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(54) ## SUCTION CLEANER

(57) The present invention is directed to a vacuum 10 including a dust extraction system. The system includes a filter assembly 1500, an airflow generation assembly, and valve assembly 1000. The airflow generation assembly is configured to draw contaminated air toward the filter assembly 1500 and exhaust filtered air as a discharge stream. The filter assembly 1500 is configured to remove contaminants from the contaminated airflow by capturing particulate material suspended within the airflow. The valve assembly 1000 is configured to selectively direct filtered airflow into the filter assembly 1500 such that the filtered air stream cleans the filter 1505A.

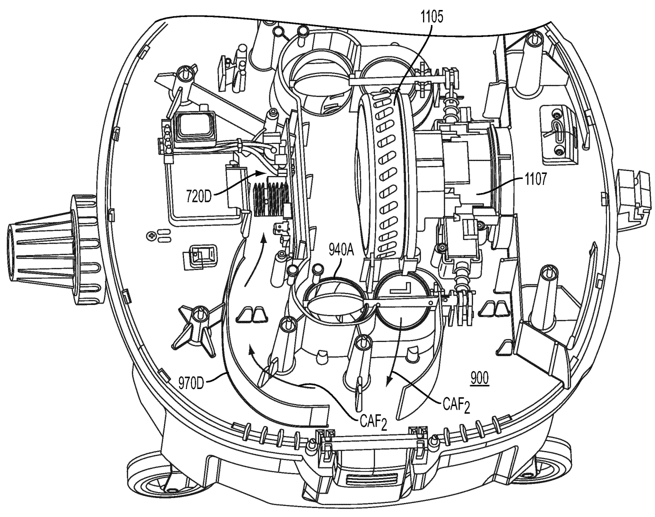


FIG. 12C

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## Description

**[0001]** The present application is a continuation in part application of pending U.S.

**[0002]** Patent Application No. 13/431,302, filed on March 27, 2012 and entitled "VACUUM", the contents of which is incorporated herein by reference in its entirety.

**[0003]** The present invention is directed toward a construction site or tool shop vacuum and, in particular, to a vacuum including a filter system and an airflow arrangement that periodically cleans the filter system during operation.

**[0004]** Tool shop vacuum cleaners (e.g., wet-dry vacuums) are designed to collect debris from a work area or connected tool via suction. Such vacuums typically include a tank and motor that drives an impeller to generate an airstream within the tank. Since the airstream includes debris, care must be taken to prevent the debris from reaching the motor and causing damage. In light of this, conventional systems further include a filter positioned upstream from the motor to capture debris as the contaminated airflow passes through the tank. Over time, however, the debris accumulates on the filter, restricting airflow and hampering performance. For example, a filter initially enabling airflow of approximately 80 cfm may begin degrading within minutes of operation, diminishing airflow capacity to approximately 10 cfm. Consequently, conventional vacuum systems require regular cleaning or replacement of the filter. This process requires a user to stop vacuum operation, open the tank, and remove the filter for cleaning or replacement. This is a time-intensive process that interrupts workflow.

**[0005]** Thus, it would be desirable to provide an airflow arrangement configured to clean a filter during operation, thereby increasing filter life and extending time between manual cleaning of the filter, as well as filter replacement.

**[0006]** The present invention is directed toward a construction site shop vacuum including a tank and a lid coupled to the tank. A separator plate is disposed within the vacuum such that the lid generally defines a motor chamber and the tank generally defines a collection chamber. The motor chamber houses a motor assembly, which is supported by the separator plate. The collection chamber, oriented upstream from the motor assembly, houses a filter system suspended from the separator plate. The separator plate includes conduits that permit airflow between the collection and motor chambers. Airflow between the chambers is controlled utilizing a valve assembly that selectively opens and closes the conduits.

**[0007]** Specifically, the valve assembly operates in a first mode, in which contaminated airflow is drawn into the collection chamber, passing through the filter system in a first direction. The filter medium of the filter system captures debris present in the airflow, cleaning the air passing therethrough. The filtered airflow is then directed into the motor chamber, exiting the vacuum as exhaust.

**[0008]** The valve assembly further operates in a second mode, in which at least a portion of the filtered airflow is redirected from the motor chamber back into the collection chamber. Specifically, the airflow is directed through the filter system in a second direction to expel debris that has accumulated on the filter medium. With this configuration, the media of the filter system are periodically cleaned during operation of the vacuum.

**[0009]** IG. 1 illustrates a front perspective view of a vacuum in accordance with an embodiment of the invention.

FIG. 2 illustrates a rear perspective view of the vacuum device shown in FIG. 1.

FIG. 3 illustrates a wheel assembly structure for rollably supporting the vacuum on a floor surface.

FIG. 4 illustrates an arrangement of the wheel assembly of FIG. 3 on the vacuum of FIG. 1.

FIG. 5 illustrates a hook tethered by a flexible strap to a connector secured to the vacuum of FIG. 1.

FIG. 6A illustrates the hook and strap of FIG. 5 securing a hose to the vacuum of FIG. 1.

FIG. 6B illustrates the hook and strap of FIG. 5 secured respectively to a lip of a tank and a head of the vacuum of FIG. 1.

FIG. 7A illustrates a light source and pivotable support structure attached to the vacuum of FIG. 1.

FIG. 7B illustrates an enlarged view of the light source and pivotable support structure of FIG. 7A.

FIG. 8A illustrates a cross sectional view of a sealing mechanism.

FIG. 8B illustrates a bottom perspective view of the sealing mechanism of FIG. 8A.

FIG. 9A illustrates an isolated view of a separator plate in accordance with an embodiment of the invention.

FIG. 9B illustrates a top perspective view of the separator plate shown in FIG. 9A.

FIG. 9C illustrates a bottom perspective view of the separator plate shown in FIG. 9A.

FIG. 10A illustrates a top perspective view of a valve assembly in accordance with an embodiment of the invention, the valve assembly being mounted on the separator plate of FIG. 9A.

FIG. 10B illustrates an isolated, front perspective view of the valve assembly shown in FIG. 10A.

FIG. 10C illustrates an isolated, rear perspective view of the valve assembly shown in FIG. 10A.

FIG. 10D illustrates a cross sectional view of a conduit and a valve of the valve assembly, showing the forces acting upon a disc.

FIG. 10E illustrates a side perspective of an embodiment of a ski of the valve assembly of FIG. 10A.

FIG. 10F illustrates a side perspective view of another embodiment of a ski of the valve assembly of FIG. 10A.

FIG. 11A illustrates an isolated view of an airflow assembly in accordance with an embodiment of the invention.

FIGS. 11B and 11C illustrate perspective views of the airflow assembly of FIG. 11A mounted on the separator plate shown in FIG. 9A.

FIGS. 12A, 12B, and 12C illustrate the vacuum system with the vacuum head and manifold removed, showing a motor shroud mounted on the separator plate of FIG. 9A.

FIG. 13A illustrates a front perspective view of a manifold in accordance with an embodiment of the invention, shown in isolation.

FIG. 13B illustrates a cross sectional view of the manifold shown in FIG. 13A.

FIG. 13C illustrates a bottom perspective view of the manifold shown in FIG. 13A.

FIG. 13D illustrates a perspective cross-sectional view through manifold of FIG. 13A.

FIG. 13E illustrates a side cross-sectional view through the manifold of FIG. 13A.

FIG. 13F illustrates an enlarged side cross-sectional view of the manifold shown in FIG. 13A.

FIG. 14A illustrates an exploded view of the tank and the manifold of the vacuum system, showing the positional relationship between the manifold and the separator plate of FIG. 9A.

FIGS. 14B and 14C illustrate perspective views of vacuum system with the vacuum head removed for clarity, showing the manifold of FIG. 13A mounted on the separator plate of FIG. 9A.

FIG. 15A illustrates a perspective view of a filter assembly in accordance with an embodiment of the invention, shown mounted on the separator plate of FIG. 9A.

FIG. 15B illustrates a cross sectional view of the filter assembly shown in FIG. 15A.

FIG. 16A illustrates an exploded view of a filter device in accordance with an embodiment of the invention.

FIG. 16B illustrates a perspective view of the filter device shown in FIG. 16A.

FIGS. 17A - 17C illustrate schematic views showing the operation of the airflow assembly.

FIGS. 18A and 18B illustrate a schematic views showing airflow through the filter device.

FIGS. 19A and 19B illustrate a schematic views showing airflow through the airflow assembly.

FIG. 20 illustrates an electrical diagram in accordance with an embodiment of the invention.

**[0010]** Like reference numerals have been used to identify like elements throughout this disclosure.

**[0011]** Referring to FIGS. 1 and 2, a vacuum system **10** in accordance with an embodiment of the invention (e.g., a wet/dry vacuum cleaner) includes a body **100** having a tank portion **105** coupled to a head or head **110** via one or more latch devices **112.** Tank **105** may possess any dimensions and shapes suitable for its described purpose.

**[0012]** The tank portion **105** may further include one or more latch receptacles formed into the side wall **205.** Each latch receptacle receives a corresponding latch device operable to couple the tank **105** to the head **110.**

**[0013]** Referring to FIGS. 3 and 4, a vacuum supporting wheel assembly (e.g., rear wheels) may be in the form of a caster **305** including a wheel **315** disposed below a support structure **318.** The wheel **315** is rotatably mounted to a fork **320** that, in turn, is pivotally coupled to the support **318** via a central pin **322.** Support **318** includes an opening **316** for receiving pin **322** having an axis **319.** Wheel **315** may rotate about axis **319** in opening **316** or it may be held stationary as fork **320** is engaged by rotational stoppers **317.** Fork **320** extends from pin **322** such that a rotational axis of wheel **315** does not intersect with an axis of pin **312.** In this arrangement the axis of wheel **315** is offset from pin **322** as shown at the right in FIG. 4 The wheel base is thereby shifted rearward providing for a larger wheel base with respect to the front wheels of the vacuum than a non-offset or centrally mounted wheelbases such as shown at the left in FIG. 4. FIG. 4 illustrates how the offset pinned caster arrangement **306** provides a greater wheel base than the centrally arranged caster arrangement of 307.
(e.g., rear wheels) Referring back to FIG. 1, the tank **105**

further includes an intake port **255** formed into the side wall **205** (along the forward portion of the side wall). A vacuum connector **260,** secured to the exterior side of the intake port **255,** couples to a hose connector **265,** which, in turn, couples to a flexible tube (e.g., a hose) utilized to capture debris.

**[0014]** As illustrated in FIGS. 5, 6A and 6B, a hook **530** is teathered to the vacuum via a flexible cord **532.** The cord is connected to an anchor **534** on an opposite end of the cord from the hook. The anchor is secured to the vacuum (e.g., on the head **110** of the vacuum). The hook may be pulled so that the cord extends around an object (e.g., the debris suction hose mentioned above) and then hooked to the vacuum.

**[0015]** A light **402** may be secured to a top of head **110.** The light may include a halogen lamp **404** or other type light. FIGS. 7A and 7B illustrate the light accessory. The light may pivot about an axis **Ap** and rotate about an axis **Ax.** A rotation structure **420** includes a first rotator **430** that is secured to the vacuum body **100** and a second rotator **440** that is fixed to and rotates with lamp **404,** but relative to fist rotator **430.** A pivot structure **455** which is attached to second rotator **440** includes a first pivot **450** that pivots relative to a second pivot **460** about an axis **Ap.** Lamp **404** is attached to second pivot so that it can pivot up and down about axis **Ap** in a direction **PD** relative to body **100.** Lamp **404** can also swivel or rotate 360° about axis **Ax** in the **SWD** direction. The lamp can be powered by an independent extension cord to a wall outlet or power may be supplied by the vacuum directly or through an outlet socket on the vacuum (supplied by the vacuum main power cord).

**[0016]** FIGS. 8A and 8B illustrate the interface and seal between head **110** and tank **105.** Two vertical walls **982A** and **982B** extend downward from the outer lower surface of separator plate **900.** At lower distal ends of the walls inwardly facing projections may extend. A channel or strip **983** of flexible sealing material (e.g., foam) may be inserted between the walls and within the projections to secure the material within the walls and projections. The channel **983** is shown deformed in FIG. 8A may be made of foam, rubber, flexible polymer or any suitable flexible material that may provide a good vacuum seal between head **110** and tank **105.** When assembled, channel **983** may extend below the walls **982A** and **B.** When head **110** is sealed to tank **105,** channel **983** is forced into contact with rim surface **984** of tank **105** thereby fluidly sealing the interface between tank **105** and head **110.**

**[0017]** Referring to FIGS. 9A, 9B, and 9C, a separator plate **900** engages the tank rim **212,** separating the tank cavity **214** (the collection chamber) from the cavity of the vacuum head **110** (also called a motor chamber). The separator plate **900** includes a platform **905** (e.g., a generally circulate plate) and one or more leg members **907A - 907D.** The platform **905** includes an upper (head facing) surface **910** and a lower (tank facing) surface **912.** The shaped and dimensions of the platform **905** may be any suitable for its described purpose. By way of example, the platform **905** may be substantially planar and possess a generally circular shape. A perimetral wall **915,** protruding upward from the platform upper surface **910,** extends about the circumference of the platform **905.** As noted above, the upper surface **910** of the platform **905** may further include one or more connection posts **917** that engage (e.g., mate, receive, etc.) corresponding connection posts **707** extending from the vacuum head **110.** Fasteners may extend through the connection posts **707, 917** to secure the lid **110** to the separator plate **900.** A pair of diametrically opposed lips **920A, 920B** extends axially (upward) from the perimetral wall **915** to provide an engagement member for each of the latch devices **112,** as described above. The platform **905** may further include one or more reinforcing ribs **921** spanning the platform upper surface **910** to enhance the strength of the platform.

**[0018]** The leg members **907A - 907D,** extending distally from the platform lower surface **912,** are configured to elevate the platform **905** and, in particular, to suspend the filter system above a supporting surface when the separator is placed directly upon the supporting surface. That is the length of the legs is selected to prevent the filters from contacting the ground when the separator plate **900** and/or head **110** is removed from the tank and set on a surface (seen in FIGS. 7E and 15A). The leg members **907A - 907D** are located proximate the outer edge of the separator plate, being disposed a predetermined angular positions thereon.

**[0019]** The leg members **907A - 907D,** moreover, are configured to key the separator plate **900** to the tank **105** such that the separator plate is oriented in a specific rotational position when inserted into the tank **105.** As shown in the figures, the platform **905** includes a first forward leg **907A,** a second forward leg **907B,** a first rearward leg **907C,** and a second rearward leg **907D.** Each leg **907A - 907D** includes a proximal leg portion **922** and a distal leg portion **925.** The proximal leg portion **922** of the forward legs **907A, 907B** includes a notch **927** (e.g., a tapered (V-shaped) notch) configured to receive the guide element **675A, 675B** protruding from the interior surface **670** of the tank **105.** As explained above, the guide element **675A, 675B** is positioned at predetermined positions along the tank. The notch **927** aligns with each of the tank guide elements **675A. 675B** such that the first guide element **675A** is received within the notch of the first forward leg **907A** and the second guide element **675B** is received within the notch of the second forward leg **907B.** Consequently, in order for the separator plate **900** to be inserted into the tank cavity, the notch **927A** of first leg member **907A** must be aligned with the first guide element **675A** and the notch **927B** of the second leg member **907B** must be aligned with the second guide element **675B.** Should the forward (notched) leg members **907A, 907B** not be aligned with their corresponding guide elements **675A, 675B** (i.e., should the rotational position of the separator plate **900** differ from the normal/predetermined position such that no leg or an unnotched leg is aligned with the guide elements), insertion of the separator plate **900** into the tank cavity **214** will be prohibited.

**[0020]** The separator plate **900** further includes a conduit system to enable the flow of air between the tank **105** (the collection chamber **214)** and the head **110** (the motor chamber). In the embodiment illustrated, the platform **905** of the separator plate **900** includes a central, raised platform or deck **902** with a first conduit pair **935** and a second conduit pair **940.** The first conduit pair **935** includes a first (forward) suction conduit or port **935A** and a first (rearward) cleaning conduit or port **935B.** Similarly, the second conduit pair **940** includes a second (forward) suction conduit or port **940A** and a second (rearward) cleaning conduit or port **940B.** The conduits **935A, 935B** of the first conduit pair **935** are positioned such that the conduits are disposed over the first filter **1505A** (FIG.15) of the filter system, while the conduits **940A, 940B** of the second conduit pair **940** are positioned such that they are disposed over the second filter **1505B** of the filter system (i.e., each filter is in fluid communication with a conduit pair).

**[0021]** The conduits **935A, 935B, 940A, 940B** may possess any shape and dimensions suitable for their described purpose. By way of example, each conduit **935A, 935B, 940A, 940B** may be generally cylindrical. Each conduit, moreover, may include a conduit baffle operable to direct the airflow in a predetermined direction. As seen best in FIG. 9A, the suction conduit **935A, 940A** may include an inboard conduit baffle **942A** that curves radially inward with respect to the platform **905** to direct the air inboard, while the cleaning conduits **935B, 940B** may include an outboard conduit baffle **942B** that curves radially outward to direct air outboard (toward the perimeter of the platform).

**[0022]** The upper surface **910** of the platform **905** further includes first **945A,** second **945B,** and third **945C** support walls that cooperate to support the airflow assembly. As shown, the first support wall **945A** extends upward from the upper surface 910 of the platform **905,** being oriented between the suction **935A, 940A** and the cleaning **935B, 940B** conduits. The second support wall **945B** is disposed proximate the cleaning conduits **940A, 940B** (i.e., is disposed outboard with respect to the first support wall). The third support wall **945C,** moreover, is positioned outboard from the second support wall **945B.** Each support walls **945A - 945C** is spaced from its adjacent support wall to define a cavity therebetween. Specifically, the first **945A** and second **945B** support walls define a fan cavity **950** that receives the fan of the airflow assembly. Similarly, the second **945B** and third **945C** support walls cooperate to define a motor cavity **955** that receives the motor of the airflow assembly. Each support wall **945A, 945B, 945C** includes a cut-out section **947** that receives and supports various components of the airflow assembly. By way of example, the second and third support walls cooperate to support the motor of the airflow assembly, with the motor resting within the cut-out section. The motor cavity **955** further includes areas **957** for supporting valve solenoid switches (discussed in greater detail below).

**[0023]** The separator plate **900** further includes a pair of opposed motor intake walls **958** extending from the third support wall **945C** to the perimetral wall **915.** The motor intake walls **958** cooperate with a motor shroud **1205** (FIG. 12A) to define a motor air intake area **960** that aligns with second head vent **715B.** Similarly, opposed walls **962** cooperate with the motor shroud **1205** to define a motor exhaust area **965** that aligns with third head vent **715C.**

**[0024]** A deflection wall or baffle **970** extends upward from platform upper surface **910** (e.g., the height of the wall may be substantially equal to or greater than the height of the deck **902).** The platform baffle **970** is positioned between the deck **902** and the perimetral wall **915.** The platform baffle **970** gradually curves such that it extends from a position along a lateral side of the deck **902** to a position along the forward side of the deck. The platform baffle **970** is operable to direct cooling air exhausted by the manifold **1305** (FIG. 13A) toward electronics housed within the head **110,** thereby cooling the electronics (discussed in greater detail below).

**[0025]** The platform **905** further includes a first yoke **975A** located proximate the first cleaning conduit **935B** and a second yoke **975B** located proximate the second cleaning conduit **940B.** Each yoke **975A, 975B** supports an associated butterfly valve **1005A, 1005B** (FIG. 10A) of the valve assembly to enable rotation of the valve on the yoke (discussed in greater detail below).

**[0026]** A series of downward-extending, angled fins **985** may be angularly spaced about the platform **905,** being located near the outer edge of the platform, proximate the shoulder **980.** The fins **985** serve as guides during the insertion of the separator plate **900** into the tank cavity **214.** A bracket **990** is also disposed on the platform lower surface **912** that receives the conductive member **635** of the electrostatic discharge device. As shown, the conductive member **635** is coupled to the platform **905** via the conductive fastener **655.**

**[0027]** A valve assembly, disposed on platform upper surface **910,** opens and closes one or more of the separator conduits **935A, 935B, 940A, 940B** to selectively permit fluid (air) therethrough. In the embodiment illustrated in FIGS. 10A- 10C, the valve assembly **1000** includes a first solenoid **1002A** in communication with to a first butterfly valve **1005A** and a second solenoid **1002B** in communication with to a second butterfly valve **1005B.** The first butterfly valve **1005A** is supported by the first platform yoke **975A,** while the second butterfly valve is supported by the second platform yoke **975B.** As seen in FIG. 10A, the valve assembly **1000** is positioned on the separator plate **900,** with each solenoid **1002A, 1002B** being positioned within areas **957** as described above. The solenoids **1002A, 1002B** may be secured to the platform 905 by a cover or bridge **1040** coupled thereto.

**[0028]** The first butterfly valve **1005A** selectively permits airflow through the first conduit pair **935A, 935B.** Similarly, the second butterfly valve **1005B** selectively permits airflow through the second conduit pair **940A, 940B.** Each butterfly valve **1005A, 1005B** includes an elongated shaft **1010A, 1010B** supporting a first or distal disc **1015A** and a second or proximal disc **1015B** longitudinally spaced along the shaft and rotationally offset from the distal disc by, e.g., approximately 45°.

**[0029]** The proximal end of the shaft **1010A, 1010B** is connected to a crank arm **1017A, 1017B,** which, in turn, is pivotally coupled to a linking member **1020A, 1020B** via a pivot pin **1022A, 1022B.** The linking member **1020A, 1020B** is repositioned via a plunger **1025A, 1025B** that is driven by the solenoid **1002A, 1002B.** Specifically, the plunger **1025A, 1025B** reciprocates axially to rotate the discs. The linking member **1020A, 1020B** may further include a downward-extending, curved support or ski **1030A, 1030B** configured to slide along the platform upper surface **910** as the plunger **1025A, 1025B** reciprocates. The ski **1030A, 1030B** maintains the positioning of the plunger **1025A, 1025B** with respect to the solenoid during the plunger's reciprocal motion, keeping the plunger aligned with the drum of the solenoid **1002A, 1002B** and preventing the plunger from becoming jammed in the solenoid drum at full extension. With this configuration, each solenoid **1002A, 1002B** may be selectively engaged to rotate the shaft **1010A, 1010B** about its longitudinal axis in a clockwise or counter clockwise direction. The degree of rotation includes, but is not limited to, approximately 45°. FIGS. 10E and 10F respectively show alternate embodiment skis **1020C** and **1020D.** Ski **1020D** also includes an opening location member **1022D** disposed in proximity to the opening in which plunger **1025A** would be pinned. Opening location member **1022D** aids in positioning the plunger for pinning to ski **1020D** and for maintaining ski **1020D** orientation with respect to plunger **1025A.**

**[0030]** As a result, the valve assembly **1000** may selectively position each disc **1015A, 1015B** with respect to its associated conduit **935A, 935B, 940A, 940B** to enable the passage of fluid (e.g., air) therethrough. In operation, the valve assembly **1000** rotationally positions the discs **1015A, 1015B** in a first position, in which the suction conduits **935A, 940A** are opened and the cleaning conduits **935B, 940B** are closed. That is, the butterfly valve **1005A, 1005B** positions the shaft **1010A, 1010B** such that the first disc **1015A** is oriented generally transverse to the opening defined by the suction conduit **935A, 940A** (as illustrated in FIG. 10A), thereby permitting airflow between the tank **105** (the collection chamber **214)** and the head **110** (the motor chamber). The second disc **1015B,** meanwhile, is positioned such that the disc completely covers the opening of the cleaning conduit **935B, 940B** preventing the flow of air between the head **110** to the tank **105.** Alternatively,, the valves **1005A, 1005B** may rotationally position the discs **1015A, 1015B** in a second (reversed) position, in which the suction conduits **935A, 940A** are closed and the cleaning conduits **935B, 940B** are opened.

**[0031]** As shown in FIG. 10D, the conduits **935A, 935B, 940A, 940B** and discs **1015A, 1015B** are configured such that air flowing through the conduit creates a balanced system in which the forces on the butterfly valve **1005A, 1005B** are equally applied across both surfaces of the disc **1015A, 1015B** (indicated by arrows **F1** and **F2).** Specifically, when an air pressure (positive or negative) is experienced on the upper side of the disk, the downward force (F1 upper) on one side of the rotating axis is generally equal to the downward force (F2 upper) on the other side of the axis. Therefore, a pressure on the top side of the disk does not significantly increase the force necessary to toggle the valve. Likewise, when an air pressure is experienced on the lower side of the disk, the upward force (F1 lower) on one side of the rotating axis is generally equal to the upward force (F2 lower) on the other side of the axis. Therefore, a pressure on the lower side of the disk does not significantly increase the force necessary to toggle the valve to its next operating condition. This enables the utilization of a small solenoid to rotate the valve **1005A, 1005B** as described above, and provides an advantage over other valve types (e.g., piston valves, etc.) which have larger pressures to overcome and require large forces to toggle between operating positions. That is, the conduit structure enables the use of a lower power solenoid since valve rotation does not require overcoming a significant eccentric force applied to the disc **1015A, 1015B** by the air in or airflow through the conduit.

**[0032]** An airflow assembly, housed within the motor chamber defined by head **110** and supported on the upper platform surface **910,** generates air pressure (positive and/or negative), within the vacuum device **10,** as well directs the flow of air within the head **110.** Referring to FIGS. 11A - 11C, the airflow assembly includes an airflow generating device **1102** having a centrifugal fan **1105** driven by a motor **1107.** The fan **1105** includes an annular housing or baffle **1110** and a plurality of slots **1112** disposed about the perimeter of the housing. The slots **1112** may be angled (e.g., offset and/or nonparallel to the rotational axis of the housing) to direct air in a predetermined direction. With this configuration, air is drawn into the central channel **1115** and is directed radially outward (from the fan rotational axis) through the slots **1112.** The airflow generating device **1102** may further include a forward gasket **1122** coupled to the forward (inboard facing) side of the fan **1105,** and a manifold spacer **1125** coupled to the rearward side of the fan. The motor **1107** may include any type of motor suitable for its described purpose. By way of example, the motor **1107** may include a universal series motor with a central channel **1127.** The motor **1107** is configured to drive (e.g., rotate) the fan **1105** in a clockwise and/or counterclockwise direction, as well as to draw cooling air into the motor channel **1127.** In an embodiment, the motor **1107** rotates the fan **1105** in a predetermined direction to generate a negative pressure within the vacuum device **10,** which, in turn, generates a suction airstream (an intake airstream) that enters the tank portion **105** via the inlet port **255.** As illustrated, the forward side of the motor **1107** may be coupled to the rearward (outboard facing) side of the fan **1105,** and a rearward gasket **1130** may be coupled to the outboard side of the motor.

**[0033]** Referring to FIGS. 11B and 11C, the airflow generating device **1102** is oriented on the separator plate platform **905** such that it is located between the butterfly valves **1005A, 1005B,** with the fan **1105** and manifold spacer **1125** being positioned within the fan cavity **950** of the platform **905,** as well as aligned with the cut out section **947** formed into the first **945A** and second **945B** walls. The motor **1107,** moreover, is position within motor cavity **955** such that the motor channel **1127** is aligned with the cut-out sections formed into the second **945B** and third **945C** platform walls. In a preferred embodiment, the fan **1105** is oriented such that its rotational axis **R** is oriented generally horizontally, i.e., such that the rotational axis is generally parallel to the platform **905** of the separator plate **900.** Stated another way, the fan rotational axis **R** is oriented generally transverse (e.g. orthogonal) to the longitudinal axis of a filter **1505A, 1505B** (FIG. 15). As such, the air intake direction of the fan **1105** may be oriented generally transverse (e.g., generally orthogonal) to the airflow passing through the conduit pairs **935, 940.**

**[0034]** Referring to FIGS. 12A and 12B, the motor **1107** is housed in a motor shroud **1205** defining a motor air intake port **1210** and a motor air outlet or exhaust port **1220.** The motor shroud **1205** separates the cooling airstream generated by the motor from the vacuum airstream. The intake port **1210** cooperates with walls **958** on the platform **905** to define the motor intake area **960** as described above. Similarly, the exhaust port **1220** cooperates with the walls **962** on the platform upper surface **910** to define the motor exhaust area **965** as described above. In operation, the ambient air is drawn into the motor air intake **1210,** travels over the motor (cooling it), and is then exhausted via motor air exhaust **1220.**

**[0035]** FIG. 12C shows a top perspective view of separation plate **900** including a baffle **970D** for directing air from discharge of the fan **1105** to electronics **720D** for cooling of the electronics. FIG. **12C** illustrates cooling air flow arrows **CAF2** showing the path which air takes on its way to dashboard **720D.**

**[0036]** The airflow assembly further includes a manifold operable to direct the airflow in predetermined directions. The manifold includes a plurality of chambers that function as baffles, cooperating to direct airflow in predetermined directions. Referring to FIGS. 13A - 13C, the manifold **1305** includes a forward inlet chamber **1310,** an intermediate fan discharge chamber **1315,** and a rearward exhaust chamber **1320.** The exhaust chamber **1320** includes an exhaust port **1325** to permit exhaust of the filtered air from the manifold **1305.** In addition, the fan discharge chamber **1315** includes a first window or opening **1330** configured to permit the flow of fluid between the fan discharge chamber **1315** and the exhaust chamber **1320.** Additionally, the fan discharge chamber **1315** includes a second window or opening **1335** including an interior deflector **1337** extending angularly inward into the fan discharge chamber such that it directs a portion of the air flowing downstream, through the manifold out of the manifold and into the cavity defined by the head **110.**

**[0037]** In another embodiment, manifold **1305** includes a forward inlet chamber **1310D.** Adjacent to forward inlet chamber **1310D** is a fan discharge chamber **1315D.** A blower baffle **1316D** is disposed in fan discharge chamber **1315D.** A portion of fan discharge air **1306D** is directed toward motor **1107** by blower baffle **1316D** and passes over motor **1107.** At times during vacuum operation, discharge air **1306D** is at a lower temperature than motor **1107** and serves to cool motor **1107** as it passes over motor **1107.**

**[0038]** In an alternate embodiment, like with the prior described vacuum, the vacuum includes a forward inlet chamber **1310** for defining an airflow passage between suction ports **935A, 940A** and the fan intake. In the alternate embodiment however, air passing through the fan discharge chamber **1315D** can be redirected to flow over the exterior of motor **1107** before it is discharged into the vacuum head **110.** At times during vacuum operation, discharge air **1306D** is at a lower temperature than motor **1107** and serves to cool motor **1107** as it passes over motor **1107.** Air discharged from discharge chamber **1315** may also be diverted toward vacuum electronics to cool such electronics. After contacting and cooling the motor, the electronics, and any other components it contacts, the air is discharged from the vacuum through openings in vacuum head **110.**

**[0039]** FIGS. 13D-F show blower baffle **1316D** disposed in fan discharge chamber **1315D.** Baffle **1316D** serves as an air diversion baffle or structure for directing at least a portion of the discharge air from the fan discharge **1105** toward and onto motor **1107.** FIG. 13F illustrates cooling air flow arrows **CAF1** showing the path which motor **1107** cooling air takes between the fan discharge and motor **1107.**

**[0040]** Referring to FIGS. 14A - 14C, once coupled to the separation plate **900,** the inlet chamber **1310** is positioned over the suction conduits **935A, 940A,** the discharge chamber **1315** is positioned over the fan **1105** and the cleaning conduits **935B, 940B,** and the exhaust chamber **1320** is positioned over the motor shroud **1205.** The operation of the manifold **1305** is discussed in greater detail below.

**[0041]** The vacuum device **10** includes a filter assembly that captures particles within the contaminated airstream entering the tank **105,** cleaning the airstream as the airstream flows through the body **100** of the vacuum device **10.** In the embodiment illustrated in FIGS. 15A and 15B, the filter assembly **1500** includes a first filter **1505A** and a second filter **1505B.** The filters **1505A,**

**1505B** may be coupled to the platform lower surface **912,** being generally radially aligned along opposite sides of plate center point and suspended above the floor of the tank **105.** Additionally, as best seen in FIG. 15B, each filter **1505A, 1505B** is in communication with both conduits **935A, 935B, 940A, 940B** forming a conduit pair **935, 940** (i.e., the first filter **1505A** is in fluid communication with the first conduit pair **935,** while second filter **1505B** is in fluid communication with second conduit pair **940).**

**[0042]** Referring to embodiment illustrated in FIGS. 16A and 16B, each filter **1505A, 1505B** may include a substantially rigid, inner cage **1605** generally concentrically disposed within a core member or outer cage **1610.** The inner cage **1605,** which houses a ball float **1612,** may be generally cylindrical. The outer cage **1610,** which formed of wire screen, may possess a generally frustoconical shape. The outer cage is generally rigid, providing stiffness from end to end such that it can be threadingly tightened along one of the ends to an end cap. Specifically, the lower (narrower) terminus of the outer cage **1610** couples to a lower end cap **1615,** while the upper (wider) terminus of the outer cage couples to an upper end cap **1620.** The lower end cap **1615** may be in form of a solid, circular plate with an exterior wall extending upward from the plate and extending about its periphery, as well as an inner wall or rib **1622** concentric with the outer wall and configured to engage the core member **1610** lower end. The upper end cap **1620** may be generally annular, including a plurality of ratchet teeth **1625** disposed along on its upper side (being angularly spaced about the perimeter of the cap). The inner channel **1630** of the upper end cap **1620,** moreover, is threaded to mate with corresponding threads on a filter mount **1635** (discussed in greater detail below).

**[0043]** A filter medium **1640** operable to remove particulates from the airstream is mounted on the outer cage **1610.** As shown, the filter medium **1640** may in the form of a sleeve including a hollow channel **1642** defined by the interior surface of a wall **1643** and a plurality of longitudinal fins **1644** angularly spaced about the exterior surface of the wall. The filter medium **1640** may possess a shape and dimensions that enable it to contour to the exterior surface of the outer cage **1610** (e.g., the filter may be generally frustoconical). By way of specific example, the filter medium **1640** may possess an upper (wide end) diameter of approximately 6.4 inches, a lower (narrow end diameter) of approximately 5.25 inches, and a length (height) of approximately 5.2 inches. It should be understood that the filter medium **1640** may possess any suitable shape and dimensions, and may be formed of any material an have any structure suitable for its described purpose.

**[0044]** The filter mount **1635,** secured to the lower surface **912** of the separator plate **900** (e.g., via fasteners), couples to the upper end cap **1620.** The filter mount **1635** includes a seat member **1655** (e.g., a ball seat), a base **1660,** and a threaded plug **1665** that engages the threads of the inner channel **1630** of the upper end cap **1620.** A channel **1670** is formed into the filter mount **1635** to permit airflow from the filter to its associated conduit pair **935, 940.**

**[0045]** The operation of the vacuum device **10** is explained with references to FIGS. 17A - 17C and FIGS. 18A - 18C. The motor **1107** is activated (e.g., via controls **725** on dashboard **720),** rotating the fan **1105.** The fan **1105** creates a vacuum (suction) airflow within the body **100** of the vacuum device **10.** Referring to FIGS. 17A and 18A, in a first operational mode, the butterfly values **1005A, 1005B** are positioned in their normal, full suction position. In this position, the vacuum device **10** generates suction airflow that is filtered through the filter medium **1640** of each filter **1505A, 1505B.** Specifically, the butterfly valves **1005A, 1005B** are set such that both the first suction conduit **935A** and the second suction conduit **940A** are opened, and both the first cleaning conduit **935B** and the second cleaning conduit **940B** are closed. As a result, the fan **1105** draws contaminated air **A1** including debris (particulate material) into the tank **105** (e.g., via an inlet/hose). The contaminated air **A1** travels through the collection chamber **214** and is drawn toward the filters **1505A, 1505B.** Specifically, the air passes through the filter medium **1640** in a first filter direction, with the air entering the filter medium via the medium exterior surface. As the contaminated air **A1** passes through the filter medium **1640** of the filters **1505A, 1505B,** particles and other debris within the contaminated air are captured by the filter medium. Larger debris falls (via gravity) to the bottom of the tank **105,** while smaller debris becomes attached and/or embedded within the filter medium **1640.** This airstream, now filtered air **A2,** passes upward, through the central channel of the filter (as defined by inner cage **1605)** and toward the suction conduit **935A, 940A.**

**[0046]** The filtered air **A2** passes through the suction conduit **935A, 940A,** i.e., from the collection chamber defined by the tank **105** and into the motor chamber defined by the vacuum head **110.** Specifically, the filtered air **A2** enters the manifold **1305** of the air assembly disposed within the motor chamber, entering the inlet chamber **1310.** The filtered air **A2** is drawn into the fan central aperture **1115** and is directed radially outward therefrom as fan exhaust or discharge air **A3** (indicated by arrows). The discharge air **A3** is directed, via the slots **1112,** into the manifold discharge chamber **1315.** The cleaner conduits **935B, 940B** are closed/sealed; consequently, a portion of the discharge air **A3** is directed from the discharge chamber **1315,** through the first window **1330,** and into the exhaust chamber **1320.** Additionally, a portion of the discharge air **A3** is deflected by manifold deflector **1337** such that it passes through the second window **1335.** As such, a portion of the discharge air **A3** exits the manifold **1305** (and the vacuum system **10)** as manifold exhaust air **A4** via manifold exhaust outlet **1325.** Additionally, a portion of the discharge air is recycled as electronics coolant **A3',** exiting the manifold **1305** and returning to the motor chamber defined by the head **110** to cool electronics housed in the head (discussed in greater detail below).

**[0047]** Referring to FIGS. 17B and 18B, in a second operational mode, the filter medium **1640** of the first filter **1505A** is purged of debris. In this mode, the first butterfly valve **1005A** is engaged to reorient the valve from its normal position to its purge position. Specifically, the first rod **1010A** is rotated such that distal disc **1015A** covers/seals the first suction conduit **935A** and the proximal disc **1015B** is positioned such that it is oriented generally transverse to the opening of the first cleaning conduit **935B.** In this configuration, the first cleaning conduit **935B** is opened, while the first suction conduit **935A** is closed/sealed. The second butterfly valve **1005B** remains in its normal position as described above, with the second suction conduit **940A** being opened and the second cleaning conduit **940B** being closed/sealed.

**[0048]** In this configuration, the suction airflow through the first filter **1505A** ceases. That is, contaminated air **A1** no longer passes through the filter medium **1640** of the first filter **1505A** via the filter medium exterior surface. Suction airflow through the second filter **1505B,** however, is maintained. The filtered air **A2** from the second filter **1505B** enters the manifold **1305,** where it is drawn into the fan **1105** and expelled through fan slots **1112** as discharge air **A3.** With the cleaning conduit **935B** in its opened position, at least a portion of the discharge air **A3** is directed downward, into the first cleaning conduit **935B** (indicated by arrow). The discharge air **A3** enters the central channel of the first filter **1505A** (as defined by the inner cage **1605)** and is forced radially outward, passing through the filter medium **1640** in a second filter direction. As shown in FIG. 18B, this outward airflow functions as a purging airflow effective to dislodge at least a portion of the debris and/or particles **1800** previously attached to and/or embedded within the filter medium **1640.** Any remaining discharge air **A3** (i.e., and discharge air not directed into the cleaning conduit **935B)** is directed as indicated above, being expelled from the tank as either manifold exhaust **A4** or being recycled as electronics coolant **A3'.**

**[0049]** In a third operational mode, the filter medium **1640** of the second filter **1505B** is purged. The same operation described above with regard to the first filter **1505A** occurs with the second filter **1505B.** Referring to FIGS. 17C and 18B, the first butterfly valve **1005A** is returned to its normal position, in which the first suction conduit **935A** is opened and first cleaning conduit **935B** is sealed/closed. In addition, the second butterfly valve **1005B** is engaged, moving the valve from its normal position to a purge position, in which the second suction conduit **940A** is closed and the second cleaning conduit **940B** is opened. Similar to that described above, discharge airflow **A3** drawn into the manifold **1305** as filtered air is either directed into the second cleaning conduit **940B,** out of the head **1010** via the manifold exhaust chamber **1320,** or back into the head **1010** via second window **1035.** The discharge air **A3** that is directed through the cleaning conduit passes through the filter medium **1640** of the second filter **1505B** in a second direction (opposite the first direction), thereby purging the filter medium of debris captured thereon.

**[0050]** The amount of time for the purge is not particularly limited. By way of example, the airflow system may operate in the suction mode for a first predetermined period of time and in the purging/cleaning mode for a second predetermined period of time, with the second period of time being less than the first period. In an embodiment, the valve system cycles, generating suction air for approximately 30 seconds, and then generating purge air for approximately 0.3 seconds, alternately purging the first filter **1505A** and the second filter **705B.** This process continues, with the filters **1505A, 1505B** alternately being purged in approximately every 20 seconds.

**[0051]** Referring to FIGS. 19A and 19B, during operation, cooling air **A5** for the motor **1007** is drawn in through the motor intake port **1210** of the motor shroud **1205,** where it is directed across the motor, cooling it, and then out through motor exhaust **1220** as motor exhaust air **A5'.** As mentioned above, the motor airflow **A5, A5'** remains separate from the vacuum airflow **A1, A2, A3, A3', A4** vacuum filtered air, with the motor shroud preventing the motor air **A5, A5'** from entering the manifold **1305.**

**[0052]** FIG. 20 illustrates an electrical schematic for the vacuum device **10** in accordance with an embodiment of the invention. As shown, the electrical system **2000** includes a microprocessor **2005** in communication with the motor via motor connect **2010,** as well as the butterfly valves **1005, 1005B** via a solenoid connect **2015,** which, in turn, is in communication with solenoid switches **1002A, 1002B.** The system **2000** may further include a pressure or flow sensor **2020** operable to indicate when the intake airflow **A1** is reaches (e.g., is above or below) a predetermined threshold value. By way of example, it may indicate when the airflow pressure or flow velocity is below a specified value, thereby notifying the user that the filters must be removed for manual cleaning or replacement.

**[0053]** While the present invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. It is to be understood that terms such as "top", "bottom", "front", "rear", "side", "height", "length", "width", "upper", "lower", "interior", "exterior", and the like as may be used herein, merely describe points of reference and do not limit the present invention to any particular orientation or configuration.

## Claims

1. A vacuum device comprising:

   a tank portion including a collection chamber;
   a head portion having an airflow assembly including an airflow generating device operable to generate airflow within the vacuum device such that an intake airstream is drawn into the collection chamber via an air inlet and an exhaust airstream is exhausted from the airflow chamber via an exhaust outlet;
   a first filter disposed within the tank collection chamber;
   a second filter disposed within the tank collection chamber;
   a separator between the head portion and the tank portion, the separator including;
   a first passageway through the separator and in fluid communication with the first filter, the first passageway allowing airflow between the collection chamber and airflow generating device, and
   a second passageway through the separator and in fluid communication with the second filter, the second passageway allowing airflow between the collection chamber and airflow generating device; and
   the airflow assembly further including,
   a third passageway in fluid communication with the first filter, the third passageway allowing airflow between the first filter and an air source outside the collection chamber; and
   a fourth passageway in fluid communication with the second filter, the fourth passageway allowing airflow between the second filter and an air source outside the collection chamber; and
   a valve assembly operable to selectively and independently permit airflow between at least one of the first filter and the airflow generating device or the outside air source and between the second filter and the airflow generating device or the outside air source.

2. The vacuum device of claim 1, wherein:

   a rotational axis of the airflow generating device is horizontal in operation.

3. The vacuum device of claim 1, wherein the valve assembly includes at least two butterfly valves each including a shaft and two offset gates secured to the shaft, the offset gates alternately mating with two respective air passage seats to alternately open one of the first and second passageways while simultaneously closing one of third and fourth passageways.

4. The vacuum device of claim 1, wherein:

   the airflow generating device comprises a fan rotating about a fan rotational axis; and
   the fan rotational axis is oriented generally orthogonal to a filter axis.

5. The vacuum device of claim 1, wherein the airflow generating device comprises a centrifugal fan.

6. The vacuum device of claim 1, further comprising a baffle for directing exhaust air from a fan of the airflow generating device onto a motor of the airflow generating device.

7. The vacuum device of claim 1, wherein a light source is pivotably mounted on the head.

8. The vacuum device of claim 1, wherein a fexible member is secure at one end the vacuum and a hook is secured to another end of the flexible member, the flexible member configured to be drawn around an accessory to secure the accessory to the vacuum via the connection of the hook to the rim.

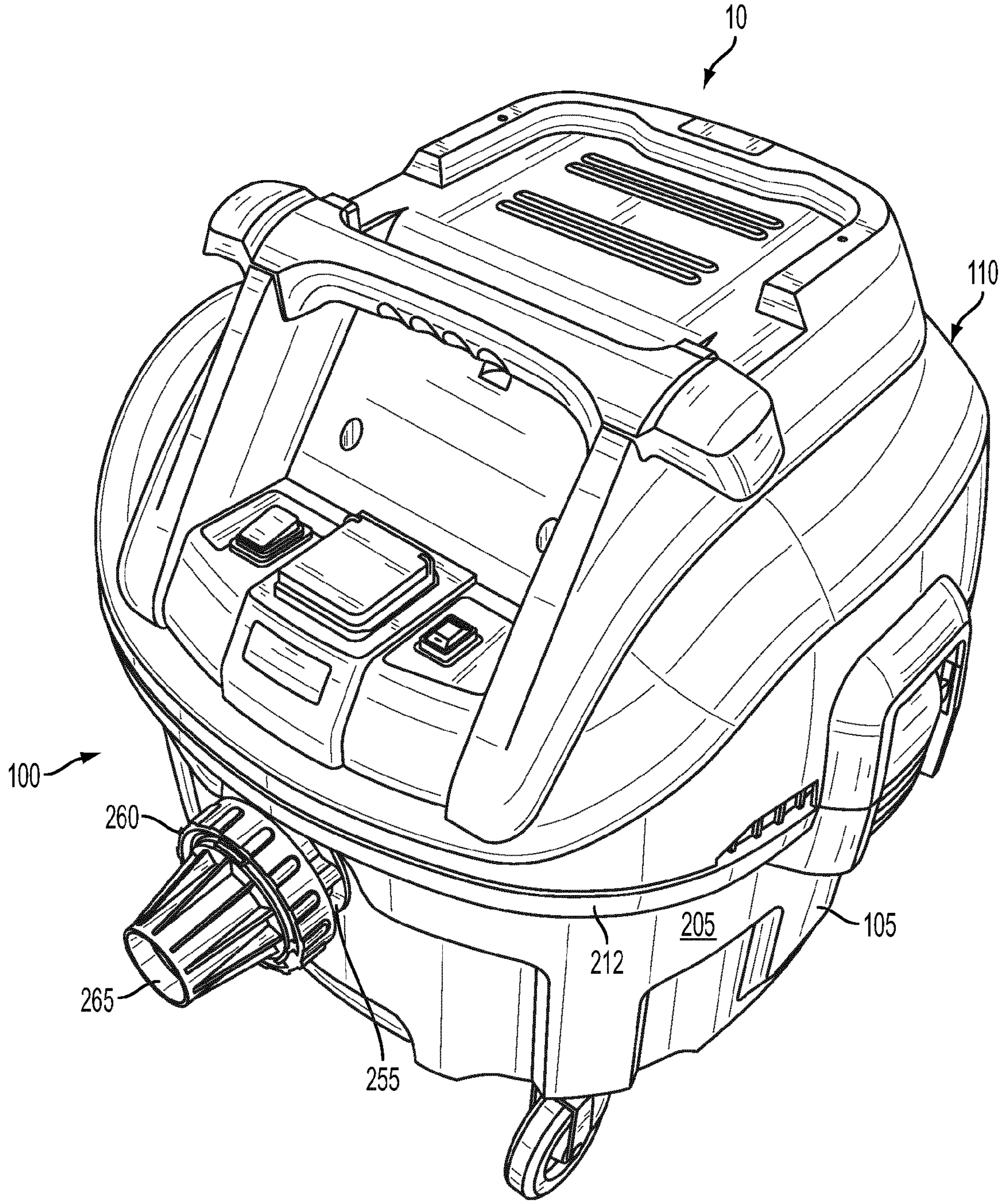



FIG. 1

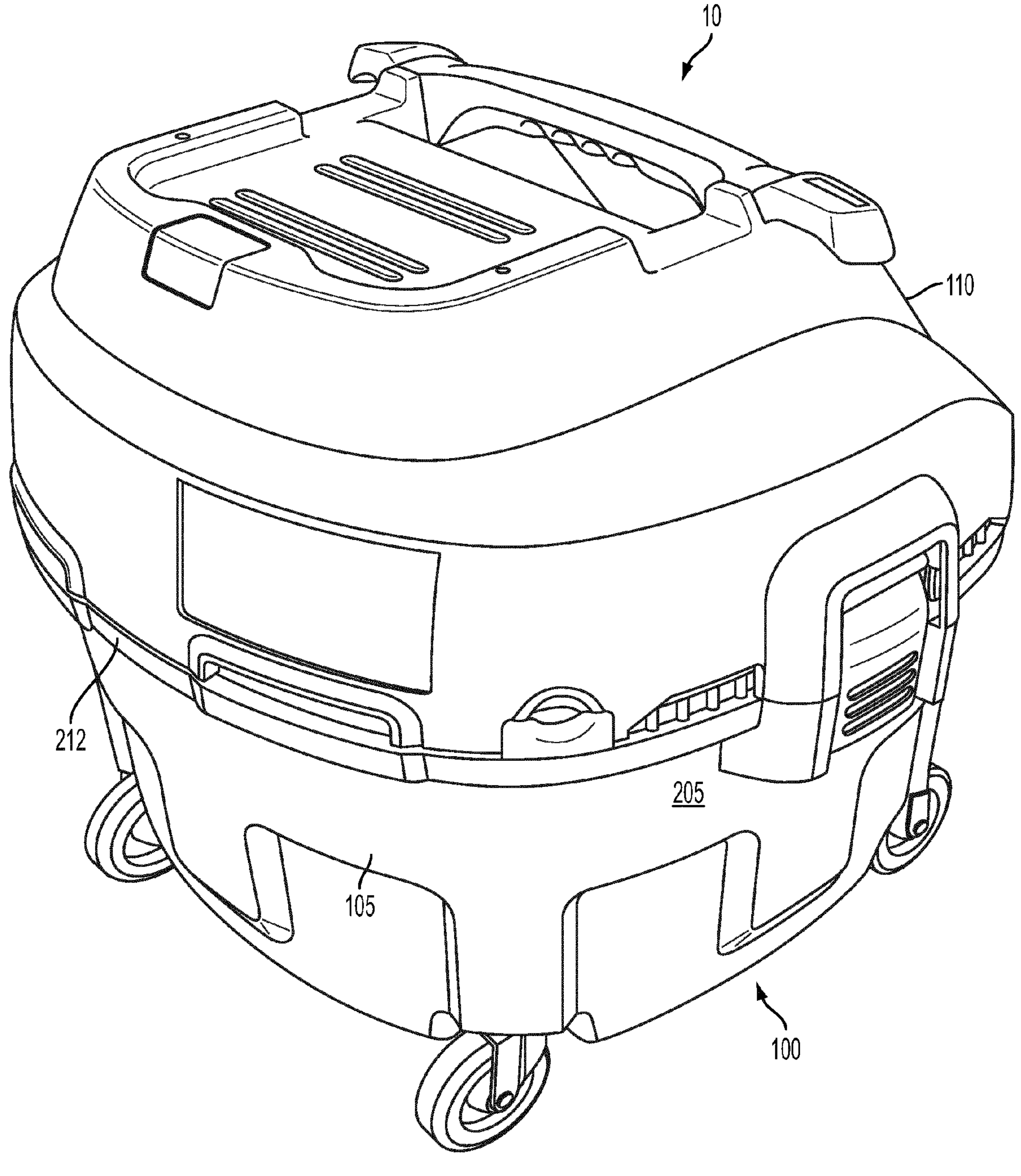



FIG. 2

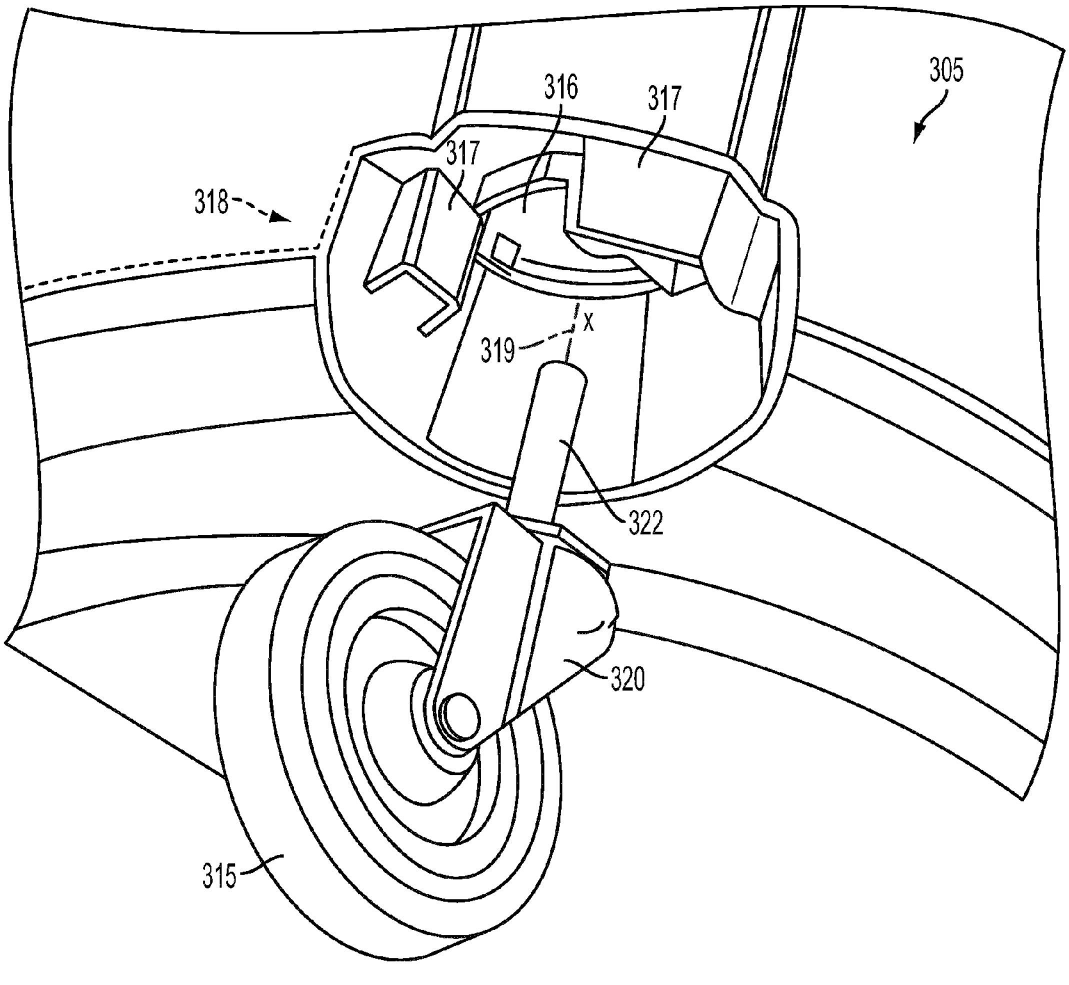



FIG. 3

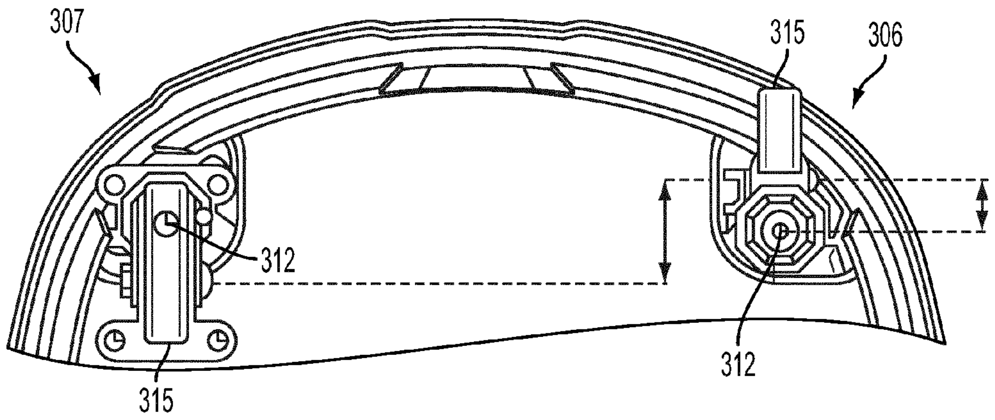



FIG. 4

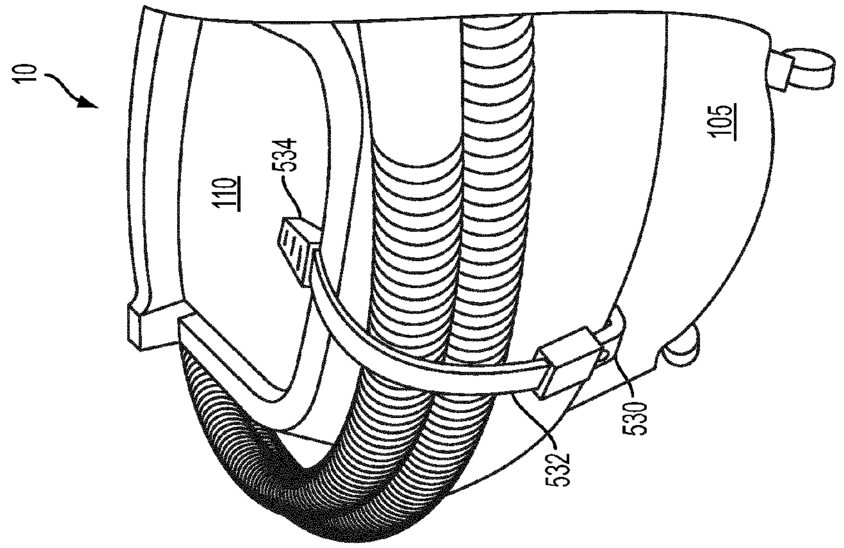



FIG. 6A

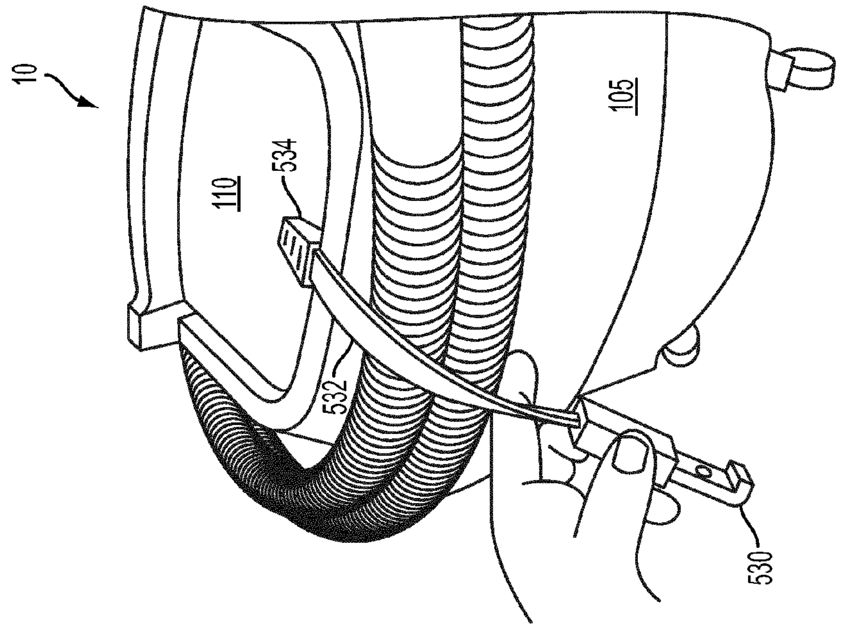



FIG. 5

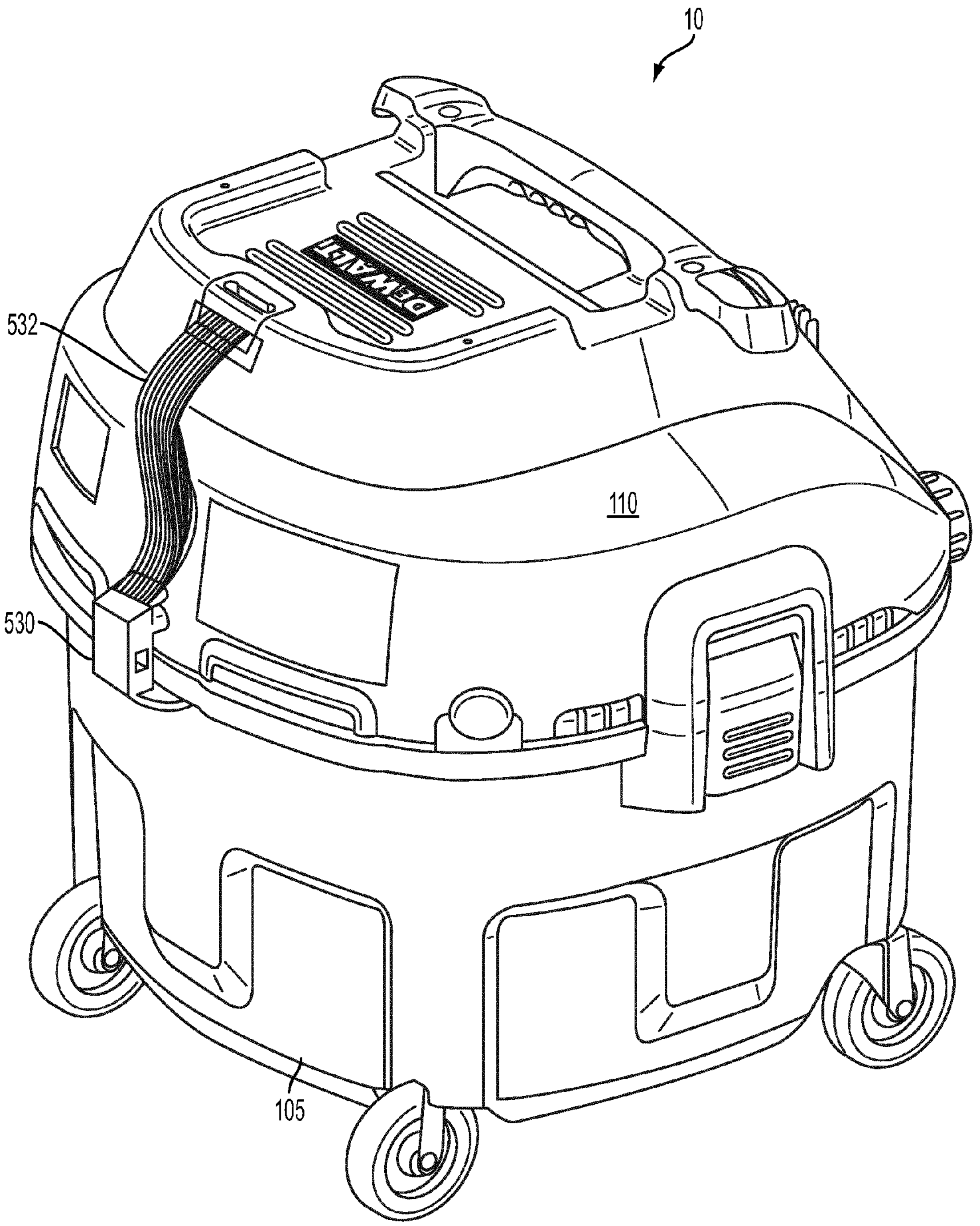



FIG. 6B

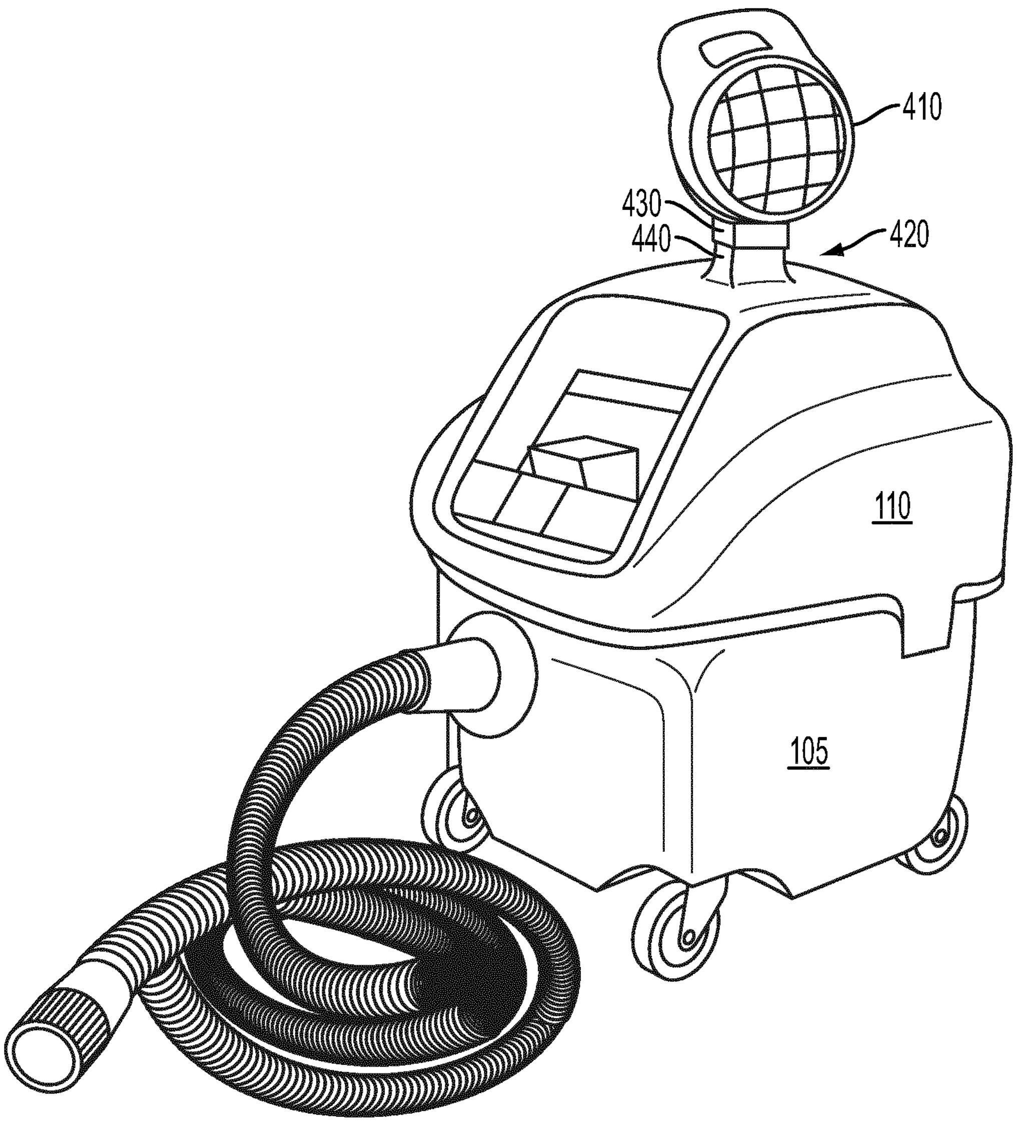



FIG. 7A

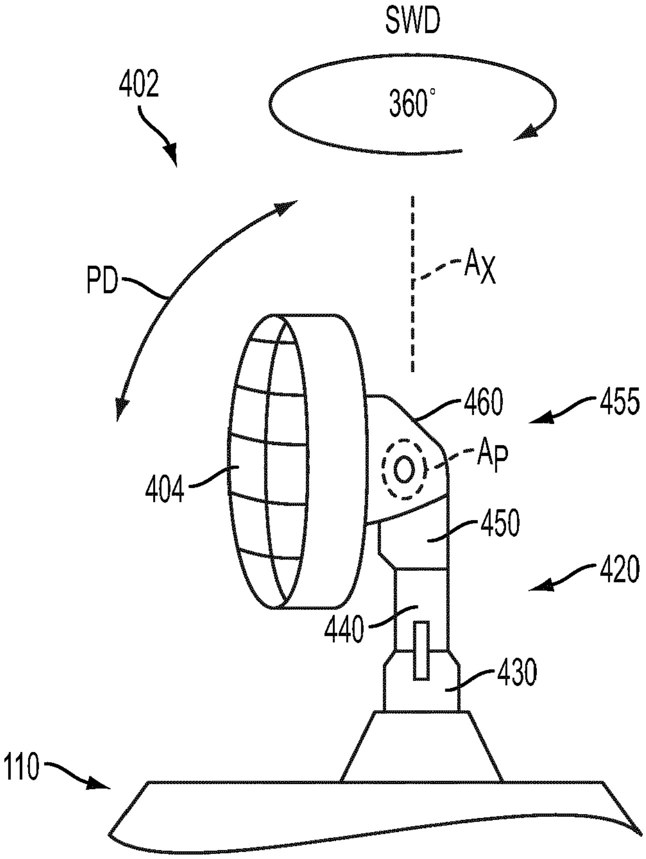



FIG. 7B

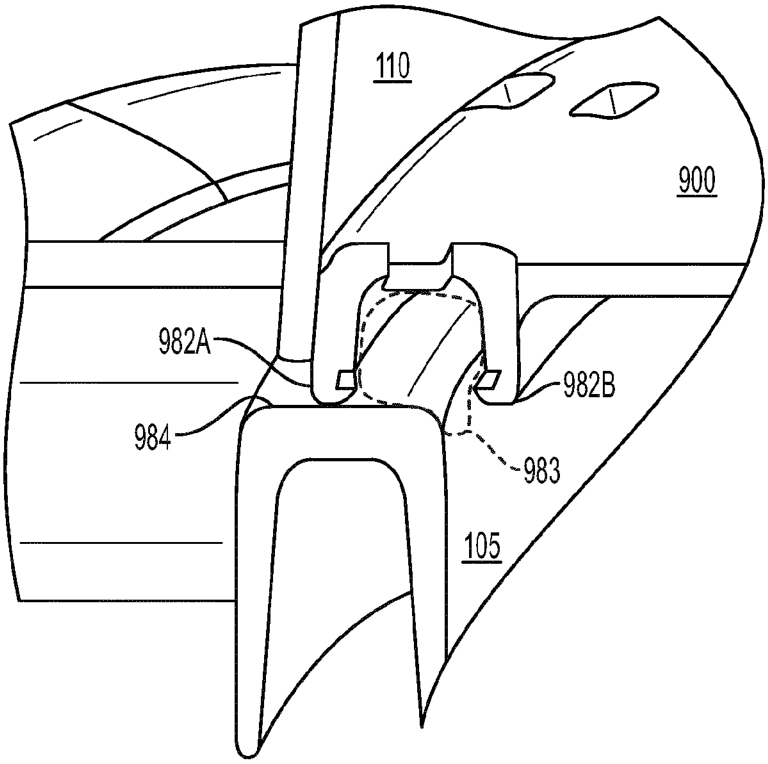



FIG. 8A

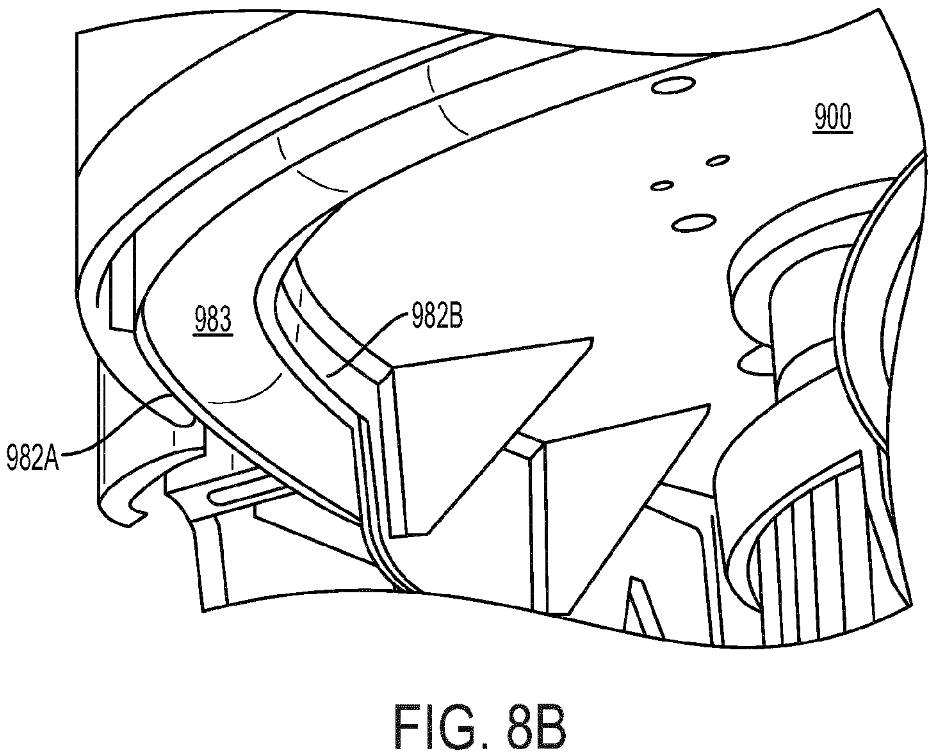



FIG. 8B

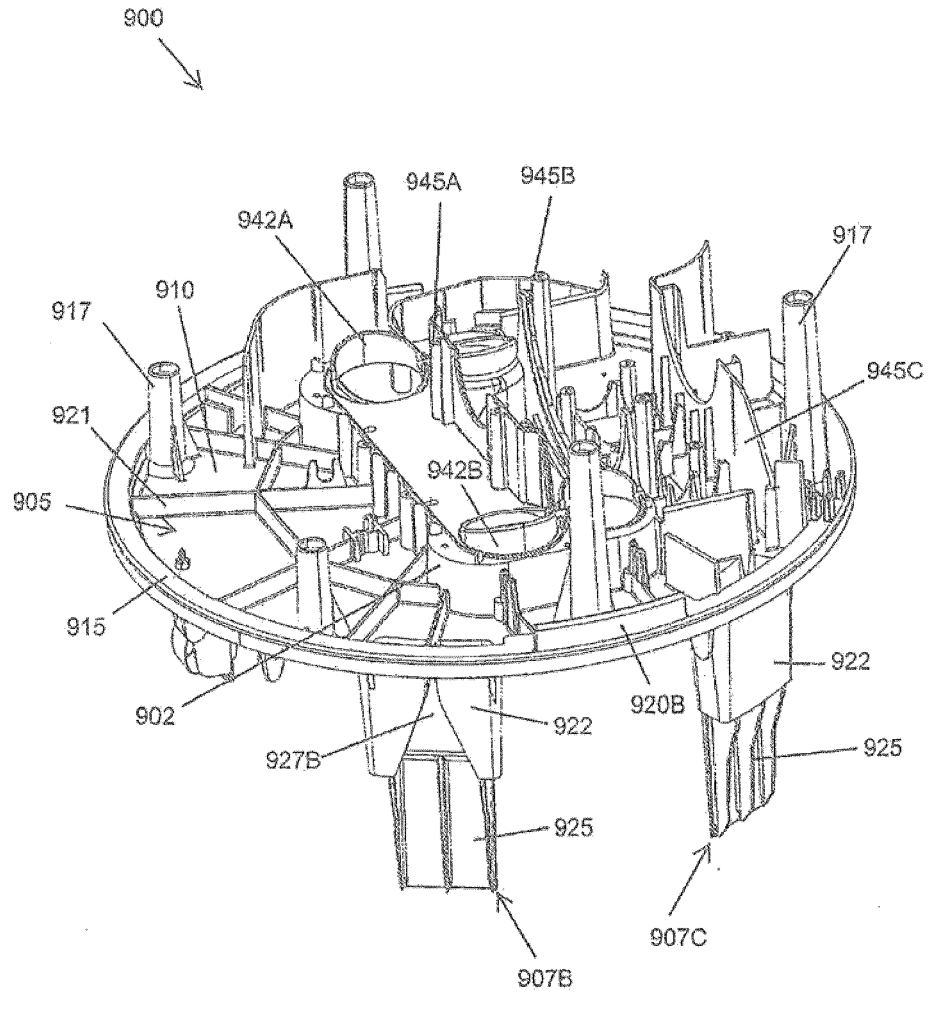
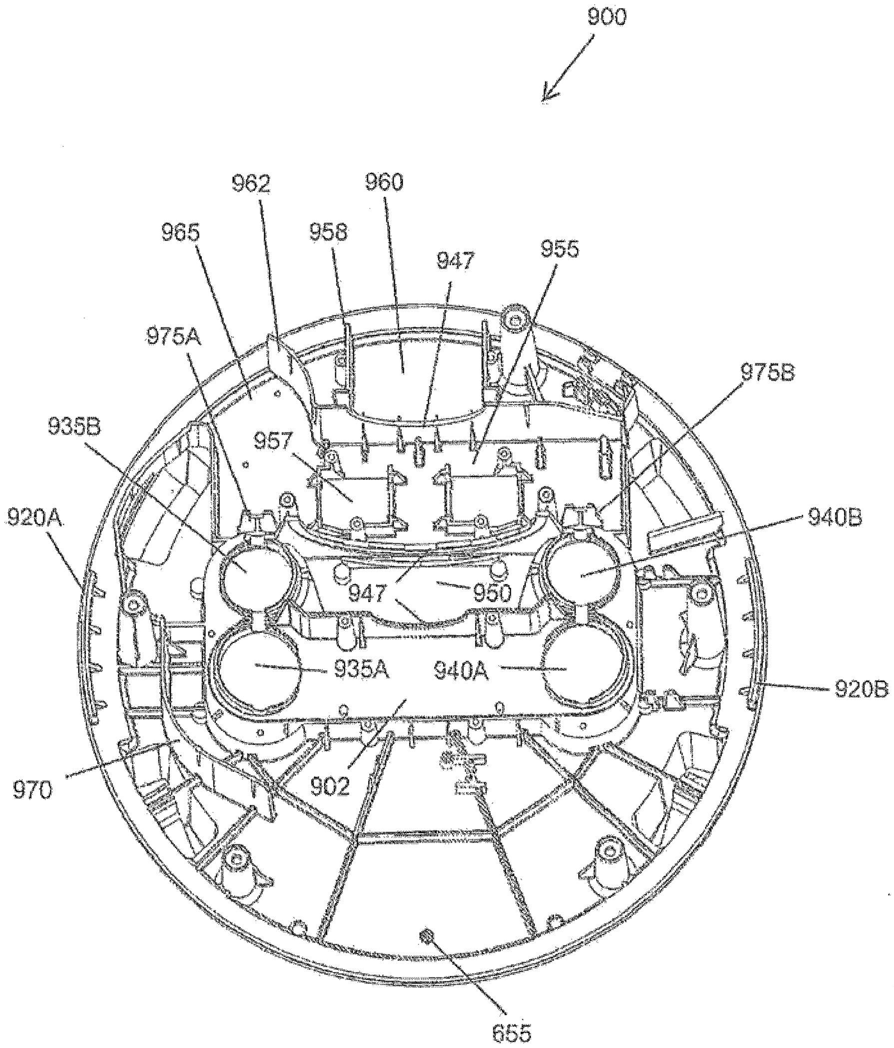

900
945A
945B
942A
917
910
917
945C
921
942B
905
915
922
902
920B
922
927B
925
925
907C
907B

FIG.9A


900
962
960
965
958
947
955
975A
975B
935B
957
920A
940B
947
950
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970
902
655

FIG.9B

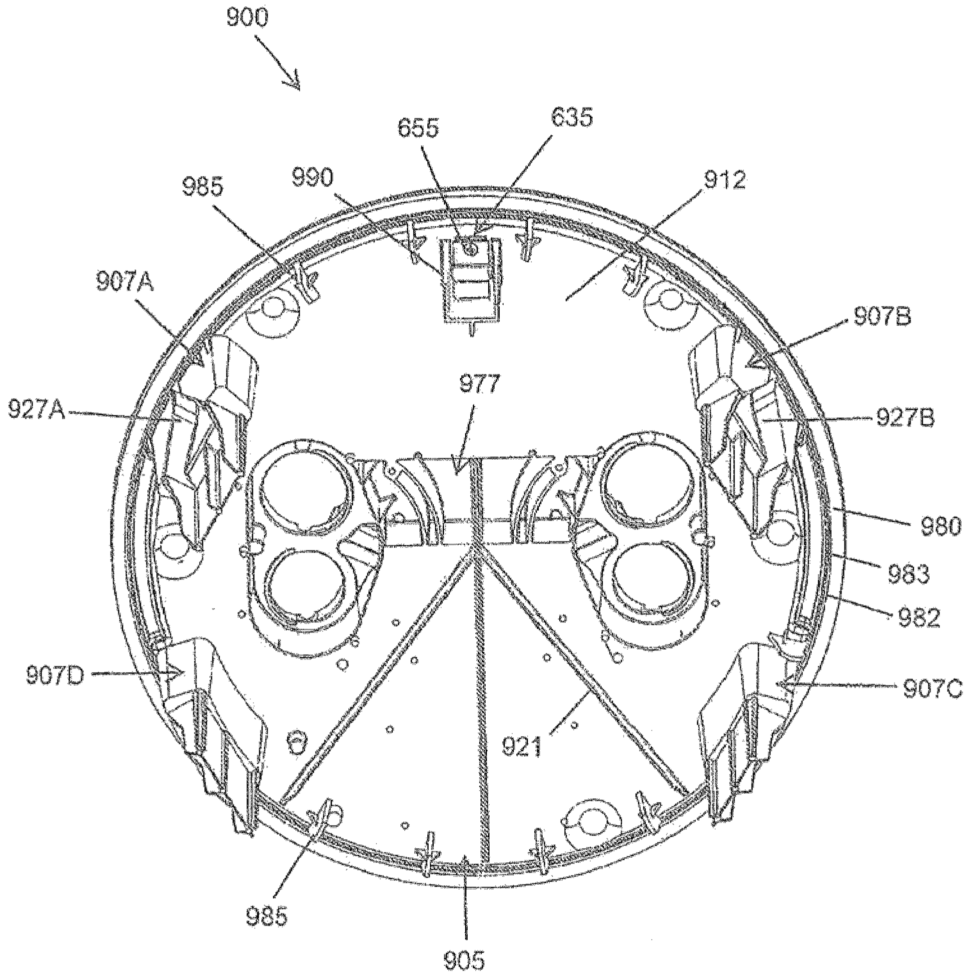

900
655
635
985
990
912
907A
907B
977
927A
927B
980
983
982
907D
907C
921
985
905

FIG.9C

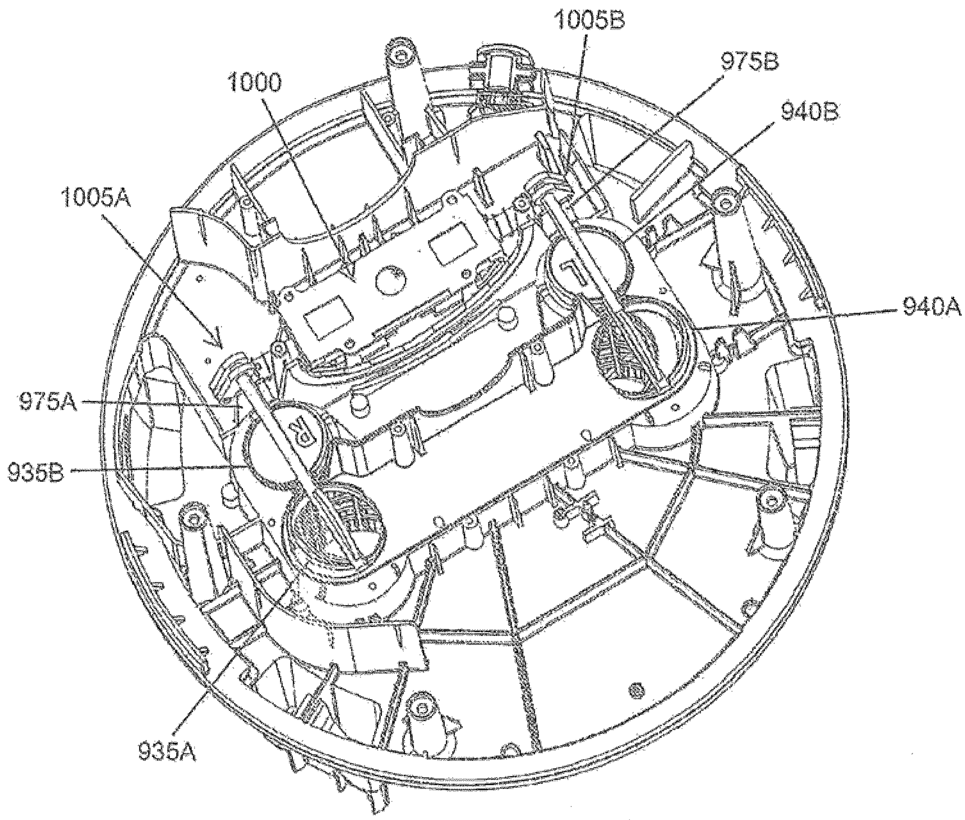



FIG.10A

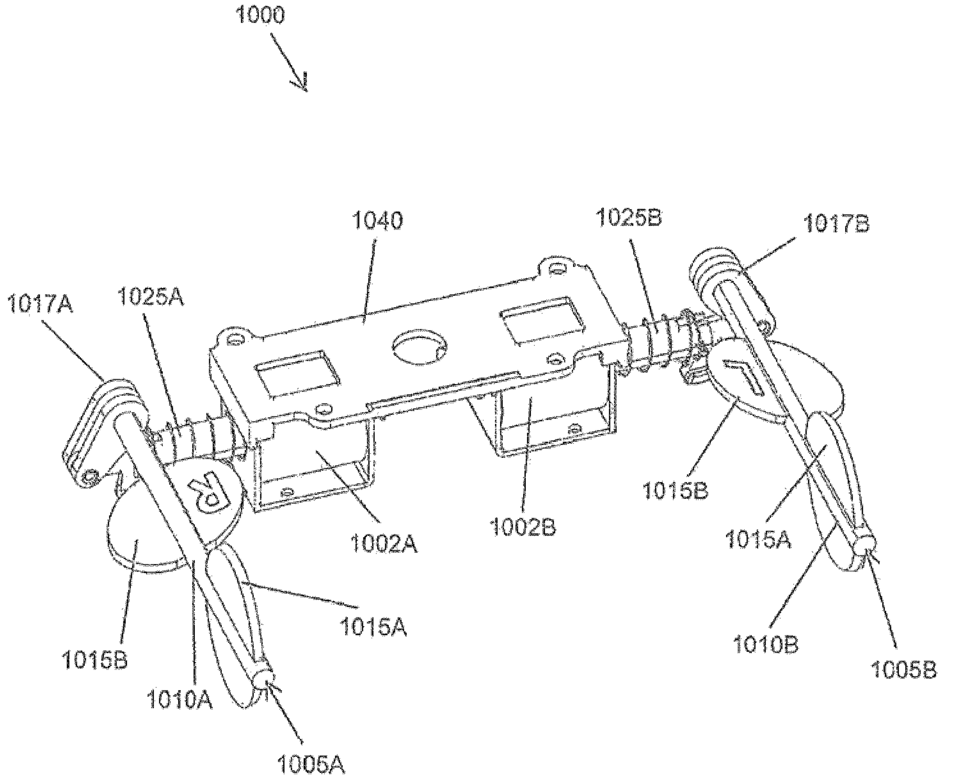
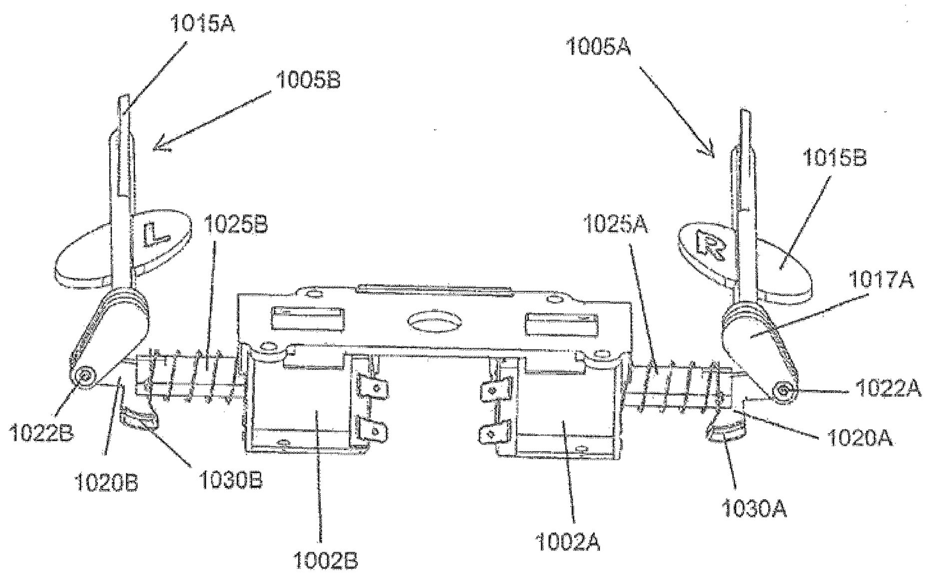

1000
1040
1025B
1017B
1017A
1025A
1015B
1015A
1002A
1002B
1015A
1010B
1005B
1015B
1010A
1005A

FIG.10B


1015A
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1005A
1015B
1025B
1025A
1017A
1022A
1020A
1022B
1020B
1030B
1030A
1002B
1002A
L
R

FIG.10C

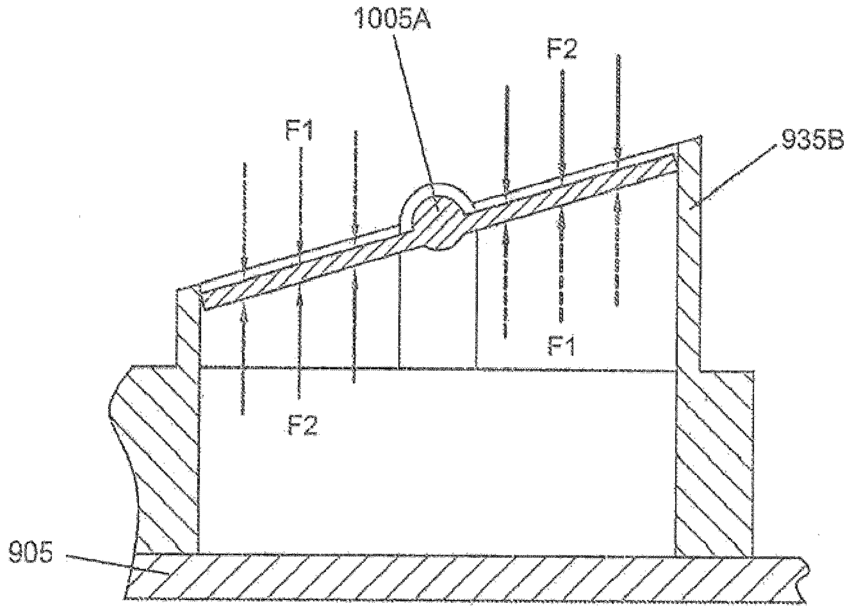



FIG.10D

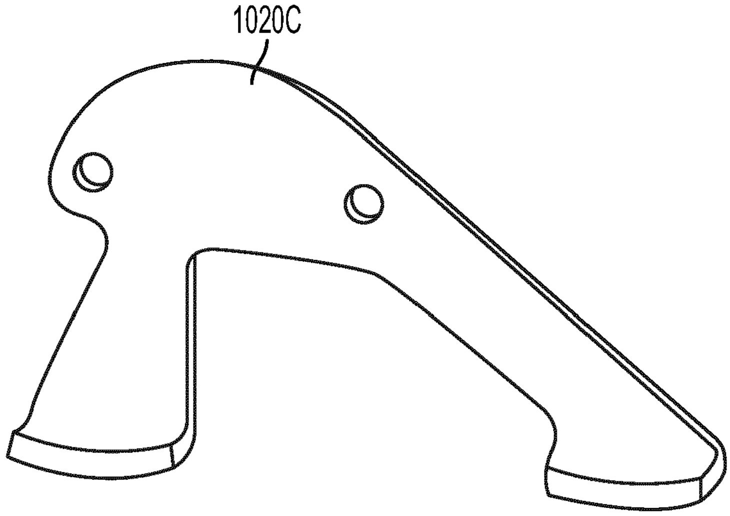



FIG. 10E

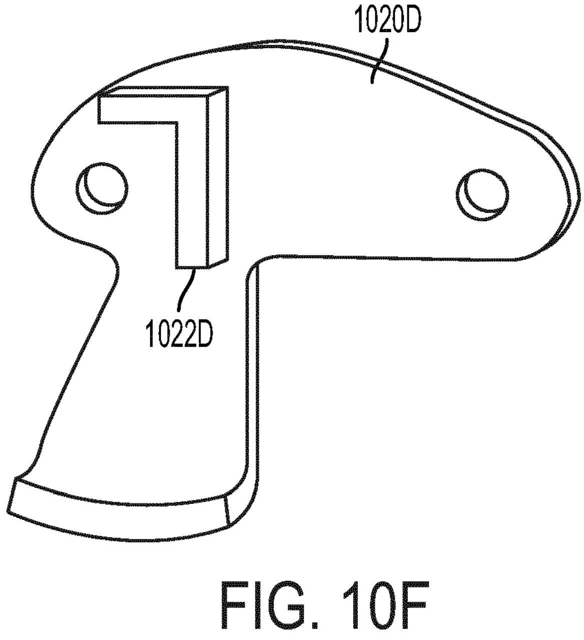



FIG. 10F

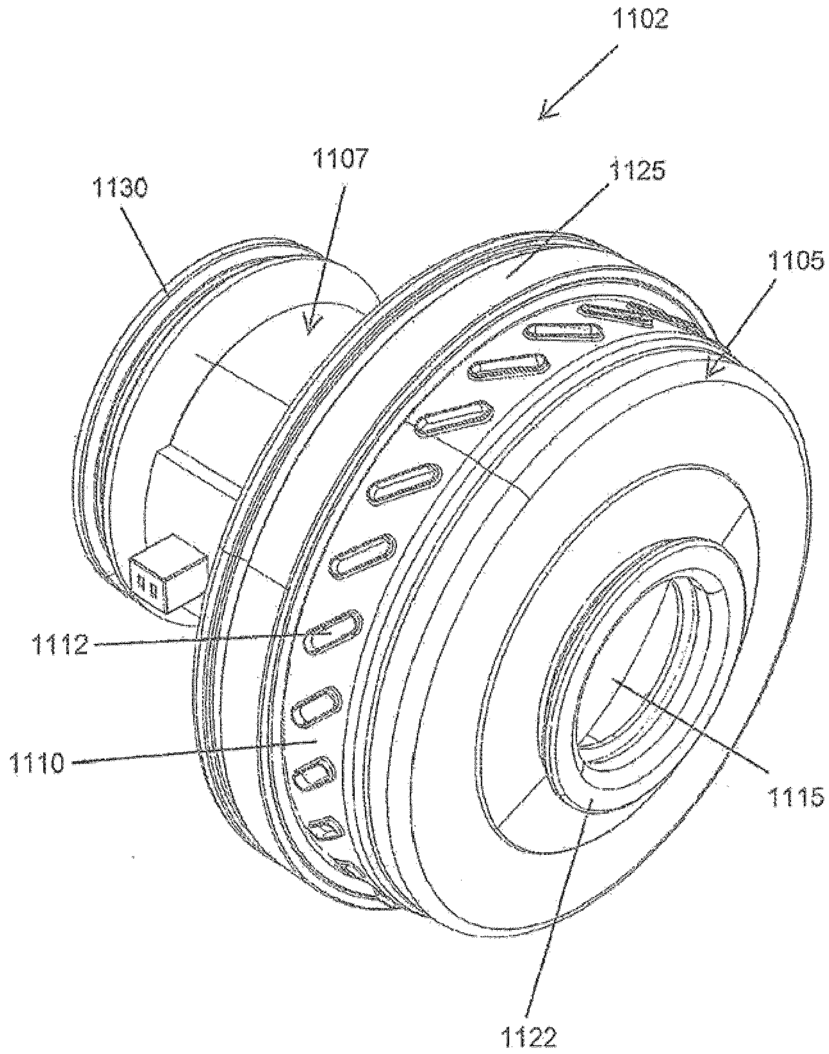



FIG.11A

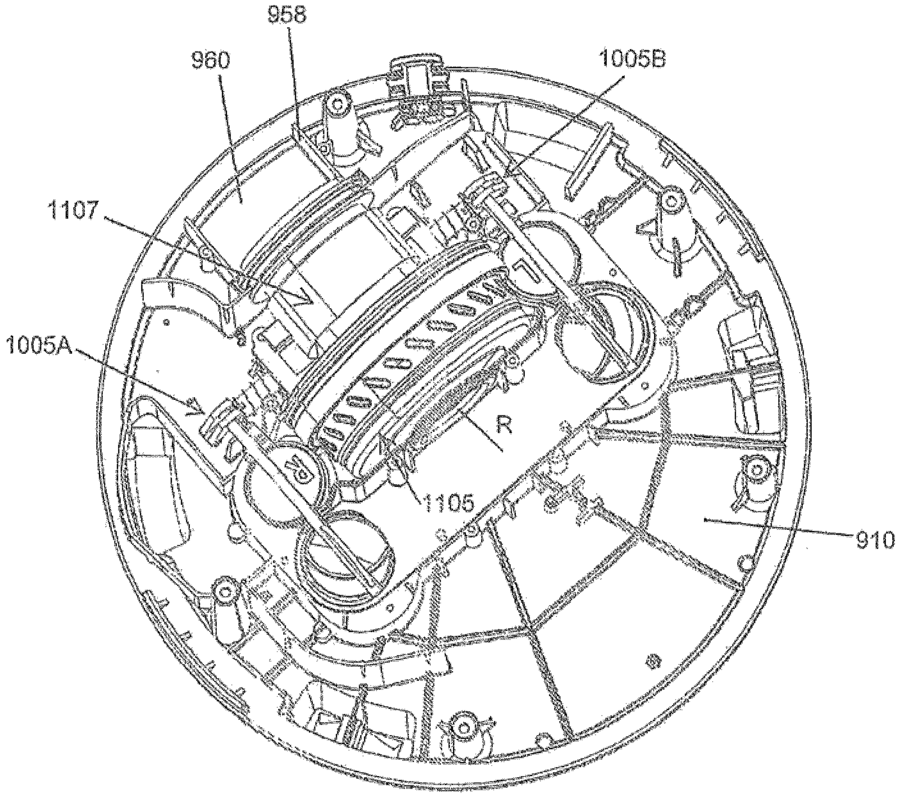



FIG.11B

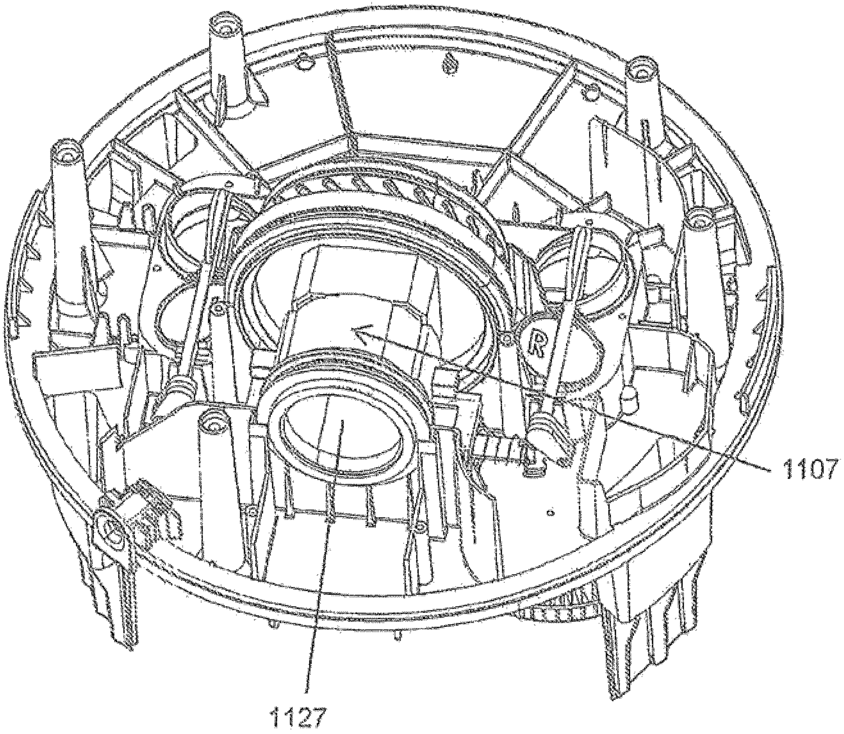



FIG.11C

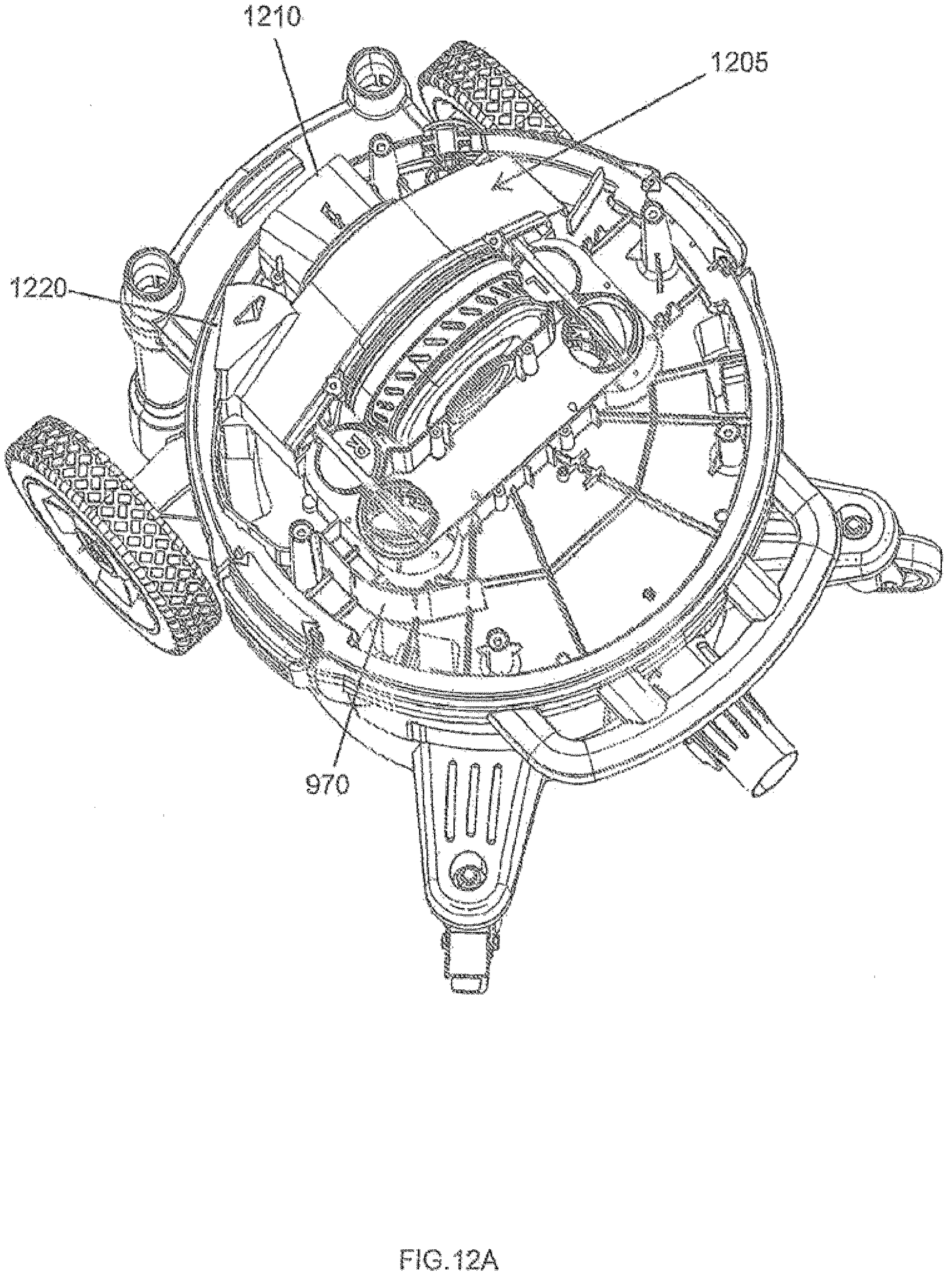



FIG.12A

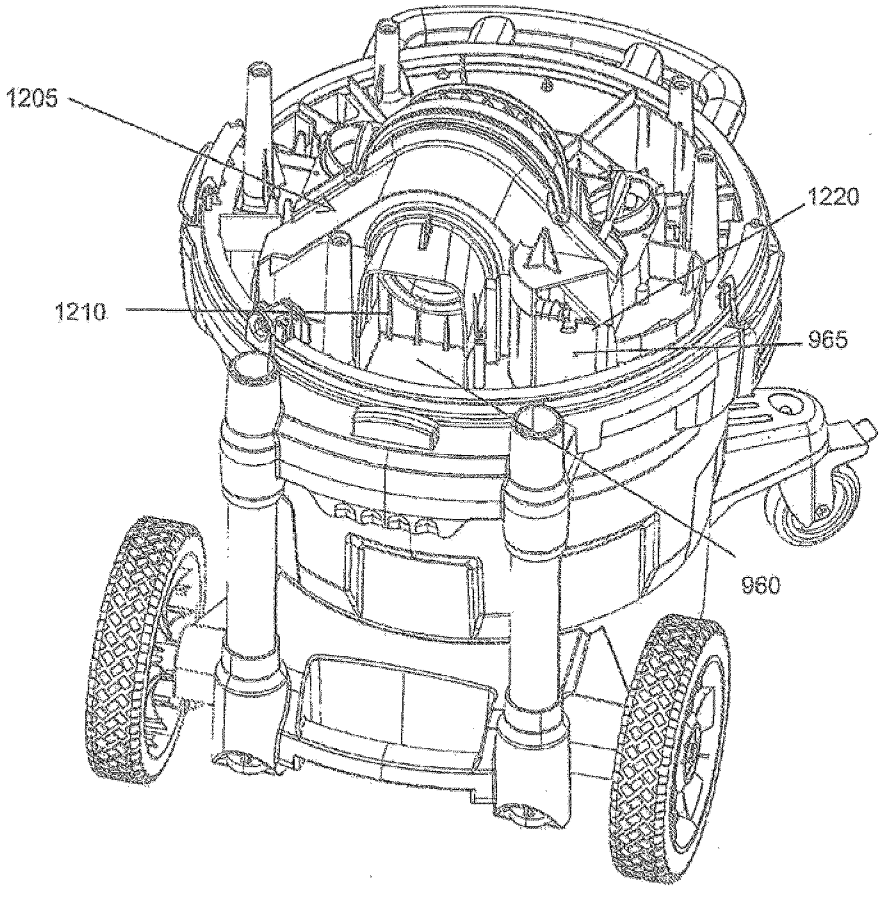



FIG.12B

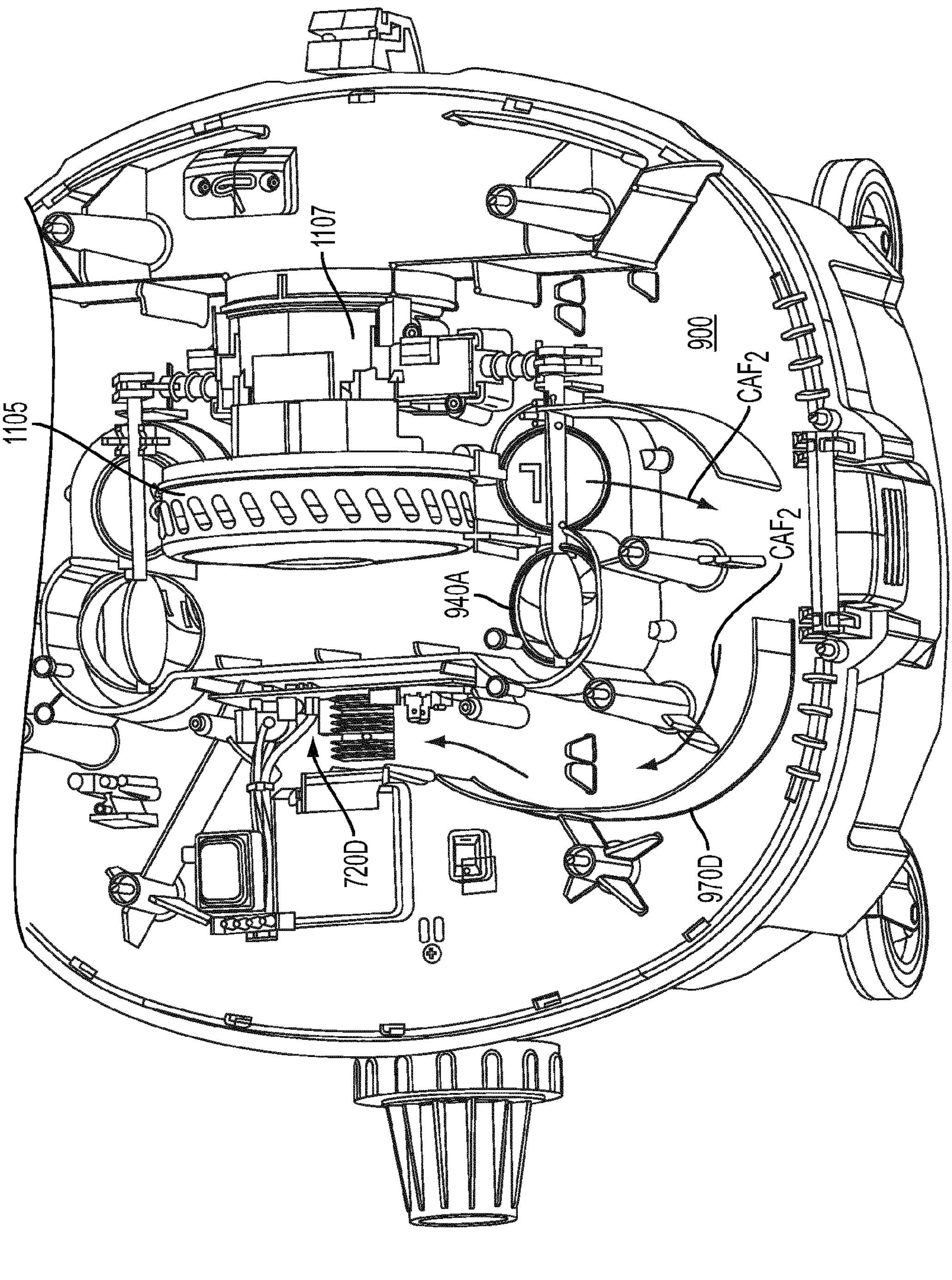



FIG. 12C

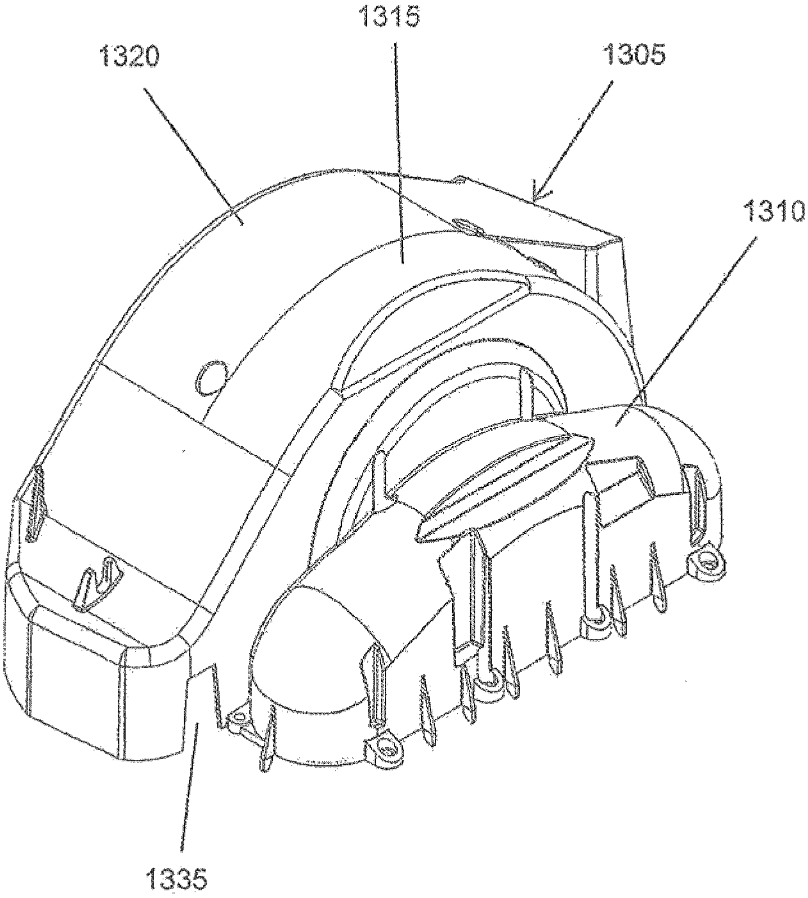



FIG.13A

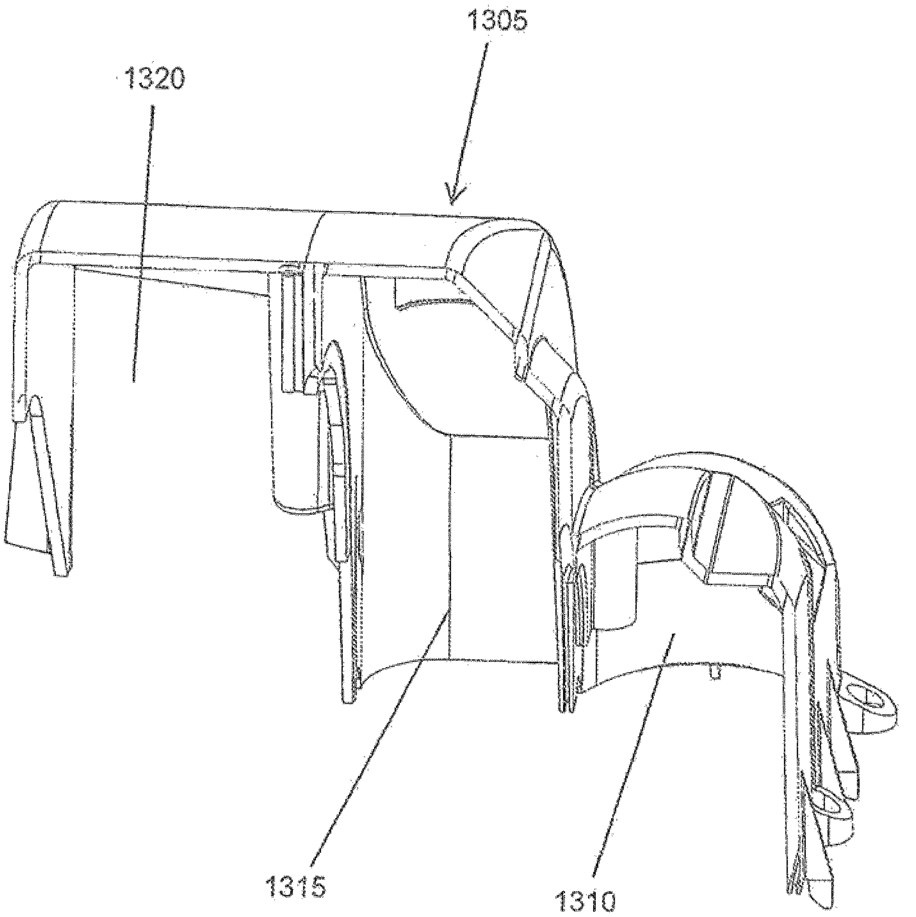



FIG.13B

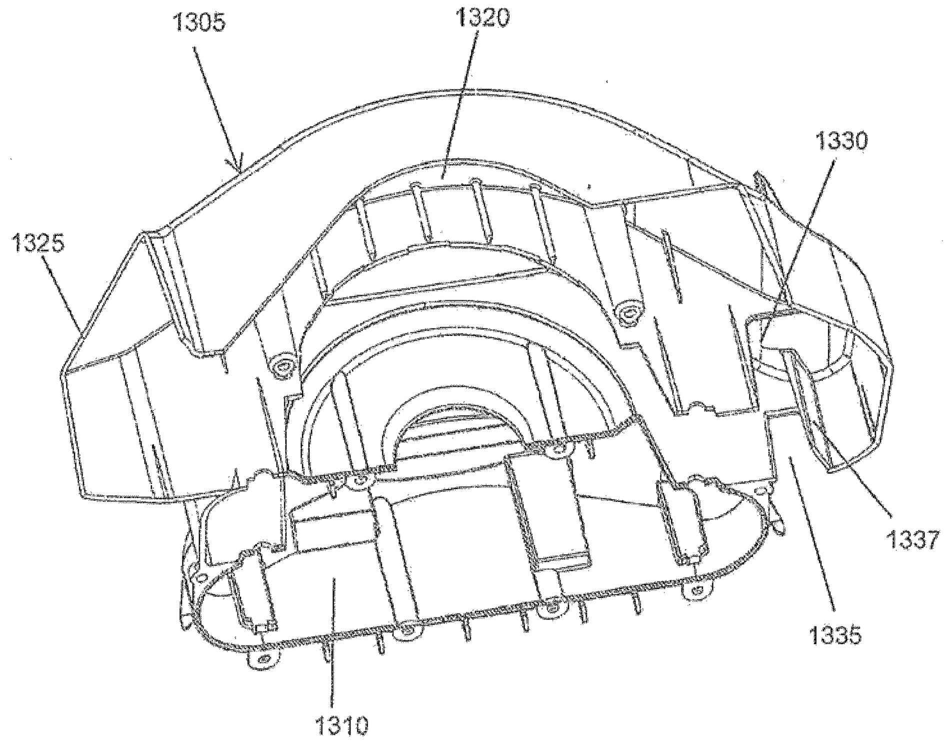



FIG.13C

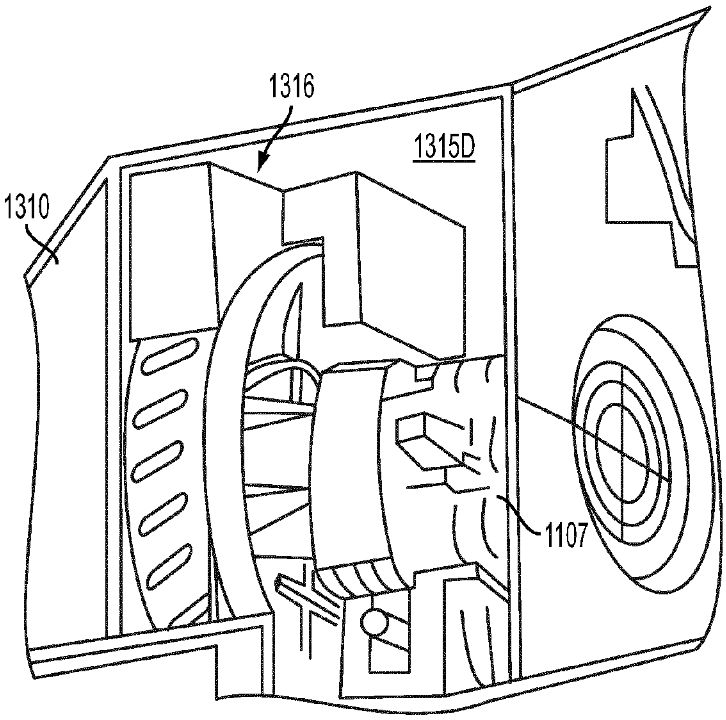



FIG. 13D

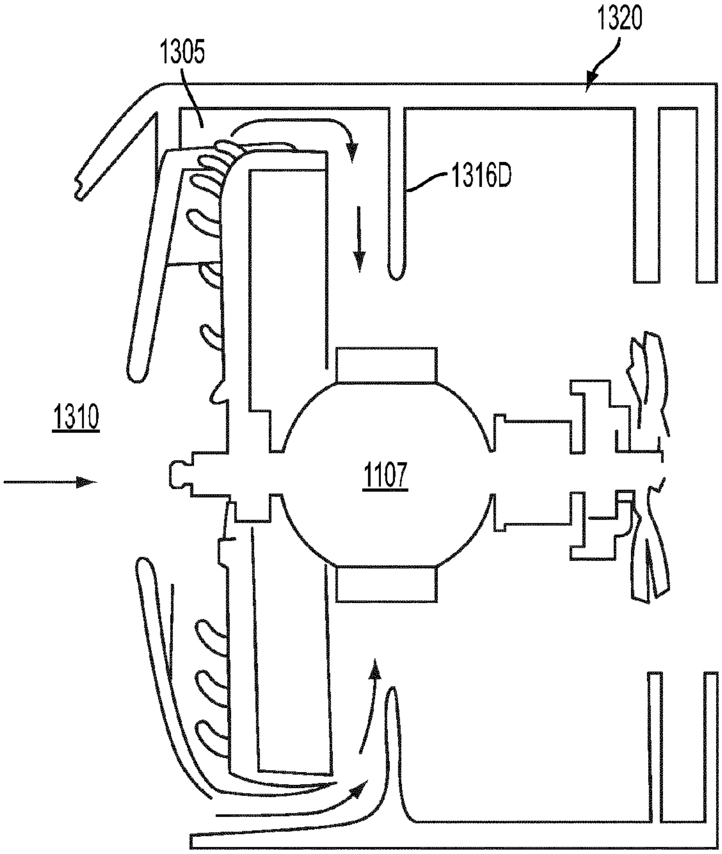



FIG. 13E

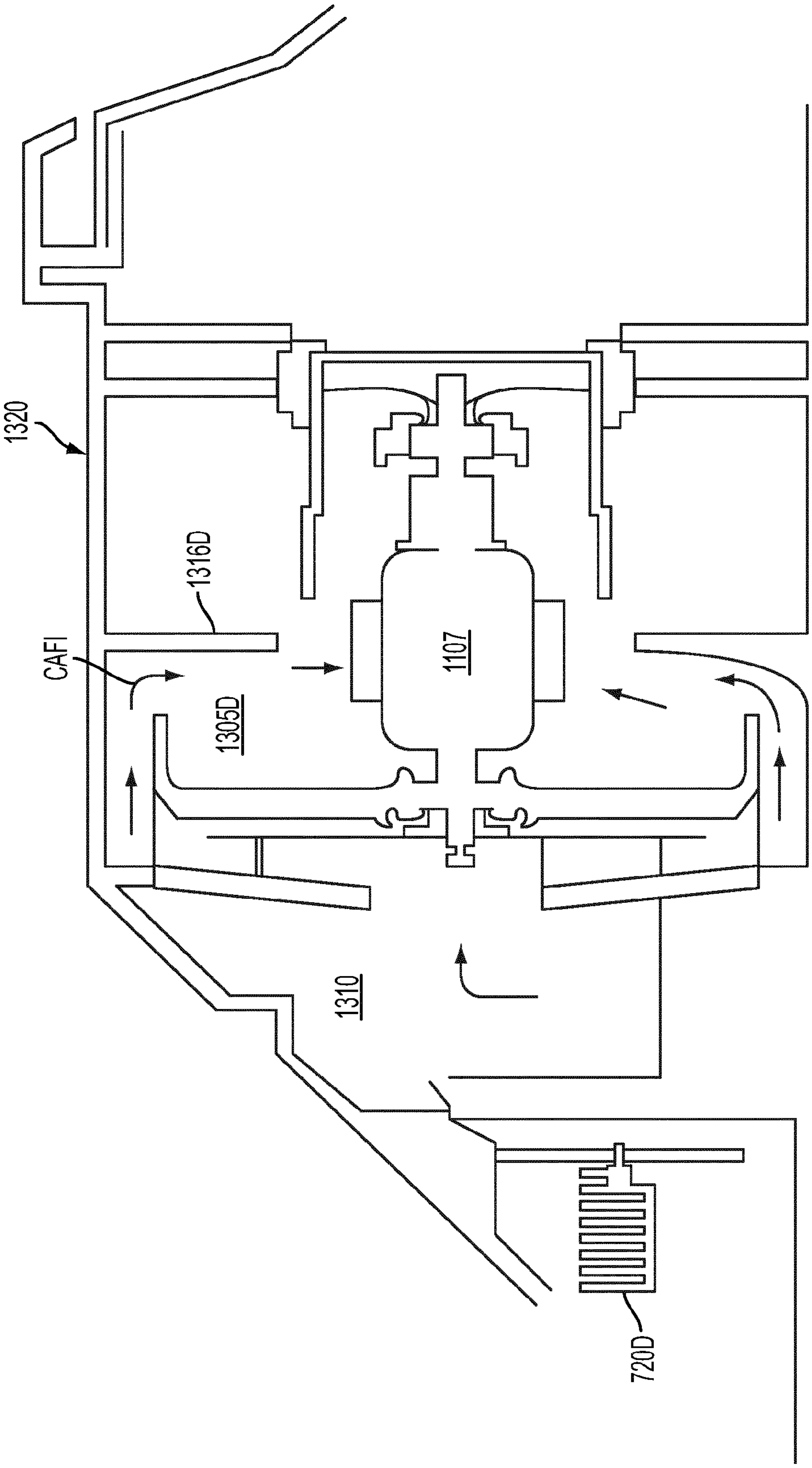



FIG. 13F

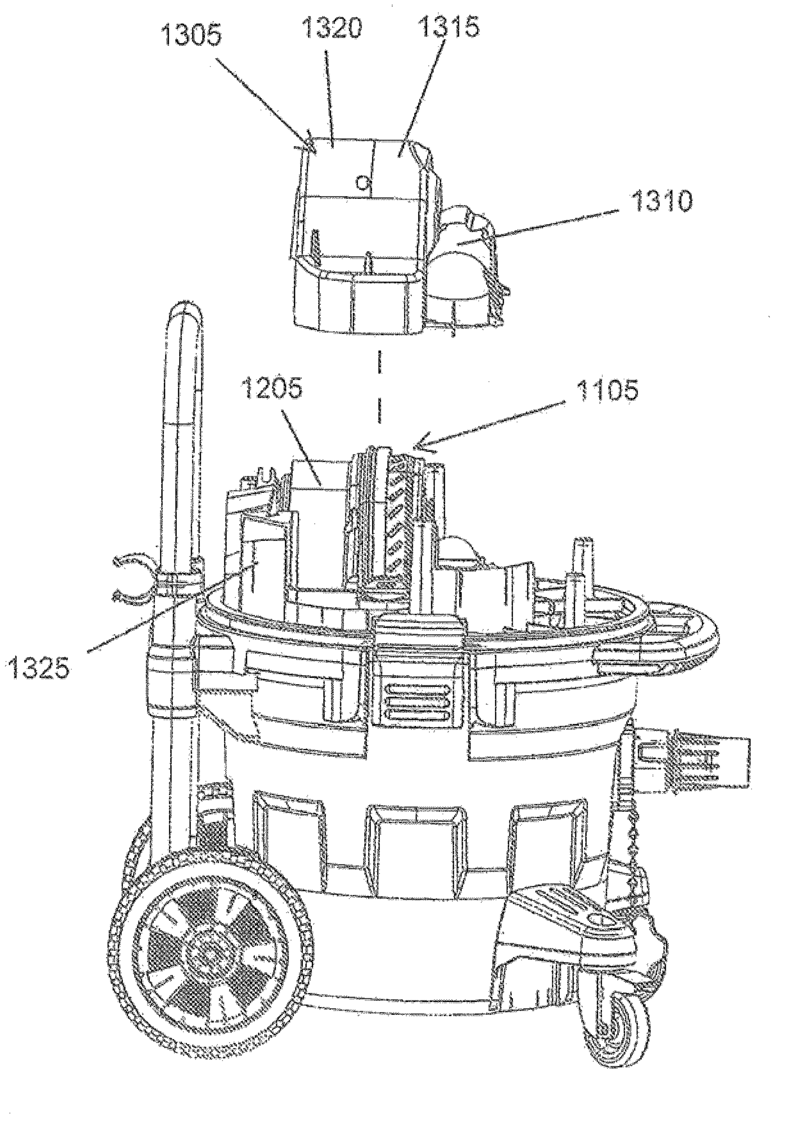



FIG.14A

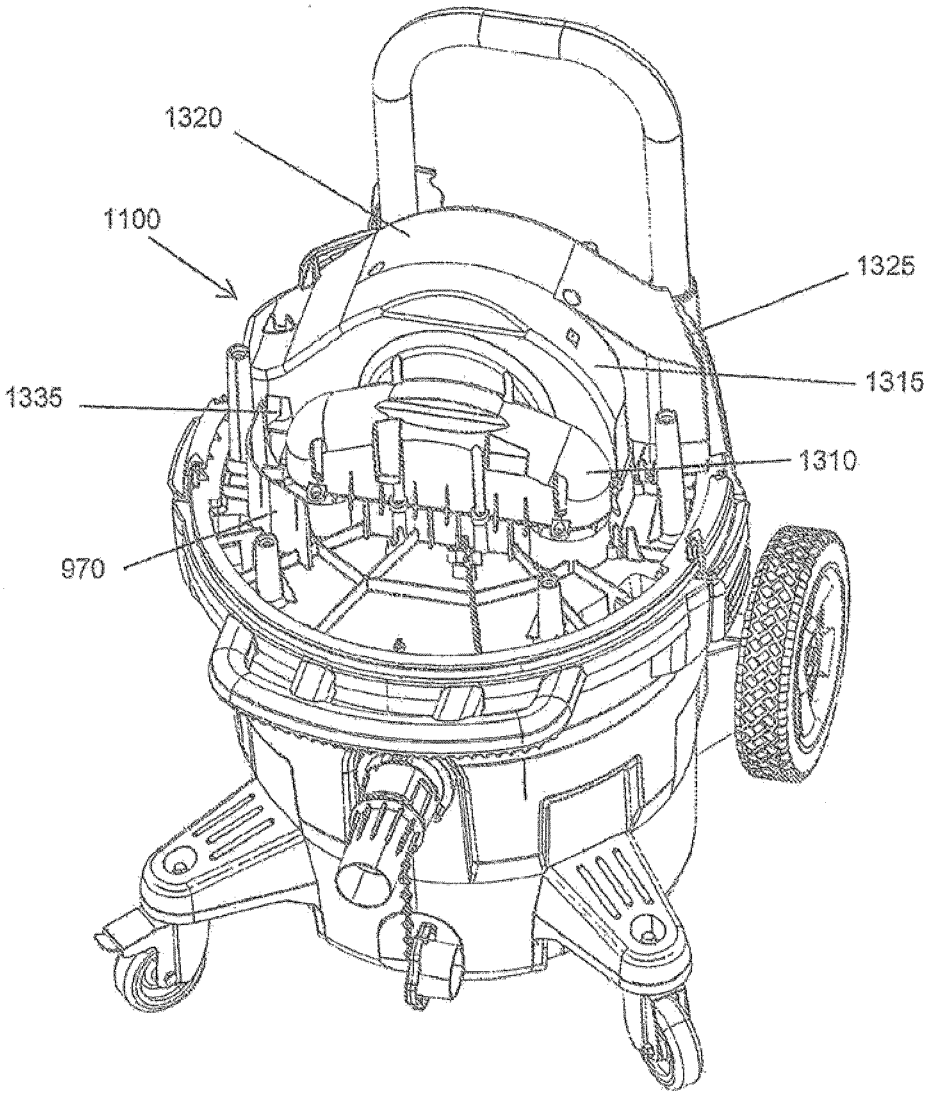



FIG.14B

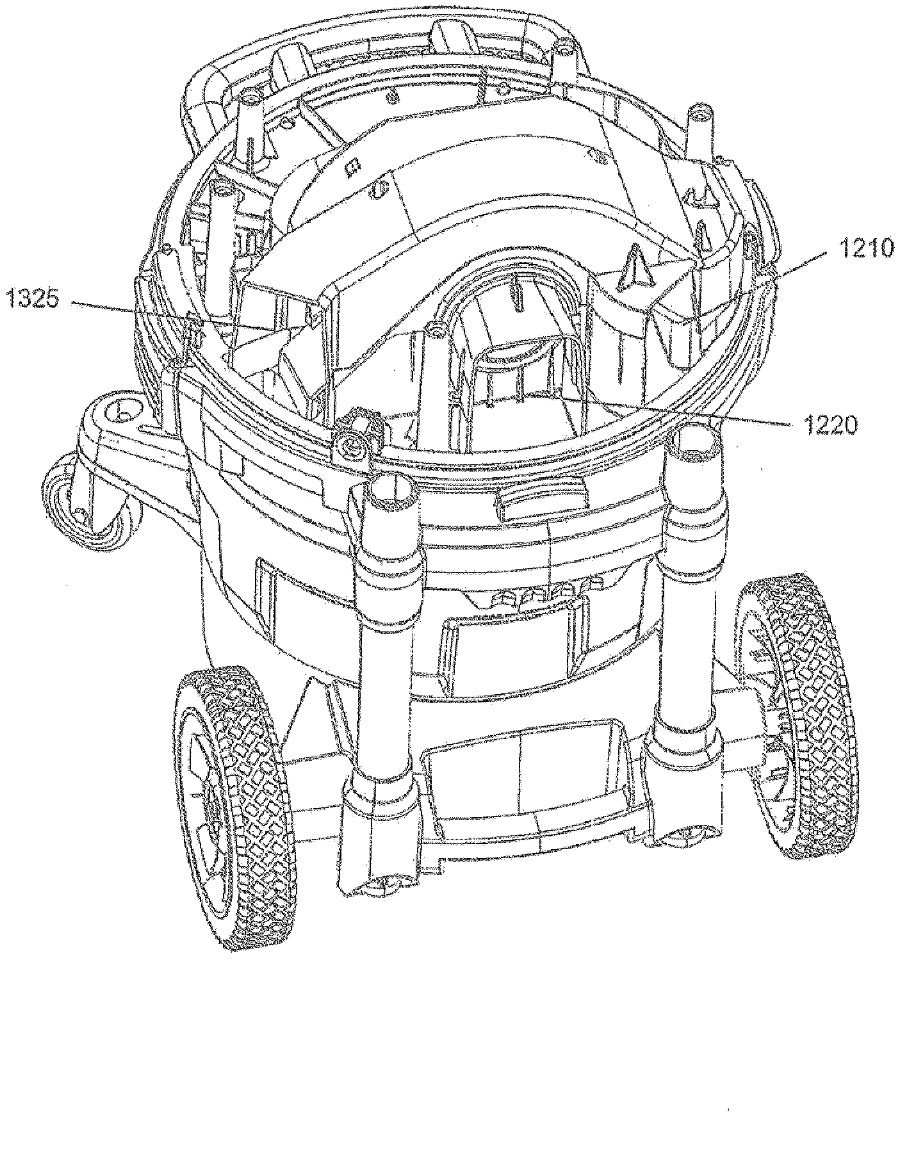



FIG.14C

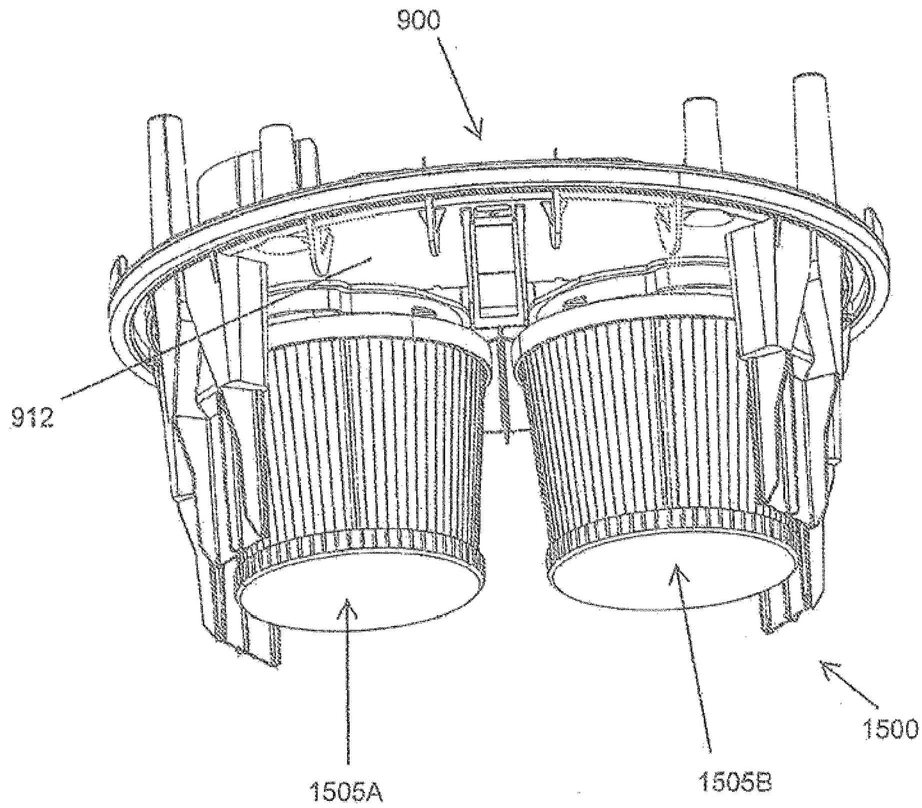



FIG.15A

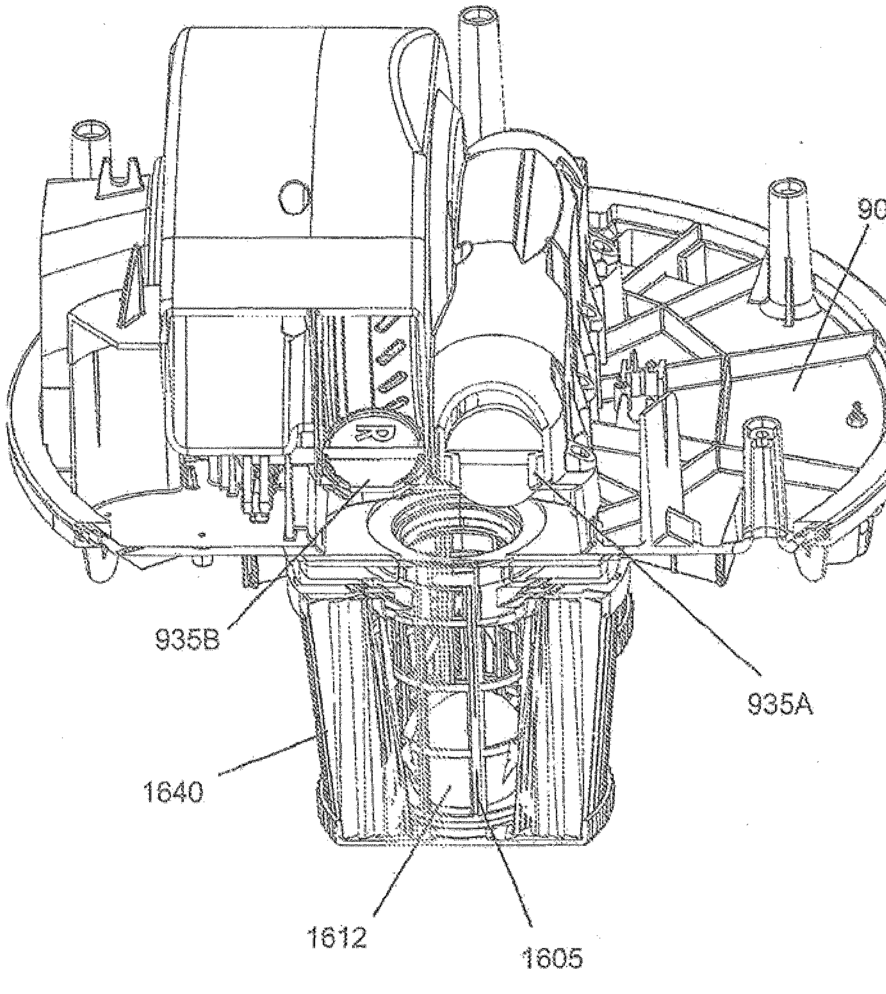
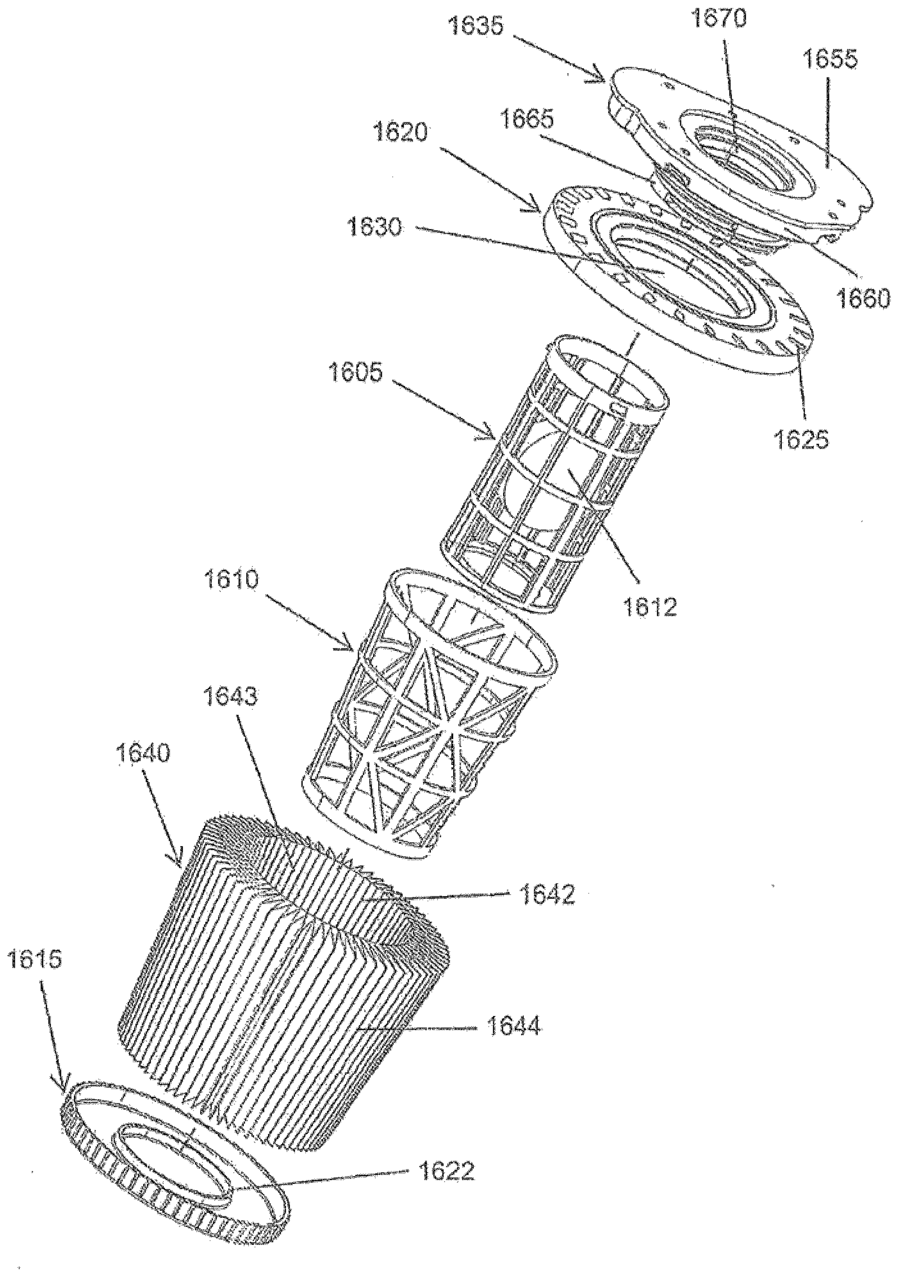



FIG.15B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1670
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1622

FIG.16A

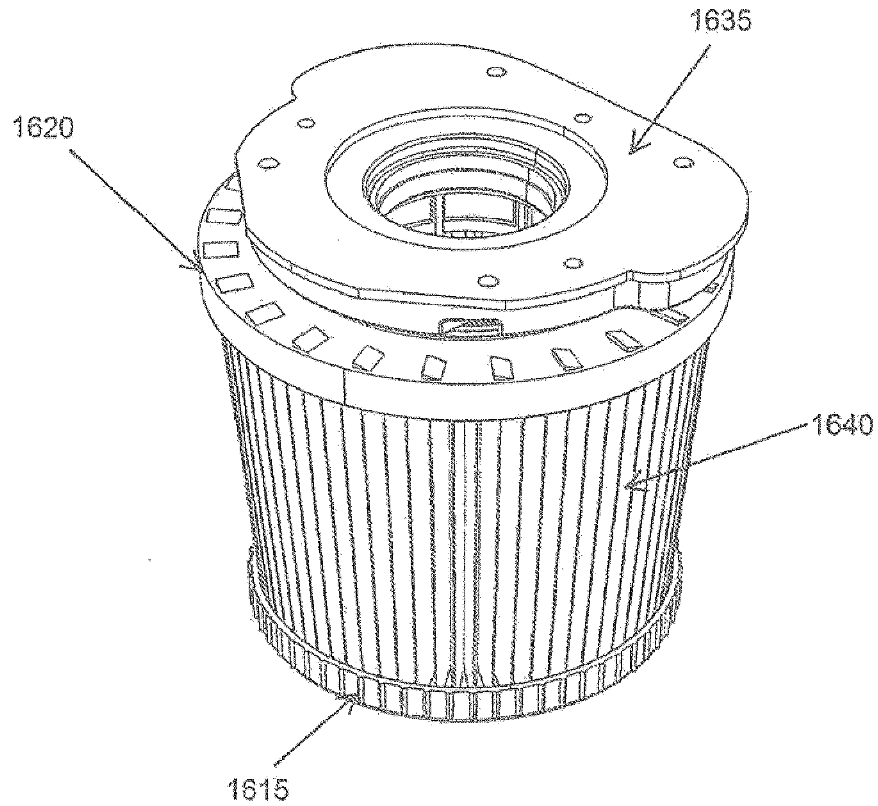


FIG.16B

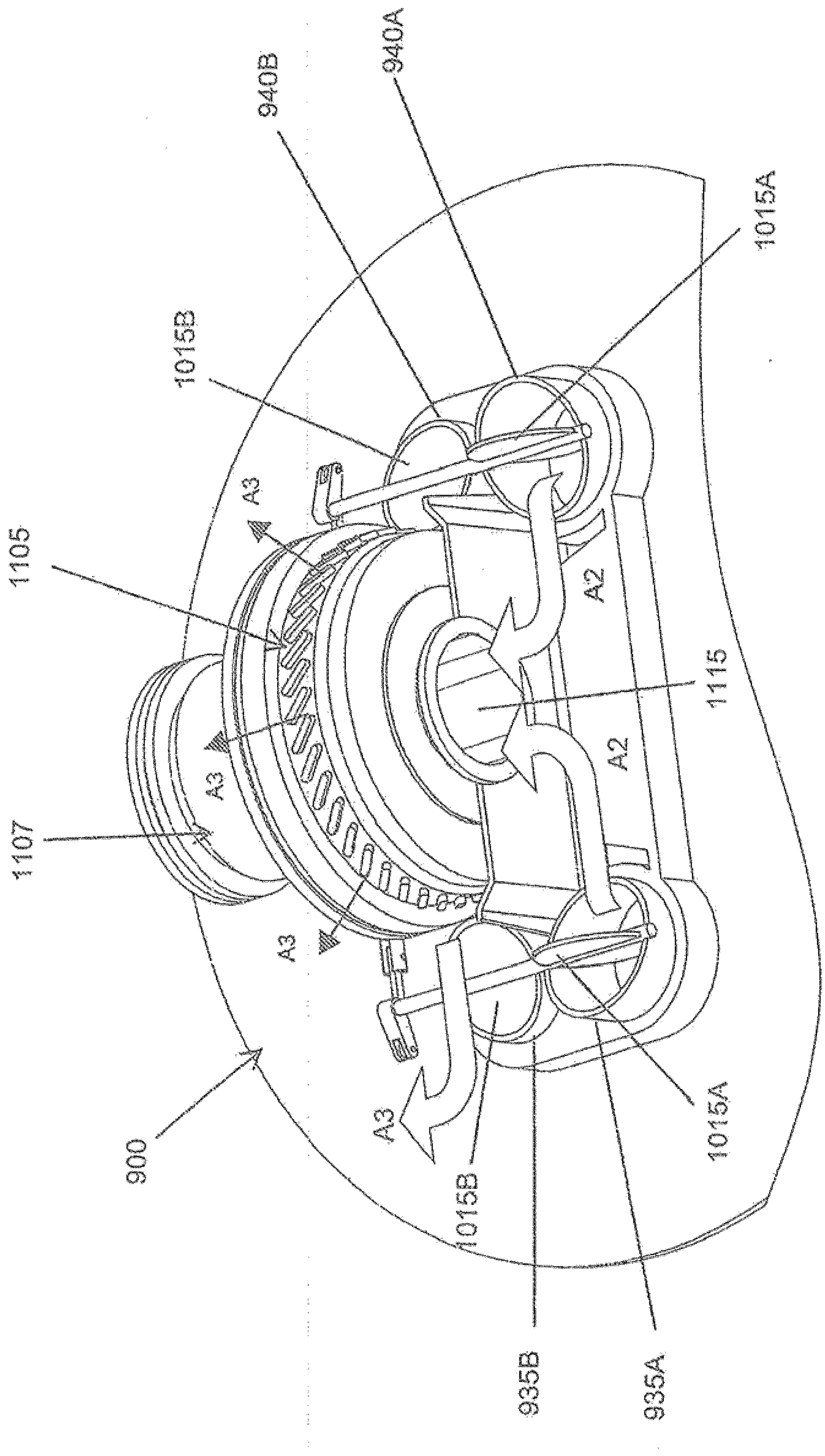


FIG.17A

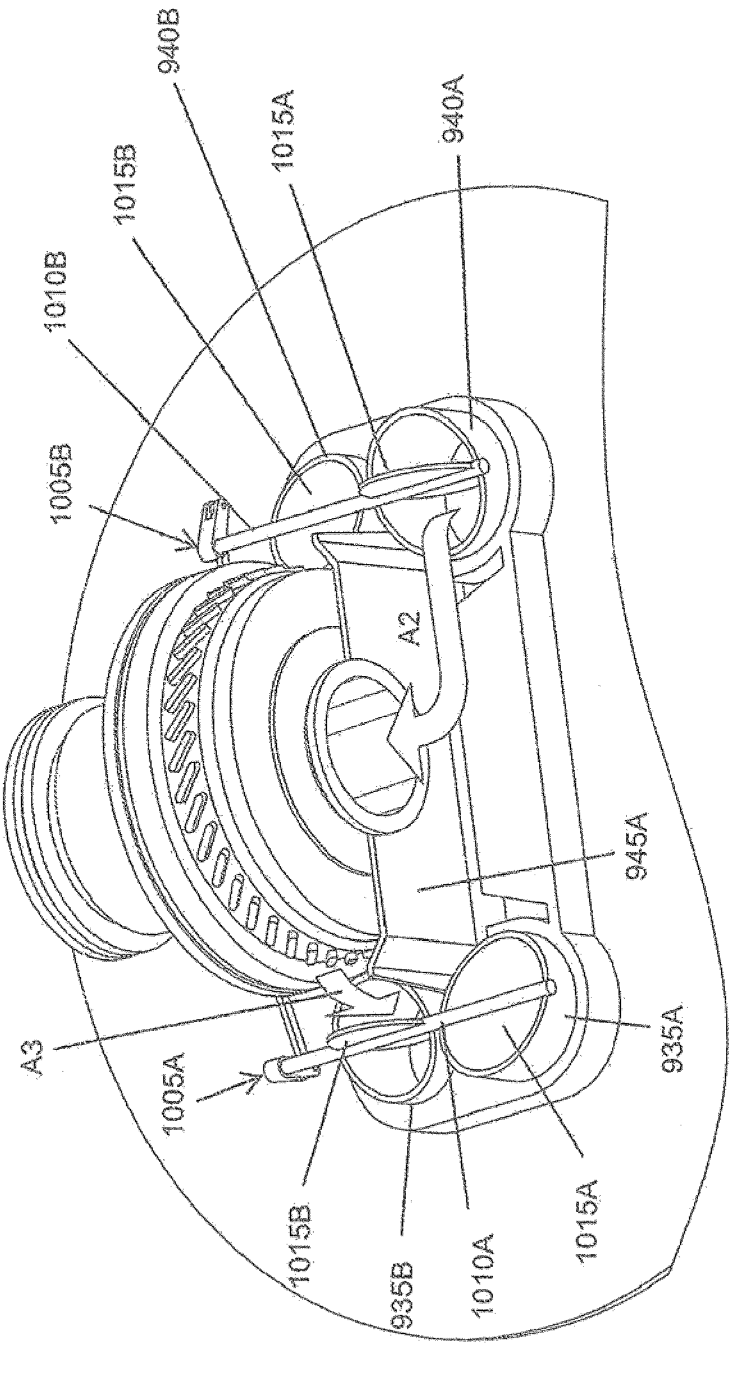
940B
1015A
940A
1015B
1010B
1005B
A2
945A
935A
A3
1005A
1015B
935B
1010A
1015A

FIG.17B

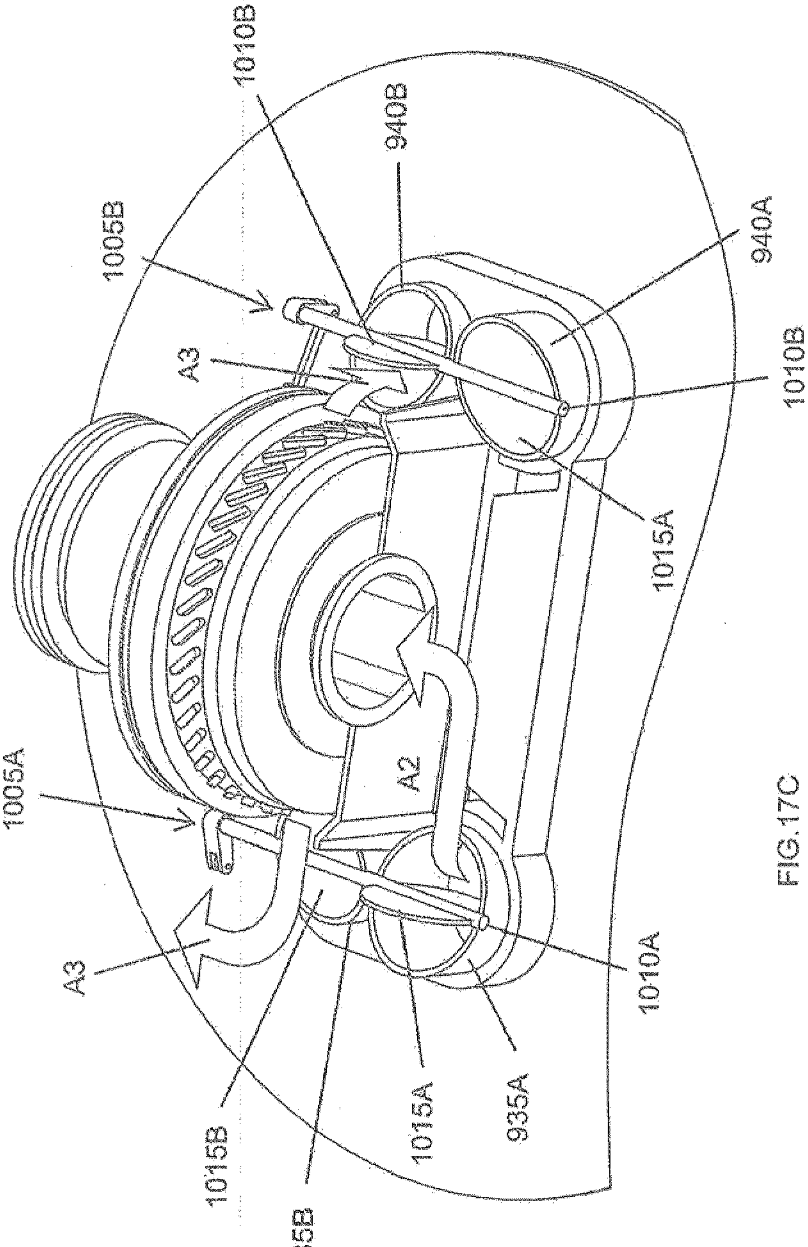
1010B
940B
1005B
940A
A3
1010B
1015A
A2
1005A
A3
1010A
1015B
1015A
935A
935B

FIG.17C

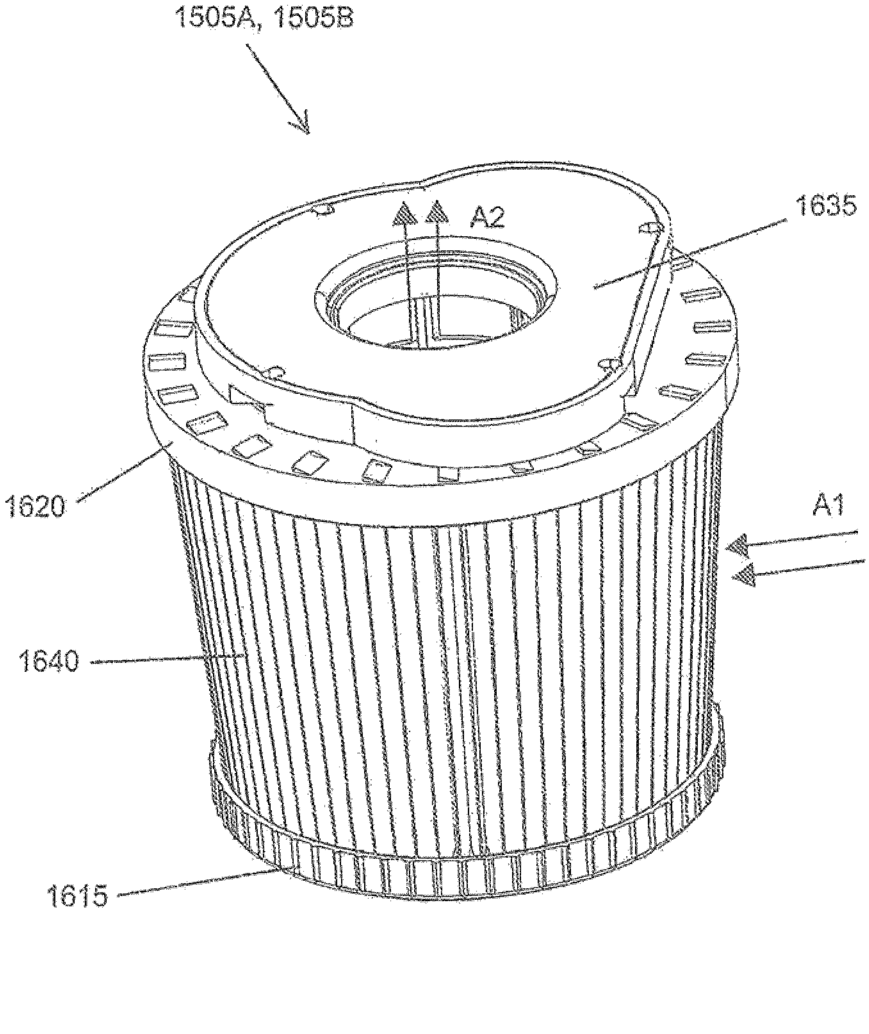


FIG.18A

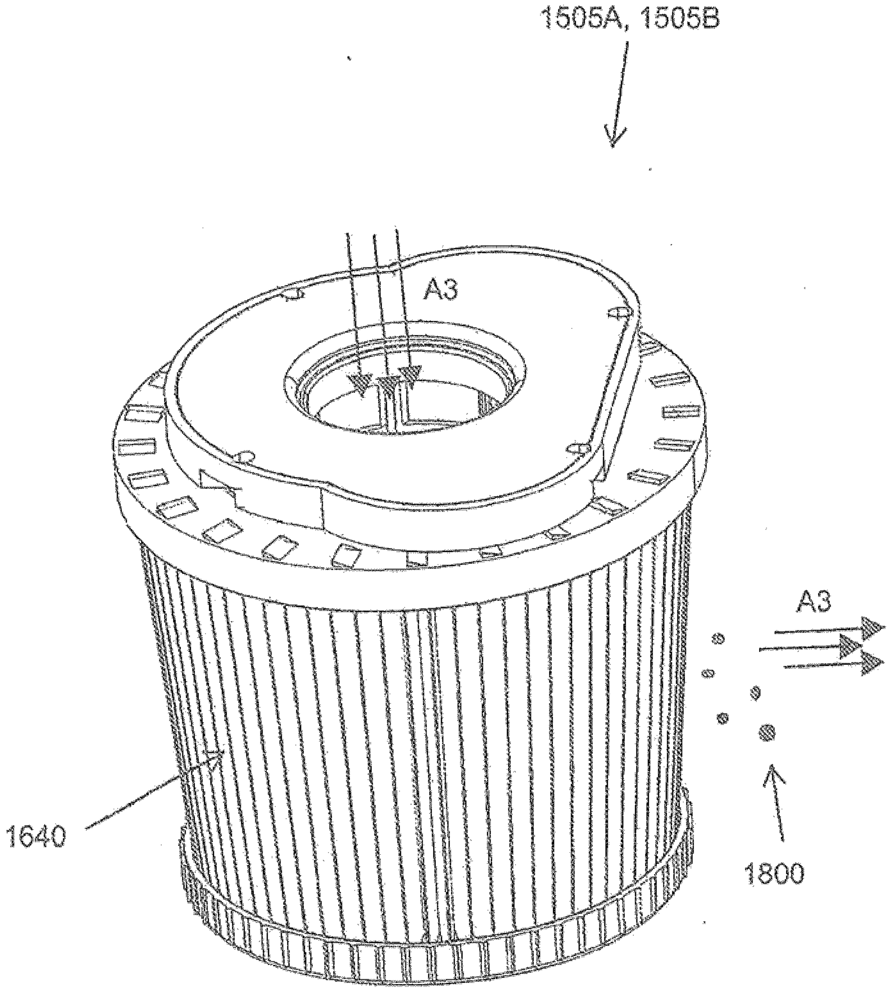


FIG.18B

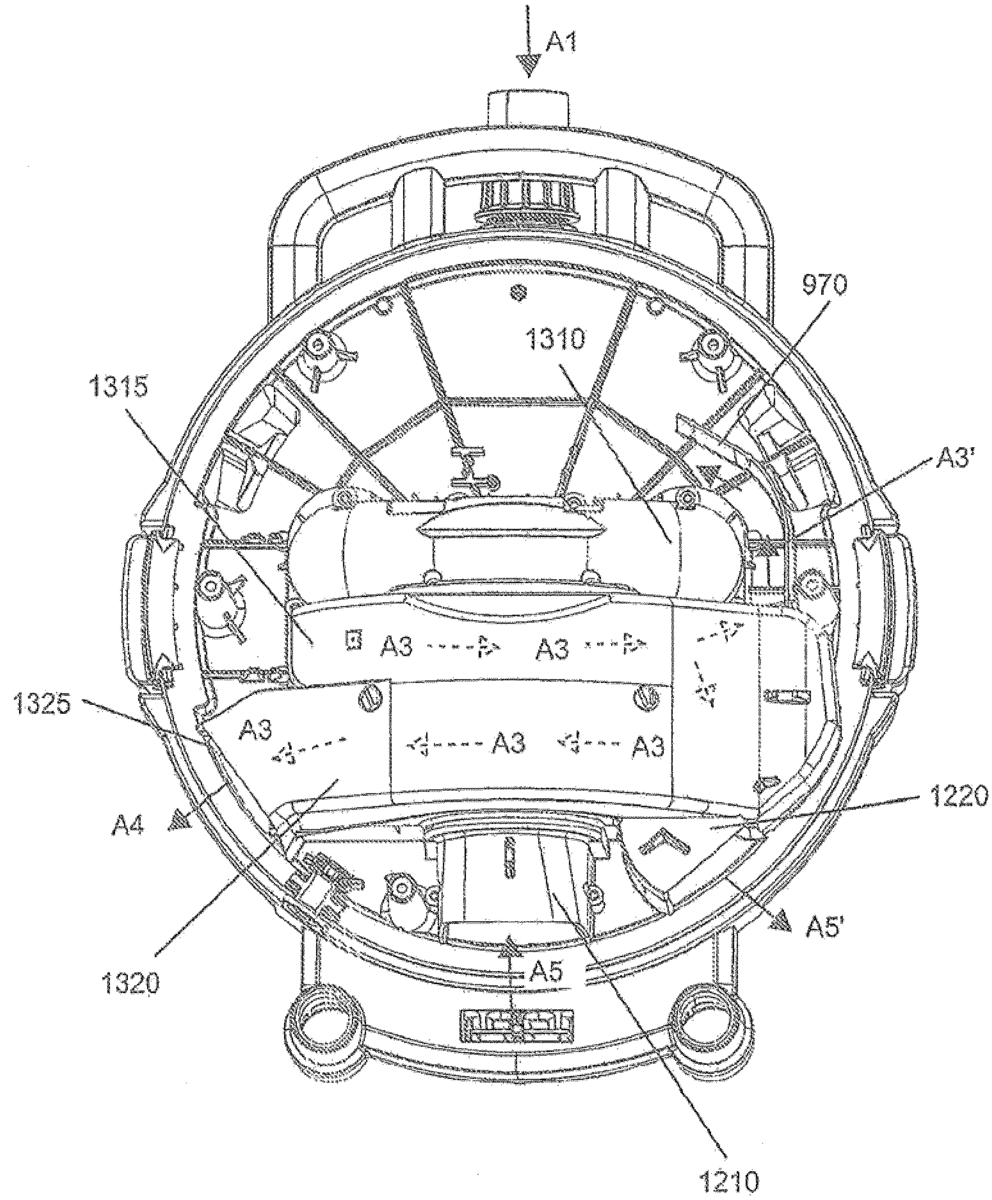


FIG.19A

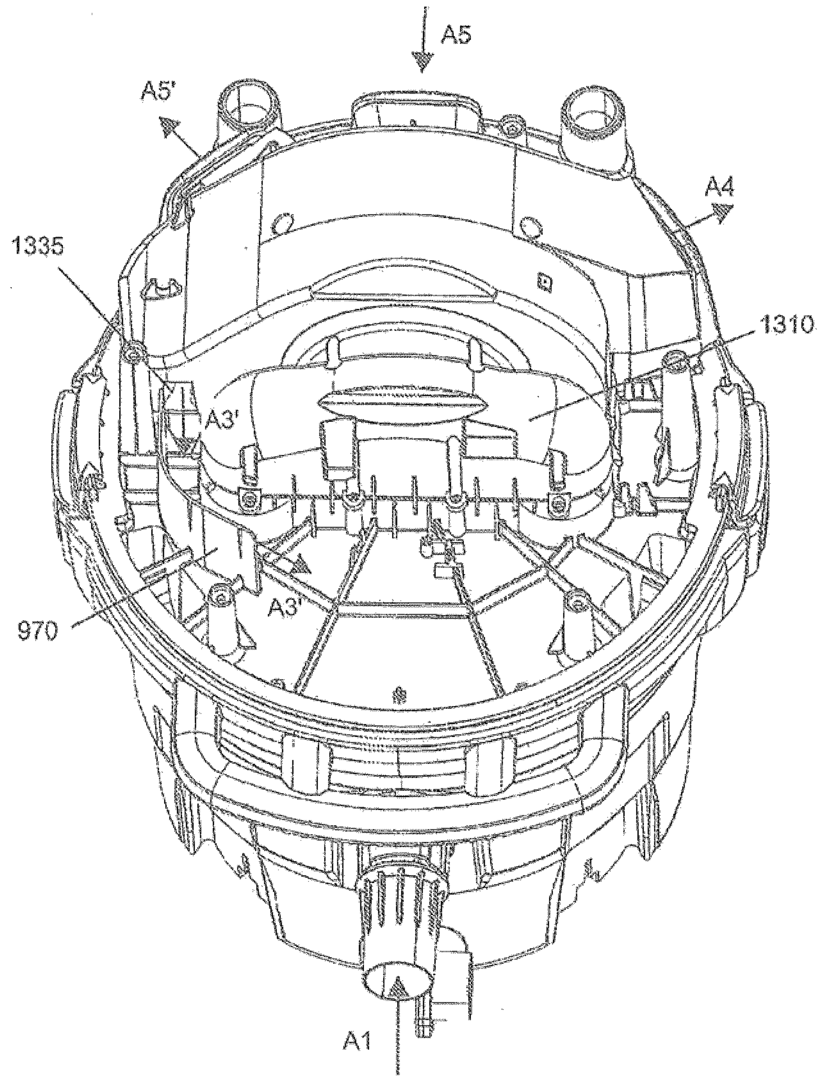


FIG.19B

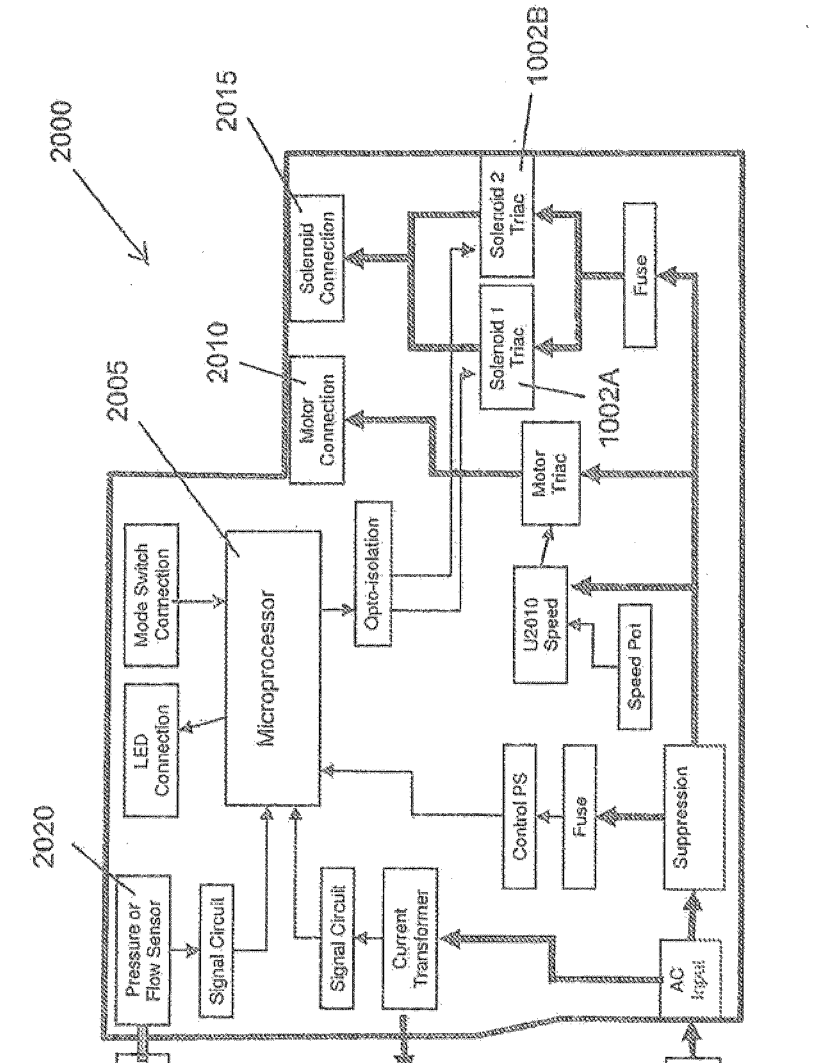
2000
2015
1002B
2010
2005
1002A
2020
Solenoid Connection
Solenoid 2 Triac
Solenoid 1 Triac
Fuse
Motor Connection
Motor Triac
Microprocessor
Opto-isolation
Mode Switch Connection
LED Connection
U2010 Speed
Speed Pot
Control PS
Fuse
Suppression
Pressure or Flow Sensor
Signal Circuit
Signal Circuit
Current Transformer
AC Input
Small Hose
Tool Outlet
Main Switch

FIG.20

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- US 13431302 B **[0002]**