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(54) **MIXER BASE ASSEMBLY FOR MIXING VESSELS AND METHOD OF USE**

MISCHERBASISANORDNUNG FÜR MISCHBEHÄLTER UND VERFAHREN ZUR VERWENDUNG

ENSEMBLE BASE DE MÉLANGEUR POUR CUVES DE MÉLANGE ET PROCÉDÉ D'UTILISATION

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(56) References cited:
WO-A1-2018/162174
WO-A1-2019/180710
US-A- 5 882 113

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Description

BACKGROUND OF THE INVENTION

[0001] Mixing vessels are mounted to mixer bases for use. However, different mixing vessels have different shapes and/or configurations and can require specialized mixer bases for use.

WO 2019/180710 A1 discloses a device, in accordance with the preamble of claim 1, for storing and circulating drinking water with vortex circulation. The device includes a base, a tank and an actuator housed in the base and configured to circulate the drinking water stored in the tank with vortex flow.

The US patent US 5,882,113 A relates to a device for homogenizing and/or heating a liquid or mashy substance contained in a container. The container is connectable with the device. The base body includes a device for homogenizing the liquid or mashy substance and/or a device for heating the liquid or mashy substance.

WO 2018/162174 A1 refers to a flow-promoting device for performing a biological or chemical transformation, or physical or chemical trapping from, or release of agents to, a fluidic medium.

[0002] The present invention provides for ameliorating at least some of the disadvantages of the prior art. These and other advantages of the present invention will be apparent from the description as set forth below.

BRIEF SUMMARY OF THE INVENTION

[0003] An embodiment of the invention provides a mixer base assembly comprising (a) a body having (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls; (iv) an inlet port arranged in a side wall; (v) an outlet port arranged in a side wall; (vi) a fluid mixing chamber including a baffle, the fluid mixing chamber having a bottom wall; (vii) a sampling port arranged in a side wall; and, (viii) at least one probe port arranged in a side wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) a levitating magnetic impeller arranged in the impeller seat, the impeller comprising a magnet, a base, and at least two blades, wherein the at least two blades extend above the bottom wall of the fluid mixing chamber into the fluid mixing chamber.

[0004] In another embodiment, a method for mixing fluid comprises connecting a mixing vessel to a mixer base assembly comprising (a) a body having (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls; (iv) an inlet port arranged in a side wall; (v) an outlet port arranged in a side wall; (vi) a sampling port arranged in a side wall; (vii) at least one probe port arranged in a side wall; and, (viii) a fluid mixing chamber including a baffle, the fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) a levitating magnetic impeller arranged in the impeller seat, the impeller comprising a magnet, a base, and at least two blades, wherein the at least two blades extend above the bottom wall of the fluid mixing chamber into the fluid mixing chamber; introducing fluid into the fluid mixing chamber, and rotating the magnetic impeller to mix the fluid in the fluid mixing chamber.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0005]

Figure 1 is an exploded top view of a mixer base assembly according to an embodiment of the invention, wherein the mixer base assembly comprises a body comprising a baffle, a fluid mixing chamber, two probe ports, a sample port, an inlet port, an outlet port, a vent inlet port, and a vent outlet port, the mixer base also comprising a levitating magnetic impeller, and an interface plate including an impeller seat, two probes, an inlet connector, an outlet connector, a vent filter, a sample port plug including a sealing gasket, a sample port nut, and fluid conduits.

Figure 2 is a bottom view of the mixer base assembly shown in Figure 1.

Figure 3A is a top view of a portion of the mixer base assembly shown in Figure 1, showing an inlet port communicating with the fluid mixing chamber; Figure 3B is a cross-sectional view of the mixer base assembly shown in Figure 3A, including an arrow showing the flow path of fluid through the inlet port into the fluid mixing chamber.

Figure 4A is a top view of another portion of the mixer base assembly shown in Figure 1, showing an outlet port communicating with the fluid mixing chamber; Figure 4B is a cross-sectional view of the mixer base assembly shown in Figure 4A, including an arrow showing the flow path of fluid through from the fluid mixture chamber and the outlet port.

Figure 5 shows a cross-sectional view of another portion of the mixer base assembly shown in Figure 1, showing a downwardly sloped bottom wall of the fluid mixing chamber and the tips of two probes arranged to sense fluid parameters in the fluid mixing chamber, preferably wherein the slope toward the outlet port minimizes hold-up volume and/or helps create a taller height of fluid with a minimum volume to allow sensing of the fluid parameters. Figure 5 also shows that the tips of the probes are angled downwardly into the fluid mixing chamber.

Figure 6 is a partial cross-sectional view of another portion of the mixer base assembly shown in Figure

1, showing a vent filter inlet port, a vent filter outlet port, a vent filter communicating with the vent filter outlet port, and fluid conduits.

Figure 7 is a top perspective view of the interface plate shown in Figure 1, also showing the impeller seat.

Figure 8 is a partial top view of the mixer base assembly shown in Figure 1, showing the body including the baffle, and the impeller.

Figures 9A, 10A, 11A, and 12A show embodiments of the mixer base assembly connectable to a variety of mixing vessels, wherein the mixer base assembly is docked into a hardware system (shown in Figures 13A-13D) containing electronics and a drive unit to rotate the impeller.

Figure 9A shows an embodiment of the mixer base assembly connectable to a commercially available rigid mixing vessel, including a threaded mounting ring that can be threaded to the bottom of the mixing vessel and mated (e.g., by pins or screws) to the mating face of the mixer base assembly; Figure 9B shows an enlarged view of the threaded base of the mixing vessel and the mounting ring, Figures 9C and 9D show, respectively, a cross-sectional view, and a bottom perspective view, of the mounting ring

Figure 10A shows an embodiment of the mixer base assembly connectable to a custom molded rigid mixing vessel; Figure 10B shows an enlarged view of the mounting flange at the bottom of the mixing vessel and the mating face of the mixer base assembly, wherein they can be mated together (e.g., by pins or screws, or welded); and Figure 10C shows a perspective bottom view of the mounting flange at the bottom of the mixing vessel.

Figure 11A shows an embodiment of the mixer base assembly connectable to a flexible mixing vessel (a biocontainer) arranged in a tote, including upper and lower sanitary flanges and a tri-clamp; Figure 11B shows an enlarged view of the upper sanitary flange and the tri-clamp; and Figure 11C shows an exploded view of the upper sanitary flange, the tri-clamp, and the lower sanitary flange (that can be mated, e.g., by pins or screws, or injection molded as part of the body) to the mating face of the mixer base assembly.

Figure 12A shows an embodiment of the mixer base assembly connectable by an adapter to a custom vacuum formed mixing vessel having halves welded together, wherein the vessel can be rigid or flexible; also showing a mating flange connectable to the bottom of the mixing vessel and an adapter for connecting the mating flange to the mixer base assembly; Figure 12B shows an enlarged view of the mating flange and adapter, Figure 12C shows top perspective views of the mating flange, adapter, and a sealing ring providing a seal between the adapter and the mating face of the mixer base assembly; and Figure 12D shows a bottom perspective view of the sealing ring.

Figure 13A shows an illustrative hardware system, Figure 13B shows a front partially disassembled view of the hardware system shown in Figure 13A, Figure 13C shows a rear partially disassembled view of the hardware system shown in Figure 13A, and Figure 13D shows an internal view of the hardware system shown in Figure 13A.

DETAILED DESCRIPTION OF THE INVENTION

[0006] In accordance with an embodiment of the invention, a mixer base assembly is provided comprising (a) a body having (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls; (iv) an inlet port arranged in a side wall; (v) an outlet port arranged in a side wall; (vi) a sampling port arranged in a side wall; (vii) at least one probe port arranged in a side wall; and, (viii) a fluid mixing chamber including a baffle, the fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) a levitating magnetic impeller arranged in the impeller seat, the impeller comprising a magnet, a base, and at least two blades, wherein the at least two blades extend above the bottom wall of the fluid mixing chamber into the fluid mixing chamber.

[0007] In some embodiments, the impeller seat is fluid tightly sealed to the bottom wall of the fluid mixing chamber. Alternatively, it can be included as part of the fluid mixing chamber (e.g., as a single, injection-molded part).

[0008] In a typical embodiment, the mixer base assembly includes two probe ports.

[0009] In some embodiments, the mixer base assembly further a vent inlet port and a vent outlet port, wherein the vent outlet port is arranged in a side wall of the body. In another embodiment, the vent outlet port is arranged in the body of the mixing vessel.

[0010] In a preferred embodiment, the bottom wall of the mixing chamber slopes downwardly toward the outlet port, and in a more preferred embodiment, the mixer base assembly further comprises at least one probe arranged in the at least one probe port, wherein a tip of the at least one probe (where the sensing element is located) is angled downwardly into the mixing chamber. In some embodiments, the mixer base assembly includes two probe ports, and two probes, each arranged in a separate probe port, wherein the tip of each probe is angled downwardly into the mixing chamber.

[0011] In another embodiment, a method for using a

mixing fluid comprises connecting a mixing vessel to a mixer base assembly comprising (a) a body having (i) an upper end including a mating face for mixing vessel connection; (ii) a lower end including a cavity; (iii) a plurality of side walls; (iv) an inlet port arranged in a side wall; (v) an outlet port arranged in a side wall; (vi) a sampling port arranged in a side wall; (vii) at least one probe port arranged in a side wall; and, (viii) a fluid mixing chamber including a baffle, the fluid mixing chamber having a bottom wall; (b) an impeller seat arranged in the cavity in the lower end of the body; and, (c) a levitating magnetic impeller arranged in the impeller seat, the impeller comprising a magnet, a base, and at least two blades, wherein the at least two blades extend above the bottom wall of the fluid mixing chamber into the fluid mixing chamber; introducing fluid into the fluid mixing chamber, and rotating the magnetic impeller to mix the fluid in the fluid mixing chamber.

[0012] Embodiments of the method can further comprise, for example, measuring or detecting a parameter of the fluid in the fluid mixing chamber (e.g., measuring the pH and/or the conductivity of the fluid) and/or sampling the fluid in the fluid mixing chamber and/or venting air from the mixer base assembly.

[0013] Advantageously, embodiments of the present invention provide a "clever base" that can be used with a variety of mixing vessels having different shapes and/or configurations. Homogenized mixing of a wide range of liquid volumes (e.g, about 35 ml to about 10,000 ml) and/or a liquids having wide range of viscosities (e.g., about 1 to about 25 Centipoise (cP)) can be achieved while minimizing or eliminating splashing, foaming, and/or vortexing of the liquids. Moreover, the use of a levitating magnetic impeller significantly reduces shear force, and eliminates rubbing of parts, thus reducing or eliminating particle shed that could contaminate the fluid.

[0014] Embodiments of the invention can be used with low volume mixing vessels, and if desired, can be connected to aseptic sampling devices (manual or automatic). If the mixing vessel does not have a vent filter, embodiments of the invention can include connection for a vent filter to maintain sterility and equilibrium of pressures within the system.

[0015] Preferably, the mixer base assembly is single-use.

[0016] Each of the components of the invention will now be described in more detail below, wherein like components have like reference numbers.

[0017] Figure 1 is an exploded top view of an embodiment of the mixer base assembly according to the invention, wherein the mixer base assembly 500 is part of a mixing base system 1000.

[0018] The illustrated embodiment of the mixer base assembly 500 comprises a body 550 having an upper end 571 including a mating face 575 for mixing vessel/mixing vessel adapter connection; a lower end 572 including a cavity 557; a plurality of side walls (4 side walls 551A, 551B, 551C, 551D are illustrated; an inlet port 501 (shown in more detail in Figure 3B) arranged in a side wall 551A (also showing an inlet port fitting 501A arranged in the inlet port); an outlet port 502 (having an entrance 502' and an exit 502") (the inlet and outlet ports can be separate components installed in the body or included in the body as a single injection molded part) passing through a different side wall 551C (also showing an outlet port fitting 502A arranged in the outlet port 502 as it passes (exits at 502") through the side wall); a sampling port 507 arranged in a side wall 551D (the illustrated port having external threads); at least one probe port arranged in a side wall 551C (two probe ports 518, 519 are illustrated, in some embodiments, the ports having internal threads, and probe adapters 818B and 819B have external threads, as well as o-rings (o-rings not shown)); and, a fluid mixing chamber 530 including a baffle (or vortex breaker) 525, the fluid mixing chamber having a bottom wall 531 with a through hole 532; an interface plate 600 comprising an impeller seat 615, wherein the interface plate is arranged in the cavity 557 in the lower end of the body 572, the interface plate also including a top surface 601, a bottom surface 602 (for docking to the drive unit), a spindle 610, and a lip 612 wherein the impeller seat and lip are fluid tightly sealed to the bottom wall of the fluid mixing chamber through the through hole 532 (alternatively, the impeller seat can be included as part of the fluid mixing chamber); and a levitating rotating magnetic impeller 650 arranged in the impeller seat, the impeller comprising a base 652 including a magnet and having a central vertical opening 653 (for the spindle 610, providing an axis about which the impeller rotates) and at least two blades (four blades 651A, 651B, 651C, 651D are illustrated), wherein the blades extend above the bottom wall of the fluid mixing chamber into the fluid mixing chamber. As shown in more detail in Figure 5, preferably, the bottom wall of the mixing chamber slopes downwardly toward the entrance 502' of the outlet port.

[0019] As shown in Figures 3A-3B, fluid is preferably directed via the inlet port 501 to a lower part of the fluid mixing chamber to minimize splashing upon entry, and as shown in Figures 4A-4B, the outlet port 502 is positioned at a low point in the bottom wall and passes through the side wall to aid in full draining of the fluid mixture chamber.

[0020] In the illustrated embodiment shown in Figure 1, the mixer base assembly 500 comprises a baffle (or vortex breaker) 525 in the fluid mixing chamber 530 which is advantageous for minimizing or eliminating splashing, foaming, and/or vortexing of the liquids.

[0021] Optionally, as shown in Figures 1 and 6, if a mixing vessel to be attached to the mixer base assembly does not include a vent, the mixer base assembly can further comprise a vent inlet port 511 (also showing a vent inlet port fitting 511A arranged in the vent inlet port) and a vent outlet port 512 (also showing a vent outlet port fitting 512A arranged in the vent outlet port), wherein the vent outlet port is arranged in a side wall of the body 551A, and the vent port is in communication (e.g., via a

conduit 924) with a vent filter 912. A variety of vent filters are known in the art and are commercially available. The fittings 511A, 512A, conduit 924, and filter 912 can be included with an embodiment of the mixer base assembly, or can be included with an embodiment of the mixing base system.

[0022] If desired, embodiments of the mixing base system 1000 or the mixer base assembly can include a sampling arrangement 700 comprising a sample port plug 707 and sample port nut 707A, wherein the sample port plug 707 can be arranged in the sampling port 507. In some embodiments, the sampling arrangement is for use with a threaded connection such as, for example, a DN 25 threaded connection. If desired, an autosampling system can be installed through the sampling port 507 and/or manual sampling can be carried out through outlet port exit 502". Illustratively, samples can be taken offline to measure parameters that the probes are not reading or to confirm a probe reading or to calibrate a sensor.

[0023] Additionally, or alternatively, embodiments of the mixing base system 1000 or the mixer base assembly can include a connector system 900 comprising an inlet connector 201 and an outlet connector 202, such as aseptic connectors. A variety of connectors, including aseptic connectors, are commercially available, from, for example, Pall Corporation (Port Washington, NY, e.g., KLEENPAK® PRESTO); Cole-Parmer (Vernon Hills, IL); and Eldon James (Denver, CO).

[0024] Embodiments of the mixing base system or the mixer base assembly further comprise at least one probe 800, typically, two probes 818, 819 (in some embodiments probe adapters 818B and 819B are used to connect the probes to the probe ports), wherein Figure 5 also shows the tips of two probes 818A, 819A arranged to sense fluid parameters of fluid in the fluid mixing chamber, preferably wherein the slope toward the outlet port minimizes hold-up volume (sometimes referred to as "carry-over volume") and/or helps create a taller height of fluid with a minimum volume to allow sensing of the fluid parameters. The Figure also shows that the tips of the probes are angled downwardly into the fluid mixing chamber. Advantageously, this allows positioning the tips as low as possible, and certain probes need to be positioned a few degrees above horizontal to operate correctly.

[0025] A variety of probes are suitable for use in embodiments of the invention, and are commercially available. Suitable probes include, for example, pH probes, conductivity probes, temperature sensors, dissolved oxygen probes, and cell counters.

[0026] The body can be fabricated from any suitable rigid impervious material, including any impervious thermoplastic material, which is compatible with the fluid being processed. For example, the housing can be fabricated from a metal, such as stainless steel, or from a polymer. In a preferred embodiment, the body is injection molded. The adapter plate is preferably plastic, and cannot be a magnetic material.

[0027] The mixer base assembly is connectable to a variety of mixing vessels (e.g., as shown in Figures 9A, 10A, 11A, and 12A).

[0028] Figure 9A shows an embodiment of the mixer base assembly connectable to a commercially available rigid mixing vessel 1500A having threads 1501 at the bottom, allowing connection with a threaded mounting ring 1502 (having threads 1502A) that can be threaded to the bottom of the mixing vessel and mated (e.g., by pins or screws) to the mating face of the mixer base assembly; Figure 9B shows an enlarged view of the threaded base of the mixing vessel and the mounting ring, Figures 9C and 9D show, respectively, a cross-sectional view, and a bottom perspective view, of the mounting ring 1502.

[0029] Figure 10A shows an embodiment of the mixer base assembly connectable to a custom molded rigid mixing vessel 1500B having a base 1510 and a mounting flange 1511; Figure 10B shows an enlarged view of the mounting flange 1511 at the bottom of the mixing vessel and the mating face of the mixer base assembly, wherein they can be mated together (e.g., by pins or screws); and Figure 10C shows a perspective bottom view of the mounting flange 1511 at the bottom of the mixing vessel.

[0030] Figure 11A shows an embodiment of the mixer base assembly connectable to a custom formed flexible mixing vessel (a biocontainer) 1500C arranged in a tote 1507, including a clamping arrangement 1525 comprising upper and lower sanitary flanges 1526A, 1526B, and a tri-clamp 1527; Figure 11B shows an enlarged view of the upper sanitary flange 1526A and the tri-clamp 1527; and Figure 11C shows an exploded view of the upper sanitary flange 1526A, the tri-clamp 1527, and the lower sanitary flange 1526B (that can be mated, e.g., by pins or screws) to the mating face of the mixer base assembly.

[0031] Figure 12A shows an embodiment of the mixer base assembly connectable by an adapter to a custom vacuum formed mixing vessel 1500D having halves welded 1517A, 1517B together, wherein the vessel can be rigid or flexible; also showing a mating flange 1518 connectable to the bottom of the mixing vessel and an adapter 1519 for connecting the mating flange to the mixer base assembly; Figure 12B shows an enlarged view of the mating flange 1518 and adapter 1519, Figure 12C shows top perspective views of the mating flange 1518, adapter 1519, and a sealing ring 1521 providing a seal between the adapter and the mating face of the mixer base assembly; and Figure 12D shows a bottom perspective view of the sealing ring 1521.

[0032] Mixing vessels can be docked to a variety of drive systems. Drive systems include a motor, an input/output (IO) module, a power supply, fans, wiring and connectors, and, optionally, a weighing system, arranged in a housing.

[0033] Figures 13A-13D show an illustrative drive system 2500 comprising a motor 2000 (shown in Figures 13B and 13C); an I/O module 2100, DC-DC converters 2150A, 2150B and terminal blocks 2155 (mounted to a

rail 2160), inlet and outlet fans 2175A, 2175B (Figure 13D), a power receptacle 2190; a weighing system 2200 (shown including a weighing system cover 2201 and a weighing system load cell 2202 (Figures 13B and 13C), as well as a weighing system display 2203 and weighing system connector 2204 (Figure 13D).

[0034] The illustrated housing 2300 includes a front cover 2301, a rear cover 2302, a top cover/mixer base support 2303, and a chassis 2304.

[0035] Figure 13C shows a top cover gasket 2401 is mounted on top of the top cover/mixer base support 2303, and a mixer base assembly gasket 2402 is mounted on top of the motor 2000.

[0036] A variety of motors for magnetically levitating and spinning the impellers are known in the art. Commercially available motors include those available from Pall Corporation (Port Washington, NY; e.g., LEVMIXER® SYSTEM) and Levitronix GmbH (Zurich, Switzerland).

[0037] The mating face of the mixer base assembly can be adapted for connection to a variety of size, shape, and/or type of mixing vessels, and the bottom surface of the interface plate can be adapted for docking to a variety of drive systems. In some embodiments, components and/or processes such as screws, pins, bolts, mounting rings, adapters, o-rings (with or without grooves or channels in the mating face), sanitary gaskets, and/or ultrasonic welding can be used for efficient connection. Figures 9B-9D, 10B-10C, 11B-11C, and 12B-12D show exemplary components and processes for connection, and Figure 13C shows exemplary components for docking.

[0038] The following examples further illustrate the invention but, of course, should not be construed as in any way limiting its scope.

EXAMPLE 1

[0039] This example demonstrates the quick (less than 60 seconds) homogenous mixing time and low carry-over volume (less than 20 mL) when using a mixer base assembly according to an embodiment of the invention with a variety of mixing vessels and fluid viscosities.

[0040] An embodiment of a mixer base assembly as generally shown in Figure 1 is connected to mixing vessels and drive units as generally shown in Figures 9A, 10A, 11A, and 12B.

[0041] In each experiment, the fluid volume is 100 mL, and the impeller speed is 700 rpm. In one set of experiments, the fluid viscosity is 1 Pa•s (1 cP), in the other set of experiments, the fluid viscosity is 25 Pa•s (25 cP).

[0042] The homogenous mixing time is conducted via additions of acids and bases, and time recorded to stability of pH, defined as a 10 second period of time with a pH change of < 0.1. At 1 Pa•s (1 cP), the mixing time for the acid is 14 seconds, and the mixing time for the base is 13 seconds. At 25 Pa•s (25 cP), the mixing time for the acid is 24 seconds, and the mixing time for the base is 31 seconds.

[0043] The carry-over volume for the mixing vessel shown in Figure 9A is 7 mL; for Figure 10A, 11 mL; for Figure 11A, 4 mL, and for Figure 12A, 15 mL.

EXAMPLE 2

[0044] This example demonstrates the quick (less than 60 seconds) homogenous mixing time and low carry-over volume (less than 20 mL) when using a mixer base assembly according to an embodiment of the invention with a variety of mixing vessels and fluid viscosities.

[0045] This example is similar to Example 1, with the exception that the fluid volume is 10,000 mL (100:1 turndown ratio), and the impeller speed is 5000 rpm.

[0046] As with Example 1, in one set of experiments, the fluid viscosity is 1 Pa•s (1 cP), in the other set of experiments, the fluid viscosity is 25 Pa•s (25 cP).

[0047] At 1 Pa•s (1 cP), the mixing time for the acid for the mixing vessel shown in Figure 9A is 20 seconds, for Figure 10A is 35 seconds, for Figure 11A is 9 seconds, and for Figure 12A is 29 seconds. The mixing time for the base for each of these mixing vessels is 31 seconds, 44 seconds, 45 seconds, and 34 seconds, respectively.

[0048] At 25 Pa•s (25 cP), the mixing time for the acid for the mixing vessel shown in Figure 9A is 33 seconds, for Figure 10A is 22 seconds, for Figure 11A is 39 seconds, and for Figure 12A is 32 seconds. The mixing time for the base for the mixing vessel shown in Figure 9A is not stable after 1197 seconds (it is believed the shape and footprint of the vessel does not allow good mixing at high viscosity); for Figure 10A is 35 seconds, for Figure 11A is 34 seconds, and for Figure 12A is 34 seconds.

[0049] As with Example 1, the carry-over volume for the mixing vessel shown in Figure 9A is 7 mL; for Figure 10A, 11 mL; for Figure 11A, 4 mL, and for Figure 12A, 15 mL.

[0050] The use of the terms "a" and "an" and "the" and "at least one" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The use of the term "at least one" followed by a list of one or more items (for example, "at least one of A and B") is to be construed to mean one item selected from the listed items (A or B) or any combination of two or more of the listed items (A and B), unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be con-

strued as indicating any non-claimed element as essential to the practice of the invention.

[0051] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein.

Claims

1. A mixer base assembly (500) comprising:

   (a) a body (550) having:

   (i) an upper end (571) including a mating face (575) for mixing vessel connection;
   (ii) a lower end (572) including a cavity (557);
   (iii) a plurality of side walls (551A, 551B, 551C, 551D);
   (iv) an inlet port (501) arranged in a side wall (551A);
   (v) an outlet port (502) arranged in a side wall (551C), and
   (vi) a fluid mixing chamber (530) including a baffle (525), the fluid mixing chamber (530) having a bottom wall (531);

   (b) an impeller seat (615) arranged in the cavity (557) in the lower end (572) of the body (550); and,
   (c) a levitating magnetic impeller (650) arranged in the impeller seat (615), the impeller (650) comprising a magnet, a base, and at least two blades, wherein the at least two blades (651A, 651B, 651C, 651D) extend above the bottom wall of the fluid mixing chamber (530) into the fluid mixing chamber (530),

   characterized in that the body (550) has:

   (vii) a sampling port (507) arranged in a side wall; and
   (viii) at least one probe port (518; 519) arranged in a side wall.

2. The mixer base assembly (500) of claim 1, further comprising a vent inlet port (511) and a vent outlet port (512), wherein the vent outlet port (512) is arranged in a side wall (551A) of the body (550).

3. The mixer base assembly (500) of any one of claim 1 or 2, wherein the bottom wall (531) of the mixing chamber (530) slopes downwardly toward the outlet port (502).

4. The mixer base assembly (500) of any one of claims 1-3, further comprising at least one probe insertable into the at least one probe port (518; 519).

5. The mixer base assembly (500) of any one of claims 1-4, further comprising a sampling arrangement (700) comprising a sample port plug (707) and a sample port nut (707A), wherein the sample port plug (707) is insertable into the sampling port (507).

6. A method for mixing fluid, the method comprising:

   connecting a mixing vessel (1500A) to a mixer base assembly (500) comprising (a) a body (550) having (i) an upper end (571) including a mating face for mixing vessel connection; (ii) a lower end (572) including a cavity (557); (iii) a plurality of side walls (551A, 551B, 551C, 551D); (iv) an inlet port (501) arranged in a side wall (551A); (v) an outlet port (502) arranged in a side wall (551C); (vi) a sampling port (507) arranged in a side wall (551D); (vii) at least one probe port (518; 519) arranged in a side wall; and, (viii) a fluid mixing chamber (530) including a baffle (525), the fluid mixing chamber (530) having a bottom wall (531); (b) an impeller seat (615) arranged in the cavity (557) in the lower end of the body (550); and, (c) a levitating magnetic impeller (650) arranged in the impeller seat (615), the impeller (650) comprising a magnet, a base, and at least two blades (651A, 651B, 651C, 651D), wherein the at least two blades blades (651A, 651B, 651C, 651D) extend above the bottom wall (531) of the fluid mixing chamber (530) into the fluid mixing chamber (530); and,
   introducing fluid into the fluid chamber, and rotating the magnetic impeller (650) to mix the fluid in the mixing chamber (530).

7. The method of claim 6, further comprising measuring the pH and/or conductivity of the fluid in the fluid mixing chamber (530).

8. The method of claim 6 or 7, further comprising sampling the fluid in the fluid mixing chamber (530).

Patentansprüche

1. Mischerbasisanordnung (500), welche umfasst:

   (a) einen Körper (550), aufweisend:

   (i) ein oberes Ende (571), welches eine Gegenfläche (575) für einen Mischgefäßan-

schluss umfasst;
(ii) ein unteres Ende (572), welches eine Vertiefung (557) umfasst;
(iii) eine Mehrzahl von Seitenwänden (551A, 551B, 551C, 551D);
(iv) einen Einlass-Port (501), welcher in einer Seitenwand (551A) angeordnet ist;
(v) einen Auslass-Port (502), welcher in einer Seitenwand (551C) angeordnet ist; und
(vi) eine Fluidmischkammer (530), welche ein Leitelement (525) umfasst, wobei die Fluidmischkammer (530) eine Bodenwand (531) aufweist;

(b) einen Impellersitz (615), welcher in der Vertiefung (557) in dem unteren Ende (572) des Körpers (550) angeordnet ist; und
(c) einen freischwebenden magnetischen Impeller (650), welcher in dem Impellersitz (615) angeordnet ist, wobei der Impeller (650) einen Magneten, eine Basis und mindestens zwei Flügel umfasst, wobei die mindestens zwei Flügel (651A, 651B, 651C, 651D) sich über der Bodenwand der Fluidmischkammer (530) in die Fluidmischkammer (530) hinein erstrecken,

dadurch gekennzeichnet, dass der Körper (550) aufweist:

(vii) einen Probenahme-Port (507), welcher in einer Seitenwand angeordnet ist; und
(viii) mindestens einen Sonden-Port (518; 519), welcher in einer Seitenwand angeordnet ist.

2. Mischerbasisanordnung (500) nach Anspruch 1, ferner umfassend einen Lüftungseinlass-Port (511) und einen Lüftungsauslass-Port (512), wobei der Lüftungsauslass-Port (512) in einer Seitenwand (551A) des Körpers (550) angeordnet ist.

3. Mischerbasisanordnung (500) nach einem der Ansprüche 1 oder 2, wobei die Bodenwand (531) der Mischkammer (530) nach unten in Richtung zu dem Auslass-Port (502) hin abfällt.

4. Mischerbasisanordnung (500) nach einem der Ansprüche 1 bis 3, ferner umfassend mindestens eine in den mindestens einen Sonden-Port (518; 519) einführbare Sonde.

5. Mischerbasisanordnung (500) nach einem der Ansprüche 1 bis 4, ferner umfassend eine Probenahmeanordnung (700), welche einen Probenahme-Port-Stopfen (707) und eine Probenahme-Port-Mutter (707A) umfasst, wobei der Probenahme-Port-Stopfen (707) in den Probenahme-Port (507) einführbar ist.

6. Verfahren zum Mischen eines Fluids, wobei das Verfahren umfasst: Verbinden eines Mischgefäßes (1500A) mit einer Mischerbasisanordnung (500), welche umfasst: (a) einen Körper (550), aufweisend: (i) ein oberes Ende (571), welches eine Gegenfläche für einen Mischgefäßanschluss umfasst; (ii) ein unteres Ende (572), welches eine Vertiefung (557) umfasst; (iii) eine Mehrzahl von Seitenwänden (551A, 551B, 551C, 551D); (iv) einen Einlass-Port (501), welcher in einer Seitenwand (551A) angeordnet ist; (v) einen Auslass-Port (502), welcher in einer Seitenwand (551C) angeordnet ist; (vi) einen Probenahme-Port (507), welcher in einer Seitenwand (551D) angeordnet ist;

(vii) mindestens einen Sonden-Port (518; 519), welcher in einer Seitenwand angeordnet ist; und
(viii) eine Fluidmischkammer (530), welche ein Leitelement (525) umfasst, wobei die Fluidmischkammer (530) eine Bodenwand (531) aufweist; (b) einen Impellersitz (615), welcher in der Vertiefung (557) in dem unteren Ende (572) des Körpers (550) angeordnet ist; und (c) einen freischwebenden magnetischen Impeller (650), welcher in dem Impellersitz (615) angeordnet ist, wobei der Impeller (650) einen Magneten, eine Basis und mindestens zwei Flügel (651A, 651B, 651C, 651D) umfasst, wobei die mindestens zwei Flügel (651A, 651B, 651C, 651D) sich über der Bodenwand (531) der Fluidmischkammer (530) in die Fluidmischkammer (530) hinein erstrecken; und
Einführen eines Fluids in die Fluidmischkammer und Rotieren des magnetischen Impellers (650), um das Fluid in der Fluidmischkammer (530) zu mischen.

7. Verfahren nach Anspruch 6, ferner umfassend: Messen des pH-Wertes und/oder der Leitfähigkeit des Fluids in der Fluidmischkammer (530).

8. Verfahren nach Anspruch 6 oder 7, ferner umfassend eine Probenahme des Fluids in der Fluidmischkammer (530).

Revendications

1. Assemblage de base de mélangeur (500) comprenant :

(a) un corps (550) présentant :

(i) une extrémité supérieure (571) incluant une face d'accouplement (575) pour un raccordement de cuve de mélange ;
(ii) une extrémité inférieure (572) incluant une cavité (557) ;

(iii) plusieurs parois latérales (551A, 551B, 551C, 551D) ;
(iv) un orifice d'entrée (501) disposé dans une paroi latérale (551A) ;
(v) un orifice de sortie (502) disposé dans une paroi latérale (551C), et
(vi) une chambre de mélange de fluide (530) incluant une chicane (525), la chambre de mélange de fluide (530) présentant une paroi de fond (531) ;

(b) un siège de pale (615) disposé dans la cavité (557) dans l'extrémité inférieure (572) du corps (550) ; et,
(c) une pale à sustentation magnétique (650) disposée dans le siège de pale (615), la pale (650) comprenant un aimant, une base, et au moins deux lames, dans lequel les au moins deux lames (651A, 651B, 651C, 651D) s'étendent au-dessus de la paroi de fond de la chambre de mélange de fluide (530) dans la chambre de mélange de fluide (530), **caractérisé en ce que** le corps (550) présente :

(vii) un orifice d'échantillonnage (507) disposé dans une paroi latérale ; et
(viii) au moins un orifice de sonde (518; 519) disposé dans une paroi latérale.

2. Assemblage de base de mélangeur (500) selon la revendication 1, comprenant de plus un orifice d'entrée d'évent (511) et un orifice de sortie d'évent (512), dans lequel l'orifice de sortie d'évent (512) est disposé dans une paroi latérale (551A) du corps (550).

3. Assemblage de base de mélangeur (500) selon l'une quelconque des revendications 1 ou 2, dans lequel la paroi de fond (531) de la chambre de mélange (530) est inclinée vers le bas vers l'orifice de sortie (502).

4. Assemblage de base de mélangeur (500) selon l'une quelconque des revendications 1-3, comprenant de plus au moins une sonde pouvant être insérée dans le au moins un orifice de sonde (518 ; 519).

5. Assemblage de base de mélangeur (500) selon l'une quelconque des revendications 1-4, comprenant de plus un dispositif d'échantillonnage (700) comprenant un bouchon d'orifice d'échantillon (507) et un écrou d'orifice d'échantillon (707A), dans lequel le bouchon d'orifice d'échantillon (707) peut être inséré dans l'orifice d'échantillonnage (507).

6. Procédé de mélange de fluide, le procédé comprenant :

le raccordement d'une cuve de mélange (1500A) à un assemblage de base de mélangeur (500) comprenant (a) un corps (550) présentant (i) une extrémité supérieure (571) incluant une face d'accouplement pour un raccordement de cuve de mélange ; (ii) une extrémité inférieure (572) incluant une cavité (557) ; (iii) plusieurs parois latérales (551A, 551B, 551C, 551D) ; (iv) un orifice d'entrée (501) disposé dans une paroi latérale (551A) ; (v) un orifice de sortie (502) disposé dans une paroi latérale (551C) ; (vi) un orifice d'échantillonnage (507) disposé dans une paroi latérale (551D) ; (vii) au moins un orifice de sonde (518; 519) disposé dans une paroi latérale ; et, (viii) une chambre de mélange de fluide (530) incluant une chicane (525), la chambre de mélange de fluide (530) présentant une paroi de fond (531) ; (b) un siège de pale (615) disposé dans la cavité (557) dans l'extrémité inférieure du corps (550) ; et, (c) une pale à sustentation magnétique (650) disposée dans le siège de pale (615), la pale (650) comprenant un aimant, une base, et au moins deux lames (651A, 651B, 651C, 651D), dans lequel les au moins deux lames (651A, 651B, 651C, 651D) s'étendent au-dessus de la paroi de fond (531) de la chambre de mélange de fluide (530) dans la chambre de mélange de fluide (530) ; et, l'introduction de fluide dans la chambre de fluide, et la rotation de la pale magnétique (650) pour mélanger le fluide dans la chambre de mélange (530).

7. Procédé selon la revendication 6, comprenant de plus la mesure du pH et/ou de la conductivité du fluide dans la chambre de mélange de fluide (530).

8. Procédé selon la revendication 6 ou 7, comprenant de plus l'échantillonnage du fluide dans la chambre de mélange de fluide (530).

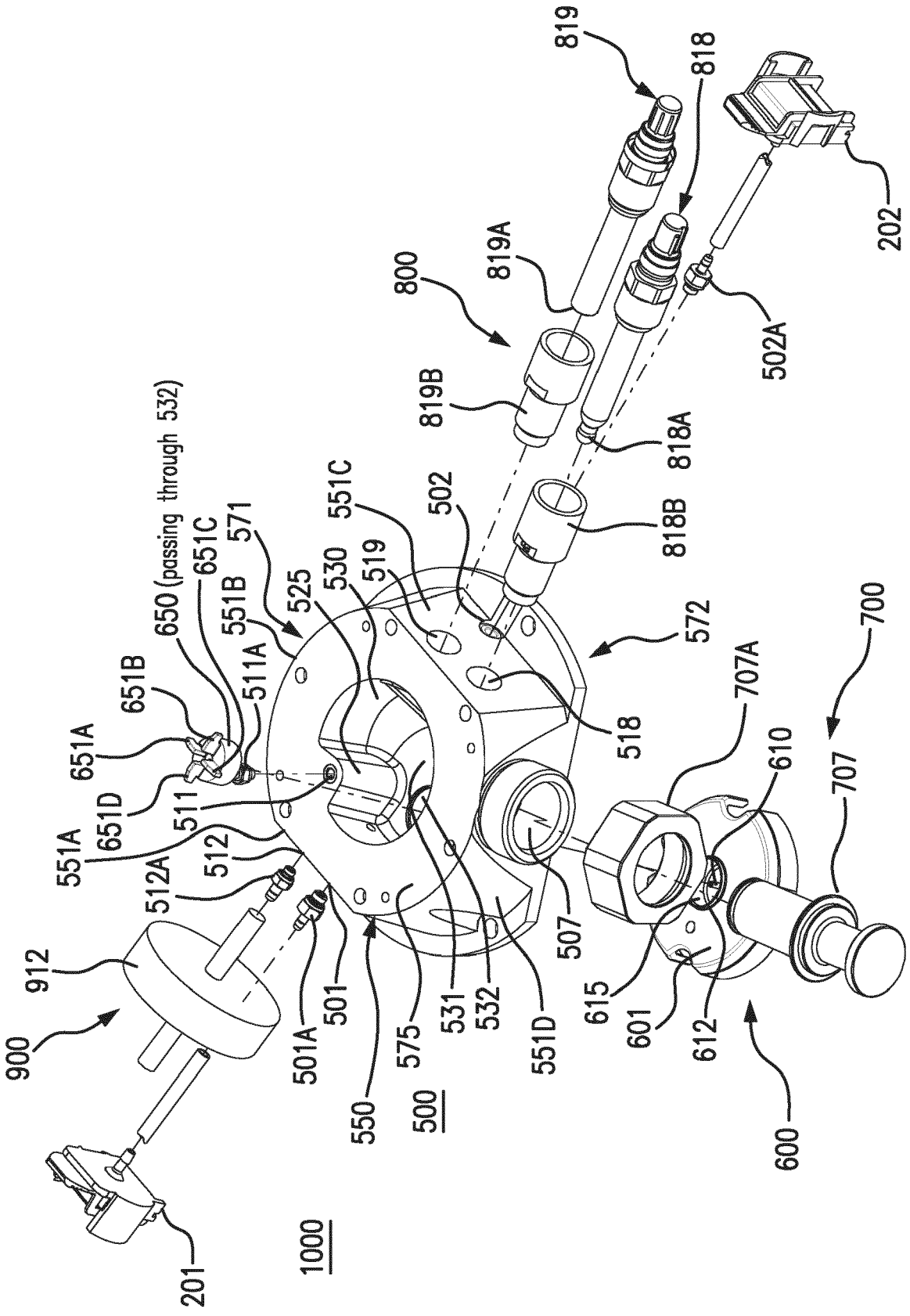
819
818
202
800
819A
502A
819B
818A
818B
502
551C
571
525
530
519
572
700
707A
610
707
518
507
615
601
612
600
550
575
531
532
551D
501
501A
900
912
512A
512
551A
651D
511
651A
651B
650 (passing through 532)
651C
551B
511A
201
1000
500

FIG. 1

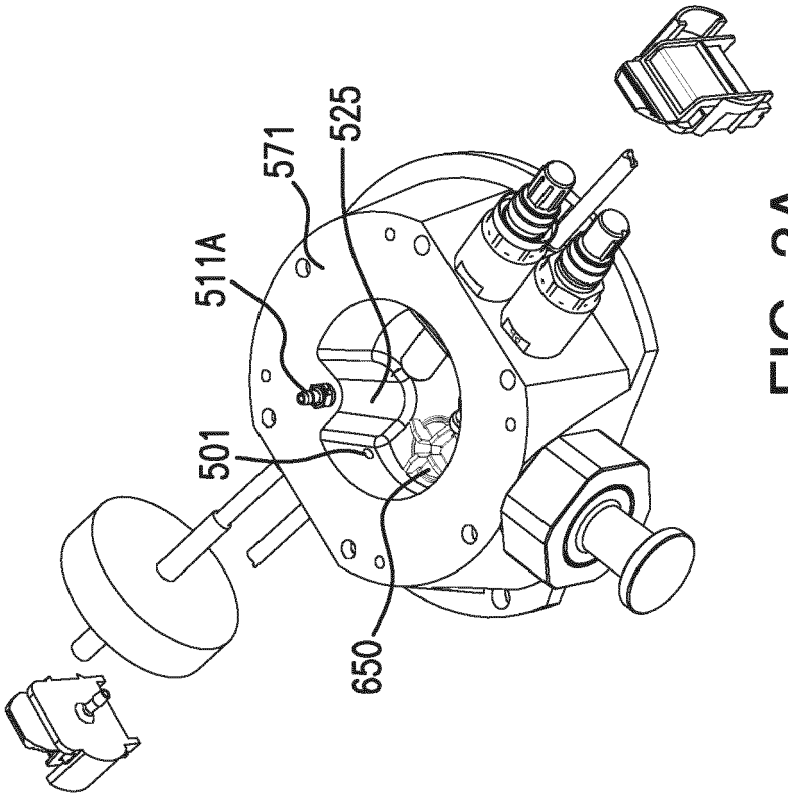

FIG. 3A

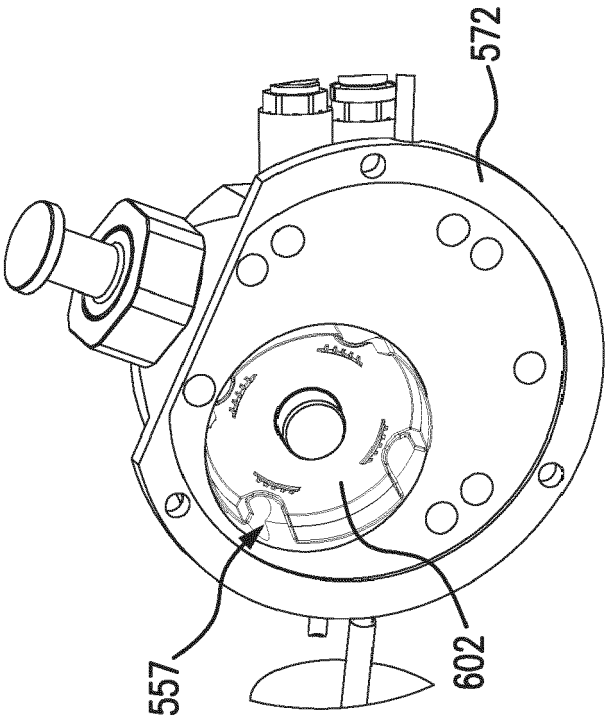

FIG. 2

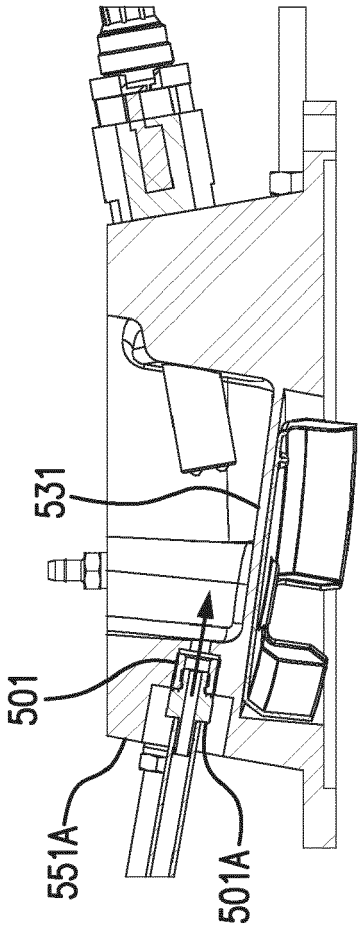

FIG. 3B

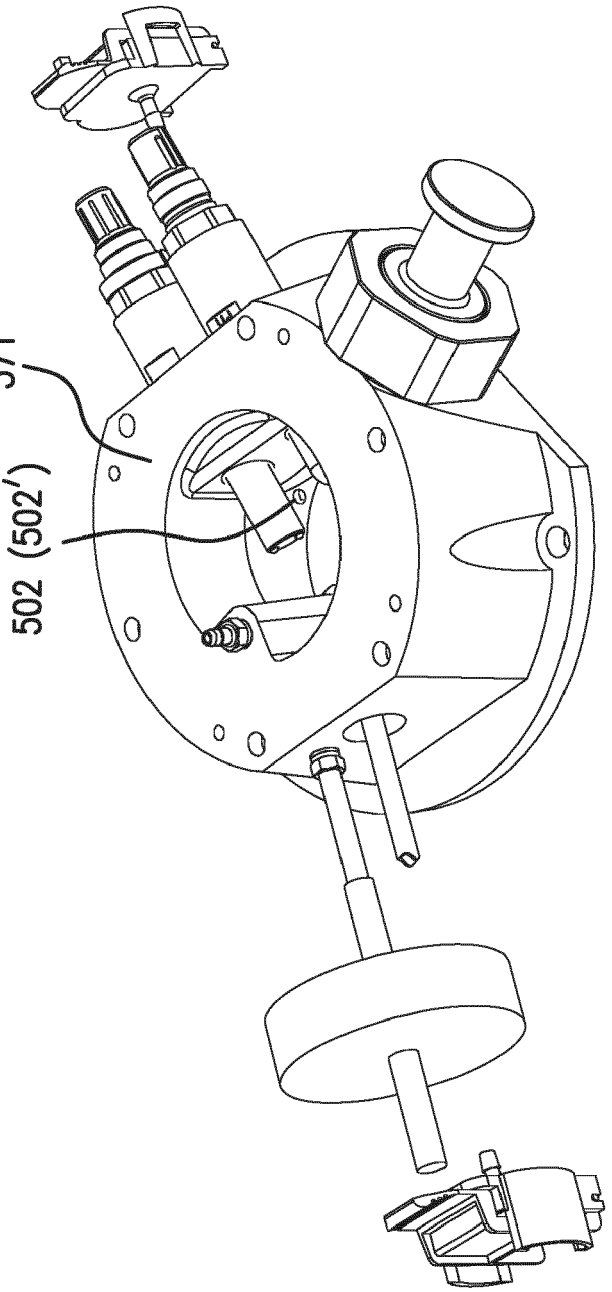

FIG. 4A

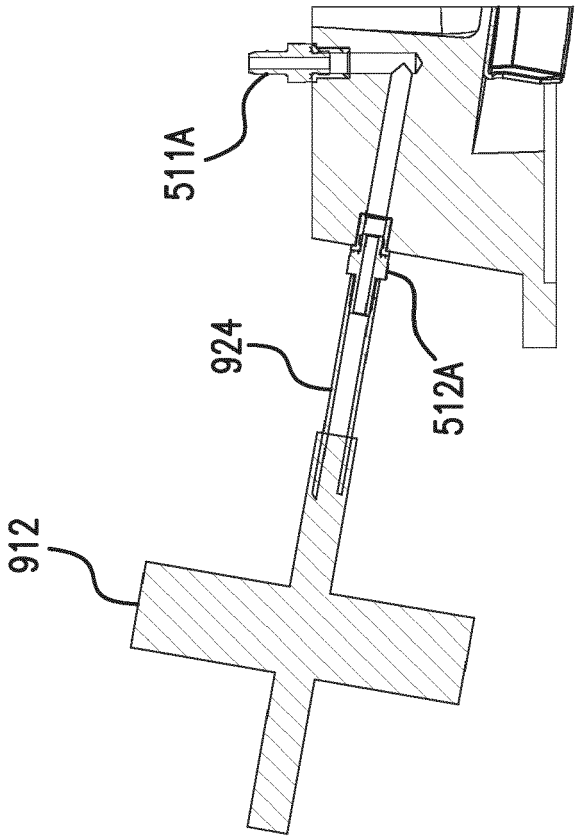

FIG. 6

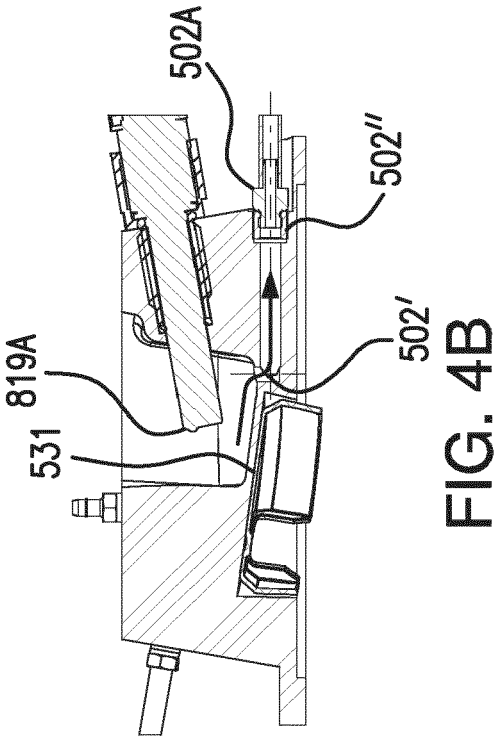

FIG. 4B

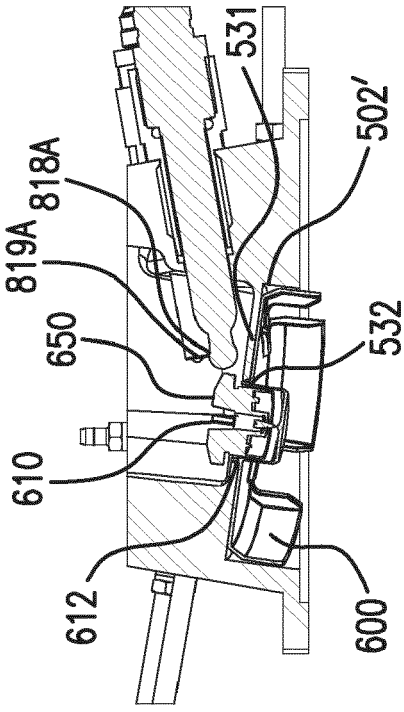

FIG. 5

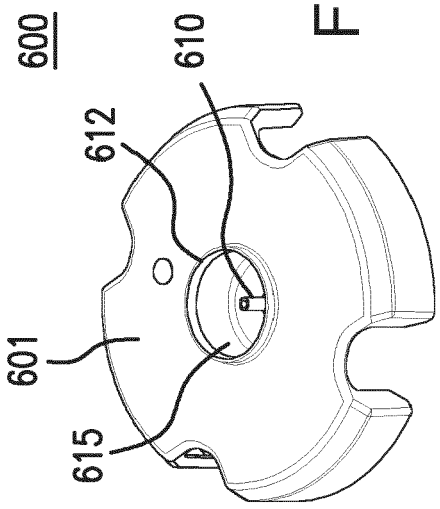

FIG. 7

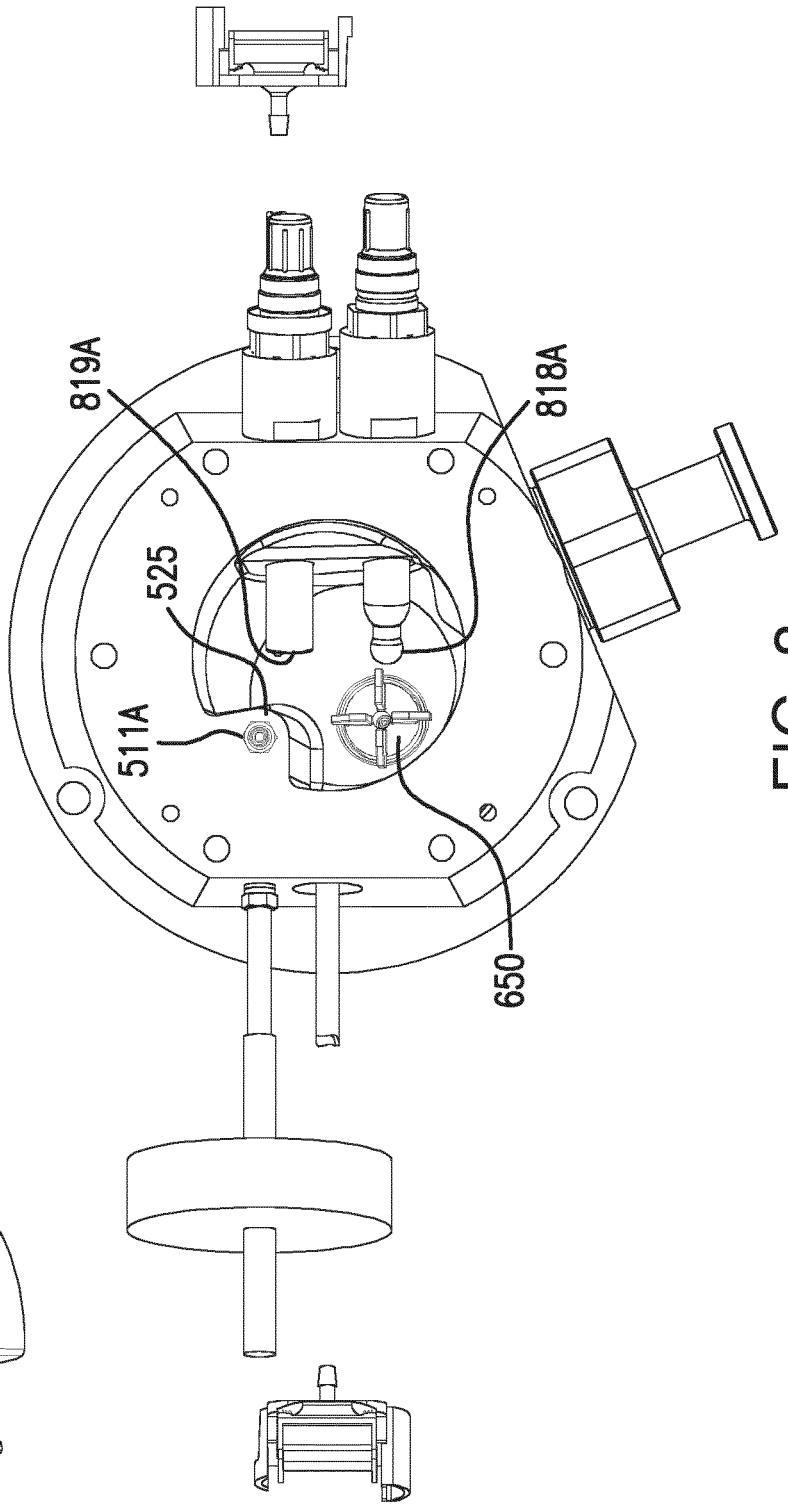

FIG. 8

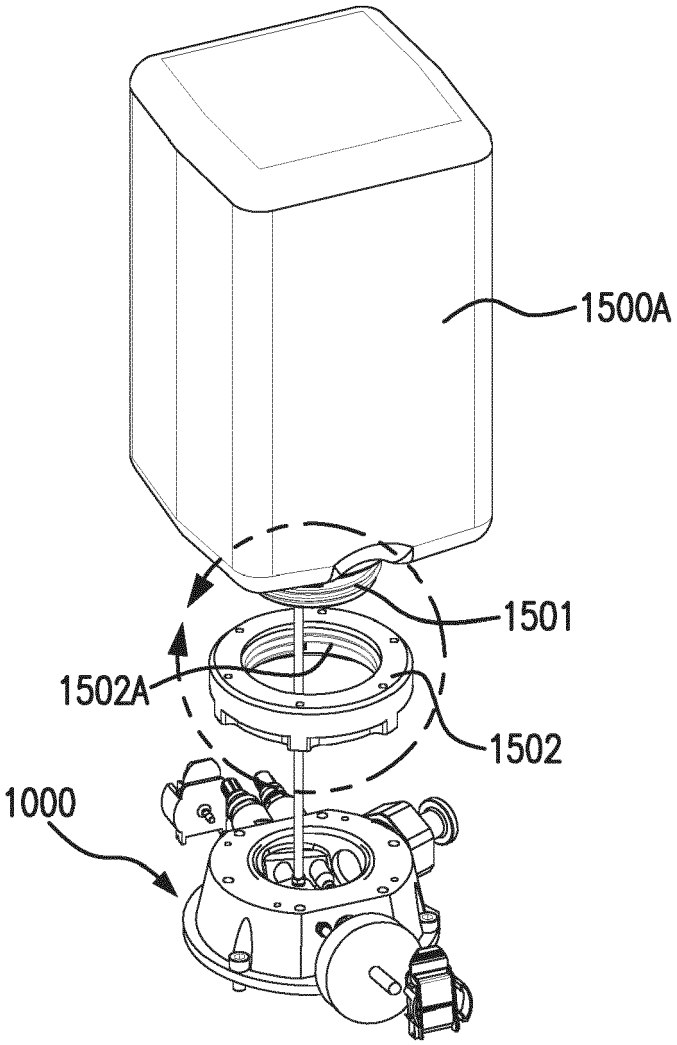

FIG. 9A

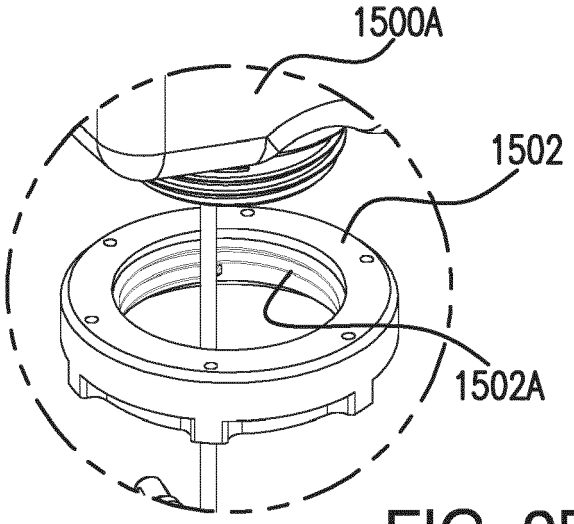

FIG. 9B

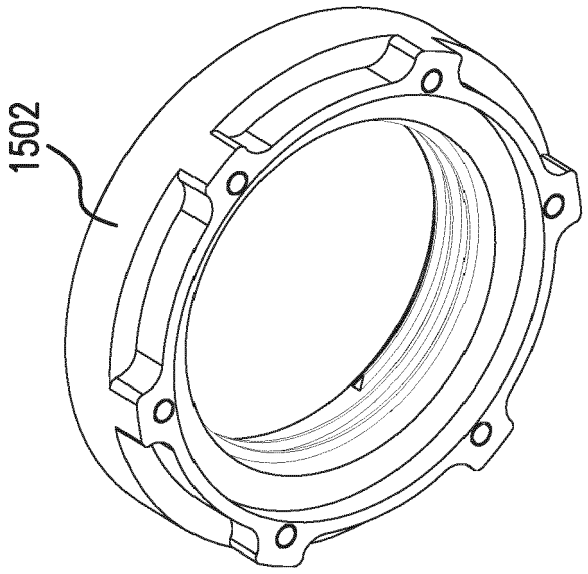

FIG. 9D

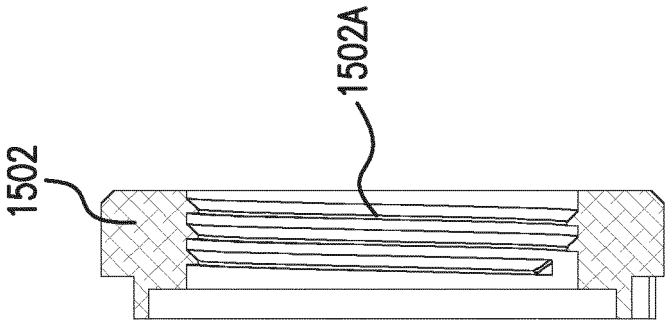

FIG. 9C

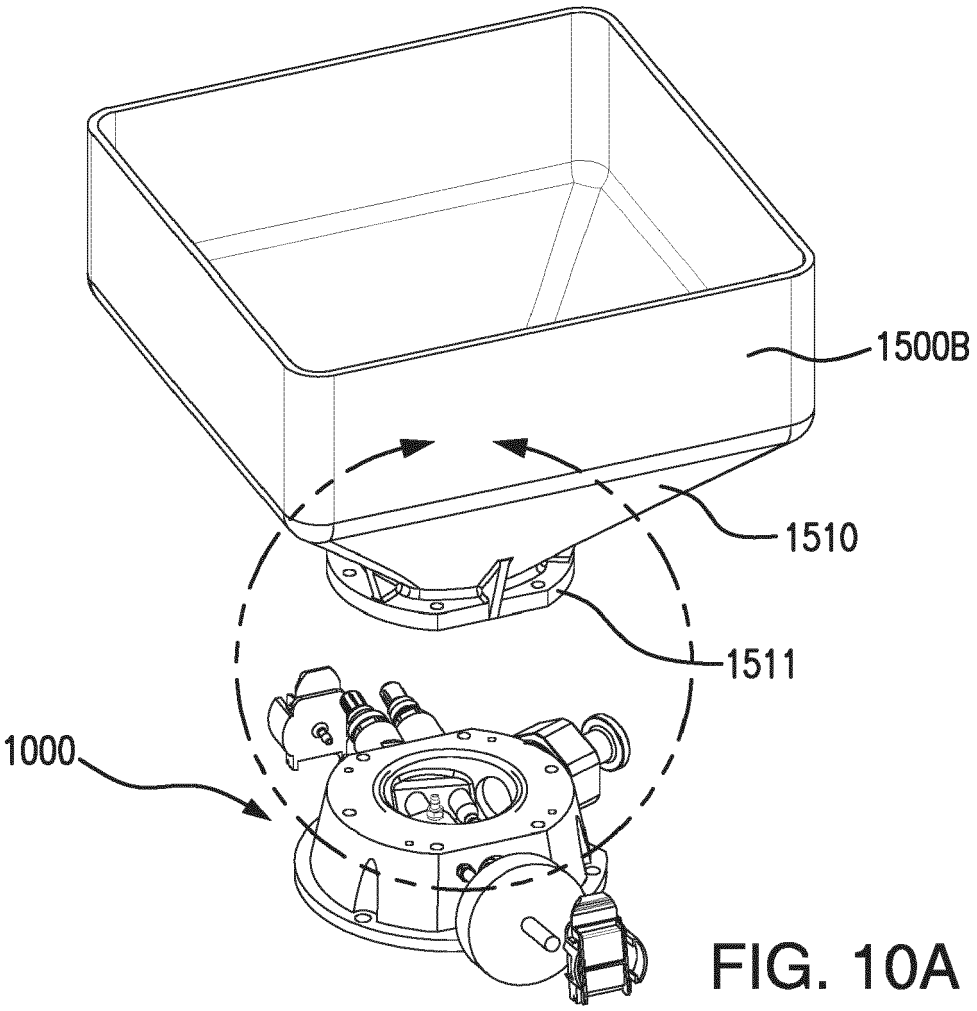

FIG. 10A

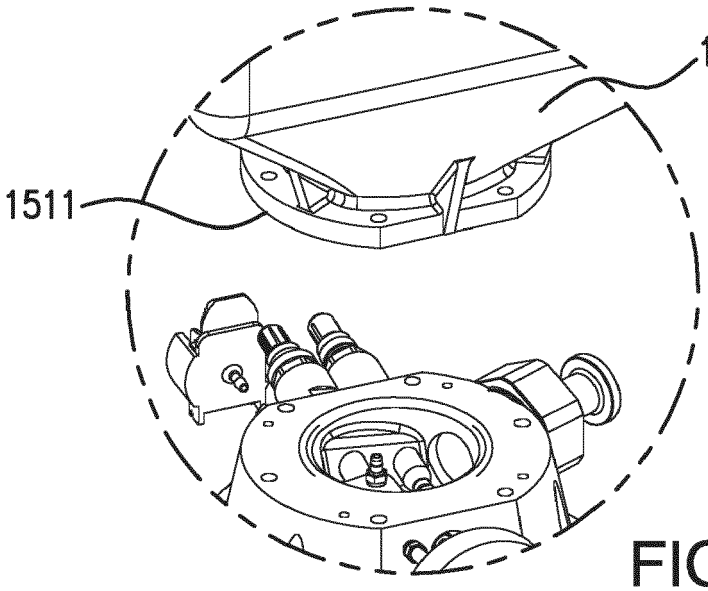

FIG. 10B

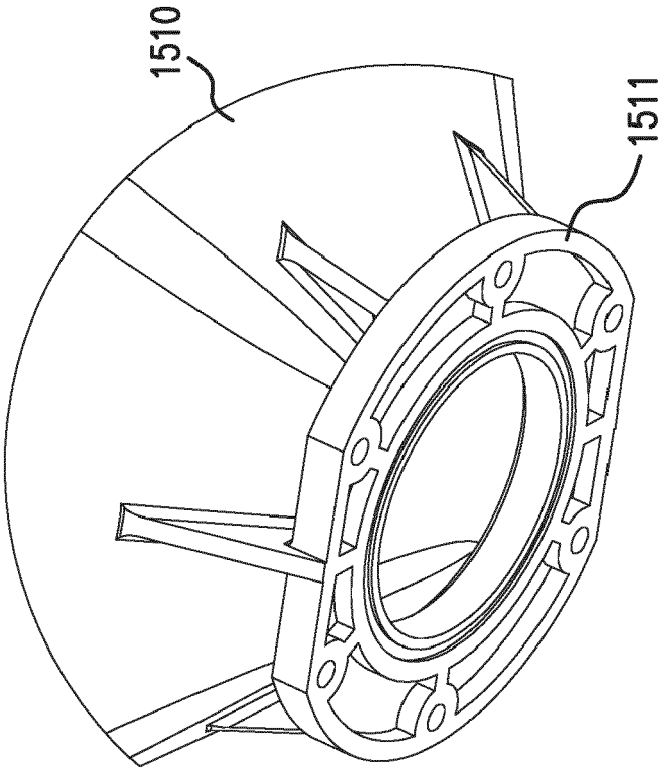

FIG. 10C

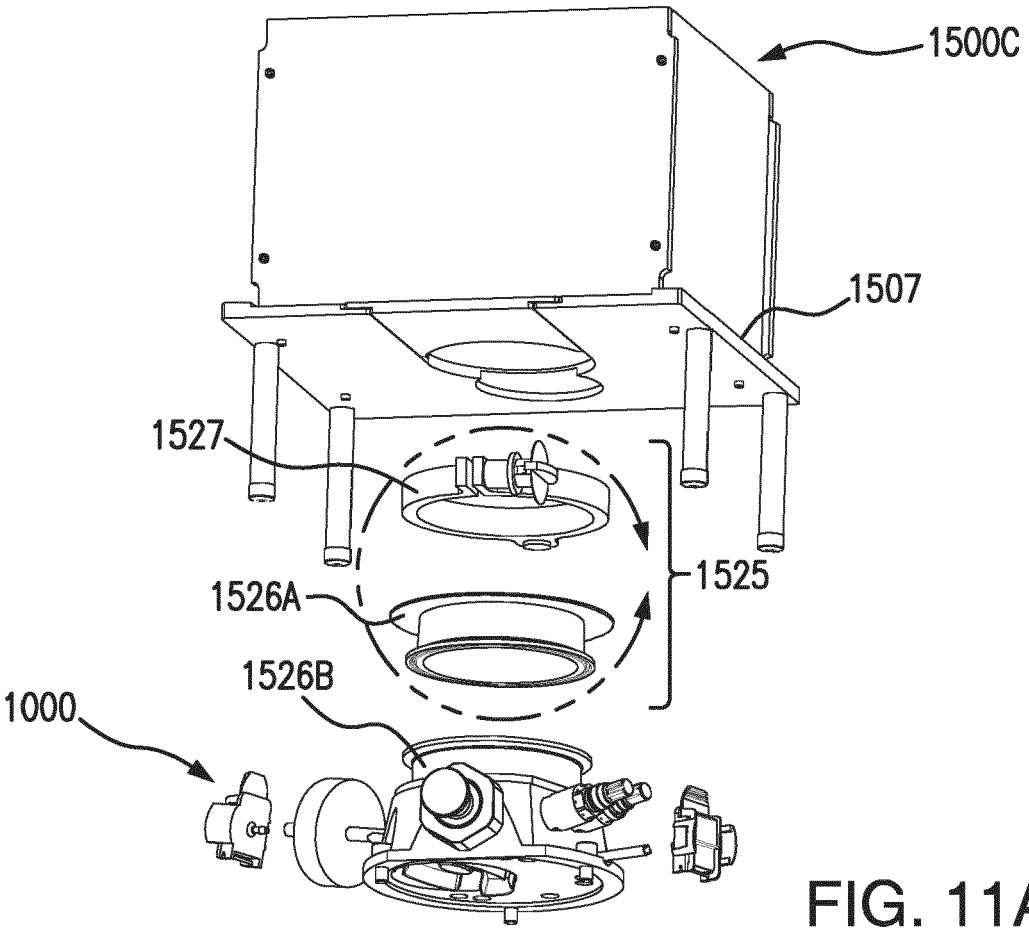

FIG. 11A

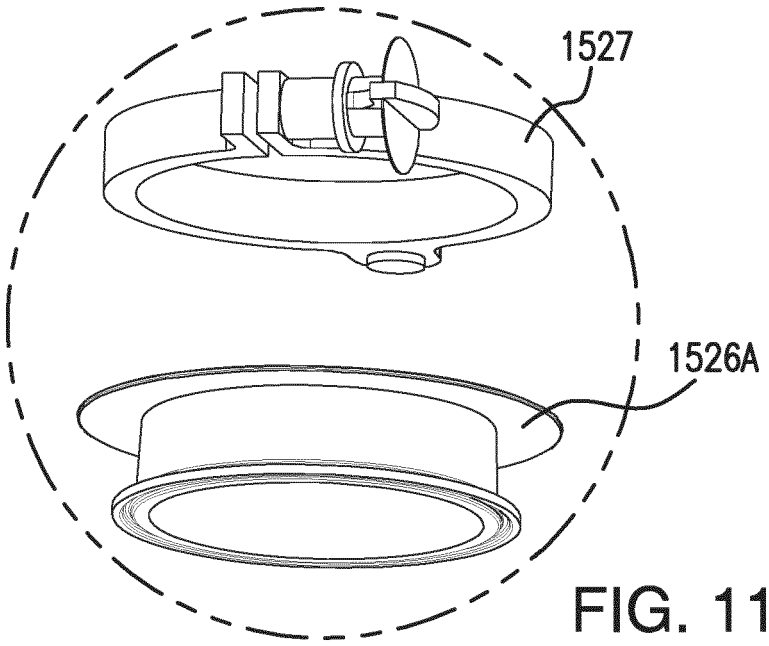

FIG. 11B

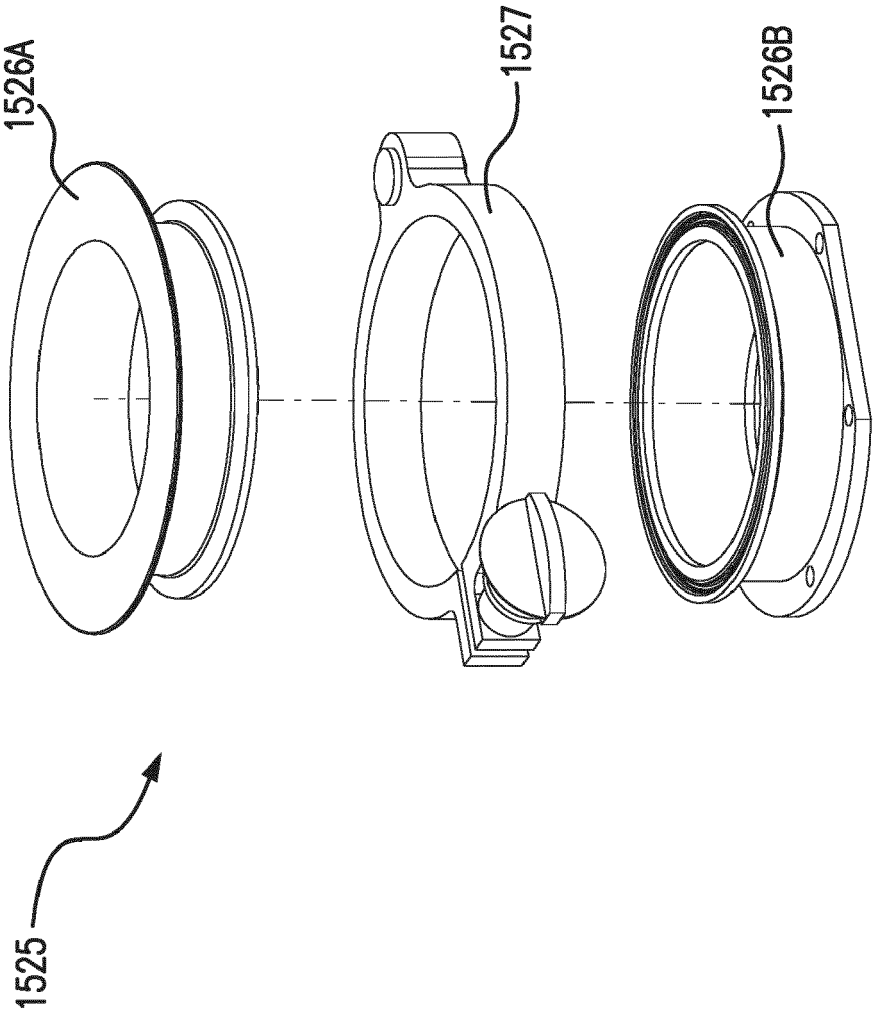

FIG. 11C

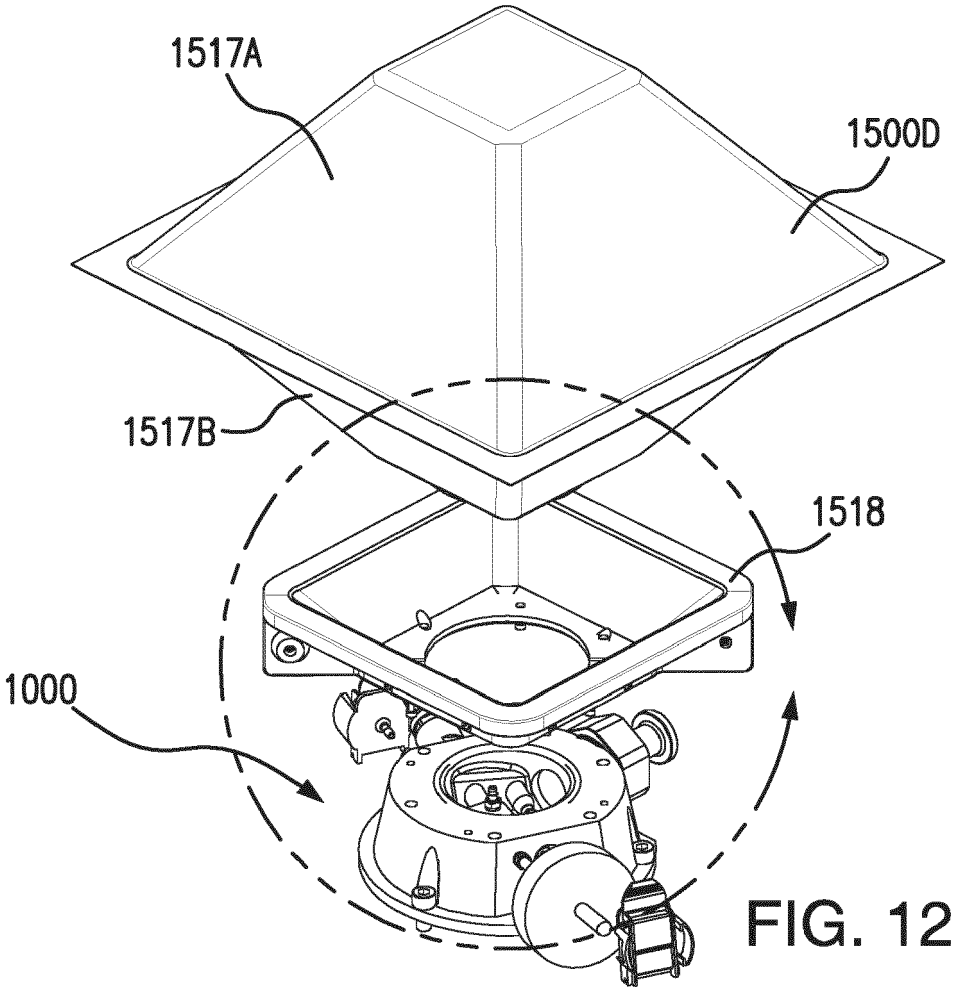

FIG. 12A

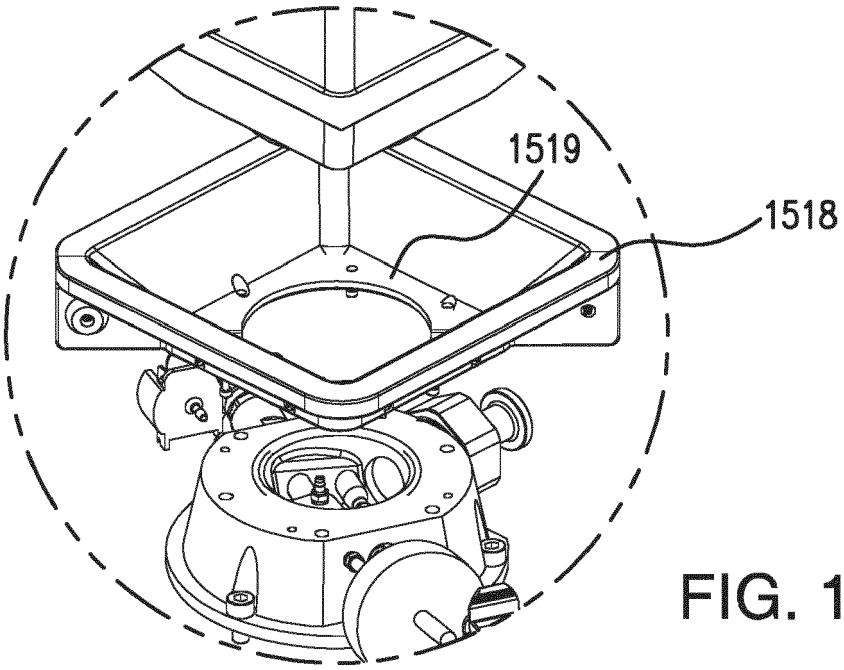

FIG. 12B

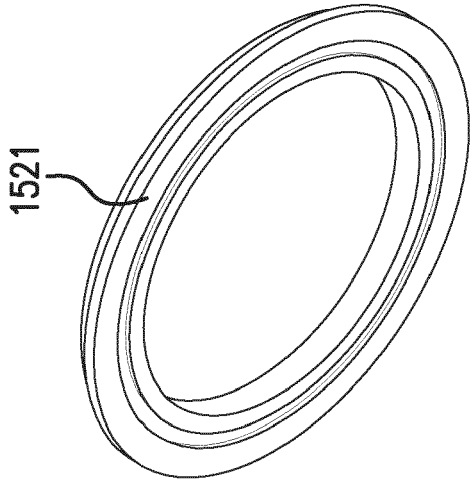

FIG. 12D

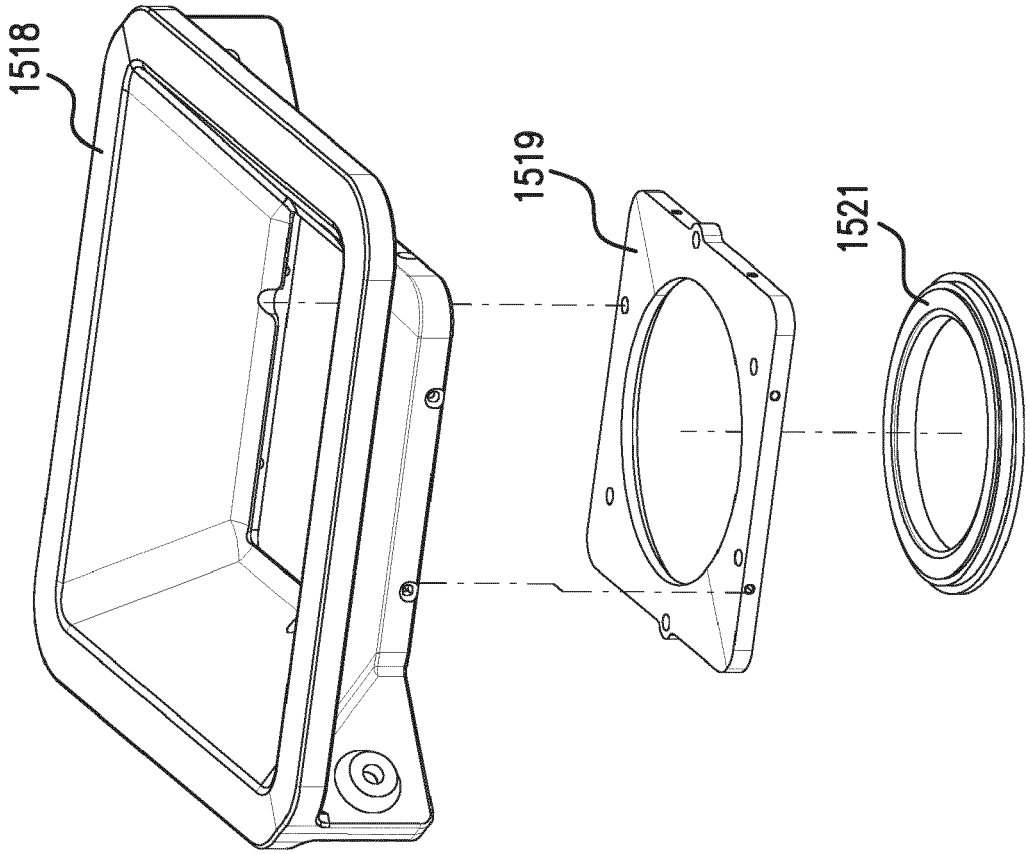

FIG. 12C

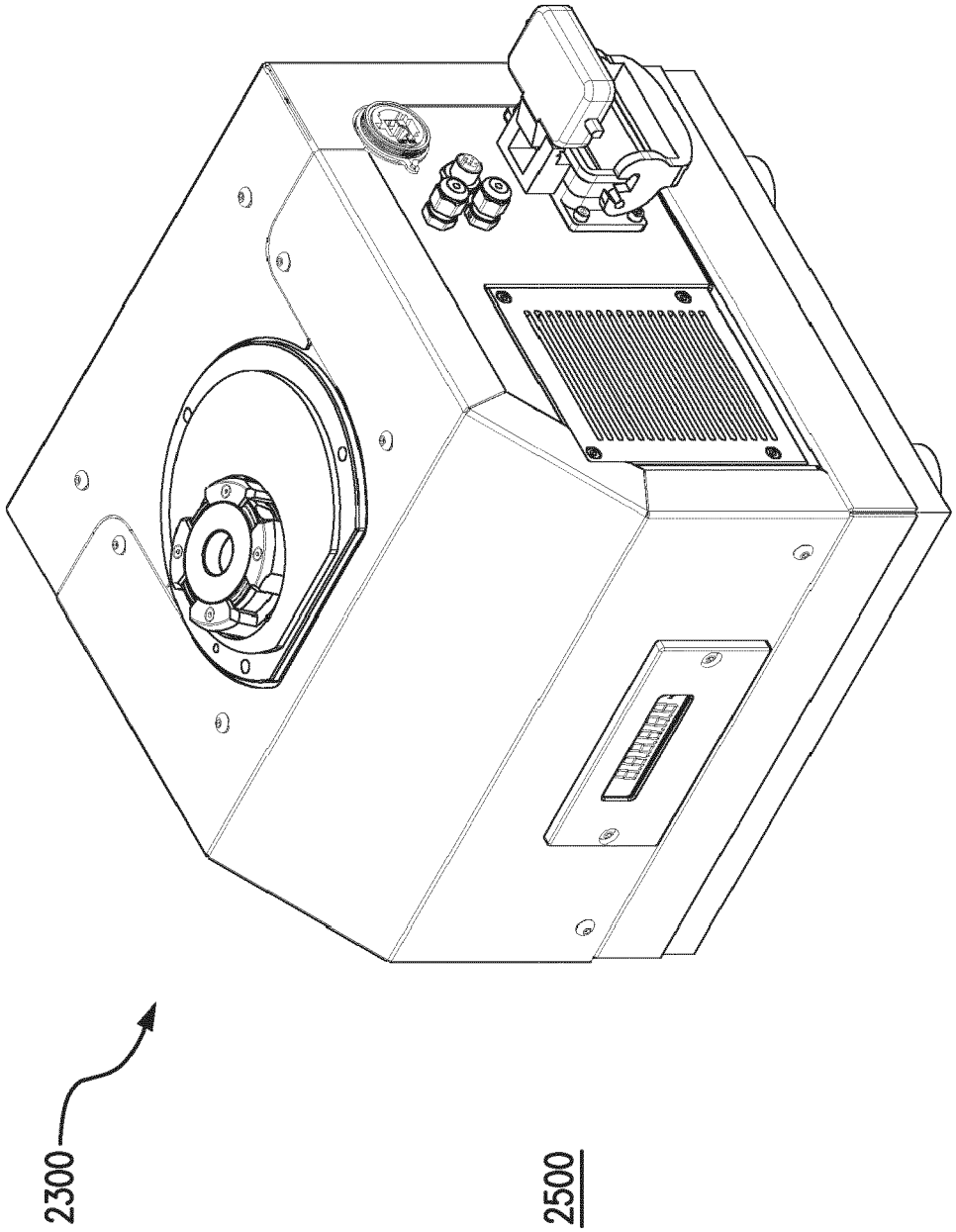

FIG. 13A

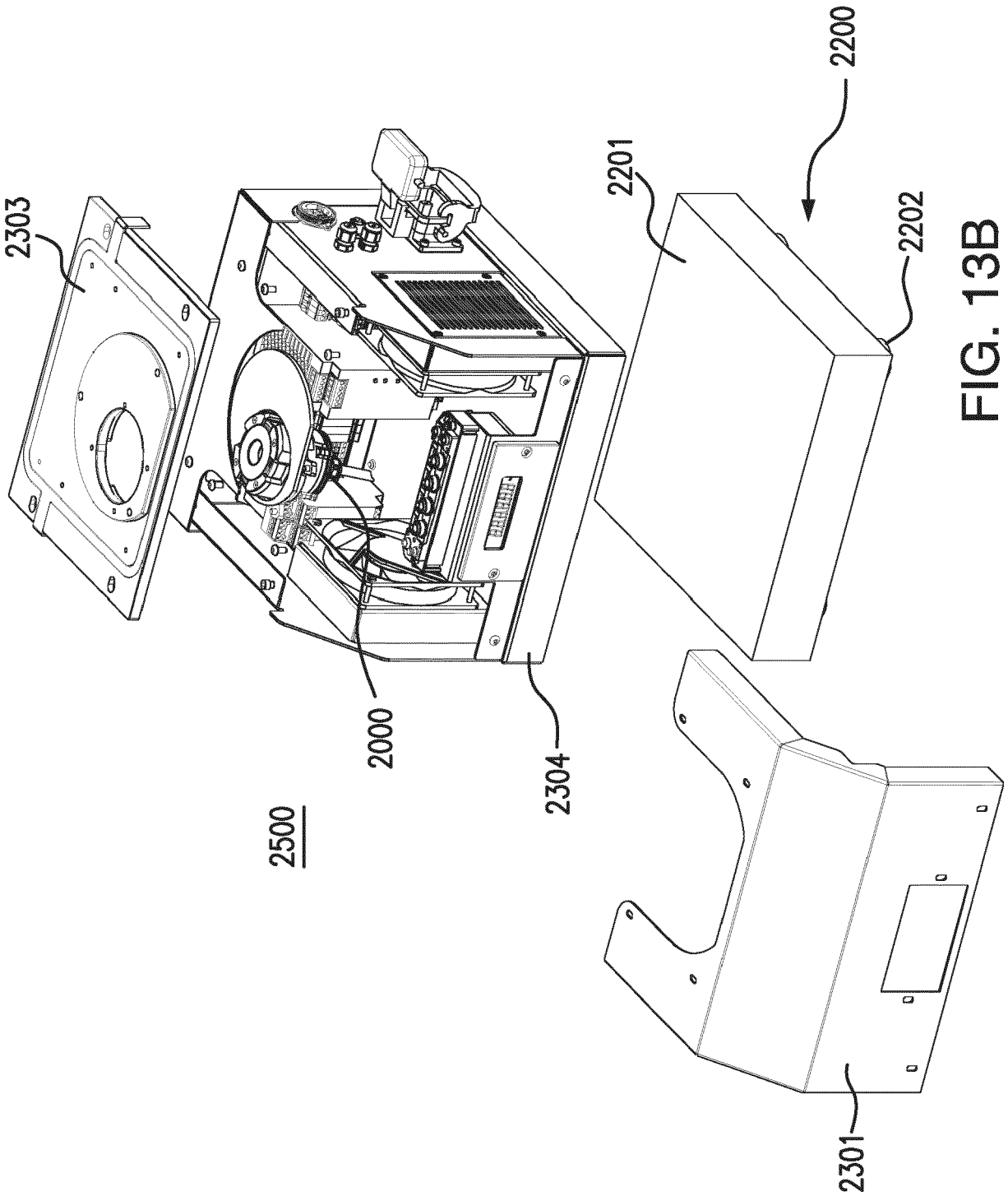

FIG. 13B

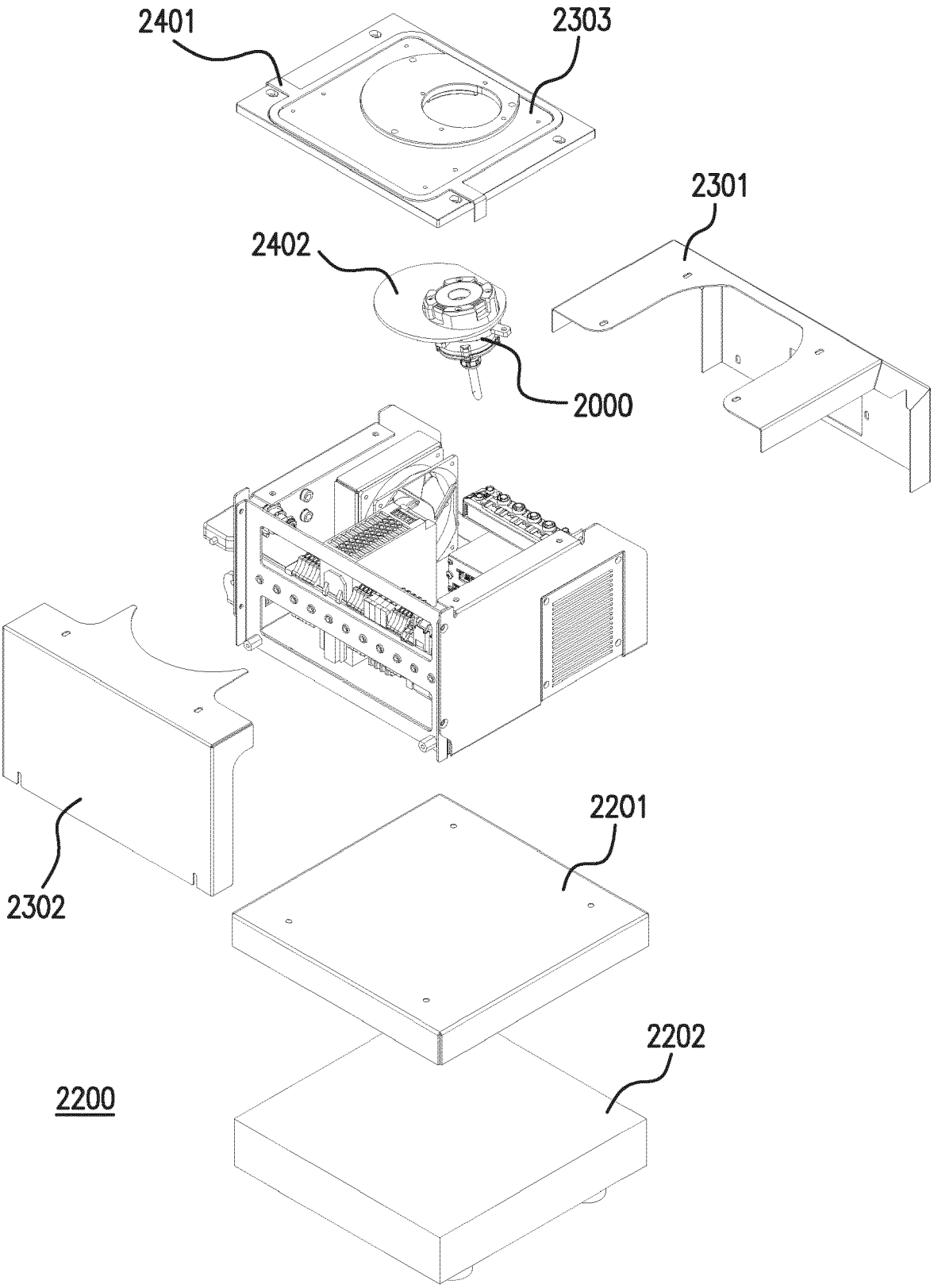

FIG. 13C

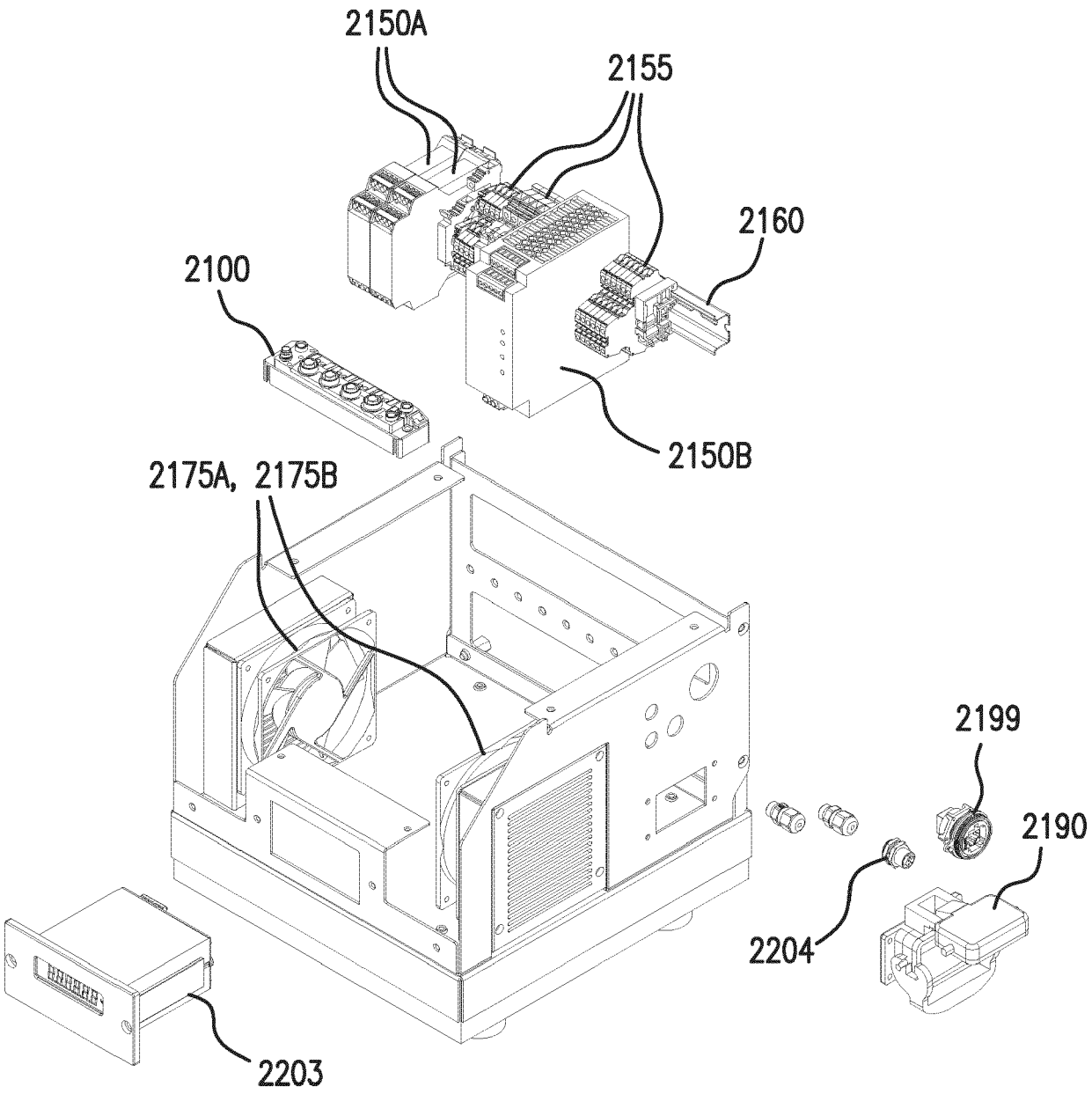

FIG. 13D

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2019180710 A1 **[0001]**
- US 5882113 A **[0001]**
- WO 2018162174 A1 **[0001]**