



(22) Date de dépôt/Filing Date: 2007/06/14

(41) Mise à la disp. pub./Open to Public Insp.: 2008/12/13

(45) Date de délivrance/Issue Date: 2010/08/24

(30) Priorité/Priority: 2007/06/13 (US11/762,496)

(51) Cl.Int./Int.Cl. *A47K 11/00* (2006.01)

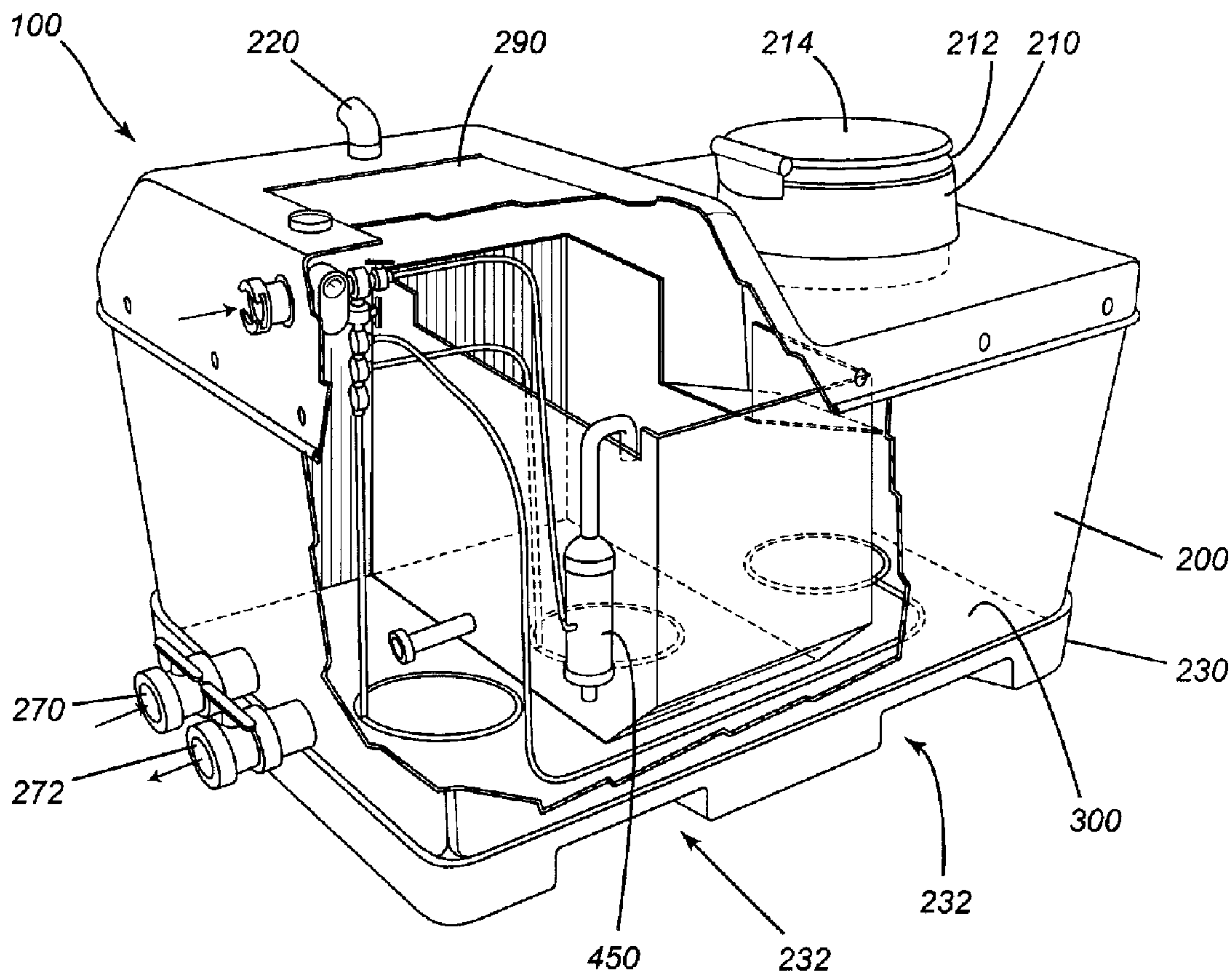
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(54) Titre : TOILETTES PORTATIVES A COMPOSTAGE

(54) Title: PORTABLE COMPOSTING TOILET SYSTEM



(57) Abrégé/Abstract:

A portable composting toilet system has a compartmentalized receptacle for receiving human waste, a gray-water circulation subsystem for circulating gray water formed by mixing water with waste through the compartmentalized receptacle to promote

(57) **Abrégé(suite)/Abstract(continued):**

mixing of the waste to thereby accelerate digestion of the waste, and an air-circulation subsystem for emitting air bubbles into a sludge formed at a bottom of the compartmentalized receptacle to break up the sludge to thereby accelerate digestion of the waste. The air circulation subsystem can include an air-driven pump that causes the gray water to circulate while allow feeding pressurized air to diffuser loops in each compartment to create sludge-breaking bubbles. This portable composting toilet system so efficiently decomposes waste that the maintenance costs of hauling residual sludge to the surface (when the toilet is used underground in a mine) is significantly lower than for conventional toilets, thus providing substantial cost savings to mine operators.

ABSTRACT

A portable composting toilet system has a compartmentalized receptacle for receiving human waste, a gray-water circulation subsystem for circulating gray water formed by mixing water with waste through the compartmentalized receptacle to promote mixing of the waste to thereby accelerate digestion of the waste, and an air-circulation subsystem for emitting air bubbles into a sludge formed at a bottom of the compartmentalized receptacle to break up the sludge to thereby accelerate digestion of the waste. The air circulation subsystem can include an air-driven pump that causes the gray water to circulate while allow feeding pressurized air to diffuser loops in each compartment to create sludge-breaking bubbles. This portable composting toilet system so efficiently decomposes waste that the maintenance costs of hauling residual sludge to the surface (when the toilet is used underground in a mine) is significantly lower than for conventional toilets, thus providing substantial cost savings to mine operators.

PORTABLE COMPOSTING TOILET SYSTEM

TECHNICAL FIELD

The present invention relates in general to toilets and, more particularly, to portable composting toilets.

5 BACKGROUND OF THE INVENTION

Portable outhouses, such as those commonly used at construction sites and in underground mines, hold only a limited amount of water and thus must be emptied frequently. In the context of an underground mine, odor and waste disposal pose serious problems. Hauling waste to the surface for disposal is
10 both expensive and time-consuming.

Portable composting toilets utilize a holding tank to store and process human waste. ("Composting" means the microbial decomposition of organic matter.) Typically, these portable composting toilets use a chemical or biological digester to accelerate the biological decomposition of the human
15 waste in order to reduce both the amount of sludge that has to be hauled to the surface and the frequency with which the toilet has to be emptied.

However, current composting toilets suffer from a number of shortcomings. One such shortcoming is that conventional portable composting systems require daily maintenance because the composting material must be
20 "flipped", usually by a manually operated drum on a daily basis, in order to maintain efficient bacterial breakdown of the human waste.

Furthermore, these portable outhouses are typically constructed of plastic which has a propensity to develop surface micro-cracks which become repositories for waste matter. Using disinfectants to clean the toilet has the
25 unfortunate side-effect of destroying or at least substantially diminishing the biological breakdown process. Even attempting to cleanse these portable outhouses with water is problematic because water tends to dilute the bacterial digester, thus reducing the efficacy of the biological breakdown, and

furthermore adds weight to the sludge that has to be periodically hauled to the surface. Thus, cleaning of these portable composting toilets usually requires manual scrubbing with special cleaners, which is labor-intensive.

Accordingly, an improved portable composting toilet that overcame one
5 or more of the shortcomings of the prior art would be highly desirable.

SUMMARY OF THE INVENTION

In general, a portable composting toilet has a compartmentalized receptacle for receiving and circulating human waste mixed with water and a biological digesting product to accelerate bio-degradation (composting) of the
10 waste. The portable composting toilet receives human waste into one portion of its compartmentalized receptacle, mixes the waste with water to form gray water while the sludge settles to the bottom of the receptacle. The portable composting toilet uses a gray water-circulation subsystem to circulate the gray water (containing waste or partially dissolved waste) to continually turn and
15 circulate the gray water and waste, thus greatly expediting the composting of the human waste. The portable composting toilet also utilizes an air-circulation subsystem that not only drives the water-circulation subsystem but also emits air bubbles from diffuser loops in each compartment of the compartmentalized receptacle in order to break up the sludge that collects at the bottom of the
20 compartments of the compartmentalized receptacle, thereby further expediting the bio-degradation of the human waste. Accordingly, the frequency with which the portable composting toilet requires emptying and the total mass of composted waste that has to be hauled to the surface (when used underground in a mine) is substantially reduced, resulting in substantial cost savings for the
25 mining company.

In other words, the present invention entails a portable composting toilet system for receiving and processing human waste. The toilet system comprises a housing having an opening disposed above a compartmentalized receptacle for receiving human waste, the compartmentalized receptacle further receiving
30 water and a digesting product to biologically digest the waste. The toilet system has a gray water circulation subsystem for circulating gray water formed by

mixing water with waste through the compartmentalized receptacle to promote mixing of the waste to thereby accelerate digestion of the waste. The toilet system also has an air circulation subsystem for emitting air bubbles into a sludge formed at a bottom of the compartmentalized receptacle to break up the
5 sludge to thereby accelerate digestion of the waste.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will become apparent from the following detailed description, taken in combination with the appended drawings, in which:

10 FIG. 1 is a perspective view of a portable composting toilet system in accordance with an embodiment of the present invention;

FIG. 2 is a partial cutaway of the portable composting toilet system shown in FIG. 1;

15 FIG. 3 is an perspective view of the compartmentalized receptacle used in the portable composting toilet system shown in FIG. 1;

FIG. 4 is a side cross-sectional view of the portable composting toilet system shown in FIG. 1;

20 FIG. 5 is an exploded view of a vent subassembly for mounting to the housing of a toilet system in accordance with an embodiment of the present invention;

FIG. 6 is a side elevational view of a portable composting toilet system having a privacy enclosure and external steps in accordance with another embodiment of the present invention;

25 FIG. 7 is a side elevational view (with a partial cutaway to shown internal air holes) of an air-powered pump for driving the gray water circulation subsystem of a toilet system in accordance with an embodiment of the present invention;

FIG. 8 is a side elevational view of an overflow pipe for use in a portable composting toilet system in accordance with an embodiment of the present invention;

FIG. 9 is a top plan view of an air-distribution unit for use in a portable
5 composting toilet system in accordance with an embodiment of the present invention; and

FIG. 10 is an isometric view of a diffuser loop for use in an air-circulation subsystem in a portable composting toilet system in accordance with an embodiment of the present invention.

10 It will be noted that throughout the appended drawings, like features are identified by like reference numerals. It should also be noted that the figures are not necessarily drawn to scale.

DETAILED DESCRIPTION

In general, and as will be elaborated below in greater detail, FIGS. 1 to 4
15 depict a portable composting toilet system designated generally by reference numeral 100. This portable composting toilet system 100 is designed to receive and process human waste. The toilet system 100 comprises a housing 200 having an opening 210 that is disposed above a compartmentalized receptacle 300 for receiving waste (urine, feces, toilet paper, etc.). The compartmentalized
20 receptacle 300 (or tub assembly) can be considered part of the housing. The compartmentalized receptacle 300 is designed to be partly filled with a volume of water into which a biological digesting product and optionally also an anti-foaming agent are added to biologically digest the human waste. The toilet system 100 also comprises a gray water circulation subsystem 400 for
25 circulating gray water (formed by mixing water with human waste) through the compartmentalized receptacle 300 to promote mixing of the waste to thereby accelerate digestion and composting of the waste. The toilet system 100 further comprises an air circulation subsystem 500 for emitting air bubbles into a sludge formed at a bottom of the compartmentalized receptacle in order to break up the
30 sludge to thereby accelerate digestion of the waste. In a main implementation

of this technology, the gray water circulation subsystem 400 is driven by a pump which, in turn, is powered by air pressure from the air-circulation subsystem 500.

Housing

5 The housing 200 as shown in FIGS. 1 to 4 is a boxlike structure constructed preferably of fiberglass, which is structurally rigid yet lightweight and which is relatively easy to clean. The housing has a circular opening 210 through which a user of the toilet may urinate and/or defecate and/or dispose of toilet paper into the compartmentalized receptacle 300 (or tub assembly) that is
10 integrated within the housing 200. Preferably, placed atop the circular opening 210 is a pivotally-mounted plastic toilet seat 212 and optionally also a pivotally-mounted plastic toilet lid 214. As will be appreciated, the lid 214 should be closed when the toilet is not in operation to limit effluent odors from the composting process.

15 In one embodiment, as shown in FIGS. 1 to 5, the housing 200 also includes a vent 220 for exhausting gas (i.e. to prevent a build-up of methane) to equilibrate the pressure inside the compartmentalized receptacle. The housing 200 also a base 230 beneath the compartmentalized receptacle, a top structure 240 (that covers the compartmentalized receptacle 300), a detachable privacy
20 enclosure 250 and a detachable staircase structure 260.

 As shown particularly in FIG. 5, the vent 220 on the housing 200 can have an elbow 221, a screen 222, a male threaded connector 223 and a matching female (internally threaded) connector 224 for securing the vent 220 to the housing 200. In one particular implementation, the vent 220 is affixed to
25 a top (generally horizontal) surface of the housing 200, as illustrated in FIGS. 1 to 5.

 As depicted in FIGS. 1 to 4, the housing 200 also has a pair of externally mounted drainage valves 270, 272 that act as an inlet and an outlet for washing out the compartmentalized receptacle. The valves 270, 272 preferably have
30 threaded connectors (not shown) for connecting hose adapters, although types

of mechanical connections can be used. The valves 270, 272 can be manually opened or closed by turning the handle located atop each of the valves from a parallel position (open) to a perpendicular position (closed). Of course, other types of valves could be used in lieu of the valves shown in the figures. To

5 periodically wash out the compartmentalized receptacle, a user or maintenance crew connects high-pressure hoses to the valves, and injects high-pressure water or other cleaning liquid (optionally including a cleaner or disinfectant) via one of these valves into the tub, thus forcing the ejection of waste and sludge through the other valve (the outlet) until wash-out of the receptacle is complete.

10 This periodic wash-out can either be done *in situ*, i.e. down in the mine, or the tub can be hauled to the surface as part of a regular maintenance program. Because the housing is constructed of fiberglass and not plastic, the housing 200 may simply be hosed down with water, i.e. the labor-intensive scrubbing required for conventional plastic housings is no longer necessary. Furthermore,

15 since the toilet system 100 uses water in the biological breakdown of the fecal waste, there is no concerns that hosing down with water will dilute the digesting agent and thus impede or hamper the composting process.

As further illustrated in FIGS. 1 to 4, the bottom structure or base 230 of the housing has parallel, spaced-apart flat surfaces (or pads) 232 to permit safe

20 handling by a forklift. Due its relatively compact size and relatively light weight, this portable composting toilet system 100 can be moved fairly easily using a forklift so that the toilet system can be relocated within the mine as worker relocate over time.

As shown in FIG. 6, the housing 200 may include a detachable privacy

25 enclosure 250 with a hinged door to thus define a toilet stall. On an inside wall of the privacy enclosure can be mounted a bracket 280 for holding toilet paper 282, one or more railings, a light, an exhaust fan, or other such amenities. In other embodiments of the toilet system, there may be more than one opening and toilet seat per unit. Accordingly, the privacy enclosure can be divided to

30 define, for example, two distinct toilet stalls. The openings in the housing would enable human waste to be deposited into the compartmentalized receptacle for processing and composting in the manner described above.

As further shown in FIG. 6, a staircase structure 260 having a plurality of grided steps 262 can be attached to the privacy enclosure 250 and/or to the housing 200 to facilitate access to the toilet seat. In other words, due to the height of the compartmentalized receptacle, a staircase structure is preferably provided to give users easy access to the toilet seat atop the compartmentalized receptacle.

Referring back to FIGS. 1 and 2, the housing 200 also has an access hatch 290 for enabling access to various internal components of the toilet system 100, such as providing access to an air pressure regulator for regulating pressure in the air-circulation subsystem 500 and/or for periodically adding a biological enzyme digester and an anti-foaming agent to the gray water. The access hatch is preferably located in the top structure 240 (or cover) of the compartmentalized receptacle 300.

Compartmentalized Receptacle

The compartmentalized receptacle 300 (as best shown in FIG. 3 and FIG. 4) can be designed in various ways to enable circulation, mixing, and turning of the waste for expedited composting. In one embodiment, the compartmentalized receptacle 300 comprises a first compartment 310 for housing a pump for circulating the gray water, a second compartment 320 adjacent to the first compartment into which the gray water flows for further mixing and digestion of waste, and a third compartment 330 adjacent to the second compartment into which gray water flows, the third compartment being in fluid communication with the first compartment so that the gray water and waste can be drawn back into the first compartment, thereby circulating the gray water and waste for optimal bio-degradation while also continually flushing the first, second and third compartments to enhance composting of the waste.

Optionally, the second compartment and the third compartment are divided by a wall 340 having a downwardly-angled deflector shield 342 to prevent waste from back-splashing a user of the toilet system. The wall 340 has an opening directly above the deflector shield through which the gray water overflows to rinse the deflector shield 342. As will be appreciated, this gray

water sluicing over the deflector shield 342 is not clean water, but is nonetheless relatively cleaner gray water than the other gray water in the tub (or receptacle).

5 The three-chamber version of the compartmentalized receptacle 300 can be made by inserting a small tub 350 inside a larger tub 360. In other words, the first, second and third compartments can be formed by inserting the small tub 350 within the larger tub 360 whereby the small tub 350 fits flush against one side 362 of the larger tub 360 but defines a passageway 364 along an opposite side 366 of the larger tub to permit gray water and waste to be drawn
10 back into the first compartment 310 from the third compartment 330. This passageway 364 is preferably a triangular channel formed by the beveled underside of the smaller tub.

In another embodiment, the compartmentalized receptacle 300 can have a fourth compartment for ultraviolet-light sterilization of the waste. This fourth
15 compartment can also be used for chlorination. As will be appreciated by those of ordinary skill in the art of composting toilets, the toilet system can be modified to have a fifth chamber, a sixth chamber, or effectively any number of chambers to provide progressive washing-out of the gray water.

In yet another embodiment, the compartmentalized receptacle 300 could
20 be constructed with only two compartments, a front compartment for directly receiving human waste and a rear compartment for housing a pump for circulating gray water mixed with waste into the front compartment, the front and rear compartments being in fluid communication to permit gray water and waste to be drawn back into the rear compartment. In other words, this two-chamber
25 (two-bay) version would eliminate the central chamber (or middle bay).

Gray Water Circulation Subsystem

The gray water circulation subsystem 400, as noted above, is designed to circulate gray water (i.e. dirty water containing dissolved or partially dissolved waste, including waste particles and debris, toilet paper, etc.) through the
30 various chambers or compartments of the compartmentalized receptacle 300.

This continual circulation and mixing accelerates bio-degradation and composting of the waste.

The gray water circulation subsystem 400 uses a pump 450 that receives air pressure from a pressurized air source. In the main implementation of this technology, pressurized air is fed into an air-distribution system having an air manifold that diverts (or "bleeds off") a portion of the airflow from the air circulation subsystem 500 in order to initially prime the pump 450 and then to power the pump 450 that, in turn, drives the gray water circulation subsystem 400. Further details about the air-circulation subsystem and air-distribution unit will be provided in the subsequent section.

As shown in FIG. 7, the pump 450 has a novel design that allows it to be partially submerged in the gray water (e.g. in the first compartment) and to displace the gray water without an impeller. The absence of the impeller in pump 450 is a great advantage because an impeller would become clogged with waste and toilet paper. In one embodiment, the pump 450 has a tubular pump body 460 capped at top and bottom ends by tube caps 472. An internal pipe 470 (for transporting gray water) extends through the tubular body 460 and extends upwardly to a U-shaped or "elbow-shaped" spout 475 for delivering gray water into a second compartment adjacent to the first compartment. The pump 450 drives the water upwardly and over the wall that separates the first compartment from the second compartment.

As further depicted in FIG. 7, the tubular pump body 460 also comprises an air intake port 452 in fluid communication with a plurality of holes 454 perforated at intervals along the pipe 470. Preferably, these holes 454 are arranged longitudinally along the pipe 470 inside the tubular pump body 460, as shown in FIG. 7, although other arrangements of holes 454 could be used to achieve similar results. Thus, as shown in FIG. 7, the partly perforated pipe 470 extends through the tubular pump body 460 so that the tubular pump body 460 is concentric with the perforated pipe 470, thus defining an annular air gap between the perforated pipe 470 and the tubular pump body 460. The air intake 452 receives pressurized air which pressurizes the annular gap between the

tubular pump body 460 and the pipe 470. Because the top of the pipe 470 (i.e. the open end of the elbow 475) is at atmospheric pressure while the bottom is pressurized above atmospheric pressure, the gray water is driven upwardly into the adjacent, second compartment. Gray water is thus drawn from the bottom
5 of the pump 450 into the pipe 470 and conveyed upwardly by the pressure differential until it is delivered into the second compartment. As long as the pressure differential is maintained, the gray water will circulate through the gray-water circulation subsystem 400.

To prime the pump 450, pressurized air from the pressurized air source
10 is injected into the tubular pump body via the air inlet causing pressurization of the inside of the tubular pump body. As the pump is submersed, and the top of the elbow (or U-shaped spout) is exposed to the atmosphere, the air pressure differential between the top and bottom of the pump will push the water upwardly because the air pressure at the top of the pump (being at atmospheric
15 pressure) is less than the air pressure at the bottom (being pressurized to above atmospheric pressure). This pressure differential thus causes the gray water to be displaced upwardly through the U-shaped spout or elbow and into the second compartment. As noted in the preceding paragraph, once the pressure differential is established (after the pump has been primed), the gray
20 water will circulate continuously.

The gray water fills up in the second compartment, and is "cleaned" somewhat relative to the gray water in the first compartment, and then overflows into the third compartment by flowing through the opening in the wall between the second and third compartments. In flowing through the opening in the wall
25 between the second and third compartments, the "cleaner" gray water flows over the deflector shield, thus rinsing and cleaning the deflector shield. (It bears underscoring that expressions such as "relatively clean", "cleaner" and "cleaning" are to be construed within the context of gray water; in other words, all of the gray water contained in the toilet is dirty or gray, but the water is
30 gradually cleaned as it is processed. As the gray water circulates, waste particles and debris eventually settle or sediment from the water and form a sludge at the bottom of the receptacle. The gray water (and especially the top

portion thereof) thus becomes gradually cleaner in time as the waste sediments or settles from the water. As gray water is transferred to adjacent compartments, it thus gradually becomes cleaner, thus providing a mechanism to rinse the deflector and to effectively flush the system.

5 Gray water in the third compartment is drawn back by the pump 450 to the first compartment via the passageway 364 (e.g. the triangular channel along the bottom of the receptacle), thus completing the circulation cycle. Once the pump has been primed, the pump will continually circulate the gray water inside the toilet system as long as the pump's air pressure maintains the pressure
10 differential needed to drive the water over the first wall into the second compartment. As will be appreciated, the passageway 364 (e.g. triangular channel) should be designed to be large enough to permit relatively unfettered passage of water-borne waste, toilet paper, etc.

As illustrated in FIG. 8, the gray water circulation subsystem 400 may
15 further include an overflow pipe 480 (also known as a "stand pipe"). The overflow pipe shown by way of example in FIG. 8 includes a substantially vertical pipe 482 (which, in this particular implementation, would be approximately two feet long, i.e. 60 cm long) that is joined via a 90-degree elbow 483 to a tank adapter 484, drainage valve (such as valves 270, 272) or to
20 other mechanical coupling means that enable one to connect the overflow pipe through the housing to a hose or other discharge means for discharging or removing excess waste (i.e. "waste overflow"). Thus, in the unlikely event that the compartmentalized receptacle 300 of the toilet system 100 becomes too full (i.e. the level of waste water or gray water) reaches the top of the overflow pipe,
25 the gray water will begin to flow down the overflow pipe 480 and out of the toilet system 100 into, for example, an auxiliary container or reservoir via a hose or other discharge means.

Air Circulation Subsystem

The air-circulation subsystem 500 can also be designed in different ways
30 to accomplish the twin objectives of powering the gray water circulation subsystem and providing air bubbles to break up the sludge formed at the

bottom of the compartmentalized receptacle 300. In the main embodiment, the air-circulation subsystem 500 has an air-distribution unit 505 such as the one shown by way of example in FIG. 9. The air-distribution unit 505 shown in FIG. 9 has an air inlet 510 for receiving pressurized airflow from a pressurized air source (not shown, but typically an air compressor and/or compressed air tank), an optional air pressure gauge 520 (e.g. with a needle dial or digital readout) for indicating the air pressure entering the air-distribution unit 505, one or more air-pressure regulators 530 (manually operable valves for regulating airflow into the diffuser loops and into the pump), an air manifold 540 for dividing the pressurized airflow into a plurality of air conduits (e.g. air hoses) 545 for delivering pressurized air to diffuser loops 550 (shown in FIG. 10) that are disposed in sludge formations at the bottom of the compartmentalized receptacle 300.

As will be elaborated below, the diffuser loops 550 have a plurality of air holes 552 for diffusing pressurized air into the bottom of the compartmentalized receptacle 300 to create air bubbles for breaking up the sludge that forms at the bottom of the compartmentalized receptacle 300. By breaking up the sludge, these air bubbles accelerate the digestion and composting of the waste.

As shown in FIG. 9, the air inlet 510 is mounted through the housing 200 and may include a threaded connection or a spring-loaded "quick-connect" for connecting to an air hose (not shown) that delivers pressurized air from the pressurized air source (not shown), such as a compressed-air tank or air compressor.

As shown in FIG. 9, the air manifold 540 also divides the air between, on the one hand, the three air hoses 545 leading to the diffuser loops 550, and on the other hand, the air hose 546 leading to the pump 450. Upstream of air hose 546, the air-distribution unit 505 can have another air regulator 531 for regulating the airflow to the pump. This air pressure regulator 531, which (as shown in FIG. 9) is preferably disposed between the air gauge 520 and the air hose 546, is useful for controlling foaming (even when an anti-foaming agent is being used). As further depicted in FIG. 9, the air manifold 540 has a plurality

of nipples 541 that are connected by hose clamps 542 to respective air hoses 545, 546.

In addition to feeding pressurized air into the diffuser loops to create sludge-breaking air bubbles, the air-distribution unit 505 of the air-circulation subsystem 500 also drives the gray water circulation subsystem 400 by priming and pressurizing the pump 450. Priming and pressurization of the pump, as was described above in the preceding section, generates a pressure differential that draws water upwardly from a first compartment to overflow into a second, adjacent compartment, thereby driving the gray water circulation subsystem.

In the particular implementation shown in FIG. 9, the air-circulation subsystem 500 uses the air manifold 540 disposed upstream of the pump 450 to divide the pressurized airflow between the pump 450 and three parallel diffuser loops 550, one diffuser loop being disposed in each of three separate compartments of the compartmentalized receptacle 300. Although three diffuser loops 550 are used in this particular implementation (i.e. one diffuser loop per compartment), it should be appreciated that variants of this portable composting toilet system 100 could have more than one diffuser loop 550 per compartment or, alternatively, there could be one or more compartments having no loops at all.

The air manifold 540 shown in FIG. 9 can be either an assembly of T-joints arranged to divide the flow into parallel streams (as shown) or cast or molded as a single manifold unit. The details of the manifold and of the various connections used to implement the air-distribution unit are presented merely by way of example, but it should be readily appreciated that different types of fastenings or connections can be used to secure the various hoses, fittings and adapters.

As illustrated in FIG. 10, the diffuser loops 550 are preferably made of a length of flexible plastic tubing 551 having a plurality of small holes 552 therein through which sludge-breaking bubbles are emitted. As depicted in FIG. 10, the ends 554 of the plastic tubing 551 are connected (e.g. with hose clamps 555) to respective hose adapters 556 which are connected, in turn, to a common T-joint

560. The T-joint 560 connects to a vertical pipe 562 that is tapped at an upper end for connecting to a threaded pipe adapter 564. The pipe adapter is, in turn, connected to a hose adapter 566 for connecting to one of the air hoses 545 extending down from the air manifold 540. The air hoses 545 are connected to the nipple of the hose adapter 566 using a hose clamp 547. An airtight connection is thus provided between the air manifold and each of the three parallel diffuser loops 550.

As shown in FIG. 10, the flexible plastic tubing 551 of the diffuser loops 550 can be weighted down with at least one weighted collar 570 (e.g. one or more stainless steel nuts) slid over the flexible plastic tubing 551 prior to clamping the ends of the tubing 554 to the T-joint 560. The weighted collars 570 help to keep the diffuser loops submerged within the sludge at the bottom of the compartmentalized receptacle. Keeping the diffuser loops well submerged is important in ensuring that the air bubbles are effective in breaking up the sludge. Were the diffuser to float atop the sludge, their ability to break Alternatively, a heavier material can be used for the diffuser loops 550, in which case the weighted collars 570 may no longer be needed to keep the diffuser loops submerged within the sludge at the bottom of the compartmentalized receptacle.

Due to its water and air circulation subsystems, the portable composting toilet system 100 thus continually circulates, mixes and flushes the waste to expedite bio-degradation and composting of the waste. The portable composting toilet system thus functions as a mini sewage treatment plant. As a result, the overall performance of this novel toilet system is superior to that of prior-art portable composting latrines. Specifically, this novel portable composting toilet system can effectively process human waste from 40 persons per days and requires removal of the resulting sludge only once during a 12-18 month period. The amount of manpower required for maintenance of this novel portable toilet system is much lower (about 29 hours/month) than that required for prior-art composting latrines (122 hours/month) or for portable outhouses (117 hours/month). In the context of underground mines where hauling waste to the surface is expensive, this dramatic improvement in portable composting

technology could result in substantial cost-savings for mining companies.

It is obvious for those skilled in the art that as the technology develops the basic idea of the invention can be implemented in various ways. The invention and the embodiments thereof are thus not restricted to the examples
5 described above, but they may vary within the scope of the claims.

CLAIMS:

1. A portable composting toilet system for receiving and processing human waste, the system comprising:
 - a housing having an opening disposed above a compartmentalized receptacle for receiving human waste, the compartmentalized receptacle further receiving water and a digesting product to biologically digest the waste;
 - a gray water circulation subsystem for circulating gray water formed by mixing water with waste through the compartmentalized receptacle to promote mixing of the waste to thereby accelerate digestion of the waste; and
 - an air circulation subsystem for emitting air bubbles into a sludge formed at a bottom of the compartmentalized receptacle to break up the sludge to thereby accelerate digestion of the waste.
2. The toilet system as claimed in claim 1 wherein the compartmentalized receptacle comprises a first compartment for housing a pump for circulating the gray water, a second compartment adjacent to the first compartment into which the gray water flows for further mixing and digestion of waste, and a third compartment adjacent to the second compartment into which gray water flows, the third compartment being in fluid communication with the first compartment so that the gray water and waste can be drawn back into the first compartment, thereby circulating the gray water and waste for optimal bio-degradation while also continually flushing the first, second and third compartments to enhance composting of the waste.
3. The toilet system as claimed in claim 1 wherein the air circulation subsystem comprises:
 - an air inlet for receiving pressurized airflow from a pressurized air source; and

an air manifold for dividing the pressurized airflow into a plurality of air conduits for delivering pressurized air to diffuser loops disposed in sludge at the bottom of the compartmentalized receptacle, the diffuser loops comprising air holes for diffusing pressurized air into the compartmentalized receptacle to create air bubbles for breaking up the sludge to accelerate digestion of the waste.

4. The toilet system as claimed in claim 1 wherein the air circulation subsystem comprises a pump primed by air pressure for generating a vacuum pressure to draw water upwardly from a first compartment to overflow into a second, adjacent compartment, thereby driving the gray water circulation subsystem.
5. The toilet system as claimed in claim 4 wherein the air circulation subsystem further comprises an air manifold disposed upstream of the pump for dividing pressurized airflow from a pressurized air source between the pump and three parallel diffuser loops, one diffuser loop being disposed in each of three separate compartments of the compartmentalized receptacle.
6. The toilet system as claimed in claim 5 wherein the air circulation subsystem further comprises:

an air inlet mounted on the housing for connecting to an air hose that delivers pressurized air from the pressurized air source; and

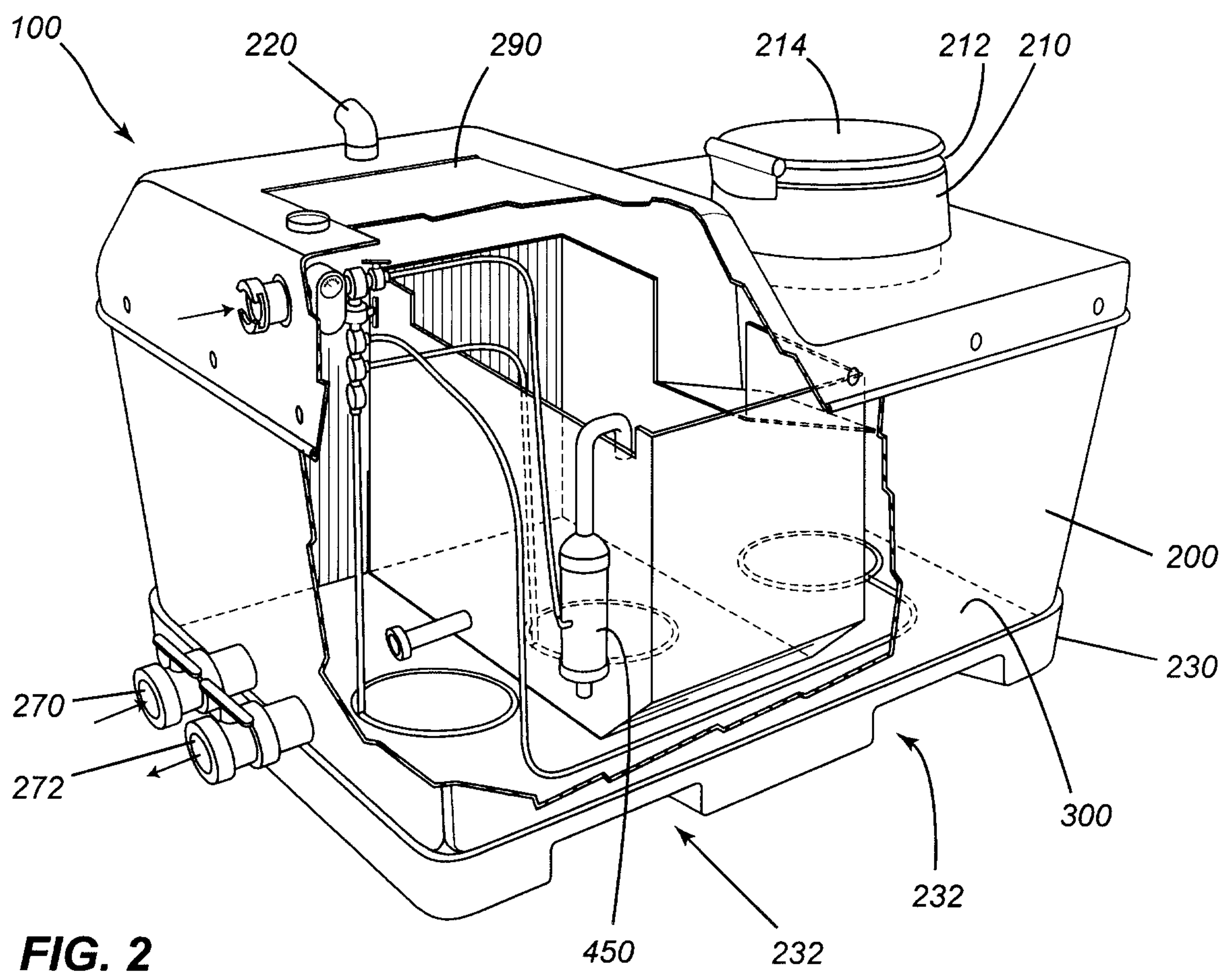
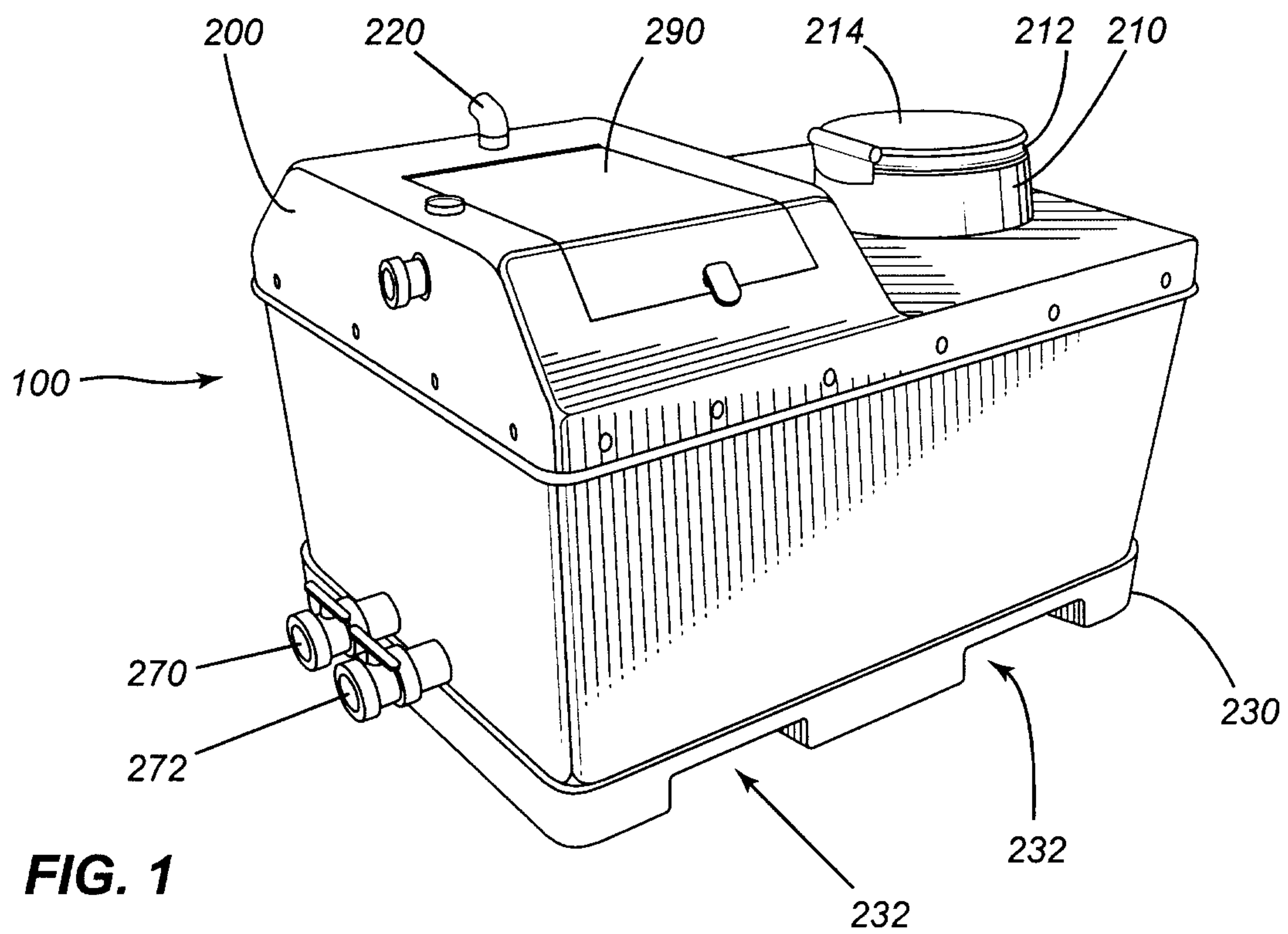
an air pressure regulator disposed downstream of the air inlet to regulate airflow.
7. The toilet system as claimed in claim 1 wherein the air-circulation subsystem comprises an air-distribution unit having an air inlet mounted on the housing, an air-pressure gauge mounted on the housing in proximity to the air inlet, an air regulator for regulating the airflow and an air manifold for dividing the airflow between an air-pressure-driven pump and a group of parallel diffuser loops.

8. The toilet system as claimed in claim 7 wherein each of the diffuser loops comprises a length of flexible tubing having a plurality of small holes therein through which bubbles are emitted, wherein ends of the flexible tubing are connected to a common T-joint that is also connected to an air hose through which air is delivered from the air manifold.
9. The toilet system as claimed in claim 8 wherein the flexible tubing is weighted down with at least one weight attached to the flexible tubing.
10. The toilet system as claimed in claim 2 wherein the second compartment and the third compartment are divided by a wall having a downwardly-angled deflector shield to prevent waste from back-splashing a user of the toilet system.
11. The toilet system as claimed in claim 10 wherein the wall comprises an opening above the deflector shield through which the gray water overflows to rinse the deflector shield.
12. The toilet system as claimed in claim 2 wherein the first, second and third compartments are formed by inserting a small tub within a larger tub whereby the small tub fits flush against one side of the larger tub but defines a passageway along an opposite side of the larger tub to permit gray water and waste to be drawn back into the first compartment from the third compartment.
13. The toilet system as claimed in claim 1 wherein the air-circulation subsystem comprises an air-distribution unit having an air inlet, an air pressure gauge downstream of the inlet, a T-joint downstream of the gauge for dividing airflow exiting the gauge, a first regulator downstream of the T-joint for regulating airflow into an air hose connected to a pump that drives the gray-water circulation subsystem and a second regulator downstream of the T-joint for regulating airflow into a plurality of parallel diffuser loops that emit air bubbles to break up sludge formed at the bottom of the compartmentalized receptacle.

14. The toilet system as claimed in claim 1 wherein the compartmentalized receptacle comprises only two compartments, a front compartment for directly receiving human waste and a rear compartment for housing a pump for circulating gray water mixed with waste into the front compartment, the front and rear compartments being in fluid communication to permit gray water and waste to be drawn back into the rear compartment.
15. The toilet system as claimed in claim 1 wherein the gray water circulation subsystem comprises a pump for being partially submerged in the gray water of a first compartment, the pump having a tubular pump body through which a perforated pipe passes to deliver gray water upwardly through a spout into a second compartment adjacent to the first compartment, the tubular pump body comprising an air intake port for delivering pressurized air into an annular gap between the tubular pump body and the perforated pipe.
16. The toilet system as claimed in claim 15 wherein the plurality of holes are arranged longitudinally along the perforated pipe.
17. The toilet system as claimed in claim 1 wherein the housing comprises a pair of externally mounted drainage valves that act as an inlet and an outlet for washing out the compartmentalized receptacle.
18. The toilet system as claimed in claim 1 wherein the housing comprises a detachable privacy enclosure to which may be secured a staircase structure having a plurality of steps.
19. The toilet system as claimed in claim 1 wherein the housing comprises a base having parallel, spaced-apart flat surfaces to permit safe handling by a forklift.
20. The toilet system as claimed in claim 1 wherein the housing comprises an access hatch for enabling access to an air pressure regulator for

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regulating pressure in the air-circulation subsystem and for periodically adding a biological enzyme digester and an anti-foaming agent to the gray water.



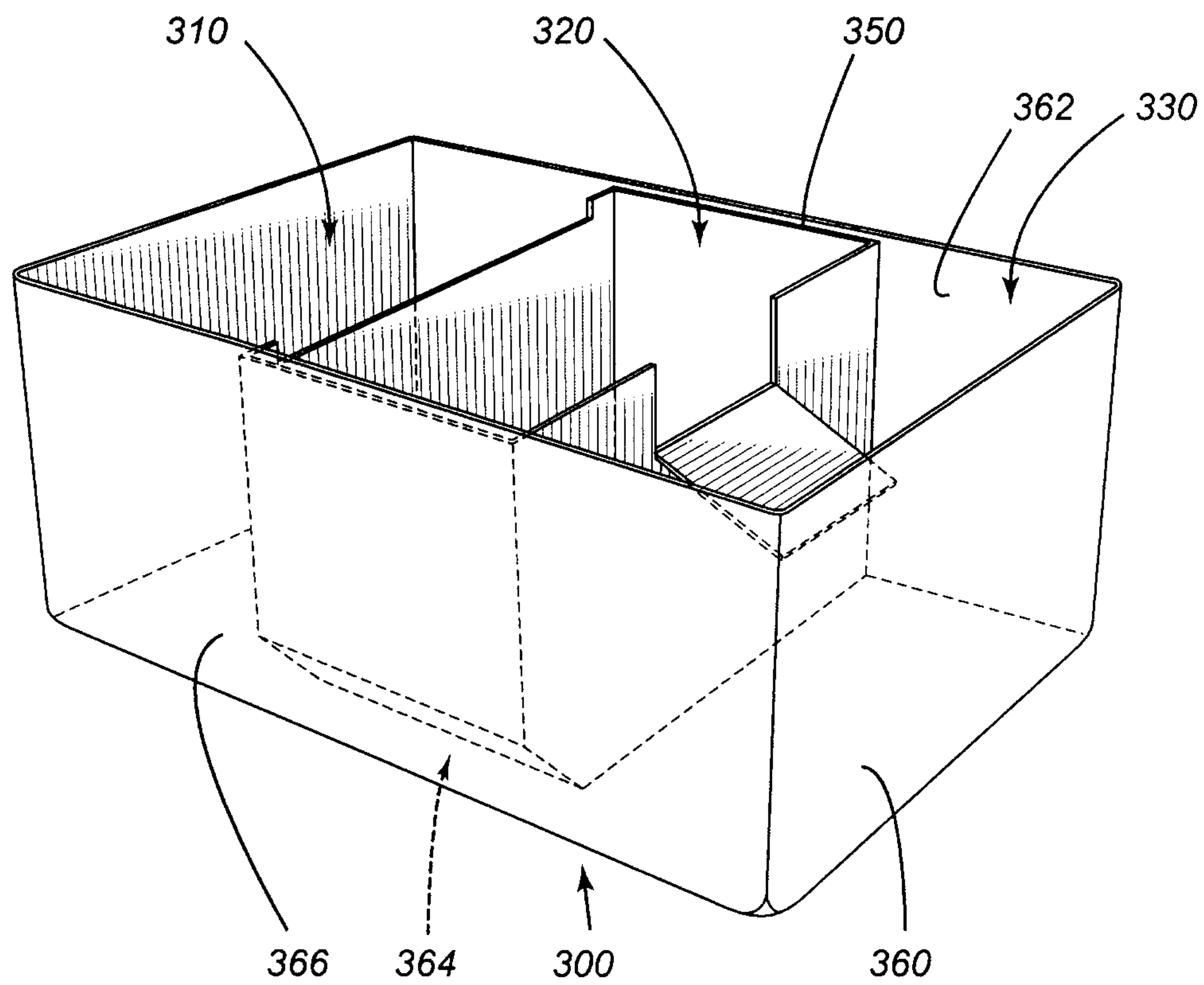
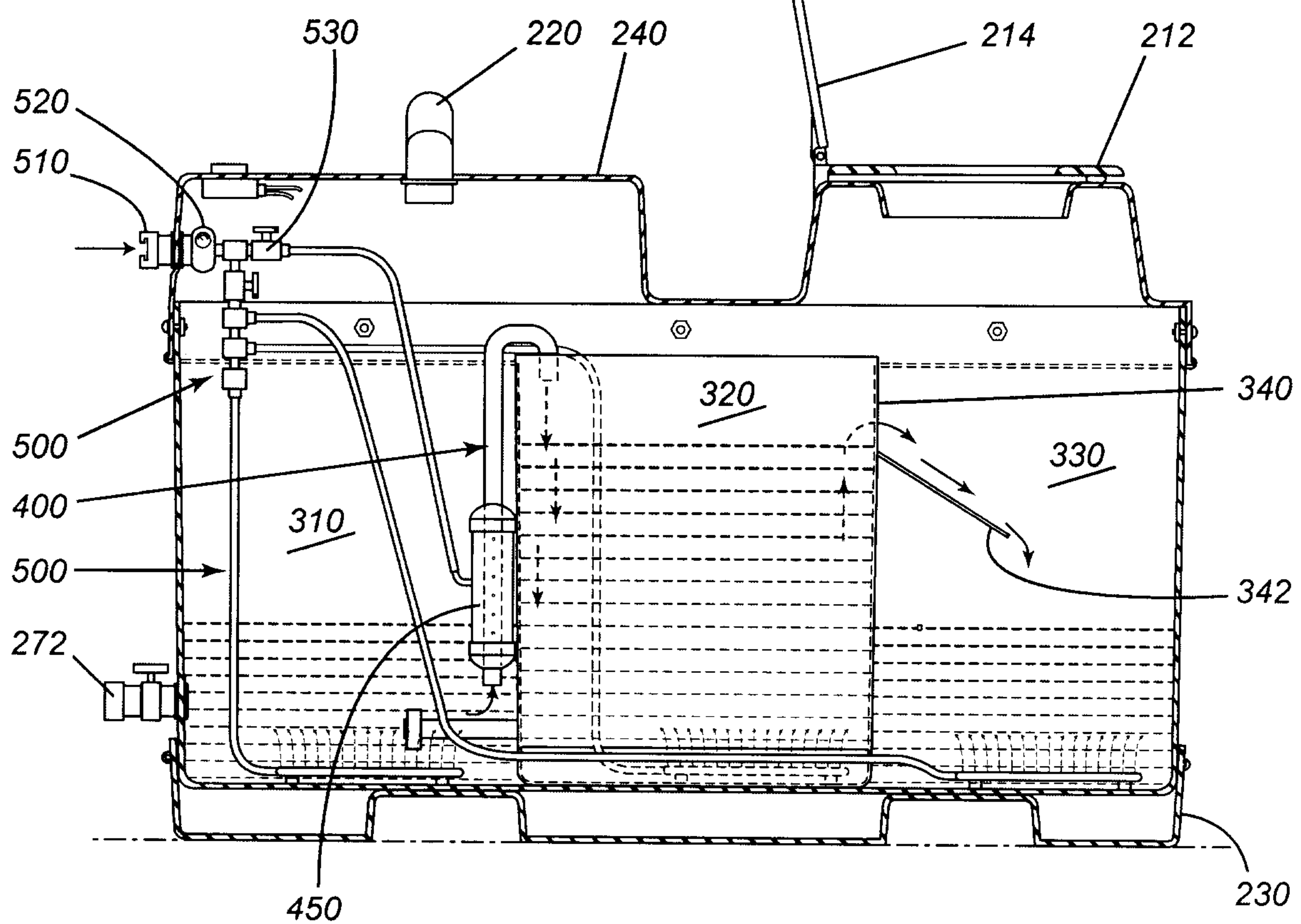
**FIG. 3****FIG. 4**

FIG. 5

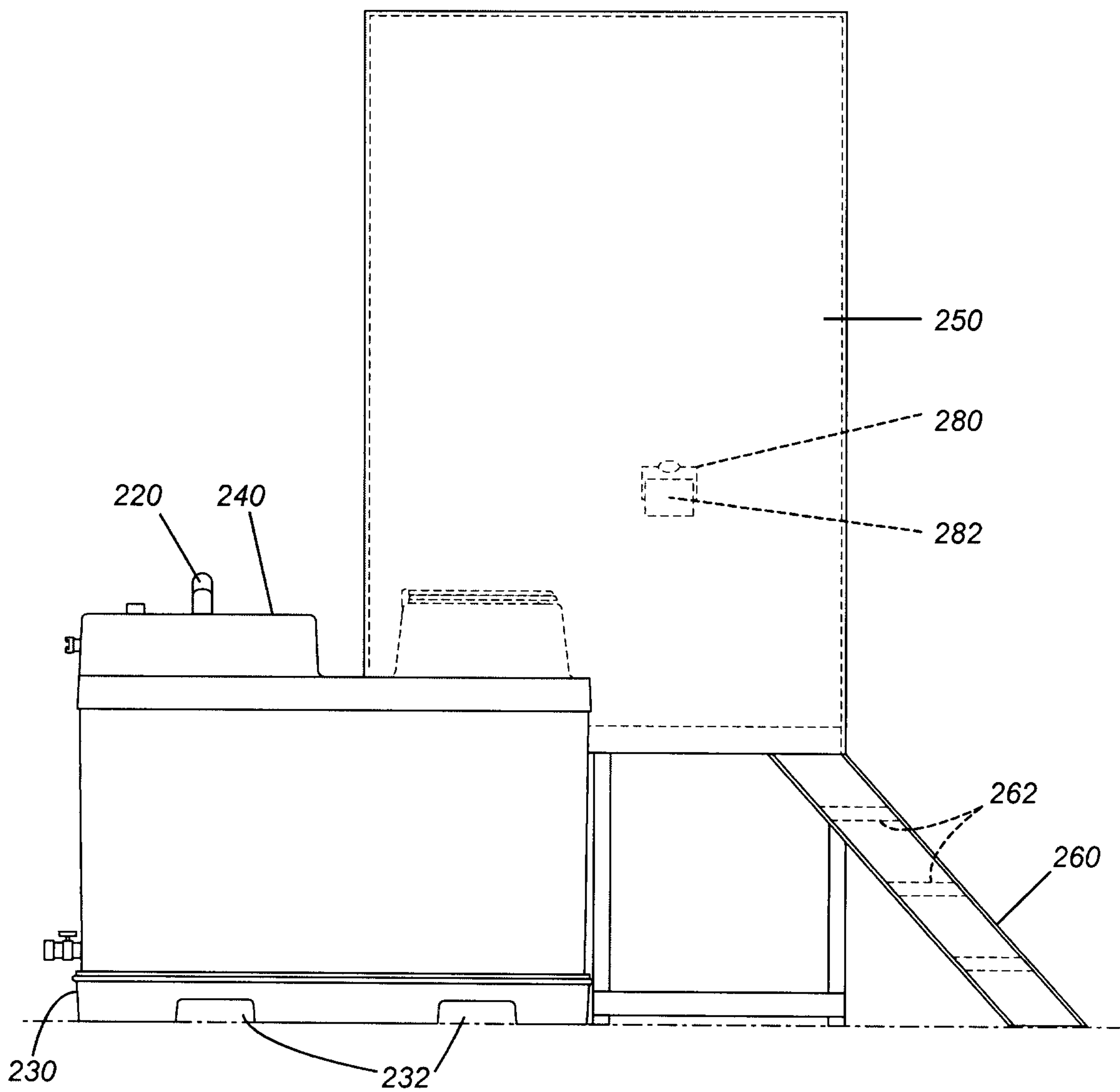
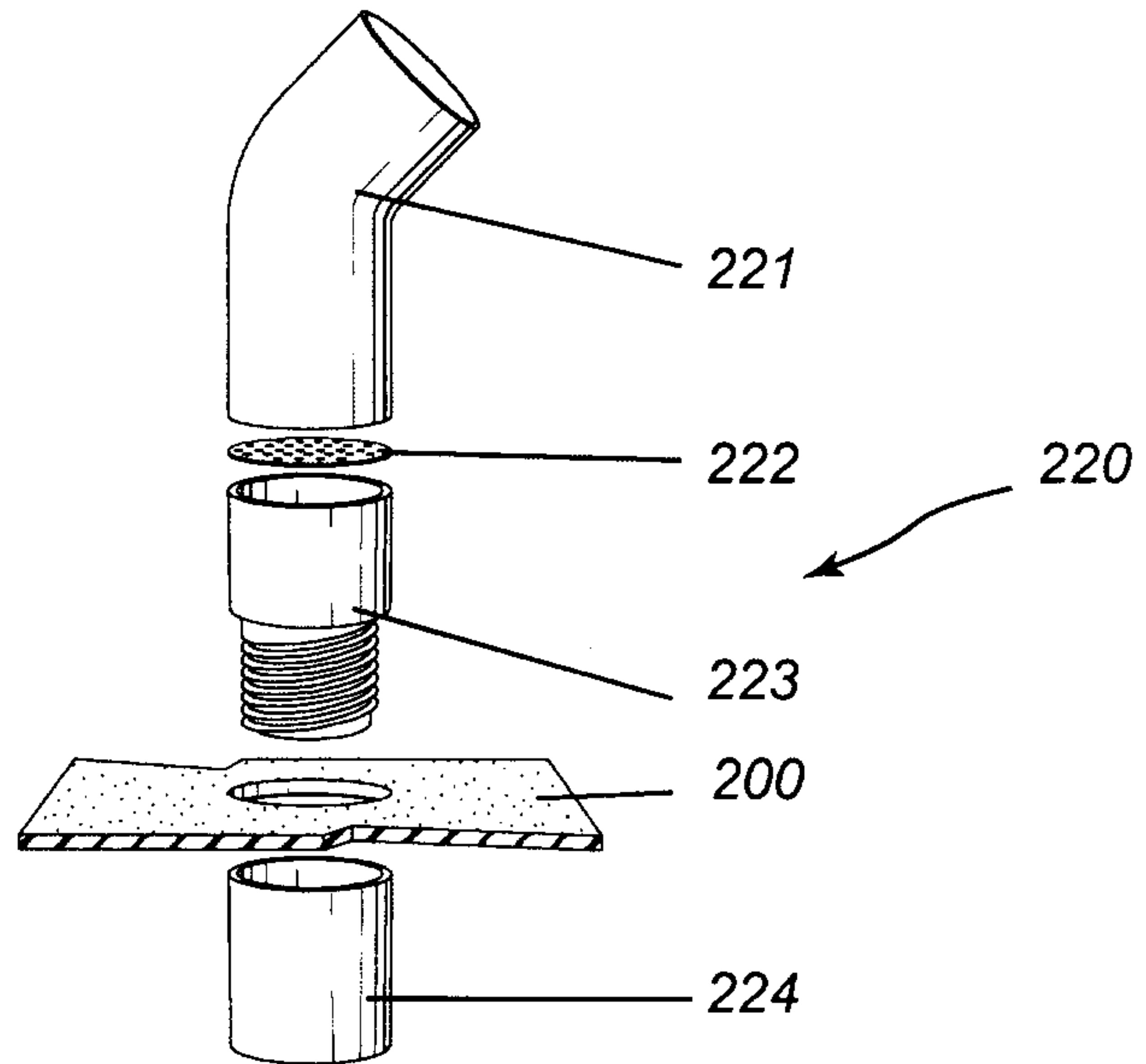


FIG. 6

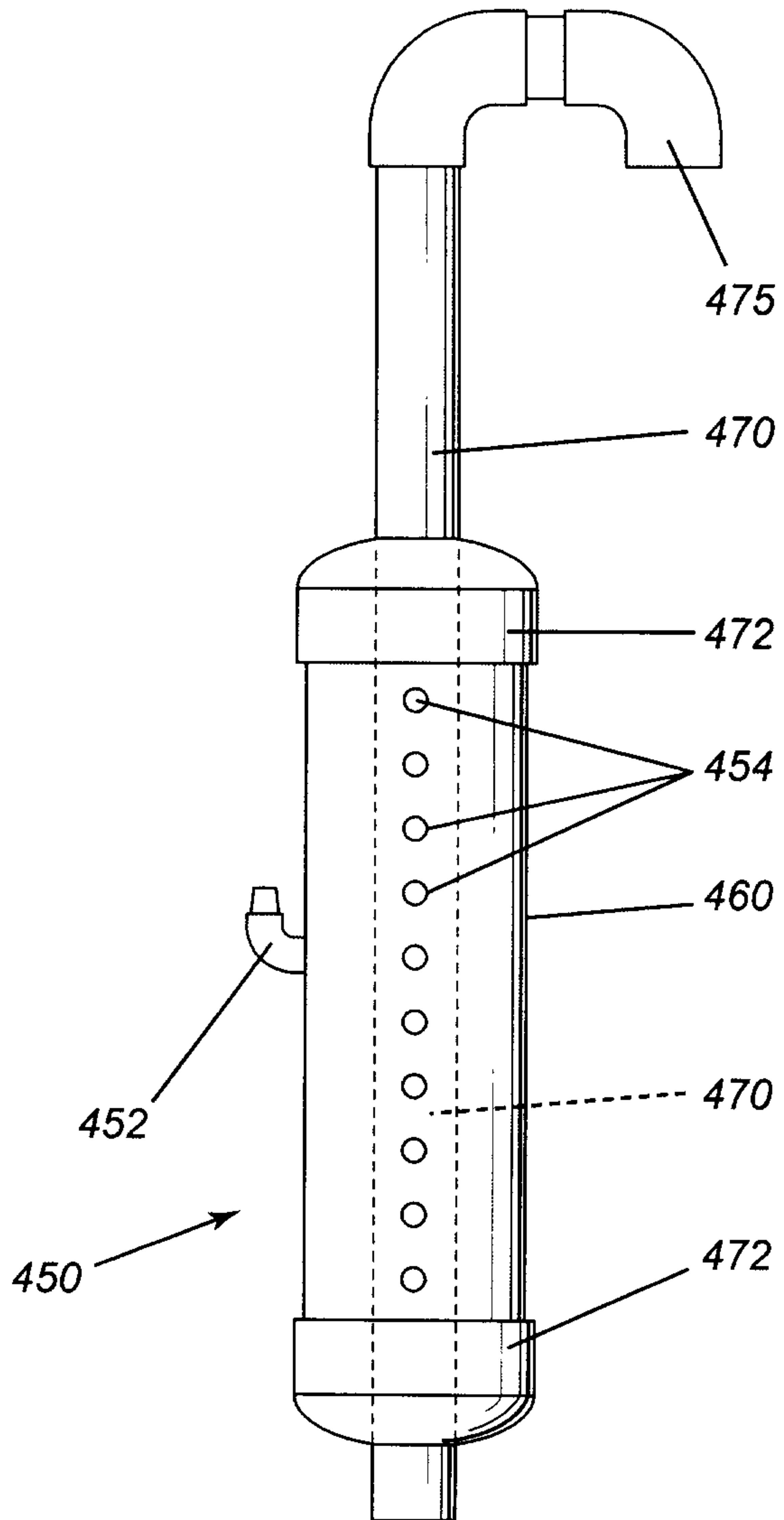


FIG. 7

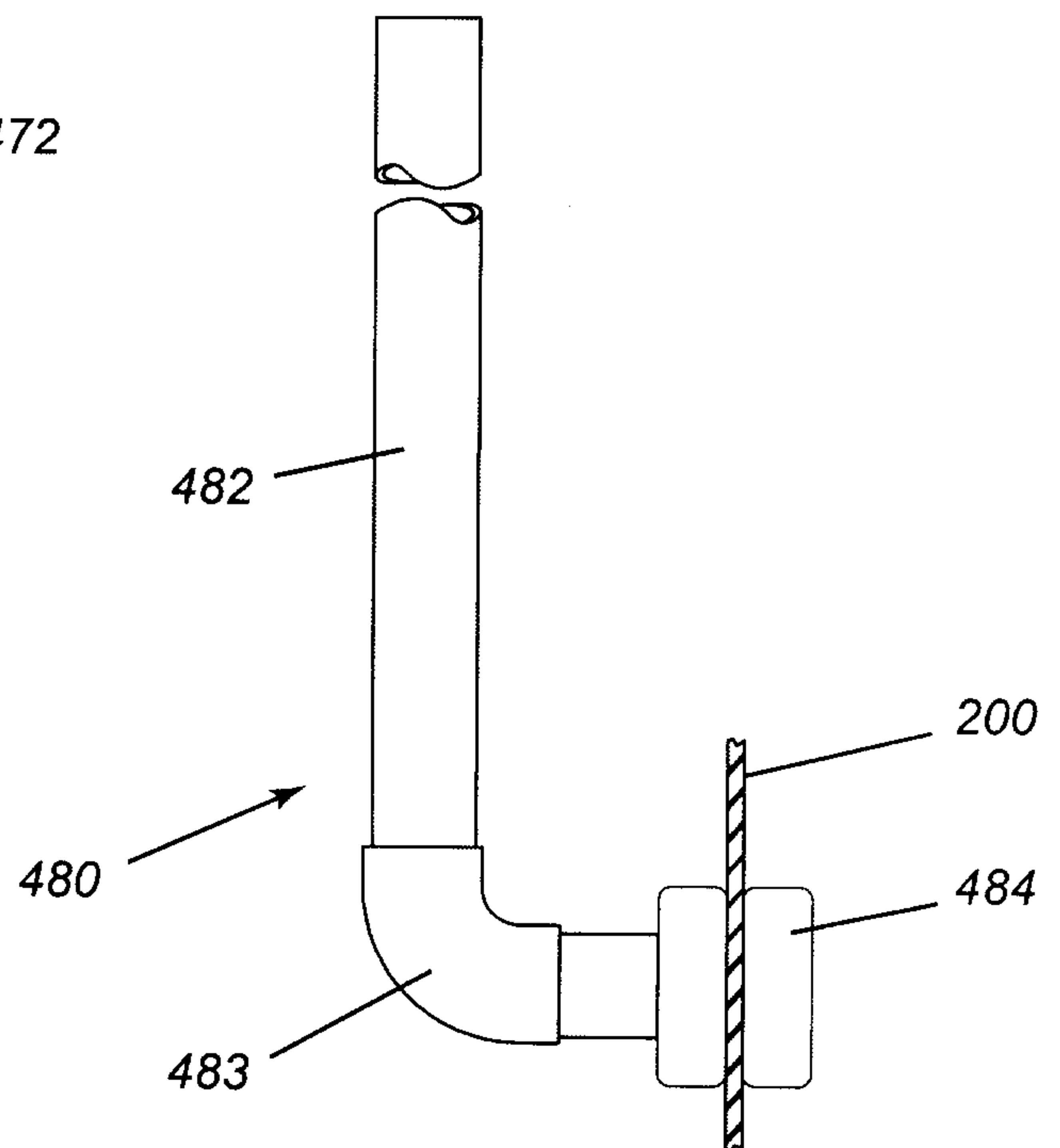


FIG. 8

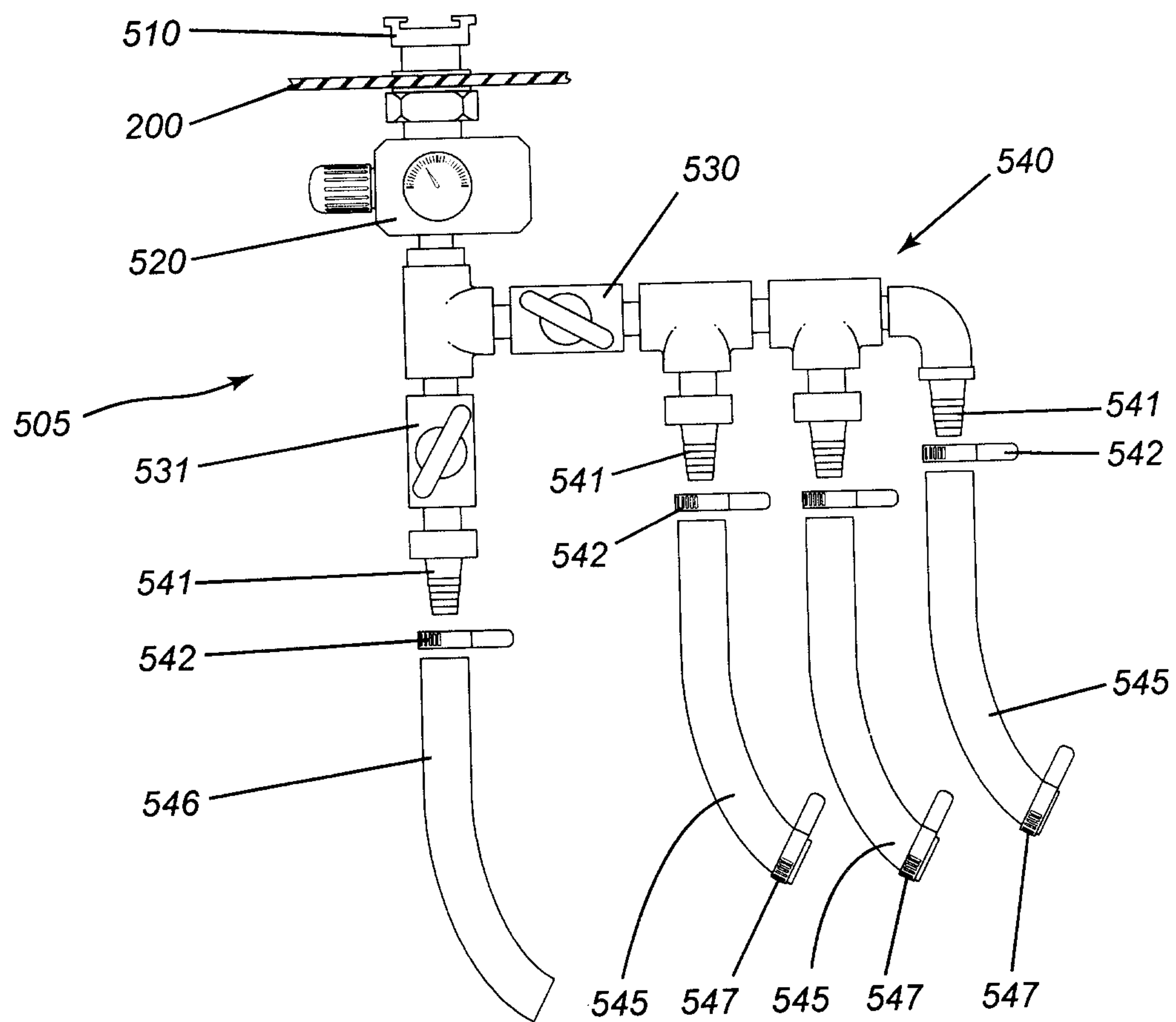


FIG. 9

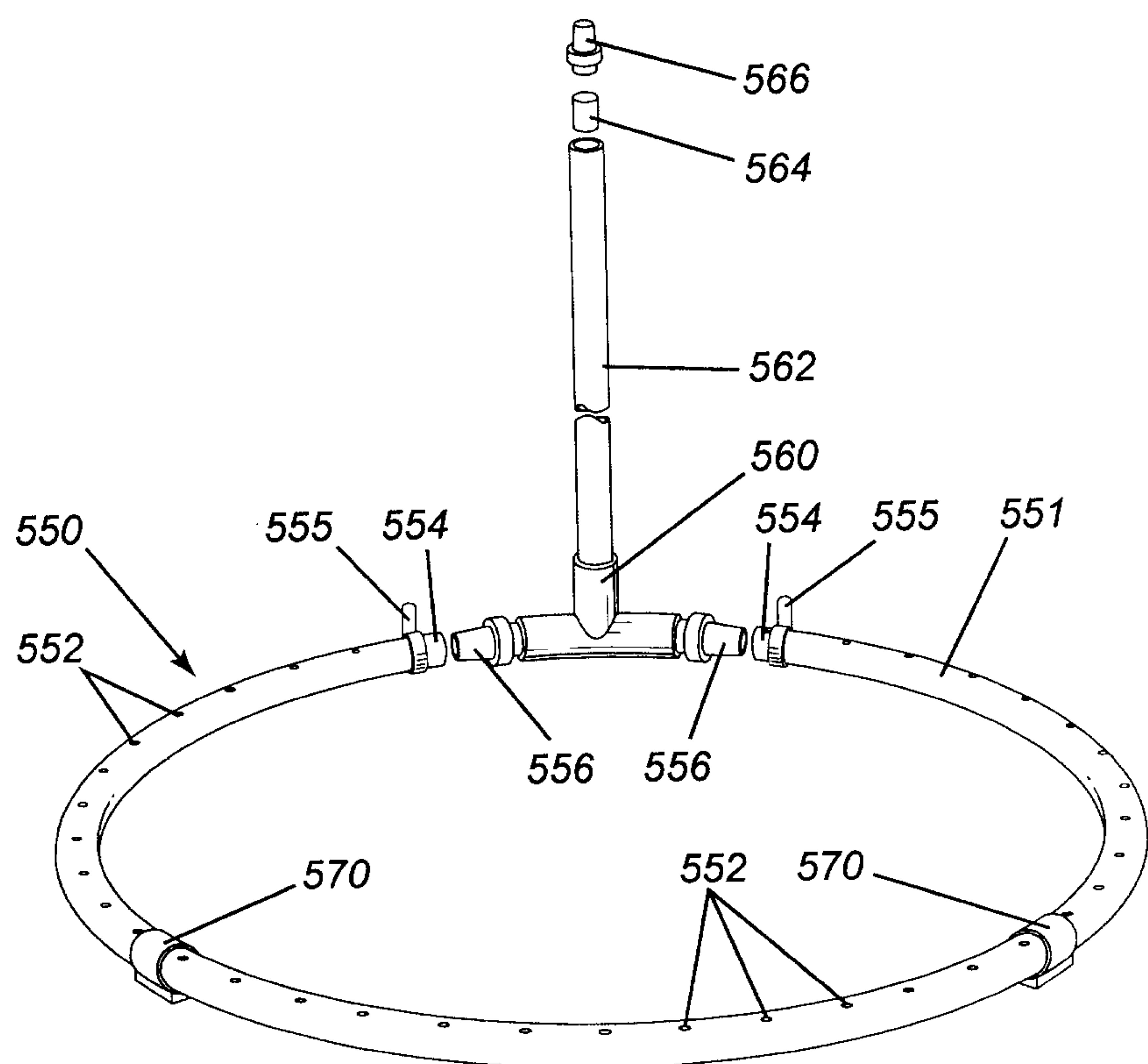


FIG. 10

