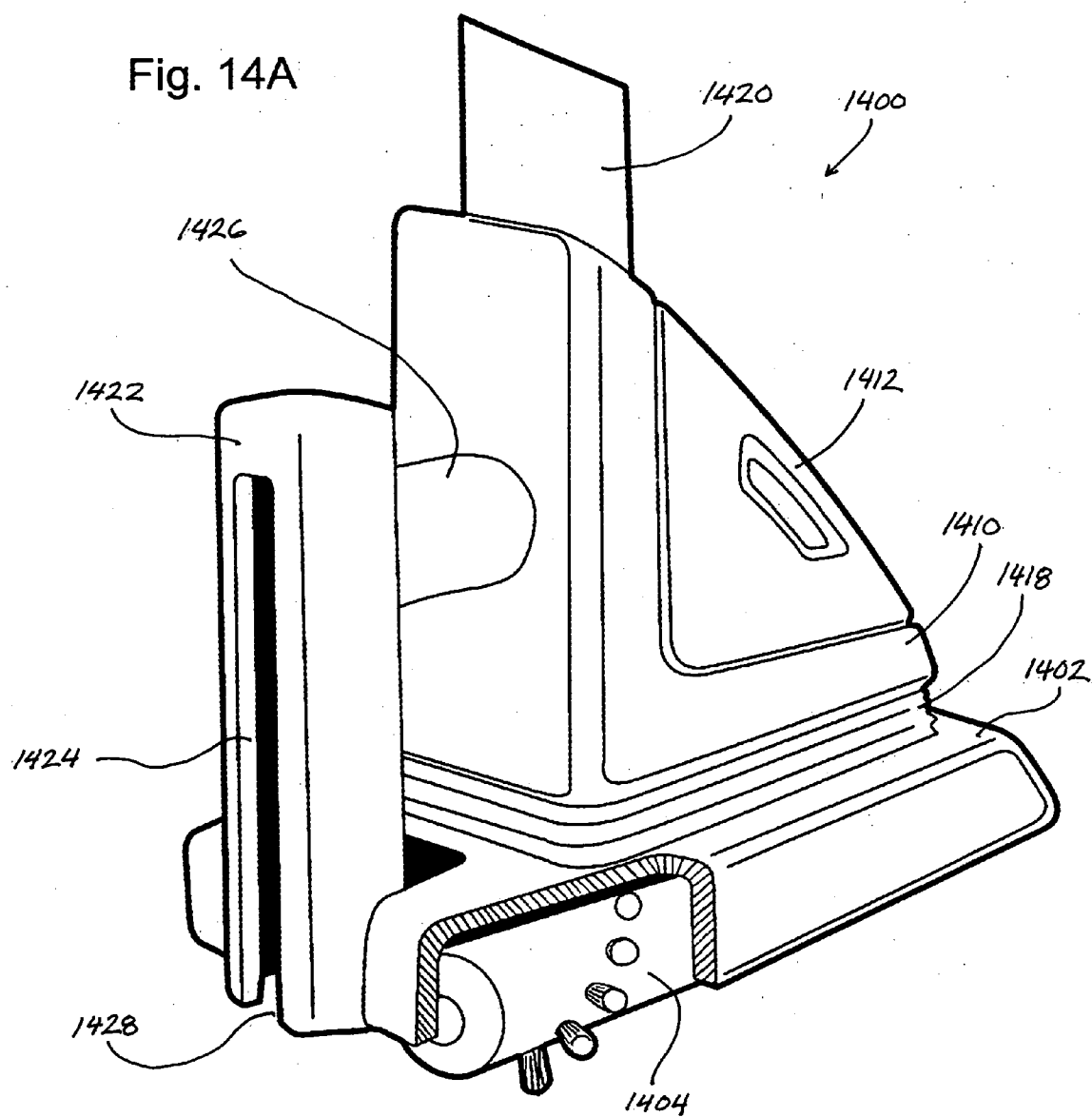
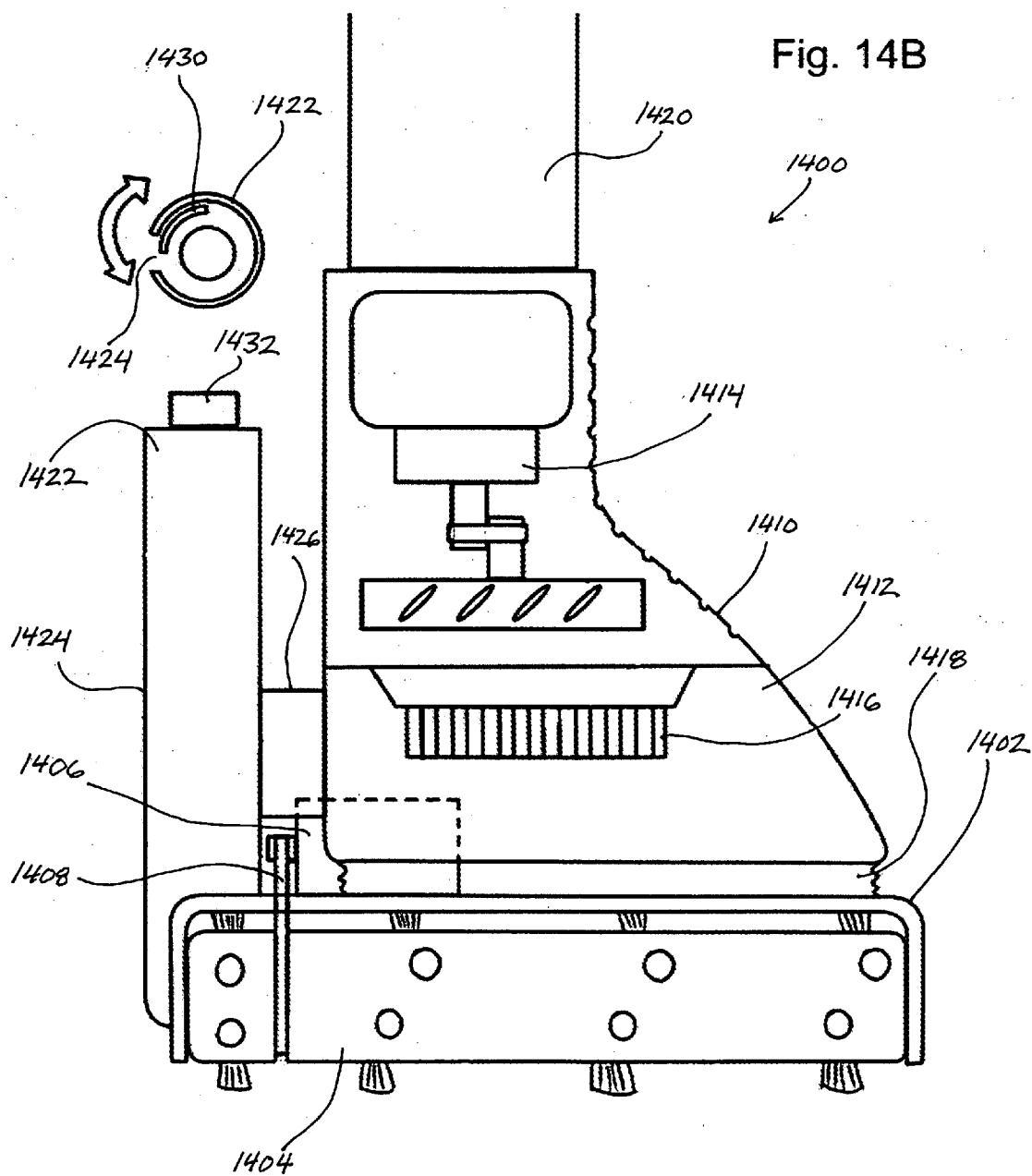


Fig. 14A





STAIR CLEANING VACUUM CLEANER

FIELD OF THE INVENTION

[0001] The present invention relates to vacuum cleaners, and particularly to a novel vacuum cleaner adapted for cleaning in stairwells and other confined spaces.

BACKGROUND

[0002] Vacuum cleaning devices are in widespread use as a tool to clean floors, upholstery, stairs, and other surfaces. Such vacuum cleaners are provided in a number of configurations, such as upright and canister vacuum cleaners, wet extractors, stick vacuums, electric brooms and so on. While these known vacuum cleaner configurations are useful for cleaning various surfaces, it has been found that they are generally better suited for some surfaces than others. For example, upright vacuum cleaners, such as those illustrated in U.S. Pat. Nos. 5,564,160, and 6,829,804, include a floor-engaging base to which an upright handle is pivotally attached, and are generally best suited for cleaning relatively unobstructed floor spaces. While such upright vacuums may be provided with a recessed grip on the handle just above the base to help the user lift the base for cleaning above the floor, such as in U.S. Pat. No. 5,564,160, the shape and balance of the device inhibits prolonged ergonomic use in this manner. As such, while such a grip might improve the user's comfort, various other features endemic to typical upright vacuums still make using them to clean stairs and other elevated surfaces relatively uncomfortable. Furthermore, even if a grip is provided on a conventional upright vacuum, it typically does not allow easy rotation of the device to clean vertical surfaces or other inclined surfaces, such as stair risers. When doing so, the user is often faced with the dangerous combination of heightened exposure to a rotating brushroll and unwieldy ergonomics.

[0003] Canister vacuum cleaners can be somewhat more user-friendly for cleaning stairs, stair risers, and other elevated and vertical surfaces. However, even these devices suffer from various shortcomings. Canister vacuums typically have a floor-cleaning nozzle attached by a hose to a canister that holds a dirt collection device and a vacuum source. The provision of a cleaning nozzle on the end of a hose allows greater flexibility in manipulating the vacuum nozzle to clean elevated and vertical surfaces. However, the canister portion of the device is typically at constant risk of tumbling down the stairs, the user's movement is limited by the device's hose length, and the use of a long hose often results in reduced suction at the nozzle inlet. Upright vacuums provided with extension hoses for cleaning above the floor also typically suffer from these and other problems. While some canister vacuums, such as that shown in U.S. Pat. No. 5,755,007, include a recess to make them more stable on stairs, such cleaners still must be constantly moved as the user progresses along the length of the stairs and reaches the end of the hose's reach, and they still suffer from potentially reduced suction force.

[0004] A third type of vacuum, commonly referred to as a stick vacuum, may be somewhat more appropriate for cleaning stairs and vertical surfaces than upright and canister vacuums. Stick vacuums are essentially lightweight or compact upright vacuums, and may be battery powered to make them more portable. An example of a stick vacuum is shown

in U.S. Pat. No. D382,681. Stick vacuums often are easier to manipulate than upright vacuums, do not suffer from reduced suction caused by the use of a long hose (although use of battery power may require less powerful vacuum motors), and do not require constant tending to a canister. However, these devices still are not ideally designed for cleaning stairs and vertical surfaces. For example, stick vacuums are generally made to mimic the structure and ergonomics of a typical upright vacuum cleaner, and many do not even include a grip at the bottom of the handle to assist with lifting the device for above-floor and stair cleaning. Furthermore, even if the stick vacuum is provided with a handle along its length, such devices are not known to include features that allow them to be rotated to clean upright surfaces. For example, the device of U.S. Pat. No. 6,108,864 includes a handle (item 102 in FIG. 3) located along its length, but it would be difficult for a user to use this handle to turn the device to face a stair riser without holding the device in an unbalanced position. Stick vacuums are also typically just as long as a conventional vacuum cleaner, which makes them difficult to manipulate in enclosed stairwells, closets, and other confined spaces. This length also makes it difficult for the user to hold the grip located at the end of the handle when cleaning stairs.

[0005] Still other vacuums are provided in compact handheld configurations that are often very easy to manipulate to clean raised and vertical surfaces. For example U.S. Pat. No. 4,993,108 illustrates a handheld vacuum cleaner with a stair riser cleaning feature that directs the inlet nozzle horizontally without having to rotate the device. However, even these devices are limited because the handle is located so close to the inlet nozzle, that in many instances the user must kneel or bend to reach the surface being cleaned.

[0006] In view of the foregoing considerations, and others not specifically listed herein, there exists a need for an improved vacuum cleaner for cleaning raised and vertical surfaces, and particularly stair treads and risers. It will be understood that the recitation of the foregoing observations of the prior art does not constitute an admission that these observations were previously known or understood by others, and is not intended to limit the invention to excluding embodiments that do not resolve or improve any or all of the foregoing observed aspects of the prior art.

[0007] Any and all patents listed in this specification are incorporated herein by reference.

SUMMARY OF THE INVENTION

[0008] In a first aspect, the present invention provides a vacuum cleaner having a generally elongated housing having a first housing end and a second housing end, a rear grip located at the first housing end, and an air inlet located at the second housing end. A vacuum fan and a motor are located within the housing and the motor is adapted to drive the vacuum fan to draw a working air flow into the air inlet. A dirt receptacle is operatively associated with the housing and adapted to remove particles from the working air flow. The vacuum cleaner also includes one or more foregrips located on the housing between the rear grip and the air inlet. The one or more foregrips are adapted to provide a user with multiple hand positions around the perimeter of the housing.

[0009] In a second aspect, the present invention provides a vacuum cleaner having a generally elongated housing

having a first housing end and a second housing end, a rear grip located at the first housing end, and an air inlet located at the second housing end. A vacuum fan and a motor are located within the housing, and the motor is adapted to drive the vacuum fan to draw a working air flow into the air inlet. A dirt receptacle is operatively associated with the housing and adapted to remove particles from the working air flow. The vacuum cleaner also has one or more foregrips located on the housing between the rear grip and the air inlet. The one or more foregrips are positioned to allow a typical user to simultaneously grasp the rear grip and the one or more foregrips and clean staircase surfaces while remaining substantially upright.

[0010] In a third aspect, the present invention provides a vacuum cleaner having a generally elongated housing with a longitudinal axis, a first housing end, and a second housing end. A rear grip is located at the first housing end, and an air inlet is located at the second housing end. A vacuum fan and a motor are located within the housing and the motor is adapted to drive the vacuum fan to draw a working air flow into the air inlet. A dirt receptacle is operatively associated with the housing and adapted to remove particles from the working air flow. One or more foregrips are located on the housing between the rear grip and the air inlet. The one or more foregrips are adapted to allow a user to hold and operate the vacuum cleaner when the housing is rotated about the longitudinal axis at a first angular position, and at a second angular position. The first angular position is approximately 90 degrees or more from the second angular position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention is described in detail with reference to the examples of preferred embodiments shown in the following figures, in which like parts are designated by like reference numerals.

[0012] FIG. 1 is a perspective view of an embodiment of a vacuum cleaner of the present invention.

[0013] FIG. 2A is a perspective view of another embodiment of a vacuum cleaner of the present invention, showing various complementary parts therewith.

[0014] FIG. 2B is a cutaway schematic view of a dust bag configuration that may be employed with the embodiment of FIG. 2A.

[0015] FIG. 2C is a cutaway schematic view of a dirt cup configuration that may be employed with the embodiment of FIG. 2A.

[0016] FIG. 2D is a cutaway schematic view of a cyclone separator configuration that may be employed with the embodiment of FIG. 2A.

[0017] FIG. 3 is a perspective view of a first alternative handle arrangement of the present invention.

[0018] FIG. 4 is a perspective view of a second alternative handle arrangement of the present invention.

[0019] FIG. 5 is a partially cut away side view of still another embodiment of a vacuum cleaner of the present invention.

[0020] FIG. 6 is a partially cut away side view of another alternative handle arrangement of the present invention.

[0021] FIG. 7 is a partially cut away side view of another alternative handle arrangement of the present invention.

[0022] FIG. 8 is a schematic view of another alternative handle arrangement of the present invention.

[0023] FIG. 9A is a partially cut away, partially schematic view of an embodiment of a vacuum cleaner of the present invention having telescoping portions, shown with the telescoping portions retracted.

[0024] FIG. 9B is a partially cut away, partially schematic view of the embodiment of FIG. 9A, shown with the telescoping portions extended.

[0025] FIG. 9C is a cut away fragmented view of a telescoping lock that may be used with embodiments of the present invention.

[0026] FIG. 10 is a partially cut away fragmented view of an embodiment of a vacuum cleaner handle of the present invention.

[0027] FIG. 11 is a cut away front view of an embodiment of a cleaning tool of the present invention.

[0028] FIG. 12A is a cut away side view of an embodiment of a cleaning tool of the present invention, shown along reference line II-II of FIG. 12B.

[0029] FIG. 12B is a cut away front view of the cleaning tool of FIG. 12A, shown along reference line I-I thereof.

[0030] FIG. 13 is a partially cut away front view of still another embodiment of a cleaning tool of the present invention.

[0031] FIG. 14A is a partially cut away perspective view of an embodiment of a stair cleaning vacuum of the present invention.

[0032] FIG. 14B is a schematic side view of an embodiment of a stair cleaning vacuum of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0033] The present invention provides a vacuum cleaner that can be used to clean floors and carpets, but is particularly adapted to clean stair treads or other elevated horizontal surfaces, stair risers and other inclined or vertical surfaces, and surfaces located in confined spaces. A number of variations of the present invention are described herein, but the illustration of these particular embodiments is not intended to limit the scope of the appended claims. In addition, while the devices described herein relate to a vacuum cleaner, it will be understood that the invention may also cover other, similar devices, such as wet extractors and the like.

[0034] Various inventive vacuum cleaner accessories are also described herein. These accessories are inventive in their own right, and may be used in conjunction with the vacuum cleaners of the present invention, or with other cleaning devices, as will be understood by those of ordinary skill in the art.

[0035] Referring now to FIG. 1, in a first embodiment, the present invention provides a stair cleaning vacuum 100 generally comprising a housing 102 having an inlet nozzle 104 at a first end of the housing 102, and a rear grip 106 at

a second end of the housing **102**. The housing **102** contains a conventional vacuum fan and motor assembly (sometimes referred to as a “fan/motor”), which is contained within the housing **102** and not visible in FIG. **1**. The housing also includes appropriate features to power the fan/motor, such as a power cord or batteries, as are known in the art.

[0036] In the embodiment of FIG. **1**, the fan/motor is contained in a fan/motor chamber **109** beneath a shroud **108** having a number exhaust vent apertures **110** passing there-through. In operation, air drawn in by the fan/motor is exhausted from the housing **102** through these apertures **110**. A post-motor filter **112** may be located between the vent apertures **110** and the fan/motor exhaust port to provide a final filtration stage, as known in the art. In such a case, the shroud **108** may be removable or openable to service the post-motor filter **112**. As with any other filters described herein or otherwise used in embodiments of the invention, the post-motor filter **112** may take any shape or form. Typical filters are formed as a foam sheet or block, a pleated sheet rigidly held in a frame, a rigid panel, a flexible sheet, and so on. Such filters may also have any filtration performance grade, such as HEPA grade (an acronym for “High Efficiency Particle Air,” which is standardized as being capable of removing 99.97% of particles 0.3 microns in size or larger) or ULPA grade (an acronym for “Ultra Low Penetration Air,” which is standardized as being capable of removing 99.999% of particles 0.12 microns in size or larger). Of course, lesser or greater grades of filtration media may also be used.

[0037] It is also known in the art to measure the differential pressure across the post-motor filter and others filter in a vacuum cleaner, using conventional pressure sensors, to determine when the pressure drop exceeds a given threshold to identify when the filter is clogged, and such features may be used with the present invention for the post-motor filter **112** or other filters. In addition, such a pressure differential sensor could also be used to determine when the post-motor filter **112** or other filter is absent, as would be indicated by little or no pressure drop across the sensors. Thus, suitable electronics may be wired to a differential pressure sensor to alert the user of the absence of the post-motor filter **112** or other filters in the device, or the need to service such filters.

[0038] A dirt receptacle **114** is provided in or on the housing **102**, preferably between the fan/motor chamber **109** and the inlet nozzle **104**. In the shown embodiment, the dirt receptacle **114** includes a transparent outer wall **116** forming a cup-like receptacle, and an inlet **118** through the end nearest the inlet nozzle **104**. The inlet **118** may have a flap and/or tubular extension (not shown) into the receptacle **114** to help prevent entrapped dirt from falling back through the inlet **118**. A filter **120** is positioned in the dirt receptacle **114** to cover the receptacle outlet (not shown) or the fan/motor inlet (not shown) and filter dirt out of the airstream.

[0039] While a cup and filter arrangement is illustrated, the dirt receptacle **114** may alternatively comprise any known type of dirt separation and retention system. Several exemplary variations are described later herein with reference to FIGS. **2A** to **2D** and **5**. For example, the dirt receptacle **114** may comprise a structural extension of the housing **102**, as explained more fully with reference to the embodiment of FIG. **5**, or may be a non-structural part that is attached to the housing **102**, as explained more fully with

reference to the embodiment of FIGS. **2A** to **2D**. The dirt receptacle **114** may also comprise a chamber within the housing **104** that is emptied by opening or removing a door through the housing wall. Other configurations for the dirt receptacle may be used as well, and the dirt separation function of the vacuum cleaner **100** may be performed by any principle, such as cyclonic separation, dirt entrapment (filtering), or combinations thereof.

[0040] The inlet nozzle **104** may comprise any structure adapted to clean objects and surfaces, such as hardwood and carpets. A typical inlet nozzle **104** may comprise a laterally elongated cleaning head **122** having a similarly elongated inlet slot (not shown) facing downward towards the intended location of a surface desired to be cleaned. Wheels or skids may be provided to hold the inlet slot a predetermined distance from the surface being cleaned (see, e.g., FIG. **13**), and such devices may be adjustable to modify this height to suit the given conditions or surface type. Bristles may also be provided to help entrap hair, agitate the surface, and otherwise assist with cleaning. It is also known to place skirt-like strips of material on the bottom surface to prevent particles from escaping the airflow entering the inlet slot. One or more brushrolls may be positioned in the inlet nozzle **104** to further agitate the surface being cleaned and enhance cleaning performance. Such brushrolls may be powered by the fan/motor, a separate motor, by an airflow-powered impeller drive, or by other known means. The inlet nozzle **104** may also be removable, such as by actuating one or more release clasps **124**, rotating a bayonet fitting, or by simply pulling on the inlet nozzle **104** to overcome a friction fit. Once removed, other types of inlet nozzle (such as dusters, crevice tools, and so on) may be attached to the vacuum cleaner **100**, as known in the art.

[0041] In the embodiment of FIG. **1**, the inlet nozzle **104** is angled relative to the vacuum cleaner housing **102** such that the inlet nozzle’s working surface (that is, the surface that is intended to face the surface being cleaned) is angled at about 30-60 degrees, and most preferably about 45 degrees, relative to the longitudinal axis **101** of the vacuum cleaner housing **102**. This allows the operator to address the surface being cleaned with the vacuum cleaner **100** in a comfortable angled position. Other angles may be used if so desired.

[0042] The inlet nozzle **104** may also be rotatably mounted to the housing **102** so that the angle between its working surface and the housing **102** can be changed. For example, the inlet nozzle **104** may be pivotable about an axis perpendicular to the longitudinal axis **101** of the housing **102**. Such pivoting would allow the leading edge of the inlet nozzle **104** to move vertically with respect to the rear edge of the inlet nozzle **104** (or vice-versa), such as typically found in conventional upright vacuums. The inlet nozzle may instead be rotatable about the housing’s longitudinal axis **101**, or about an intermediate axis oriented somewhere between the longitudinal axis **101** and an axis perpendicular to the longitudinal axis **101**. Various combinations of pivots may also be used to provide more complex rotation capabilities. Such pivoting mechanism are known in the art. In addition, in cases in which the inlet nozzle **104** is rotatable, it may also be desirable to provide pivot locks to prevent rotation when it is not desired.

[0043] The rear grip **106** is, in this embodiment, rigidly attached to the housing **102** at the second end, and is located

generally opposite the inlet nozzle 104. The rear grip 106 is used to support and maneuver the back of the vacuum cleaner 100, and may have any shape suitable for doing so. Preferably, the rear grip 106 is generally circular in shape, and forms a loop that gives the user flexibility in selecting an ergonomic position in which to hold the rear grip 106. The center of the rear grip 106 loop may be located along the longitudinal axis 101, but may be forward or rearward of this axis 101 if it is found to provide improved ergonomics or other benefits. For example, it may be beneficial to locate the center of the rear grip 106 slightly forward of the longitudinal axis 101 to assist with manipulating the vacuum 100 under low objects. The rear grip 106 also preferably has a circular or at least somewhat rounded cross-sectional profile to provide a natural fit in the user's hand.

[0044] While it is suitable to provide the grip as a simple rigid extension of the housing 102, it may instead be separately formed and attached to the housing 102 by fasteners, welding, adhesives, snap engagement, or the any other suitable attachment method or mechanism.

[0045] The rear grip 106, and any other part of the vacuum cleaner 100, may be made from any suitable material, such as ABS plastic (i.e., acrylonitrile-butadiene-styrene copolymers), other plastics, metal, and so on. Plastics are generally preferred as a relatively inexpensive, moldable and structurally rigid material. The rear grip 106 may also include one or more gripping surfaces 126 comprising a material that is more particularly adapted to provide a favorable tactile feel and/or enhanced gripping friction. The gripping surfaces 126 may be formed by treating the surface of the material that forms the rear grip 106, such as by including dimples, checkering, ridges or bumps, or may be provided as a separate tactile material applied to the rear grip 106 itself by mechanical or adhesive attachment, overmolding, or the like. Of course, surface treatments and a separate tactile material may both be used, if desired.

[0046] A protrusion 128 extends into the opening formed by the rear grip 106, and has a power switch (not shown) located thereon. This position for the power switch is expected to provide convenient and intuitive operation of the vacuum cleaner 100, and ready access to turn the vacuum cleaner 100 on or off. This location also shields the power switch to some degree from being accidentally activated. Further details of this configuration are described elsewhere herein.

[0047] The vacuum cleaner 100 also includes a foregrip 130 located between the rear grip 106 and the inlet nozzle 104. As with the rear grip, the foregrip 130 may be made from any suitable material, and may also include gripping surfaces or surface treatments to enhance the user's grip and feel. As with the rear grip 106, the foregrip 130 preferably has a rounded cross-sectional shape, or is otherwise shaped to naturally fit into a user's hand. In the embodiment of FIG. 1, the foregrip 130 is formed into an elliptical, circular, or otherwise continuous loop-like shape that surrounds the housing 102. One or more radial posts (not shown) are provided between the foregrip 130 and the housing 102 to hold it in place and provide one or more gaps between the foregrip 130 and the housing 102 into which the user may fit his or her fingers or hand.

[0048] The foregrip 130 includes various features to enhance the ergonomics and control of the vacuum cleaner

100. For example, the foregrip 130 shown in FIG. 1 has a continuous loop-like shape that surrounds the vacuum cleaner housing 102, which allows the user to hold the foregrip 130 in virtually any annular location around the housing 102. This provides improved flexibility in handling the device, and allows the user to rotate the housing to point the inlet nozzle 104 horizontally to clean surfaces such as stair treads, vertically to clean surfaces such as stair risers, or at any angle in between. Regardless of which angular position the housing 102 is in, the user can still maintain a firm and comfortable grip on the rear grip 106 and foregrip 130, and thus on the vacuum cleaner 100 as a whole. It will be appreciated from the foregoing that the foregrip 130 of the embodiment of FIG. 1 provides many of the advantages of a rotating inlet nozzle 104 without the need to supply such a feature, but such rotatable inlet nozzle features may still be provided nonetheless.

[0049] Another advantage of the present invention is that the user can apply a bending moment force to the vacuum cleaner housing 102 by pressing in opposite directions on the rear grip 106 and foregrip 130. This bending moment force can be used to apply significant pressure between the inlet nozzle 104 and the surface being cleaned. Such pressure can be helpful to agitate the surface, scrub out deeply-embedded or clinging contaminants and dirt, remove entangled hair and fibers, and so on. In addition, the user can press forward on both grips to press the inlet nozzle 104 against the surface being cleaned, but without moving the inlet nozzle 104. This is not possible with conventional upright vacuums and canister vacuum cleaning heads, except when they are perfectly upright, because they are specifically designed to traverse the floor when they are pressed forward. In view of the foregoing capabilities, the vacuum cleaner 100 should be constructed to be able to resist any anticipated reasonable amount of bending or longitudinal force that may be applied through it during normal use.

[0050] It will also be seen that the foregrip 130 is arranged about the vacuum's longitudinal axis 101, along which a number of the working parts are approximately located. As such, the foregrip 130 should generally surround the device's center of gravity CG, which is likely to be proximal to the longitudinal axis 101. This being the case, as the user rotates the vacuum cleaner 100, the center of gravity CG will remain at generally the same location, causing the general balance of the device to feel the same regardless of its angular orientation. Furthermore, the user will be able to maintain a comfortable hold on the foregrip 130, with his or her hand above or beside the center of gravity CG, regardless of the angular orientation. This prevents adverse situations often encountered in the prior art of upright and stick vacuums when users attempted to orient the inlets of such vacuums vertically. These devices typically had no grip for stair cleaning, or a grip that was located on the front face of the device. When using these devices to clean vertical surfaces, the user was typically required to turn the device over and, if it was then possible, hold the provided grip with the center of gravity balanced above the user's hand, typically leading to an unstable situation. Alternatively, if there was no grip or the grip was blocked with the device turned over, the user would have to attempt to hold the device at a location that was not intended to be a handle, thereby risking damaging or dropping the device and contact with the inlet nozzle.

[0051] While it is likely that users will grasp the foregrip 130 in numerous different places at various times, it is expected that particular parts of the foregrip 130 will be preferred by many users for a large number of cleaning tasks. For example, it is currently believed that many users will prefer to hold the foregrip 130 generally along the side of the housing 102 for most stair cleaning tasks. This would correspond to about the one- to five-o'clock position on the foregrip 130 (as viewed along the longitudinal axis 101 from the rear grip 106) for users that place the right hand forward, and about the seven- to eleven-o'clock position on the foregrip 130 for users that place the right hand forward. When the user rotates the device to orient the inlet nozzle 104 to face stair risers, the user is expected to prefer to hold the foregrip 130 about 90 degrees from the original hand grip position, and perhaps as far as the opposite side of the housing. The user also may wish to hold the foregrip 130 with both hands on both sides of the housing 102 during either horizontal or vertical cleaning, depending on the distance to the surface being cleaned and other factors.

[0052] In view of the foregoing, the housing 102 is preferably provided with depressions 134 radially inward of the foregrip 130 at these expected preferred locations. The depressions 134 increase the size of the gap between the housing 102 and the foregrip 130, thereby making it easier for the user to secure a hold at the expected preferred locations. The use of such depressions also allows a more compact foregrip 130, particularly if there is no substantial detriment to the user's ability to grasp the foregrip 130 at locations other than the depressions 134.

[0053] As shown in the embodiment of FIG. 1, it is currently preferred to provide a first depression 134 radially inward from the foregrip 130 on one side of the housing 103, and a second depression 134 radially inward from the foregrip 130 on the other side of the housing 103. In a preferred embodiment, the first depression's center point with respect to its annular extent around the circumference of the housing 102 is located, as viewed along the longitudinal axis 101, at about one- to five-o'clock, and more preferably at about two- to four-o'clock. In this embodiment, the second depression's center point is at about seven- to eleven-o'clock, and more preferably at about eight- to ten-o'clock. Of course, more or fewer depressions may be used, they may be located at different positions (such as at about twelve-o'clock and/or six-o'clock), or they may be omitted entirely.

[0054] It has been found that the position of the foregrip 130 along the longitudinal axis 101 of the vacuum cleaner 100 is also a factor to consider in providing a highly-ergonomic stair cleaning vacuum cleaner. It is preferred to locate the foregrip 130 at a point along the longitudinal axis 101 that allows the user to comfortably grasp both grips and operate the vacuum cleaner 100. In operation, the user is likely to grasp the rear grip 106 with one hand, and the foregrip 130 with the other hand, and move the inlet nozzle 104 in a sweeping action across surfaces being cleaned. If the distance between the grips is too great, the user might find it difficult to grasp both grips at the same time while still being able to easily maneuver the device. If the distance between the foregrip 130 and the inlet nozzle 104 is too small, the user may have to bend over a significant distance

to apply the inlet nozzle 104 to the surface being cleaned. These are both typical drawbacks of many conventional upright vacuum cleaners.

[0055] Considering the general build of many users, in one embodiment, the distance between the grips is about six to thirty inches. In a more preferred embodiment, the foregrip 130 is spaced from the most distant graspable portion of the rear grip 106 by about eight to twenty-four inches. These distances are expected to allow the user to comfortably grasp both grips and operate the vacuum cleaner 100 at about a 30 to 60 degree angle on the surface being cleaned, while remaining in a generally upright, comfortable standing position.

[0056] To further add to the ergonomics, it is preferred to locate the center of gravity CG between the foregrip 130 and rear grip 106. Doing so should reduce fatigue by distributing the weight between the user's hands, and improve the ease with which the user can rotate and swing the device. The position of the center of gravity CG can be adjusted when designing the device by selectively positioning the various working parts along the length of the vacuum cleaner 100, adding ballast, removing excess weight, and by other methods understood by those of ordinary skill in the art.

[0057] Referring now to FIGS. 2A through 2D, another embodiment of the present invention is disclosed to illustrate various additional features of the invention. As shown in FIG. 2A, this embodiment comprises a vacuum cleaner 200 having an elongated housing 202, and inlet nozzle 204, a rear grip 206, and a foregrip 230. The housing 202 includes a fan/motor chamber 209, with a fan/motor 207 (FIGS. 2A-2D) therein. The fan/motor chamber 209 is located between the grips, and the housing 202 includes a number of outlet apertures 210 to exhaust the working airflow from the fan/motor chamber 209 to the atmosphere. These apertures 210 are shown on the top surface of the device, but any other suitable location could be used. Of course, a filter may be provided between the outlet apertures 210 and the fan/motor 207. Like the embodiment of FIG. 1, the foregrip 230 is attached to the housing by a number of radial posts 236, and depressions 234 are provided to facilitate grasping the foregrip 230. A power switch (not shown) may be provided in any suitable location, and suitable power supply means, such as a power cord or batteries, are also be provided, as known in the art.

[0058] In this embodiment, the inlet nozzle 204 is attached to the housing 202 by a structural portion 238 of the housing 202. In light of the fact that the grips can be used to generate a significant bending moment within the housing 202, this structural portion is preferably constructed to resist such forces. In addition, this structural portion 238 preferably is formed to provide a dirt receptacle pocket 240 located adjacent the fan/motor chamber 209. An inlet air passage 242 (FIGS. 2B-2D) joins the inlet nozzle 204 to the pocket 240, either by entering through the bottom of the pocket, as in the variations of FIGS. 2B and 2C, or through the side, as in FIG. 2D. The pocket also includes a fan/motor inlet opening 244 that leads to the fan inlet.

[0059] The vacuum cleaner 200 also includes a dirt receptacle 214, which is shaped and sized to be selectively positionable in the pocket 240. As best shown in FIGS. 2A to 2D, the dirt receptacle 214 is retained in the pocket 240 by fitting into a lip 246 at the end adjacent the inlet nozzle

204, and by a slideable tab 248 at the end adjacent the fan/motor chamber 209. A button 250 is provided to actuate the tab 248 and slide it out of engagement with the dirt receptacle 214 when it is desired to remove the dirt receptacle 214. A spring (not shown) is also provided to bias the tab 248 into engagement with the dirt receptacle 214 when the button 250 is not being actuated. Of course, any other retention mechanism(s) may alternatively be used to hold the dirt receptacle 214 in the housing 202, as will be appreciated by those of ordinary skill in the art.

[0060] The present invention may be used with any type of dirt separation system using any theory of operation. Thus, it is envisioned that various different types of dirt receptacle 214 may be used, and may be interchangeable with one another to provide the user with various cleaning options. Three examples are shown in the embodiment of FIGS. 2A to 2D and described below.

[0061] In a first embodiment, shown most specifically in FIG. 2B, the vacuum cleaner 200 employs a filter bag 252 to remove dirt from the working air flow. In this embodiment, the dirt receptacle 214 has an opening 254 through its bottom wall to the filter bag 252 opening attaches. The filter bag 252 is held in place by a flange 256 attached around its opening, and this flange 256 may be held in place by a friction fit, mechanical fasteners, being captured in place, or by any other means, as known in the art. The dirt receptacle 214 may include ribs 258 to hold the filter bag 252 away from the interior walls and allow air to flow evenly through the filter bag 252. To this end, similar ribs 260 may also be located on a lid over the end of the dirt receptacle 214, or on a wall of the housing 202 that faces into the dirt receptacle 214.

[0062] In the embodiment of FIG. 2B, the fan/motor 207 generates a working air flow that enters the filter bag 252 from the inlet air passage 242. The working air passes through the walls of the filter bag 252 to remove particles, passes into the fan/motor 207, and exits the vacuum cleaner 200 through the exhaust apertures 210.

[0063] Referring now to FIG. 2C, in another embodiment, the dirt receptacle 214 comprises a dirt cup that captures dirt passing therethrough using a non-bag filter. In this embodiment a filter 262 is positioned in the top of the dirt receptacle to filter air passing therethrough. Suitable ridges 264 or other features hold the filter 262 in place. The filter 262 is shown as a simple pleated filter having a planar shape, but may have a conical shape, cylindrical shape, or any other useful shape. As noted previously herein, any type of filter having any filter grade may be used. In addition, a number of different filters may be used, such as a pleated HEPA filter with a relatively coarse screen located upstream to block larger particles from occluding the HEPA filter. Other variations will be apparent to those of ordinary skill in the art.

[0064] In this embodiment, air enters the dirt receptacle 214 from the inlet air passage 242 through an opening 266 in the bottom wall. The opening 266 may somewhat extended in the shape of a pipe to provide an area into which dirt particles can fall without exiting the opening when the fan/motor is turned off. In addition a one-way flap valve 268 may be located at the top of the opening to prevent dirt from flowing back therethrough. Such a flap valve may also be provided with the other embodiments described herein.

[0065] Referring now to FIG. 2D, in still another embodiment, the dirt receptacle 214 comprises a cyclone separation

chamber in which the working airflow is swirled to remove dirt and dust by centrifugal or cyclonic action. In this embodiment, the inlet air passage 242 may be provided through the structural portion 238 of the housing 202 and terminate at or near the top of the dirt receptacle 214. Also in this embodiment, the inlet air passage 242 enters or terminates at an inlet port 270 through the dirt receptacle sidewall in a tangential or nearly tangential manner, which initiates a cyclonic flow therein. A frusto-conical filter 272 is located over the fan/motor inlet opening 244 to prevent dirt and debris that is not separated by cyclonic action from entering the fan/motor 207. As before, any alternative filter shape, material, construction or filtration grade may be used, and multiple filter layers may also be used, as known in the art.

[0066] Of course, alternative means for initiating cyclonic airflow may be used with the embodiment of FIG. 2D. For example, the inlet air passage 242 may be generally perpendicular to the inlet port 270, and a diverting member may be included to initiate tangential airflow. The inlet air passage 242 may also be through the bottom wall of the dirt receptacle 214 and include a diverter to initiate cyclonic action. Other variations are also possible, as known by those of ordinary skill in the art.

[0067] The variations of FIGS. 2B to 2D are exemplary, and any other suitable variations to the foregoing embodiments may be practiced with the present invention. For example, the pocket 240 may be omitted, in which case the dirt receptacle would be carried externally to the housing 202 and connected by suitable air conduits to the inlet nozzle 204 and fan/motor 207. Also, the dirt receptacle 214 may be covered by an access panel or door. The dirt receptacle 214 may also be omitted and replaced by a non-removable chamber within the housing. In this variation, the chamber may be selectively covered by a door or the like to facilitate the chamber's emptying. This variation is particularly suited for use with a filter bag, but may be used with other types of dirt separators. Other variations will be apparent to those of ordinary skill in the art in view of the present disclosure and with routine experimentation with the invention. In addition, various additional features may be provided with the dirt receptacle 214, such as gaskets, lids, and so on.

[0068] While the embodiments disclosed thus far have illustrated a looped rear grip and a looped foregrip, these constructions are not strictly required. In other embodiments, the loop-shaped grips may be flattened on one side, or may have rectilinear shapes. In still other embodiments, the loop-shaped grips may be replaced by any combination of rear grip and foregrip that provide the user with hand positions to ergonomically maneuver the device and rotate it into different positions for cleaning horizontal and inclined surfaces. The looped foregrip may also be replaced by a grip having a single hand position that is suited to conveniently apply, in conjunction with the rear grip, a bending moment on the vacuum cleaner housing. The looped foregrip may also be formed as a partial loop to provide multiple hand positions around a portion of the vacuum cleaner housing, or separated into multiple separate grips located around the housing.

[0069] One exemplary variation of the grip construction is shown in FIG. 3. In this embodiment, the vacuum cleaner 300 comprises a rear grip 306 having a more conventional

straight shape, and the foregrip comprises two separate straight grips **330** that extend generally radially from the vacuum cleaner housing **302** at a location adjacent or just forward of the fan/motor chamber **309**. A similar variation is shown in FIG. **4**, in which the vacuum cleaner **400** includes a pistol-grip style rear grip **406**, and pistol-grip style foregrips **430** (only one of which is visible). In either of these embodiments, it may be desirable to construct the foregrips **330**, **430** such that they can be removed and inserted in various different locations on the housing. The foregrips **330**, **430** also may be provided with joints or pivots to allow them to be articulated into more desirable positions. In still other variations, the foregrips **330**, **430** may be formed as extensions of the housing **302**, **402**, or as graspable depressions or openings in the housing **302**, **402**. While the variations of FIGS. **3** and **4** do not allow unlimited hand positions on the foregrip, they still allow greater flexibility and control than grips on conventional vacuum cleaners.

[0070] Referring now to FIG. **5**, another embodiment of the invention is illustrated and described in detail. In this embodiment, the invention comprises a vacuum cleaner **500**, having a generally cylindrical housing **502** with a circular or looped rear grip **506**, and a circular or looped foregrip **530**. Of course, other grip shapes may be used, as explained previously herein. Like the embodiment of FIG. **1**, a protrusion **528** extends into the rear grip **506**, and a power switch **529** is located on the protrusion **528** to provide quick and efficient activation and deactivation of the device. The foregrip **530** is attached to the housing **502** by a number of radially-extending posts **536**.

[0071] The foregrip **530** surrounds a fan/motor chamber **509** in which the fan/motor **507** is located. The impeller fan **507'** is adjacent the bottom end of the housing **502**, and the motor **507''** located between the fan **507'** and the rear grip **506**. If motor cooling is required, the motor **507''** may be cooled by the working airflow after it is cleaned by the filtration system, by a separate flow of air, or by simple ventilation. In the embodiment of FIG. **5**, the housing includes a number of vents **540** for allowing air to pass through the housing **502** to cool the motor **507''**. A foam ring **542** may also be provided to prevent particles from the motor from exiting the vents **540** and obstruct the user's view into the fan/motor chamber **509**.

[0072] The housing **502** also includes a number exhaust apertures **510** for releasing the working air flow to the atmosphere after it is cleaned by the vacuum cleaner **500**. The apertures **510** are arranged in an annular pattern around the fan **507'**, but may be in other locations. A post-motor filter **512** may also be provided to further filter the air as it exits the device.

[0073] The motor **507''** is powered by a plurality of batteries **534**, which are arranged in an annular fashion around the motor **507''**. Of course, other locations for the batteries **534** are possible, such as in the grips or in the portion of the housing **502** between the fan/motor chamber **509** and the rear grip **506**. Power may also be provided by a conventional power cord. In battery-operated embodiments, the vacuum **500** may have exposed or exposable electrical connectors **538** that are adapted to fit in a corresponding charger. For example, in the shown embodiment, electrical connectors **538** are provided at the top of the rear grip **506**, and the vacuum is provided with a charger (not

shown) upon which the vacuum **500** is hung by the rear grip **506** in a vertical orientation to both store the device, and recharge the batteries **534**.

[0074] A cylindrical dirt receptacle **514** is removably attached at a bottom end of the housing **502** adjacent the fan/motor chamber **509**. In this embodiment, the housing **502** terminates at the dirt receptacle **514**, and therefore the dirt receptacle **514** is constructed as a structural member of the vacuum cleaner **500** that can convey bending moments and longitudinal loads from the grips **506**, **530** to the inlet nozzle **504**. A set of over-center clamps **548** are used to hold the dirt receptacle **514** and housing **502** together, but bayonet fittings, threaded fitment, tabs and slots, screws, or other fasteners may alternatively be used. While the foregoing construction is preferred in this embodiment, other variations may be used. In one variation, the dirt receptacle **514** may be removably attached in pocket formed in a structural portion of the housing that extends to the inlet nozzle **504**, as in the previous embodiments. In another variation, the dirt receptacle **514**, or at least a portion of it, may be permanently attached to the housing **502**, and only the bottom end of it is removable from the device, along with the inlet nozzle **504**. For example, the bottom wall **522** may be removably attached to the sidewalls **516** by threaded engagement, bayonet fittings, clamps, screws, or the like.

[0075] A filter **520** is provided in or above the dirt receptacle **514**, and attached by any suitable means to the housing **502**, the dirt receptacle **514**, or both. In the shown embodiment, the filter **520** comprises a coarse perforated shroud **520'** that acts as a preliminary filter, and a pleated fine filter **520''** that acts as a fine particle filter. Of course, other filter arrangements may be used, as explained previously herein. For example, in one alternative variation, the coarse perforated shroud may be replaced by a cage-like structure having a filter material positioned across the cage openings. Suitable materials include metal screens, fabric meshes made from woven materials or formed from spun-bonded or meltblown synthetic fibrous materials, and the like. The filter **520** may also include a self-cleaning feature, such as a scraper or other device, to remove dirt from its outer surface between or during use.

[0076] The nozzle inlet **504** of the embodiment of FIG. **5** comprises an entry tube **524** that passes through the dirt receptacle bottom wall **522**. It will be appreciated that any type of cleaning device may be attached to the entry tube **524**, such as an elongated cleaning head as shown in the previous embodiments, a crevice tool, a dusting attachment, a so-called powerhead having a rotating agitator, and so on. Of course, if a powered attachment is provided, suitable power leads can be provided to connect the powered attachment to the electric circuit. These leads may pass around or through the dirt receptacle, or may be integrated into the dirt receptacle body.

[0077] Located inside the entry tube **524** is a helical ramp **526**. The helical ramp **526** extends radially inward from the entry tube's inner wall, and may terminate short of the entry tube's centerline, as shown, to allow an unobstructed central path through the entry tube **524**, or may extend to the centerline (or beyond) to block any direct flow of air through the entry tube **524**. A one-way flap valve **532** made of a flexible material, such as are known in the art, is provided at the end of the entry tube **524** to prevent reverse flow of dirt

out of the dirt receptacle **514**. It has been found that the use of the foregoing helical ramp **524** is sufficient to establish a cyclonic airflow pattern within the dirt receptacle **514**, despite the presence of the flap valve **532**.

[0078] While the foregoing cyclonic arrangement for the dirt receptacle **514** is preferred, other types of dirt separation system may alternatively be used, as will be appreciated by those of ordinary skill in the art in view of the present disclosure.

[0079] Referring now to FIGS. **6** through **8**, as previously mentioned herein, the rear grip and/or foregrip may be pivotable or otherwise articulated to provide even greater ergonomic flexibility and control of the device. Various non-limiting examples of such movable grips will now be described in detail.

[0080] Referring specifically to FIG. **6**, there is illustrated another embodiment of a vacuum cleaner **600**, similar to the embodiment of FIG. **5**, having a pivotable rear grip **606**, and a rotatable foregrip **630**. In this embodiment, the rear grip **606** is attached to the housing **602** by a pivoting joint **610**. To form this pivoting joint **610** the rear grip **606** is attached to a post **612**, which fits into a corresponding opening **613** at the rear of the housing **602**. The opening **613** includes a radial track **614** into which a corresponding annular wall **616** on the post **612** fits. This arrangement allows the parts to pivot relative to one another, but fixes them in the linear direction to prevent their removal. Suitable travel stops (not shown) may be provided to prevent excessive relative rotation, and a locking mechanism (not shown) may also be provided to hold the parts in a particular desired relative angular orientation.

[0081] The foregrip **630** of the embodiment of FIG. **6** is also rotatable about the vacuum cleaner housing **602**. In this embodiment, the foregrip is attached to the housing **602** by a number of radially-extending posts **618**, which terminate at their inner radial extents at a ring **620**. The ring **620** is captured within a track **622** in the housing **602**, in which it is free to rotate. Travel stops or a lock may be provided to prevent excessive rotation or selectively prevent any rotation. Bearings or low-friction sliding surfaces may be provided in either the foregrip rotating arrangement or the rear grip pivoting arrangement to facilitate movement between the parts. Of course, other mechanisms for providing relative rotation between the rear grip **606** and/or the foregrip **630** and the housing **602** may be used instead.

[0082] The pivoting arrangements of FIG. **6** are expected to provide a particular advantage in that they allow the user to hold one grip and rotate the entire vacuum cleaner **600** with the other grip. For example, if the foregrip rotating mechanism is provided, the user can hold the foregrip **630** in generally a single position, and rotate the entire device by twisting the rear grip **606**. Similarly, if the rear grip rotation feature is provided, the user can hold the rear grip **606** in generally one position, and rotate the entire vacuum cleaner **600** by manipulating the foregrip **630** much like an automobile steering wheel. While foregrip and rear grip rotating mechanisms such as those shown in FIG. **6**, may both be provided with embodiments of the invention, it is expected that it would only be necessary to provide one of these features to obtain these additional benefits of having rotating grip.

[0083] It may also be desirable to allow the user to adjust the distance between the rear grip and the foregrip. To this

end, another embodiment of the invention, shown in FIG. **7**, provides a vacuum cleaner **700** having a housing **702**, a rear grip **706**, a foregrip **730**, and other features as described elsewhere herein. In this embodiment, the foregrip **730** is attached to a ring **720** by a number of radial posts **718**, and the ring **720** surrounds the cylindrical outer surface of the housing **702**. The ring **720** is sized such that it can slide along the length of the housing **702**, but is provided with a locking device that can be used to hold the ring **720**, and thus the foregrip **730**, in various axial positions along the length of the housing **702**.

[0084] In the embodiment of FIG. **7**, the foregrip locking device is a locking ring **722** with a gap **724** spanned by a tightening cam mechanism **726**. The cam mechanism **726** comprises flanges **728** that extend radially outward from the locking ring **722** on either side of the gap **724**. A bolt **738** passes through both flanges **728**, and is retained by its head **732** in one of the flanges **728**. The other end of the bolt **738** is pivotally attached to a cam-shaped lobe **734** having a lever arm **736** attached thereto. When the lever arm **736** is used to rotate the cam-shaped lobe **734**, pivot point between the lobe **734** and the bolt **738** moves towards or away from the flange **728**. This closes the gap **724** and compresses the locking ring **722** to hold it in place, or vice versa. The locking ring **722** surrounds the foregrip ring **720**, and thus, when it is locked in place, so too is the foregrip **730**. Another advantage of this embodiment is that the ring **720** and foregrip **730** may be rotated about the housing **702** when the locking ring **722** is loosened. Of course, any other suitable locking mechanism, such as pins, set screws, and so on, could be used instead.

[0085] Referring now to FIG. **8**, another example of a rotating grip assembly is provided. In this embodiment, the foregrip **830** comprises a loop-like device that is attached to the housing **802** of a vacuum cleaner **800**, much like in the embodiments of FIGS. **1** and **2**. The foregrip **830** of this embodiment is pivotable about an axis generally perpendicular to the longitudinal axis **801** of the vacuum **800**. This perpendicular axis extends orthogonal to the page in the view of FIG. **8**. The foregrip **830** is movable between two positions: an operating position, designated by reference numeral A, and a collapsed position, designated by reference numeral B. Of course, intermediate or other positions may also be provided. In the operating position A, the foregrip **830** is in position to be grasped by a user as explained previously herein. In the collapsed position B, the foregrip lies at or near the surface of the housing **802**, making the vacuum cleaner **800** more compact, and allowing it to rest more flatly against a wall **804** or other flat surface.

[0086] The inventors have found that the overall length of the vacuum cleaner of the present invention can be established to better suit it for cleaning in stairwells, closets, and other elevated and/or confined spaces. Typical vacuum cleaners are intended, as their primary use, to clean floors. As such, they include ergonomic features directed towards cleaning floors, such as a relatively long handle that prevents the user from having to stoop during normal operations of the device. However, when users clean stairs, they often clean from the bottom up, and stand on a low step to clean higher steps. As such, the distance and angle to the surface being cleaned is different when cleaning stairs than it is when cleaning floors, and users often find conventional vacuums to be too long and cumbersome to use for stair cleaning. Handheld vacuums have been used as a substitute

for upright, stick and canister vacuums for cleaning stairs and confined spaces, but such vacuums require the user to stoop, if not kneel, to clean. In addition, some canister vacuum extension wands have adjustable lengths, but they still do not overcome the various other problems with canisters when cleaning stairs, such as the risk of the canister falling. In still other cases, upright vacuums having telescoping or collapsible handles have been provided, but these devices are still difficult to use on stairs because they typically have a conventional single-grip design that makes it difficult to address relatively high stairs, or use a pivoting base that is not particularly suited for cleaning stair risers. Even when such upright vacuums are provided with a second grip to assist with stair cleaning, it is often so close to the base that the user still must stoop to clean the stairs.

[0087] Embodiments of the present invention address these shortcomings by providing a relatively compact vacuum cleaner that is long enough to allow typical users to clean elevated stairs without excessive stooping, yet short enough to still provide ergonomic grip and control of the device, and the ability to maneuver in tight spaces, such as enclosed stairwells. As an ancillary benefit, this length may also prove to be better adapted for cleaning in confined spaces, such as closets. In a preferred embodiment, the vacuum cleaner of the present invention has an overall length of about 18 to 46 inches, and more preferably about 20 to 24 inches. In another preferred embodiment, the distance between the foregrip and the inlet nozzle is about 12 to 18 inches, and more preferably about 14 to 16 inches.

[0088] While the foregoing lengths are preferred, it may be desirable in some instances to make the vacuum cleaner longer or shorter. To obtain the benefits of the foregoing lengths yet still provide even greater ergonomics and control, embodiments of the present invention may include one or more telescoping sections. Referring now to FIGS. 9A to 9C one such embodiment is illustrated and described in detail.

[0089] FIGS. 9A and 9B illustrate a telescoping vacuum cleaner 900 in the fully-retracted and fully-extended positions, respectively. The vacuum cleaner 900 comprises a housing 902, a rear grip 906, a foregrip 930, and an inlet nozzle 904, as described elsewhere herein. The rear grip 906 and inlet nozzle 904 are telescopically attached to the housing 902, but in other embodiments only one telescoping part may be provided.

[0090] The telescoping mechanism for the rear grip 906 comprises a post 910 attached to the top end of the housing 902, and a sleeve 912 attached to the rear grip 906. The post 910 preferably is hollow to route wires 940 from the power switch 942 to the housing 902, but the power switch 942 may instead be located on the housing 902, or telescoping power leads, such as shown in U.S. Pat. No. 6,148,474 may be used. This patent is incorporated herein by reference.

[0091] A lock 914 is provided between the post 910 and the sleeve 912 to selectively prevent and allow the sleeve to slide along the post. While any telescoping lock mechanism may be used, a preferred embodiment of the lock is shown in FIG. 8C. The lock 814 comprises a pair of rollers 916 that are captured in place in openings 918 in the sleeve 912. These rollers fit into corresponding detents 920 on the post 910, and are held in place by a slider 922. In the shown position, the slider 922 holds the rollers 916 in the detents

920, thereby preventing relative movement between the sleeve 912 and post 910. When it is desired to unlock the sleeve 912 from the post 910, the slider is pressed downward against a spring 924 until the rollers 916 are free to move into a pair of recesses 926 in the slider 922, and out of the detents 920. With the rollers 916 out of the way, the sleeve 912 is free to slide along the post 910, thus allowing telescopic movement of the rear grip 906. Any means may be used to actuate the slider 922, such as a simple tab 928 that protrudes from the sleeve 912.

[0092] The inlet nozzle 904 is attached by a similar post 932, sleeve 934, and lock 936. In the case of the inlet nozzle 904, the post 932 preferably is a hollow tube that also forms a portion of the inlet air flow path 938 from the inlet nozzle 904 to the dirt receptacle (not shown). However, in an alternative embodiment, the inlet air flow path is instead formed by a flexible hose or a separate rigid telescoping tube. If it is desired to include a brushroll or other electrically-operated devices in the inlet nozzle 904, suitable telescoping electrical leads may be used in conjunction with the telescoping mechanism, wires may be provided outside the telescoping mechanism, or wires may be provided through the post 932 and sleeve 934 or a separate telescoping channel.

[0093] The foregoing telescoping arrangement allows several inches of extension at each end of the vacuum cleaner 900, which can effectively convert it from a configuration adapted to clean raised surfaces such as stairs, to a more conventional upright or stick vacuum configuration adapted to clean floors. An overall extension of about 14 to 20 inches is preferred to effectuate this conversion. As noted before, while both the rear grip 906 and inlet nozzle 904 are shown as being mounted in a telescoping manner, the desired telescoping capability may instead be provided by mounting just one of these parts on a telescoping mount.

[0094] As shown in the embodiment of FIGS. 9A to 9C, the posts 910, 932 are attached to the housing 902, and the sleeves 912, 934 are attached to the part that is telescoped away from the housing 902. This configuration is preferred, as it allows the user to grasp the housing 902 in one hand, and grasp the inlet nozzle 904 or rear grip 906 in the other hand while simultaneously activating the respective lock 914, 936, and pull the parts apart to telescope them. The foregrip 930 provides a convenient hand hold on the housing 902 during this action. Alternatively, however, the posts 910, 912 may instead be attached to the rear grip 906 and inlet nozzle 904, respectively, the sleeves 912, 934 attached to the housing 902.

[0095] Turning now to FIG. 10, another embodiment of the invention is illustrated and described. It has been found that the particular task of cleaning stairs often requires the user to stop the vacuuming process, relocated or reorient the vacuum cleaner, and then resume vacuuming. Using conventional vacuum cleaners, the users usually leave the vacuum fan running throughout this process because, for example, the power switch is remotely located (as in many canisters), not easily activated by hand (as with many upright vacuums with foot-operated power switches), or not within reach without letting go of the vacuum cleaner with one hand. As a result of this tendency to keep the vacuum motor running at all times, the stair cleaning process increases the risk of injury, and requires greater energy

consumption. This excess power consumption is particularly an issue for cordless vacuum cleaners because it leads to shortened battery life.

[0096] In view of the foregoing, the present invention may also include a power trigger **1008** located in the rear grip **1006** proximal to the expected hand location of a typical user. The power trigger **1008** comprises a momentary-on switch that completes the electrical circuit to activate the fan/motor (not shown) when it is depressed, but interrupts the circuit when it is released, thus allowing the user to deactivate the device between cleaning motions and conserve battery power. While the momentary on switch is preferred, other switch types may be used instead, such as a simple on-off switch (one having an on position and an off position), or a push switch (one that turns the circuit on an off with successive depressions).

[0097] In the embodiment of FIG. 10, the power trigger **1008** is mounted in the rear grip **1006** at approximately the end of the vacuum cleaner. In this position, it may be activated by simply squeezing the rear grip **1006**, regardless of whether the vacuum cleaner is positioned for cleaning horizontal surfaces or rotated 180 degrees for cleaning vertical surfaces. The power trigger **1008** is generally contained within the rear grip **1006**, and may be covered by an overmolded flexible cover **1012**. This cover **1012** may comprise a tacky material or otherwise have enhancing features, such as dimples **1014**. Markings may be embossed or printed on the cover **1012** or elsewhere on the rear grip **1006** to alert the user to the presence of the power trigger **1008**.

[0098] In the embodiment of FIG. 10, the power trigger **1008** is wired into an electrical circuit with a main power switch **1010**. The main power switch **1010** is shown mounted on a protrusion **1016** that extends into the loop formed by the rear grip **1006**, but other locations may be used. In this embodiment, the main power lead **1018** from the power source (not shown) is attached to the first pole of the main power switch **1010**. A second wire **1020** extends between the second pole of the main power switch **1010** and the first pole of the power trigger **1008**. A third wire **1022** attaches the second pole of the power trigger **1008** to the remainder of the electrical circuit. In this configuration, the power trigger **1008** will only activate the device when the main power switch **1010** is on, thereby reducing the likelihood of accidental activation, and providing a backup switch to turn the device off if one switch fails.

[0099] It will be appreciated that numerous variations on this design are possible. For example, the power trigger **1008** may be located elsewhere than the rear grip **1006**, and even in the foregrip (not shown), if so desired. The vacuum cleaner may also include multiple power triggers **1008** that must be activated in unison to start the fan/motor. For example, one power trigger may be located in the rear grip **1006**, and another in the foregrip, which would ensure that the operator has a firm grip on the device before beginning use. Still further, the vacuum cleaner may have multiple power triggers that separately control the fan/motor, which would provide the user with various optional hand locations in which to activate the device.

[0100] The present invention also provides a number of inlet nozzles having particular suitability for cleaning stairs or other surfaces, and which may be used with other

embodiments of the invention or with conventional vacuum cleaning devices. Embodiments of these inlet nozzles are shown in FIGS. 11 to 13.

[0101] Referring to FIG. 11, a first embodiment of an inlet nozzle **1100** comprises a brushroll chamber **1102** having a downwardly facing opening **1104** in which a rotatable brushroll **1106** is located. The brushroll **1106** comprises any rotating agitator design, such as a cylindrical spindle **1108** with a number of cleaning bristles **1110** extending radially therefrom. The brushroll **1106** is mounted to the inlet nozzle **1100** by bearings **1112** or journals. A motor **1114** is mounted in the inlet nozzle **1100** to drive the brushroll **1106** through a belt **1116**.

[0102] The inlet nozzle **1100** also includes one or more angled cleaning spinners **1118**, which are mounted to rotate about one or more axes that are tilted with respect to the rotary axis of the brushroll **1106**. In the shown embodiment, two angled cleaning spinners **1118** are provided, one on each end of the brushroll **1106**. Each spinner **1118** includes a set of radially-extending cleaning bristles **1120**. The spinners **1118** are inclined at about 45 degrees with respect to the brushroll axis, and each is mounted to the brushroll chamber **1102** by a bearing **1122**. Each spinner **1118** includes a gear **1124**, which is driven by a corresponding gear **1126** on each end of the brushroll **1106**. Alternatively, the gears **1124**, **1126** may be replaced by rubber or other surfaces that drive one another by friction, the spinners **1118** may have their own motors and/or belt drives, or the spinners **1118** may be otherwise driven.

[0103] The inlet nozzle **1100** includes a vacuum tube **1128** that may be attached to a vacuum source. The vacuum tube enters the brushroll chamber **1102** at an inlet opening **1130**. In use, the inlet nozzle **1100** of FIG. 11 is applied to stair treads and risers such that the brushroll **1106** cleans the main surfaces, and the spinners **1118** reach into the tight space at the junction between the treads and risers. The working air flows into the opening **1104**, past the brushroll **1106** and spinners **1118**, and into the inlet opening **1130** to be cleaned by the attached vacuum cleaner.

[0104] Another embodiment of an inlet nozzle of the present invention is shown in FIGS. 12A and 12B. FIG. 12A is a cut away side view of an inlet nozzle **1200** shown along reference line II-II of FIG. 12B, and FIG. 12B is a cut away front view of the inlet nozzle **1200** shown along reference line I-I. According to this embodiment, the inlet nozzle **1200** comprises a tubular grip **1202** having a vacuum passage **1204** extending therethrough. The grip **1202** terminates at one end at an opening **1206** for attaching to a vacuum cleaner, and at the other end to a cleaning head **1208**.

[0105] The cleaning head **1208** is mounted to a boss **1210** located at the end of the grip **1202**. The boss **1210** has a cylindrical exterior profile, with a portion of the profile being removed to form a boss opening **1228** that opens into the vacuum passage **1204**. The cleaning head **1208** is retained in the axial direction between two flanges **1212** and **1214**. As such, the cleaning head **1208** can be rotated about the boss **1214**, but the flanges **1212** and **1214** prevent axial movement or inadvertent removal of the cleaning head **1208**.

[0106] The cleaning head **1208** comprises two generally parallel trapezoidal plates **1216** and **1218** that are held

together by sidewalls **1220** and/or interior walls **1222**. The sidewalls **1220** and interior walls **1222** are positioned and shaped to form a first nozzle opening **1224** at one end of the cleaning head **1208**, and a second nozzle opening **1226** at the opposite end of the cleaning head **1208**. Each nozzle opening **1224**, **1226** comprises an air passage, formed between the plates **1216**, **1218** and interior walls **1222**, that leads to the rotational center of the cleaning head **1208**. As such, the first and second nozzle openings **1224**, **1226** can be selectively placed in communication with the vacuum passage **1204** by rotating the cleaning head **1208** to align the desired nozzle opening air passage with the boss opening **1228**.

[0107] As best shown in FIG. **12B**, in a preferred embodiment, the first nozzle opening **1224** comprises a relatively small opening formed by generally converging sidewalls **1220**. This nozzle opening is suited to cleaning in tight spaces, such as the junction between stair risers and stair treads. The second nozzle opening **1226** is wider and flat, and is more suited to cleaning larger areas. While these two nozzle opening shapes are preferred, it will be appreciated that other shapes may be provided, and more nozzle openings may be formed in the cleaning head. For example, the first nozzle opening **1224** may be more pointed, rather than being rounded, or the plates **1216**, **1218** may be formed as curved surfaces, rather than being flat.

[0108] Referring now to FIG. **13**, still another inlet nozzle **1300** of the present invention comprises a cleaning head **1302** that is pivotally attached to a vacuum tube **1304** by a ball-and-socket joint **1306**. In this embodiment, the cleaning head **1302** comprises a generally rectangular body having a number of cleaning bristles **1308** extending downwardly from the outer perimeter of the head **1302**. A number of wheels **1310** or skids (not shown) may be provided to prevent the cleaning head **1302** from coming into direct contact with the surface being cleaned.

[0109] The ball-and-socket joint **1306** is formed by a generally spherical end portion **1312** of the vacuum tube **1304**, which is contained within a generally spherical socket formed between a boss **1314** on the cleaning head **1302**, and a cap ring **1316** that is removably attached to the boss **1314** to capture the spherical end portion **1312** in place. The cap ring **1316** may be attached in any manner, such as by threaded fasteners **1318** that pass through the cap ring **1316** and engage threaded holes (not shown) in the boss **1314**. Using this construction, the vacuum tube **1304** can be rotated relative to the cleaning head **1302** in any direction until the vacuum tube **1304** contacts the cap ring **1316**. If desired, one or more springs may be provided to bias the cleaning head **1302** into a particular position, or travel stops may be provided to limit rotation in certain directions.

[0110] A final embodiment of the invention is shown in FIGS. **14A** and **14B**. This embodiment comprises a hybrid stair cleaning nozzle/vacuum cleaner **1400** that is particularly suited for cleaning stair treads and risers. The vacuum cleaner **1400** generally comprises a downwardly directed floor nozzle **1402** having one or more brushrolls **1404** rotatably disposed therein. A motor **1406** and belt **1408** are provided to drive the brushrolls **1404**. The floor nozzle **1402** is attached to a vacuum housing **1410** in which a dustcup **1412** and a fan/motor **1414** are located. A rigid connection may be provided between the floor nozzle **1402** and the housing **1410**, but it is preferred to use a flexible or pivotable

connection, such as the shown bellows-type connection **1418**. Any type of dust separator, such as a dust bag or cyclone, may be used. In the embodiment of FIGS. **14A** and **14B**, the dustcup **1412** has a generally planar filter **1416** to clean the air passing therethrough. One or more air conduits (not shown) pass from the floor nozzle **1402** to the dustcup **1412** to convey dust-laden air thereto.

[0111] A handle **1420** is attached to the top of the housing **1410** for use in guiding the vacuum cleaner **1400** across the floor or on stairs. The use of the bellows connection **1418** or other flexible joint allows the user to hold the device at a variety of angles relative to the floor or stair treads as he or she cleans them.

[0112] The vacuum cleaner **1400** also includes a riser nozzle **1422**, which is attached to the side of the device, preferably at one end of the brushroll **1404**. The riser nozzle comprises a generally vertically-oriented inlet conduit having an inlet opening **1424** facing to the side of the housing **1410**. In this position, the vertical inlet opening **1424** can apply suction to clean stair risers without having to rotate the vacuum cleaner or lift the floor nozzle **1402**. A separate conduit **1426** may lead from the riser nozzle **1422** to the dustcup, or it may share a common conduit or conduits with the floor nozzle **1402**. If desired, the bottom end of the riser nozzle **1422** may include a downward-facing opening **1428**, as shown in FIG. **14A**, to provide crevice cleaning in the corner between stair treads and risers.

[0113] In anticipation that the angle between some stair treads and risers may be less than 90 degrees, the riser nozzle **1422** may be attached to the housing **1410** or floor nozzle **1402** by a pivot or other flexible joint that allows it to tilt towards or away from the housing **1410**. In such a case, the separate air conduit **1426** may be formed by a flexible hose to allow such movement.

[0114] It is also anticipated that it will not be desirable to always apply suction to the riser nozzle **1422**. As such, the riser nozzle **1422** preferably includes a valve to block the vertical inlet opening **1424**, or otherwise impede or stop the flow of working air to the riser nozzle **1422**. For example, as shown most clearly in the inset to FIG. **14B**, in one embodiment the riser nozzle **1422** includes a rotating valve **1430** that can be turned to block the vertical inlet opening **1424**. A knob **1432** is provided on the outside of the riser nozzle **1422** to move the valve **1430** in the directions shown by the two-headed arrow. In a variation of this embodiment, the knob **1432** may be replaced by a lever arm having a spring that biases the lever to place the valve **1430** in the closed position. The lever is positioned outboard of the riser nozzle **1422**, and when the vacuum cleaner **1400** is placed close enough to a stair riser, contact with the riser presses the lever towards the vacuum cleaner **1400** and opens the valve **1430**. This provides automatic operation of the riser nozzle **1422**.

[0115] Various alternatives to the embodiments of FIGS. **14A** and **14B** are envisioned. For example, rather than providing the device as a self-contained vacuum cleaner **1400**, the floor nozzle **1402** and riser nozzle **1422** may be provided as a separate assembly that can be attached to vacuum cleaners of the present invention or to conventional vacuum cleaners. Furthermore, other valves and actuating arrangements, both automatic and manual, may be used instead, as will be appreciated by those of ordinary skill in the art in view of the present disclosure and with routine experimentation with the inventions described herein.

[0116] While the embodiments described herein are preferred, these preferred embodiments are not intended to limit the scope of the invention. Also, many additional variations of the embodiments described herein will be apparent to those of ordinary skill in the art in view of the present disclosure and with practice of the invention. Furthermore, while the foregoing features of the invention, such as the foregrip, cleaning nozzles, and so on, have been described together as contributing to enhanced vacuum cleaner ergonomics and control and improved cleaning of stairs and other elevated or vertical surfaces, it will be appreciated that these features have separate utility and inventiveness on their own, and are not all required to be used together in every embodiment of the invention. As such, the present invention includes embodiments in which the features described herein are used individually or in various other inventive combinations. Such alternative embodiments and combinations of the various features herein are within the scope of the present invention, which is limited only by the appended claims.

We claim:

1. A vacuum cleaner comprising:
 - a generally elongated housing having a first housing end and a second housing end;
 - a rear grip located at the first housing end;
 - an air inlet located at the second housing end;
 - a vacuum fan located within the housing;
 - a motor located within the housing and adapted to drive the vacuum fan to draw a working air flow into the air inlet;
 - a dirt receptacle operatively associated with the housing and adapted to remove particles from the working air flow; and
 - one or more foregrips located on the housing between the rear grip and the air inlet, the one or more foregrips being adapted to provide a user with multiple hand positions around the perimeter of the housing.
2. The vacuum cleaner of claim 1, wherein the rear grip is movable with respect to the housing.
3. The vacuum cleaner of claim 1, wherein the rear grip is attached to the housing by a telescoping grip member.
4. The vacuum cleaner of claim 1, wherein the air inlet is attached to the housing by a telescoping inlet member.
5. The vacuum cleaner of claim 1, wherein the rear grip is attached to the housing by a telescoping grip member, and the air inlet is attached to the housing by a telescoping inlet member.
6. The vacuum cleaner of claim 1, wherein the rear grip comprises a loop.
7. The vacuum cleaner of claim 6, further comprising a protrusion extending into the loop, and a power switch disposed on the protrusion.
8. The vacuum cleaner of claim 1, wherein the dirt receptacle comprises a dust bag.
9. The vacuum cleaner of claim 1, wherein the dirt receptacle comprises a filter.
10. The vacuum cleaner of claim 1, wherein the dirt receptacle comprises a cyclone separator.

11. The vacuum cleaner of claim 1, wherein the dirt receptacle forms structural portion of housing, and the air inlet is attached to dirt receptacle.

12. The vacuum cleaner of claim 1, wherein the dirt receptacle is selectively positionable in a pocket formed in the housing.

13. The vacuum cleaner of claim 1, wherein the one or more foregrips comprise a loop that extends around the housing.

14. The vacuum cleaner of claim 13, wherein the loop extends entirely around the housing.

15. The vacuum cleaner of claim 13, wherein the housing comprises one or more depressions located radially inward of the loop.

16. The vacuum cleaner of claim 1, wherein the one or more foregrips comprise at least one grip protruding radially from the housing.

17. The vacuum cleaner of claim 1, wherein the one or more foregrips are movable with respect to housing.

18. A vacuum cleaner comprising:

- a generally elongated housing having a first housing end and a second housing end;

- a rear grip located at the first housing end;

- an air inlet located at the second housing end;

- a vacuum fan located within the housing;

- a motor located within the housing and adapted to drive the vacuum fan to draw a working air flow into the air inlet;

- a dirt receptacle operatively associated with the housing and adapted to remove particles from the working air flow; and

- one or more foregrips located on the housing between the rear grip and the air inlet, the one or more foregrips being positioned to allow a typical user to simultaneously grasp the rear grip and the one or more foregrips and clean staircase surfaces while remaining substantially upright.

19. The vacuum cleaner of claim 18, wherein the distance between a distal end of the rear grip and a distal end of the air inlet is about 20 inches to about 30 inches.

20. The vacuum cleaner of claim 18, wherein the distance between a rearmost graspable portion of the rear grip and at least one of the one or more foregrips is about 10 inches to about 14 inches.

21. The vacuum cleaner of claim 18, wherein the distance between at least one of the one or more foregrips and the air inlet is about 14 inches to about 16 inches.

22. The vacuum cleaner of claim 18, wherein the motor is positioned between the rear grip and the one or more foregrips.

23. The vacuum cleaner of claim 18, wherein the dirt receptacle is positioned between the one or more foregrips and the air inlet.

24. A vacuum cleaner comprising:

- a generally elongated housing having a longitudinal axis, a first housing end, and a second housing end;

- a rear grip located at the first housing end;

- an air inlet located at the second housing end;

- a vacuum fan located within the housing;

a motor located within the housing and adapted to drive the vacuum fan to draw a working air flow into the air inlet;

a dirt receptacle operatively associated with the housing and adapted to remove particles from the working air flow; and

one or more foregrips located on the housing between the rear grip and the air inlet, the one or more foregrips being adapted to allow a user to hold and operate the vacuum cleaner when the housing is rotated about the longitudinal axis at a first angular position, and at a second angular position, the first angular position being approximately 90 degrees or more from the second angular position.

25. The vacuum cleaner of claim 24, wherein the first angular position corresponds to a position in which the air

inlet is directed towards an approximately horizontal surface to be cleaned, and the second angular position corresponds to a position in which the air inlet is directed towards an approximately vertical surface to be cleaned.

26. The vacuum cleaner of claim 24, wherein the one or more foregrips comprise a loop that extends around the housing.

27. The vacuum cleaner of claim 24, wherein the motor is positioned between the rear grip and the one or more foregrips.

28. The vacuum cleaner of claim 24, wherein the dirt receptacle is positioned between the one or more foregrips and the air inlet.

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