



(51) International Patent Classification:

A47L 9/10 (2006.01) B01D 46/10 (2006.01)
A47L 9/00 (2006.01) B01D 46/24 (2006.01)
A47L 9/16 (2006.01) B01D 46/26 (2006.01)
B01D 46/02 (2006.01)

(21) International Application Number:

PCT/US2019/060233

(22) International Filing Date:

07 November 2019 (07.11.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/756,760 07 November 2018 (07.11.2018) US

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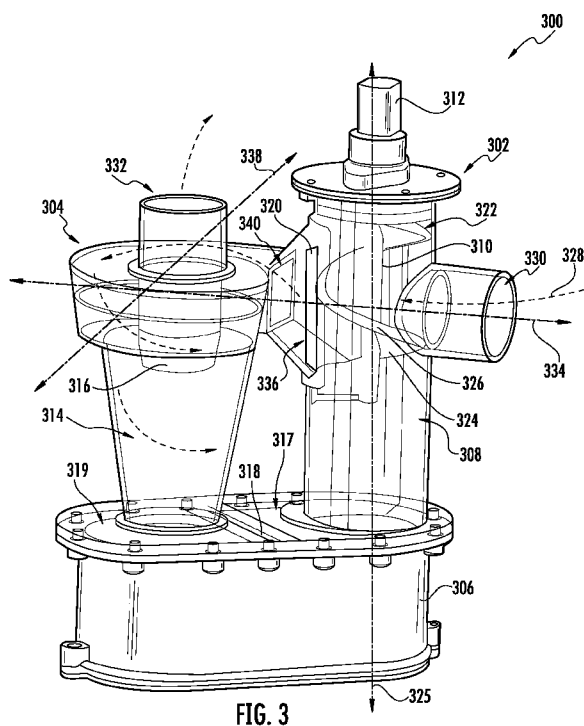
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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

(54) Title: DEBRIS COMPACTOR FOR A VACUUM CLEANER AND VACUUM CLEANER HAVING THE SAME



(57) Abstract: A debris compactor may include an inlet configured to receive debris, an auger chamber having an auger extending therein, and a dust cup disposed at a distal end of the auger chamber. The auger may be configured to urge the debris into the dust cup.

Published:

— *with international search report (Art. 21(3))*

DEBRIS COMPACTOR FOR A VACUUM CLEANER AND VACUUM CLEANER
HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application Serial No. 62/756,760, filed on November 7, 2018, entitled Debris Compactor for a Vacuum Cleaner and Vacuum Cleaner having the same, which is fully incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure is generally directed to surface treatment apparatuses and more specifically to a debris compactor configured to urge debris into a dust cup of a vacuum cleaner.

BACKGROUND INFORMATION

[0003] Surface treatment apparatuses may include vacuum cleaners configured to suction debris from a surface. Debris suctioned from a surface may be deposited in a dust cup for temporary storage. As the dust cup fills, performance of the vacuum cleaner may be degraded. As a result, it may be necessary to periodically empty the dust cup such that the vacuum cleaner maintains consistent performance.

[0004] One approach to reducing the frequency at which the dust cup is emptied is to increase the volume of the dust cup. However, increasing the dust cup volume can detrimentally effect, for example, the maneuverability of the vacuum cleaner. For example, in a robotic vacuum cleaner or an upright vacuum cleaner, a large dust cup may prevent the vacuum cleaner from cleaning under furniture.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] These and other features and advantages will be better understood by reading the following detailed description, taken together with the drawings, wherein:

[0006] FIG. 1 is a schematic cross-sectional view of an example of a debris compactor, consistent with embodiments of the present disclosure.

[0007] FIG. 2 is a schematic cross-sectional view of an example of a collection system, consistent with embodiments of the present disclosure.

[0008] FIG. 3 is a perspective view of an example of a collection system, consistent with embodiments of the present disclosure.

[0009] FIG. 4 is another perspective view of the collection system of FIG. 3, consistent with embodiments of the present disclosure.

[0010] FIG. 5 is a perspective view of an example of a collection system, consistent with embodiments of the present disclosure.

[0011] FIG. 6 is another perspective view of the collection of FIG. 5, consistent with embodiments of the present disclosure.

[0012] FIG. 7 is a perspective view of an example of a collection system, consistent with embodiments of the present disclosure.

[0013] FIG. 8 is a perspective view of an example of a debris compactor capable of being used with the collection system of FIG. 7, consistent with embodiments of the present disclosure.

[0014] FIG. 9 is a perspective view of the debris compactor of FIG. 8 having the housing removed, consistent with embodiments of the present disclosure.

[0015] FIG. 10 is a perspective view of an example of a cyclonic separator capable of being used with the collection system of FIG. 7, consistent with embodiments of the present disclosure.

[0016] FIG. 11 is a top view of the cyclonic separator of FIG. 10, consistent with embodiments of the present disclosure.

[0017] FIG. 12 is a perspective view of an example of a collection system, consistent with embodiments of the present disclosure.

[0018] FIG. 13 is a perspective view of an example of a collection system, consistent with embodiments of the present disclosure.

[0019] FIG. 14 is a perspective view of an example of a collection system coupled to at least a portion of an upright vacuum cleaner, consistent with embodiments of the present disclosure.

[0020] FIG. 15 is a perspective view of an example of a collection system having a handle, consistent with embodiments of the present disclosure.

[0021] FIG. 16 is a perspective view of the handle of FIG. 15, consistent with embodiments of the present disclosure.

[0022] FIGS. 17 is a perspective view of an example of an auger chamber, consistent with embodiments of the present disclosure.

[0023] FIG. 18 is another perspective view of the auger chamber of FIG. 17, consistent with embodiments of the present disclosure.

[0024] FIG. 19 is a perspective view of an example of a filter medium capable of being used with the auger chamber of FIG. 17, consistent with embodiments of the present disclosure.

[0025] FIG. 20 shows a perspective view of an example of a dust cup having a base in an open position, consistent with embodiments of the present disclosure.

[0026] FIG. 21 shows a perspective view of the dust cup of FIG. 20 having the base in a closed position, consistent with embodiments of the present disclosure.

[0027] FIG. 22 shows a perspective view of the dust cup of FIG. 20 being removed from an example of an upright vacuum cleaner, consistent with embodiments of the present disclosure.

[0028] FIG. 23 shows cross-sectional view of an example of a wand vacuum having a debris compactor, consistent with embodiments of the present disclosure.

[0029] FIG. 24 shows a perspective view of an example of a debris compactor, consistent with embodiments of the present disclosure.

[0030] FIG. 25 shows a perspective view of an example of a debris compactor, consistent with embodiments of the present disclosure.

[0031] FIG. 26 shows a perspective view of an example of a debris compactor, consistent with embodiments of the present disclosure.

[0032] FIG. 27 shows a perspective view of an example of a debris compactor, consistent with embodiments of the present disclosure.

[0033] FIG. 28 shows an exploded view of an example of a debris compactor having a 30 millimeter auger and of a debris compactor having a 60 millimeter auger, consistent with embodiments of the present disclosure.

[0034] FIG. 29 shows a perspective view of an example of a debris compactor, consistent with embodiments of the present disclosure.

[0035] FIG. 30 is a schematic view of an example of a wand vacuum having a debris compactor, consistent with embodiments of the present disclosure.

[0036] FIG. 31 is a schematic view of an example of a wand vacuum having a debris compactor, consistent with embodiments of the present disclosure.

[0037] FIG. 32 is a schematic view of an example of a wand vacuum having a debris compactor, consistent with embodiments of the present disclosure.

[0038] FIG. 33 shows multiple schematic views of examples of wand vacuums having debris compactors, consistent with embodiments of the present disclosure.

DETAILED DESCRIPTION

[0039] The present disclosure is generally directed to a debris compactor configured to urge debris into a dust cup of a surface treatment apparatus. The debris compactor includes an auger (or screw) disposed within a flow path extending through the surface treatment apparatus such

that a fluid (e.g., air) having debris entrained therein passes over the auger. The auger extends along a chamber defined within the surface treatment apparatus. The chamber includes a fluid inlet, a fluid outlet, and a dust cup opening. Fluid flows into the chamber through the fluid inlet and exits the chamber through the fluid outlet. Debris that is removed from the fluid flow, may be deposited within a dust cup that is fluidly coupled to the chamber through the dust cup opening. The fluid outlet includes a filter medium to capture debris entrained within the fluid after the fluid passes over the auger. The auger may engage the filter medium such that a rotation of the auger removes debris from the filter medium and urges the debris along the chamber in a direction of the dust cup. As such, when compared to depositing debris directly into the dust cup (i.e., without using an auger), the quantity of debris stored within the dust cup may be increased (i.e., the debris stored in the dust cup is compacted due to operation of the auger). As a result, the frequency at which the dust cup is emptied may be decreased when an auger is used without increasing a volume of the dust cup.

[0040] FIG. 1 shows a schematic example of a debris compactor 100 including an auger 102 disposed within an auger chamber 103 having a dirty air inlet 109. The auger 102 is configured to urge debris along the auger chamber 103 and into a dust cup 106. The dust cup 106 may be located at a distal end of the auger chamber 103. As shown, the auger 102 is rotated by a motor 108 coupled to the auger 102. As the auger 102 is rotated, debris that is engaging the auger 102 is urged along the auger chamber 103 in a direction of the dust cup 106 until the debris is deposited in the dust cup 106. In other words, the dust cup 106 may generally be described as being configured to receive debris from the debris compactor 100.

[0041] When the debris within the dust cup 106 reaches a predetermined fill level 110, continued rotation of the auger 102 will cause the debris to be compacted within the dust cup 106. In other words, as more debris is urged into the dust cup 106 by rotation of the auger 102, the greater the compaction of the debris within the dust cup 106.

[0042] In some instances, a vacuum may be applied to the auger chamber 103 in order to draw debris into the auger chamber 103 for compaction by the auger. Additionally, or alternatively, debris may be gravity fed into the auger chamber 103. As a result, the presence of a vacuum source to draw debris into the auger chamber 103 may be unnecessary.

[0043] In instances having a suction generated within the auger chamber 103 (e.g., by a suction motor), the debris compactor 100 can be located in multiple different locations in the flow path. For example, the debris compactor 100 can be positioned at a cyclone outlet or at a cyclone inlet of a vacuum system having a cyclonic separator. By way of further example, in vacuum systems not having a cyclone, the debris compactor 100 can be disposed at an inlet to a suction

motor. In some instances, the dust cup 106 for holding the debris may not be part of the air flow. In other words, debris is caused to be deposited in the dust cup 106 substantially as a result of the movement of the auger 102 and the air flow does not pass through the dust cup 106.

[0044] A diameter of the auger 102 can vary based on application (e.g., for use in an upright vacuum, robotic vacuum, wand vacuum, docking station configured to remove debris from a vacuum, and/or any debris receiving device). For example, the auger 102 may have a diameter of 15 millimeters (mm), 30 mm, 45 mm, 60 mm, 80 mm, 90 mm, 120 mm, 145 mm, and/or any other diameter. Similarly, a length of the auger 102 can vary based on application. For example, the auger 102 may have a length of 15 millimeters (mm), 30 mm, 45 mm, 60 mm, 80 mm, 90 mm, 120 mm, 145 mm, and/or any other length. The auger 102 can be configured to be rotated at a rate in a range of, for example, 15 rotations-per-minute (RPM) and 100 RPM. By way of further example, the auger 102 can be configured to be rotated at a rate of 22 RPM. By way of still further example, the auger 102 can be configured to be rotated at a rate of 75 RPM.

[0045] FIG. 2 shows a schematic example of a collection system 201, wherein the debris compactor 100 is fluidly coupled to a cyclonic separator 200. As shown, the cyclonic separator 200 includes a cyclone chamber 202 and a vortex finder 204. The cyclonic separator 200 is fluidly coupled to a suction source (e.g., a suction motor) 206. The suction motor 206 causes air to be drawn into the dirty air inlet 109 of the debris compactor 100 and pass over the auger 102. In other words, the suction motor 206 can generally be described as being configured to draw air through the debris compactor 100. As shown, the air passes through a filter medium 210 (e.g., a mesh filter, a foam filter, a fabric filter, and/or any other filter medium) extending between the cyclone chamber 202 and the auger chamber 103 at an air inlet 211 of the cyclone chamber 202 (or an air outlet of the debris compactor 100 or auger chamber 103). In other words, the suction motor 206 is fluidly coupled to the auger chamber 103 via the air inlet 211. At least a portion of the debris entrained within the air accumulates on the filter medium 210 such that, as the auger 102 is rotated, any debris collected on the filter medium 210 is urged by the auger 102 in a direction of the dust cup 106. For example, the auger 102 may engage (e.g., contact) at least a portion of the filter medium 210 such that at least a portion of the debris adhered to the filter medium 210 is urged in a direction of the dust cup 106. In some instances, a surface area of the filter medium 210 may generally correspond to a surface area of the air inlet 211 of the cyclone chamber 202. Additionally, or alternatively, the surface area of the filter medium 210 may be selected based, at least in part, on a desired air flow velocity through

the filter medium 210. Increasing air flow velocity may improve the effectiveness of the auger 102 in urging debris adhered to the filter medium 210 towards the dust cup 106. For example, the surface area of the filter medium 210 can be such that an air flow velocity extending through the filter medium 210 measures in a range of 3 meters per second (m/s) to 30 m/s. By way of further example, the surface area of the filter medium 210 can be such that an air flow velocity extending through the filter medium 210 measures about 20 m/s. In some instances, the surface area of the filter medium 210 can measure in a range of 900 square millimeters (mm²) and 1100 mm².

[0046] The filter medium 210 can be configured to allow debris particles having a certain particle size to pass therethrough. As such, larger particles can be urged into the dust cup 106 by the auger 102 and smaller particles can be deposited in the dust cup 106 by cyclonic action. Therefore, the cyclonic separator 200 can be configured to cyclonically separate particles from the air flow having a particle size measuring less than an average pore size of the filter medium 210. For example, the filter medium 210 may have an average pore size in a range of 30 microns (μm) to 100 μm. By way of further example, the filter medium 210 may have an average pore size in a range of 60 μm to 80 μm. By way of still further example, the filter medium 210 may have an average pore size of about 74 μm.

[0047] After the air passes through the filter medium 210 at least a portion of the remaining debris in the air may be separated from the air by cyclonic forces and deposited within the dust cup 106. The air may then exit the cyclone chamber 202, pass through the suction motor 206 and a post motor filter 209, and exit the cyclonic separator 200.

[0048] By having the airflow pass over the auger 102, at least a portion of any debris that accumulates on the auger 102 may also be removed from the auger 102. As a result, the auger 102 can be generally described as self-cleaning as a result of air flowing over the auger 102.

[0049] As shown, the dust cup 106 includes a divider 212 extending between the cyclonic separator 200 and the debris compactor 100. As such, larger particulates separated from the filter medium 210 may be collected in an auger collection portion 214 of the dust cup 106 and finer particulates that are separated from the air by cyclonic action may be collected in a cyclonic separator portion 216 of the dust cup 106.

[0050] FIGS. 3 and 4 show a perspective view of an example of a collection system 300, which may be an example of the collection system 201 of FIG. 2. As shown, the collection system 300 includes a debris compactor 302, a cyclonic separator 304, and a dust cup 306. The debris compactor 302 defines an auger chamber 308 configured to receive an auger 310. A motor 312 is coupled to the auger 310 such that activating the motor 312 causes the auger 310 to

rotate within the auger chamber 308. Rotation of the auger 310 urges debris engaging (e.g., contacting) the auger 310 in a direction of the dust cup 306. As debris gathers in the dust cup 306, rotation of the auger 310 may compact the debris within the dust cup 306. For example, when a sufficient quantity of debris is collected within the dust cup 306 such that the debris in the dust cup 306 engages the auger 310, the auger 310 may compact the debris within the dust cup 306 by continuing to urge additional debris into the dust cup 306.

[0051] A filter medium 320 can extend between the debris compactor 302 and the cyclonic separator 304. The filter medium 320 can be positioned such that the filter medium 320 and/or an interior surface of the auger chamber 308 engages (e.g., contacts) a peripheral edge 322 of a helical body 324 that defines at least a portion of the auger 310. As such, as debris collects on the filter medium 320, rotation of the auger 310 causes debris to be urged along the filter medium 320 in a direction of the dust cup 306. In other words, the auger 310 may be generally described as being configured to clean the filter medium 320. The peripheral edge 322 of the helical body 324 of the auger 310 can include a peripheral lining 326 (e.g., a rubber such as a silicone rubber or natural rubber). The peripheral lining 326 may be configured to form a seal between the auger 310 and the filter medium 320 and/or an interior surface of the auger chamber 308 and/or mitigate the effects wear due to the engagement of the auger 310 with the filter medium 320. Debris which is not captured by the filter medium 320, may pass through the filter medium 320 and into the cyclonic separator 304.

[0052] The filter medium 320 and/or the helical body 324 of the auger 310 can be configured such that rotation of the auger 310 results in the auger 310 cleaning (e.g., removing at least a portion of the debris adhered to the filter medium 320) substantially all of the surface of the filter medium 320 facing the auger 310. For example, the pitch of the helical body 324 can be configured such that a first portion of the helical body 324 engages a first distal end of the filter medium 320 and a second portion of the helical body 324 engages a second distal end of the filter medium 320. As such, rotation of the auger 310 causes the helical body 324 to move relative to the filter medium 320 such that a substantial portion of a surface area of the filter medium 320 comes into engagement with a portion of the helical body 324. Additionally, or alternatively, the filter medium 320 can be configured to have a curvature that generally corresponds to that of the helical body 324 of the auger 310 such that a portion of the helical body 324 extends from a first side to a second side of the filter medium 320. The pitch of the helical body 324 can be variable and/or constant along the length of the auger 310. Having a variable pitch may improve the efficiency of the auger 310. In some instances, the auger 310 can be angled relative to a longitudinal axis 325 of the debris compactor 302.

[0053] As shown, the debris compactor 302 is fluidly coupled to the cyclonic separator 304. The cyclonic separator 304 includes a cyclone chamber 314 and a vortex finder 316. The cyclone chamber 314 is configured such that a cyclone is generated therein when air is drawn into the cyclone chamber 314 by a suction motor. The cyclone chamber 314 is fluidly coupled to the dust cup 306 such that debris that falls out of the cyclonic airflow is deposited within the dust cup 306. A divider 318 is provided within the dust cup 306 such that the dust cup 306 defines at least two compartments that are fluidly separated from each other. For example, the dust cup 306 may include an auger (or first) compartment 317 to, for example, collect debris from the debris compactor 302 (e.g., debris removed from the filter medium 320) and a cyclone (or second) compartment 319 to, for example, collect debris from the cyclonic separator 304 (e.g., debris separated from the air flow by cyclonic action). As such, the auger compartment 317 may generally be described as corresponding to the debris compactor 302 and the cyclone compartment 319 may generally be described as corresponding to the cyclonic separator 304.

[0054] As shown, a flow path 328 extends from an inlet 330 of the auger chamber 308 over the auger 310 through the filter medium 320 into the cyclone chamber 314 out an outlet 332 of the cyclone chamber 314 and to a suction motor. A center line of the inlet 330 may generally be aligned with the center of the filter medium 320. As also shown, a central axis 334 of an outlet 336 of the auger chamber 308 may form a non-perpendicular (e.g., obtuse) angle with a central axis 338 of an inlet 340 of the cyclone chamber 314.

[0055] FIGS. 5 and 6 show a perspective view of an example of the collection system 300, wherein the central axis 334 of the outlet 336 of the auger chamber 308 forms a substantially perpendicular angle with the central axis 338 of the inlet 340 of the cyclone chamber 314.

[0056] FIG. 7 shows a perspective view of a collection system 700, which may be an example of the collection system 201 of FIG. 2. As shown, the collection system 700 includes a debris compactor 702, a cyclonic separator 704, and a dust cup 706. The dust cup 706 includes an auger compartment 708 and a cyclone compartment 710. The auger compartment 708 is fluidly separated from the cyclone compartment 710 by a divider 712. A motor 714 is configured to drive an auger 716. As shown, the motor 714 may be coupled to the auger 716 via a gearbox 718. The current draw of the motor 714 may be monitored to determine, for example, a jam, a stall condition, or an amount of debris stored within the dust cup 706 (e.g., to generate a notification to empty the dust cup 706).

[0057] FIG. 8 shows a perspective view of the debris compactor 702. As shown, the debris compactor 702 includes an auger chamber 802. The auger chamber 802 may have a generally frustoconical shape.

[0058] FIG. 9 shows a perspective view of the debris compactor 702 having the auger chamber 802 removed therefrom. As shown, a filter medium 902 and the auger 716 are configured to extend within the auger chamber 802. The filter medium 902 can be configured to extend at least partially around the auger 716 such that a curvature of the filter medium 902 corresponds to that of the auger 716. For example, the filter medium 902 may extend around at least half of the circumference of the auger 716. In some instances, the filter medium 902 may extend completely around the auger 716 with the exception of the portion of the auger 716 that is proximate the inlet to the debris compactor 702.

[0059] In some instances, the filter medium 902 can be configured to have a surface area corresponding to a desired air flow velocity through the filter medium 902 for a given suction force. For example, the surface area of the filter medium 902 can be such that an air flow velocity extending through the filter medium 902 measures in a range of 3 meters per second (m/s) to 30 m/s. By way of further example the surface area of the filter medium 902 can be such that an air flow velocity extending through the filter medium 902 measures about 20 m/s.

[0060] As air flow velocity increases, the force applied to debris adhered to the filter medium 902 may increase. As the force increases, it may become easier for the auger 716 to urge debris in a direction of the dust cup 706.

[0061] As shown, the filter medium 902 is configured to be spaced apart from an inner surface of the auger chamber 802. A plurality of ribs 906 can extend from the filter medium 902 and engage the inner surface of the auger chamber 802 such that a plenum is defined between the filter medium 902 and the inner surface of the auger chamber 802.

[0062] As shown, the filter medium 902 and the auger 716 may have a generally frustoconical shape. For example, and as shown, the filter medium 902 and the auger 716 may taper in a direction extending away from the dust cup 706. However, the filter medium 902 and/or the auger 716 may have any suitable shape, for example, a cylindrical shape.

[0063] FIG. 10 shows a perspective view of the cyclonic separator 704. FIG. 11 shows a top view of the cyclonic separator 704. As shown, an inlet 1102 to the cyclonic separator 704 may generally be described as being a scroll inlet.

[0064] FIG. 12 shows a perspective view of a collection system 1200, which may be an example of the collection system 201 of FIG. 2. As shown, the collection system 1200 includes a debris compactor 1202 and a cyclonic separator 1204. The cyclonic separator 1204 includes a plurality of cyclones 1206 (e.g., at least two cyclones, at least three cyclones, at least four cyclones, and/or any other number of cyclones). For example, the cyclonic separator 1204 may include four 40 mm cyclones. As shown, a plurality of conduits 1208 fluidly couple each

cyclone 1206 to a suction motor. Each cyclone 1206 is fluidly coupled to the debris compactor 1202 such that debris entrained in air is drawn into the debris compactor 1202 before the air passes into a respective cyclone 1206. As such, larger particles of debris may be removed from the air flow before reaching a respective cyclone 1206. For example, hair may be captured in the debris compactor 1202 such that the hair does not degrade the performance of the cyclones 1206. Hair captured by the debris compactor 1202 may migrate along an auger disposed within the debris compactor 1202.

[0065] FIG. 13 shows a perspective view of an example of a collection system 1300, which may be an example of the collection system 1200 of FIG. 12. As shown, each of the conduits 1208 is fluidly coupled to a plenum 1302 disposed above the cyclonic separator 1204. The plenum 1302 is fluidly coupled to the suction motor.

[0066] FIG. 14 shows a perspective view of a debris collection system 1400 coupled to at least a portion of an upright vacuum cleaner 1402 (e.g., a chassis 1403) and may be an example of the collection system 1300 of FIG. 13. As shown, the debris collection system 1400 includes a handle 1404 extending between the upright vacuum cleaner 1402 and the debris collection system 1400. The handle 1404 can include a latch 1406 configured to be actuated between a latched and de-latched position such that the debris collection system 1400 can be removably coupled to the upright vacuum cleaner 1402.

[0067] As shown in FIG. 15 the handle 1404 can be configured to engage at least a portion of a motor 1502 that causes an auger to rotate within the debris collection system 1400. For example, the handle 1404 may define a cavity for receiving at least a portion of the motor 1502. As shown in FIG. 16, the motor 1502 may be coupled to the handle 1404 and the handle may be configured such that one or more power cables 1602 can be routed through the handle 1404. The power cable 1602 is configured to energize the motor 1502.

[0068] FIGS. 17 and 18 show perspective views of an auger chamber 1700 configured to receive an auger therein. As shown, the auger chamber 1700 includes a dirty air inlet 1702 and a plurality of air outlets 1704. Each air outlet 1704 is configured to receive a filter medium 1706. When the auger is installed in the auger chamber 1700, the auger is configured to engage the filter mediums 1706. FIG. 19 shows an example of the filter medium 1706. As shown, the filter medium 1706 can be configured to have a curvature that generally corresponds to that of the auger chamber 1700 and/or the auger.

[0069] FIG. 20 shows a perspective bottom view of a dust cup 2000, which may be an example of dust cup 106 of FIG. 1. As shown, the dust cup 2000 includes a base 2002. The base 2002 may be configured to pivot between an open and a closed position and/or be configured to be

removable. As shown, the base 2002 defines a plurality of compartments that are configured to be sealed from each other when the base 2002 is in the closed position. For example, the base 2002 may define a plurality of cyclone compartments 2004 that correspond to a portion of the dust cup 2000 configured to receive debris that is separated from an airflow by cyclonic action. As also shown, the base 2002 may also define at least one auger compartment 2006 that corresponds to a portion of the dust cup 2000 configured to receive debris that is urged into the dust cup 2000 by an auger. The base 2002 may also define an outlet 2008 for exhausting clean air (e.g., air that has passed through both the auger and cyclone) that corresponds to an exhaust channel 2009 extending along the dust cup 2000. As shown, a seal 2010 can be provided on the base 2002 for providing a substantially airtight seal between the outlet 2008, the auger compartment 2006, and each cyclone compartment 2004.

[0070] FIG. 21 shows a perspective view of the dust cup 2000 having the base 2002 in the closed position and a dirty air inlet 2102 proximate the base 2002. FIG. 22 shows a perspective view of the dust cup 2000 being removed from an upright vacuum cleaner 2200. As shown, the upright vacuum cleaner 2200 includes a mount 2202 that defines a cavity 2204 for receiving the dust cup 2000. The cavity 2204 may also be configured to receive a filter 2206 for filtering air being exhausted from the dust cup 2000. The filter 2206 may be a high efficiency particulate air (HEPA) filter.

[0071] FIG. 23 shows a cross-sectional view of an example of a debris compactor 2300, which may be an example of the debris compactor 100 of FIG. 1, in a wand vacuum 2302 (e.g., a vacuum configured to be held in the hand of a user). As shown, the wand vacuum 2302 includes a wand 2304 that defines a dirty air inlet 2306, a power source 2308 (e.g., one or more batteries), and a suction motor 2310 configured to draw air from the dirty air inlet 2306 and through the debris compactor 2300. As shown, the debris compactor 2300 includes an auger 2312 configured to engage a filter medium disposed within an opening 2314. The auger 2312 urges debris that collects on the filter medium into a dust cup 2316 at a distal end of the auger 2312. A longitudinal axis 2313 of the auger 2312 may extend substantially parallel to a longitudinal axis 2315 of the wand 2304. In some instances, a central longitudinal axis of the auger 2312 may be spaced apart from a central longitudinal axis of the wand 2304. As shown, the auger 2312 may extend between at least a portion of the wand 2304 and the power source 2308 and/or at least a portion of the suction motor 2310. The suction motor 2310 includes an impeller 2318 configured to generate a suction force. The impeller 2318 may have a diameter of 30 millimeters (mm). The auger 2312 is rotated using a motor. The motor can be coupled

to a gear box. The gear box can be configured such that the motor rotates the auger 2312 at a rotation rate of approximately 75 rotations per minute (RPM).

[0072] FIG. 24 shows an example of a debris compactor 2400, which may be an example of the debris compactor 100 of FIG. 1. As shown, the debris compactor 2400 includes an auger chamber 2402 having an auger 2404 disposed therein. The auger chamber 2402 includes a plurality of ribs 2406 extending along an interior surface 2403 of the auger chamber 2402 and are configured to engage the auger 2404. As shown, the ribs 2406 may extend along the surface of the auger chamber 2402 in a spiral shape. The ribs 2406 may assist in urging debris towards a dust cup, when, for example, suction is not applied to the auger chamber 2402. For example, suction may not be applied to the auger chamber 2402 when the debris compactor 2400 is utilized in a docking station for receiving debris stored in a vacuum cleaner (e.g., a robotic vacuum cleaner).

[0073] FIG. 25 shows an example of a debris compactor 2500, which may be an example of the debris compactor 100 of FIG. 1. As shown, the debris compactor 2500 includes an auger chamber 2502 having an auger 2504 disposed therein. The auger chamber 2502 may have a substantially smooth interior surface 2506. When a suction force is applied to the auger chamber 2502, the suction force may result in a sufficient force between the debris and the smooth interior surface 2506 such that debris can be urged by the auger 2504 towards a dust cup without using, for example, the ribs 2406.

[0074] FIG. 26 shows a perspective view of a debris compactor 2600, which may be an example of the debris compactor 100 of FIG. 1. The debris compactor 2600 can be configured to not utilize an airflow to draw debris into an auger chamber 2602. FIG. 27 shows a perspective view of a debris compactor 2700, which may be an example of the debris compactor 100 of FIG. 1. The debris compactor 2700 can be configured to draw debris into an auger chamber 2702 using suction. As shown, the debris compactor 2700 is not fluidly coupled to a cyclone chamber.

[0075] FIG. 28 shows an exploded view of a debris compactor 2800 having 60 mm diameter auger 2802 and an exploded view of a debris compactor 2801 having a 30 mm diameter auger 2803. However, other diameter augers can be used, for example, a 15 mm, a 80 mm, a 90 mm, a 120 mm, a 145 mm, and/or any other diameter auger. As shown, the debris compactor 2800 may use a suction-based auger chamber 2804 or a suction-less auger chamber 2806.

[0076] FIG. 29 shows a perspective view of a debris compactor 2900 coupled to a dust cup 2902, which may be an example of the debris compactor 100 of FIG. 1.

[0077] FIGS. 30-32 show schematic examples of wand vacuums 3000, 3100, and 3200 having debris compactors 3002, 3102, and 3202, respectively. The debris compactors 3002, 3102, and 3202 may be an example of the debris compactor 100 of FIG. 1. FIG. 30 shows a first airflow path 3004 extending through the wand vacuum 3000. As shown in FIG. 30, a rotation axis 3006 of a suction motor 3008 extends transverse to (e.g., perpendicular to) a rotation axis 3010 of an auger 3012 of the debris compactor 3002. FIG. 31 shows a second airflow path 3104 extending through the wand vacuum 3100. As shown in FIG. 31, a rotation axis 3106 of a suction motor 3108 extends substantially parallel to a rotation axis 3110 of an auger 3112 of the debris compactor 3102. In some instances, the rotation axis 3106 may be collinear with the rotation axis 3110. As also shown in FIG. 31, a dust cup 3114 can be disposed between the suction motor 3108 and the auger 3112. FIG. 32 shows a third airflow 3204 path extending through the wand vacuum 3200. As shown in FIG. 32, a rotation axis 3206 of a suction motor 3208 extends substantially parallel to a rotation axis 3210 of an auger 3212 of the debris compactor 3202. In some instances, the rotation axis 3206 may be collinear with the rotation axis 3210. As also shown in FIG. 32, the auger 3212 can be disposed between the suction motor 3208 and a dust cup 3214.

[0078] FIG. 33 shows multiple schematic examples of wand vacuums having a debris compactor, such as for example, the debris compactor 100 of FIG. 1.

[0079] An example of a debris compactor, consistent with the present disclosure, may include an inlet configured to receive debris, an auger chamber having an auger extending therein, and a dust cup disposed at a distal end of the auger chamber. The auger may be configured to urge the debris into the dust cup.

[0080] In some instances, the debris compactor may include an outlet that may be configured to be coupled to a suction source to cause air to be drawn across the auger. In some instances, the debris compactor may include a filter medium, wherein the filter medium may be disposed at the outlet. In some instances, the auger may be configured to engage the filter medium. In some instances, the debris compactor may include a motor configured to cause the auger to rotate within the auger chamber. In some instances, a peripheral edge of the auger may include a peripheral lining.

[0081] An example of a collection system for collecting debris, consistent with the present disclosure, may include a debris compactor, a dust cup configured to receive debris from the debris compactor, and a suction source configured to draw air through the debris compactor. The debris compactor may include an inlet configured to receive debris and an auger chamber having an auger extending therein.

[0082] In some instances, the debris compactor may further include a filter medium disposed at an outlet of the auger chamber. In some instances, the collection system may further include a motor configured to rotate the auger. In some instances, the auger may be configured to engage the filter medium such that rotation of the auger urges debris accumulated on the filter medium in a direction of the dust cup. In some instances, the collection system may further include a cyclonic separator fluidly coupled to the suction source and the debris compactor. In some instances, the dust cup may be configured to receive debris from the cyclonic separator. In some instances, the dust cup may define at least a first and a second compartment, wherein the first compartment corresponds to the debris compactor and the second compartment corresponds to the cyclonic separator.

[0083] An example of a vacuum cleaner, consistent with the present disclosure, may include a chassis and a collection system for collecting debris coupled to the chassis. The collection system may include a debris compactor, a dust cup configured to receive debris from the debris compactor, and a suction source configured to draw air through the debris compactor. The debris compactor may include an inlet configured to receive debris and an auger chamber having an auger extending therein.

[0084] In some instances, the debris compactor may further include a filter medium at an outlet of the auger chamber. In some instances, the vacuum cleaner may further include a motor configured to rotate the auger. In some instances, the auger may be configured to engage the filter medium such that rotation of the auger urges debris accumulated on the filter medium in a direction of the dust cup. In some instances, the vacuum cleaner may further include a cyclonic separator fluidly coupled to the suction source and the debris compactor. In some instances, the dust cup may be further configured to receive debris from the cyclonic separator. In some instances, the dust cup may define at least a first and a second compartment, wherein the first compartment corresponds to the debris compactor and the second compartment corresponds to the cyclonic separator.

[0085] While the principles of the invention have been described herein, it is to be understood by those skilled in the art that this description is made only by way of example and not as a limitation as to the scope of the invention. Other embodiments are contemplated within the scope of the present invention in addition to the exemplary embodiments shown and described herein. Modifications and substitutions by one of ordinary skill in the art are considered to be within the scope of the present invention, which is not to be limited except by the following claims.

What is claimed is:

1. A debris compactor comprising:
an inlet configured to receive debris;
an auger chamber having an auger extending therein; and
a dust cup disposed at a distal end of the auger chamber, the auger being configured to urge the debris into the dust cup.
2. The debris compactor of claim 1 further comprising an outlet configured to be coupled to a suction source to cause air to be drawn across the auger.
3. The debris compactor of claim 2 further comprising a filter medium, the filter medium being disposed at the outlet.
4. The debris compactor of claim 3, wherein the auger is configured to engage the filter medium.
5. The debris compactor of claim 1 further comprising a motor configured to cause the auger to rotate within the auger chamber.
6. The debris compactor of claim 1, wherein a peripheral edge of the auger includes a peripheral lining.
7. A collection system for collecting debris comprising:
a debris compactor, the debris compactor including:
an inlet configured to receive debris; and
an auger chamber having an auger extending therein;
a dust cup configured to receive debris from the debris compactor; and
a suction source configured to draw air through the debris compactor.
8. The collection system of claim 7, wherein the debris compactor further comprises a filter medium disposed at an outlet of the auger chamber.

9. The collection system of claim 8 further comprising a motor configured to rotate the auger.
10. The collection system of claim 9, wherein the auger is configured to engage the filter medium and rotation of the auger urges debris accumulated on the filter medium in a direction of the dust cup.
11. The collection system of claim 7 further comprising a cyclonic separator fluidly coupled to the suction source and the debris compactor.
12. The collection system of claim 11, wherein the dust cup is further configured to receive debris from the cyclonic separator.
13. The collection system of claim 12, wherein the dust cup defines at least a first and a second compartment, the first compartment corresponding to the debris compactor and the second compartment corresponding to the cyclonic separator.
14. A vacuum cleaner comprising:
 - a chassis; and
 - a collection system for collecting debris coupled to the chassis, the collection system including:
 - a debris compactor, the debris compactor including:
 - an inlet configured to receive debris; and
 - an auger chamber having an auger extending therein;
 - a dust cup configured to receive debris from the debris compactor; and
 - a suction source configured to draw air through the debris compactor.
15. The vacuum cleaner of claim 14, wherein the debris compactor further comprises a filter medium at an outlet of the auger chamber.
16. The vacuum cleaner of claim 15 further comprising a motor configured to rotate the auger.

17. The vacuum cleaner of claim 16, wherein the auger is configured to engage the filter medium and rotation of the auger urges debris accumulated on the filter medium in a direction of the dust cup.
18. The vacuum cleaner of claim 14 further comprising a cyclonic separator fluidly coupled to the suction source and the debris compactor.
19. The vacuum cleaner of claim 18, wherein the dust cup is further configured to receive debris from the cyclonic separator.
20. The vacuum cleaner of claim 19, wherein the dust cup defines at least a first and a second compartment, the first compartment corresponding to the debris compactor and the second compartment corresponding to the cyclonic separator.

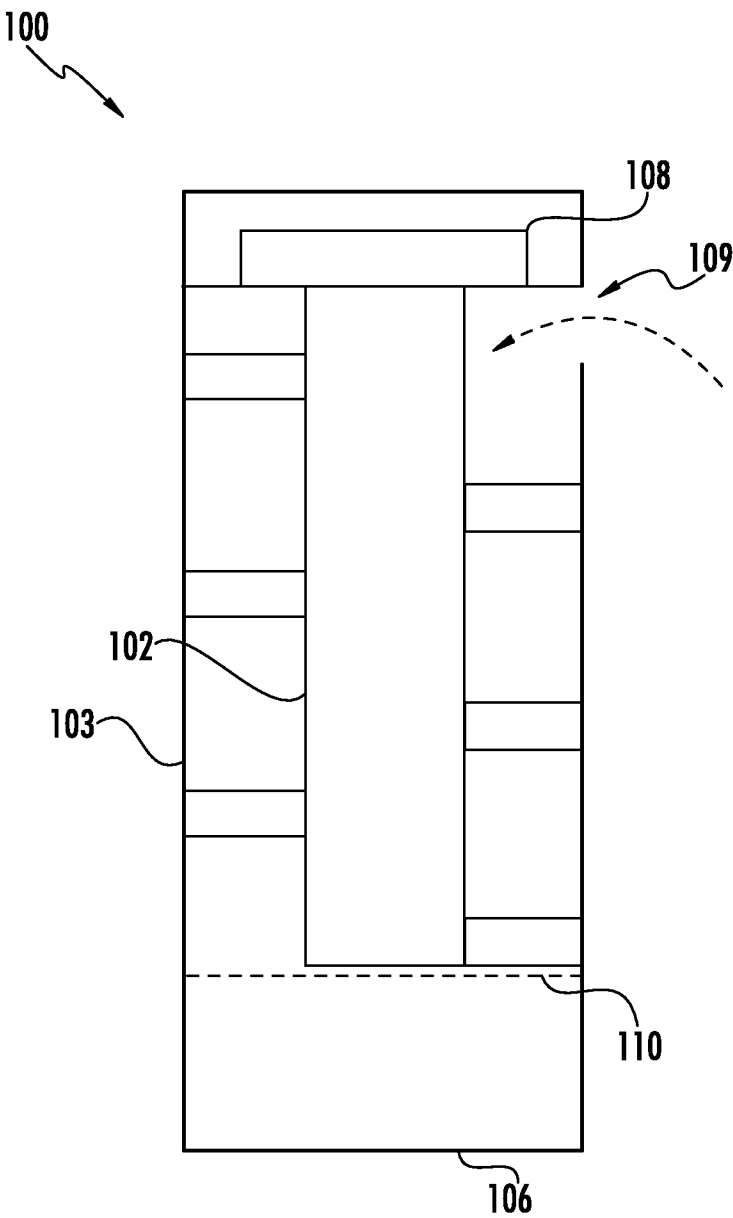


FIG. 1

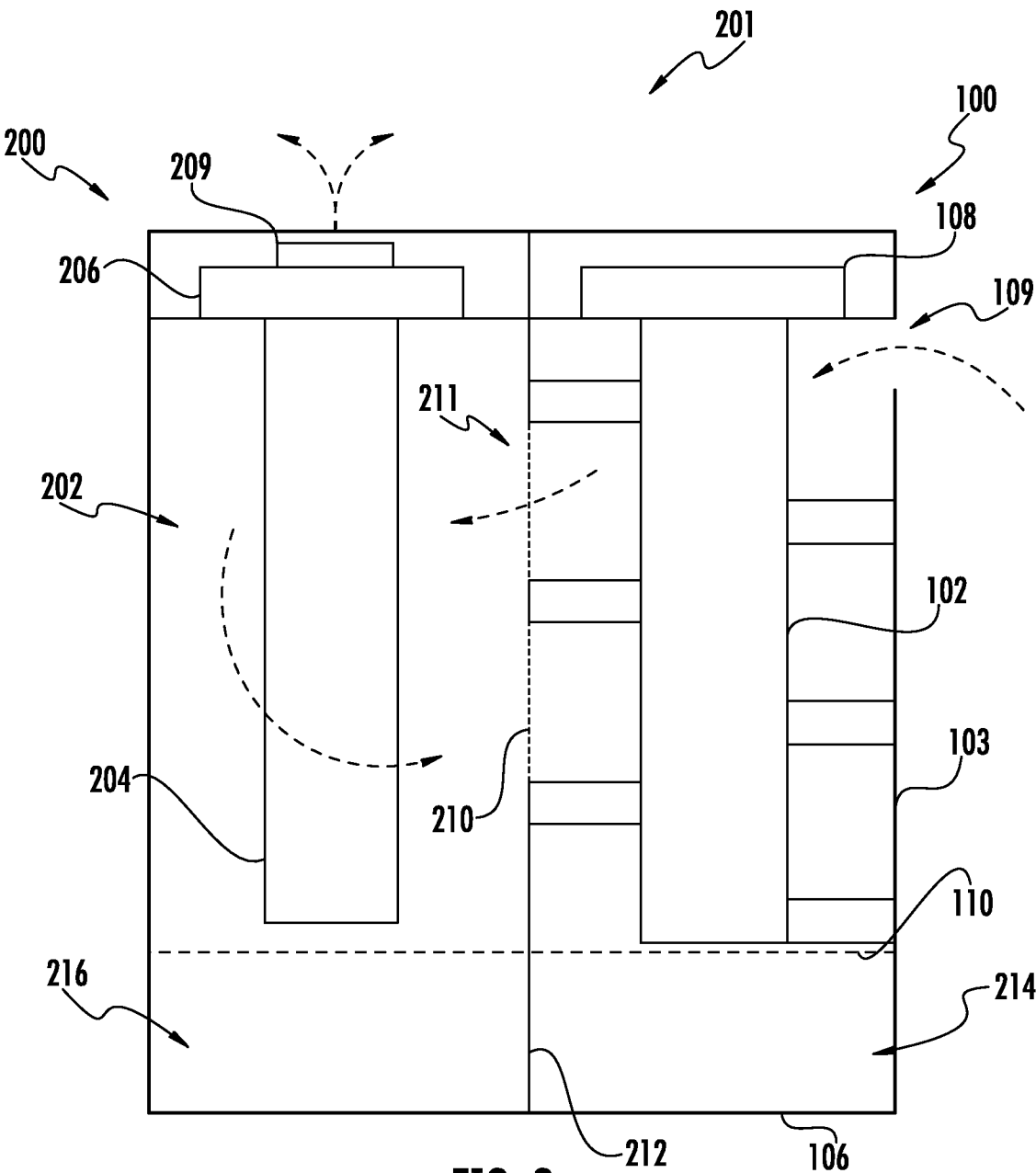


FIG. 2

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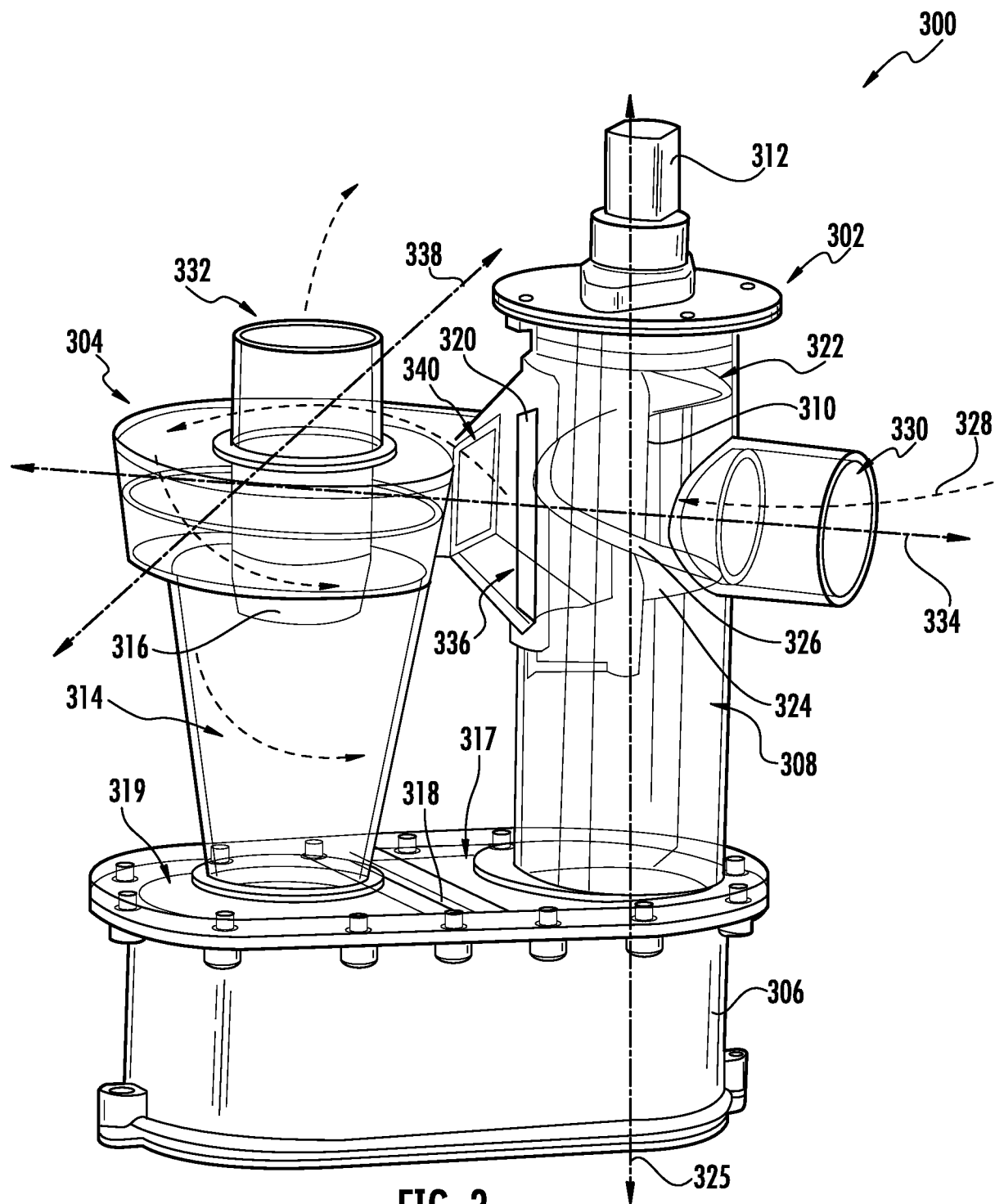
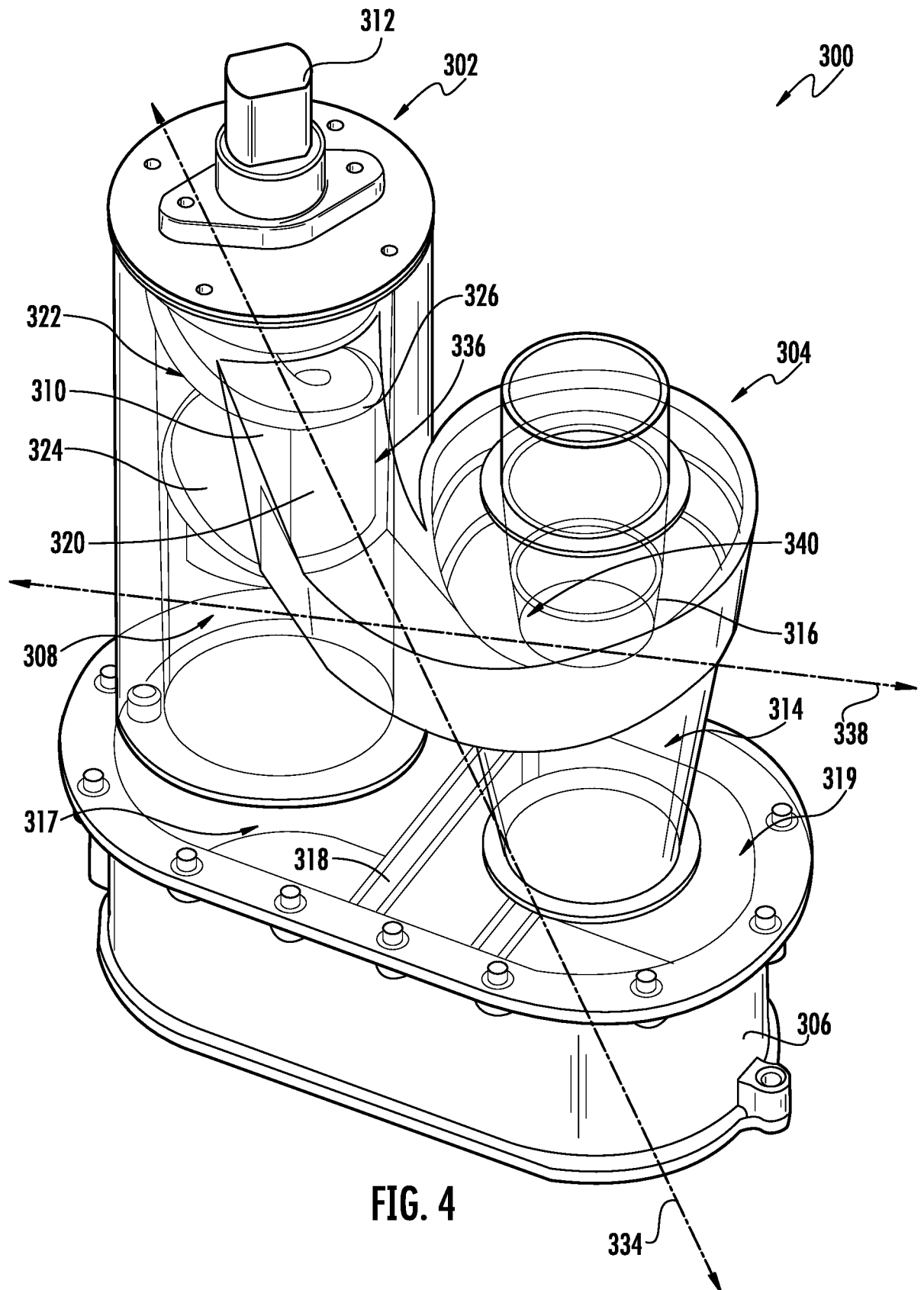


FIG. 3

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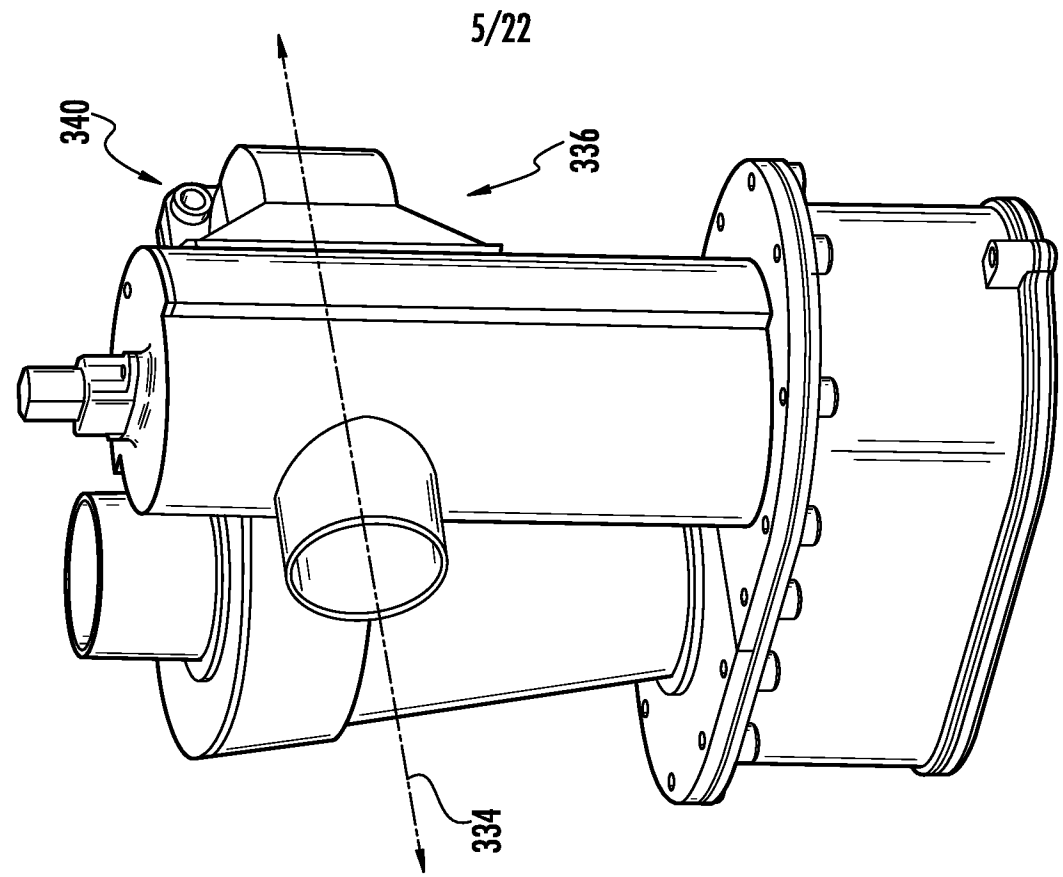


FIG. 6

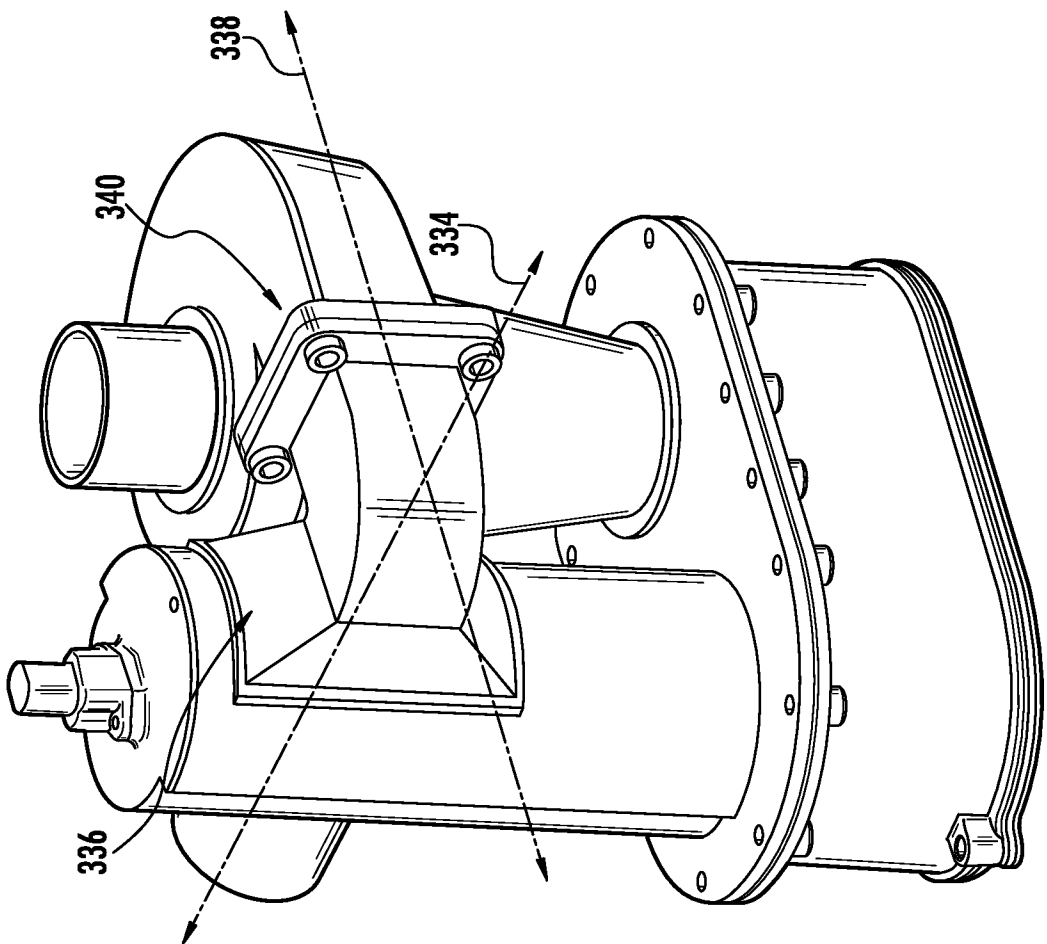


FIG. 5

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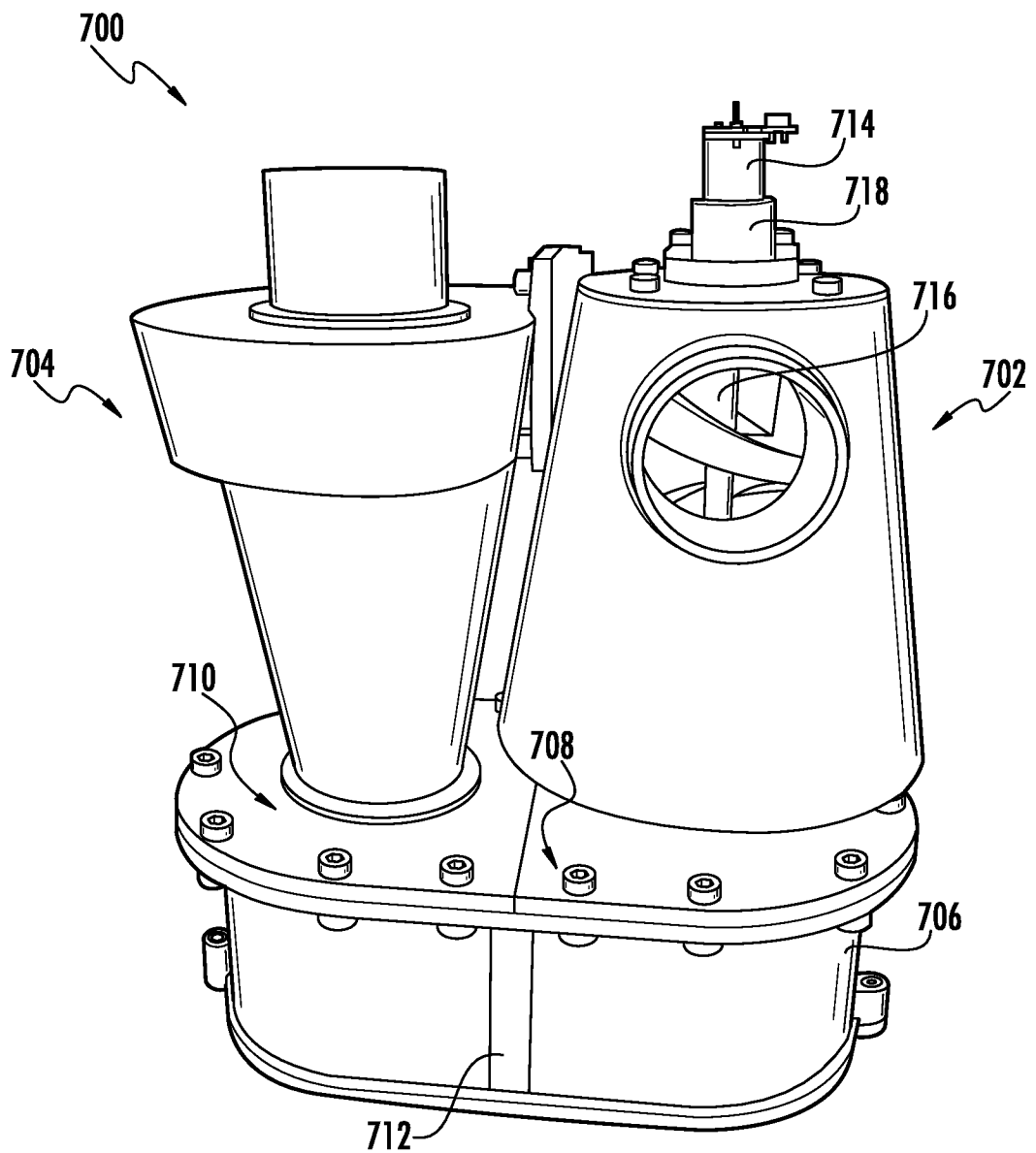
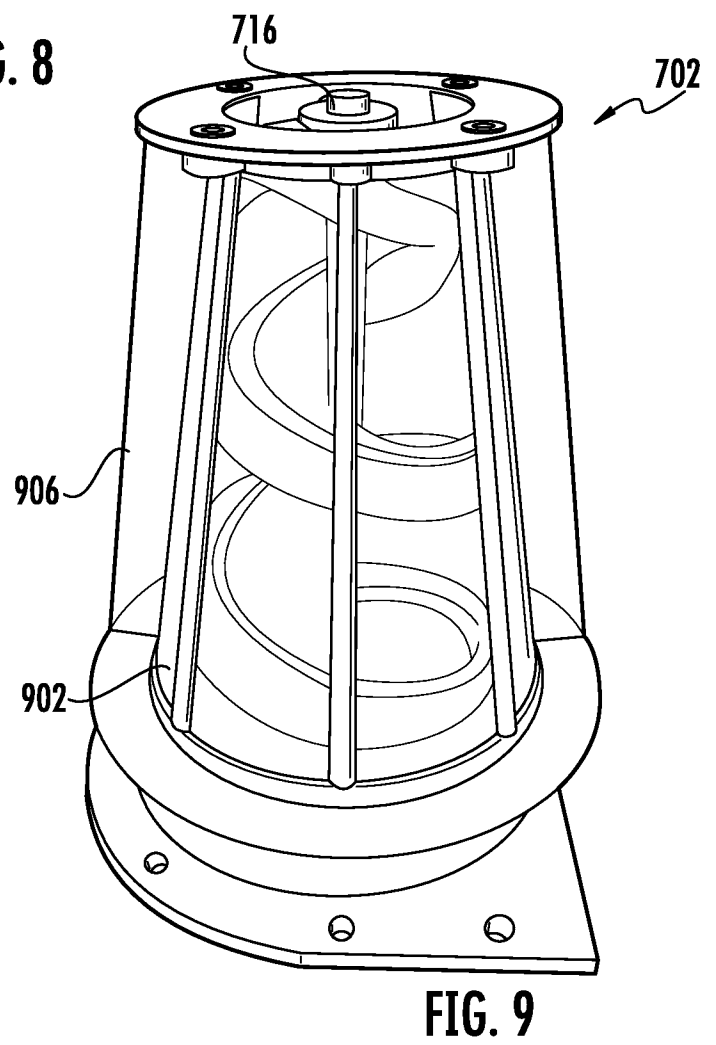
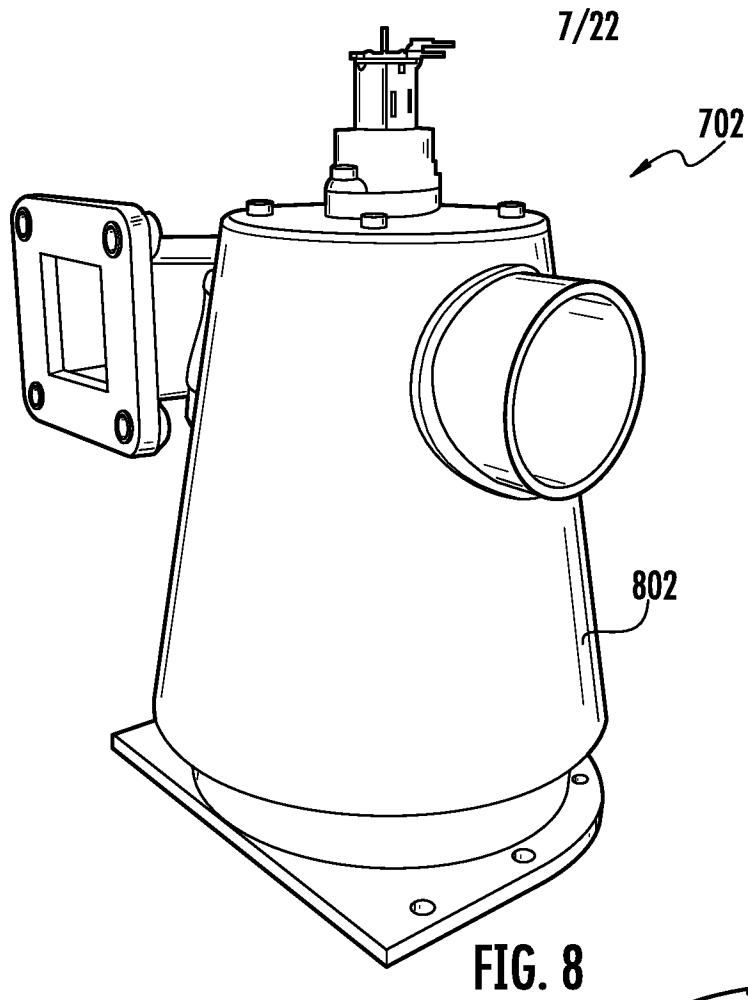


FIG. 7



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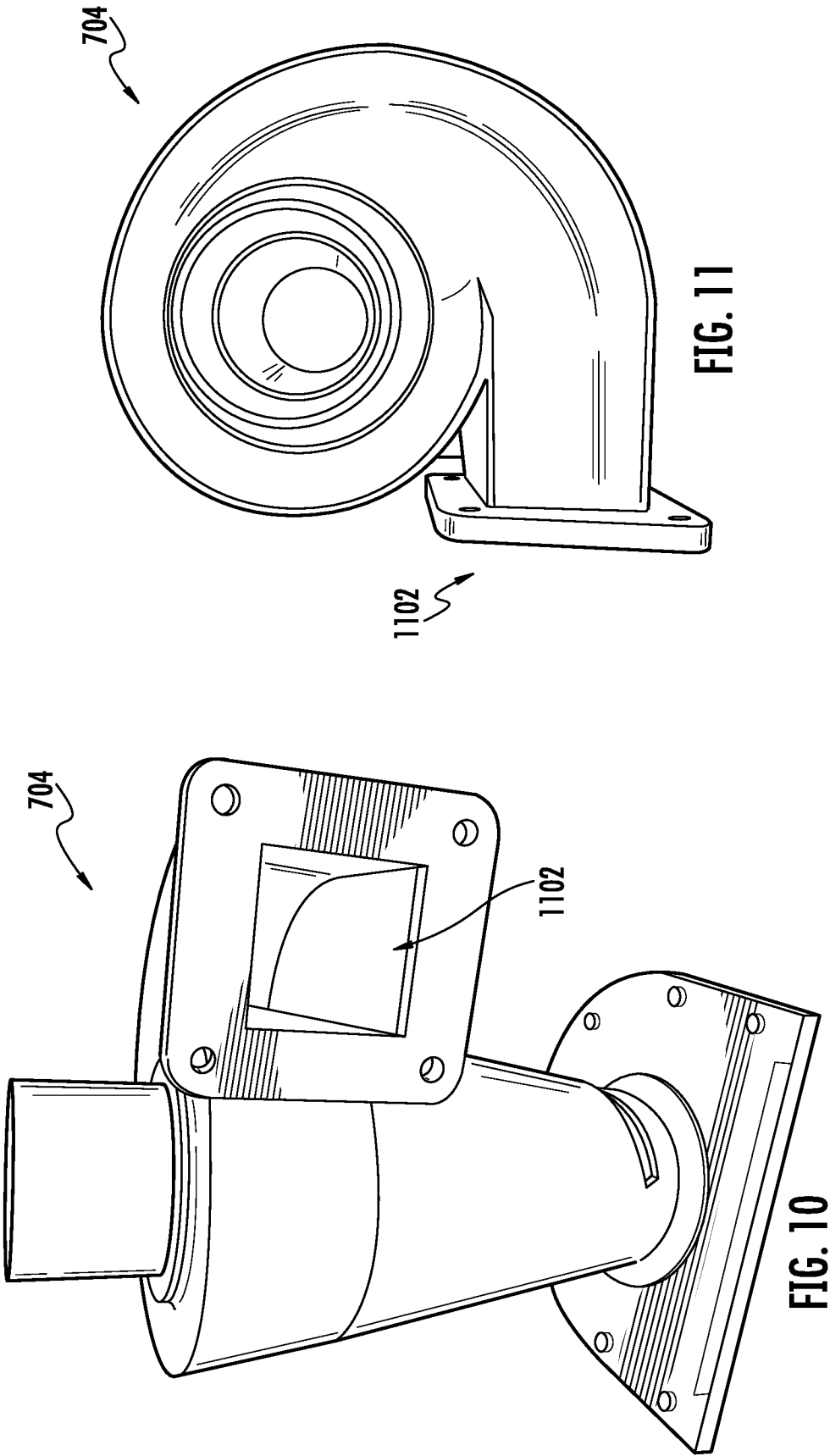


FIG. 11

FIG. 10

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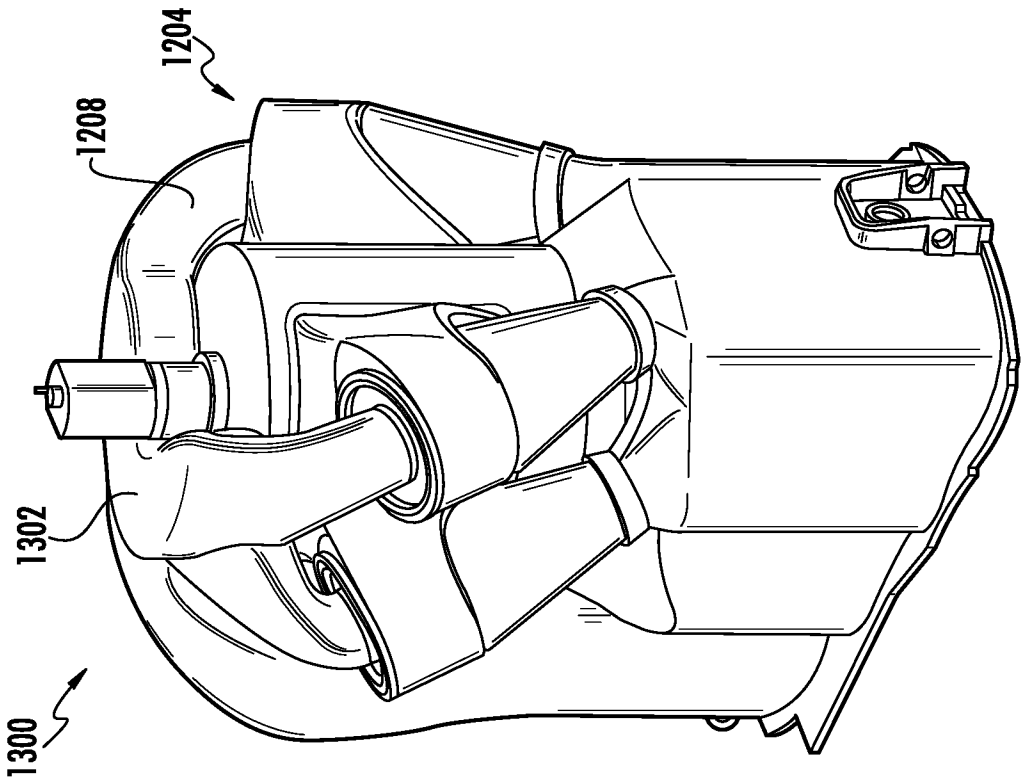


FIG. 13

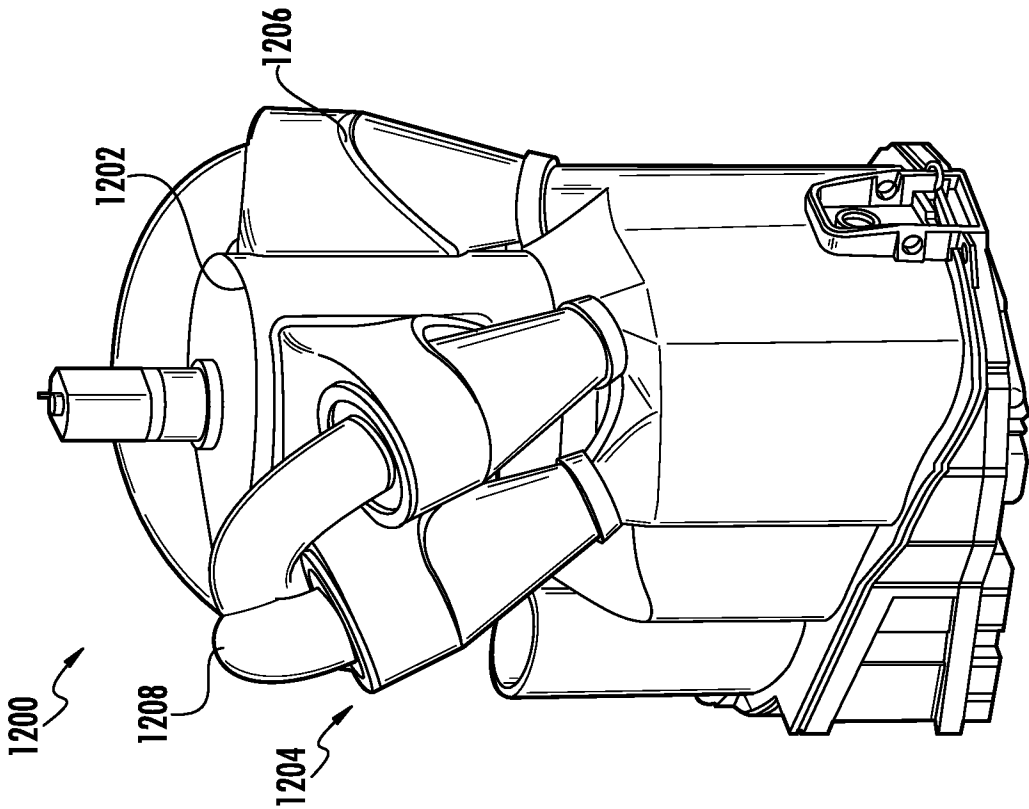


FIG. 12

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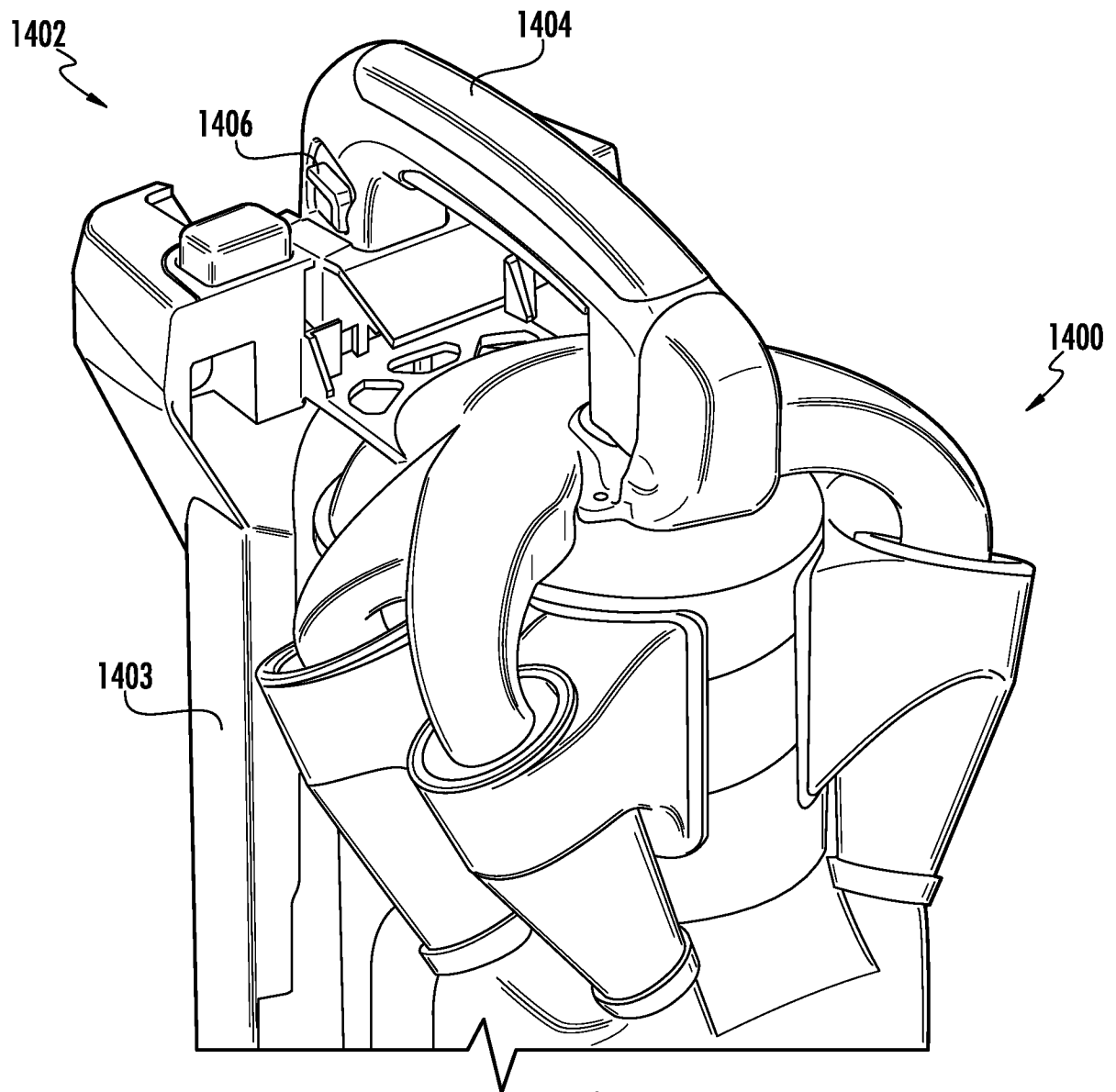


FIG. 14

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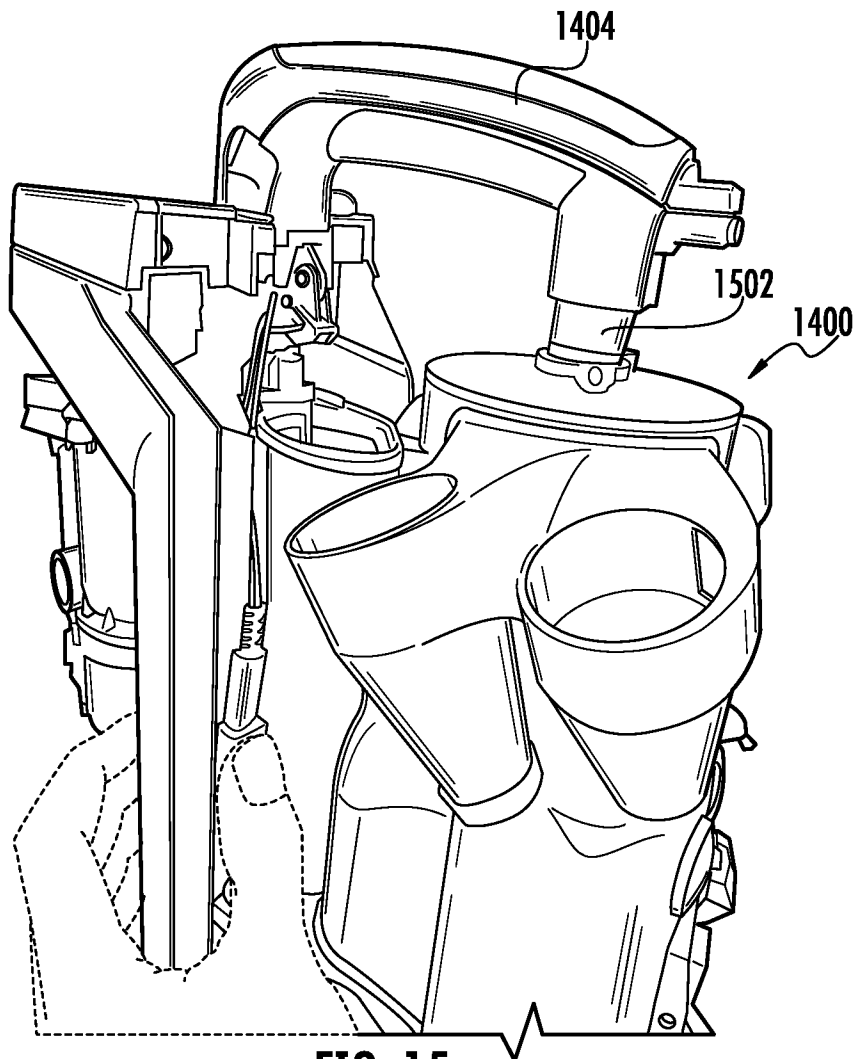


FIG. 15

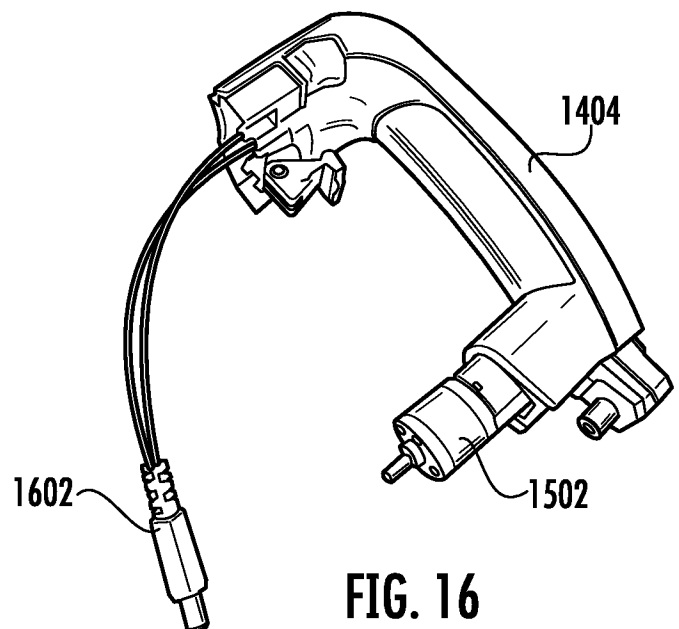
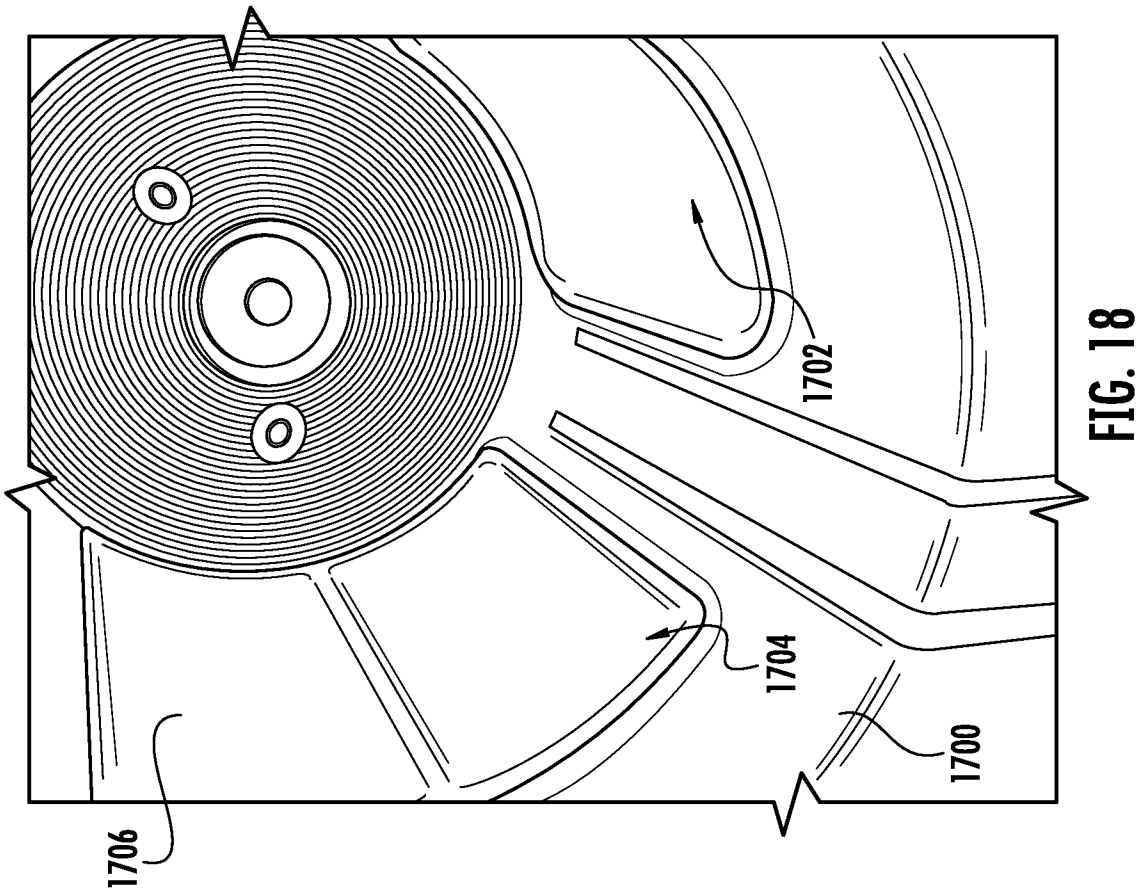
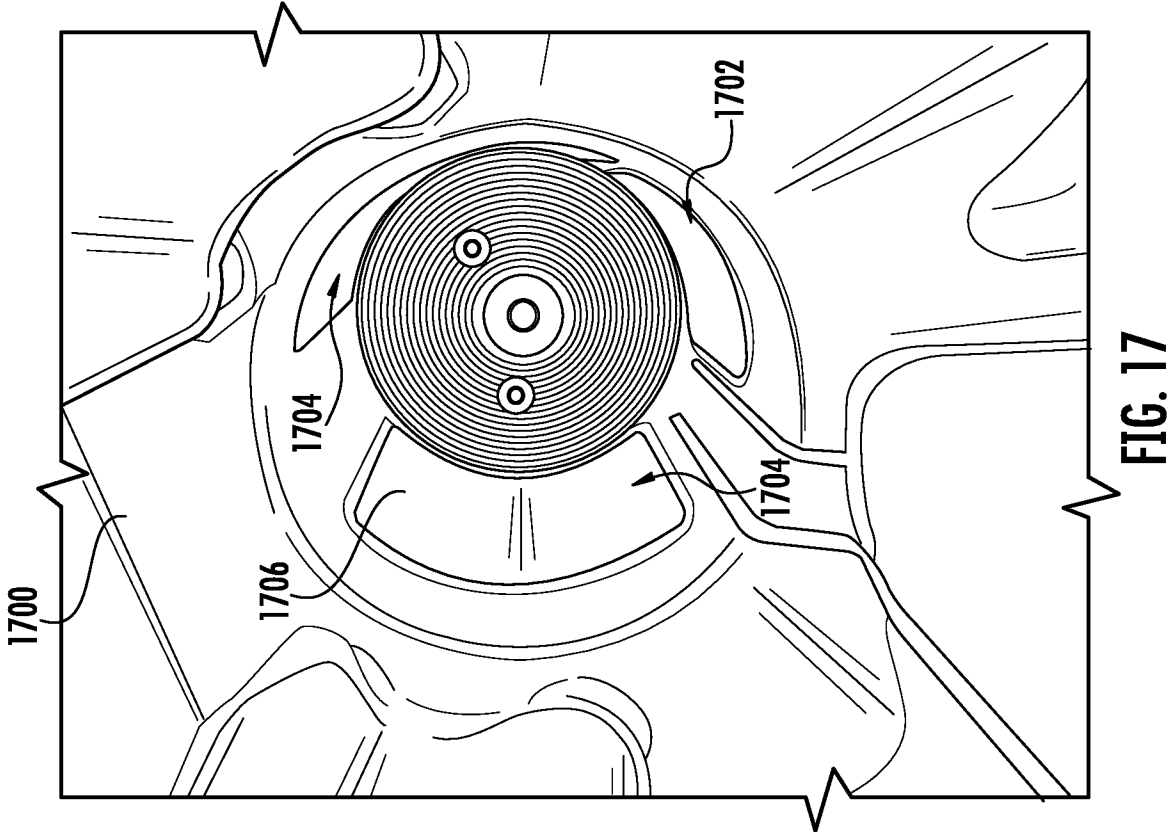


FIG. 16



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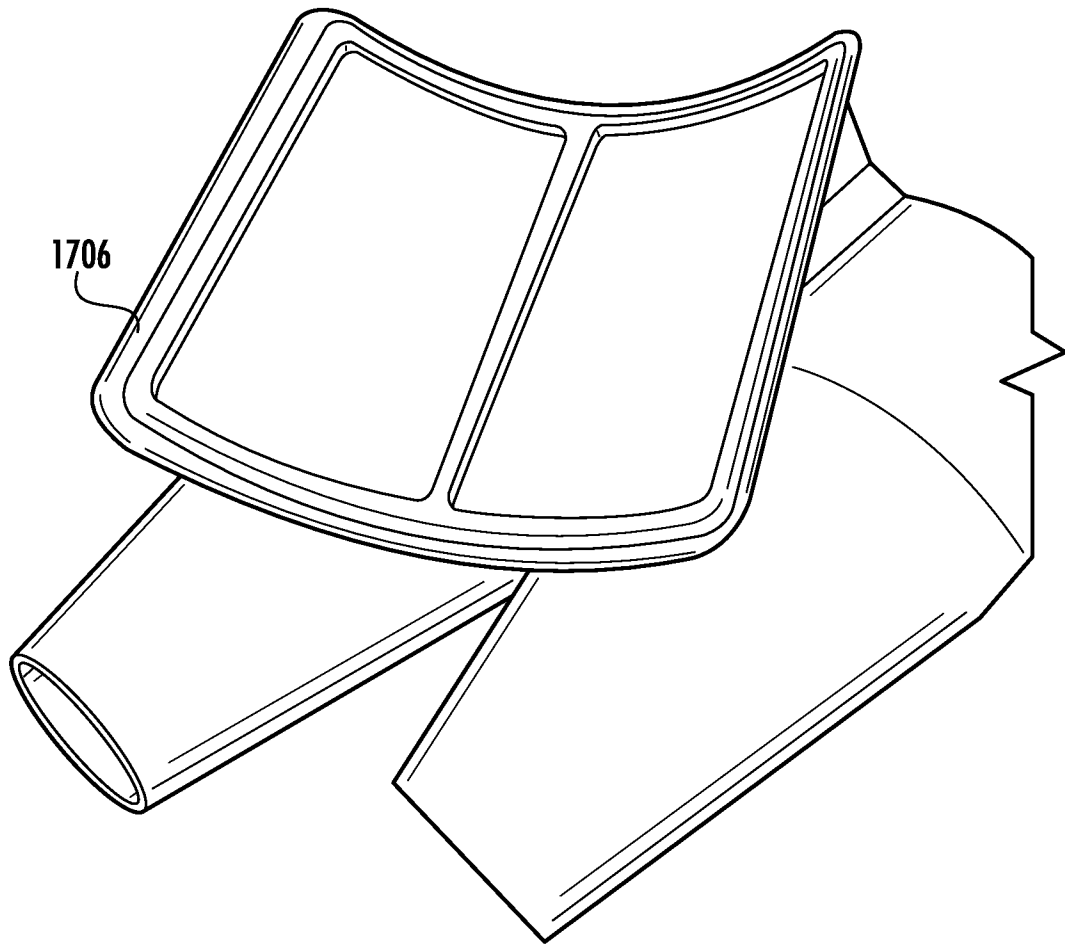
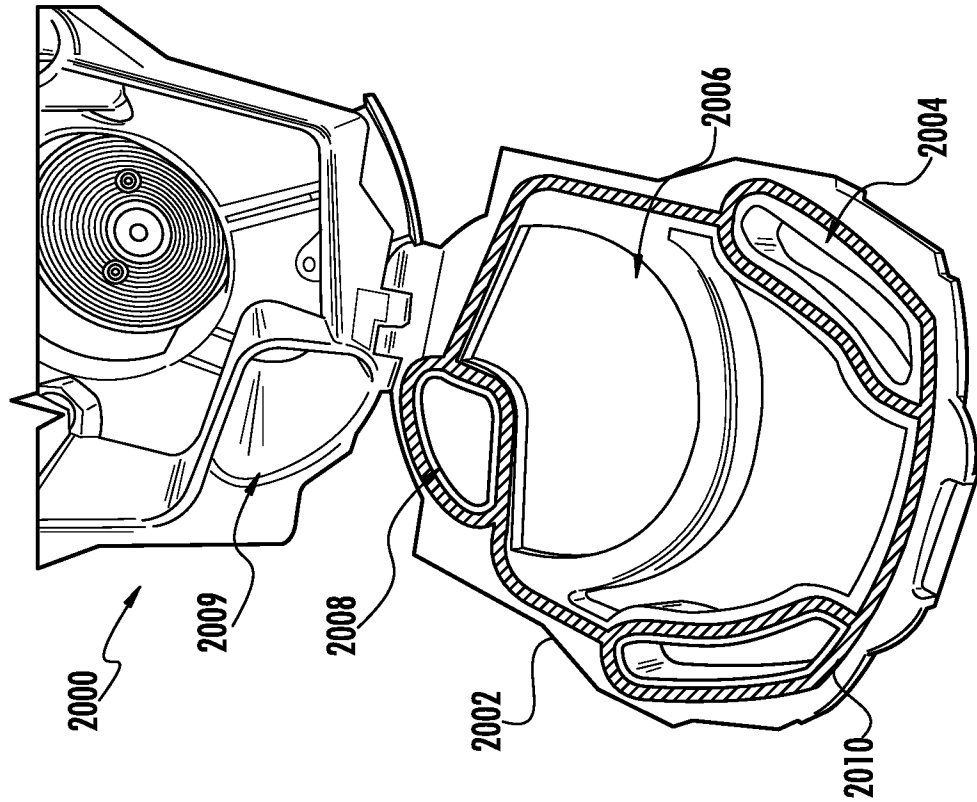
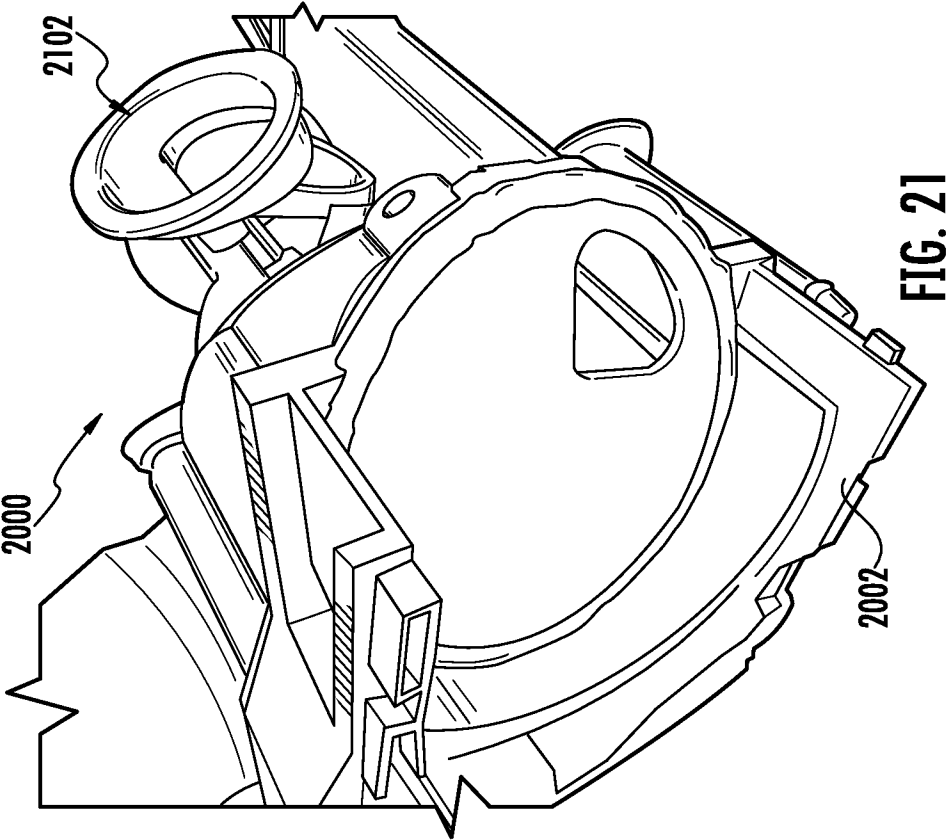


FIG. 19



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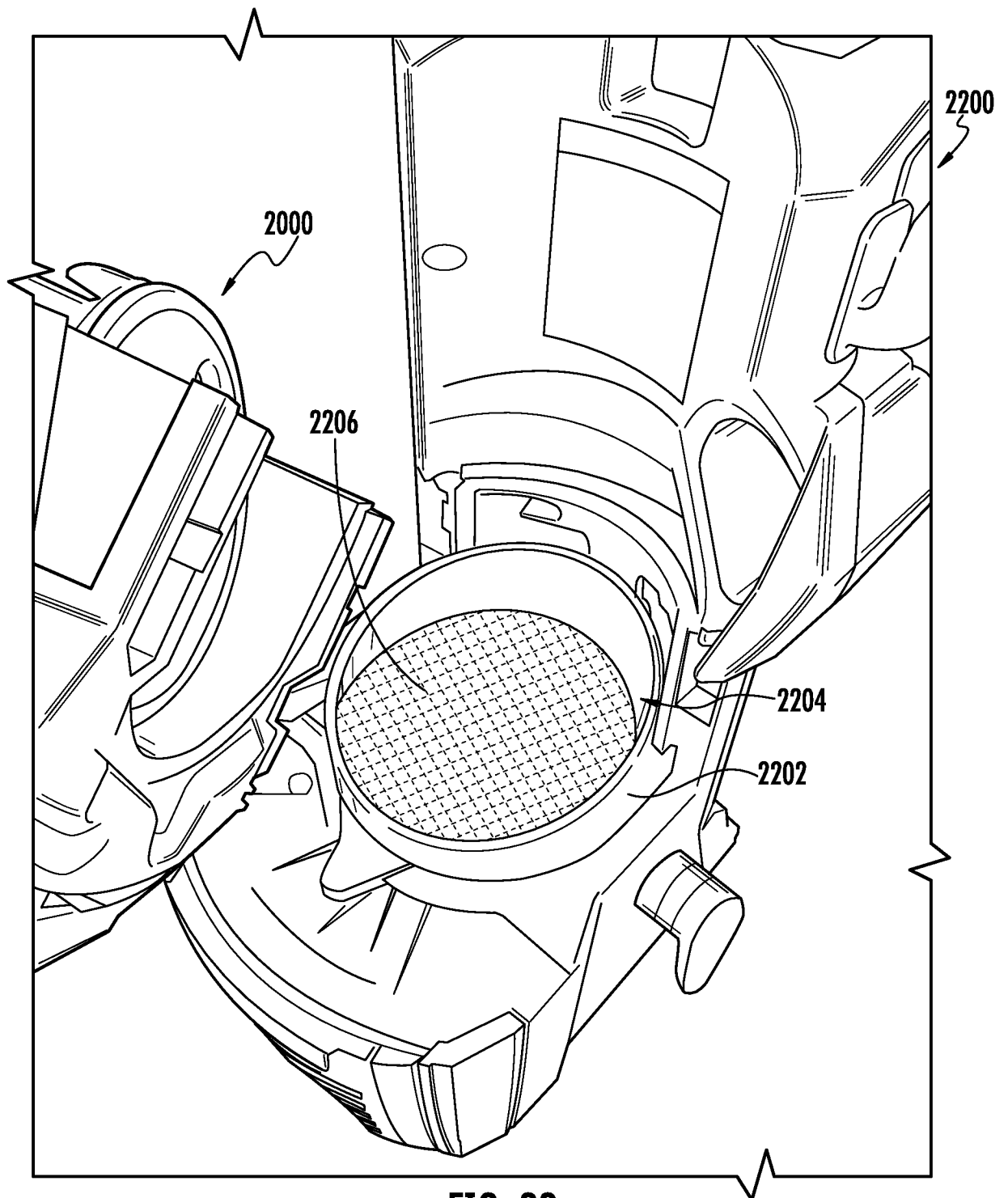


FIG. 22

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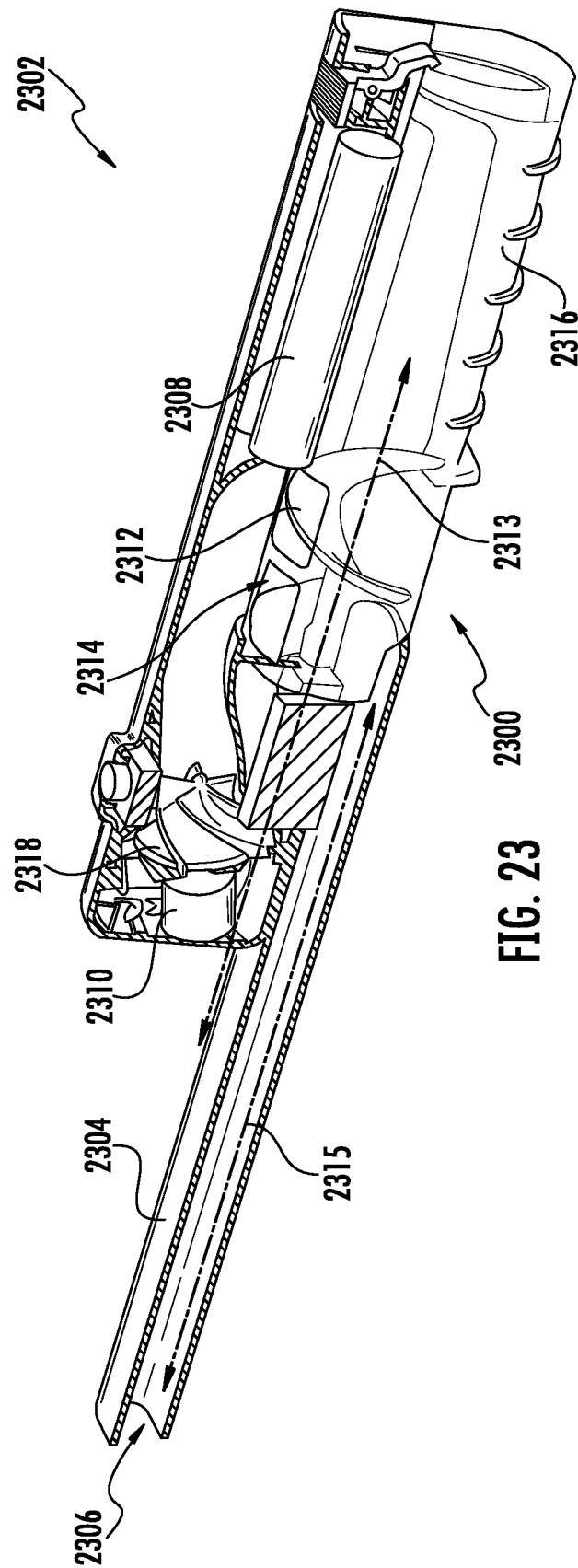
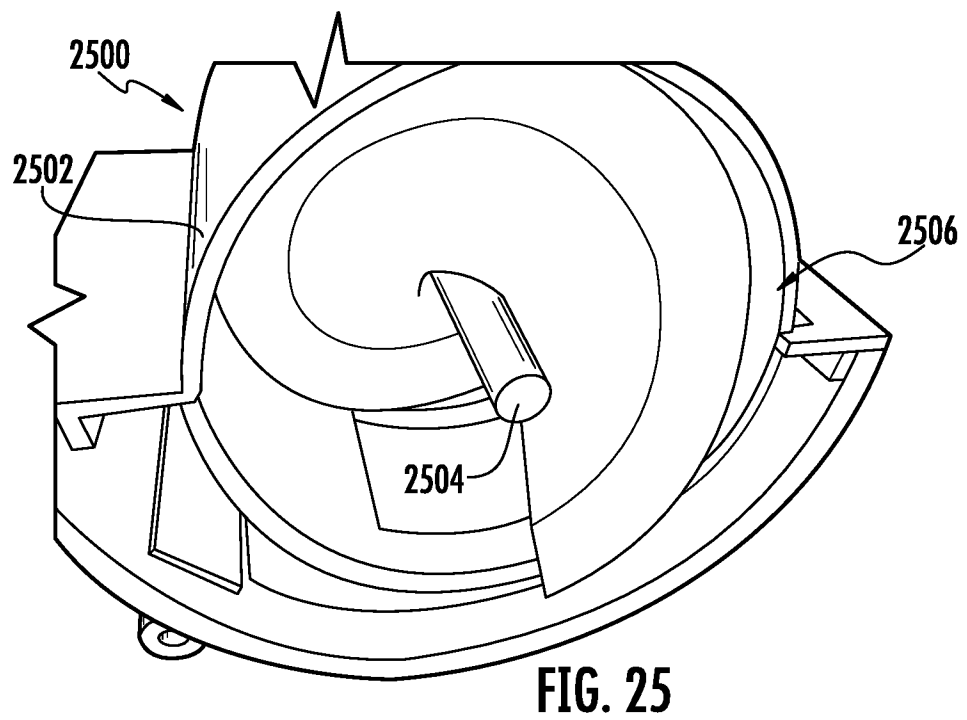
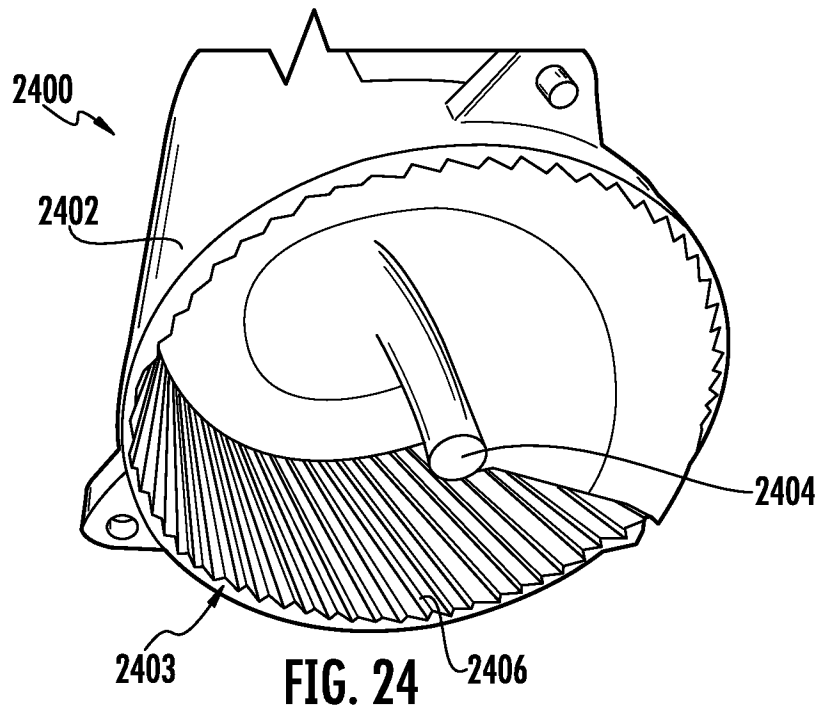


FIG. 23

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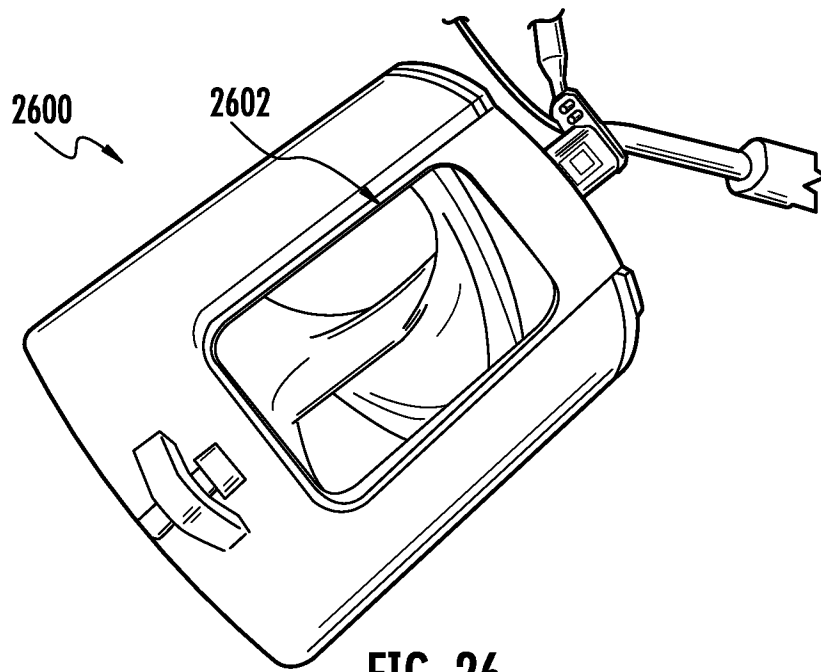


FIG. 26

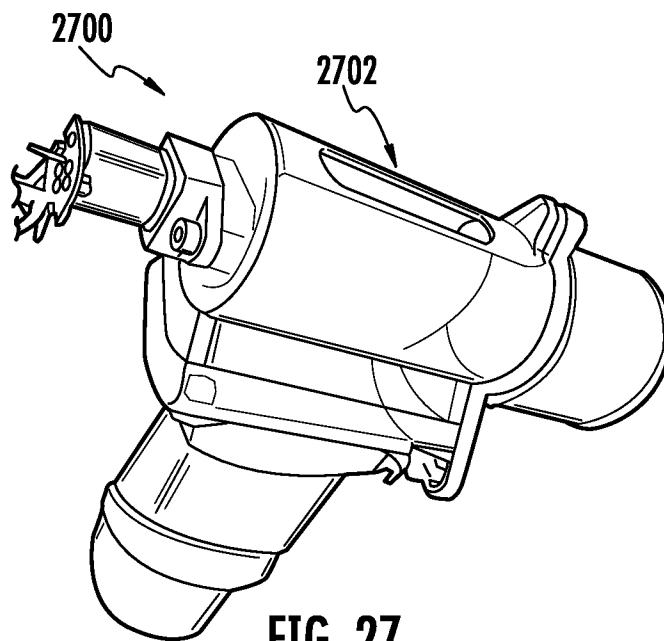


FIG. 27

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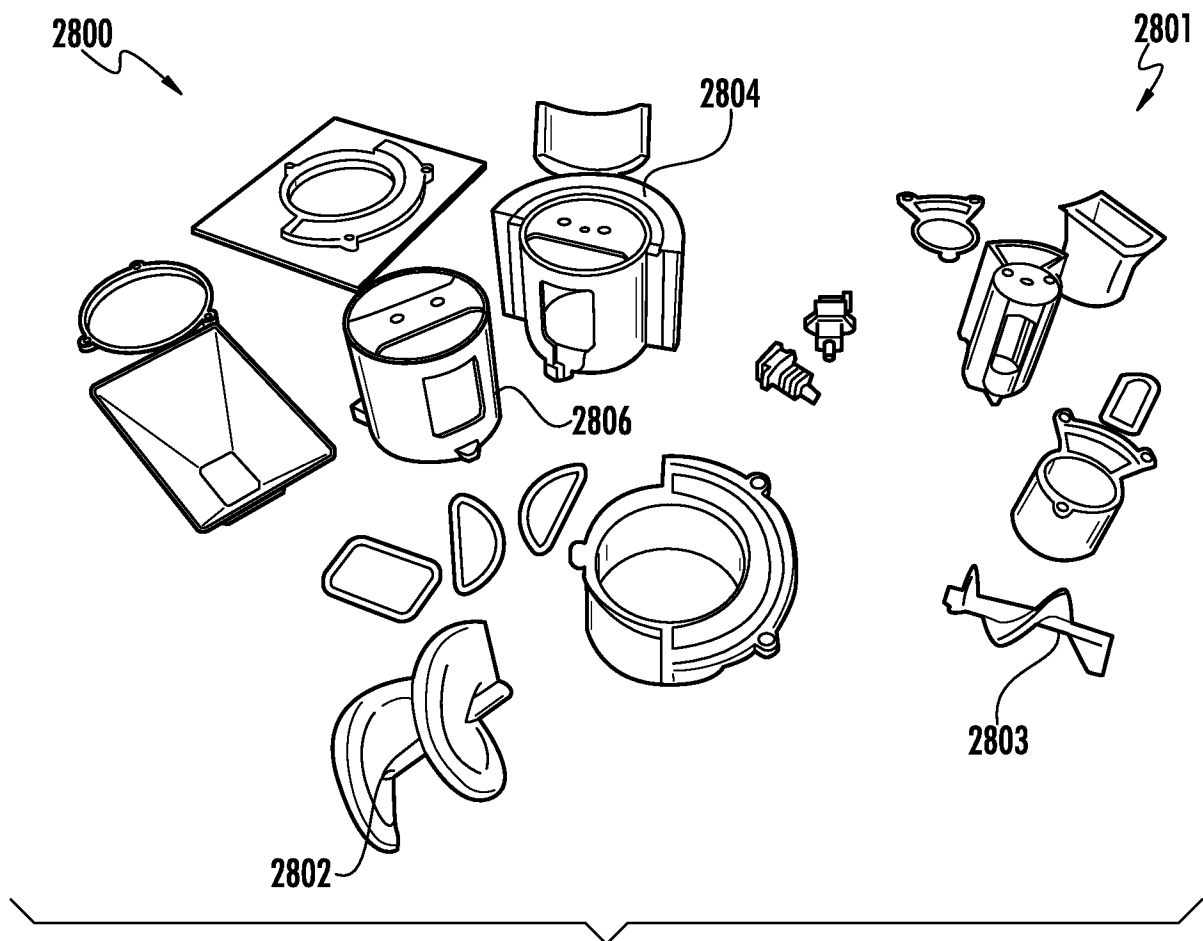
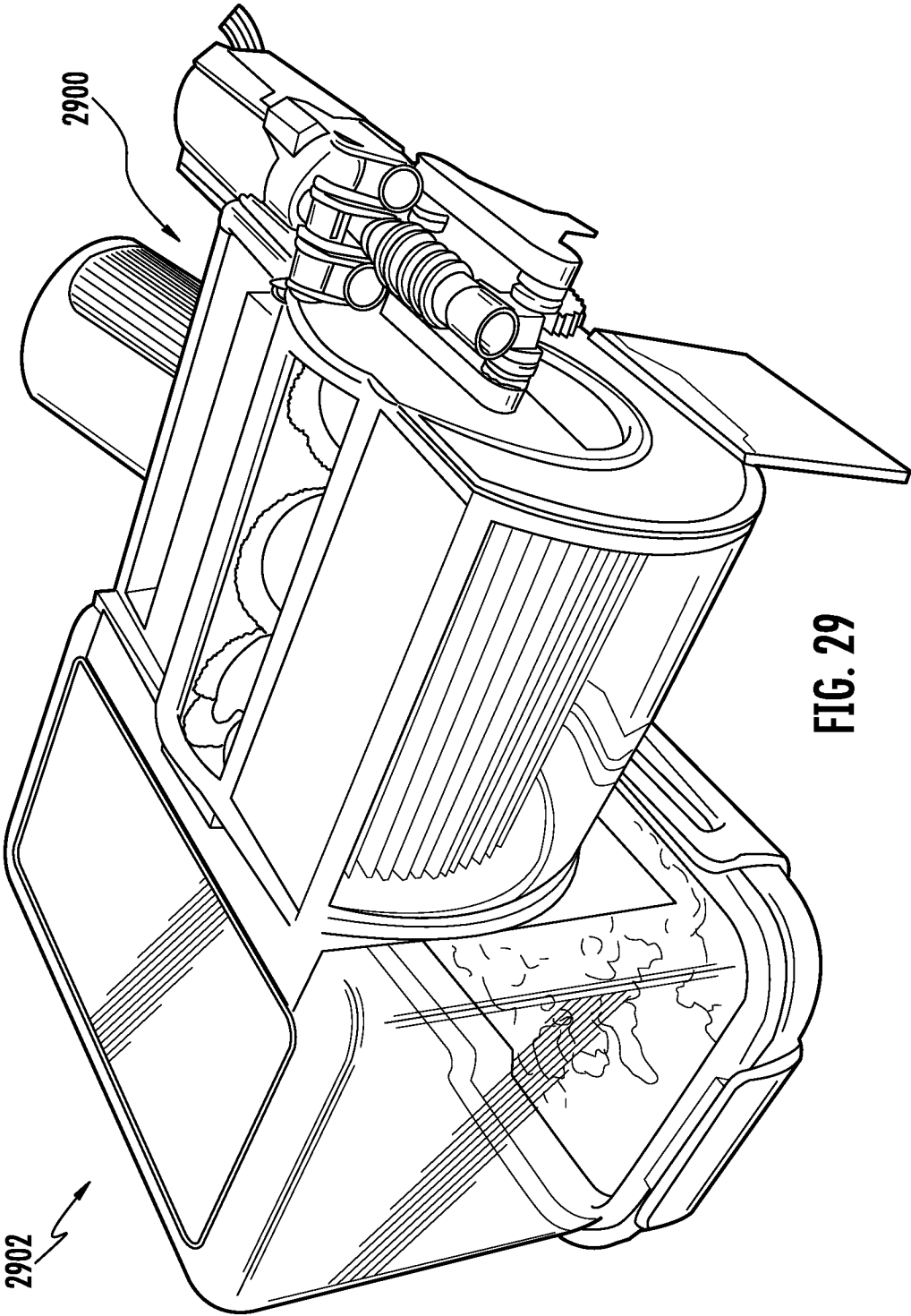


FIG. 28



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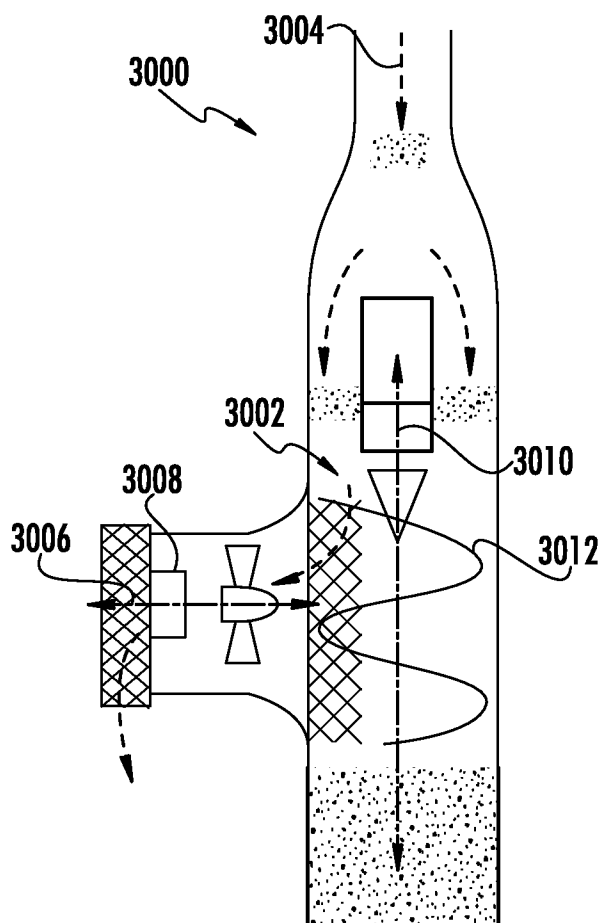


FIG. 30

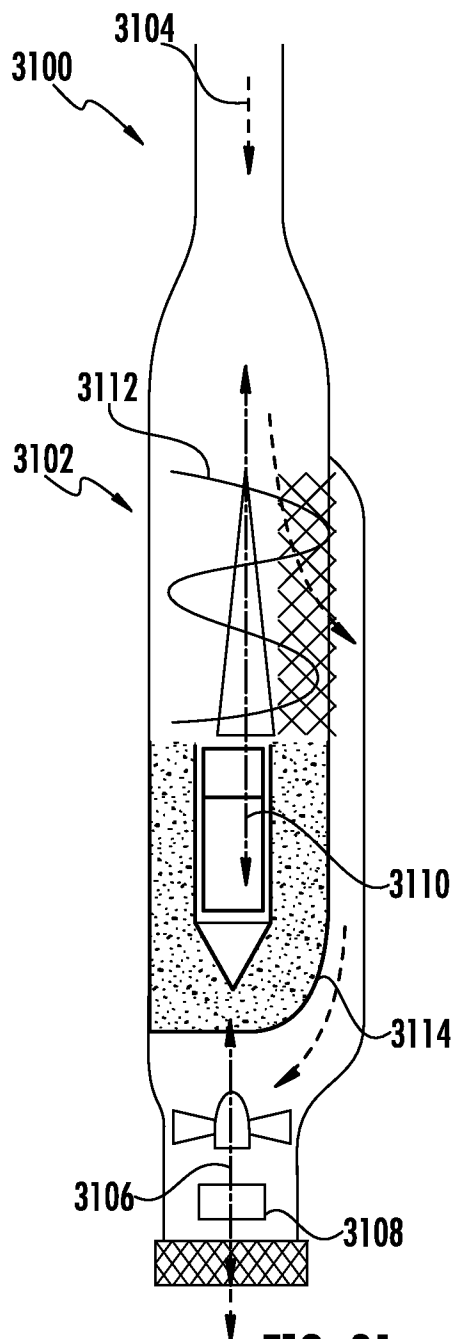


FIG. 31

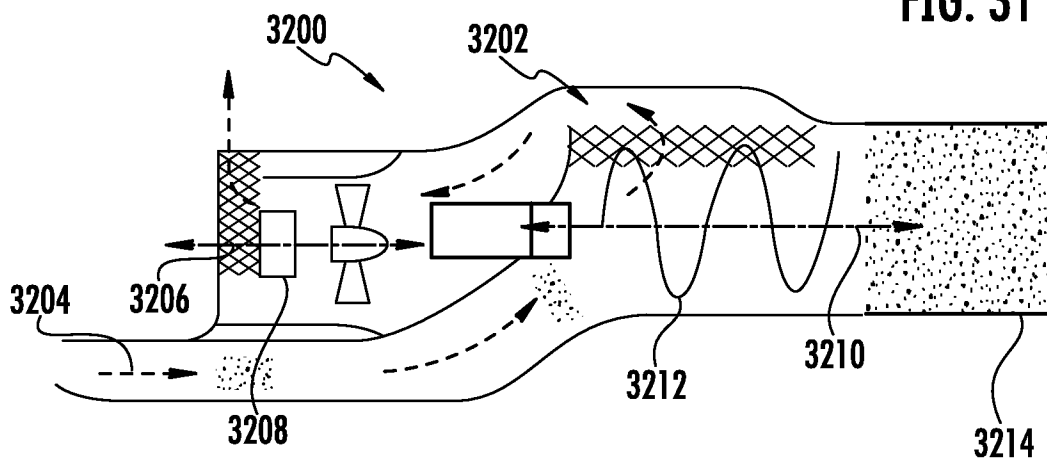


FIG. 32

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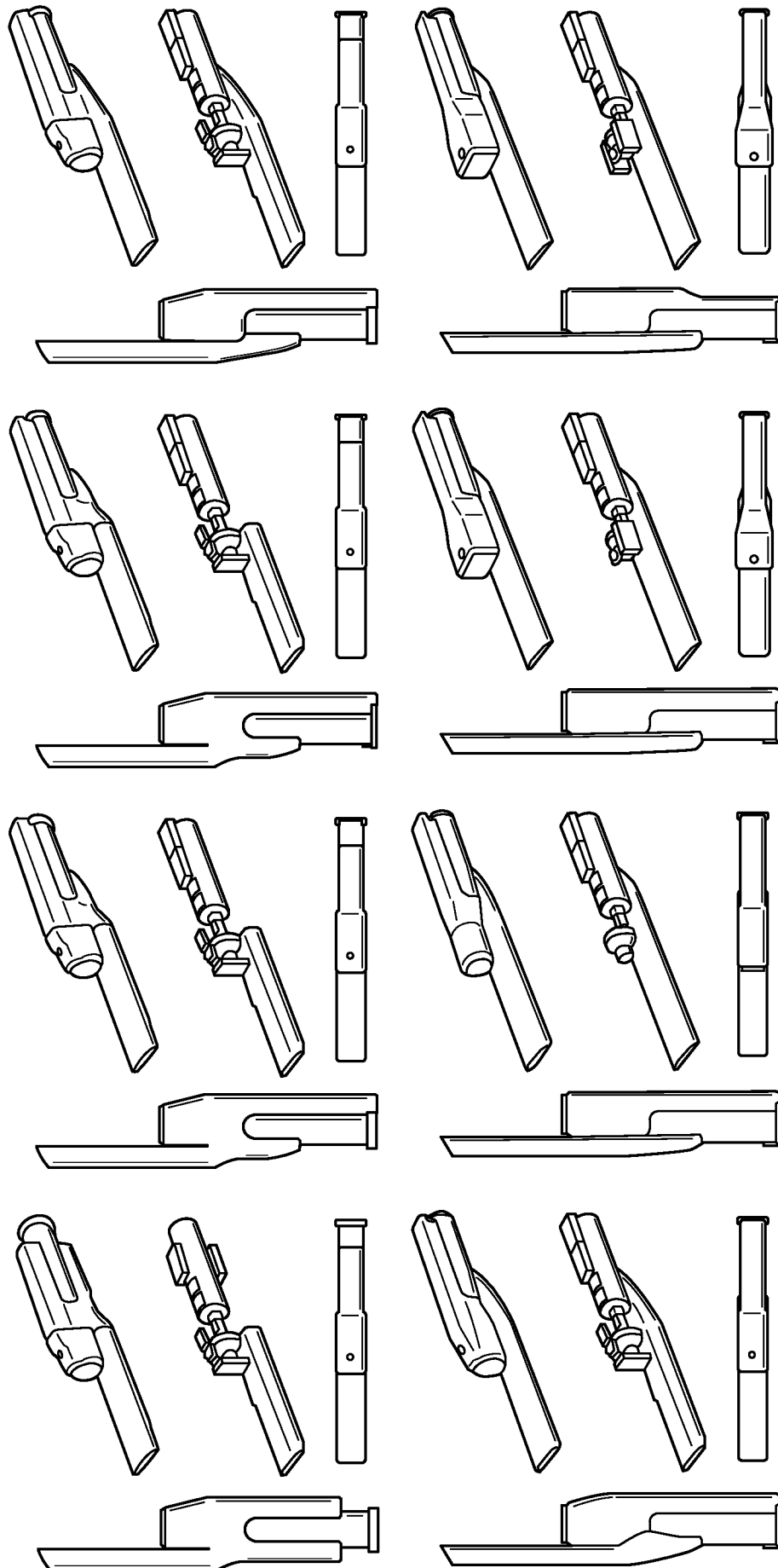


FIG. 33

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/060233

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A47L 9/10; A47L 9/00; A47L 9/16; B01D 46/02; B01D 46/10; B01D 46/24; B01D 46/26 (2019.01)

CPC - A47L 9/10; A47L 9/00; A47L 9/102; A47L 9/106; A47L 9/16; B01D 46/02; B01D 46/10; B01D 46/24; B01D 46/26; B01D 46/48; B25D 17/00; B65G 69/18; E21F 5/10 (2019.08)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC - 15/327.1; 15/350; 55/337; 55/426 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 9,279,555 B2 (BASSETT) 08 March 2016 (08.03.2016) entire document	1-20
Y	US 8,209,815 B2 (MAKAROV et al) 03 July 2012 (03.07.2012) entire document	1-20
Y	US 6,168,641 B1 (TUVIN et al) 02 January 2001 (02.01.2001) entire document	14-20

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

17 December 2019

Date of mailing of the international search report

14 JAN 2020

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