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(54) SURFACE CLEANING APPARATUS AND COMMUNICATION METHOD

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APPAREIL DE NETTOYAGE DE SURFACE ET PROCÉDÉ DE COMMUNICATION

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Description

TECHNICAL FIELD

[0001] This disclosure relates to an apparatus with a powerline communication system and methods for communication via a power line for an apparatus.

BACKGROUND

[0002] Surface cleaning apparatuses such as vacuum cleaners are well-known devices for removing dirt and debris (which can include dirt, dust, soil, hair, and other debris) from a variety of surfaces such as soft flooring including carpets and rugs, hard or bare flooring, including tile, hardwood, laminate, vinyl, and linoleum, or other fabric surfaces such as upholstery. Such surface cleaning apparatuses typically include a user control portion, which can include a user interface or at least one control button or switch, and a surface cleaning portion operably coupled to the user control portion. The user control portion and the surface cleaning portion can be located remotely from one another within the surface cleaning apparatus and operably coupled via at least one of a power line or a communications line.

[0003] WO 2015/077588 A1 describes a power line communication system for controlling a function or operation of at least one component of a surface cleaning device, wherein a controller is located remotely from the at least one user control. The controller and the user control are both provided along a portion of the main body of the cleaning system.

[0004] Documents US 2013/0198995 A1, GB 2 355 392 A and WO 2018/170259 A1 describe in a similar manner as WO 2015/077588 A1 mentioned above cleaning devices with a power line communication system.

BRIEF DESCRIPTION

[0005] The invention is defined in claim 1. Further developments are given in the dependent claims.

[0006] The invention further relates to a method of communication for a surface cleaning apparatus under use of a powerline communication system as in the invention, the method including outputting power via a DC battery-powered source through a power line, receiving a user input at a user control, generating an input to a toggle switch based on the receiving the user input, outputting a pulse width modulation signal along the power line to a controller during the outputting power and operating, via the controller, a component of the surface cleaning apparatus based on the pulse width modulation signal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] In the drawings:

FIG. 1 is a schematic illustration of a surface cleaning apparatus having a user control portion and a surface cleaning portion according to various aspects described herein.

FIG. 2 is a schematic illustration of a communication apparatus between the user control portion and the surface cleaning portion.

FIG. 3 is a schematic view of a vacuum cleaner according to aspects of the present disclosure.

FIG. 4 is a perspective view of the vacuum cleaner of FIG. 3.

FIG. 5 is a perspective view of the base unit of FIG. 4 with portions removed according to aspects of the present disclosure.

FIG. 6 is a perspective view of the diverter assembly of FIG. 5 with portions removed.

FIG. 7 is a cross-sectional view through line V-V of FIG. 6 with portions removed.

FIG. 8 is a perspective view of the base unit of FIG. 5 with portions removed according to aspects of the present disclosure.

FIG. 9 is a perspective view of the diverter assembly of FIG. 8 with portions removed.

FIG. 10 is a cross-sectional view through line VIII-VIII of FIG. 9 with portions removed.

FIG. 11 is a perspective view of the base unit 14 of FIG. 4 with the diverter member in a down position.

FIG. 12 is a perspective view of the base unit 14 of FIG. 4 with the diverter member in an up position.

FIG. 13 is a cross-sectional view through line XI-XI of FIG. 11.

FIG. 14 is a cross-sectional view through line XII-XII of FIG. 12.

FIG. 15 is a perspective view of the vacuum cleaner of FIG. 3 with the handle in the folded position.

FIG. 16 is an exploded view of the vacuum cleaner handle of FIG 4.

FIG. 17 is an exploded view of the interlocking assembly of FIG. 16.

FIG. 18 is a cross-sectional view through line XVI-XVI of FIG. 4 with the trigger not in a locked position.

FIG. 19 is a cross-sectional view through line XVI-XVI of FIG. 4 with the trigger in an unlocked pivoting position.

FIG. 20 is a schematic view of a surface cleaning apparatus according to various aspects described herein.

FIG. 21 is a perspective view of the surface cleaning apparatus of FIG. 20 in the form of a handheld vacuum cleaner including a base assembly and an upright assembly according to various aspects described herein.

FIG. 22 is a partially-exploded view of the vacuum cleaner of FIG. 21.

FIG. 23 is a side sectional view of the vacuum cleaner of FIG. 21 along line XXIII-XXIII.

FIG. 24 is a perspective view of a hand grip of FIG. 21 including a user interface according to various

aspects described herein.

FIG. 25 is a partially-exploded view of the hand grip of FIG. 24 with a user interface in a first configuration.

FIG. 26 is a sectional view of the hand grip and user interface of FIG. 25.

FIG. 27 is a sectional view of a handheld vacuum cleaner portion of the upright assembly of FIG. 21 along line XXIII-XXIII.

FIG. 28 is a sectional view of a dirt separation and collection module in the handheld vacuum cleaner portion of FIG. 27 according to various aspects described herein.

FIG. 29A-B illustrates an emptying process for the dirt separation and collection module of FIG. 28.

FIG. 30 is a partially-exploded view of a wand of the vacuum cleaner of FIG. 21 according to various aspects described herein.

FIG. 31 is a sectional view of the assembled wand of FIG. 30 along line XXXI-XXXI.

FIG. 32 is a partially-exploded view of another wand that can be utilized in the vacuum cleaner of FIG. 21 according to various aspects described herein.

FIG. 33 is a sectional view of the assembled wand of FIG. 32 along line XXXIII-XXXIII.

FIG. 34 is a partially-exploded view of the base assembly of FIG. 21 according to various aspects described herein.

FIG. 35 is a perspective view of a brushroll that can be utilized in the base assembly of FIG. 21 according to various aspects described herein.

FIG. 36 is a sectional view of the base assembly of FIG. 21.

FIG. 37 is a partially-exploded view of the base assembly of FIG. 21 illustrating an alternate brushroll that can be utilized in the base assembly.

FIG. 38 is a sectional view of the base assembly of FIG. 21.

DETAILED DESCRIPTION

[0008] The present invention relates to a method of communication within a surface cleaning apparatus. The method of communication can be used within a variety of surface cleaning apparatuses having a power source connected to a remote processor via a power line. Non-limiting examples of such suitable surface cleaning apparatuses for cleaning debris from a surface include a portable or handheld surface cleaner, which can be in the form of a stick vacuum or wand vacuum, an upright vacuum cleaner, a canister cleaner, a cordless surface cleaner, including a stick cleaner, sweeper, or mop, an autonomous or robotic surface cleaner, an extraction cleaner, steam and hard floor cleaners, lift-off upright to portable cleaners, or commercial surface cleaners.

[0009] FIG. 1 is a schematic illustration of various functional systems of a surface cleaning apparatus 2. The surface cleaning apparatus 2 can include a user control portion 2a and a surface cleaning portion 2b. The surface cleaning portion 2b is the portion of the surface cleaning apparatus 2 that contacts the surface to be cleaned for the removal of dirt and debris from the surface. In one example, the surface cleaning portion 2b can be a foot or base of a surface cleaning apparatus 2. The user control portion 2a can be any portion of the surface cleaning apparatus 2 that includes at least one user control 3 for receiving a user input to control various features of the surface cleaning apparatus 2. Non-limiting examples of such an at least one user control include a user interface, buttons, switches, and mode selectors.

[0010] The user control portion 2a and the surface cleaning portion 2b can be located remotely from one another. The term remote includes that they are spaced apart within the surface cleaning apparatus 2. By way of non-limiting example, the remotely located user control portion 2a and surface cleaning portion 2b can be provided as a user control portion 2a provided on a handle or an upright portion of a surface cleaner while the surface cleaning portion 2b is the base or foot of a surface cleaner, a user control portion 2a provided at a handle with a surface cleaning portion 2b provided on a canister, or a user control portion 2a on a top surface of an autonomous or robotic surface cleaner and a surface cleaning portion 2b at a floor-contacting lower surface of the autonomous or robotic surface cleaner. The user control portion 2a can be operably coupled to a power source 4 for powering the various operational features of the surface cleaning apparatus 2, including features provided with or located on the surface cleaning portion 2b. In one aspect, the power source 4 can be located adjacent to or near the user control portion 2a, and spaced apart from or remotely from the surface cleaning portion 2b. The surface cleaning portion 2b can include a controller or processor 5 for receiving control information and power from the power source 4.

[0011] The power source 4 can be operably coupled to the processor 5 on the surface cleaning portion 2b by a power line 6. In one aspect, the power line 6 can be a DC power line. The processor 5 can be any suitable processor 5 capable of receiving communication from the power line 6, non-limiting examples of which include a microcontroller unit (MCU), a printed circuit board (PCB) or printed circuit board assembly (PCBA), or other basic processor 5. The power line 6 can couple to the processor 5 by any suitable power connector, such as a two pin connector. While the power line 6 is illustrated as the only connection between the user control portion 2a and the surface cleaning portion 2b it will be understood that other components, fluid pathways, etc. can link the user control portion 2a and the surface cleaning portion 2b.

[0012] In a conventional surface cleaning apparatus 2, when the user control portion 2a and the surface cleaning portion 2b are located remotely from one another or spaced apart from one another within the surface cleaning apparatus 2, a communications line, separate from the power line 6, is provided to convey control signals from the user control portion 2a to the surface cleaning

portion 2b. The inclusion of a communications line results in added cost of manufacturing the surface cleaning apparatus 2. In the aspects of the present disclosure, an apparatus and method are provided that allow for control signals to be provided from the user control portion 2a and the power source 4 to the surface cleaning portion 2b and the processor 5 via the power line 6 itself, without the need for an additional communications line.

[0013] FIG. 2 is a schematic illustration of the communication apparatus for the surface cleaning apparatus 2 and which allows for control signals to be provided from the user control portion 2a and the power source 4 to the surface cleaning portion 2b and the processor 5 via the power line 6 itself. A powerline communication system for a DC battery-powered surface cleaning device wherein a DC powerline that connects a "remote" power source and user control (e.g. in handle) to a processor and one or more electrically powered components in a surface cleaning portion (e.g. the foot) is also used to communicate signals between the user control and processor.

[0014] In this example, the at least one user control 3 is illustrated, by way of non-limiting example, as a mode selector 3a by which a user can select between cleaning modes of operation of the surface cleaning apparatus 2. The mode selector 3a can selectively occupy one of a first position 3b, a second position 3c, a third position 3d, or a fourth position 3e, by way of non-limiting examples, to select the different desired mode of operation. Such positions have been schematically illustrated as boxes for illustrative purposes. By way of non-limiting example, the modes of operation to be selected from can include an auto sensing mode, a carpet mode, a hard floor mode, or an edge mode. In one example, one mode of operation can correspond to each of the first position 3b, second position 3c, third position 3d, and fourth position 3e of the mode selector 3a.

[0015] The mode selector 3a is operably coupled with a toggle switch 7 provided within the surface cleaning apparatus 2, which can be any suitable toggle switch 7, a non-limiting example of which includes a solid-state switch. The toggle switch 7 receives an input from the mode selector 3a via the power line 6, the input from the mode selector 3a indicative of the mode selected by the user. The toggle switch 7 is, in turn, operably coupled with the processor 5 via the power line 6, such that the toggle switch 7 can then introduce a pulse width modulation (PWM) signal to the processor 5 over the power line 6, the PWM signal provided to the processor 5 via the power line 6 corresponding to the mode input received by the toggle switch 7 from the mode selector 3a. In this way, the mode selected by the user at the mode selector 3a generates an input to the toggle switch 7 that determines the pulse width of the PWM signal then provided from the toggle switch 7 to the processor 5 to cause an operation at the surface cleaning portion 2b that corresponds to the mode selected by the user via the mode selector 3a.

[0016] During normal operation of the surface cleaning apparatus 2, when the toggle switch 7 is not introducing a PWM signal over the power line 6, the signal transmitted over the power line 6 from the user control portion 2a to the processor 5 of the surface cleaning portion 2b is typically high or uninterrupted, and can be thought of as representing 100% power transmission via the power line 6 and this is schematically illustrated with a line indicated as 6e. When a communication signal is transmitted from the user control to provide an input indicating a different mode of operation to the toggle switch 7, the toggle switch 7 is prompted to introduce or toggle the PWM signal over the power line 6. PWM is a method of communication by generating a pulsing signal. In this example, the toggle switch 7 generates the pulsing signal to be transmitted via the power line 6. The pulse width of the PWM signal encodes the communication signal either by the duty cycle of the PWM signal or the frequency of the PWM signal.

[0017] During normal operation of the surface cleaning apparatus 2, when the toggle switch 7 is not introducing a PWM signal over the power line 6, the 100% power transmission, illustrated schematically at 6e, via the power line 6 defines a regular interval or period of current supplied through the power line 6. When the toggle switch 7 is prompted to introduce the PWM signal that is transmitted to the power line 6, the power signal is pulsed, such that the 'on' time of the power supply is less than 100% power transmission, or less than the regular interval or period of current. The term duty cycle refers to the proportion or percentage of 'on' time of the PWM signal to the regular interval or period of the power transmitted through the power line 6. A low duty cycle corresponds to low power, because the power is off for a greater percentage of the time than it is on. A high duty cycle corresponds to high power, because the power is on for a greater percentage of the time than it is off. For example, a duty cycle of 50% refers to a power signal that is on half the time and off half the time. The frequency of the PWM signal is simply the inverse of the pulse width.

[0018] In response to the mode of operation input provided from the mode selector 3a to the toggle switch 7, the duty cycle generated by the PWM signal from the toggle switch 7 can provide an input to the processor 5 of the surface cleaning portion 2b, the processor 5 configured to affect a particular function at the surface cleaning portion 2b in response to the characteristics of the PWM signal received. The function effected by the processor 5 can also or alternately include control of a component 8 provided at the surface cleaning portion 2b that is operably coupled with the processor 5 to be controlled by the processor 5 in response to the PWM signal received at the processor 5. In the illustrated example where the user control 3 is a mode selector 3a with multiple positions corresponding to different modes of operation, it is contemplated that, by way of non-limiting example, an 80% duty cycle 6d can provide an input to the processor 5 to indicate that the surface cleaning portion 2b should be operated in the auto sensing mode, a 60% duty cycle 6c can provide an input to the processor 5 to

indicate that the surface cleaning portion 2b should be operated in the carpet mode, a 40% duty cycle 6b can provide an input to the processor 5 to indicate that the surface cleaning portion 2b should be operated in the hard floor mode, and a 20% duty cycle 6a can provide an input to the processor 5 to indicate that the surface cleaning portion 2b should be operated in the edge mode. While the 6a-6e power transmissions have been separately shown for illustrative purposes it will be understood that such transmissions are all over the same power line 6.

[0019] While the example described herein refers to selecting a mode of operation for the surface cleaning apparatus 2, it will be understood that the method of communicating via the power line 6 can be used to control any function or component 8 of the surface cleaning apparatus 2 that is provided at the surface cleaning portion 2b, non-limiting examples of which include modes of operation, an agitator, a dusting assembly, a fluid distributor, a steam generator, sensors, such as an ultrasonic floor-type sensor, and mechanically actuated features, such as a lift or a door that can raise or lower the height of the surface cleaning portion 2b relative to the surface to be cleaned, which can be selected based on a floor type detected. Any suitable function or component can be controlled such that the PWM signal input sensed by the processor 5 signals the processor 5 to effect a change or an action at the surface cleaning portion 2b.

[0020] In addition to reducing cost and complexity of the surface cleaning apparatus 2 by obviating the need for a separate communications line between the user control portion 2a and the surface cleaning portion 2b in addition to the power line 6, another advantage of the communication method via the power line 6 described herein is that the power transmitted via the power line 6 is essentially uninterrupted to the surface cleaning portion 2b. The toggle switch 7 generates the PWM signal to the power line 6, but the PWM signal makes up a small voltage compared to the total voltage generated by the power source 4, as well as modulating the pulse width only for a percentage of the time, such that the power to the processor 5 is essentially uninterrupted as far as the load at the surface cleaning portion 2b. Thus, the PWM signal can be used to provide communication via the power line 6 without significantly hampering the ability of the power line 6 to provide the necessary power to the surface cleaning portion 2b from the power source 4. Further yet, voltage dividers, such as a potential divider or a resistor voltage divider, can be operably coupled with the power line 6 or the processor 5 to knock down the voltage of the signal to a suitable level that can be sensed or read by the processor 5.

[0021] Referring now to FIG. 3 and FIG. 4, there is shown a schematic view of a vacuum cleaner 10 and a perspective view of the vacuum cleaner 10, respectively, that can include the communication apparatus and method as described above, according to aspects of the present disclosure. The vacuum cleaner 10 is shown herein as a stick-type vacuum cleaner, with a housing including an upper unit 12 coupled with a base unit 14 adapted to be moved over a surface to be cleaned S. The vacuum cleaner 10 can alternatively be configured as an upright-type vacuum cleaner, a canister-type vacuum cleaner, or a hand-held vacuum cleaner. Furthermore, the vacuum cleaner 10 can additionally be configured to distribute a fluid and/or to extract a fluid, where the fluid may for example be liquid or steam.

[0022] The upper unit 12 is pivotally mounted to the base unit 14 for movement between an upright storage position, shown in FIG. 4, and a reclined use position (not shown). The vacuum cleaner 10 can be provided with a detent mechanism, such as a pedal pivotally mounted to the base unit 14, for selectively releasing the upper unit 12 from the storage position to the use position. The details of such a detent pedal are known in the art, and will not be discussed in further detail herein.

[0023] The upper unit 12 can include a vacuum collection system for creating a partial vacuum to suck up debris (which may include dirt, dust, soil, hair, and other debris) from the surface to be cleaned S and collecting the removed debris in a space provided on the vacuum cleaner 10 for later disposal.

[0024] The upper unit 12 includes a suction source 16 in fluid communication with the base unit 14 for generating a working airstream and a separating and collection assembly 18 for separating and collecting debris (which can be solid, liquid, or a combination thereof) from the working airstream for later disposal. The upper unit 12 further includes a handle 28 to facilitate movement of the vacuum cleaner 10 by a user. A handle coupler 30 can receive the proximal end of the handle 28, which may be fixed with respect to the upper unit 12, or may pivot to allow the handle 28 to rotate or fold about a horizontal axis relative to the upper unit 12. As illustrated, the handle 28 is pivotally mounted to the upper unit 12 via handle coupler 30 for movement between an upright position, shown in FIG. 4, and a folded position, shown in FIG. 15. The handle 28 may further include the power switch 36 as well as other controls and indicators used during operation. The handle 28 may further include a handle grip 32 opposite the handle coupler 30.

[0025] In one configuration illustrated herein, the collection assembly 18 can include a cyclone separator 22 for separating contaminants from a working airstream and a removable debris cup 24 for receiving and collecting the separated contaminants from the cyclone separator 22. The cyclone separator 22 can have a single cyclonic separation stage, or multiple stages. In another configuration, the collection assembly 18 can include an integrally formed cyclone separator 22 and debris cup 24, with the debris cup 24 being provided with a structure, such as a bottom-opening debris door, for contaminant disposal. It is understood that other types of collection assemblies 18 can be used, such as a centrifugal separator, a bulk separator, a filter bag, or a water-bath separator. The upper unit 12 can also be provided with one

or more additional filters 20 upstream or downstream of the separating and collection assembly 18 or the suction source 16.

[0026] The suction source 16, such as a motor/fan assembly, is provided in fluid communication with the separating and collection assembly 18, and can be positioned downstream or upstream of the separating and collection assembly 18. The suction source 16 can be electrically coupled to a power source 34, such as a battery or by a power cord plugged into a household electrical outlet. A suction power switch 36 disposed between the suction source 16 and the power source 34 can be selectively closed by the user upon pressing a vacuum power button 35, thereby activating the suction source 16. As shown herein, the suction source 16 is downstream of the separating and collection assembly 18 for a 'clean air' system; alternatively, the suction source 16 can be upstream of the separation and collection assembly 18 for a 'dirty air' system.

[0027] In another configuration, the separation and collection assembly 18, suction source 16, filters 20, power source 34 and power switch 36 may all be disposed within a removable hand-held unit 26 which is removable from the upper unit 12. When disposed in the upper unit 12, the hand-held unit 26 provides the separation and collection assembly 18, suction source 16, filters 20 and power source 34 for the vacuum cleaner 10. When removed from the upper unit 12, the hand-held unit 26 may operate independently from the upper unit 12 to create partial vacuum to suck up debris (which may include dirt, dust, soil, hair, and other debris) from the surface to be cleaned S. It is noted that features of the present disclosure may be applicable to vacuum cleaners not having a hand-held unit.

[0028] The base unit 14 is in fluid communication with the suction source 16 for engaging and cleaning the surface to be cleaned S. The base unit 14 includes a base housing 40 having a suction nozzle 42 at least partially disposed on the underside and front of the base housing 40. The base housing 40 can secure an agitator 38 within the base unit 14 for agitating debris on the surface to be cleaned S so that the debris is more easily ingested into the suction nozzle 42. Some examples of agitators 38 include, but are not limited to, a rotatable brushroll, dual rotating brushrolls, or a stationary brush. The agitator 38 illustrated herein is a rotatable brushroll positioned within the base unit 14 adjacent the suction nozzle 42 for rotational movement about an axis X, and can be coupled to and driven by a dedicated agitator motor provided in the base unit 14 via a commonly known arrangement including a drive belt. Alternatively, the agitator 38 can be coupled to and driven by the suction source 16 in the upper unit 12. It is within the scope of the present disclosure for the agitator 38 to be mounted within the base unit 14 in a fixed or floating vertical position relative to the base unit 14.

[0029] The vacuum cleaner 10 can be used to effectively clean the surface to be cleaned S by removing debris (which may include dirt, dust, soil, hair, and other debris) from the surface to be cleaned S in accordance with the following method. The sequence of steps discussed is for illustrative purposes only and is not meant to limit the method in any way as it is understood that the steps may proceed in a different logical order, additional or intervening steps may be included, or described steps may be divided into multiple steps, without detracting from the aspects of the present disclosure.

[0030] To perform vacuum cleaning in the canister configuration shown in FIG. 3, the suction source 16 is coupled to the power source 34 and draws in debris-laden air through the base unit 14 and into the separating and collection assembly 18 where the debris is substantially separated from the working air. The air flow then passes through the suction source 16, and through any optional filters 20 positioned upstream and/or downstream from the suction source 16, prior to being exhausted from the vacuum cleaner 10. During vacuum cleaning, the agitator 38 can agitate debris on the surface to be cleaned S so that the debris is more easily ingested into the suction nozzle 42. The separating and collection assembly 18 can be periodically emptied of debris. Likewise, the optional filters 20 can periodically be cleaned or replaced.

[0031] FIG. 5 is the base unit 14 from FIG. 4 according to aspects of the present invention with portions of the base housing 40 removed. The base housing 40 encloses components of the base unit 14 to create a partially enclosed space therein. The agitator 38 is provided at a forward portion of the base housing 40. The base housing 40 can also include a sole plate 44 fastened to the underside of the base housing 40 to secure the agitator 38 within the base housing 40 and define the suction nozzle 42.

[0032] The suction nozzle 42 includes a suction nozzle opening defined by an underside suction nozzle opening 43 formed in the underside of the sole plate 44 and a front suction nozzle opening 41 formed in the front of the sole plate 44 and front the base housing 40. The suction nozzle openings 41, 43 are in fluid communication with a duct 48 coupled at one end to the base housing 40, which fluidly communicates the suction nozzle openings 41, 43 with the collection assembly 18 (FIG. 4). It will be understood that the underside suction nozzle opening 43 and the front suction nozzle opening 41 may be formed from a single opening in the sole plate 44 and may be considered to be a single opening. Alternatively, the suction nozzle openings 41, 43 may be considered to be separate openings wherein the suction nozzle 42 may be provided with at least one of the underside suction nozzle opening 43 or the front suction nozzle opening 41.

[0033] Referring now to FIGS. 5-6, the base unit 14 can further include a suction nozzle opening diverter assembly 50 including a diverting member 52, two pivoting members 54, a solenoid piston 56, a diverter biasing spring 58 and edge illuminators 60 configured to selectively restrict a portion of the suction nozzle 42 and provide illumination when the restricting occurs. The diverter

member 52 extends along the front of the base housing 40 between the front vertical edges of two vertical side walls 62 with a middle portion bottom edge 88 of the diverter member 52 defining the upper boundary of the front suction nozzle opening 41 and the upper edge of the diverter member 52 in communication with a front portion of the base housing 40 (best seen in FIGS. 11 and 12). Opposing diverter member ends 82 are elevated upward with respect the diverter member middle 84 such that the end portion bottom edges 86 of the diverter member ends 82 are elevated higher than the middle portion bottom edge 88 of the diverter member middle 84.

[0034] The two pivoting members 54 extend substantially perpendicularly from the diverter member 52 along the sides of the base housing 40 towards the rear of the base housing 40. The pivoting members 54 are provided with an aperture 80 that receives a horizontal pin (not shown) disposed in the base housing 40 for pivotally mounting the pivoting members 54 to the base housing 40 wherein the two apertures 80 axially align, defining a pivot axis Y. Alternatively, a pin may be provided on the pivoting members 54 and an aperture for receiving the axles in the base housing 40. The rear end of at least one pivoting members 54 is further provided with a spring mount 90 and a diverter end portion 92 having an inverted diverter end wedge 94 disposed on the lower side of the diverter end portion 92 sloping upwardly towards the solenoid piston 56.

[0035] The solenoid piston 56 is disposed in the rear of the base housing 40 and is configured to selectively engage at least one of the pivoting members 54. The solenoid piston 56 is of conventional design and includes a stationary housing 64 having an inductive coil (not shown) mounted therein, connected to a power supply, and configured to surround a piston 66 having a cone-shaped termination cap 96. The solenoid piston 56 is selectively movable between a horizontally extended position and a retracted position when the inductive coil is alternately energized and de-energized wherein the termination cap 96 is in communication with the diverter end wedge 94 of the diverter end portion 92 when extended and not in communication when retracted.

[0036] The edge illuminators 60 are mounted in the base housing 40 along the two vertical side walls 62 behind light transmitting screens 63 which may form a portion of the vertical side walls 62 such that light illuminated from the edge illuminators 60 pass through the light transmitting screens 63. The edge illuminators 60 can be selected from known constructions, including light emitting diodes (LED) or incandescent lamps, for example. The edge illuminators 60 are of conventional construction and include at least one lens (not shown), at least one light emitting element (LED) (not shown), a printed circuit board (PCB) 74 and electrical leads 76.

[0037] Referring now to FIGS. 4-5, electrical conductor leads 68 extend from the solenoid piston 56 and the edge illuminators 60 electrical leads 76, routing through the base unit 14 through the upper unit 12 and handle 28, and are connected to an electrical switch 70 housed in the handle 28. The electrical switch 70 is, in turn, connected to a power source 72 to selectively energize the solenoid piston 56 and edge illuminators 60. In this manner it will be understood that the It will be understood that the electrical leads and electrical conductor leads form a power line. The electrical switch 70 may be operatively coupled to a conventional push button 75 disposed in the front portion of the handle 28 as illustrated or a "rocker" or toggle switch 73 (FIG. 5) as is commonly known in the art can be included on a portion of the power line such that it becomes selectively engaged when a user engages the push button 75.

[0038] An optional visual indicator, such as an indicator light 78, may be mounted to upper portion of the handle 28 for indicating when the solenoid piston 56 and edge illuminators 60 have been activated. The indicator light 78 can be selected from known constructions, including light emitting diodes (LED) or incandescent lamps, for example. The indicator light 78 is of conventional construction and includes a lens (not shown), a light emitting element (LED) (not shown), and electrical leads (not shown) connected in series with the electrical switch 70, solenoid piston 56 and edge illuminators 60.

[0039] It will be understood that the operation of the vacuum cleaner 10 can be controlled via one or more controllers 77 (FIG. 5) operatively coupled with one or more components of the vacuum cleaner 10. For example, a controller can be operably coupled with the agitator 38 and suction source 16 to adjust the rotation of the agitator 38 or operation of the suction source 16. The controller (FIG. 7) can include a printed circuit board (PCB) operably coupled with a user interface or user control. Alternatively, the controller can be a portion of the component itself such a motor controller.

[0040] FIG. 7 shows a cross section of the diverter assembly 50 and solenoid piston 56 of FIG. 6 taken along line V-V and more clearly illustrates the interaction between the termination cap 96 and the diverter end wedge 94. The cone shape of the termination cap 96 forms a piston wedge 98 sloping towards the diverter end portion 92. The piston wedge 98 is in register with, but does not fully engage the diverter end wedge 94 when the piston 66 of the solenoid piston 56 is in the retracted position as illustrated. When the piston 66 is extended, the piston wedge 98 engages the diverter end wedge 94.

[0041] The piston wedge 98 converts the horizontal force of the piston 66 into a force perpendicular to the piston wedge 98 having horizontal and vertical components and imparts it to the diverter end wedge 94. As the piston 66 extends, the diverter end wedge 94 and piston wedge 98 slip relative to each other such that the diverter end portion 92 pivots upward about the pivot axis Y. When the piston 66 is again retracted, the piston wedge 98 and the diverter end wedge 94 disengage and the diverter end portion 92 pivots downwards due to the tension force of the diverter biasing spring 58 shown in FIG. 6. The movement of the piston 66 and diverter end portion

92 are schematically illustrated by arrows 100. It will be understood that the forces imparted on the diverter end wedge 94 by the solenoid piston 56 when the piston 66 is extended may be optimized to overcome all resistive forces such as friction, weight and spring tension in order provide for upward movement of the diverter end portion 92. It will also be understood that the diverter biasing spring 58 may have a spring rate that is optimized to overcome all resistive forces such as friction and weight in order to provide for downward movement of the diverter end portion 92 when the piston 66 is retracted.

[0042] Referring again to FIG. 6, the diverter member 52 is configured to selectively pivot about the pivot axis Y so as to move upwards and downwards to selectively restrict a portion of the suction nozzle 42, thereby increasing the suction force through the unrestricted portion, given that the same volume of air is being drawn through a smaller opening. The upward movement of the diverter end portion 92 caused by the piston 66 extending and the downward movement of the diverter end portion 92 caused by the diverter biasing spring 58 when the piston 66 is retracted causes the diverter assembly 50 to pivot about the pivot axis Y such that the diverter member 52 pivots downward and upward respectively as schematically illustrated by arrows 102.

[0043] Referring to FIGS. 8-9, according to aspects of the present disclosure where like elements from the previous disclosure are identified with the same reference numerals and include a prime (') symbol, the solenoid piston 56 and indicator light 78 of the first aspect are replaced with a foot actuated pedal assembly 104. The pedal assembly 104 includes a mode indicator 106, a pivoting pedal 108, a pedal biasing spring 110, a sliding wedge 112 and sliding wedge biasing spring 114. The pedal assembly 104 is disposed in the rear of the base housing 40' and is configured to selectively engage at least one of the pivoting members 54'. The base housing 40' may also include a pedal recess 116 formed in the rear vertical side of the base housing 40' such that a portion of the pedal 108 may pass through the pedal recess 116 as well as an indicator recess 118 formed in the rear of the upper horizontal side of the base housing 40' such that the indicator recess 118 may be selectively covered by a portion of the mode indicator 106.

[0044] The pivoting pedal 108 includes an actuating surface 120 connected to a cylindrical axle 122 by an arm member 124. The actuating surface 120 is configured to be depressed by a user's foot. The cylindrical axle 122 is pivotally mounted to the base housing 40' with the centerline of the cylindrical axle 122 substantially parallel to the pivot axis Y'. The arm member 124 extends between the actuating surface 120 and the cylindrical axle 122 such that the actuating surface 120 is disposed above and behind the cylindrical axle 122, and includes a vertical protrusion 126 extending upwards from the top surface of the arm member 124 adjacent to the actuating surface 120. The arm member 124 also includes an arm wedge 125 (shown in FIG. 10) provided on the underside of the arm member 124 which slopes toward the diverter end portion 92' of the pivoting member 54'.

[0045] The pivoting pedal 108 is configured to selectively rotate about the cylindrical axle 122 axis between an up position wherein the upper portion of the arm member 124 is in contact with the upper boundary of the pedal recess 116 and a down position wherein the lower surface of the arm member 124 is in contact with the lower boundary of the pedal recess 116. The pedal biasing spring 110 is attached to the cylindrical axle 122 and the base housing 40' and provides torsion to the cylindrical axle 122 so as to bias the pivoting pedal 108 to the up position. The pedal assembly 104 may further include a detent mechanism for selectively securing the pivoting pedal 108 in the down position. The details of such a detent mechanism are known in the art, and will not be discussed in further detail herein.

[0046] The mode indicator 106 includes an L-shaped indicating portion 128 connected to a body portion 130. The horizontal surface of the indicating portion 128 is configured to selectively cover the indicator recess 118 and the vertical surface of the indicating portion extends downward and connects to the rear of the body portion 130. The body portion 130 includes a guide slot 132 extending horizontally, perpendicular to the pivot axis Y'. As seen in FIG. 10, the guide slot 132 is configured to receive a stationary screw 134 wherein the screw head 138 abuts the underside of the body portion 130 and the screw shaft 140 extends through the guide slot 132 and attaches to the base housing 40' (not shown) to slidably secure the mode indicator 106 to the base housing 40'. The body portion 130 may further include a hollow cylindrical spring holder 136 (FIG. 9) configured to receive one end of an indicator biasing spring (not shown) wherein the other end of the spring is attached to the base housing 40'. The indicator biasing spring exerts a horizontal force on the mode indicator 106 such that the rear of the body portion 130 is biased against the forward portion of the vertical protrusion 126 (FIG. 9).

[0047] As the pivoting pedal 108 is pivoted to the down position, the vertical protrusion 126 pivots down and away from the mode indicator 106 allowing the mode indicator 106 to move towards the rear of the base housing 40' under the spring force of the indicator biasing spring (not shown) until the stationary screw 134 abuts the forward portion of the guide slot 132 such that the horizontal surface of the indicator portion 128 covers the indicator recess 118 formed in the base housing 40'. When the pivoting pedal 108 is returned to the up position, the vertical protrusion 126 engages the mode indicator 106 and moves it forward such that the horizontal surface of the indicating portion 128 does not cover the indicator recess 118.

[0048] The sliding wedge 112 forms an elongated structure extending parallel to the pivot axis Y' wherein one side of the sliding wedge 112 forms a sliding pedal wedge 142 and spring mount 144, and the opposing side forms a sliding diverter wedge 146. The sliding pedal

wedge 142 slopes downwardly and away from the diverter end portion 92' and is disposed beneath the arm wedge 125 (FIG. 10) of the pivoting pedal 108. The sliding diverter wedge 146 slopes downwardly and towards the diverter end portion 92' and is adjacent to the diverter end wedge 94' of the diverter end portion 92'. The spring mount 144 is formed at the bottom of the sliding pedal wedge 142 and is configured to attach to one end of the sliding wedge biasing spring 114. The opposite end of the spring 114 is attached to the base housing 40'.

[0049] The sliding wedge 112 is configured to linearly slide along the bottom of the base housing 40' towards and away from the diverter end portion 92' along an axis parallel to the pivot axis Y'. The base housing 40' may include a track or guide to ensure a linear sliding path. The sliding wedge biasing spring 114 is configured to bias the sliding wedge 112 away from the diverter end portion 92'.

[0050] The switch 70' may be disposed in the base housing 40' wherein the switch is, in turn, connected to power source 72' to selectively energize edge illuminators 60'. The switch 70' may be configured such that actuating the pivoting pedal 108 to the down position energizes the edge illuminators 60'. Alternatively, a sensor may be provided in the base housing 40' to sense when the pivoting pedal 108 has been actuated and activate the switch 70', thereby energizing the edge illuminators 60'.

[0051] FIG. 10 shows a cross section of the diverter assembly 50' and pedal assembly 104 of FIG. 10 taken along line VIII-VIII of FIG. 9 and more clearly illustrates the interaction between the pivoting pedal 108, the sliding wedge 112 and the diverter end wedge 94' of the diverter end portion 92'. The arm wedge 125 on the pedal 108 is disposed above and in register, but not fully engaged with the sliding pedal wedge 142 when the pivoting pedal 108 is in the up position as illustrated. When the pivoting pedal 108 is depressed to the down position, the arm wedge 125 converts the downward force of the pivoting pedal 108 into a force perpendicular to the arm wedge 125 having horizontal and vertical components and imparts it to the sliding pedal wedge 142. As the pivoting pedal 108 travels downward, the arm wedge 125 and the sliding pedal wedge 142 slip relative to each other such that the sliding wedge 112 moves horizontally and the sliding diverter wedge 146 engages the diverter end wedge 94' of the diverter end portion 92'. The sliding diverter wedge 146 converts the horizontal force of the sliding wedge 112 into a force perpendicular to the piston wedge 98 having horizontal and vertical components and imparts it to the diverter end wedge 94'. As the sliding wedge 112 continues sliding, the diverter end wedge 94' and sliding diverter wedge 146 slip relative to each other such that the diverter end portion 92' pivots upward about the pivot axis Y'. When the pivoting pedal 108 is again returned to the up position, the sliding wedge 112 slides away from the diverter end portion 92' under the tension force of the sliding wedge biasing spring 114 such that the sliding diverter wedge 146 and diverter end wedge 94' disengage and the diverter end portion 92' pivots downwards due to the tension force of the diverter biasing spring 58' shown in FIG. 8. The movement of the pivoting pedal 108, sliding wedge 112 and diverter end portion 92' are schematically illustrated by arrows 148. It will be understood that the biasing springs may have spring rates that are optimized to overcome all resistive forces such as friction, weight and spring tension in order to provide for upward and downward movement of the diverter end portion 92' when pivoting pedal 108 is in the down or up position respectively.

[0052] The operation of the diverter assembly 50 will now be described with respect to the first aspect of the base unit 14 shown in FIGS. 4-7. However, it is noted that the diverter assembly 50' of the second aspect of the base unit 14' shown in FIGS. 8-10 operates in a similar manner, and so the following description of FIGS. 11-14 also applies for the second aspect.

[0053] FIG. 11 shows a perspective view of the base unit 14 with the diverter member 52 in an up position. The base housing 40 may further include a diverter recess 152 (best seen in FIG. 12) configured to receive the diverter member 52 such that the base housing front portion 154 is flush with the front surface of the diverter member 52 as shown. During operation, the diverter member 52 in the up position allows debris laden air to be drawn into the base unit 14 through the front suction nozzle opening 41 along the entire length of the diverter member 52 as indicated by arrows 150.

[0054] FIG. 12 shows a perspective view of the base unit 14 with the diverter member 52 in a down position. When in the diverter member 52 is in the down position the edge illuminators 60 (FIG. 5) are energized such that light illuminated from the edge illuminators 60 passes through the light transmitting screens 63 as indicated by arrows 158. During operation when the diverter member 52 is in the down position, the diverter member middle 84 restricts a portion of the front suction nozzle opening 41 such that debris laden air may only be drawn into the base unit 14 through the unrestricted portions of the front suction nozzle opening 41 disposed under the diverter member ends 82 as illustrated by arrows 156. The restricted portion of the front suction nozzle opening 41 increases the suction in the unrestricted portions such that suction is focused, resulting in a higher velocity airstream created in the area under the diverter member ends 82 than when the diverter member 52 is in the up position as shown in FIG. 11.

[0055] FIG. 13 shows the front suction nozzle opening 41 having an open height 159 defined by the height between the surface to be cleaned S and the diverter member 52 middle portion bottom edge 88. When in the down position as shown in FIG. 14 it can be seen the middle portion bottom edge 88 abuts the surface to be cleaned S such that a closed height 161 of the front suction nozzle opening 41, defined by the height between the surface to be cleaned S and the diverter member 52 end portion

bottom edge 86, is smaller than that of the open height 159 shown in FIG. 13.

[0056] It is noted that, regardless of the position of the diverter assembly 50, i.e. regardless of whether the front suction nozzle opening 41 is unrestricted or partially restricted by the diverter member 52, the underside suction nozzle opening 43 formed in the underside of the sole plate 44 may remain open to allows debris laden air to be drawn into the base unit 14 through the underside suction nozzle opening 43. The bristles of the agitator 38 can project through the underside suction nozzle opening 43 to agitator debris on the surface to be cleaned.

[0057] Referring now to FIGS. 4 and 15, another aspect of the present disclosure relates to the pivoting handle 28 of the vacuum cleaner 10. The handle 28 is selectively pivotable between an upright position as shown in FIG. 4 and a folded position as shown in FIG. 15. A trigger 162 disposed on the rear of the handle 28 is operably coupled to the handle coupler 30 so as to selectively allow the handle 28 to be pivoted about the handle coupler 30. The trigger is configured to be linearly movable to and from an unlocked pivoting position by a user pulling the trigger 162 upwards. When the trigger 162 is in the locked position, the handle 28 is locked in the upright position as shown in FIG. 4. When the trigger 162 is in the unlocked pivoting position, the handle 28 may pivot to a folded position as shown in FIG. 15. It is noted that a vacuum cleaner having the pivoting handle 28 described herein may be combined with either base unit 14, 14', or may be provided with a different vacuum cleaner base.

[0058] FIG. 16 shows an exploded view of the handle 28. The handle 28 includes a front casing 166, a rear casing 168, an interlocking assembly 164 forming a portion of the handle coupler 30, buttons 35, 75, their associated switches 36, 70, 73, and the trigger 162. The interlocking assembly 164 includes a trigger shaft 170 connected to an interlocking mechanism 172 and is disposed within the front casing 166 and rear casing 168. A portion of the trigger 162 passes through the rear casing 168 and couples to the upper end of the trigger shaft 170. A portion of the interlocking mechanism 172 couples to the upper unit 12 to form the handle coupler 30.

[0059] FIG. 17 shows an exploded view of the interlocking mechanism 172 and the lower portion of the trigger shaft 170. The lower portion of the trigger shaft 170 includes a shaft wedge 174 having bisecting inclined walls 173, 175 sloping away from each other and extending perpendicular to a vertical portion of the trigger shaft 170. The interlocking mechanism 172 includes a first and second pivoting handle mount 178, 182, two interlock members 186, two retention springs 198 and two upper unit stationary mounts 202.

[0060] The first and second pivoting handle mounts 178, 182 form generally cylindrical bodies having interior and exterior features and include circular locking projections 181, 183, wherein the locking projections 181 on the first pivoting handle mount 178 are configured to be coaxially received by the locking projections 183 on the second pivoting handle mount 182. The first and second pivoting handle mount 178, 182 further include a rectangular sleeve 184 configured to receive the two interlock members 186. The first pivoting handle mount 178 further includes handle mounting flanges 180 that attach to the rear casing 168 (FIG. 16).

[0061] The two interlocking members 186 each include a wedge protrusion 190, a male locking connector 194 opposing the wedge protrusion 190, a rectangular middle portion 191 and a void 195 configured to receive the retention spring 198.

[0062] The two upper unit stationary mounts 202 form generally cylindrical bodies having interior and exterior features and include a spring retainer 210 configured to retain the two retention springs 198, upper unit mounting flanges 206, configured to attach to the upper unit 12 (FIG. 16) and a rectangular female locking connector 212 disposed on the interior of the two upper unit stationary mounts 202 configured to selectively receive the male locking connectors 194.

[0063] FIG. 18 shows a cross sectional view of FIG. 4 taken along line XVI-XVI with the trigger 162 (FIG. 16) in the locked position. The different components of the interlocking mechanism assemble together along a handle pivot axis Z as indicated by assembly arrows 214 shown in FIG. 17. The two upper unit stationary mounts 202 and first and second pivoting handle mounts 178, 182 assemble together such that a portion of the exterior of two upper unit stationary mounts 202 are received by a portion of the interior of the first and second pivoting handle mounts 178, 182. The retention springs 198 are retained between the two upper unit stationary mounts 202 and the two interlocking members 186. The two interlocking members 186 are retained between the two upper unit stationary mounts 202 and the first and second pivoting handle mounts 178, 182 such that the male locking connectors 194 are received by the female locking connectors 212 and the wedge protrusions 190 are in communication with the bisecting inclined walls 173, 175 of the shaft wedge 174. The interlocking members 186 are coupled to the first and second pivoting handle mount 178, 182 by the rectangular middle portion 191 received in the rectangular sleeves 184 and the male locking connectors 194 engage the female locking connectors 212 to prevent rotation of the interlocking members 186, therefore the first and second pivoting handle mounts 178, 182 are prevented from pivoting as well.

[0064] FIG. 19 shows a cross sectional view of FIG. 4 taken along line XVI-XVI with the trigger 162 (FIG. 16) in the unlocked pivoting position. When the trigger 162 (FIG. 16) is in the unlocked pivoting position, the trigger shaft 170 and shaft wedge 174 move upwards. The bisecting inclined walls 173, 175 exert a force perpendicular to the bisecting inclined walls 173, 175, having horizontal and vertical components, and impart the movement to the wedge protrusions 190 of the interlocking members 186. As the trigger shaft 170 and shaft wedge

174 move upwards, the bisecting inclined walls 173, 175 and wedge protrusions 190 slip relative to each other such that the interlocking members 186 move outward towards the spring retainers 210 until the male locking connectors 194 disengage the rectangular female locking connectors 212. Once disengaged, the interlocking members 186 are free to rotate relative to the two upper unit stationary mounts 202 while still being coupled to the first and second pivoting handle mount 178, 182 connected to the handle 28. Therefore, the trigger shaft 170, first and second pivoting handle mount 178, 182 and interlocking members 186 all rotate together with the handle 28, while the two upper unit stationary mounts 202 connected to the upper unit 12 do not pivot.

[0065] When the handle is returned to the upright position as shown in FIG. 4 and the trigger 162 is in the locked position, the retention springs 198 move the interlocking members 186 towards the shaft wedge 174 such that the male locking connectors 194 engage the rectangular female locking connectors 212 and rotation of the handle 28 is prevented. It will be understood the retention springs 198 may have a spring rate that is optimized to along for disengaging movement the interlocking members 186 by a user linearly moving the trigger 162 and to overcome all resistive forces such as friction and weight in order to provide for engaging movement of the interlocking members 186. It is contemplated that the trigger shaft 170 can optionally be configured to actuate one or more additional interlocking members 186 to provide increased strength of the interlocking mechanism 172 and increased torsional stiffness at the handle coupler 30 joining the handle 28 to the upper unit 12. The at least one additional locking member (not shown) can function in a substantially similar way as the previously disclosed locking member 186, but can include an alternate structure, such as a cylindrical pin, for example.

[0066] The vacuum cleaner 10 disclosed herein provides improved cleaning performance and ease of use. One advantage that may be realized in the practice of some aspects of the described vacuum cleaner 10 is that the vacuum cleaner 10 can be configured to selectively provide increased suction to the edges of the suction nozzle 42 so as to increase cleaning potential along edges and walls. Furthermore, the edges or walls to be cleaned may be automatically illuminated to increased user visibility by the user. Another advantage is that the vacuum cleaner 10 can be configured such that the handle 28 may be easily folded by a simple pull of the trigger 162 by a user.

[0067] By incorporating the communication method as described with respect to FIGS. 1-2 in the vacuum cleaner 10 as described in FIGS. 3-19, a variety of functions and features of the vacuum cleaner 10 can be controlled by the power source 34 via the power line, or electrical conductor leads 68. Rather than requiring a separate communications line coupling the electronic controls of the upper unit 12 with the base unit 14, a toggle switch 73 (FIG. 5) can be operably coupled with the power line or electrical conductor leads 68 to introduce a PWM signal via the power line or electrical conductor leads 68 in response to inputs from the electronic controls of the upper unit 12, which can be considered the user control portion, and to effect operation of a function or component at the base unit 14, which can be considered the surface cleaning portion. Non-limiting examples of such exemplary functions, components, and features that can be controlled include the diverter assembly 50, 50', including the solenoid piston 56 and the inductive coil, edge illuminators 60 for operating in an edge mode, the pivoting pedal 108, and the switch 70. It will be understood that communicating via the power line or electrical conductor leads 68 can be used to control any function or component of the vacuum cleaner 10. Any suitable function or component can be controlled such that the PWM signal input sensed by the PCB 74 or other controller 77 signals the PCB 74 or other controller 77 to effect a change or an action.

[0068] FIG. 20 is a schematic view of various functional systems of a surface cleaning apparatus 2 in the form of an exemplary vacuum cleaner 310. The functional systems of the exemplary vacuum cleaner 310 can be arranged into any desired configuration including as a portable cleaner adapted to be hand carried by a user for cleaning relatively small areas. The vacuum cleaner 310 can be adapted to include a hose or other conduit, which can form a portion of the working air conduit between a nozzle and the suction source.

[0069] The vacuum cleaner 310 can include a recovery system 314 for removing debris from the surface to be cleaned and storing the debris. The recovery system 314 can include a suction inlet or suction nozzle 316, a suction source 318 in fluid communication with the suction nozzle 316 for generating a working air stream, and a recovery container 320 for separating and collecting debris from the working airstream for later disposal.

[0070] The suction nozzle 316 can be provided on a base or cleaning head adapted to move over the surface to be cleaned. An agitator 326 can be provided adjacent to the suction nozzle 316 for agitating the surface to be cleaned so that the debris is more easily ingested into the suction nozzle 316. Some examples of agitators 326 include, but are not limited to, a horizontally-rotating brushroll, dual horizontally-rotating brushrolls, one or more vertically-rotating brushrolls, or a stationary brush.

[0071] The suction source 318 can be any suitable suction source and is provided in fluid communication with the recovery container 320. The suction source 318 can be electrically coupled to a power source 322, such as a battery or by a power cord plugged into a household electrical outlet. A suction power switch 324 between the suction source 318 and the power source 322 can be selectively closed by the user, thereby activating the suction source 318.

[0072] A separator 321 can be formed in a portion of the recovery container 320 for separating entrained debris from the working airstream.

[0073] The vacuum cleaner 310 shown in FIG. 20 can be used to effectively remove debris from the surface to be cleaned in accordance with the following method. The sequence of steps discussed is for illustrative purposes only and is not meant to limit the method in any way as it is understood that the steps may proceed in a different logical order, additional or intervening steps may be included, or described steps may be divided into multiple steps.

[0074] In operation, the vacuum cleaner 310 is prepared for use by coupling the vacuum cleaner 310 to the power source 322. During operation of the recovery system 314, the vacuum cleaner 310 draws in debris-laden working air through the suction nozzle 316 and into the downstream recovery container 320 where the fluid debris is substantially separated from the working air. The airstream then passes through the suction source 318 prior to being exhausted from the vacuum cleaner 310. The recovery container 320 can be periodically emptied of collected fluid and debris.

[0075] FIG. 21 is a perspective view illustrating that the vacuum cleaner 310 can include a housing 330 with an upright assembly 332 and a base assembly 334. The upright assembly 332 can be pivotally connected to the base assembly 334 for directing the base assembly 334 across the surface to be cleaned. It is contemplated that the vacuum cleaner 310 can include any or all of the various systems and components described in FIG. 20, including a recovery system 314 for separating and storing dirt or debris from the surface to be cleaned. The various systems and components schematically described for FIG. 20 can be supported by either or both the base assembly 334 and the upright assembly 332 of the vacuum cleaner 310.

[0076] FIG. 22 illustrates a partially-exploded view of the vacuum cleaner 310 of FIG. 21. The upright assembly 332 includes a hand-held portion 336 supporting components of the recovery system 314, including, but not limited to, the suction source 318 and the recovery container 320. By way of non-limiting example, the suction source 318 can includes a motor/fan assembly 424 (FIG. 27).

[0077] The hand-held portion 336 can be coupled to a wand 340 having at least one wand connector 342. In the illustrated example, both a first end 344 of the wand 340 and a second end 346 of the wand 340 include a wand connector 342. The wand connector 342 at the second end 346 of the wand 340 can be coupled to the base assembly 334 via a wand receiver 348. The wand connector 342 at the first end 344 of the wand 340 can couple to a second wand receiver 350 within the hand-held portion 336. It is contemplated that the wand connectors 342 can be the same type of connector or can vary. Any suitable type of connector mechanism can be utilized, such as a quick connect mechanism or a tubing coupler in non-limiting examples.

[0078] A pivotal connection between the upright assembly 332 and the base assembly 334 can be provided by at least one pivoting mechanism. In the illustrated example, the pivoting mechanism can include a multi-axis swivel joint assembly 352 configured to pivot the upright assembly 332 from front-to-back and side-to-side with respect to the base assembly 334. A lower portion 354 of the swivel joint assembly 352 is located between the wand 340 and the base assembly 334. The lower portion 354 of the swivel joint assembly 352 provides for pivotal forward and backward rotation between the wand 340 and the base assembly 334. An upper portion 356 of the swivel joint assembly 352 is also located between the wand 340 and the base assembly 334 and provides for lateral or side-to-side rotation between the wand 340 and base assembly 334. More specifically, the lower portion 354 of the swivel joint assembly 352 is coupled between the base assembly 334 and the upper portion 356 of the swivel joint assembly 352. The upper portion 356 of the swivel joint assembly 352 is coupled to the wand receiver 348 at the second end 46 of the wand 340. Wheels 358 can be coupled to the lower portion 354 of the swivel joint assembly 352 or directly to the base assembly 334, and are adapted to move the base assembly 334 across the surface to be cleaned.

[0079] The hand-held portion 336 can also include the recovery container 320, illustrated herein as a dirt separation and collection module 360 fluidly coupled to the suction source 318 via an air outlet port 362. The dirt separation and collection module 360 can be removable from the hand-held portion 336 by a release latch 364 as shown so that it can be emptied of debris.

[0080] An upper end of the hand-held portion 336 can further include a hand grip 366 for maneuvering the vacuum cleaner 310 over a surface to be cleaned and for using the vacuum cleaner 310 in hand-held mode. At least one control mechanism is provided on the hand grip 366 and coupled to the power source 322 (FIG. 20) for selective operation of components of the vacuum cleaner 310. In the contemplated example, the at least one control mechanism is an electronic control that can form the suction power switch 324.

[0081] The agitator 326 of the illustrated example includes a brushroll 370 (FIG. 23) configured to rotate about a horizontal axis and operatively coupled to a drive shaft of a drive motor via a transmission, which can include one or more belts, gears, shafts, pulleys, or combinations thereof. An example of which will be explained in more detail below. An agitator housing 372 is provided around the suction nozzle 316 and defines an agitator chamber 374 (FIG. 23) for the brushroll 370 (FIG. 23).

[0082] Referring now to FIG. 23, a recovery airflow conduit 375 can be formed between the agitator housing 372 and the dirt separation and collection module 360. For example, a hose conduit 376 in the base assembly 334 can be fluidly coupled to a wand central conduit 378 within the wand 340. The hose conduit 376 can be flexible to facilitate pivoting movement of the swivel joint assembly 352 about multiple axes. The wand central conduit 378 is fluidly connected to a dirt inlet 380 on the dirt sep-

aration and collection module 360 via the air outlet port 362.

[0083] In the illustrated example, the power source 322 is in the form of a battery pack 382 containing one or more batteries, such as lithium-ion (Li-Ion) batteries. Optionally, the vacuum cleaner 310 can include a power cord (not shown) to connect to a wall outlet. In still another example, the battery pack 382 can include a rechargeable battery pack, such as by connecting to an external source of power to recharge batteries contained therein.

[0084] During operation of the vacuum cleaner 310, the power source 322 can supply power for the suction source 318, such as by way of non-limiting example a motor/fan assembly 424 (FIG. 27) to provide suction through the recovery airflow conduit 375. Debris-laden working air within the agitator housing 372 can be directed through the flexible hose conduit 376 and wand central conduit 378 before flowing into the dirt separation and collection module 360 by way of the dirt inlet 380 as shown. In addition, the swivel joint assembly 352 can provide for forward/backward and side-to-side pivoting motion of the upright assembly 332 with respect to the base assembly 334 when moving the base assembly 334 across the surface to be cleaned. Additional details of the motor/fan assembly 424 (FIG. 27) are described in US. Patent No. 10,064,530, issued Sep. 4, 2018.

[0085] FIG. 24 illustrates an exemplary hand grip 366 that can be utilized in the vacuum cleaner 310. The hand grip 366 can include a user interface 384 with at least one status indicator for a component of the vacuum cleaner 310. The status indicator is illustrated in the form of a suction level indicator 386 and a battery level indicator 388. While not shown, other status indicators can be provided on the user interface 384. In non-limiting examples, an LED or text display (not shown) can also indicate that a filter is clogged, that the recovery container 320 needs emptying, or that a brushroll 370 needs cleaning or inspecting.

[0086] The suction level indicator 386 is illustrated as being positioned at lateral edges of the user interface 384 and can illuminate to show a current level of suction power. More specifically, three progressively-illuminated LEDs 390 can be positioned at each lateral edge to indicate a level of suction between "high," "medium," and "low" suction powers for the suction level indicator 386. For example, repeated pressing of a suction mode selector button 392 can cycle through the "high," "medium," and "low" suction power levels, and each LED 390 of the suction level indicator 386 can illuminate in sequence accordingly. In the illustrated example, the "medium" suction power level is shown wherein two of the three LEDs 390 are illuminated on the suction level indicator 386 of the user interface 384. It will be understood that, in the illustrated example, the suction mode selector button 392 is configured to operate the suction source 318 (FIG. 21) with low, medium, and high suction power, which in turn operates the suction source 318 including the motor/fan assembly 424 (FIG. 27) at predetermined low, medium and high rotational speeds. Further still, a power button 394 can be positioned adjacent the suction mode selector button 392 or elsewhere on the user interface 384 to selectively power the suction source 318.

[0087] It will be understood that the modes or options presented to a user may not be labeled as "high," "medium," and "low" instead the modes can correlate to "modes" such as carpet, hard floor, and edge. While the mode selector has been illustrated as a button it could be any suitable user control including a switch or other mechanism. Regardless of the specific mechanism utilized it will be understood that the mode selector button 392 can also be configured to operably couple with a toggle switch 373 (FIG. 20) which in a non-limiting example includes a solid-state switch. The toggle switch 373 can receives an input from the mode selector button 392 via the power line 368 and any suitable conductors, the input from the mode selector button 392 indicative of the mode selected by the user.

[0088] The battery level indicator 388 is in the form of a series of lights, such as light-emitting diodes (LEDs) 396 that progressively illuminate to show a level of charge of the battery pack 382. In an alternate example, the battery level indicator 388 can be in the form of a pre-drawn icon displayed on a screen to indicate a level of charge of the battery pack 382.

[0089] FIG. 25 illustrates an exploded view of the hand grip 366 of FIG. 24, which more clearly illustrates that the LEDs 390 and 396 can be provided within a substructure of the hand grip 366. An upper grip 400 with an aperture 402 configured to receive and surround the power button 394 and suction mode selector button 392. A lower grip 404 coupled to the upper grip 400 can include a reflective concave portion 406, such as a white-colored or reflective or mirrored surface. The lower grip 404 can also include a plurality of divider walls 408 to isolate light emitted by the LEDs 390 and 396. The LEDs 390 (FIG. 26) and 396 (FIG. 24) for the suction level indicator 386 and the battery level indicator 388, respectively, can be positioned on a printed circuit board (PCB) 410. In addition, an isolator 412 can be coupled to the PCB 410 and include a first seat 416a for the power button 394 and a second seat 416b for the suction mode selector button 392. The isolator 412 can include openings 418a, 418b along each lateral edge to permit light for the suction level indicator 386 to be emitted. The isolator 412 can further include additional openings 420 through which the LEDs 396 can shine for the battery level indicator 388.

[0090] FIG. 26 illustrates the assembled hand grip 366. As assembled within the hand grip 366, the PCB 410 defines a lower surface 414a and an upper surface 414b. The LEDs 390 for the suction level indicator 386 are positioned on the lower surface 414a of the PCB 410 and emit light downward, toward the lower grip 404 as illustrated by first arrows 423. The reflective concave portion 406 of the lower grip 404 reflects the emitted light upward, toward the upper grip 400. Over-molded portions 422 of the lower grip 404 can block or redirect emitted light from

the LEDs 390 to shine upwardly toward the isolator 412. The openings 418a, 418b along each lateral edge of the isolator 412 permit the emitted light to shine through at the edges of the upper grip 400, as indicated via arrow 425, thereby forming the suction level indicator 386 at each lateral edge of the hand grip 366. It is further contemplated that the upper grip 400 can include molded or shaped portions to further direct or diffuse the emitted light, such as a translucent portion forming a viewing window for each LCD in the suction level indicator 386.

[0091] Turning to FIG. 27, the assembled hand-held portion 336 of the upright assembly 332 is shown including a portion of the wand 340, the battery pack 382, the hand grip 366, the motor/fan assembly 424, and the dirt separation and collection module 360.

[0092] As illustrated, a wand axis 426 can be defined through the center of the wand 340 (FIG. 23) and wand connector 342. In FIG. 27 the wand 340 is held upright, and thus the wand axis 426 is vertical. In this example, references to "a vertical axis" will be understood to also refer to the wand axis 426. It will be understood, that during use the wand 340 may be oriented in any suitable manner including angled with respect to the vertical axis.

[0093] A collector axis 428 can be defined through the center of the dirt separation and collection module 360, and a motor axis 430 can be defined through the center of the motor/fan assembly 424. It is contemplated that the wand axis 426, the collector axis 428, and the motor axis 430 can all be parallel to one another as shown. Put another way, when the wand 340 is held upright such that the wand axis 426 is vertical, the collector axis 428 and the motor axis 430 are also vertical.

[0094] A grip axis 432 can be defined through the center of the hand grip 366 as shown. The grip axis 432 forms a grip angle 434 with respect to a vertical direction, such as 60 degrees in a non-limiting example. Further, a battery axis 436 can be defined through the center of the battery pack 382 and intersect the grip axis 432. The battery axis 436 can also define a battery angle 438 with respect to a vertical direction, such as 30 degrees in a non-limiting example. Optionally, the grip axis 432 can be orthogonal to the battery axis 436.

[0095] FIG. 28 illustrates additional details of the dirt separation and collection module 360. The dirt separation and collection module 360 can include a dirt cup in the form of recovery container 320 with an inlet port in the form of the dirt inlet 380, and a separator assembly 440 coupled to the recovery container 320. Working air can enter through the dirt inlet 380 and swirls around a first stage separator assembly chamber 444 for centrifugally separating debris from the working air flow. The separator assembly 440 includes a first stage separator 442, such as a grill, that, in combination with the swirling working air, removes relatively large debris out of the working air which collects at a lower portion of the recovery container 320 defining a first stage collection area 446.

[0096] The working air moves through an inlet to a second stage separator 448 in the separator assembly 440, such as a grill or a mesh configured to filter smaller debris, and enters a second stage separation chamber 450, which is shown as a cyclonic separator herein. Smaller debris removed from the working air collects in a second stage collector 452 near the bottom of the recovery container 230. The first stage collector 446 can surround the second stage collector 452 as shown.

[0097] An exhaust outlet 454 and filter housing 458 are fluidly coupled to an upper portion of the second stage separation chamber 450. With additional reference to FIG. 27, working air exits the second stage separation chamber 450 through the exhaust outlet 454 and at least one filter in the filter housing 458 and which is shown herein as a pre-motor filter 456 of the motor/fan assembly 424. The filtered working air flows into the motor/fan assembly 424 whereupon it can be exhausted into the surrounding atmosphere through an exhaust filter, i.e. a post-motor filter 455, and an air outlet of the working air pathway through the vacuum cleaner 310, which is shown herein as formed by an exhaust grill 453.

[0098] The outer surface of the first stage separator 442 can accumulate debris, such as hair, lint, or the like that may become stuck thereon and may not fall into the first stage collection area 446. FIG. 29A shows the separator assembly 440 being removed and FIG. 29B shows the separator assembly 440 fully removed from the recovery container 320 to empty collected dirt and debris from the first and second stage collection areas 446 and 452.

[0099] The separator assembly 440 can further include a ring 461 slidably coupled to the recovery container 320. The ring 461 can be coupled to a wiper 460, such as an annular wiper, configured to contact the first stage separator 442. The separator assembly 440 can be lifted upwards with respect to the ring 461 and recovery container 320. During this lifting, the ring 461 temporarily remains coupled to the recovery containers 20, either by friction fit or a mechanical coupling such as bayonet hook, for example, and the wiper 460 slides or scrapes along the first stage separator 442 to remove accumulated debris from the outer surface of the first stage separator 442 or grill, which falls down to the first stage collection area 446.

[0100] When the separator assembly 440 has been raised to a predetermined level, it can lift away from the recovery container 320 along with the ring 461 and wiper 460. The recovery container 320 can then be inverted to remove dirt and debris from the first and second stage collection areas 446 and 452. After emptying, the separator assembly 440 can be repositioned within the recovery container 320 and the ring 461 can once again be coupled to the recovery container 320 for additional use of the vacuum cleaner 310.

[0101] FIG. 30 shows additional details of an exemplary wand assembly, which can include a wand body 462 enclosing the wand central conduit 378. In one example, the wand body 462 can be formed from an extrusion of

aluminum, and is illustrated as having an exterior rounded triangular geometric profile defining an outer periphery 468 (FIG. 31). Wand connectors 342 can couple to the wand body 462 at each end 344 and 346. A first wand connector 342 can couple the wand body 462 to the base assembly 334 and a second wand connector 342 can couple the wand body 462 to the hand-held portion 336 (FIG. 22).

[0102] A decorative insert 466 can be coupled to at least a portion of the wand body 462. In the illustrated example, the decorative insert 466 can be in the form of a flat plate and configured to couple to a recessed portion defining a face 464 of the triangular shaped wand body 462. Optionally, the decorative insert 466 can included rounded edges to form smooth surface transitions between an outer surface of the decorative insert and a second face of the wand body. It is contemplated that the decorative insert 466 can be formed of plastic, including transparent or translucent plastic. Optionally, the decorative insert 466 can include logos or other markings or indicators for operations of the vacuum cleaner 310, or locating features so as to couple a correct end of the wand body 462 to one of the base assembly 334 or hand-held portion 336 of the upright assembly 332, for example.

[0103] FIG. 31 illustrates a sectional view of the wand 340. It is contemplated that the wand body 462 can include an outer wall defining the outer periphery 468 with at least one inner partition 470 defining the wand central conduit 378. The outer wall defining the outer periphery 468 is further illustrated as including a hook 472 defining a corresponding recess 474 on either side of the face 464. Protrusions 476 on either side of the decorative insert 466 can be received within the recesses 474. It is contemplated that the protrusions 476, or the entire decorative insert 466, can have material flexibility such that the protrusions 476 can be "snap-fit" into the recesses 474 of the wand body 462. In another non-limiting example, the protrusions 476 can be made of a material having higher elasticity than that of a remainder of the decorative insert 466, such as a plastic decorative insert having rubber hooked portions configured to snap-fit or snugly insert into the recesses 474 of the wand body 462.

[0104] FIG. 32 illustrates another example of a wand assembly that can be utilized in the vacuum cleaner 310. In the illustrated example, the wand body 462a can have a generally V-shaped geometric profile with an open face 463 on one side, such as by forming a V-shaped extrusion of aluminum. A tubular member 465 can be coupled within the wand body 462a. The tubular member 465 can have an inner surface defining the wand central conduit 378a, and an outer surface shaped to form a smooth surface transition between the tubular member 465 and the wand body 462a.

[0105] FIG. 33 illustrates a sectional view with the tubular member 465a assembled within the wand body 462a. The wand body 462a can have an outer wall 468a with at least one projection 476a. The tubular member 465a can have a corresponding at least one recess 472c formed by spaced walls 472a and 472b. The at least one recess 472c is configured to surround the at least one projection 476a to securely fix the tubular member 465a in place. In one example, the at least one projection 476a can be formed from an elastic material to provide "snap-fit" coupling between the tubular member 465a and wand body 462a. In another example, the wand body 462a can have sufficient elasticity such that the tubular member 465a can be press-fit into the wand body 462a, and the at least one projection 476a can "snap" into place within the corresponding at least one recess 472c.

[0106] The tubular member 465a can be formed from a transparent material such as extruded thermoplastic or polycarbonate material. In such a case, the assembled wand would include a transparent face defined by the exposed face of the tubular member 465a when assembled within the wand body 462a. In this configuration, a transparent tubular member would provide visibility within the wand central conduit 378a, such that dirt and debris moving through the conduit would be visible to a user during operation of the vacuum cleaner 310. Additionally, potential obstructions or clogs within the tubular member could also be viewed in a facile manner through the transparent tubular member. A transparent section 467 has been illustrated in the tubular member 465a by way of non-limiting example.

[0107] FIG. 34 illustrates one example of a base assembly 334. The base assembly 334 can extend between a first side 480 and a second side 482 and a cover 484 can at least partially define the agitator chamber 374 therebetween. An aperture 486 is located in a portion of the second side 482 and allows for insertion and removal of the brushroll 370. A front bar 488 extends between the first side 480 and the second side 482 along a lower portion of the base assembly. The front bar 488 is configured to be located behind the cover 484 when the cover 484 is mounted. A headlight array 490 is illustrated as being located on the front bar 488 and extending along the width of the base assembly between the first side 480 and the second side 482. The headlight array 490 can be any suitable illumination assembly including an LED headlight array. Even though the headlight array 490 is positioned under the cover 484 it can be considered to be positioned along an outer portion of the base assembly 334. In one example, the cover 484 can include a transparent portion such that when installed, the transparent portion covers and protects the headlight array 490 and permits emitted light to shine through to the surface to be cleaned. In another example, the cover 484 can leave the headlight array 490 uncovered so as not to block emitted light from the headlight array 490.

[0108] A brushroll 370 can be positioned within the agitator chamber 374 by sliding a first end through the aperture 486 located at the second side 482 of the base assembly 334. When fully inserted, a second end 370b of the brushroll 370 can be flush with the aperture 486. In addition, the hose conduit 376 can fluidly couple the

agitator chamber 374 to the wand central conduit 378 (FIG. 23).

[0109] The base assembly 334 can include a brush drive assembly 492 positioned opposite the aperture 486 and configured to drive rotational motion of the agitator 326 (e.g. brushroll 370) within the agitator chamber 374. The brush drive assembly 492 can have components including, but not limited to, a brush motor 526, a belt 528 within a belt housing 529, and a brush drive gear 520.

[0110] Additional details of the brushroll 370 are shown in FIG. 35. The first end of the brushroll 370 can include an end plate 494 having projections 496, such as teeth, configured to engage a portion of the brush drive assembly 492 (FIG. 34). The brushroll 370 further includes a central shaft 522 coupled to brush bearings 524 (FIG. 36) at each end. In the illustrated example, the brushroll 370 includes a bristled brushroll 370 with offset, swept tufts 502 extending along an outer surface of the brushroll 370. The bristle tufts 502 can be positioned offset from a center line 504 of a tufting platform 506, and the tufts 502 can also be non-orthogonal to the tufting platform 506. In this manner, the bristled brushroll 370 can be configured to prevent hair from wrapping around the brushroll 370 during operation. Additional details of a similar brushroll are described in U.S. Publication No. 2018-0125315,

[0111] The assembled base assembly 334 is shown in FIG. 36, where the projections 496 of the end plate are coupled with the brush drive gear 520. In this manner the brush drive gear 520 is also coupled to the shaft 522 by way of a drive gear bearing. With additional reference to FIG. 34, as the brush motor 526 drives rotation of the belt 528 and brush drive gear 520, the brushroll 370 can be rotated at a variety of speeds depending on the selected suction mode (FIG. 24). A brush removal endcap 530 at the second end of the brushroll 370 provides for unlocking or removal of the brushroll 370 from the agitator chamber 374, such as for cleaning of the bristle tufts 502.

[0112] It is contemplated that a variety of agitators 326 and brushrolls 370 can be utilized within the agitator chamber 374. FIG. 37 illustrates a microfiber brushroll 510 that can be utilized. The microfiber brushroll 510 is similar to the bristled brushroll 370; one difference is the outer surface includes a microfiber layer instead of bristles. Whereas bristles can be utilized to lift hair and debris from carpet fibers, the microfiber layer can lift dirt and debris from hard surfaces such as wood or tile. Each of the brushrolls can include a brush removal endcap 498 including fasteners 512. In the illustrated example, the fasteners 512 include bayonet fasteners wherein a given brushroll is inserted through the aperture 486 and rotated, for example by 30 degrees, to lock the brushroll into place within the agitator chamber 374 (FIG. 38) via corresponding fastener receivers 514. It will be understood that other brushroll types not explicitly described can be utilized in the vacuum cleaner 310.

[0113] FIG. 38 illustrates the base assembly 334 sitting on a surface to be cleaned, the surface to be cleaned defining a first plane 530. As illustrated in cross-sectional view a center line of the headlight array 490 can be defined as a second plane 532. The second plane 532 is spaced above the first plane defined by the surface to be cleaned by a height 534. It has been determined that providing the headlight array 490 close to the first plane 530 and relatively low on the base assembly 334 provides unexpected benefits. The height can be any suitable small height that provides such benefits including, by way of non-limiting examples, spaced above the surface to be cleaned at not more than 30 mm, at less than 20 mm, and at 15.8 mm. Further still, by way of non-limiting example, the illuminance measurements as a delta from ambient values at 2 meters from the headlight array 490 can be 16 Lux and at 10 cm can be greater than 1000 Lux. In another example, the headlight array 490 can be aligned with the lower front edge of the front bar 488.

[0114] More specifically, during operation of the vacuum cleaner 310 when the headlight array 490 provides illumination it has been determined that the placement of the headlight array 490 in this very low position across the front of the base assembly 334 illuminates the surface to be cleaned very well, including that dust and/or debris are illuminated exceptionally well. It has been determined that performance is noticeably better as compared to when LEDs are mounted higher up and pointing downwardly at the surface to be cleaned. Because of the low position of the headlight array 490 and because the headlight array 490 faces forward and projects illumination at substantially a horizontal projection along the second plane 532 shadows are cast by debris on the surface to be cleaned and these shadows are very obvious to a user of the vacuum cleaner 310. It will be understood that the beam provided by the headlight array 490 can be projected with a zero-degree angle that provides a beam that is parallel to the surface to be cleaned as defined by the first plane 530.

[0115] By incorporating the communication method as described with respect to FIGS. 1-2 in the vacuum cleaner 310 as described in FIGS. 20-38, a variety of functions and features of the vacuum cleaner 310 can be controlled a power line 368 or one or more conductor leads. By way of non-limiting example, a power communication system can be utilized rather than requiring a separate communications line to couple the electronic control of the upright assembly with the base assembly. More specifically, the power communication system of the vacuum cleaner 310 can include the power line 368 and at least one user control in the form of the suction mode selector button 392, and a toggle switch 373 (FIG. 20), which is operably coupled with the power line 368 to introduce a PWM signal via the power line 368 in response to inputs from the suction mode selector button 392 to effect operation of a function or component at the base assembly 334. A separate processor or controller such as the controller 377 can be included in the base assembly 334 and be configured to receive the PWM signal via the power line 368. Alternatively, or additionally, a controller can be in-

cluded in the component itself located in the base assembly 334 such as a motor controller for the brush motor 526. Further still, the controller 377 can be separate from a "main controller" (not shown) that can control portions of the upright assembly such as the motor/fan assembly.

[0116] The controller 377 can be configured to receive the PWM signal provided by the power communication system via the power line 368 or various conductor leads. More specifically, during operation the suction mode selector button 392 can be utilized to select one of the mode. As explained above the mode can refer to an operational mode such as the type of flooring or to a suction level by way of non-limiting examples.

[0117] The toggle switch 373 can receive an input from the mode selector button 392 via the power line 368 and any suitable conductors, the input from the mode selector button 392 is indicative of the mode selected by the user. The toggle switch 373 can then introduce a PWM signal to the controller 377 over the power line 368, the PWM signal provided to the controller 377 via the power line 368 corresponding to the mode input received by the mode selector button 392 or other user controls. In this way, the mode selected by the user at the mode selector button 392 generates an input to the toggle switch 373 that determines the pulse width of the PWM signal then provided from the toggle switch 373 to the controller 377 to cause an operation at the base assembly 334 that corresponds to the mode selected by the user.

[0118] It is contemplated that during operation of the vacuum cleaner 310 that no mode may be selected and that the toggle switch 373 is not introducing a PWM signal over the power line 368 and the signal transmitted over the power line 368 to the controller 377 is typically high or uninterrupted, and can be thought of as representing 100% power transmission. When a communication signal is transmitted from the user control, including but not limited to the suction mode selector button 392, this can provide an input indicating a different mode of operation to the toggle switch 373 and the toggle switch 373 is prompted to introduce or toggle the PWM signal over the power line 368.

[0119] It is contemplated that the vacuum cleaner 310 may only be operational in a mode or when a suction mode is selected. By way of further non-limiting example it is contemplated that a first mode can include an auto sensing mode and that when this mode is selected an 80% duty cycle can provide an input to the controller 377 to indicate that one or more components of the base assembly 334 should be operated in the auto sensing mode, a 60% duty cycle can provide an input to the controller 377 to indicate that one or more components of the base assembly 334 should be operated in the carpet mode, a 40% duty cycle can provide an input to the controller 377 to indicate that one or more components of the base assembly 334 should be operated in the hard floor mode. The controller 377 as part of the powerline communication system is configured to affect a particular function or control of one or more components in response to the characteristics of the PWM signal received. The powerline communication system can be utilized to control any number of features and functions. Further, non-limiting examples of such functions, components, and features that can be controlled individually or in combination include an agitator 326 or brush motor 526, a headlight array 490, or other components or functions provided at the base assembly 334.

[0120] It will be understood that the above disclosure provides for a number of benefits including co-opting the power line or electrical conductor leads by using powerline communications. The powerline communication system and surface cleaners utilize a PWM signal, which is introduced over line or leads and a signal is encoded by either the duty cycle of the PWM signal or the frequency of the PWM signal, which will be understood to be the inverse of the pulse width modulation. The signal is intermittent, in that during operation, the power line or electrical lead is primarily high and when a communication signal is transmitted, a solid state switch toggles the PWM signal over the line and then the line returns to high such that the DC power is essentially uninterrupted as far as the load at the foot is concerned.

[0121] To the extent not already described, the different features and structures of the various aspects of the present disclosure may be used in combination with each other as desired. Thus, the various features of the different aspects may be mixed and matched as desired to form new aspects, whether or not the new aspects are expressly described.

[0122] Further aspects of the invention are provided by the subject matter of the following clauses:

1. A powerline communication system for controlling a function or operation of at least one component within a surface cleaning device, the powerline communication system comprising a power source, at least one user control adapted to receive an input from a user, a controller located remotely from the at least one user control and configured to control operation of the at least one component, and a power line electrically coupling the power source, the controller, and the at least one component and wherein the power line is further adapted to provide a communication signal between the at least one user control and the controller.
2. The powerline communication system of any preceding clause wherein the power source includes a DC battery-powered power source.
3. The powerline communication system of any preceding clause, further comprising a switch configured to introduce the communication signal over the power line as a pulse width modulation signal based on the input received by the at least one user control.
4. The powerline communication system of any preceding clause wherein the controller is configured to determine one of a duty cycle of the pulse width modulation signal or a frequency of the pulse width mod-

ulation signal and the controller is configured to operate the at least one component based thereon.

5. The powerline communication system of any preceding clause wherein the controller is in a base of the surface cleaning device and the user control is in a handle.

6. The powerline communication system of any preceding clause wherein the communication signal is intermittently transmitted and electrical power at the base is substantially uninterrupted.

7. The powerline communication system of any preceding clause wherein the at least one user control is a mode selector configured to select one of a predefined set of modes.

8. A vacuum cleaner, comprising: a base assembly including a base housing having a suction nozzle and adapted for movement along a surface to be cleaned; an upper unit pivotally coupled to the base housing and having a handle; at least one user control located on the upper unit, the at least one user control adapted to receive an input from a user; a suction source in fluid communication with the suction nozzle for generating a working airstream through the vacuum cleaner; a power source; at least one electrical component provided with the base housing; a controller located remotely from the at least one user control and configured to control operation of the at least one electrical component; and a power line electrically coupling the power source, the controller, and the at least one electrical component and wherein the power line is further adapted to transmit a communication signal between the at least one user control and the controller.

9. The vacuum cleaner of any preceding clause wherein the power source includes a DC battery-powered power source.

10. The vacuum cleaner of any preceding clause, further comprising a switch configured to introduce the communication signal over the power line in the form of a pulse width modulation signal based on the input received by the at least one user control.

11. The vacuum cleaner of any preceding clause wherein the controller is configured to determine one of a duty cycle of the pulse width modulation signal or a frequency of the pulse width modulation signal and the controller is configured to operate the at least one electrical component based thereon.

12. The vacuum cleaner of any preceding clause wherein the controller is provided with the base housing and the at least one user control is on the handle.

13. The vacuum cleaner of any preceding clause wherein the communication signal is intermittently transmitted and electrical power at the base assembly is substantially uninterrupted.

14. The vacuum cleaner of any preceding clause wherein the at least one user control is a mode selector configured to select one of a plurality of predefined set of modes.

15. The vacuum cleaner of any preceding clause wherein the switch is configured to introduce a different duty cycle of the pulse width modulation signal for each of the plurality of predefined set of modes.

16. The vacuum cleaner of any preceding clause wherein the base assembly further comprises an agitator chamber at the suction nozzle and the at least one electrical component is a motor operably coupled to an agitator therein.

17. The vacuum cleaner of any preceding clause wherein the handle is defined on a hand-held portion, the hand-held portion having a hand grip and the suction source.

18. The vacuum cleaner of any preceding clause wherein the at least one electrical component is a headlight array located along a forward oriented portion of the base housing, providing a beam that is substantially parallel to the surface to be cleaned and spaced above the surface to be cleaned at not more than 30 mm.

19. The vacuum cleaner of any preceding clause wherein a working air path is at least partially defined by a wand operably coupled between the base assembly and the hand-held portion and wherein the hand-held portion further comprises a debris removal assembly including a recovery container provided in fluid communication with the suction source and the suction source includes a motor/fan assembly operably coupled to the debris removal assembly to form a single, hand-carriable unit.

20. A method of communication for a surface cleaning apparatus, the method comprising outputting power via a DC battery-powered source through a power line; receiving a user input at a user control; generating an input to a toggle switch based on the receiving the user input; outputting a pulse width modulation signal along the power line to a controller during the outputting power; and operating, via the controller, a component of the surface cleaning apparatus based on the pulse width modulation signal.

[0123] While aspects of the present disclosure have been specifically described in connection with certain specific aspects thereof, it is to be understood that this is by way of illustration and not of limitation. Reasonable variation and modification are possible within the scope of the forgoing invention which is defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the aspects disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

Claims

1. A powerline communication system (2) for controlling a function or operation of at least one component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) of a surface

cleaning device (10, 310), the powerline communication system comprising:

a power source (4, 34, 72, 72', 322);
at least one user control (3, 75, 392) adapted to receive an input from a user;
a controller (5, 74, 77, 377) in a base (2b, 14, 334) of the surface cleaning device and located remotely from the at least one user control (3, 75, 392) provided in a handle (2a, 14, 334), the controller (5, 74, 77, 377) configured to control operation of the at least one component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526); and

a power line (6, 68, 368) electrically coupling the power source (4, 34, 72, 72', 322), the controller (5, 74, 77, 377), and the at least one component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) and wherein the power line (6, 68, 368) is further adapted to provide a communication signal between the at least one user control (3, 75, 392) and the controller (5, 74, 77, 377), **characterized in that** the communication signal is intermittently transmitted and electrical power at the base (2b, 14, 334) is substantially uninterrupted.

2. The powerline communication system (2) of claim 1 wherein the power source (4, 72, 72', 322) includes a DC battery-powered power source (4, 72, 72', 322).

3. The powerline communication system (2) of any one of claims 1-2, further comprising a switch (7, 73, 373) configured to introduce the communication signal over the power line (6, 68, 368) as a pulse width modulation signal based on the input received by the at least one user control (3, 75, 392).

4. The powerline communication system (2) of claim 3 wherein the controller (5, 74, 77, 377) is configured to determine one of a duty cycle of the pulse width modulation signal or a frequency of the pulse width modulation signal and the controller (5, 74, 77, 377) is configured to operate the at least one component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) based thereon.

5. The powerline communication system (2) of any one of claims 1-4 wherein the at least one user control (3, 75, 392) is a mode selector configured to select one of a predefined set of modes.

6. The powerline communication system (2) of any claims 1-5, wherein the surface cleaning device is a vacuum cleaner (10, 310), comprising:

a base assembly (2b, 14, 334) including a base housing having a suction nozzle (42 , 316) and adapted for movement along a surface to be cleaned;
an upper unit (12, 28, 332) pivotally coupled to the base housing and having a handle;
wherein the at least one user control (3, 75, 392) is located on the upper unit (2a, 28, 332), and a suction source (4, 72, 72', 322) in fluid communication with the suction nozzle for generating a working airstream through the vacuum cleaner.

7. The powerline communication system (2) of claim 6 wherein the at least one user control (3, 75, 392) is a mode selector configured to select one of a plurality of predefined set of modes and the switch is configured to introduce a different duty cycle of the pulse width modulation signal for each of the plurality of predefined set of modes.

8. The powerline communication system (2) of claim 6 or 7 wherein the base assembly (2b, 14, 334) further comprises an agitator chamber at the suction nozzle and the at least one electrical component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) is a motor operably coupled to an agitator therein or wherein the handle is defined on a hand-held portion, the hand-held portion having a hand grip and the suction source (4, 72, 72', 322) and the at least one electrical component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) is a headlight array located along a forward oriented portion of the base housing, providing a beam that is substantially parallel to the surface to be cleaned and spaced above the surface to be cleaned at not more than 30 mm.

9. A method of communication for a surface cleaning apparatus (10, 310) under use of a powerline communication system of claims 1 to 8, the method comprising:

outputting power via the DC battery-powered source (4, 72, 72', 322) through the power line (6, 68, 368) (6, 68, 368);
receiving a user input at the user control (3, 75, 392);
generating an input to the toggle switch based on the receiving the user input;
outputting a pulse width modulation signal along the power line (6, 68, 368) to a controller (5, 74, 77, 377) during the outputting power; and
operating, via the controller (5, 74, 77, 377), a component (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) of the surface cleaning apparatus based on the pulse width modulation signal.

Patentansprüche

1. Stromleitungskommunikationssystem (2) zum Steuern einer Funktion oder eines Betriebs mindestens

eines Bauteils (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) einer Oberflächenreinigungseinrichtung (10, 310), wobei das Stromleitungskommunikationssystem Folgendes umfasst:

eine Stromquelle (4, 34, 72, 72', 322);
mindestens ein Benutzerbedienelement (3, 75, 392), das angepasst ist, um eine Eingabe von einem Benutzer zu empfangen;
ein Steuerteil (5, 74, 77, 377) in einer Basis (2b, 14, 334) der Oberflächenreinigungseinrichtung, das sich von dem mindestens einen in einem Griff (2a, 14, 334) bereitgestellten Benutzerbedienelement (3, 75, 392) entfernt befindet, wobei das Steuerteil (5, 74, 77, 377) konfiguriert ist, um den Betrieb des mindestens einen Bauteils (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) zu steuern; und
eine Stromleitung (6, 68, 368), die die Stromquelle (4, 34, 72, 72', 322), das Steuerteil (5, 74, 77, 377) und das mindestens eine Bauteil (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) elektrisch koppelt, wobei die Stromleitung (6, 68, 368) ferner angepasst ist, um ein Kommunikationssignal zwischen dem mindestens einen Benutzerbedienelement (3, 75, 392) und dem Steuerteil (5, 74, 77, 377) bereitzustellen, **dadurch gekennzeichnet, dass** das Kommunikationssignal intermittierend übertragen wird und der elektrische Strom an der Basis (2b, 14, 334) im Wesentlichen dauerhaft ist.

2. Stromleitungskommunikationssystem (2) nach Anspruch 1, wobei die Stromquelle (4, 72, 72', 322) eine mit einer Gleichstrombatterie betriebene Stromquelle (4, 72, 72', 322) beinhaltet.

3. Stromleitungskommunikationssystem (2) nach einem der Ansprüche 1-2, das ferner einen Schalter (7, 73, 373) umfasst, der konfiguriert ist, um das Kommunikationssignal über die Stromleitung (6, 68, 368) als ein Impulsbreitenmodulationssignal basierend auf der durch das mindestens eine Benutzerbedienelement (3, 75, 392) empfangenen Eingabe einzuführen.

4. Stromleitungskommunikationssystem (2) nach Anspruch 3, wobei das Steuerteil (5, 74, 77, 377) konfiguriert ist, um entweder ein Tastverhältnis des Impulsbreitenmodulationssignals oder eine Frequenz des Impulsbreitenmodulationssignals zu bestimmen, und das Steuerteil (5, 74, 77, 377) konfiguriert ist, um das mindestens eine Bauteil (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) basierend darauf zu betreiben.

5. Stromleitungskommunikationssystem (2) nach einem der Ansprüche 1-4, wobei das mindestens eine Benutzerbedienelement (3, 75, 392) ein Moduswähler ist, der konfiguriert ist, um einen einer vordefinierten Menge von Modi zu wählen.

6. Stromleitungskommunikationssystem (2) nach einem der Ansprüche 1-5, wobei die Oberflächenreinigungseinrichtung ein Staubsauger (10, 310) ist, umfassend:

eine Basisbaugruppe (2b, 14, 334), die ein Basisgehäuse mit einer Ansaugdüse (42, 316) aufweist und zur Bewegung entlang einer zu reinigenden Oberfläche angepasst ist;
eine obere Einheit (12, 28, 332), die mit dem Basisgehäuse schwenkbar gekoppelt ist und einen Griff aufweist;
wobei sich das mindestens eine Benutzerbedienelement (3, 75, 392) auf der oberen Einheit (2a, 28, 332) befindet, und eine Ansaugquelle (4, 72, 72', 322) in Fluidverbindung mit der Ansaugdüse zum Erzeugen eines Arbeitsluftstroms durch den Staubsauger.

7. Stromleitungskommunikationssystem (2) nach Anspruch 6, wobei das mindestens eine Benutzerbedienelement (3, 75, 392) ein Moduswähler ist, der konfiguriert ist, um einen einer Vielzahl einer vordefinierten Menge von Modi zu wählen, und der Schalter konfiguriert ist, um für jeden der Vielzahl einer vordefinierten Menge von Modi ein anderes Tastverhältnis des Impulsbreitenmodulationssignals einzuführen.

8. Stromleitungskommunikationssystem (2) nach Anspruch 6 oder 7, wobei die Basisbaugruppe (2b, 14, 334) ferner eine Lockererkammer an der Ansaugdüse umfasst und das mindestens eine elektrische Bauteil (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) ein Motor ist, der betriebsbereit mit einem Lockerer darin gekoppelt ist, oder wobei der Griff auf einem in der Hand gehaltenen Abschnitt definiert ist, wobei der in der Hand gehaltene Abschnitt einen Handgriff und die Ansaugquelle (4, 72, 72', 322) aufweist und das mindestens eine elektrische Bauteil (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) eine entlang eines nach vorne gerichteten Abschnitts des Basisgehäuses platzierte Vorderleuchtenanordnung ist, die einen Strahl bereitstellt, der zu der zu reinigenden Oberfläche im Wesentlichen parallel und über der zu reinigenden Oberfläche um höchstens 30 mm beabstandet ist.

9. Verfahren zur Kommunikation für eine Oberflächenreinigungseinrichtung (10, 310) bei Verwendung eines Stromleitungskommunikationssystems nach den Ansprüchen 1 bis 8, wobei das Verfahren Folgendes umfasst:

Ausgeben von Strom über die mit einer Gleichstrombatterie betriebene Stromquelle (4, 72, 72', 322) durch die Stromleitung (6, 68, 368) (6, 68, 368);
Empfangen einer Benutzereingabe an dem Benutzerbedienelement (3, 75, 392);
Erzeugen einer Eingabe in den Kippschalter basierend auf dem Empfangen der Benutzereingabe;
Ausgeben eines Impulsbreitenmodulationssignals entlang der Stromleitung (6, 68, 368) an ein Steuerteil (5, 74, 77, 377) während des Ausgebens von Strom; und
Betreiben, über das Steuerteil (5, 74, 77, 377), eines Bauteils (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) der Oberflächenreinigungsvorrichtung basierend auf dem Impulsbreitenmodulationssignal.

Revendications

1. Système de communication par courants porteurs en ligne (2) pour commander une fonction ou un fonctionnement d'au moins un composant (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) d'un dispositif de nettoyage de surface (10, 310), le système de communication par courants porteurs en ligne comprenant :

une source d'alimentation électrique (4, 34, 72, 72', 322) ;
au moins une commande utilisateur (3, 75, 392) adaptée pour recevoir une entrée provenant d'un utilisateur ;
un organe de commande (5, 74, 77, 377) dans une base (2b, 14, 334) du dispositif de nettoyage de surface et situé à distance de l'au moins une commande utilisateur (3, 75, 392) prévue dans un manche (2a, 14, 334), l'organe de commande (5, 74, 77, 377) étant configuré pour commander le fonctionnement de l'au moins un composant (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) ; et
une ligne d'alimentation électrique (6, 68, 368) couplant électriquement la source d'alimentation électrique (4, 34, 72, 72', 322), l'organe de commande (5, 74, 77, 377), et l'au moins un composant (8, 50, 50', 56, 60, 70, 108, 326, 490, 526), et dans lequel la ligne d'alimentation électrique (6, 68, 368) est en outre adaptée pour fournir un signal de communication entre l'au moins une commande utilisateur (3, 75, 392) et l'organe de commande (5, 74, 77, 377),
caractérisé en ce que le signal de communication est transmis de façon intermittente et l'alimentation électrique dans la base (2b, 14, 334) est sensiblement ininterrompue.

2. Système de communication par courants porteurs en ligne (2) de la revendication 1, dans lequel la source d'alimentation électrique (4, 72, 72', 322) inclut une source d'alimentation électrique alimentée par batterie CC (4, 72, 72', 322).

3. Système de communication par courants porteurs en ligne (2) de l'une quelconque des revendications 1 et 2, comprenant en outre un commutateur (7, 73, 373) configuré pour introduire le signal de communication sur la ligne d'alimentation électrique (6, 68, 368) sous forme de signal à modulation d'impulsion en durée sur la base de l'entrée reçue par l'au moins une commande utilisateur (3, 75, 392).

4. Système de communication par courants porteurs en ligne (2) de la revendication 3, dans lequel l'organe de commande (5, 74, 77, 377) est configuré pour déterminer un(e) d'un cycle de service du signal à modulation d'impulsion en durée ou d'une fréquence du signal à modulation d'impulsion en durée et l'organe de commande (5, 74, 77, 377) est configuré pour mettre en fonctionnement l'au moins un composant (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) sur la base de celui/celle-ci .

5. Système de communication par courants porteurs en ligne (2) de l'une quelconque des revendications 1 à 4, dans lequel l'au moins une commande utilisateur (3, 75, 392) est un sélecteur de mode configuré pour sélectionner un d'un groupe prédéfini de modes.

6. Système de communication par courants porteurs en ligne (2) de l'une quelconque des revendications 1 à 5, dans lequel le dispositif de nettoyage de surface est un aspirateur (10, 310), comprenant :

un ensemble de base (2b, 14, 334) incluant un boîtier de base ayant un suceur d'aspiration (42, 316) et adapté pour le mouvement le long d'une surface destinée à être nettoyée ;
une unité supérieure (12, 28, 332) couplée de façon pivotante au boîtier de base et ayant un manche ;dans
lequel l'au moins une commande utilisateur (3, 75, 392) est située sur l'unité supérieure (2a, 28, 332), et une source d'aspiration (4, 72, 72', 322) en communication fluidique avec le suceur d'aspiration pour générer un courant d'air de travail à travers l'aspirateur.

7. Système de communication par courants porteurs en ligne (2) de la revendication 6, dans lequel l'au moins une commande utilisateur (3, 75, 392) est un sélecteur de mode configuré pour sélectionner un d'une pluralité du groupe prédéfini de modes et le commutateur est configuré pour introduire un diffé-

rent cycle de service du signal à modulation d'impulsion en durée pour chacun de la pluralité du groupe prédéfini de modes.

8. Système de communication par courants porteurs en ligne (2) de la revendication 6 ou 7, dans lequel l'ensemble de base (2b, 14, 334) comprend en outre une chambre d'agitateur dans le suceur d'aspiration et l'au moins un composant électrique (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) est un moteur fonctionnellement couplé à un agitateur dans celle-ci, ou dans lequel le manche est défini sur une partie tenue en main, la partie tenue en main ayant une poignée et la source d'aspiration (4, 72, 72', 322) et l'au moins un composant électrique (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) est une série de lumières frontales située le long d'une partie orientée vers l'avant du boîtier de base, fournissant un faisceau qui est sensiblement parallèle à la surface destinée à être nettoyée et espacé au-dessus de la surface destinée à être nettoyée à non plus de 30 mm.

9. Procédé de communication pour un dispositif de nettoyage de surface (10, 310) en utilisant un système de communication par courants porteurs en ligne des revendications 1 à 8, le procédé comprenant :

l'envoi d'alimentation électrique par l'intermédiaire de la source d'alimentation électrique alimentée par batterie CC (4, 72, 72', 322) à travers la ligne d'alimentation électrique (6, 68, 368) (6, 68, 368) ;
la réception d'une entrée utilisateur dans la commande utilisateur (3, 75, 392) ;
la génération d'une entrée pour le commutateur à bascule sur la base de la réception de l'entrée utilisateur ;
l'envoi d'un signal à modulation d'impulsion en durée le long de la ligne d'alimentation électrique (6, 68, 368) à un organe de commande (5, 74, 77, 377) durant l'envoi d'alimentation électrique ; et
la mise en fonctionnement, par l'intermédiaire de l'organe de commande (5, 74, 77, 377), d'un composant (8, 50, 50', 56, 60, 70, 108, 326, 490, 526) de l'appareil de nettoyage de surface sur la base du signal à modulation d'impulsion en durée.

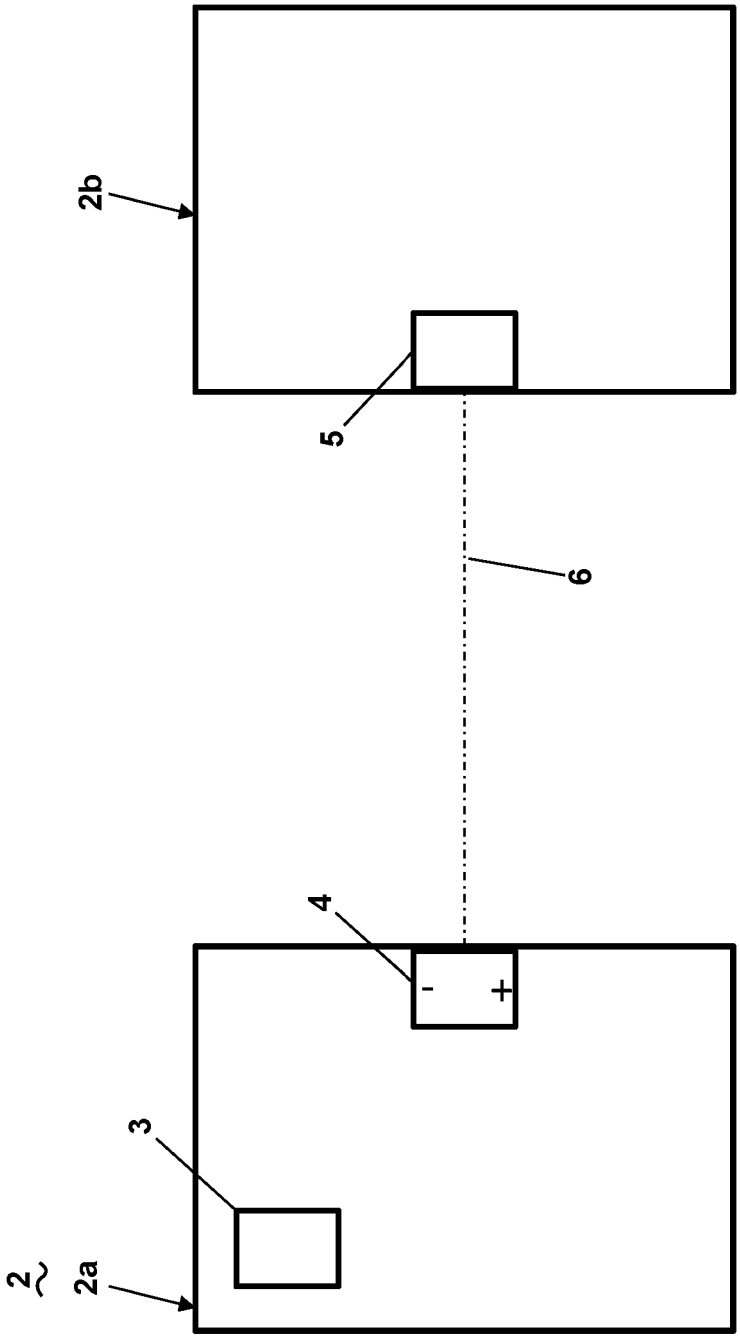

FIG. 1

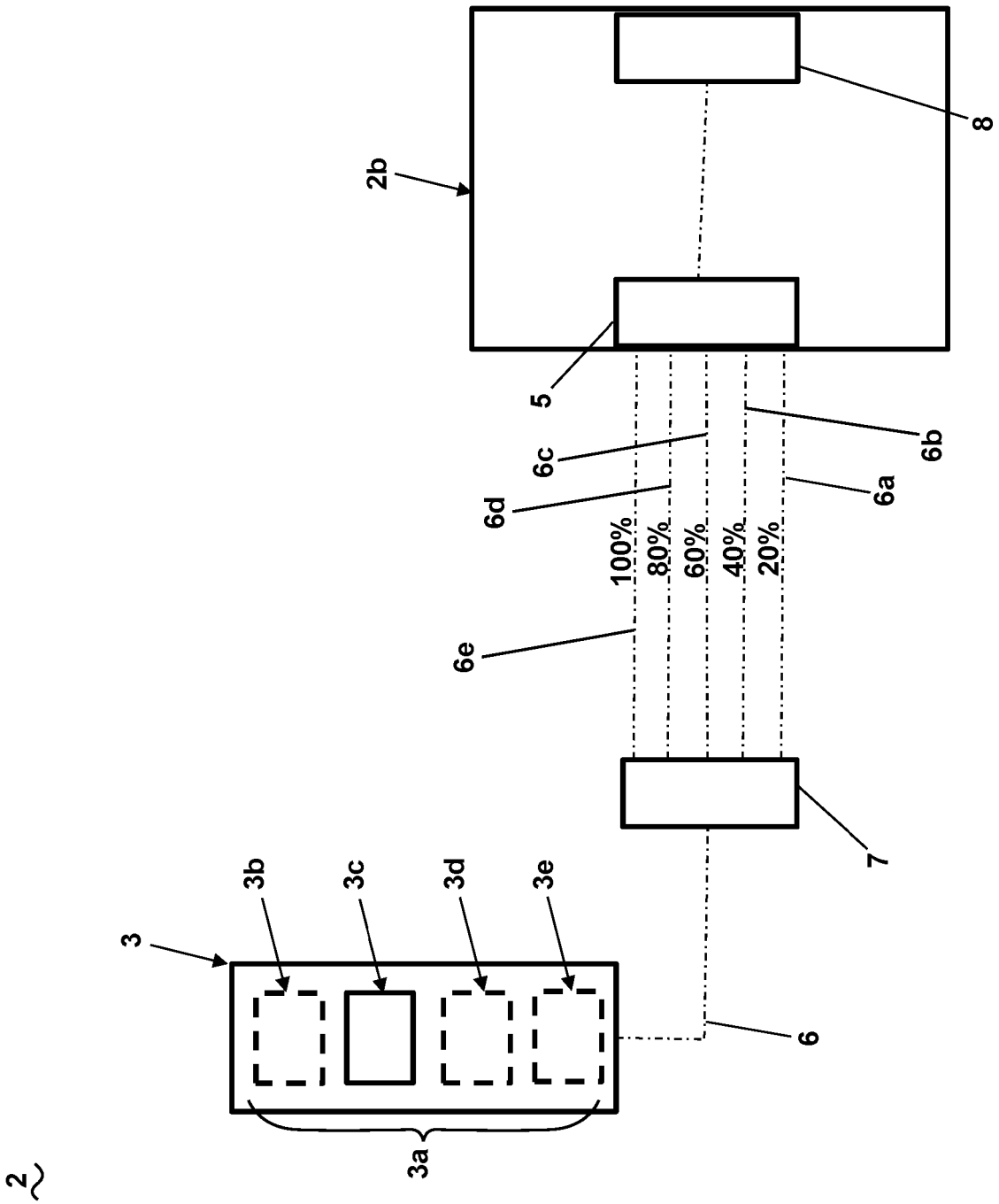

FIG. 2

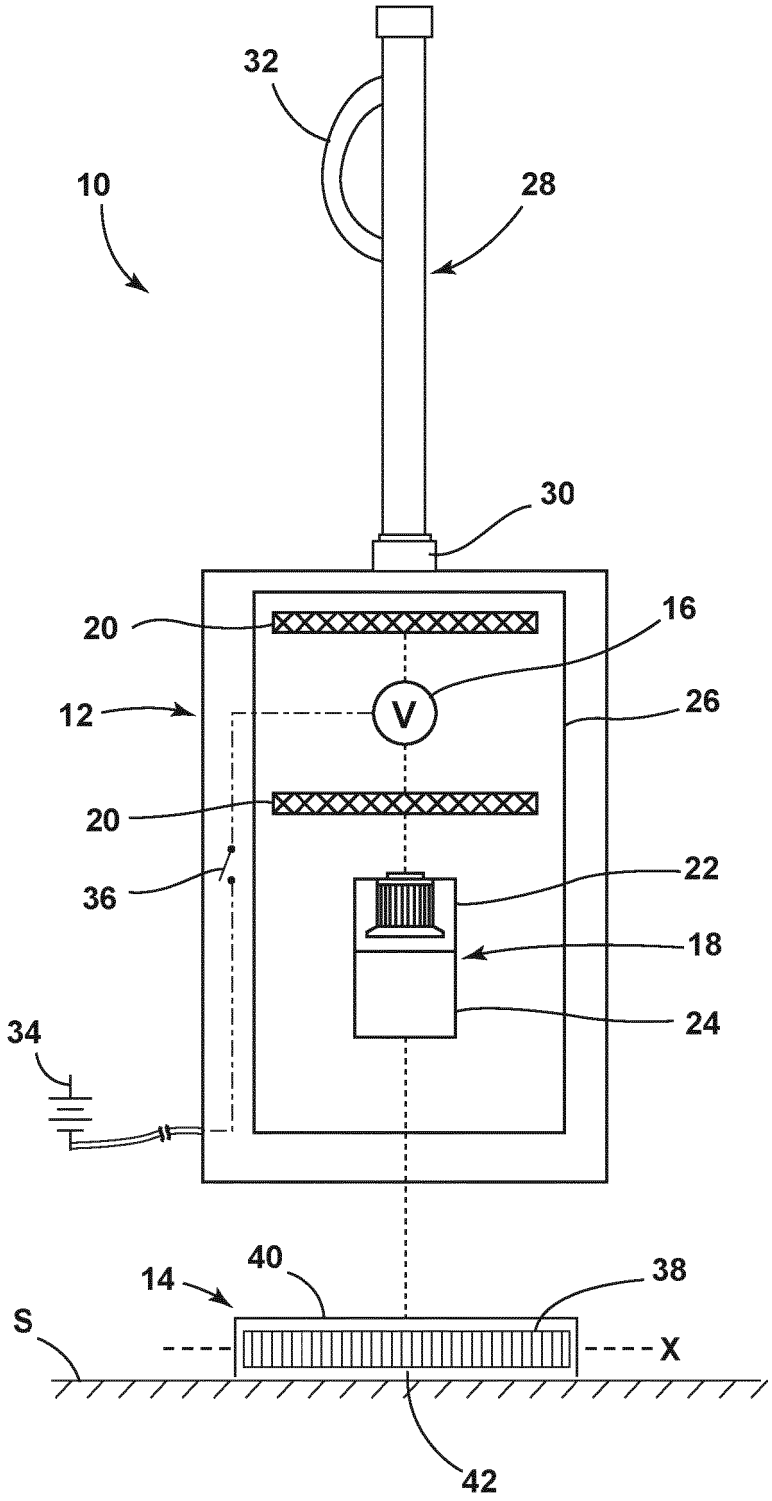

FIG. 3

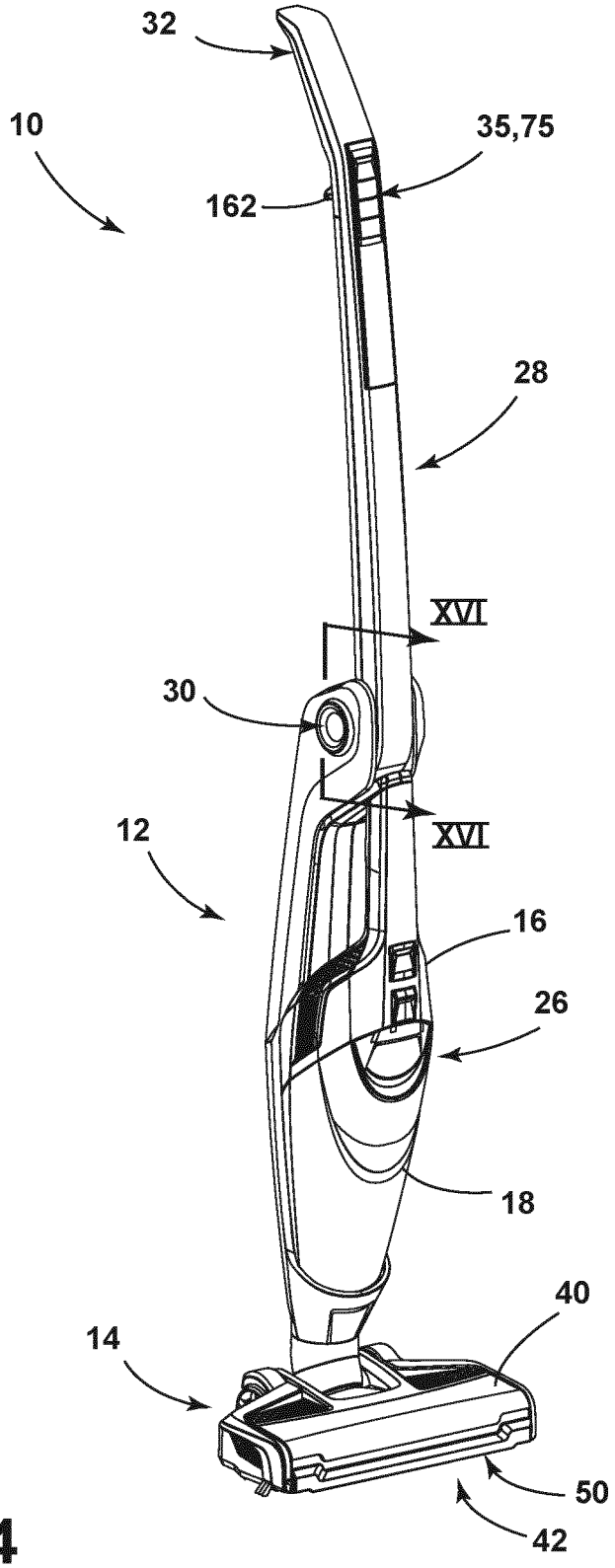

FIG. 4

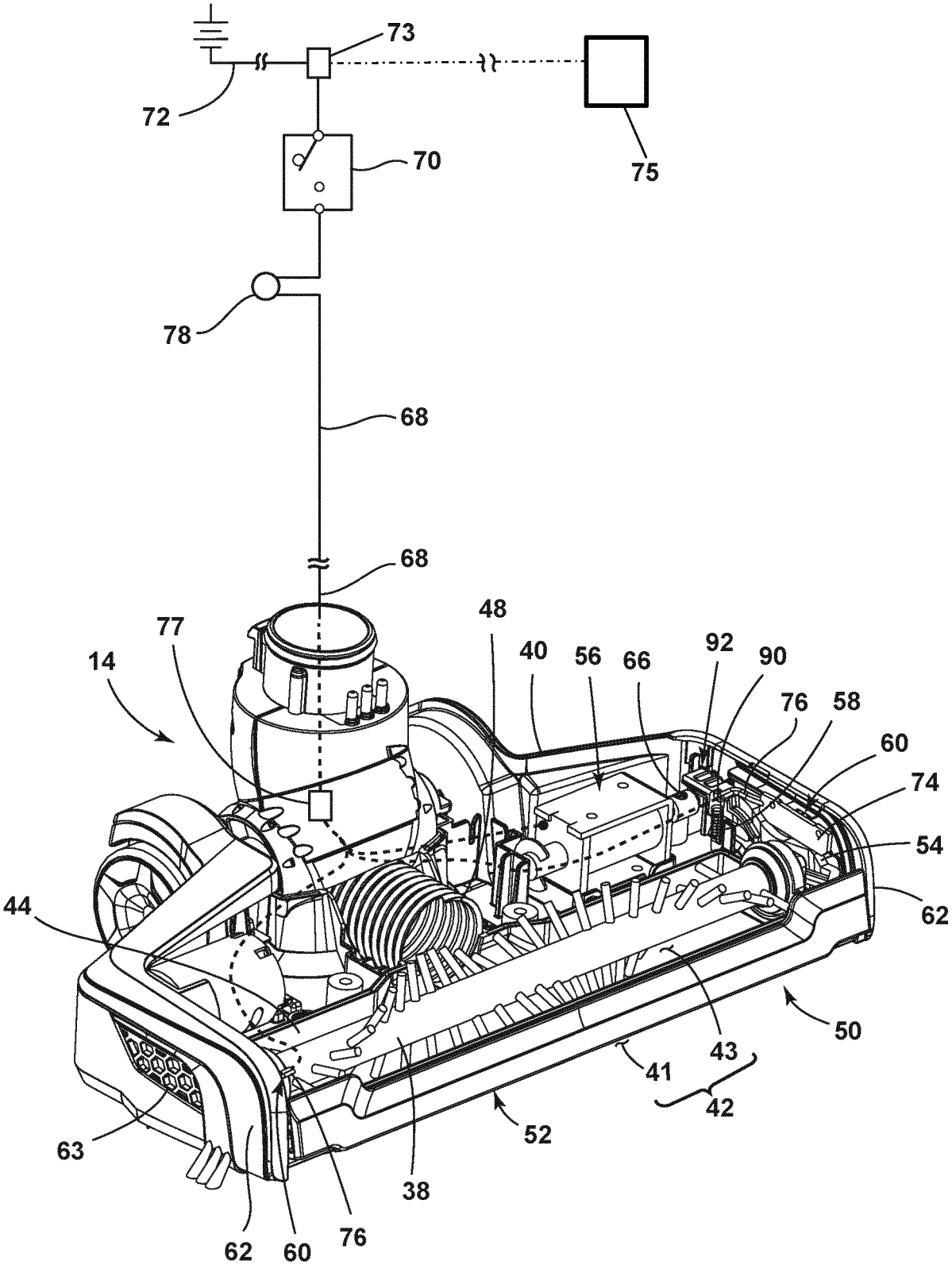
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FIG. 5

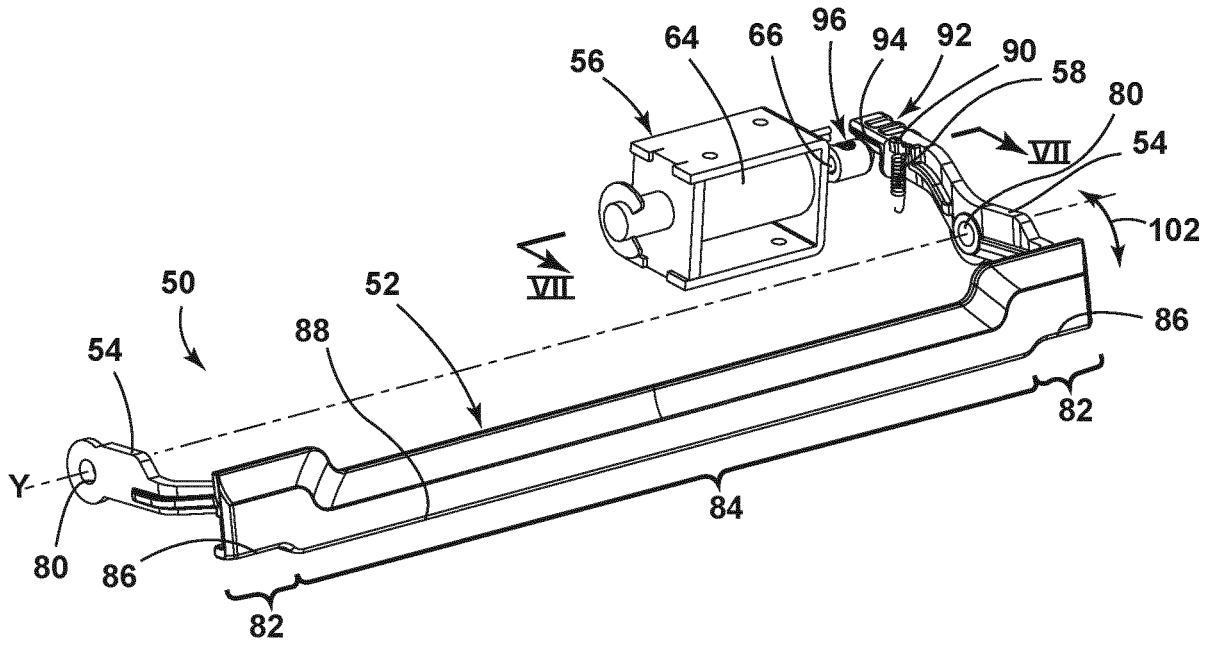
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FIG. 6

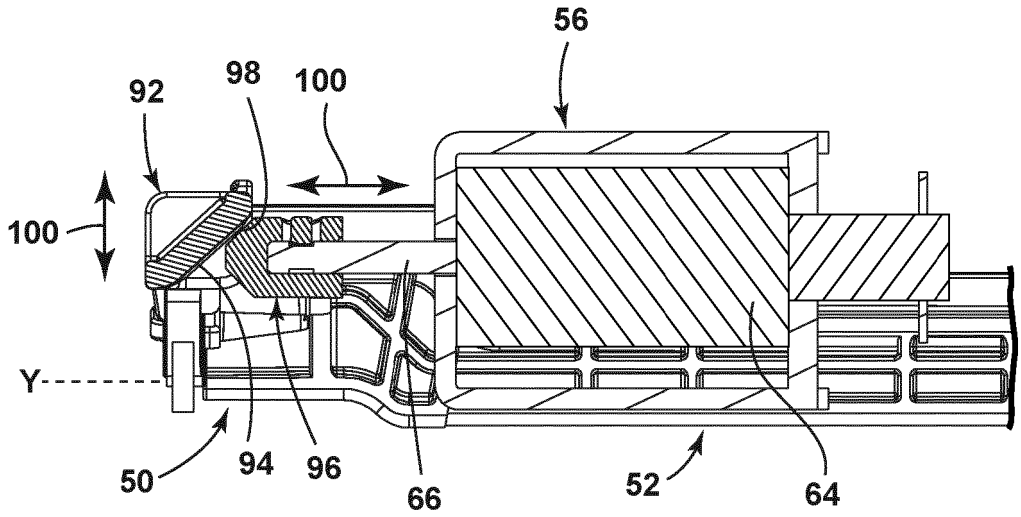

FIG. 7

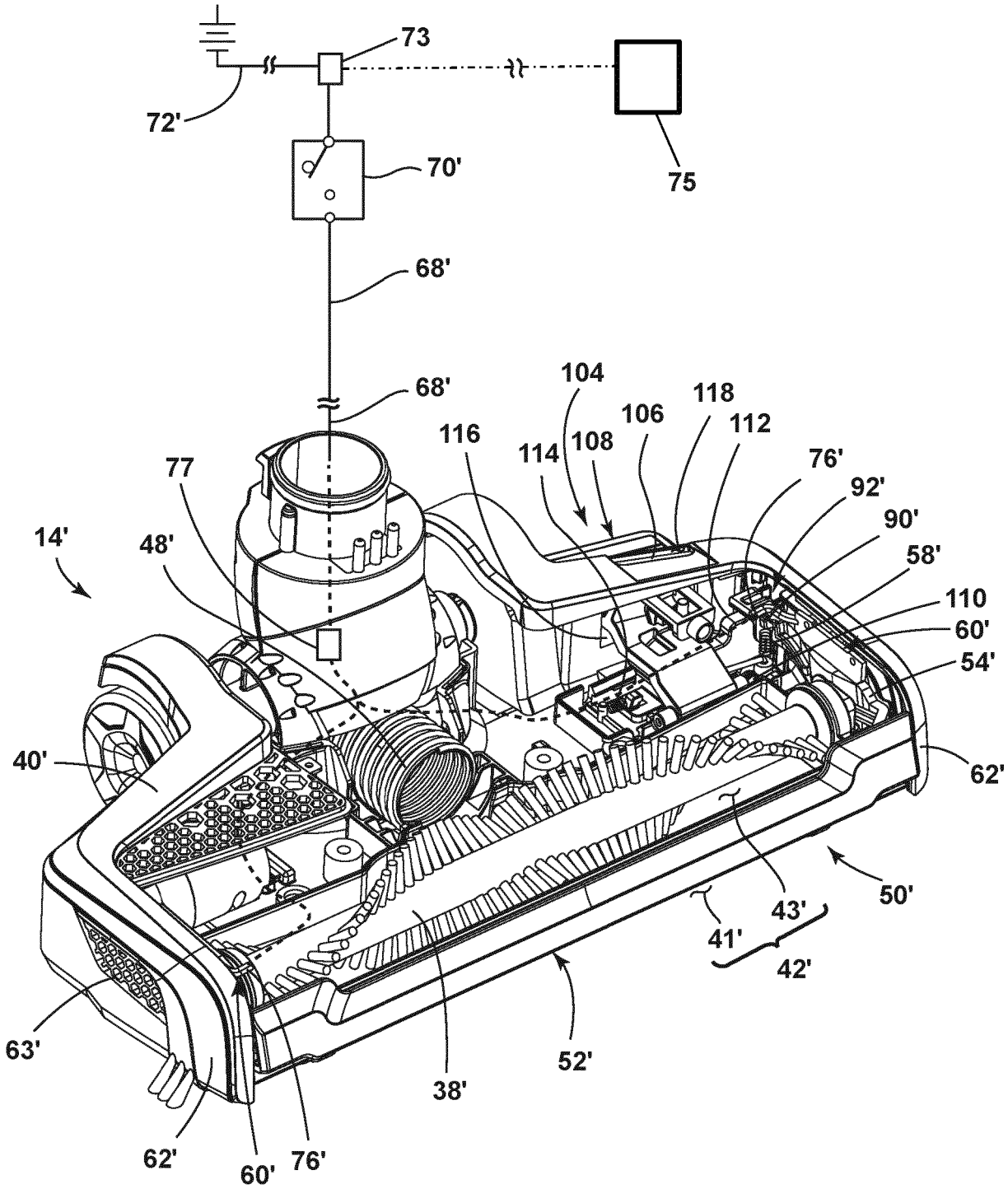
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FIG. 8

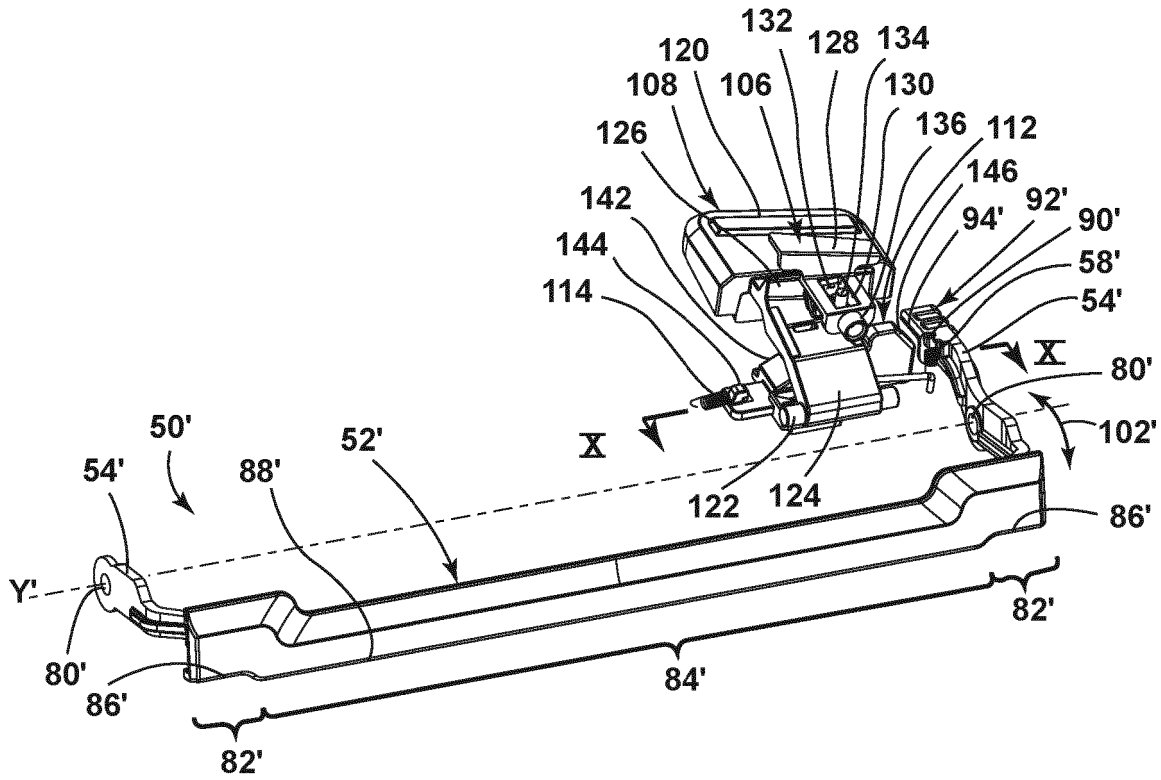
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FIG. 9

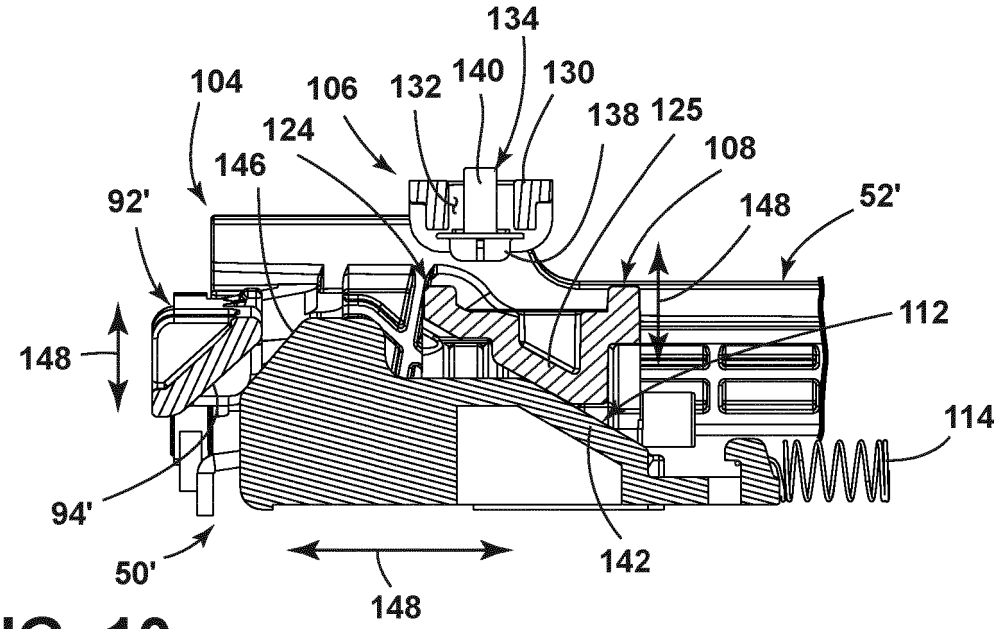
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FIG. 10

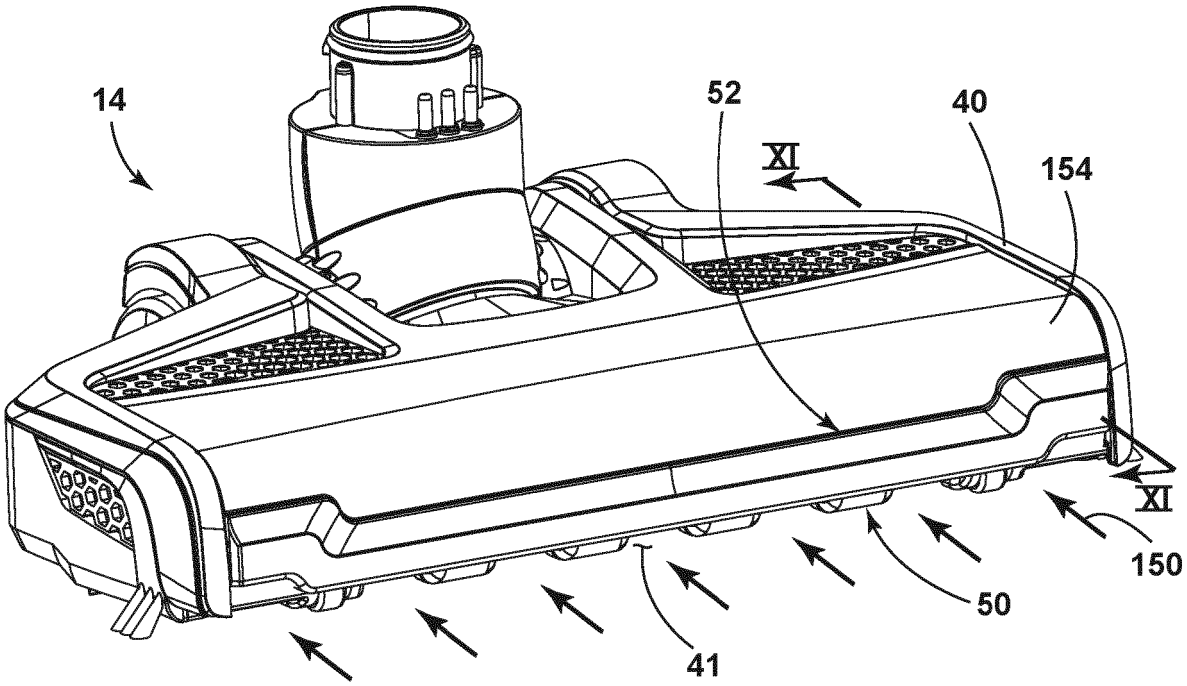

FIG. 11

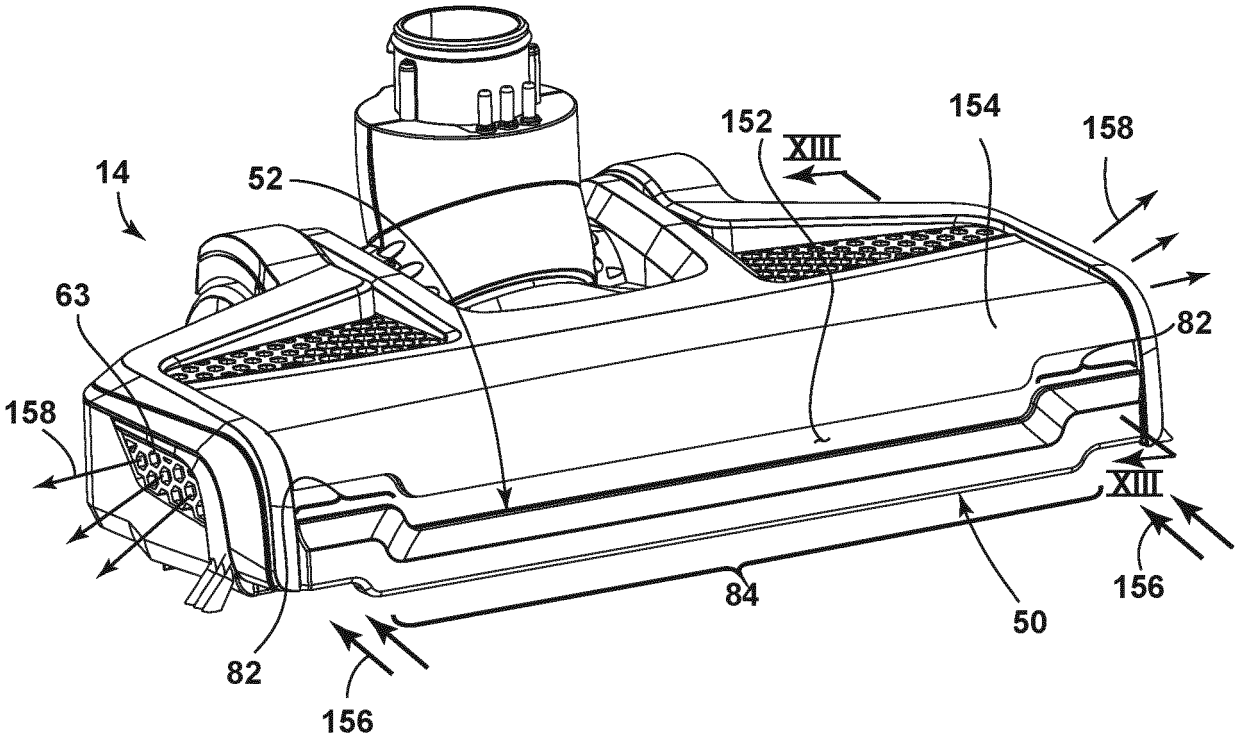

FIG. 12

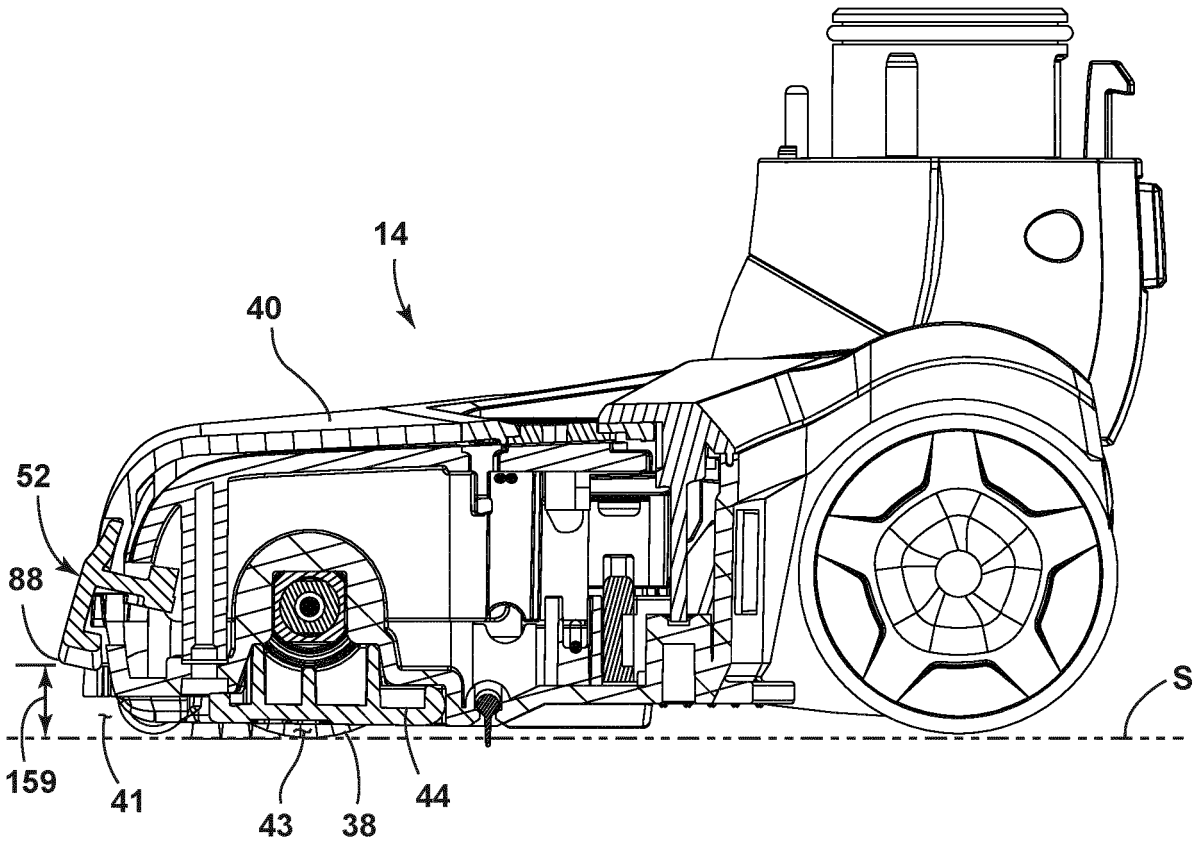

FIG. 13

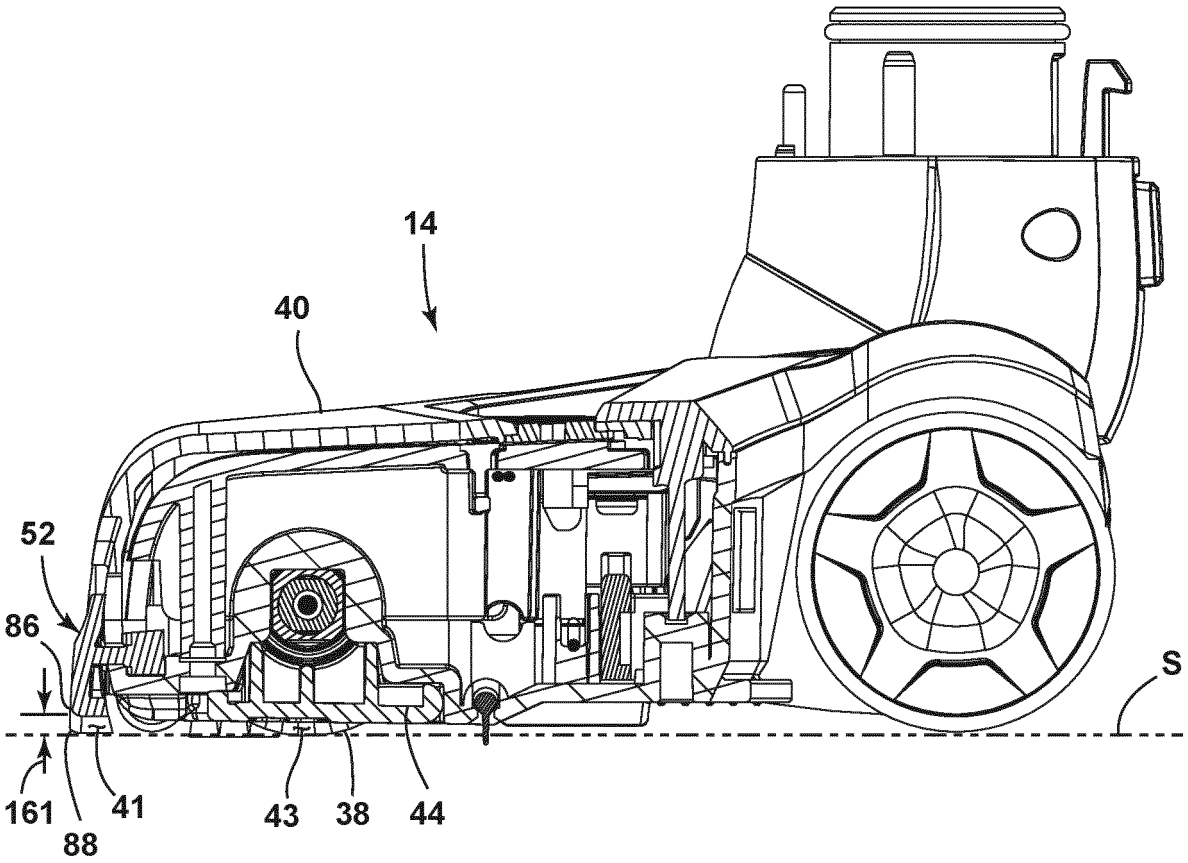

FIG. 14

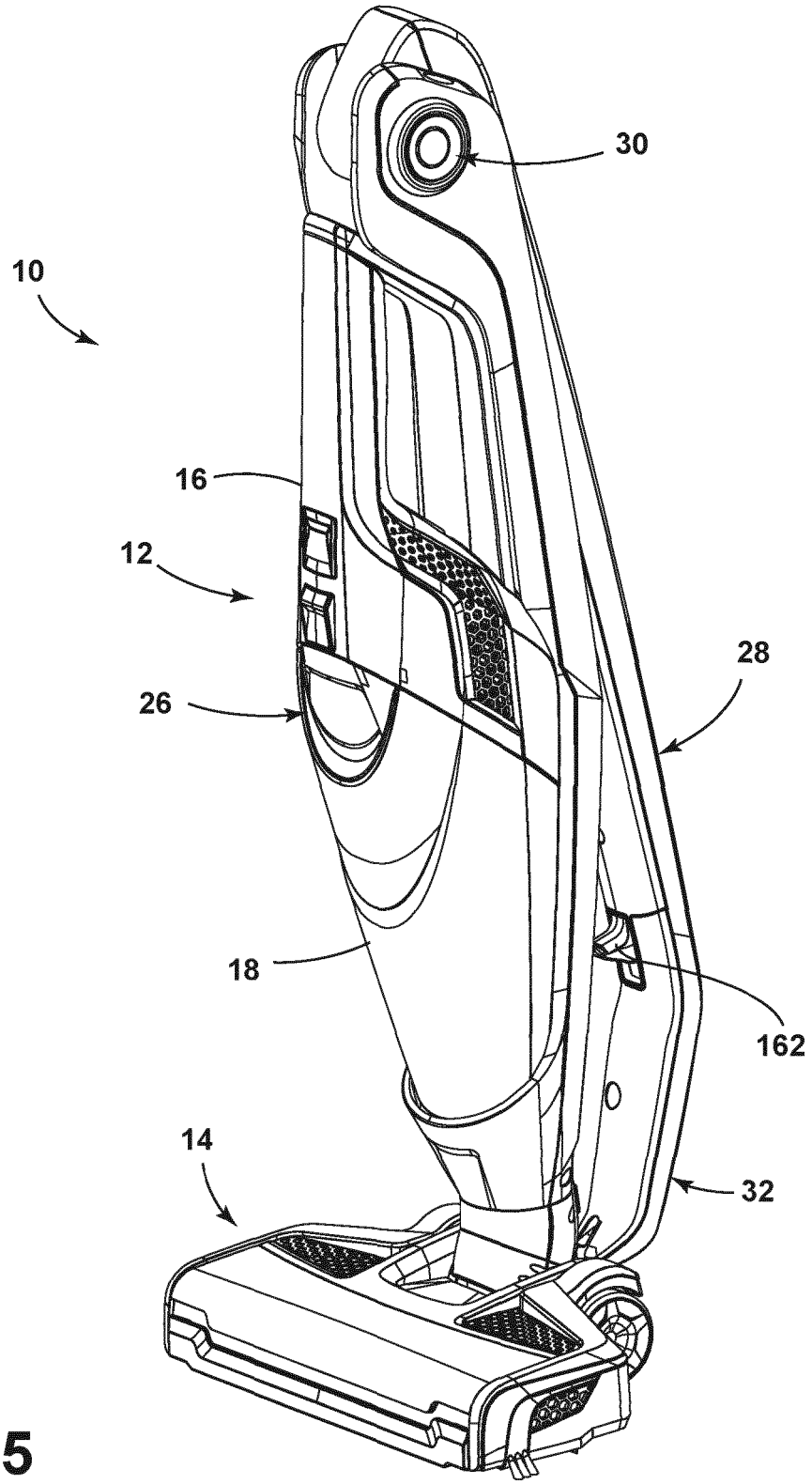

FIG. 15

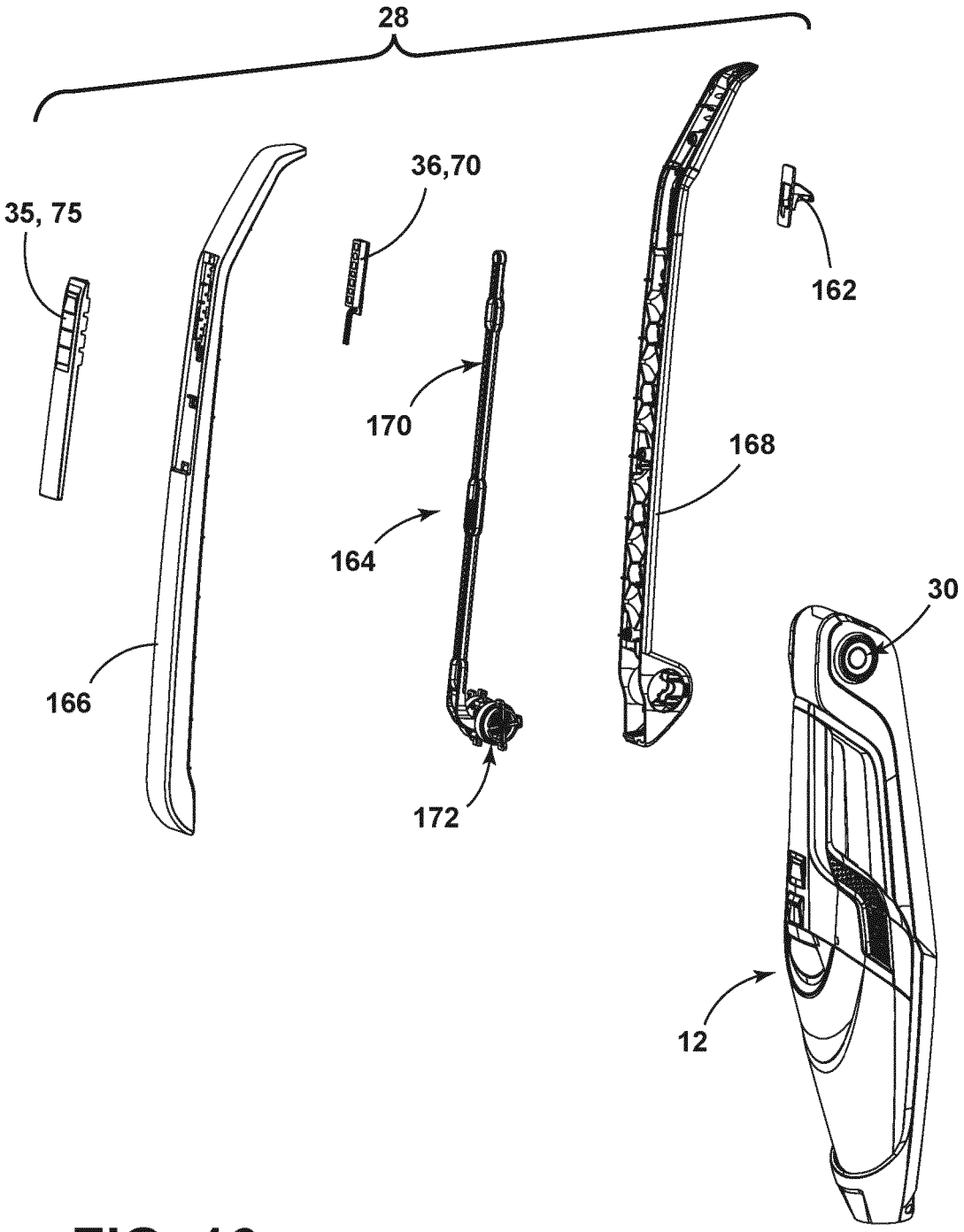

FIG. 16

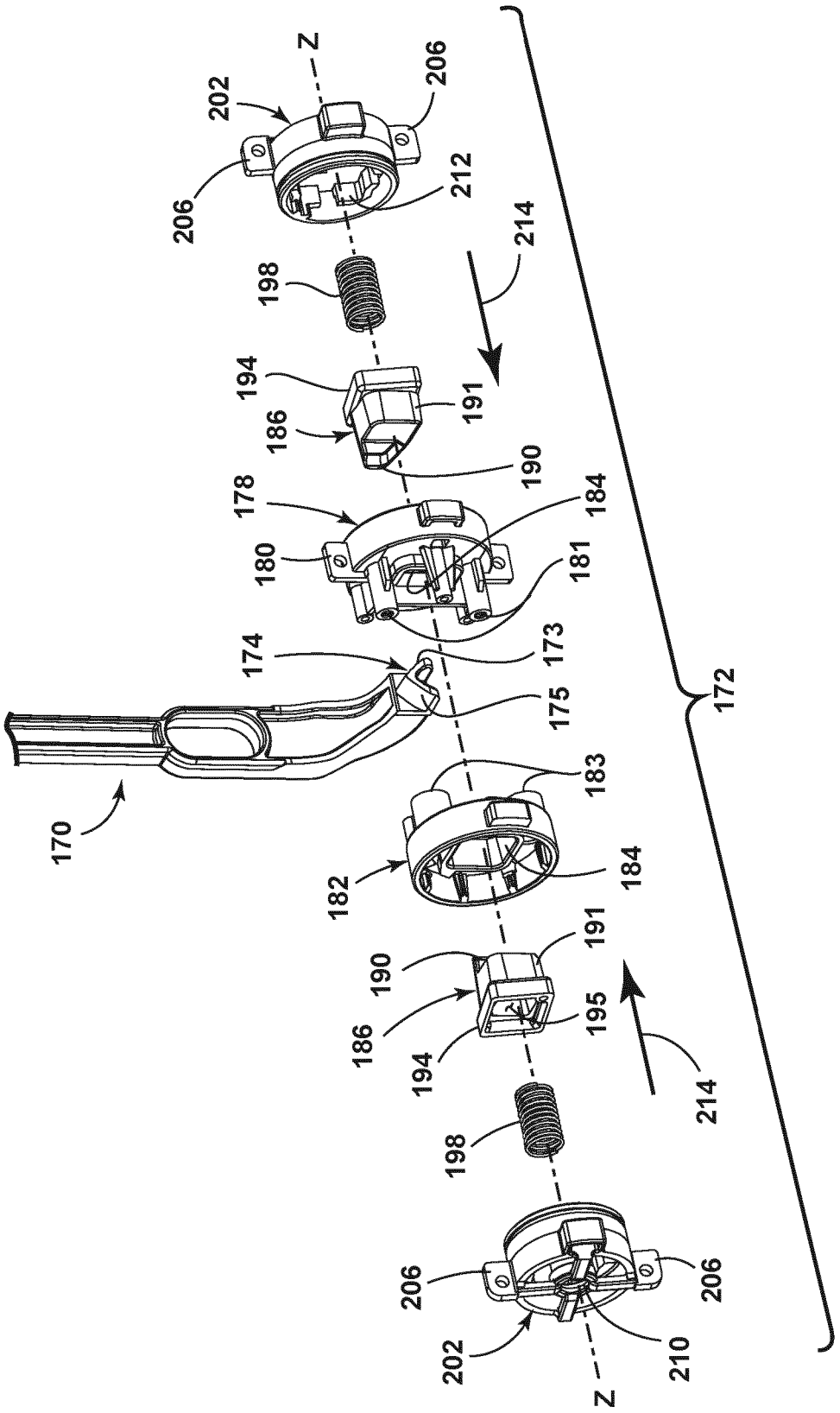
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FIG. 17

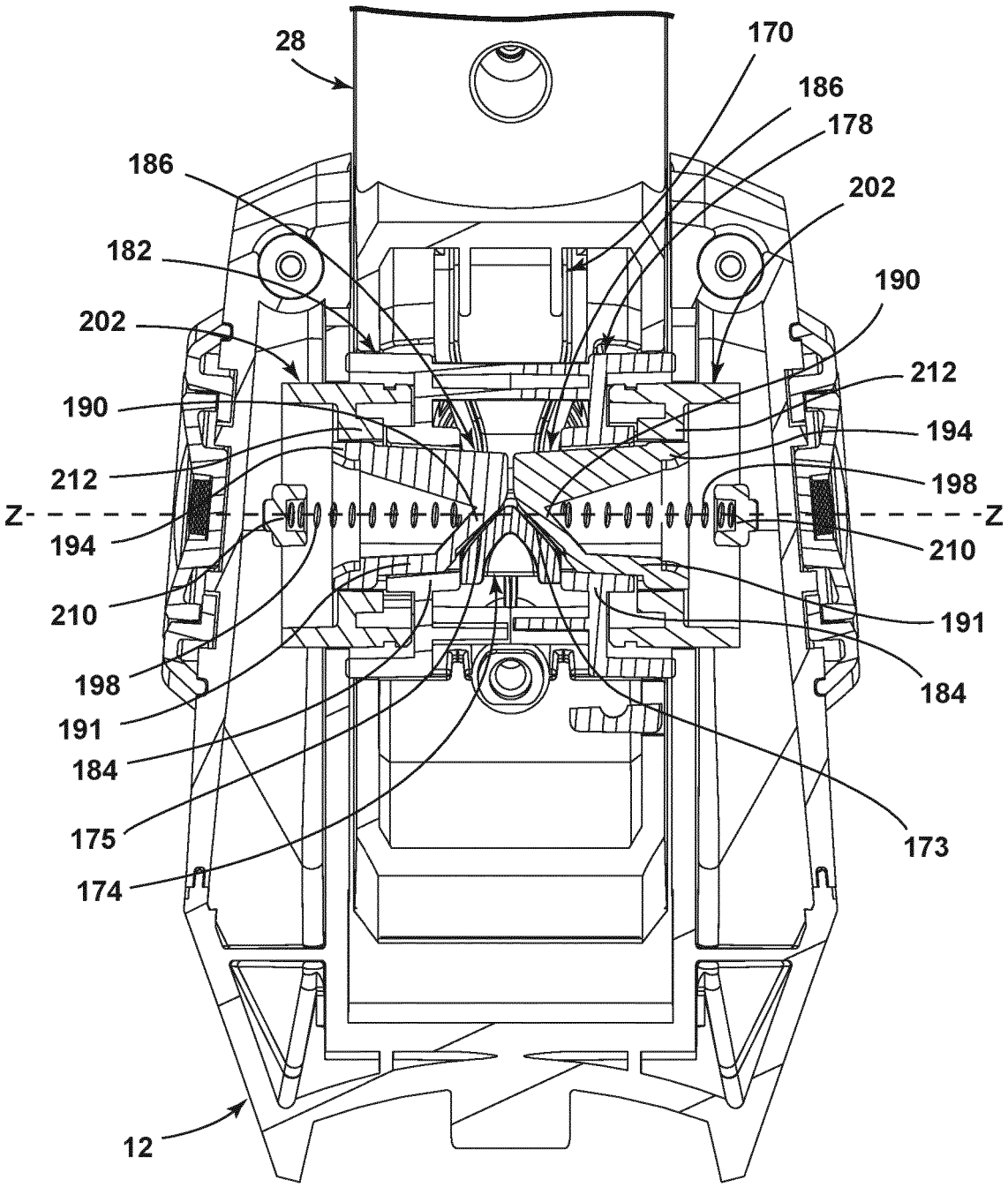
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FIG. 18

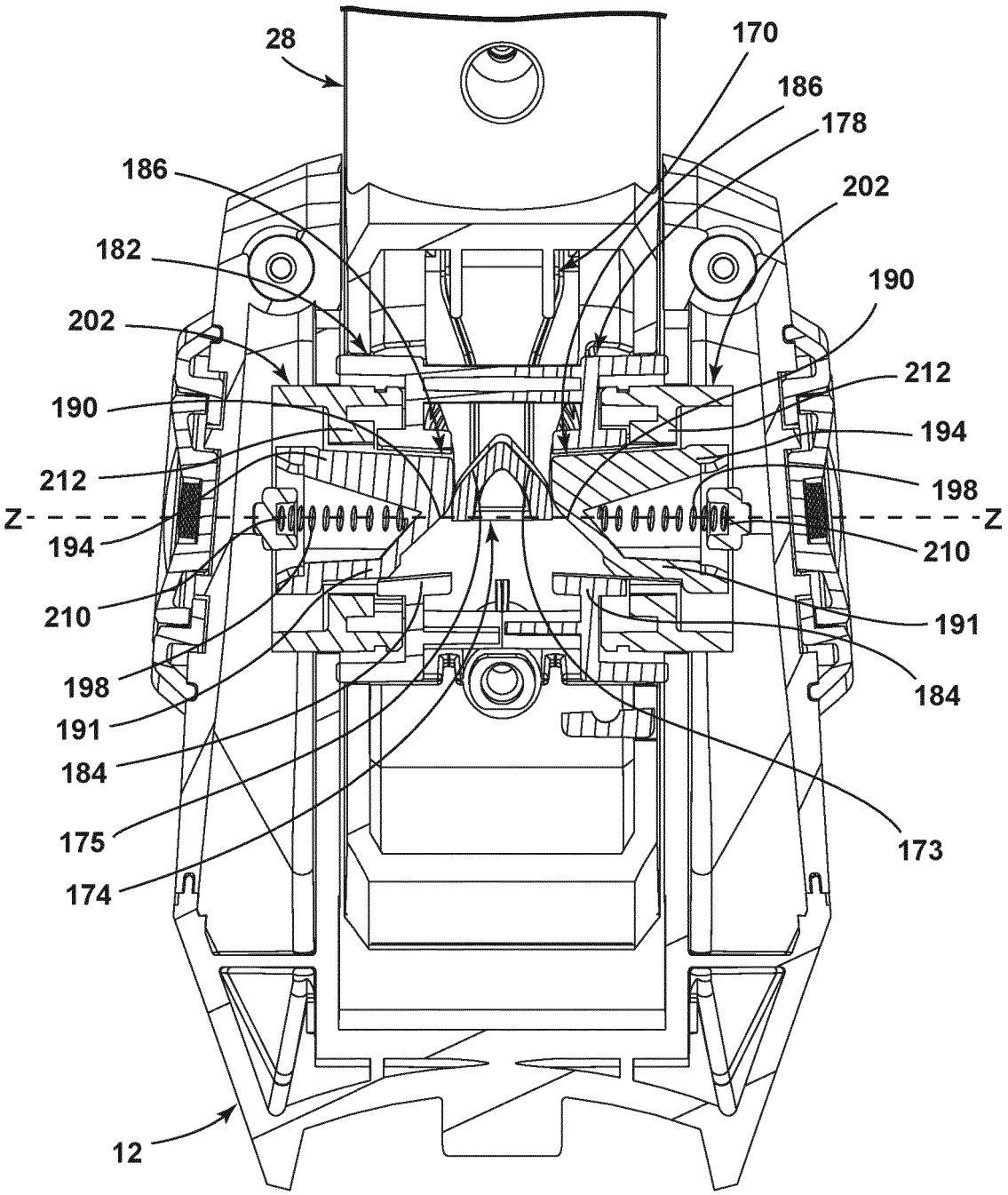
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FIG. 19

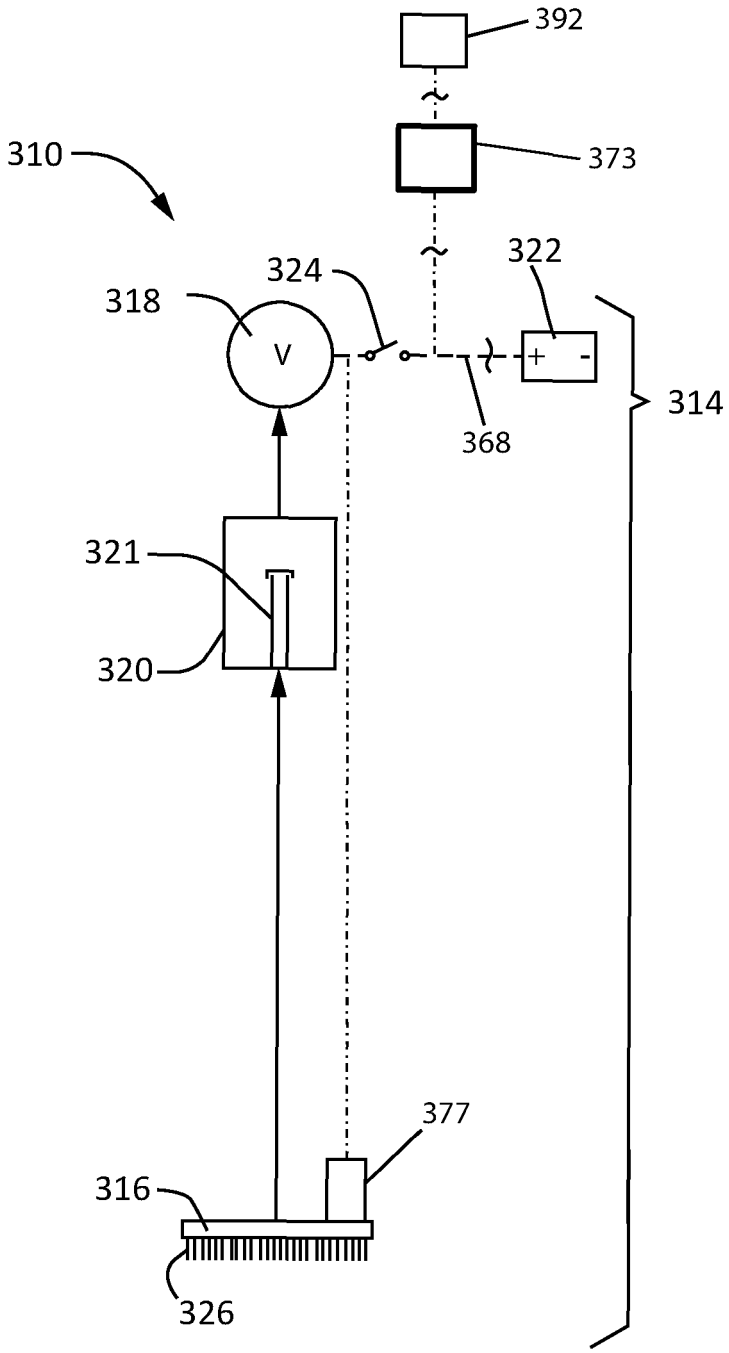

FIG. 20

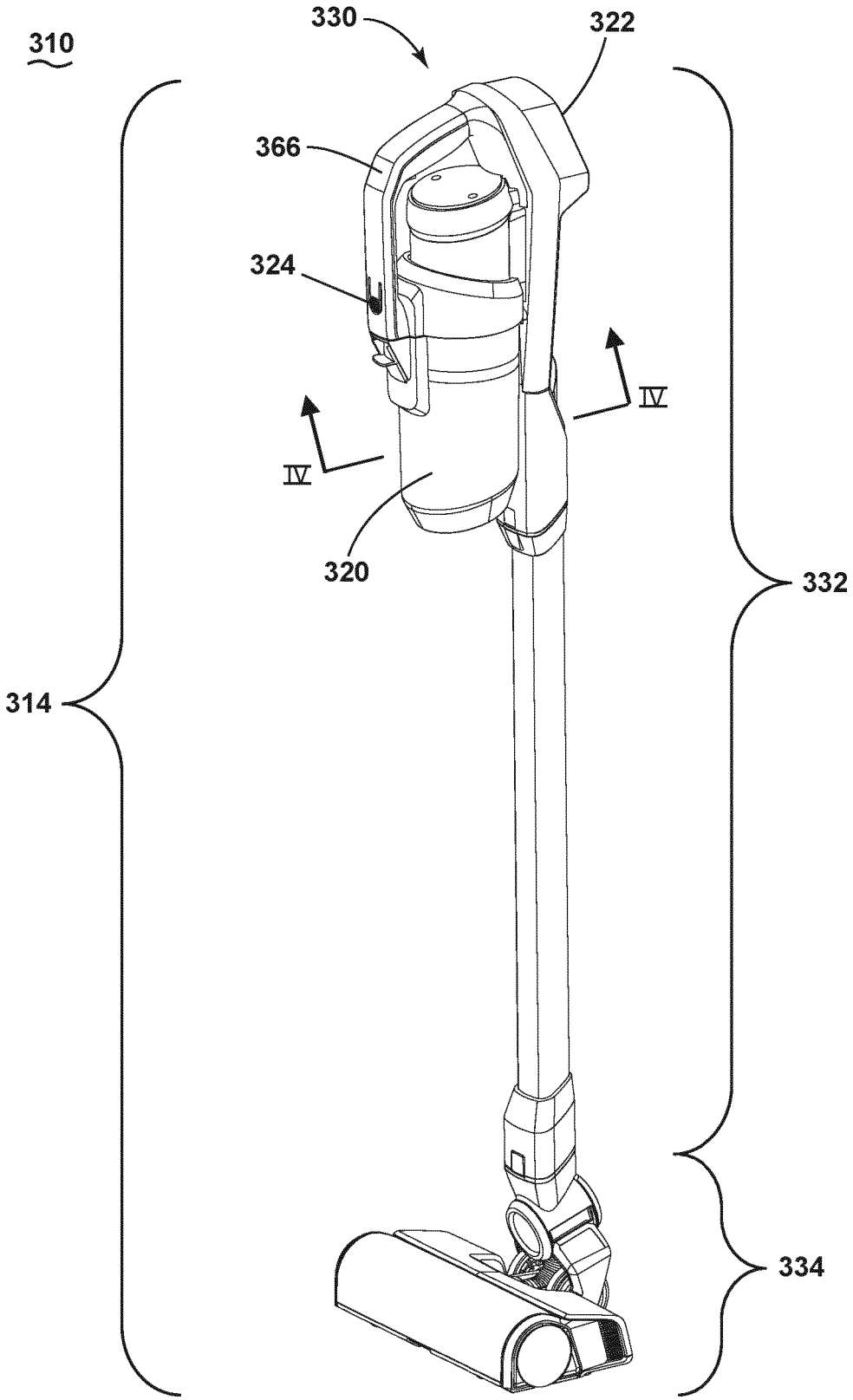

FIG. 21

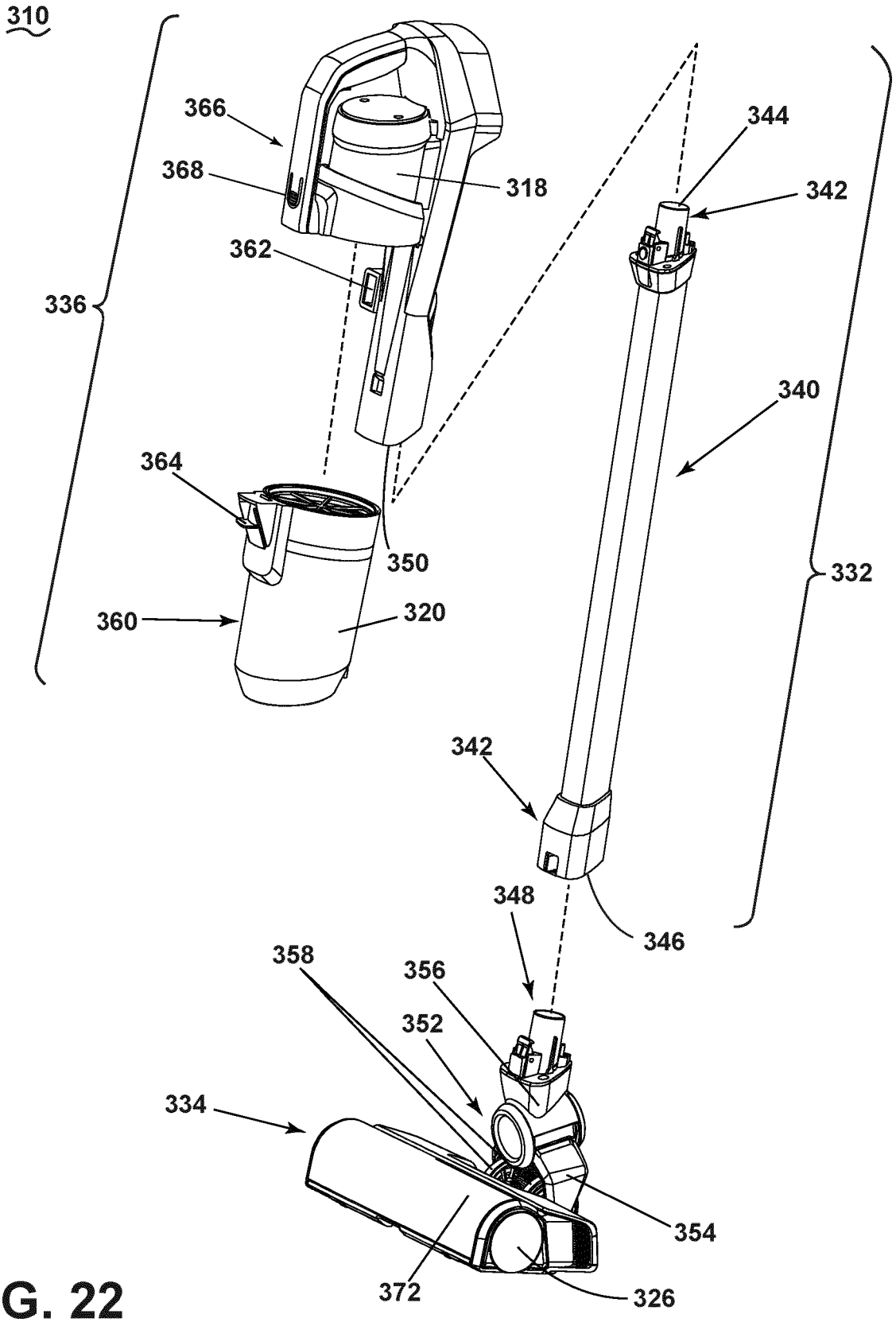
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FIG. 22

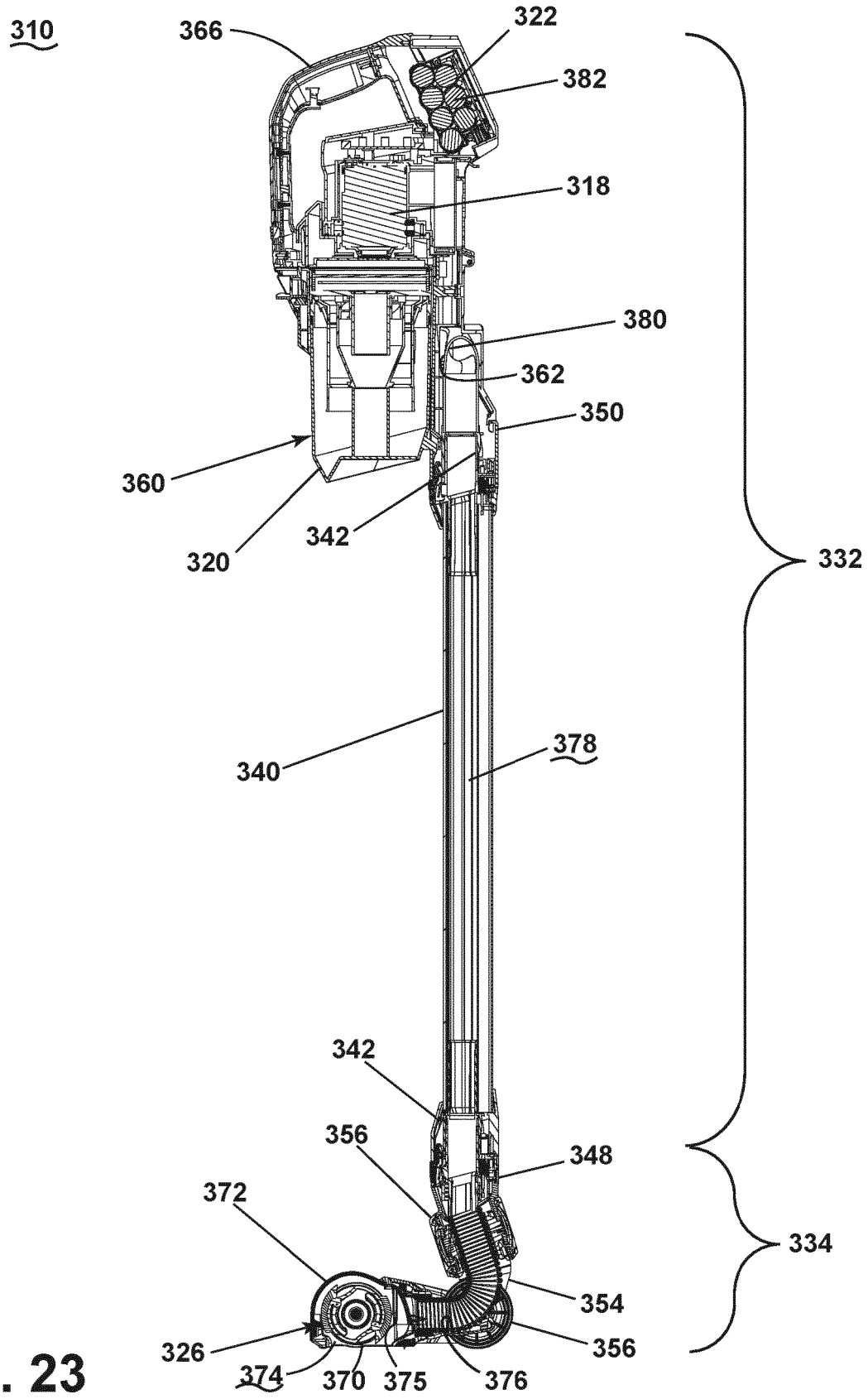
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FIG. 23

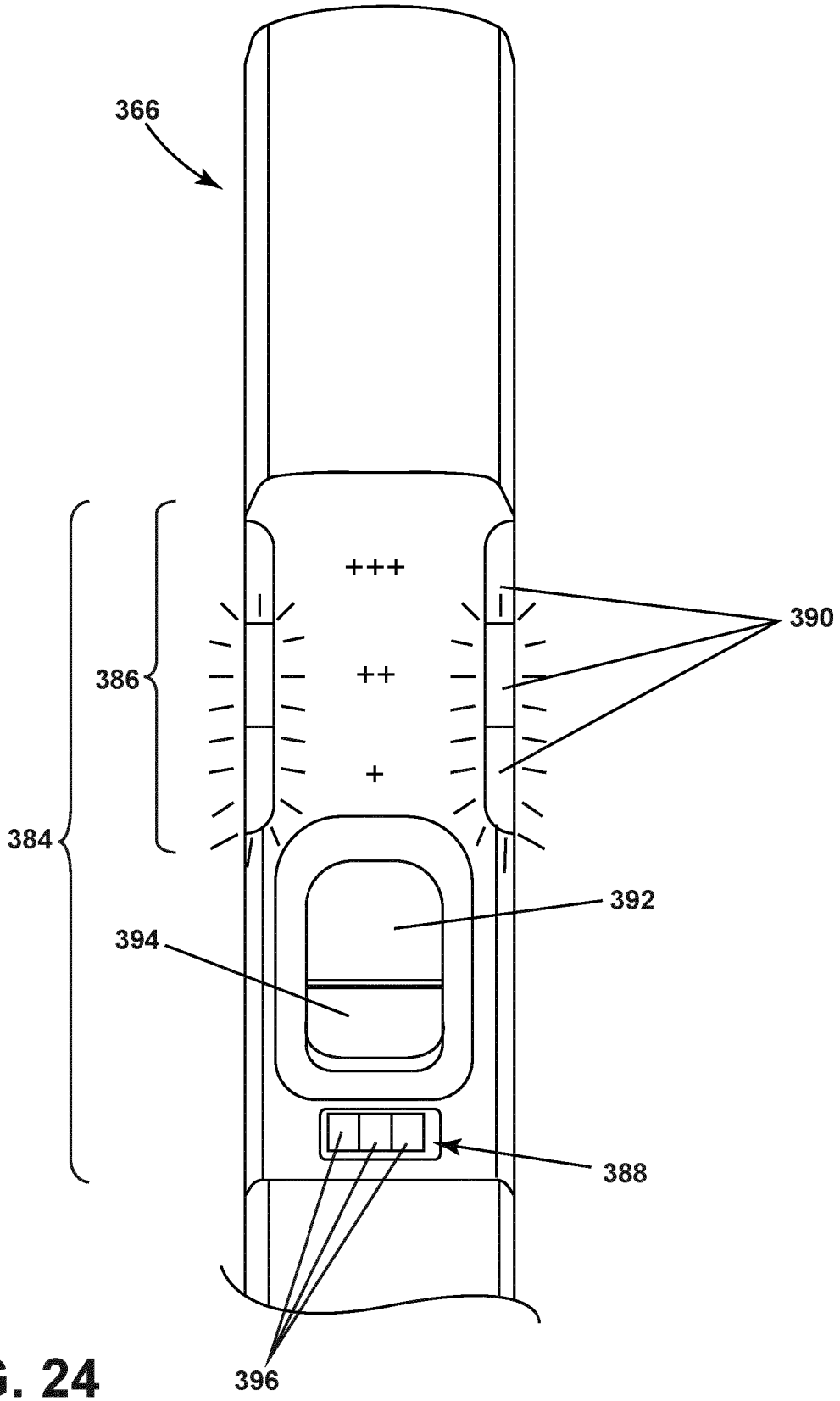

FIG. 24

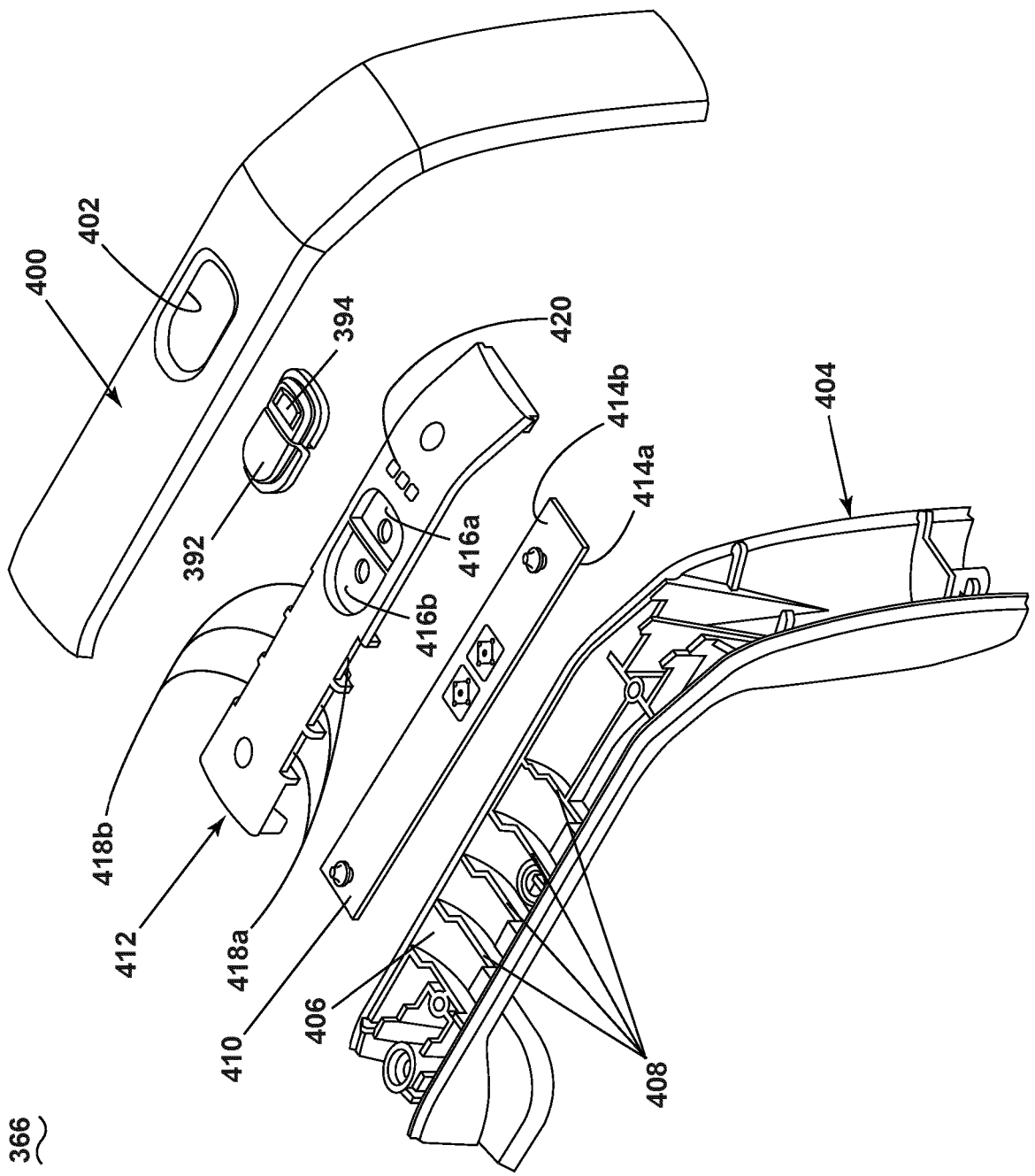
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FIG. 25

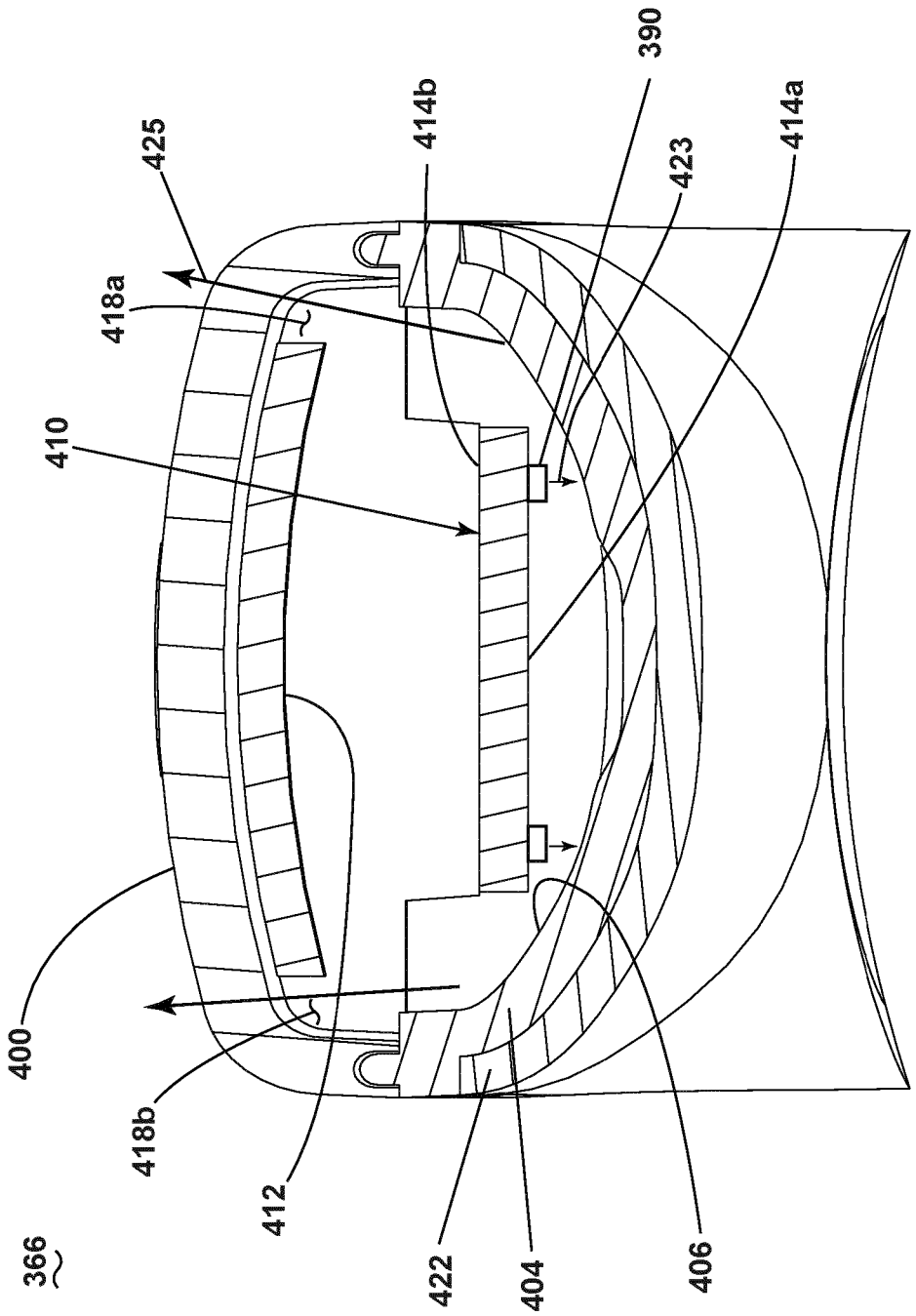

FIG. 26

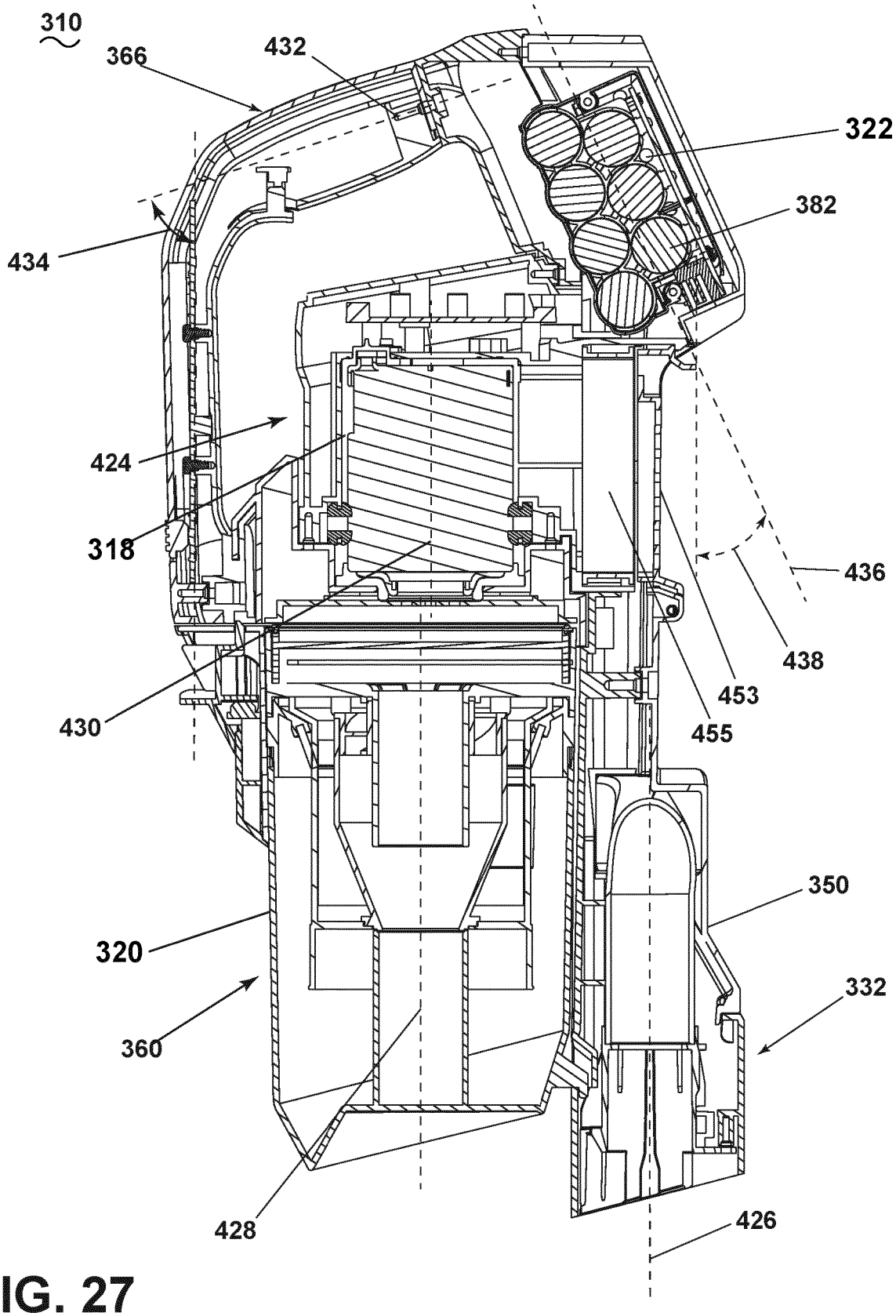
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FIG. 27

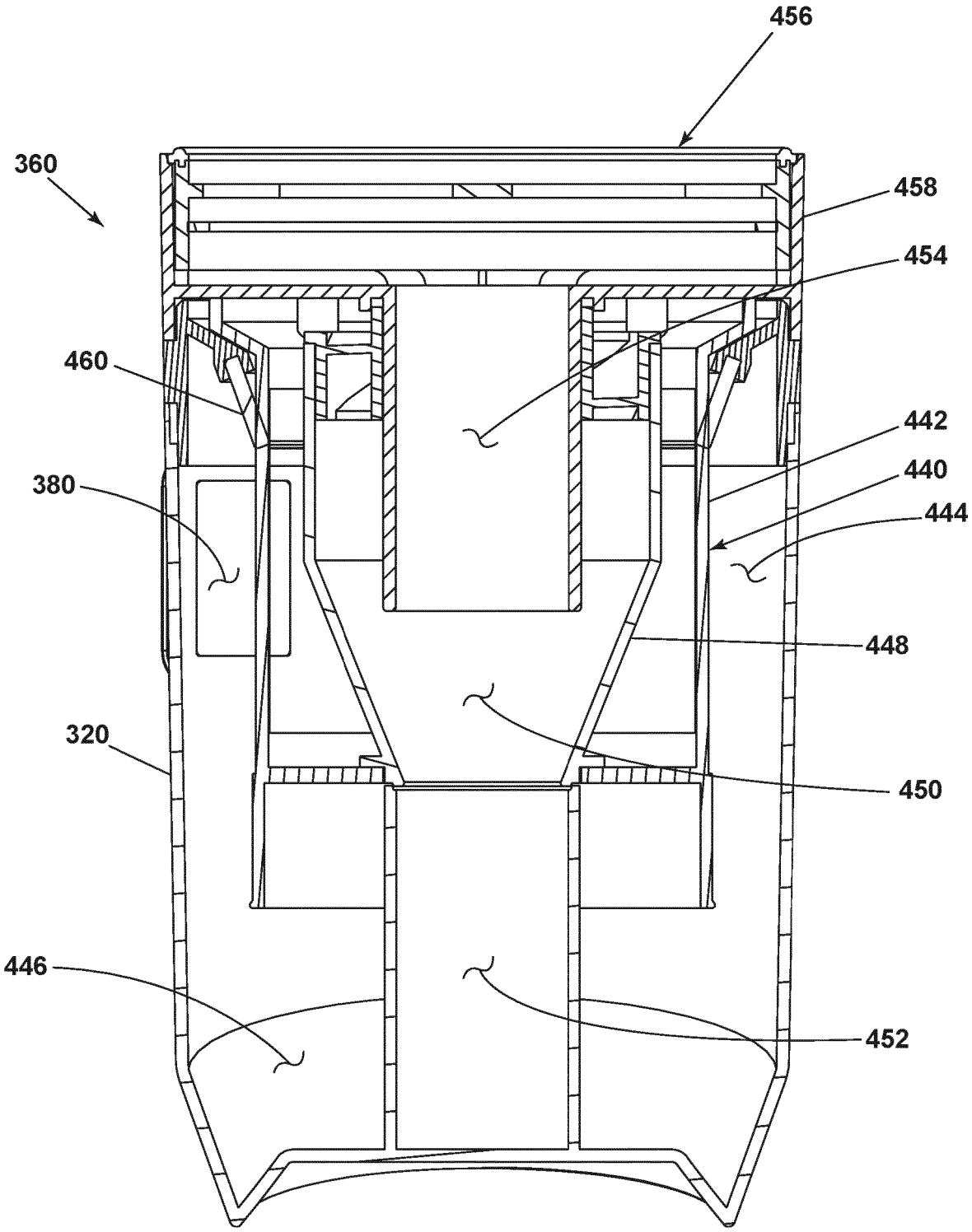


FIG. 28

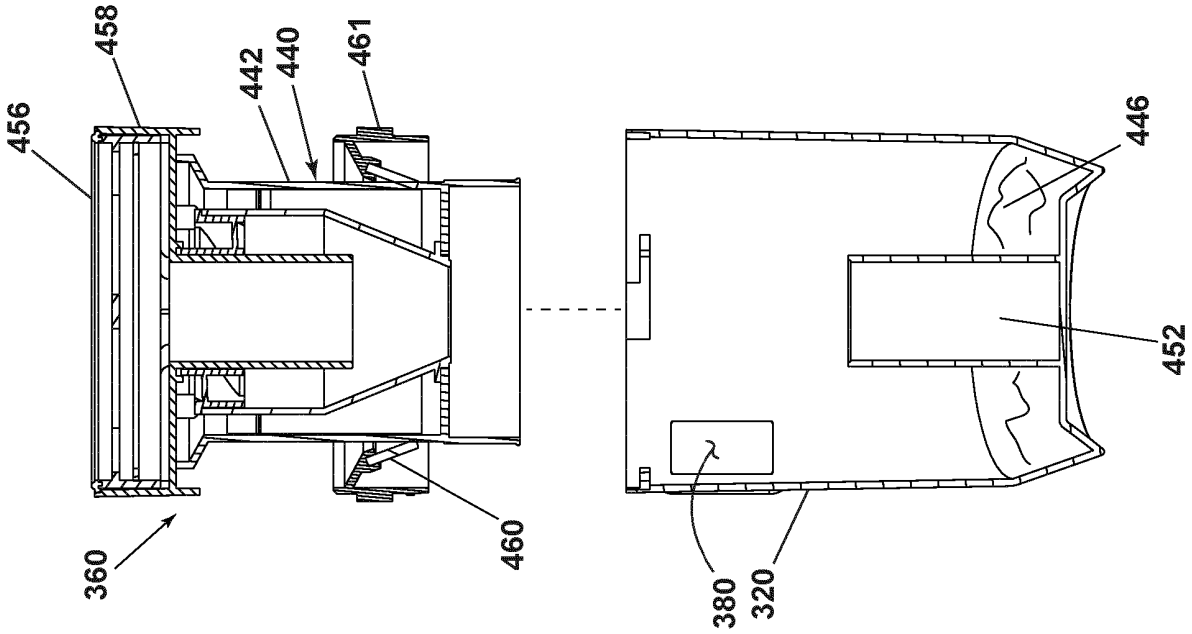


FIG. 29B

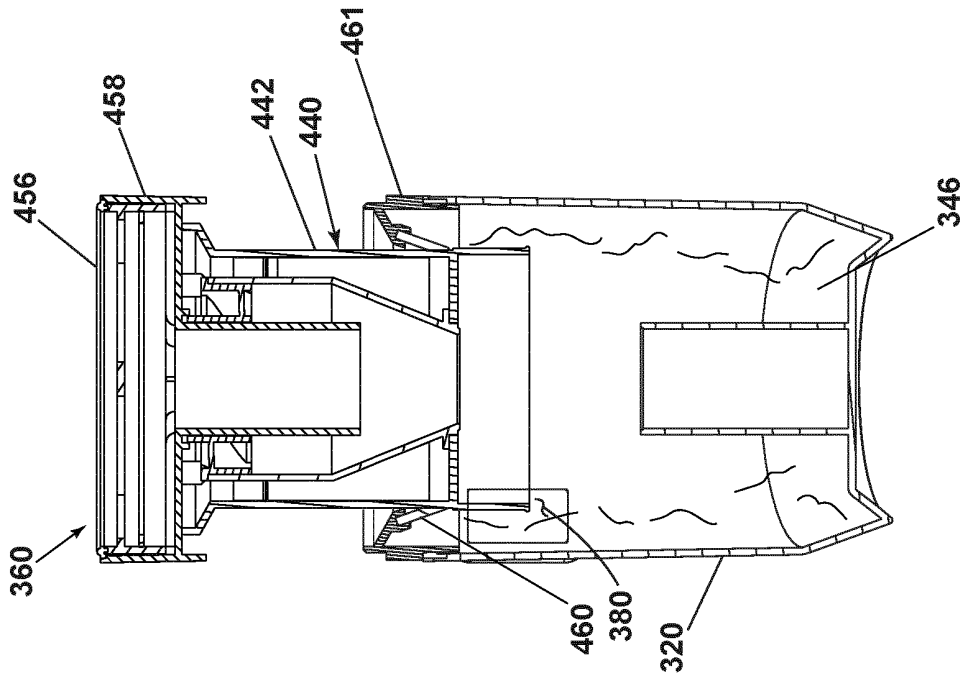


FIG. 29A

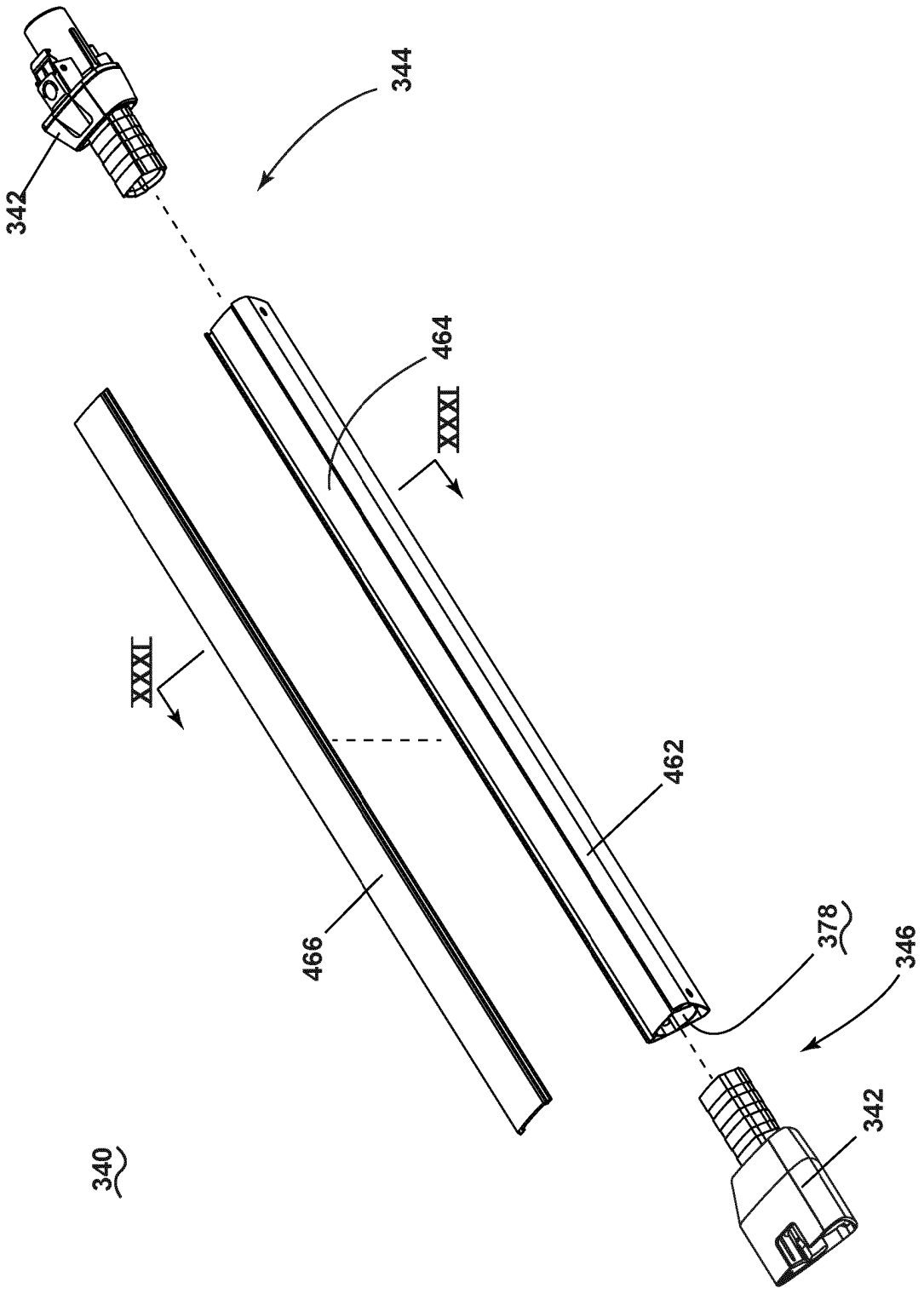


FIG. 30

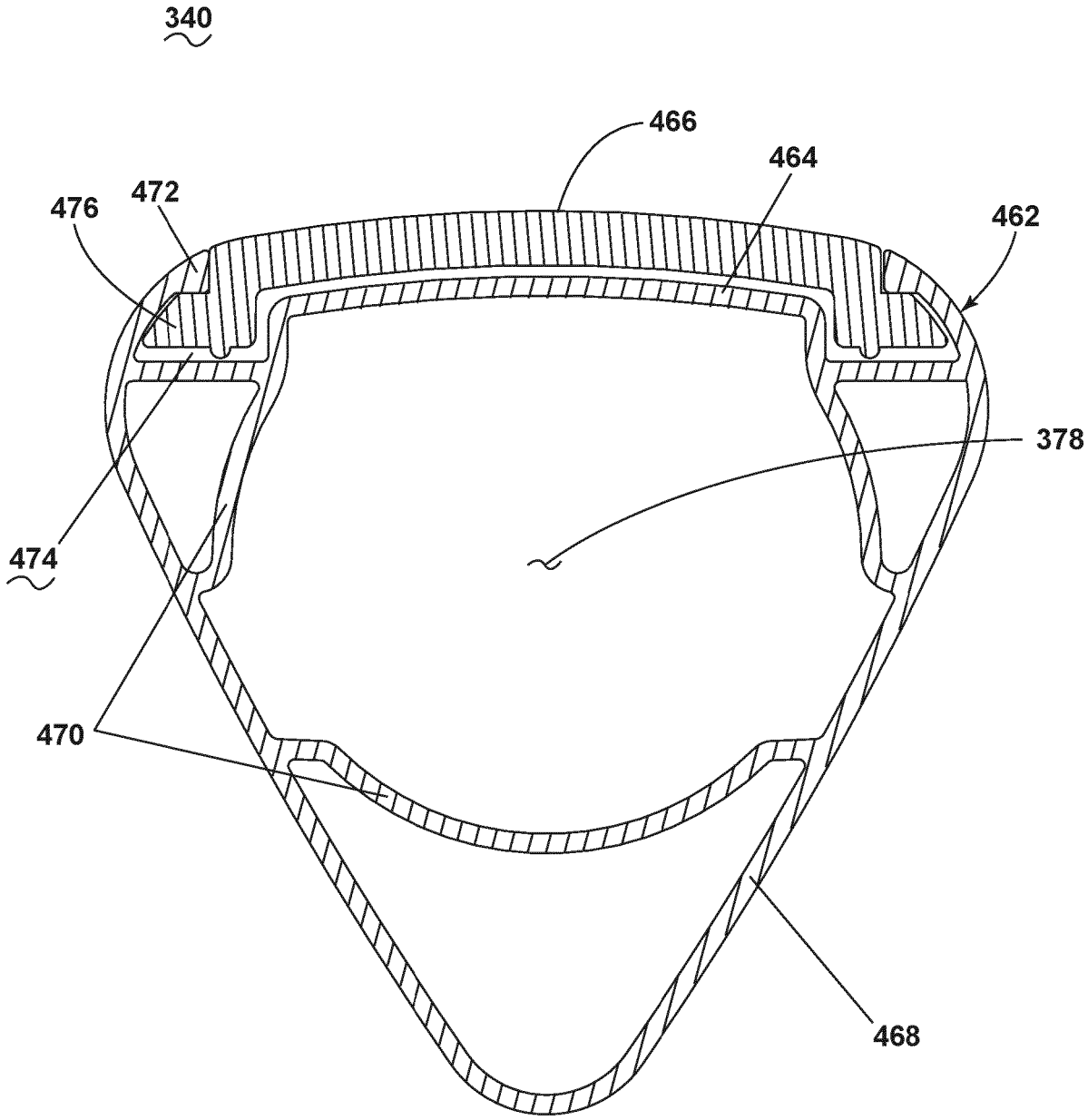


FIG. 31

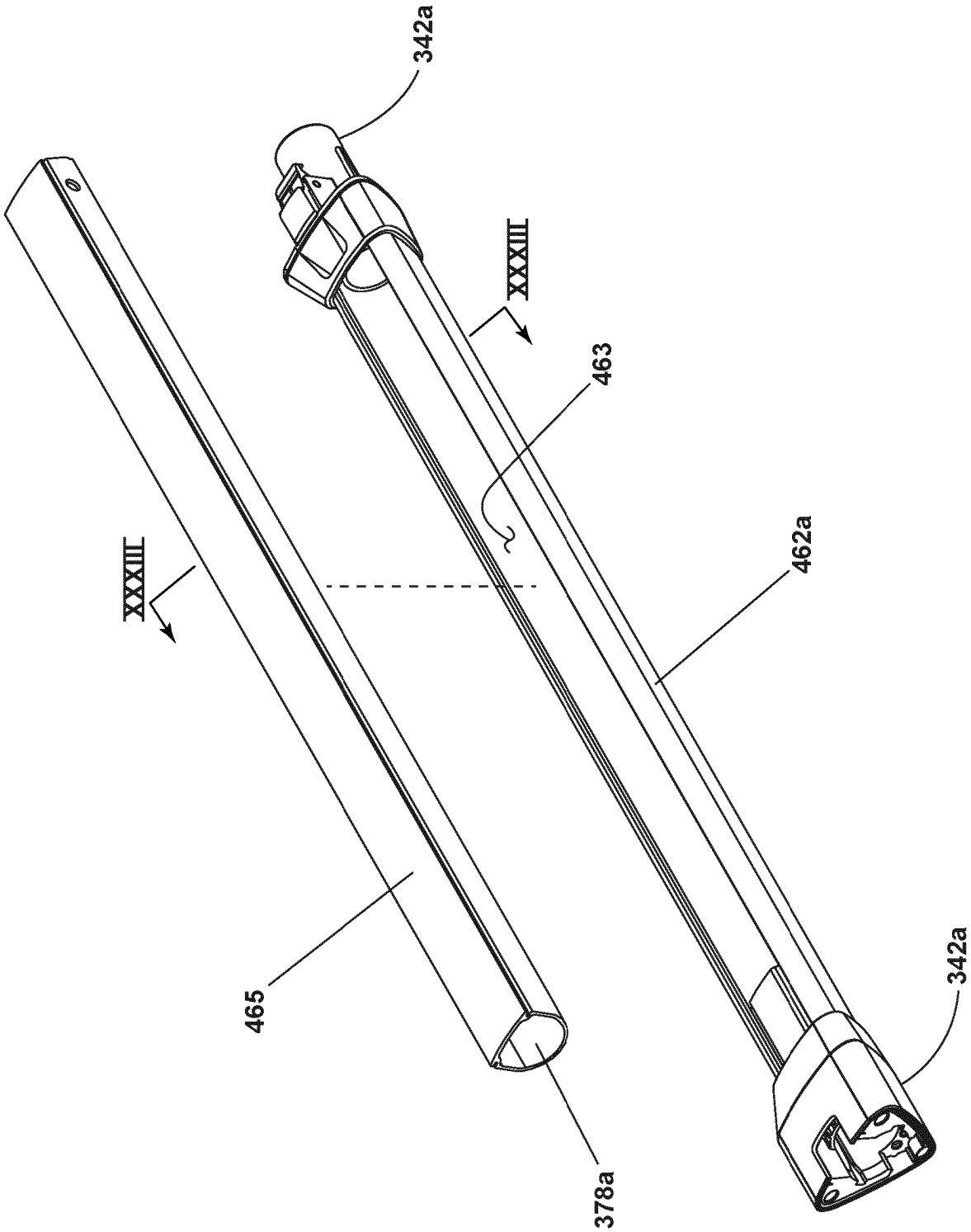


FIG. 32

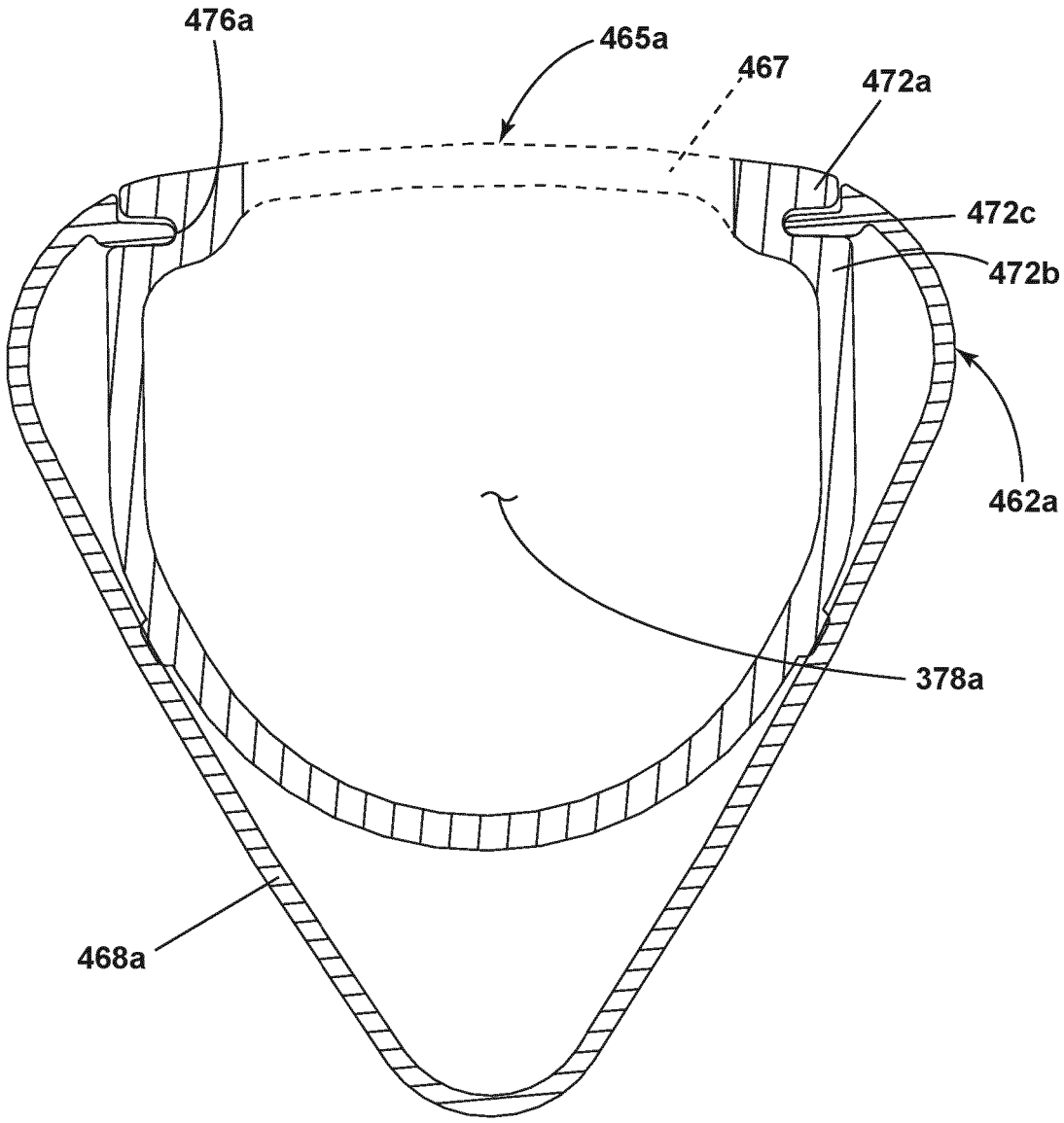
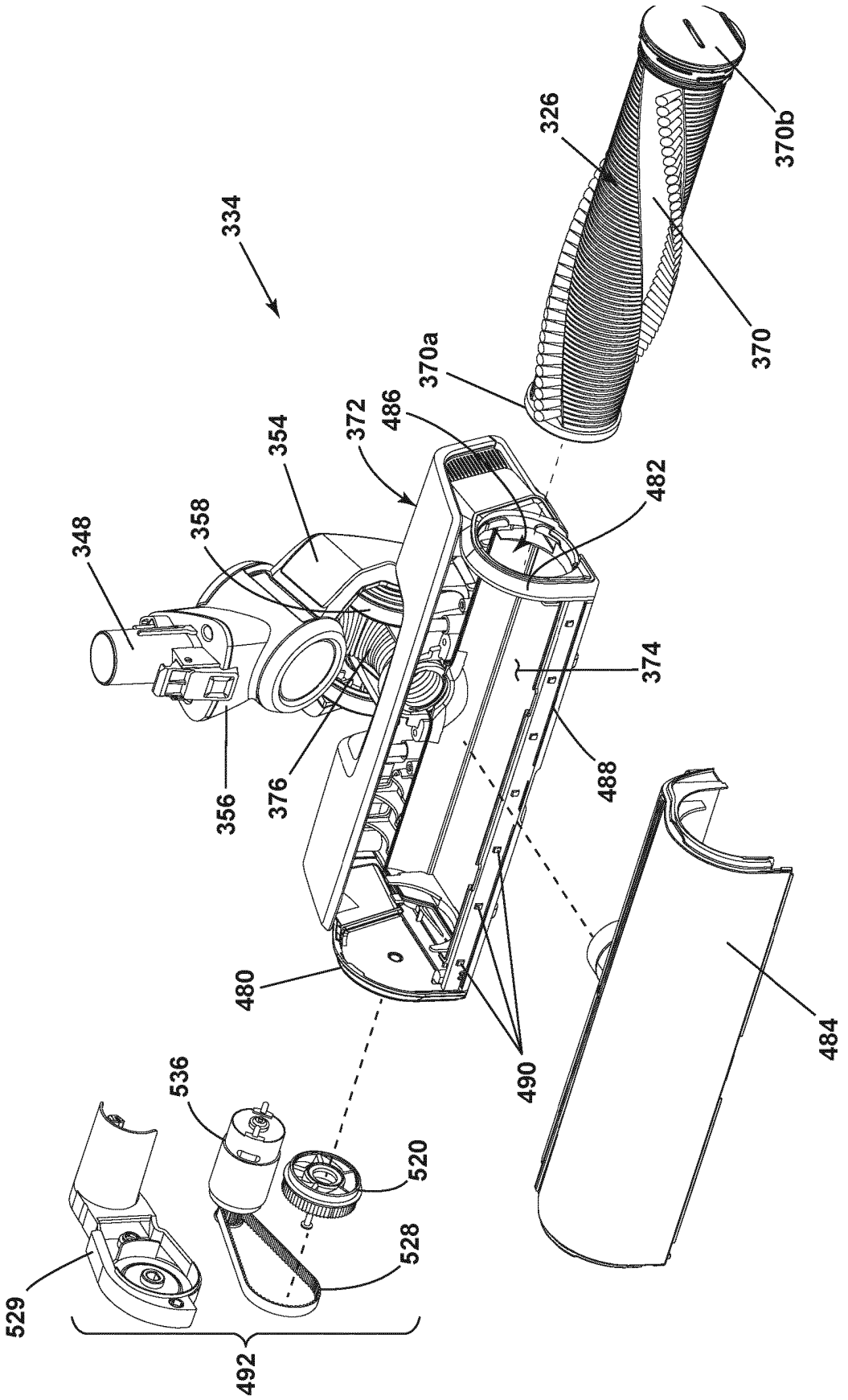


FIG. 33


334
326
370b
370
370a
372
486
354
482
348
358
374
376
356
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480
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536
520
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492

FIG. 34

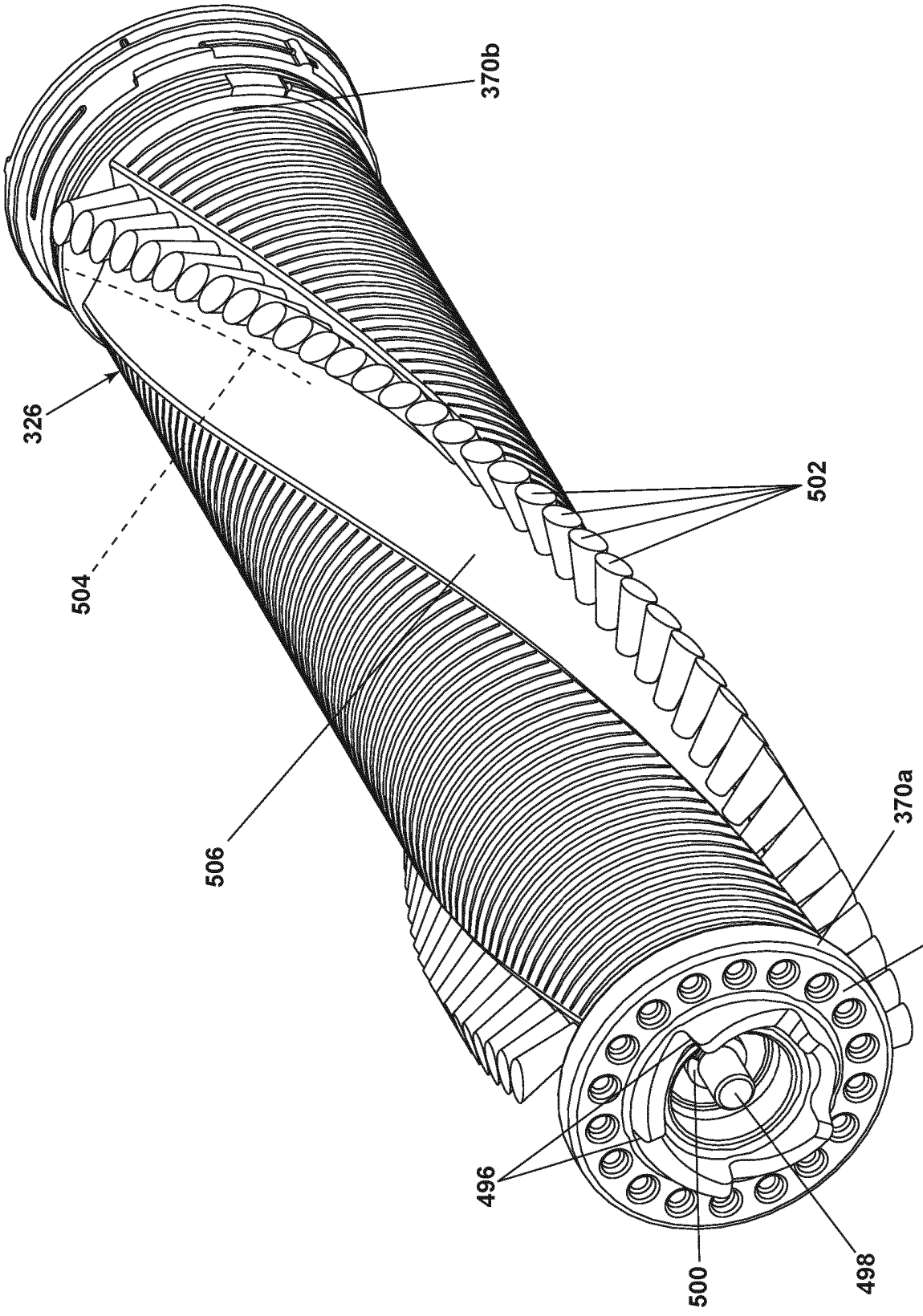
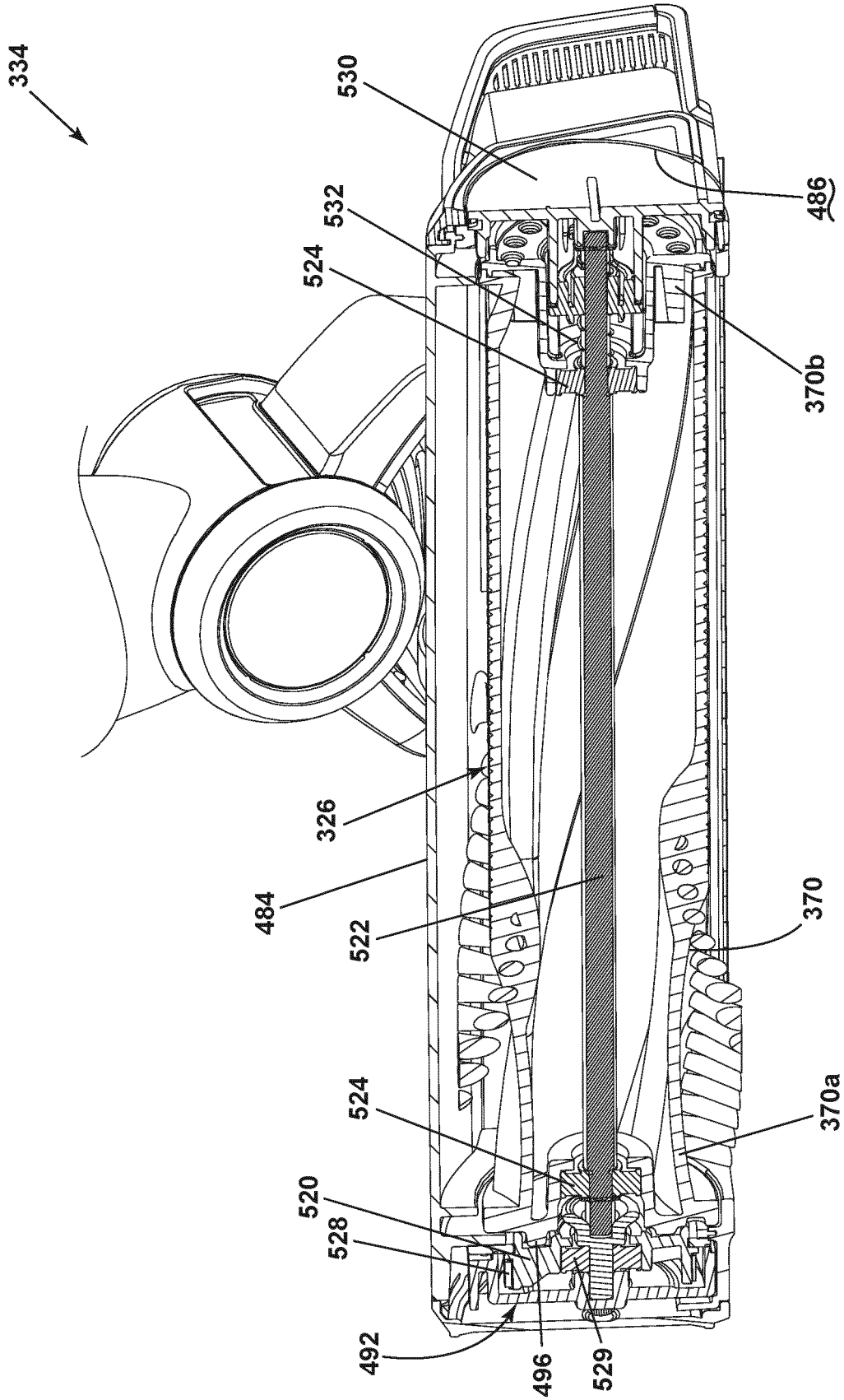


FIG. 35


334
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532
524
486
370b
326
484
522
370
524
370a
520
528
492
496
529

FIG. 36

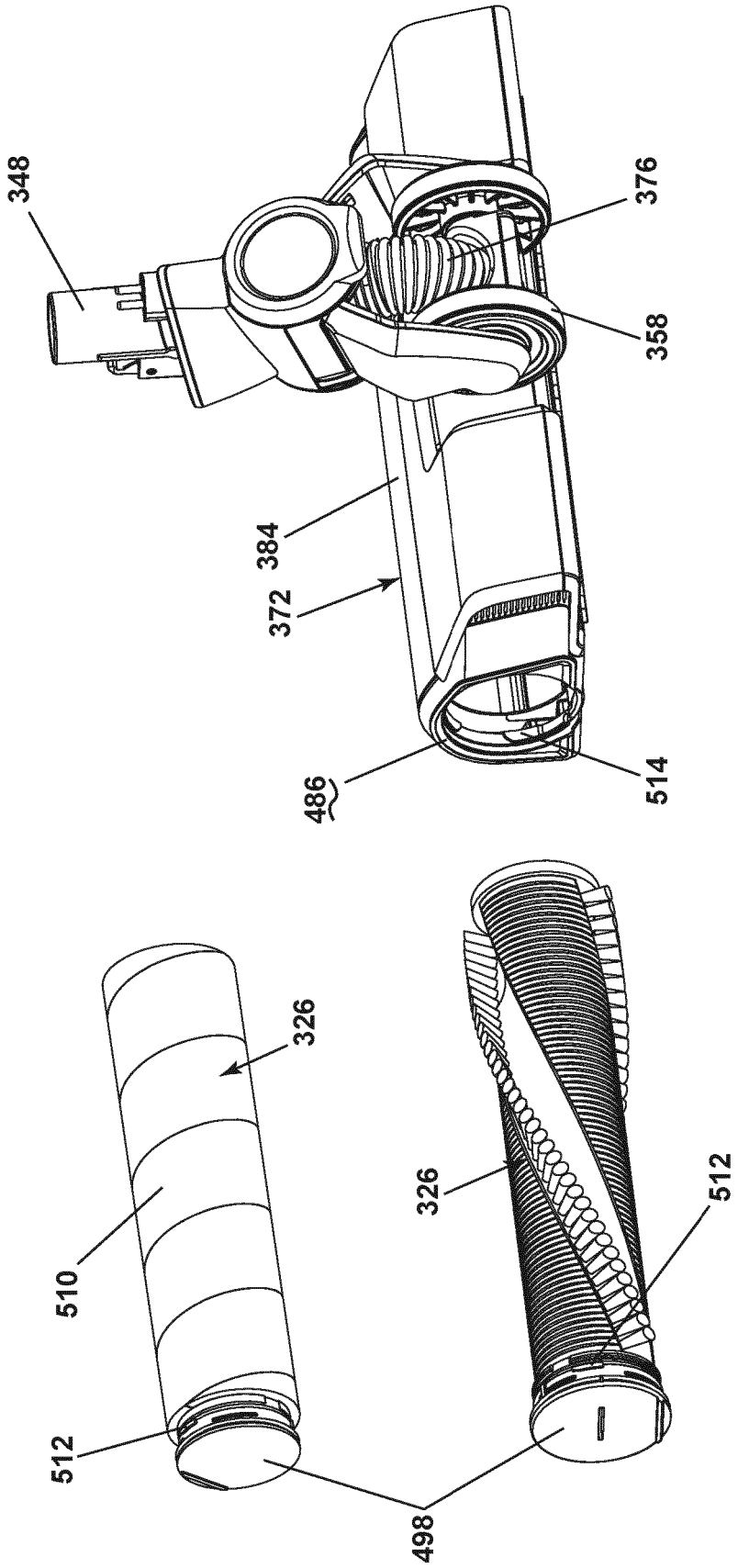

FIG. 37

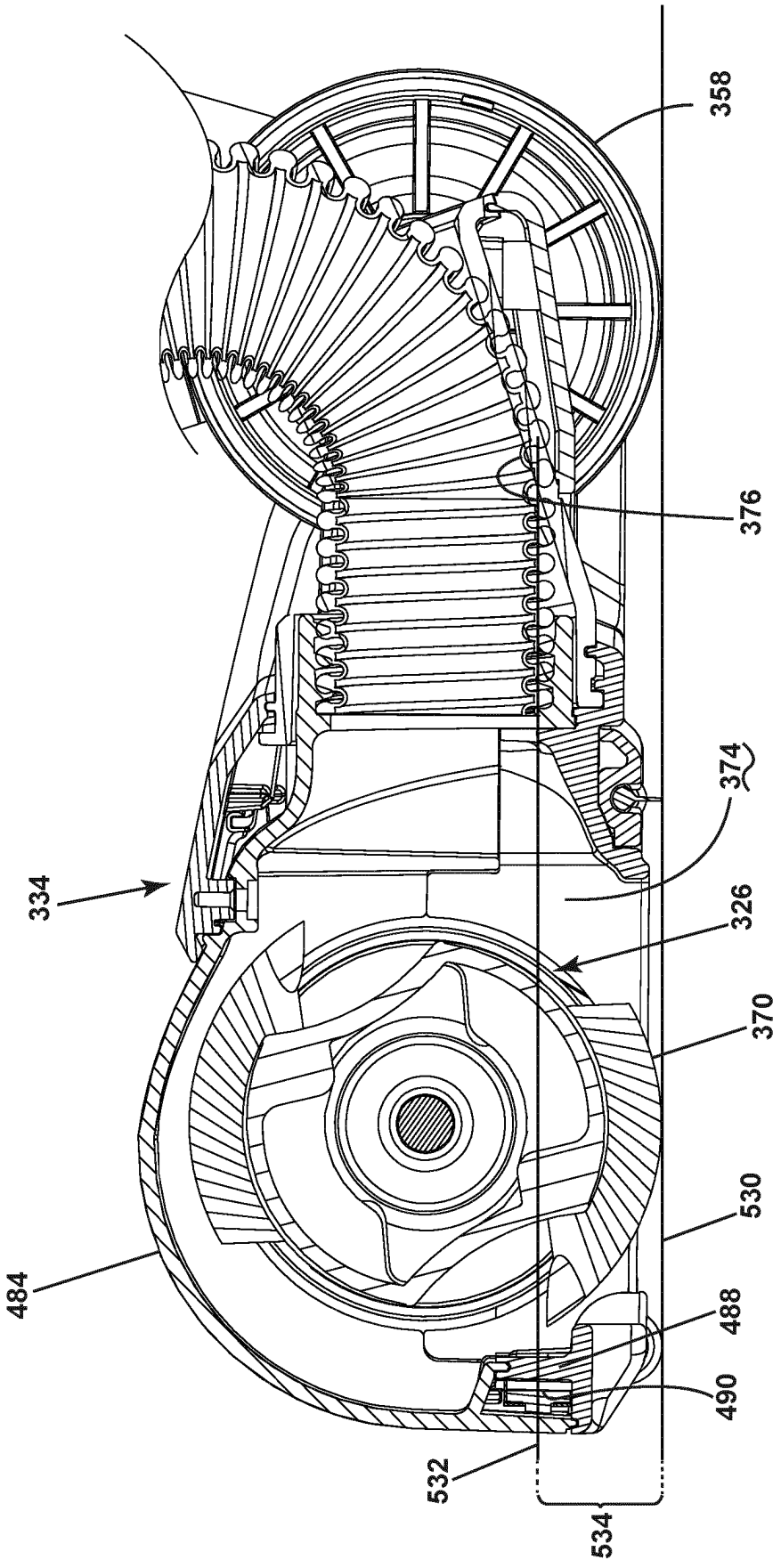

FIG. 38

REFERENCES CITED IN THE DESCRIPTION

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