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(54) **BRUSHLESS DC DRIVE MECHANISM FOR SELD PROPELLED APLICANCE**

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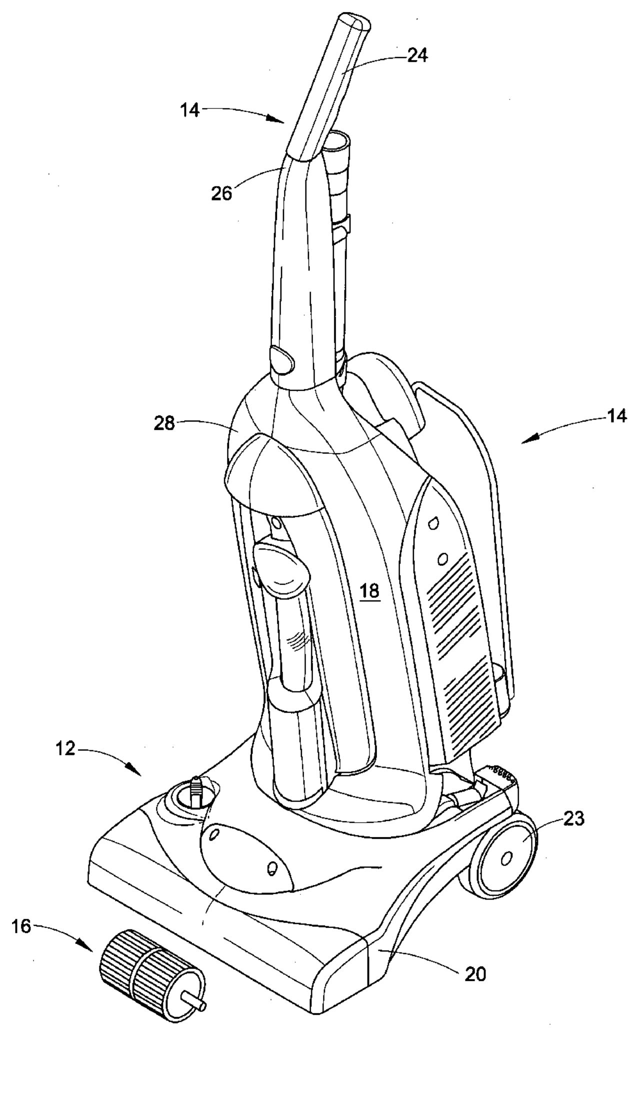
(57) **ABSTRACT**

An upright cleaning device comprising, an actuator for receiving a user input, an upper assembly, a base assembly, a rear wheel mounted to the base assembly, configured to support the rear portion of the base assembly, and a drive mechanism located in the base assembly. The actuator is mounted to upper assembly, and the upper assembly is pivotally mounted to the base assembly. The drive mechanism has its major diameter in contact with a surface to be cleaned, and the drive mechanism is configured to operate at one of: full speed in one direction, no speed and full speed in the opposite direction, according to the relative position of the actuator.



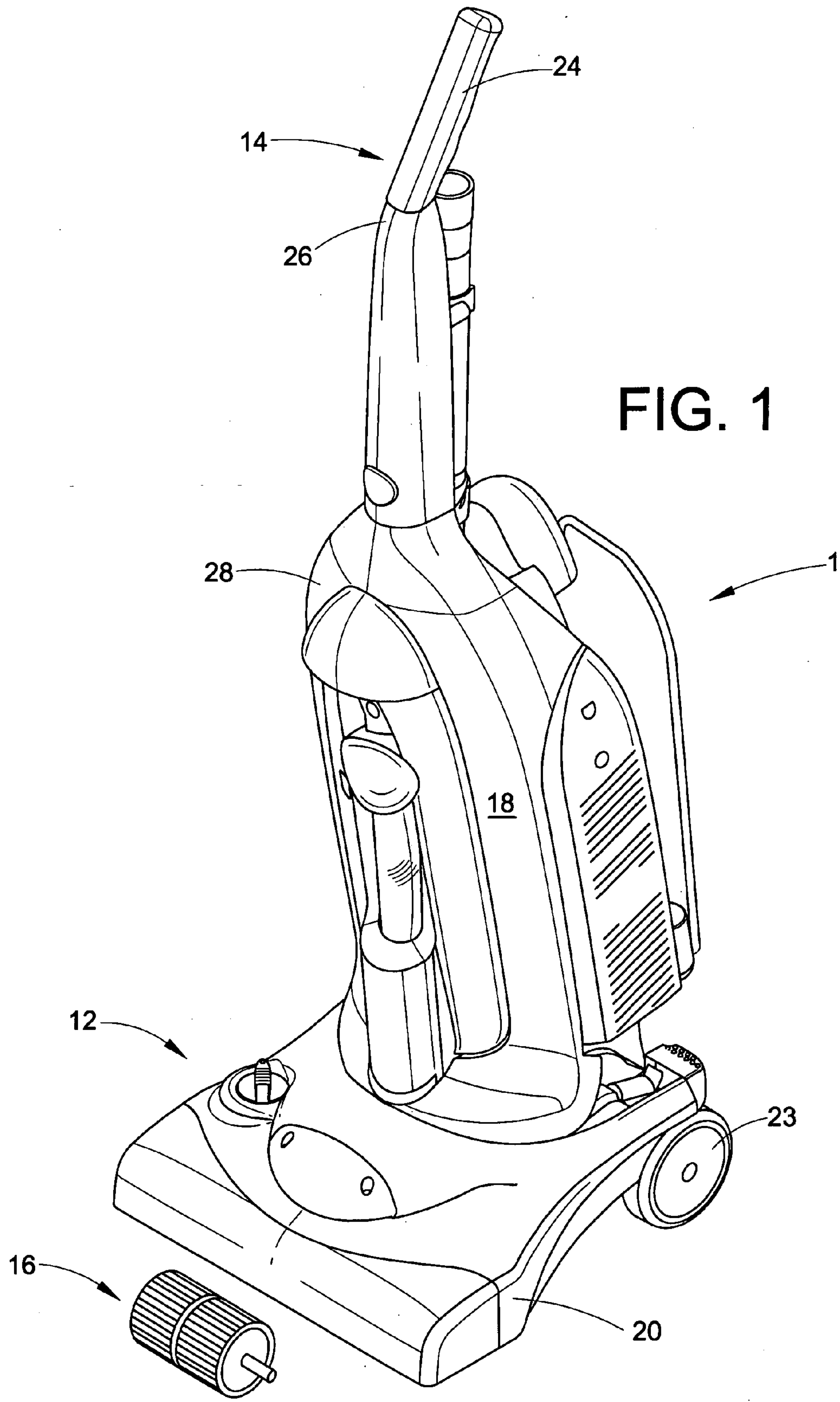
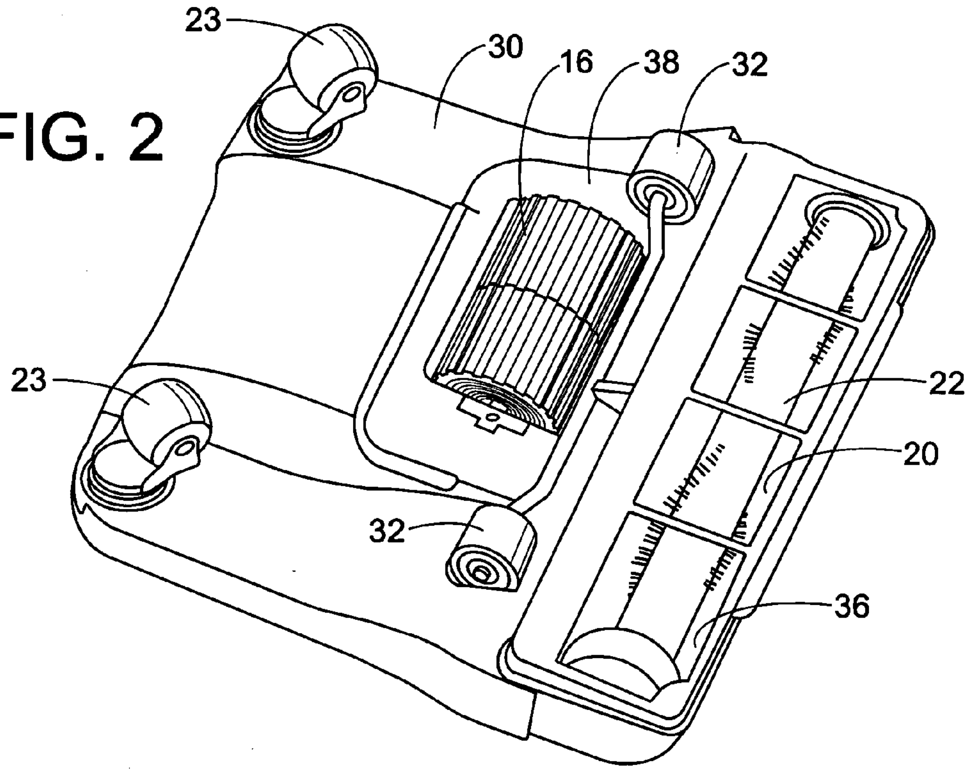


FIG. 1

FIG. 2



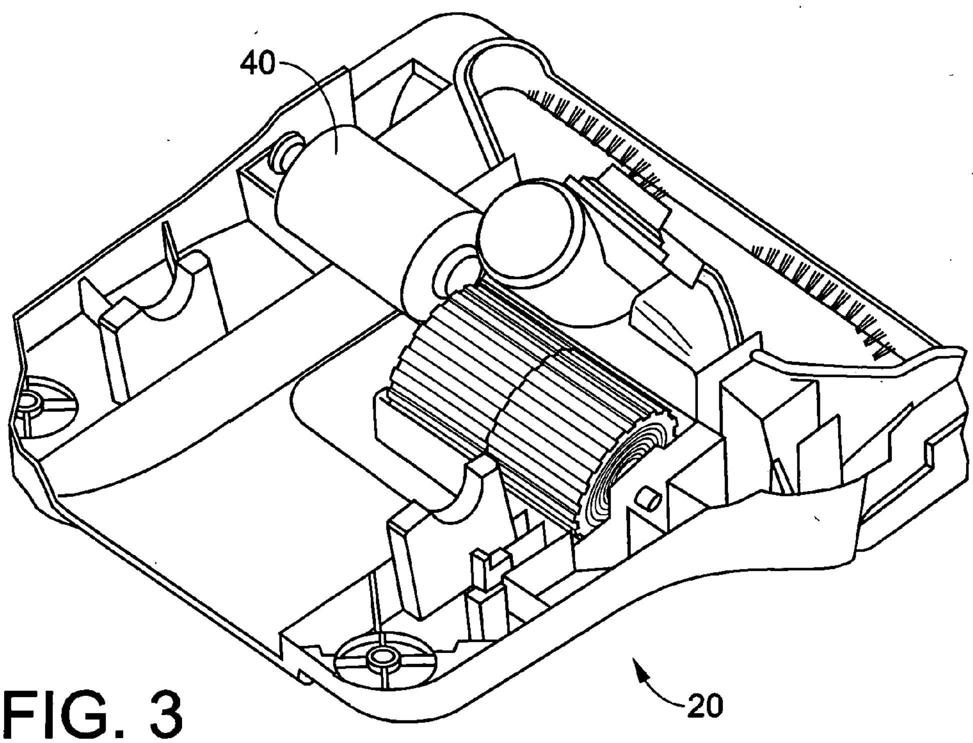


FIG. 3

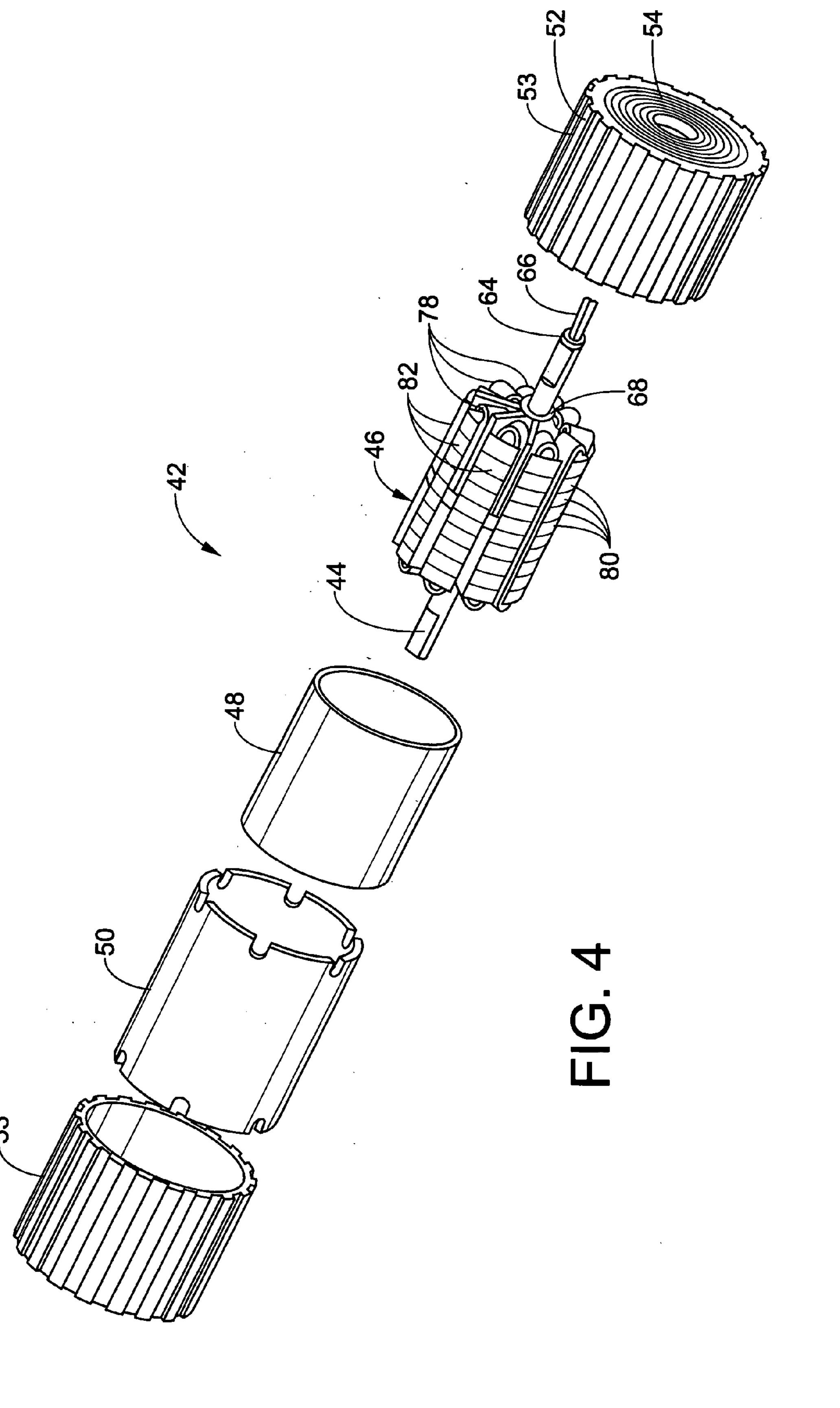


FIG. 4

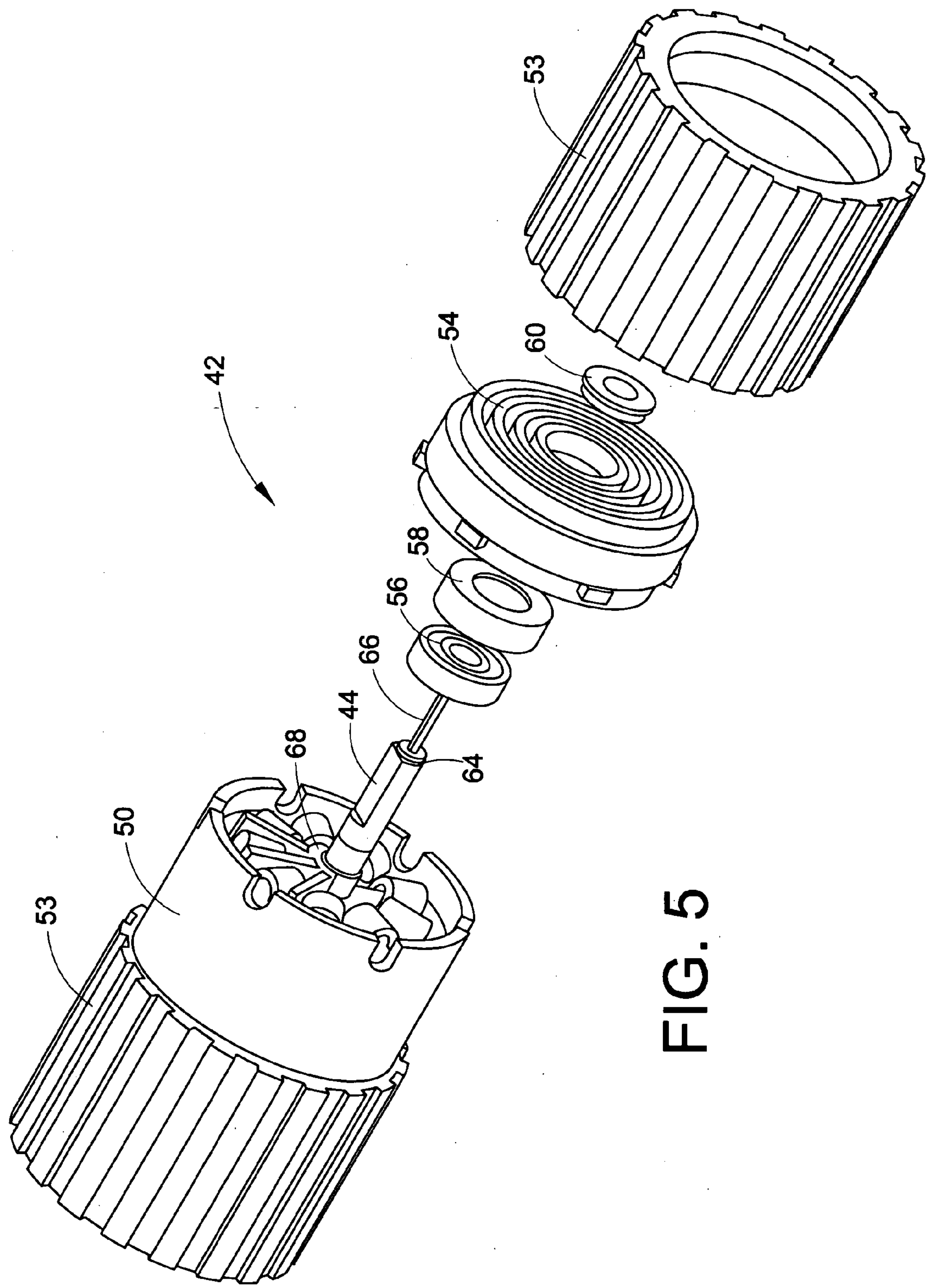


FIG. 5

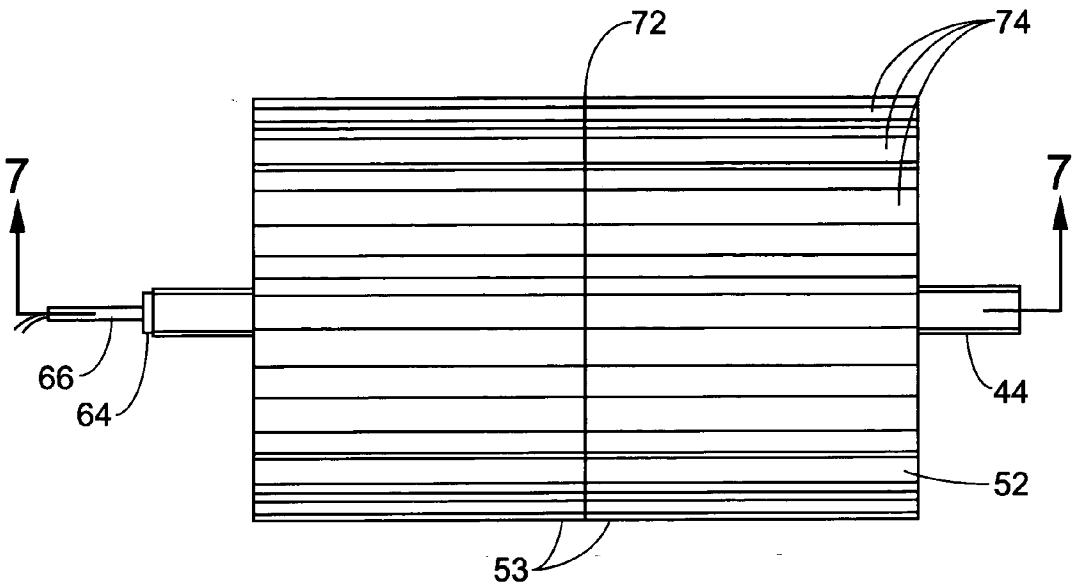

72
74
7
7
66
64
44
52
53

FIG. 6

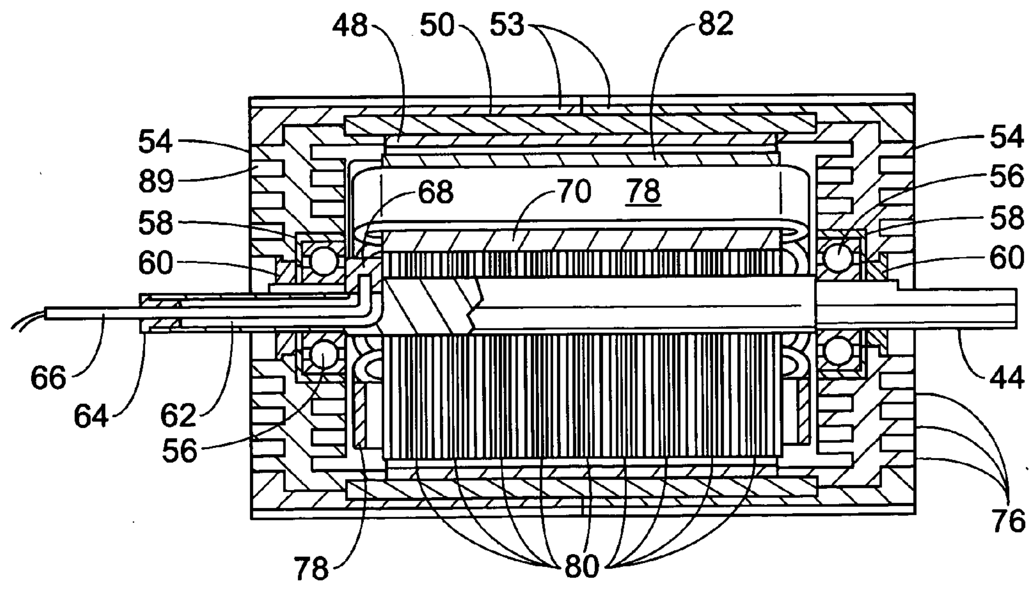

48
50
53
82
54
89
68
70
78
58
60
54
56
58
60
66
64
62
56
44
76
78
80

FIG. 7

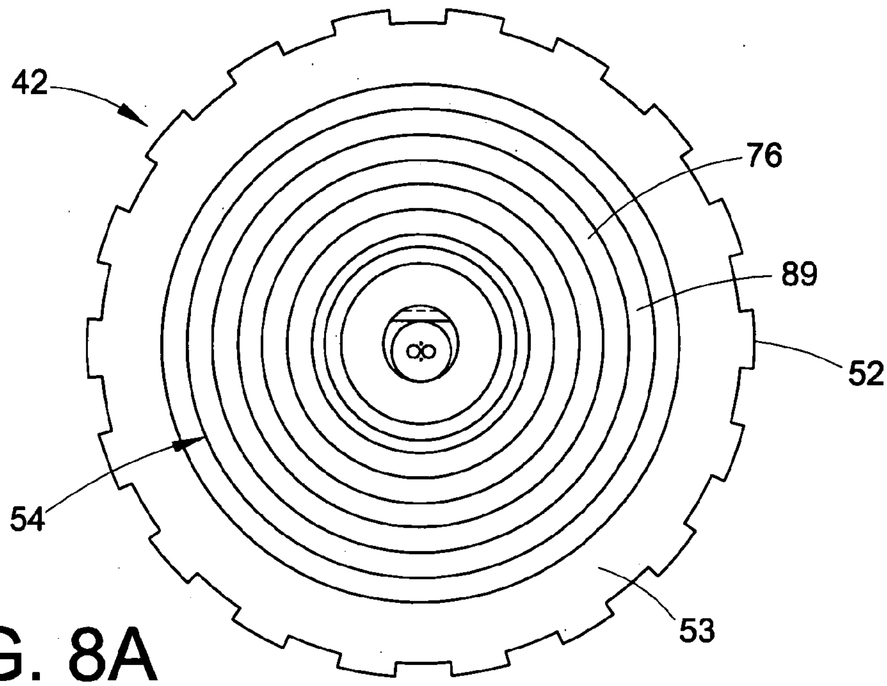


FIG. 8A

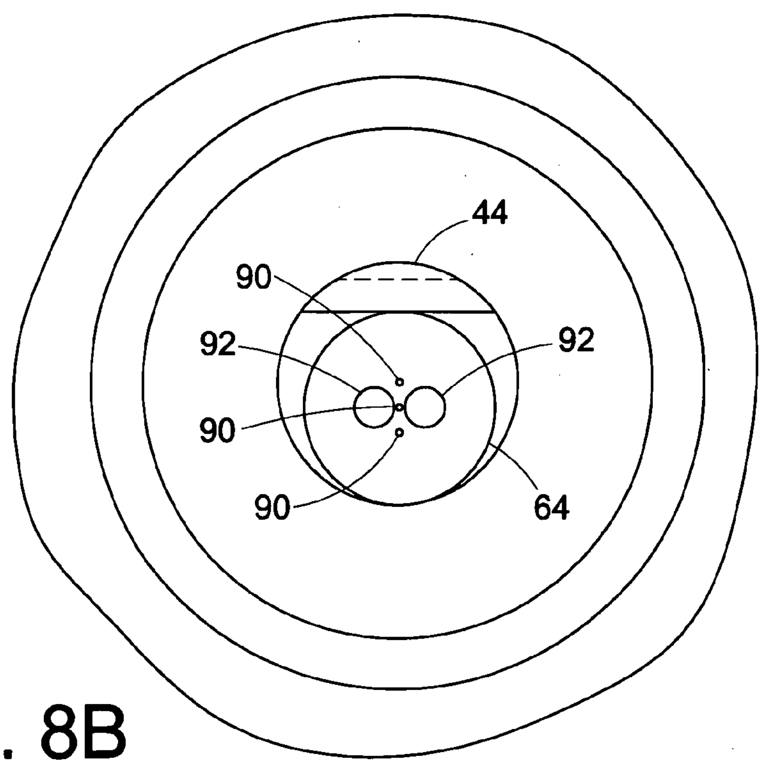


FIG. 8B

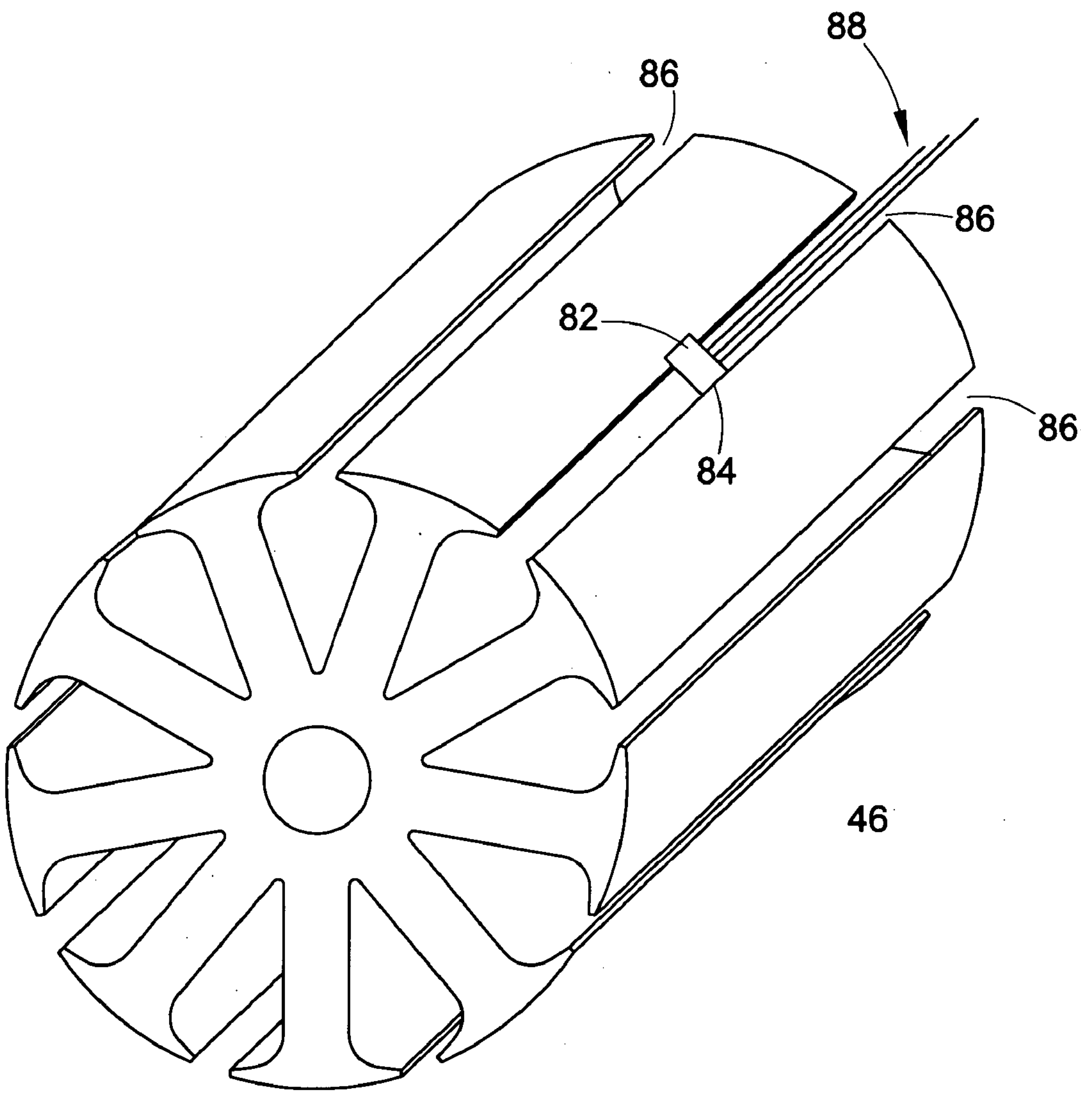
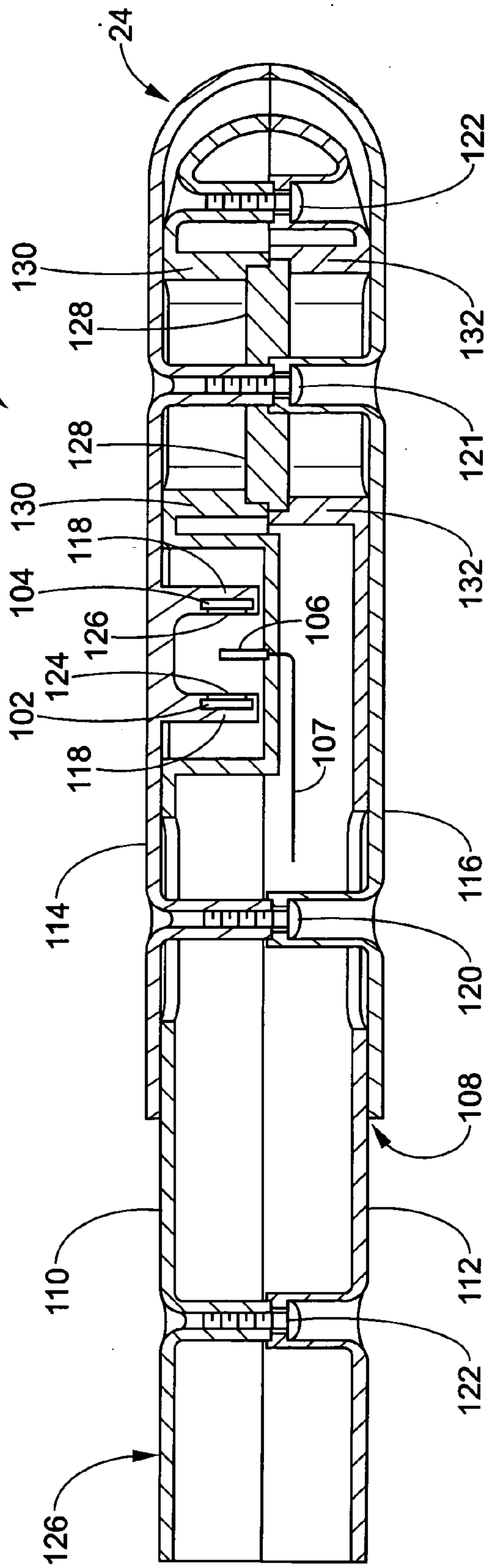


FIG. 9


24
122
130
132
100
128
121
128
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118
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104
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106
124
102
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120
108
110
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122
126

FIG. 10

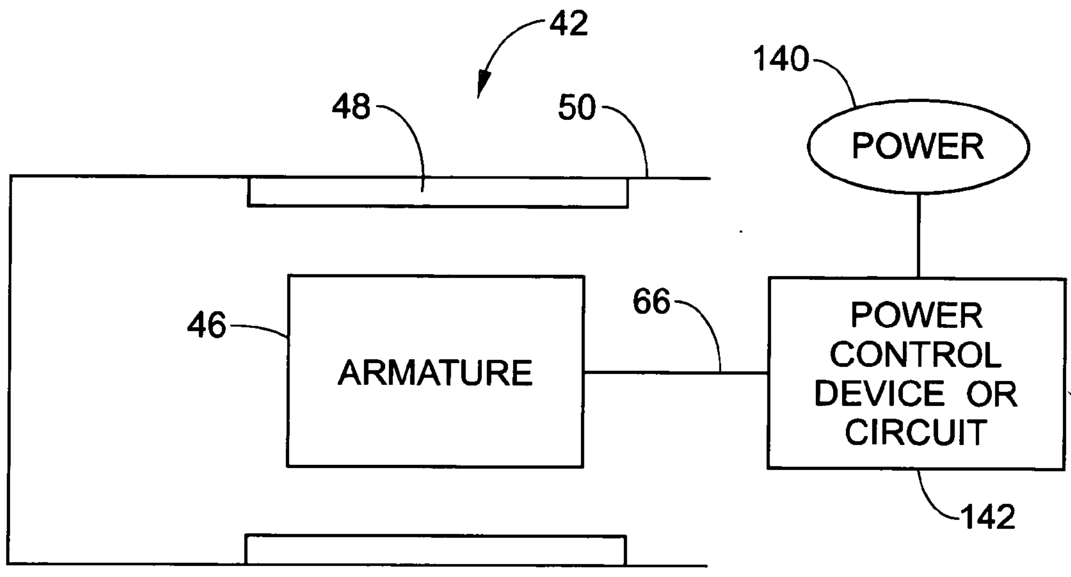

42
140
48
50
POWER
46
ARMATURE
66
POWER
CONTROL
DEVICE OR
CIRCUIT
142

FIG. 11

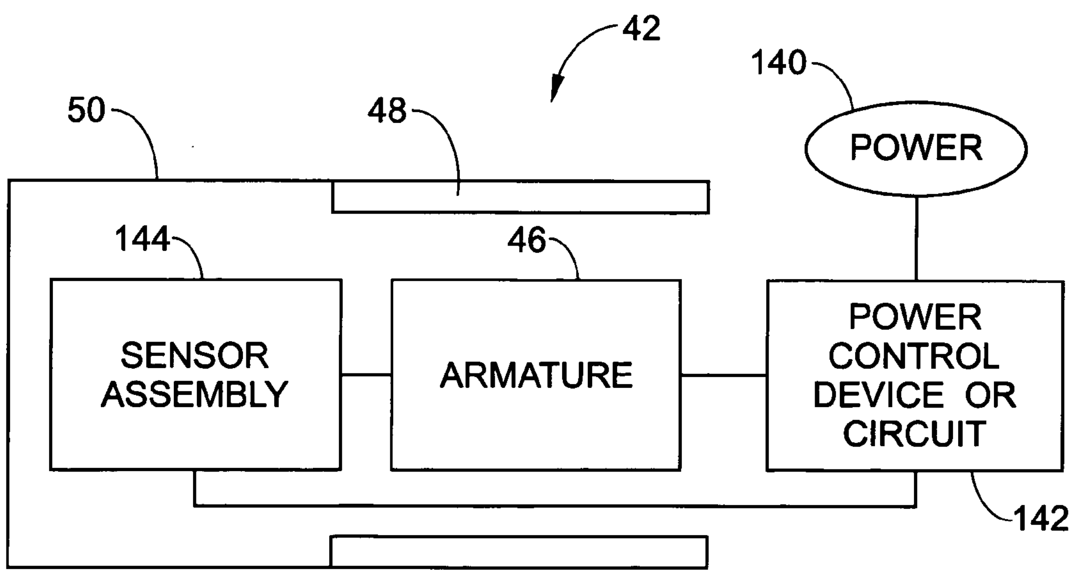
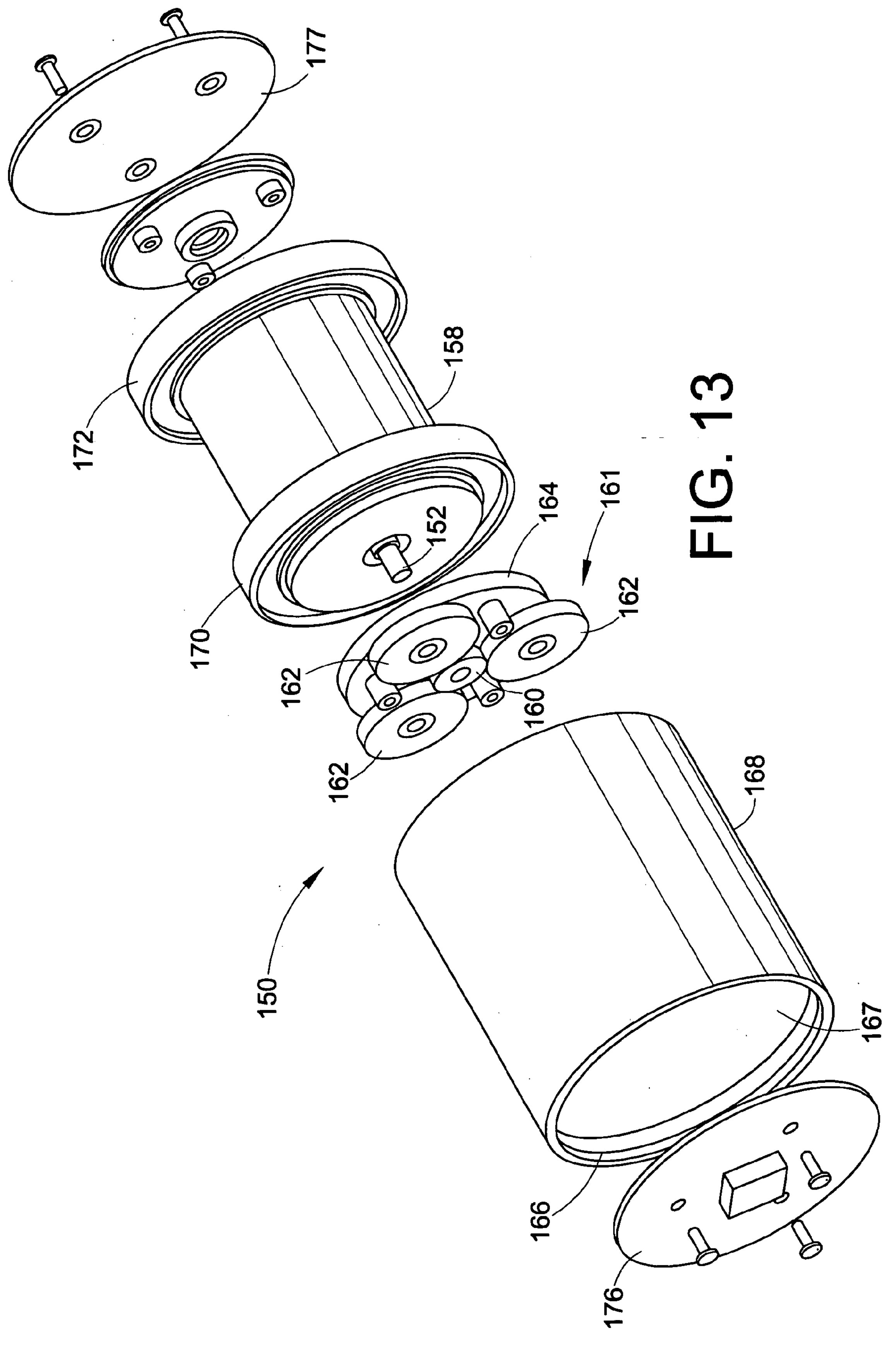

42
140
50
48
POWER
144
46
SENSOR
ASSEMBLY
ARMATURE
POWER
CONTROL
DEVICE OR
CIRCUIT
142

FIG. 12


177
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172
152
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170
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176

FIG. 13

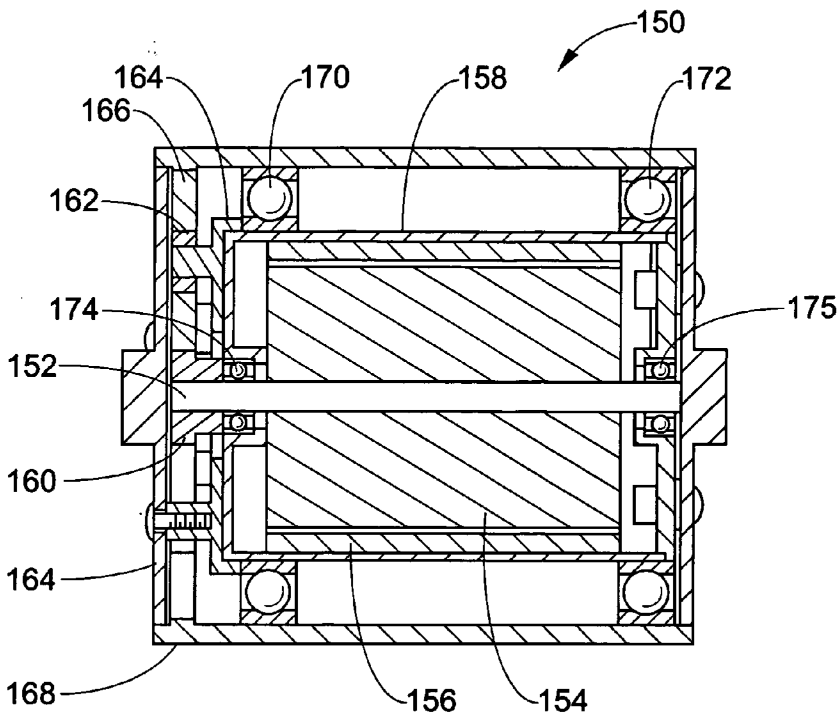

FIG. 14B

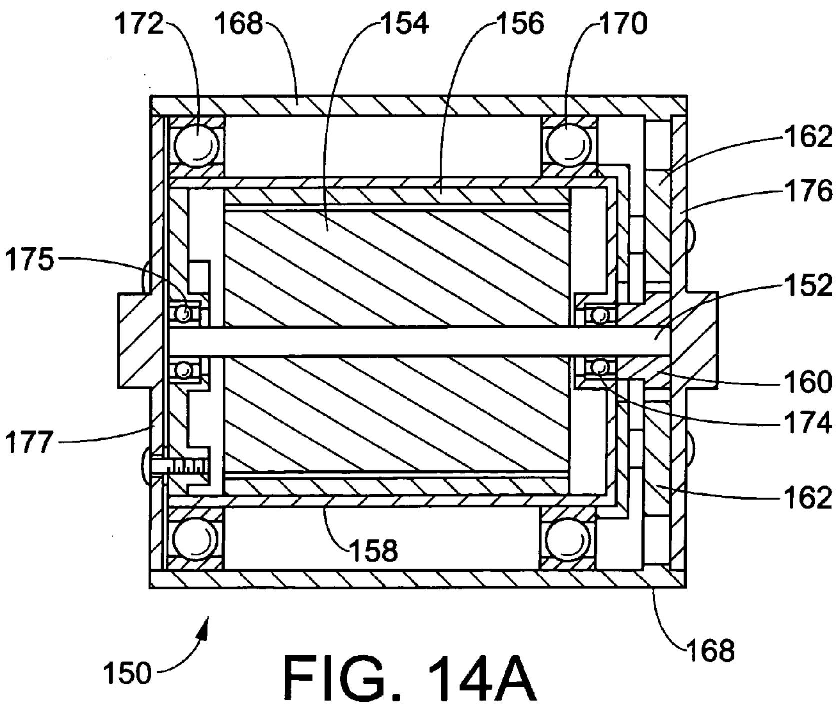

FIG. 14A

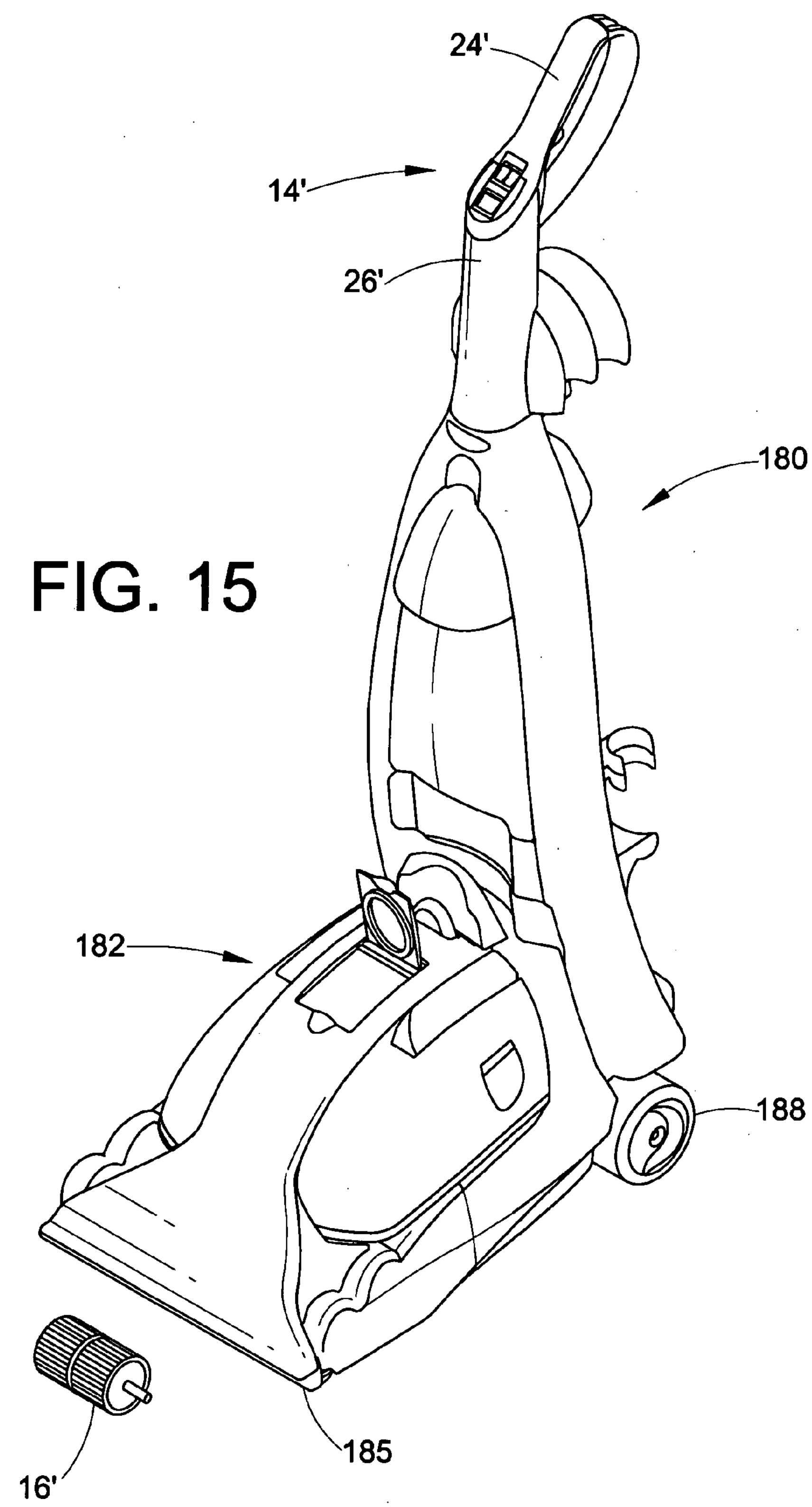

FIG. 15

BRUSHLESS DC DRIVE MECHANISM FOR SELD PROPELLED APLICANCE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to home appliances. More particularly, the present invention relates to a self-propelled or power assist drive system for use in an upright cleaning device. One such device can be a carpet extractor. It is to be appreciated, however, that the present invention may find further application in other environments where it is advantageous to controllably propel or assist cleaning devices, such as upright vacuum cleaners, and the like.

[0003] 2. Discussion of the Art

[0004] Self-propelled upright vacuum cleaners are well known in the art. However, self-propelled carpet extractors are less well known. The preferred motion of a carpet extractor or wet extractor is of a different nature than the preferred motion of an upright vacuum cleaner and thus requires a specific solution for a power-assist drive system for the extractor that solves the moisture problems as well as the mode of operation associated with the nature of the wet extractor. Specifically, the operation of an upright vacuum cleaner is characterized by quick, short strokes compared to that of an extractor. The motion of an upright vacuum cleaner is further characterized by continuously variable acceleration and deceleration. In contrast, an extractor ideally operates at a continuous velocity optimized for extraction efficiency.

[0005] The similarities shared between the two cleaning devices may lead one to conclude that a drive system designed for an upright vacuum cleaner is suitable for use in a wet extractor. This, however, will lead to operational problems if the vacuum cleaner drive is not adapted to address the distinct nature of the motion of a wet extractor. Specifically, the most popular drive systems used in upright vacuum cleaners today are mechanical friction clutches of some form. These clutches generally rely on some form of actuation force that is imposed mechanically, usually via a mechanical linkage from a reciprocating handle to a lever that forces the friction surfaces together, coupling a drive power source to an output such as a wheel. The amount of torque transmitted between the drive power source and the output is proportional to the actuation force imposed at the friction interface. The actuation force is directly proportional to a load imposed on the handle by a user.

[0006] The load on the handle is at its highest when the acceleration of the cleaner is at its highest which is at the end of each stroke, at the instant of direction change. After a direction change, the acceleration of the cleaner typically drops to zero around mid-stroke and then increases in the opposite direction until the end of the stroke. This means that the drive provides an appropriate amount of assistance, as it is needed. This also means that the drive is most effective when the unit is either always accelerating or always decelerating since acceleration or deceleration induces a load on the reciprocating handle which, in turn, imposes an actuation force at the friction interface. In contrast, the user of a wet extractor typically desires to operate the unit at a slower, more controlled, preferably constant pace to uniformly apply and then extract as much cleaning solution as possible.

[0007] If a friction drive mechanism such as that just described is employed for a wet extractor application, the drive provides assistance upon the change of direction, but when the user tries to obtain a controlled constant linear velocity, the imposed force at the handle goes to approximately zero (constant velocity means zero acceleration) and power assist is lost. When power assist is lost, the user must impose more force on the handle to push the cleaner forward. This causes the clutch to engage and power assist is restored, but as the user continues to attempt control of the pace of the unit, power assist is again lost and a cycle of jerky motion and/or very minimal power assist ensues. In order to address this problem, a wet extractor drive should preferably operate the extractor independently of the magnitude of the actuation force and yet still provide good power assist and response to user attempts to change the direction of motion.

[0008] The present invention contemplates a drive mechanism that reduces the amount of effort (force) required by the user to propel a wet extractor forward and back. The present invention addresses issues that arise from attempting to drive an appliance on a wet surface such as loss of traction and the interaction of the drive unit with the cleaning solution. The contemplated drive system accomplishes this task in a manner that does not compromise the nature of the motion associated with a wet extractor. Specifically, the motion of a wet extractor is characterized by relatively slow, approximately constant velocity forward and rearward linear strokes of relatively long length (compared to the typically shorter strokes of an upright vacuum cleaner).

[0009] Furthermore, the present invention contemplates a drive mechanism that provides more force to operate than an upright vacuum cleaner drive to overcome resistance caused by a high suction at the nozzle, base construction (specifically the base length), and, in many cases, a lack of forward support wheels. The present invention also provides benefit by operating the cleaner at an appropriate speed for effective wet extraction, helping to reduce operator-induced inefficiencies.

[0010] Still further, the present invention contemplates a drive mechanism that overcomes challenges associated with the operation of the extractor on a wet surface such as a loss of traction and an interaction of the drive unit with cleaning solution which can include the infiltration of the solution into the drive unit and a chemical interaction of the solution with materials of the drive unit.

SUMMARY OF THE INVENTION

[0011] In accordance with one aspect of the present invention, an upright cleaning device is provided, comprising an upper assembly to which an actuator for receiving a user input is mounted, a base assembly to which the upper assembly is pivotally mounted, a rear wheel mounted to the base assembly, configured to support the rear portion of the base assembly, and a drive mechanism located in the base assembly. The drive mechanism has its major diameter in contact with a surface to be cleaned, and the drive mechanism is configured to operate at one of: full speed in one direction, no speed and full speed in the opposite direction, according to the relative position of the actuator.

[0012] In accordance with another aspect of the present invention, a self-propelled upright cleaning device is provided, comprising a nozzle base, an upper housing section pivotally mounted to the nozzle base, a handle actuator, a wheel for supporting the nozzle base, and a drive mechanism located in the nozzle base and having its major diameter in contact with a surface to be cleaned. The handle actuator for receiving a user input is mounted on the upper housing section. The drive mechanism comprises a stationary shaft, a stationary armature mounted on the shaft, a tubular motor housing rotatably mounted on the shaft, and a plurality of magnets mounted to an inner face of the tubular motor housing and spaced from the armature.

[0013] In accordance with yet another aspect of the present invention, a self-propelled upright cleaning device is provided, comprising a nozzle base, an upper housing section pivotally mounted to the nozzle base, a handle actuator for receiving a user input, and a drive mechanism. The handle actuator is mounted on the upper housing section. The drive mechanism is located in the nozzle base and has its major diameter in contact with the surface to be cleaned. The drive mechanism comprises a rotating motor shaft, a rotating armature mounted on the shaft, a stationary motor housing encircling at least a portion of the rotating shaft, a sun gear mounted on at least one end of the motor shaft, a planetary gear train comprising at least one planet gear engaging the sun gear, and a ring gear engaging the at least one planet gear. The ring gear is connected to a sleeve comprising a driven surface of the drive mechanism.

[0014] In accordance with still another aspect of the present invention, a method of propelling an upright cleaning device is provided, comprising the steps of sensing a user input from a handle actuator, operating a drive mechanism located in a base assembly, the drive mechanism having its major diameter in contact with a surface to be cleaned, wherein the drive mechanism is configured to operate at one of: full speed in one direction, no speed and full speed in the opposite direction, according to sensed user input.

[0015] The advantages of the present invention will be readily apparent to those skilled in the art, upon a reading of the following disclosure and a review of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention is described in conjunction with accompanying drawings. The drawings are for purposes of illustrating exemplary embodiments of the invention and are not to be construed as limiting the invention to such embodiments. It is understood that the invention may take form in various components and arrangement of components and in various steps and arrangement of steps beyond those provided in the drawings and associated description.

[0017] **FIG. 1** is a perspective view of a first exemplary appliance, in the form of a vacuum cleaner with a drive mechanism, in the form of a wheel, according to the present invention being exploded out from it;

[0018] **FIG. 2** is a perspective view of a bottom face of a nozzle base of the vacuum cleaner of **FIG. 1** employing the drive mechanism of the present invention;

[0019] **FIG. 3** is a perspective view from an upper side thereof of the nozzle base of **FIG. 2** with a top wall removed for clarity;

[0020] **FIG. 4** is an exploded perspective view of a drive wheel assembly according to a first embodiment of the present invention;

[0021] **FIG. 5** is an enlarged partially assembled perspective view of the drive wheel assembly of **FIG. 4**;

[0022] **FIG. 6** is a fully assembled front elevational view of the drive wheel assembly of **FIGS. 4 and 5** in a reversed orientation;

[0023] **FIG. 7** is a sectional view of the drive wheel assembly of **FIG. 6**;

[0024] **FIG. 8A** is an end elevational of the drive wheel assembly of **FIG. 6** showing heat dissipating fins;

[0025] **FIG. 8B** is a greatly enlarged view of a portion of **FIG. 8A** showing and motor lead openings;

[0026] **FIG. 9** is a perspective view of an armature suitable for incorporation into motors used in drive wheel assemblies according to the present invention;

[0027] **FIG. 10** is an elevation view in cutaway of a handle portion of the appliance of **FIG. 1**;

[0028] **FIG. 11** is a functional block diagram of a first speed regulating mechanism suitable to control the drive wheel assembly according to the present invention;

[0029] **FIG. 12** is a functional block diagram of a second speed regulating mechanism suitable to control the drive wheel assembly according to the present invention;

[0030] **FIG. 13** is an exploded perspective view of a drive wheel assembly according to a second embodiment of the present invention

[0031] **FIG. 14A** is a first sectional view of the drive wheel assembly of **FIG. 13**;

[0032] **FIG. 14B** is a second, reversed, sectional view of the drive wheel assembly of **FIG. 13** and,

[0033] **FIG. 15** is a perspective view of a second exemplary appliance, in the form of a carpet extractor, with a drive mechanism, in the form of a drive wheel, according to the present invention being exploded out from it.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0034] Referring to **FIG. 1**, a self-propelled appliance **10** includes a base portion **12** and a handle portion **14**. Typically, the base portion **12** includes a means such as a drive wheel **16** (shown exploded away from the base portion **12**) for propelling the appliance **10**. Additionally, the base portion **12** may provide or house implements or actuators for performing the function of the appliance **10**. While the invention is described as being used in connection with an upright vacuum cleaner, it should be apparent that the invention could also be employed in a carpet extractor, or a similar electrically powered home appliance. However, the invention could also be used with outdoor appliances, such as lawnmowers, snowblowers, or the like.

[0035] For example, where the appliance **10** is a vacuum cleaner the handle portion can include a filter chamber **18**, and the base portion **12** may be a nozzle base. In addition to housing a means **16** for propulsion, the nozzle base includes a nozzle **20** through which dirt laden air is entrained. Dirt is removed from the air stream and collected in a bag, dirt separation chamber, or dirt cup of the filter chamber **18**. Additionally, the nozzle base may include other implements for enhancing the functionality and usability of the vacuum cleaner. For example, the nozzle base may house a brushroll **22** and additional wheels **23**, as shown in **FIG. 2**, for improving the cleaning ability and maneuverability of the vacuum cleaner **18**. Furthermore, the nozzle base may house power supplies and control circuitry. Alternatively, power supplies and control circuitry may be located in other portions of the vacuum cleaner.

[**0036**] The handle portion **14** can be pivotally mounted on the base portion and provides a means for an operator to direct the operation of the appliance **10**. For example, the handle portion **14** may be used to steer or direct the appliance **10**. Additionally, the handle portion **14** may include control elements.

[**0037**] The base portion **12** is configured such that drive wheel **16** has its major diameter in contact with the ground when in an operational mode so as to exert a propelling force on the ground when signaled by an actuator **24** via input from a user. The actuator is mounted on a handle **26** extending from an upper housing section **28** of the handle portion **14**. The additional wheels **23** on the nozzle base, which can be casters, allow the appliance to roll on the subjacent floor surface.

[**0038**] With reference now to **FIG. 2**, the base portion comprises a housing **30** on which the one or more wheels or casters **23** as well as height positioning wheels **32** are mounted. Also provided is the drive wheel **16** which is positioned rearwardly of the brushroll **22** mounted in a brushroll chamber **36** of the home appliance and before the rear casters **23** thereof. The drive wheel can be mounted to an intermediate plate **38** with the intermediate plate, in turn, being mounted to the housing **30**. The wheel **16** transmits torque to the subjacent support surface, be it carpeting or a hard surface, through a tread/ground interface thereby reducing the effort required by the operator to propel the appliance. As shown in **FIG. 3**, the brushroll **22** can be powered by a separate brushroll motor **40**, via a conventional belt (not illustrated).

[**0039**] With reference now to **FIG. 4**, the drive wheel **16** can comprise a reversible drive assembly **42**. The drive assembly **42** in this embodiment is best characterized as a powered wheel. The assembly is essentially a brushless DC motor distinguished from typical brushless DC motors by the fact that a shaft **44** and an armature **46** are held stationary while a set of magnets **48** and a motor housing **50** rotate around the armature **46**. This allows for a fairly compact design. A traction surface **52**, in the form of two tread sleeves **53**, can be applied to the motor housing **50** directly and the motor, therefore, doubles as a wheel. To this end, the motor housing **50** can include a steel motor tube.

[**0040**] With reference now to **FIG. 5**, motor end caps **54** can be rotatably mounted to the stationary shaft **44** by means of ball bearings **56**. The bearings **56** are mounted into bearing insulators **58** which are in turn mounted into end caps **54**. A rotary shaft/lip seal **60** can be provided around the shaft **44**, between the shaft **44** and the end cap **54**. As shown in **FIG. 7**, the shaft **44** can be hollowed at one end to provide a channel **62** in the shaft **44** to receive a shaft seal/strain relief **64** through which motor leads **66** are routed into the channel **62** and through a connection block/shaft seal **68** fitted in an opening **70** on the shaft surface into the internal channel **62**. Further, a non-reactive material can be used for the tread sleeves **53** in order to prevent chemical interaction between the cleaning solution and the drive mechanism.

[**0041**] If desired, the motor end caps **54** can be constructed of aluminum and insulated on their inner surfaces all around. The end caps **54** are insulated from the bearings **56** by the insulators **58**. The outer tread sleeves **53** can be made of a suitable conventional polymer and pressed on the housing **50** with adhesive enabling the motor to double as a wheel. As shown with reference to **FIG. 6**, the tread sleeves form a joint **72** in a surface tread pattern **74**. With reference to **FIG. 7**, end caps **54** can be formed with heat dissipating fins **76**.

[**0042**] The armature **46** further comprises coils **78** wound on laminations **80** forming the armature yoke. With reference to **FIGS. 7 and 9**, the armature **46** can include three Hall effect digital position sensors **82** (only one shown). Each Hall effect position sensor **82** is located in the center of the armature **46** axially in a wider slot opening **84** with the Hall position sensor **82** being flush with the outside diameter of the armature **46**. Furthermore, the three Hall position sensors **82** can be located in three adjacent armature slots **86** with all three sensors positioned in like manner with respect to the respective armature slot **86** and armature **46**. The Hall position sensors **82** can be secured in their respective slot openings **84** with high temperature epoxy. Hall leads **88** extend from each of Hall position sensors **82** out of one end of the armature **46** and below the outside diameter of the armature **46**. The three leads from each of the Hall position sensors **82** provide for interconnection to the remaining Hall position sensors **82**.

[**0043**] **FIG. 8A** shows the depth of the traction surface **52** formed on the drive assembly **42** by the tread sleeves **53**. It also shows that the heat dissipating fins **76** on the motor end caps **54** are concentric with each other and are separated by grooves **89**. With reference now to **FIG. 8B**, shaft seal/strain relief **64** is provided with Hall lead openings **90** through which Hall leads **88**, of motor leads **66**, exit the motor **42**. The shaft seal/strain relief **64** is also provided with power lead openings **92** through which the remaining leads of motor leads **66** exit the motor **42**.

[**0044**] With reference again to **FIG. 1**, the handle-mounted actuator **24** provides a means for an operator to direct the movement of the appliance **10**. For example, the actuator **24** may be used to grasp the appliance **10** and to steer or direct its movement. Additionally, the actuator **24** may include control elements.

[**0045**] For example, with reference to **FIG. 10**, the actuator **24** may include a means **100** for determining a desired drive effort for the means of self-propulsion. For example, the means **100** for determining a desired drive effort includes a first magnet **102**, a second magnet **104** and a means for sensing a magnetic field such as, for example, a Hall-effect sensor **106** and sensor leads **107**. The actuator **24** also includes means **108** for changing a relative position of the magnets and Hall-effect sensor. For example, the means **108** for changing the relative position of the magnets **102**,**104** and Hall-effect sensor **106** can include the handle portion **26**, including a handle upper half **110** and a handle lower half **112**, and the actuator **24** can include a slide upper half **114** and a slide lower half **116**. Such upper and lower halves **114,116** can form a tube slidably mounted to the handle **26**. The handle **26** is adapted or sized and shaped to be slidably received within the actuator **24**. The magnets **102,104** can be attached to magnet mounting surfaces **118** of the slide upper half **114**. Fasteners, such as first and second slide screws **120,121**, can be used to secure the slide upper half **114** and slide lower half **116** together. The handle upper half **110** and handle lower half **112** are similarly secured together with fasteners such as handle screws **122**.

[0046] When assembled, the Hall-effect sensor **106** can be disposed between like poles of the magnets **102,104**. For example, the Hall-effect sensor **106** can be situated between a north pole **124** of the first magnet **102** and a north pole **126** of the second magnet **104**. This arrangement of the magnets **102,104** provides a null in a magnetic field between the magnets **102,104** and magnetic field lines of steadily increasing intensity as a relative position of a measurement point is brought closer to either of the magnets **102,104**. Furthermore, due to this arrangement, lines of force emanating from the like poles **124,126** are in opposite directions.

[0047] The slide screws **120,121** also secure the slide upper half **114** and slide lower half **116** to a center section of a self-centering resilient member **128**. The resilient member **128** is secured at each end to upper slide partitions **130** and lower slide partitions **132**. As mentioned above, the handle **26** is adapted to be slidably received within the actuator **24**. The handle **26** constrains the actuator **24** from lateral or twisting motions. However, the handle **26** can be slid into and out of the actuator **24**, within the limits imposed by the resilient member **128**, and the partitions **130,132**.

[0048] For example, the user may direct the appliance **10** to move forward or backward by applying a pulling or a pushing force on the actuator **24**. In so doing, the user would move the handle **26** in a forward or backward direction. This urges the handle **26** into or out of the actuator **24**. As the user pushes the handle **26** into the actuator **24**, the second magnet **104** is urged closer to the Hall-effect sensor **106** and the first magnet **102** is moved further away. The Hall-effect sensor **106** senses an increased magnetic field in a first direction and produces an electric signal indicative thereof.

[0049] Similarly, if the user pulls the handle **26** out of the actuator **24**, the second magnet **104** is moved away from the Hall-effect sensor **106**, and the first magnet **102** is urged toward the Hall-effect sensor **106**. The Hall-effect sensor **106** senses first a reduction in magnetic field strength and then an increase in magnetic field strength in a second direction. The signal generated by the Hall-effect sensor **106** changes in concert with these sensed changes in the magnetic field. The user moves the handle **26** into or out of the actuator **24** according to a desired drive effort. Therefore, the signal produced is indicative of a desired drive effort.

[0050] As the user moves the handle **26** into or out of the actuator **24**, portions of the resilient member **128** are compressed while other portions are stretched by movements of the second slide screw **121**. Therefore, restorative potential energy is stored in the resilient member **128**. If the user should release the actuator **24**, the energy stored in the resilient member **128** returns the second slide screw **121** and, therefore, the handle **26** and the magnets **102,104** to the neutral position.

[0051] In the neutral position, the Hall-effect sensor **106** is located approximately equidistantly between the magnets **102,104** in a null between their respective magnetic fields. The signal from the Hall-effect sensor **106** indicates this neutral magnetic field thereby providing an indication that the desired drive effort is zero.

[0052] While the resilient member **128** in the illustrated embodiment can be made of a resilient polymer, the resilient member **128** can also be made of other known resilient materials. For example, a resilient member can be fashioned from two wound wire springs joined together to provide a central aperture between them and the loops for receiving the second slide screw **122** and other mounting screws as necessary.

[0053] With reference now to **FIG. 11**, electrical signals to the armature assembly **46** via motor leads **66** can be provided from a power source **140** through a speed adjusting circuit **142**. Alternately, with reference to **FIG. 12**, a sensor assembly **144**, can be provided, for calculating a position of the motor housing **50** relative to the armature **46**. For example, the above-described Hall sensors **82** can provide position information via Hall leads **88** of motor leads **66** to the speed adjusting circuit **142**, which permits selection of the proper commutated signal to be sent along leads **66** to the armature **46**. The sensor assembly **144** may, alternately, include an optical type sensor configured to detect rotations of the housing. While the speed adjusting circuit **142** is illustrated as being located outside of the wheel assembly **42**, the circuitry could alternately be placed within the wheel assembly **42** if so desired.

[0054] Moreover, the speed adjusting circuit or device **142** can incorporate various functional capabilities such as constant brushroll speed maintenance; overload protection stopping brushroll rotation; reverse brushroll operation easing, for example, backward movement of the vacuum cleaner; and variable brushroll rotation depending on floor surface, e.g. no rotation on tile, wood and delicate floor coverings, and fast rotation for heavy duty carpeting or especially dirty environments.

[0055] Another embodiment of a drive wheel assembly of the present invention is depicted in **FIGS. 13-14**. In this embodiment, as shown in **FIG. 14A**, a motor **150** comprises a brushless DC motor, however, the motor is more typical in that a shaft **152** and an armature **154** rotate while a set of magnets **156** and a motor housing **158** remain stationary. As shown in **FIG. 13**, the shaft **152** is outfitted with a sun gear **160** on at least one end (spur or helical type, either integral with the shaft or mounted on the shaft) for input into a planetary gear train **161**, including several planet gears **162**, of at least one stage. Each of the planet gears **162** is mounted on a mount plate **164** connected to the motor housing **158**. The planet gears **162** mesh with a ring gear **166** that is either integral with or mounted and fixed to an inner surface **167** of a sleeve **168**. The sleeve **168** is rotatably mounted on bearings **170** and **172** positioned on the motor housing **158**. Bearings **174** and **175** mount a pair of motor housing end plates **176** and **177** on the shaft **152**. The sleeve **168** can be provided with a tread surface for engaging the surface to be cleaned.

[0056] The reduction provided by the gear train allows for a more common, higher speed, lower torque motor that provides cost and availability advantages relative to the above-described stationary shaft motors. Control and actuation methods similar to those used for the first embodiment can be employed to direct the movement of the appliance, such as a vacuum cleaner or the like.

[0057] Another appliance in which the drive mechanism of the present invention can be used is a carpet extractor. For ease of appreciation of this embodiment, like components are identified by like numerals with a primed (') suffix and new components are identified by new numerals.

[0058] With reference now to **FIG. 15**, the appliance can be a carpet extractor, as opposed to a vacuum cleaner. As before, the position of the Hall-effect sensor with respect to the magnets determines the output voltage from the Hall-effect sensor. This output voltage is interpreted by a speed adjusting circuit and translated to an appropriate output speed and direction for the motor. For example, if the excitation voltage to the Hall-effect sensor is 5 VDC then a Hall-effect sensor that outputs 2.5 VDC when positioned exactly midway between the magnets can be used. With such a construction, ranges from 1 VDC to **4** VDC, at the extremes of travel of the actuator **24**' with respect to the handle **26**', would be seen. In this exemplary arrangement, 1 to 2 VDC corresponds to full speed in one direction, 2 to 3 VDC corresponds to a no speed, stationary position, and 3 to 4 VDC corresponds to full speed in the opposite direction. While one possible arrangement is disclosed, it should be appreciated that other arrangements of the Hall-effect actuation structure are also within the scope of the instant disclosure.

[0059] In an extractor application, a control algorithm can be adapted to ramp up the speed of the drive motor to avoid jerky or abrupt direction changes. This method addresses the issues associated with the slow constant velocity nature of an extractor's motion. The output speed is the same through a fairly large range of travel toward either extreme of the actuator **24**' position. This yields the same output speed for varying levels of input at the actuator **24**' yet still accommodates the user's desire to change direction. Thus, the constant, controlled speed desired for an extractor is attained and further optimized for efficient extraction.

[0060] With continuing reference to **FIG. 15**, a self-propelled carpet extractor **180** includes a base portion **182** and a handle portion **14**'. The base portion **182** includes the above-described drive wheel **16**' (shown removed from the base portion **182**) for propelling the self-propelled carpet extractor **180**. Additionally, the base portion **182** houses implements or actuators for performing the function of the carpet extractor **180**.

[0061] For example, the base portion **182** may include a cleaning solution dispensing means (not shown). In addition to housing the drive wheel **16**' for propulsion and a means for dispensing cleaning solution, the nozzle base portion **182** includes a nozzle **186** through which dirt laden cleaning solution is entrained. Dirt laden solution is removed from the nozzle and collected in a collection chamber, or other portion of the carpet extractor **180**. Additionally, the nozzle base portion **182** may include other implements for enhancing the functionality and usability of the carpet extractor **180**. For example, the nozzle base may house brushes, beater bars and additional wheels **188** for improving the cleaning ability and maneuverability of the carpet extractor **180**. Furthermore, the base portion **182** may house power supplies and control circuitry. Alternatively, power supplies and control circuitry may be located in other portions of the carpet extractor **180**. As described above, the handle **14**' provides a means for an operator to direct the operation of the carpet extractor **180**.

[0062] A change in motor direction can be accomplished via the use of an on off on rocker style switch input into the control electronics, if so desired. The switch can be actuated via the use of a reciprocating handle as illustrated in **FIG. 10**. Design elements used in the previous embodiments to address issues such as solution infiltration into the drive assembly and solution interaction with the drive assembly and the tread can also be incorporated in the embodiment of **FIG. 15**.

[0063] With the present invention, a reduced force is required by a user to propel the carpet extractor forward and back. Also, traction is not lost by the drive mechanism on a wet surface. In addition, the specific nature of motion of a wet extractor, characterized by relatively slow forward and rearward linear strokes, is not compromised by the drive mechanism. Rather, control and activation methods similar to those used for the embodiment shown in **FIGS. 1-10** can be employed to regulate the movement of the carpet extractor. Moreover, operator inefficiencies are reduced by operating the carpet extractor at an appropriate speed for effective wet extraction.

[0064] The invention has been described with reference to several preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding specification. It is intended that the invention be construed as including all such modifications and alterations insofar as they fall within the scope of the appended claims and equivalents thereof.

Having thus described the preferred embodiments, the invention is now claimed to be:

1. An upright cleaning device comprising:

an actuator for receiving a user input;

an upper assembly to which the actuator is mounted;

a base assembly, wherein the upper assembly is pivotally mounted to the base assembly;

a rear wheel, mounted to the base assembly, configured to support the rear portion of the base assembly; and

a drive mechanism located in the base assembly having its major diameter in contact with a surface to be cleaned wherein the drive mechanism is configured to operate at one of:

full speed in one direction, no speed and full speed in the opposite direction, according to the relative position of the actuator.

2. The device of claim 1, wherein the actuator comprises:

a handle slidably mounted to an upper portion of the upper assembly, first and second spaced apart magnets fixedly mounted to the handle on an axis parallel to the longitudinal axis of the handle;

a Hall-effect sensor fixedly mounted in the upper portion of the upper assembly such that the sensor is positioned: approximately midway between the first and second magnets when no user input is applied to the handle, in close proximity to the second magnet when a forward input force is applied by the user, and in close proximity to the first magnet when an opposite input force is applied by the user.

3. The device of claim 2, wherein the Hall-effect sensor produces: an excitation voltage of 2 to 3 VDC when no user input is applied to the handle structure; an excitation voltage of 1 to 2 VDC when a first input force is applied by the user; and an excitation voltage of 3 to 4 VDC when a second input force is applied by the user.

4. The device of claim 2, further comprising:

a controller which selectively powers the drive assembly inducing one of a constant speed forward rotational motion and a constant speed backward rotational motion according to an excitation voltage produced by the Hall-effect sensor.

5. The device of claim 1, wherein the drive mechanism comprises a reversible wheel assembly including:

a stationary shaft;

a stationary armature mounted on the stationary shaft;

a tubular motor housing encircling at least a portion of the stationary shaft; and

a plurality of magnets mounted to an inner portion of the tubular motor housing between the armature and the motor housing.

6. The device of claim 5, the armature further including:

a plurality of Hall-effect sensors for sensing a position of the armature, each sensor mounted in a respective armature slot approximately flush with the outside diameter of the armature.

7. The device of claim 5, the reversible wheel assembly further including:

first and second bearings mounted on the stationary shaft.

8. The device of claim 5, the reversible wheel assembly further including:

first and second motor end caps located at respective ends of the motor housing wherein each end cap is mounted on and supported by one of the first and second bearings.

9. The device of claim 8, wherein the end caps are constructed with heat dissipating fins on their outer surfaces.

10. The device of claim 8, further including:

first and second lip seals incorporated into the motor end caps and encircling the stationary shaft.

11. The device of claim 5, further comprising a wheel tread secured to and covering the motor housing.

12. The device of claim 11, wherein the wheel tread comprises two molded polymer tread end caps having a molded surface tread pattern on an outer cylindrical portion of the end caps.

13. A self-propelled upright cleaning device comprising:

a nozzle base;

an upper housing section pivotally mounted to the nozzle base;

a handle actuator, for receiving a user input, mounted on the upper housing section;

a wheel for supporting the nozzle base; and

a drive mechanism located in the nozzle base and having its major diameter in contact with a surface to be cleaned wherein the drive mechanism comprises:

a stationary shaft,

a stationary armature mounted on said shaft,

a tubular motor housing rotatably mounted on said shaft, and

a plurality of magnets mounted to an inner face of the tubular motor housing and spaced from said armature.

14. The device of claim 13, the armature further including:

a plurality of Hall-effect sensors for sensing a position of the armature, each sensor mounted in a respective armature slot approximately flush with the outside diameter of the armature.

15. The device of claim 13 wherein said drive mechanism further comprises a traction surface secured to an outer periphery of said tubular motor housing.

16. The device of claim 13 wherein said drive mechanism further comprises first and second bearings mounted on the stationary shaft for rotatably mounting the tubular motor housing.

17. The device of claim 16 further comprising first and second motor end caps located at respective ends of the motor housing, wherein each end cap is mounted on and supported by one of the first and second bearings.

18. The device of claim 17 further comprising first and second lip seals which are incorporated into a respective one of the first and second motor end caps and encircle the stationary shaft.

19. A self-propelled upright cleaning device comprising:

a nozzle base,

an upper housing section pivotally mounted to the nozzle base;

a handle actuator for receiving user input, said handle actuator being mounted on the upper housing section; and,

a drive mechanism located in the nozzle base and having its major diameter in contact with the surface to be cleaned, wherein the drive mechanism comprises:

a rotating motor shaft,

a rotating armature mounted on said shaft,

a stationary motor housing encircling at least a portion of the rotating shaft,

a sun gear mounted on at least one end of the motor shaft,

a planetary gear train comprising at least one planet gear engaging said sun gear; and

a ring gear engaging said at least one planet gear, said ring gear being connected to a sleeve comprising a driven surface of said drive mechanism.

20. The device of claim 19, the armature further including:

a plurality of Hall-effect sensors for sensing a position of the armature, each sensor mounted in a respective armature slot approximately flush with the outside diameter of the armature.

21. The device of claim 19 further comprising a wheel tread concentrically located with respect to the motor shaft wherein said wheel tread is mounted on said sleeve.

22. The device of claim 21 further comprising first and second bearings mounted on the motor shaft wherein the bearings support respective ends of said sleeve.

23. The device of claim 19, wherein the sun gear is connected to the motor shaft.

24. The device of claim 19, wherein three spaced planet gears engage said sun gear.

25. The device of claim 24, wherein the ring gear is of one piece with said sleeve.

26. A method of propelling an upright cleaning device comprising:

sensing a user input from a handle actuator;

operating a drive mechanism located in a base assembly having its major diameter in contact with a surface to be cleaned wherein the drive mechanism is configured to operate at one of: full speed in one direction, no speed and full speed in the opposite direction, according to sensed user input.

27. The method according to claim 26, wherein the step of sensing a user input comprises:

producing a first excitation voltage when no user input is applied to the handle;

producing a second excitation voltage when a forward input force is applied by the user; and

producing a third excitation voltage when an opposite input force is applied by the user.

28. The method according to claim 27, wherein a Hall-effect sensor produces the first, second and third excitation voltages according to the position of the Hall-effect sensor with respect to two fixed magnets mounted to a non-slidable portion of the handle wherein the Hall-effect sensor is mounted to a slidable portion of the handle.

29. The method according to claim 28, wherein the first excitation voltage is in the range of 2 to 3 VDC, the second excitation voltage is in the range of 1 to 2 VDC, and the third excitation voltage is in the range of 3 to 4 VDC.

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