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(54) Title: DUAL-TRAP TOILET HAVING IMPROVED TRAPWAY AND IMPROVED CONNECTING TUBE INTERFACE

(57) Abstract: A toilet assembly may comprise a toilet tank to hold flush water, a flush valve assembly positioned in the toilet tank, a toilet deck, a toilet bowl, a trapway in flow communication with the toilet bowl, a container positioned in the toilet tank, and a connecting tube extending from an interior of the container to the trapway. A first gasket positioned between the toilet tank and the toilet deck may form a seal around the flush valve assembly. A second gasket positioned between the toilet tank and the toilet deck may form a seal around the connecting tube. The first gasket may comprise a recess for receiving the flush valve assembly and a protrusion extending into the toilet deck.

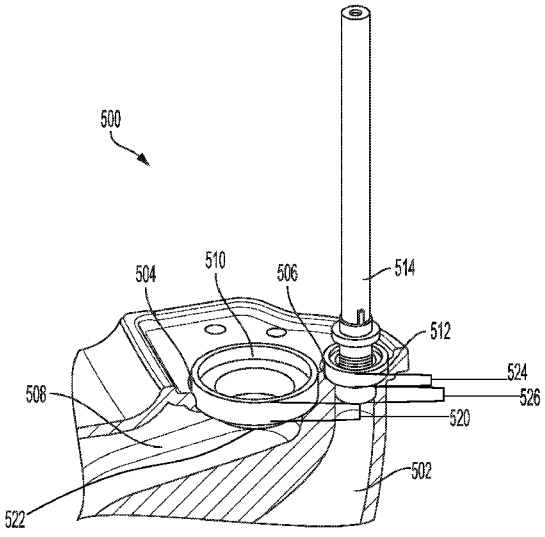


FIG. 5C

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DUAL-TRAP TOILET HAVING IMPROVED TRAPWAY AND IMPROVED CONNECTING TUBE INTERFACE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 63/333,971, filed April 22, 2022, U.S. Provisional Application No. 63/333,973, filed April 22, 2022, and U.S. Provisional Application No. 63/333,977, filed April 22, 2022, the entire contents of which are incorporated herein by reference.

FIELD

[0002] The present disclosure relates generally to dual-trap toilets.

BACKGROUND

[0003] Conventional dual-trap toilets comprise a trapway that is configured to trap water in two separate locations. A first upstream trap may be located directly downstream of the toilet bowl and may be configured to hold water in the toilet bowl in between flush cycles. A second downstream trap may be located between the first trap and an outlet from the trapway to a drainage pipe. The dual-trap configuration may prevent sewer gases from leaking out of the sewer through drainage pipe while also providing a quieter flush cycle than other flush toilets (e.g., single trap toilets).

SUMMARY

[0004] The tank of a dual-trap toilet may comprise one or more components that are fluidly coupled to the toilet bowl and/or to the trapway. The interface between the one or more components and a toilet deck above the toilet bowl and/or trapway may be configured to prevent flush water and air from leaking out of the toilet tank and into other portions of the dual-trap toilet. The present disclosure provides dual-trap toilet assemblies having an improved interface between the trapway, the toilet bowl, and the toilet tank.

[0005] A dual-trap toilet may have one or more gaskets that are configured to provide an effective seal between components of the toilet. Each of the one or more gaskets may comprise a collared portion and/or a recessed portion that protrudes into the toilet deck of the dual-trap toilet. Use of a gasket having a recess and/or protrusion as described herein may allow for the gasket to be compressed by forces acting in multiple different directions – e.g., the collar may be compressed vertically between the tank and the deck, while the protrusion may be compressed horizontally by a receiving area into which it is inserted. Compression by forces acting in multiple different directions may allow for a tighter and more secure fit to be achieved, and for a more effective and robust seal to be formed.

[0006] A first toilet assembly may comprise a toilet tank to hold flush water, a flush valve assembly positioned in the toilet tank, a toilet deck, a toilet bowl, a trapway in flow communication with the toilet bowl, a container positioned in the toilet tank, a connecting tube extending from an interior of the container to the trapway, a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly, and a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube. The container may be in flow communication with the toilet tank and may have an open lower end and a closed upper end. The trapway may comprise a sump trap, a first upstream weir, a lower trap, and a second downstream weir. The connecting tube may be coupled to the trapway at a position between the sump trap and the lower trap and may provide flow communication between the container and the trapway.

[0007] In some embodiments of the first toilet assembly, the first gasket comprises a recess receiving the flush valve assembly.

[0008] In some embodiments of the first toilet assembly, the first gasket comprises a protrusion extending into the toilet deck.

[0009] In some embodiments of the first toilet assembly, the first gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

[0010] In some embodiments of the first toilet assembly, the second gasket comprises a recess receiving the connecting tube.

[0011] In some embodiments of the first toilet assembly, the second gasket comprises a protrusion extending into the toilet deck.

[0012] In some embodiments of the first toilet assembly, the second gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

[0013] In some embodiments of the first toilet assembly, between flush cycles, the container comprises pressurized air positioned above flush water.

[0014] In some embodiments of the first toilet assembly, upon discharging water into a flush valve core to initiate a flush cycle, reduced pressure is created in pressurized air in the trapway.

[0015] In some embodiments of the first toilet assembly, upon re-filling the toilet tank with water to end a flush cycle, increased pressure is created in pressurized air in the trapway.

[0016] In some embodiments of the first toilet assembly, the flush valve assembly comprises a valve body extending from a valve inlet to a valve outlet and a valve cover having a seal to enclose the valve inlet.

[0017] In some embodiments of the first toilet assembly, the container comprises a continuous side wall, an upper end wall, and an inner wall that together bound a vacuum chamber of the container.

[0018] In some embodiments of the first toilet assembly, the inner wall bounds an inner chamber of the container.

[0019] In some embodiments of the first toilet assembly, the second gasket comprises a face seal.

[0020] In some embodiments of the first toilet assembly, the second gasket comprises a piston seal.

[0021] A second toilet assembly may comprise a toilet tank to hold flush water, a flush valve assembly positioned in the toilet tank, a toilet deck, a toilet bowl, a trapway in flow

communication with the toilet bowl, a container positioned in the toilet tank, a connecting tube extending from an interior of the container to the trapway, and a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly, wherein the first gasket comprises a recess receiving the flush valve assembly and a protrusion extending into the toilet deck. The container may be in flow communication with the toilet tank and may have an open lower end and a closed upper end. The trapway may comprise a sump trap, a first upstream weir, a lower trap, and a second downstream weir. The connecting tube may be coupled to the trapway at a position between the sump trap and the lower trap and may provide flow communication between the container and the trapway.

[0022] In some embodiments of the second toilet assembly, the first gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

[0023] In some embodiments of the second toilet assembly, an outer diameter of the protrusion of the first gasket is wider than an inner diameter of the recess of the first gasket.

[0024] In some embodiments, the second toilet assembly comprises a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube. The second gasket may comprise a recess receiving the connecting tube and a protrusion extending into the toilet deck.

[0025] In some embodiments of the second toilet assembly, the second gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion of the second gasket.

[0026] In some embodiments of the second toilet assembly, an outer diameter of the protrusion of the second gasket is wider than an inner diameter of the recess of the second gasket.

[0027] In some embodiments of the second toilet assembly, the second gasket comprises a face seal.

[0028] In some embodiments of the second toilet assembly, the second gasket comprises a piston seal.

[0029] In some embodiments of the second toilet assembly, between flush cycles, the container comprises pressurized air positioned above flush water.

[0030] In some embodiments of the second toilet assembly, upon discharging water into a flush valve core to initiate a flush cycle, reduced pressure is created in pressurized air in the trapway.

[0031] In some embodiments of the second toilet assembly, upon re-filling the toilet tank with water to end a flush cycle, increased pressure is created in pressurized air in the trapway.

BRIEF DESCRIPTION OF THE FIGURES

[0032] The following figures show various views and/or associated data for dual-trap toilets, in accordance with some embodiments. The dual-trap toilets shown in the figures may, in some embodiments, have any one or more of the characteristics described herein.

[0033] FIGS. 1A and 1B show perspective views of a dual-trap toilet, in accordance with some embodiments.

[0034] FIG. 2 shows a cross-sectional view of a dual-trap toilet, in accordance with some embodiments.

[0035] FIG. 3 shows a perspective cutaway view of a dual-trap toilet, in accordance with some embodiments.FIG. 4 shows a partial cross-sectional view of a dual-trap toilet, in accordance with some embodiments.

[0036] FIGS. 5A-5E show various views of components of a dual-trap toilet for connecting a connecting tube between a toilet tank and a trapway, in accordance with some embodiments.

[0037] FIGS. 6A-6E shows cross-sectional views of an interface between a toilet tank and a toilet deck, showing a valve gasket and a vacuum gasket, in accordance with some embodiments.

[0038] FIGS. 7A-7B show top and bottom views of a manifold plate, according to some embodiments.

DETAILED DESCRIPTION

[0039] Dual-trap toilets comprise a trapway that is configured to trap water in two separate locations. In some embodiments, dual-trap toilets may have a trapway including a sump trap, a first upstream weir, a lower trap, and a second downstream weir. A container positioned in the toilet tank may be coupled by a connecting tube that extends between an interior of the container and the trapway. The connecting tube may be coupled to the trapway at a position between the sump trap and the lower trap and may provide flow communication between the container and the trapway. Between flush cycles, the container and the trapway may contain positively pressurized air. The positively pressurized air in the trapway between flush cycles may push upwards on water in the sump trap and may result in a larger water spot in the toilet bowl than would be present if not for the positively pressurized air. Additionally, the positively pressurized air in the trapway between flush cycles may push downwards on water in the lower trap, such that a water level in an upstream end of the lower trap may be lower than a water level in a downstream end of the lower trap.

[0040] Upon initiation of a flush cycle, a flush valve seal may lift off of a flush valve inlet to the flush valve to open the flush valve, and flush water may be discharged from the toilet tank and the container through the flush valve and into the toilet bowl. As used herein, the term "flush water" may refer to any water that passes out of a toilet tank (or any subcomponent thereof, such as a container positioned inside a toilet tank, an inner chamber of said container, and/or a vacuum chamber of said container) during a flush cycle. Discharging the flush water during a flush cycle may exert a negative pressure on air in an upper end of the container, connecting tube, and trapway portion between the sump trap and the lower trap. The negative pressure may cause a drop to atmospheric pressure or to partial vacuum. The negative pressure may help create a siphon to pull water and waste through the sump area and into and out of the trapway.

[0041] A flush cycle may be considered completed upon closing the flush valve and re-filling the toilet tank, sump trap, and lower trap. Upon completion of a flush cycle, new flush water entering the toilet tank may also enter the container via one or more openings

positioned in the container wall. Entry of water into the container may compress air into an upper end of the container and may return the air contained in the regions defined by the upper end of the container, the connecting tube, and the trapway portion between a sump trap and a lower trap to atmospheric pressure and/or to a positive pressure above atmospheric pressure.

[0042] A dual-trap toilet may have one or more gaskets that are configured to provide an effective seal between components of the toilet. One or more of the gaskets may be positioned between a toilet tank and a toilet deck of the toilet. The gaskets may comprise one or more flexible and/or compressible materials, such as rubber or any natural or synthetic elastomer.

[0043] A first gasket may provide a seal around a flush valve assembly. The first gasket may form a seal around a portion of the flush valve assembly through which flush water from the flush valve may pass from the toilet tank into the toilet bowl. The seal may prevent flush water from leaking. A second gasket may provide a seal around a connecting tube. The second gasket may form a seal around a portion of the conduit through which pressurized air may pass between the container and the trapway. The seal may prevent pressurized air and/or vacuum from leaking. The seal that is formed between connecting tube, tank, and toilet deck may allow for a vacuum to be held in container upper end, connecting tube, and trapway during flush cycles; and/or may allow for pressurized air to be held in the container upper end, connecting tube, and trapway between flush cycles. Providing the two gaskets separately from one another, rather than providing a single gasket with multiple through-holes intended to provide both seals, may allow for the preciseness of the fit and the effectiveness of the seal of each of the gaskets to be improved.

Dual-trap toilets

[0044] Dual-trap toilets comprise a trapway that is configured to trap water in two separate locations. A first upstream trap may be located directly downstream of the toilet bowl and may be configured to hold water in the toilet bowl in between flush cycles. A second, downstream trap may be located between the first trap and an outlet from the trapway to a drainage pipe. The dual-trap configuration may prevent sewer gases from leaking out of

the sewer through drainage pipe while also providing a quieter flush cycle than other flush toilets (e.g., single trap toilets).

[0045] FIGS. 1A and 1B show perspective views of a dual-trap toilet, in accordance with some embodiments. Specifically, FIGS. 1A and 1B illustrate perspective views of a dual-trap toilet 100 comprising a toilet bowl 102, a toilet tank 104, and a trapway 106. In some embodiments, toilet bowl 102, toilet tank 104, and trapway 106 may be in flow communication. In some embodiments, as shown in FIG. 1B, toilet 100 may comprise a flush control 108. Flush control 108 may comprise one or more handles, push buttons, levers, chains, position sensors, and/or motion sensors that are configured to initiate a flush cycle when engaged by a user.

[0046] Between flush cycles, toilet bowl 102 may contain a volume of water. In some embodiments, a volume of water contained in toilet bowl 102 between flush cycles may be about 0.5 gallons, about 0.75 gallons, about 1 gallon, about 1.25 gallons, about 1.5 gallons, about 1.75 gallons, about 2 gallons, about 3 gallons, about 4 gallons, or about 5 gallons. In some embodiments, a volume of water contained in toilet bowl 102 between flush cycles may be greater than or equal to 2.5 gallons, 3.5 gallons, 4.5 gallons, 5.5 gallons, 6.5 gallons, 7.5 gallons, or 8.5 gallons. In some embodiments, a volume of water contained in toilet bowl 102 between flush cycles may be less than or equal to 2 gallons, 1.5 gallons, 1 gallon, 0.5 gallons, or 0.1 gallons.

[0047] Toilet tank 104 may be configured to contain flush water. Toilet tank 104 may be configured to fluidly connect to a water supply. In some embodiments, when a flush cycle is initiated, toilet tank 104 may be configured to discharge a volume of contained flush water into toilet bowl 102. Toward the end of a flush cycle, toilet tank 104 may be configured to replenish the discharged volume of water by receiving water from the water supply.

[0048] When a flush cycle is initiated (e.g., by a user who engages flush control 108), the contents of toilet bowl 102 may be siphoned into trapway 106. Trapway 106 may be configured to fluidly connect to a sewer system (or to one or more drain pipes that connect to a sewer system). During a flush cycle, the siphoned contents of toilet bowl 102 may be directed through trapway 106 and into the sewer system.

[0049] Trapway 106 may comprise a sump trap and a lower trap. The sump trap may be directly downstream of toilet bowl 102 and the lower trap may be downstream of the sump trap. When toilet 100 is between flush cycles, water may collect in both the sump trap and the lower trap. The collection of water in the sump trap and the lower trap may form a series of water seals which prevent leakage of sewer gas out of trapway 106. The water that collects in the sump trap between flush cycles may be the volume of water contained in toilet bowl 102 between flush cycles, as described above.

[0050] When toilet 100 is between flush cycles, toilet tank 104 and trapway 106 may be configured to contain positively pressurized air. The positively pressurized air contained in trapway 106 may be contained between a sump trap and a lower trap and may exert upward pressure on water collected in the sump trap and downward pressure on water collected in the lower trap. In some embodiments, the upward pressure exerted on the water collected in the sump trap by the pressurized air contained in trapway 106 may raise the water level of water contained in toilet bowl 102 between flush cycles. The raised water level of water contained in toilet bowl 102 may reduce or prevent soiling of toilet bowl 102.

[0051] In some embodiments, when a flush cycle is initiated and flush water is discharged from toilet tank 104 into toilet bowl 102, a negative pressure may be exerted on the air contained in toilet tank 104 and the air contained in trapway 106. The negative pressure may cause the pressure within toilet tank 104 and/or trapway 106 to decrease to atmospheric pressure and/or to a partial vacuum. This decrease in pressure may generate a siphon in trapway 106 that may cause the contents of toilet bowl 102 to be pulled into and subsequently out of trapway 106.

[0052] Toward the end of a flush cycle, water may again collect in toilet bowl 102 and trapway 106. Upon completion of a flush cycle, toilet tank 104 may be configured to receive new flush water from a water supply. As toilet tank 104 refills with flush water, the air contained in toilet tank 104 may be compressed, thereby increasing the pressure of the air contained in toilet tank 104 and/or the air contained in trapway 106 to atmospheric pressure and/or to a pressure above atmospheric pressure. When the air contained in toilet tank 104 and/or the air contained in trapway 106 return(s) to positively pressurized states, the flush cycle may be completed.

[0053] FIG. 2 shows a cross-sectional view of a dual-trap toilet, in accordance with some embodiments. Specifically, FIG. 2 illustrates a cross-sectional view of a toilet 200 comprising a toilet bowl 202, a toilet tank 204, a trapway 206, and a flush control 208. In some embodiments, toilet bowl 202, toilet tank 204, trapway 206, and/or flush control 208 may include features of toilet bowl 102, toilet tank 104, trapway 106, and/or flush control 108 shown in FIG. 1A and/or FIG. 1B.

[0054] A container 218 and a flush valve 224 may be positioned within and in flow communication with toilet tank 204. Container 218 may have an irregular toroidal structure that defines a vacuum chamber, an inner chamber, and an outer region in toilet tank 204 that is external to and surrounds both container 218 and the inner chamber. In some embodiments, flush valve 224 may be positioned in the inner chamber defined by container 218 such that container 218 encircles flush valve 224.

[0055] Between flush cycles, toilet tank 204 may be configured to contain flush water. Between flush cycles, a first volume of flush water may be contained the outer region in toilet tank 204 that is external to and surrounds container 218 and the inner chamber defined by the structure of container 218, a second volume of flush water may be contained in the central cavity region defined by the structure of container 218, and a third volume of flush water may be contained in a vacuum chamber contained within the internal irregular annular region of container 218.

[0056] Toilet bowl 202 may be fluidly connected to toilet tank 204 via a fluid pathway 222. Flush valve 224 may be in flow communication with fluid pathway 222 which may, in turn, be in flow communication with toilet bowl 202. In some embodiments, a flush valve gasket 210 may be positioned at an interface between flush valve 224 and fluid pathway 222. Flush valve gasket 210 may form a mechanical seal between flush valve 224 and fluid pathway 222 in order to prevent flush water and/or air from leaking out of toilet tank 204 and into toilet bowl 202 between flush cycles (i.e., to prevent water and/or air leakage from toilet tank 204 when flush valve 224 is closed).

[0057] Fluid pathway 222 may be in flow communication with a rim channel 236 that encircles the rim of toilet bowl 202. During a flush cycle, a portion of flush water may be transmitted from toilet tank 204, through fluid pathway 222, and into rim channel 236. The

flush water may then be transmitted into toilet bowl 202 from rim channel 236 through one or more rim outlets.

[0058] The portion of flush water transmitted from toilet tank 204, through fluid pathway 222, and into rim channel 236 may be between about 0.5-2 liters, about 1-3 liters, about 1-4 liters, or about 1-5 liters. Optionally, the portion of flush water transmitted from toilet tank 204, through fluid pathway 222, and into rim channel 236 may be less than or equal to 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.4, 2.6, 2.8, 3, 3.2, 3.4, 3.6, 3.8, 4, 4.2, 4.4, 4.6, 4.8, or 5 liters. Optionally, the portion of flush water transmitted from toilet tank 204, through fluid pathway 222, and into rim channel 236 may be greater than or equal to 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.4, 2.6, 2.8, 3, 3.2, 3.4, 3.6, 3.8, 4, 4.2, 4.4, 4.6, 4.8, or 5 liters.

[0059] In some embodiments, less than 50% of the total volume of flush water delivered from toilet tank 204 to toilet bowl 202 during a flush cycle may be transmitted through rim channel 236. In some embodiments, greater than 50% of the total volume of flush water delivered from toilet tank 204 to toilet bowl 202 during a flush cycle may be transmitted through rim channel 235.

[0060] A lower portion of toilet bowl 202, referred to hereinafter as sump area 214a, may be in flow communication with a first upstream portion 214u of trapway 206 through a trapway inlet 207. The first upstream portion 214u of trapway 206, sump area 214a of toilet bowl 202, and a first downstream portion 214d of trapway 206 may together form a sump trap 214, which may contain flush water between flush cycles.

[0061] In some embodiments, fluid pathway 222 may be in flow communication with a jet channel 238. Jet channel may be adjacent to an upstream end of trapway 206 and may be fluidically coupled to sump trap 214 via a jet hole 240. During a flush cycle, a portion of flush water may be transmitted from toilet tank 204, through fluid pathway 222, and into jet channel 238. In some embodiments, the flush water that is transmitted into jet channel 238 may be transferred into sump trap 214 through jet hole 240 in order to generate a siphon in toilet 200. In some embodiments, the flush water that is transmitted into jet channel 238 may be transferred into sump trap 214 through jet hole 240 at the end of the flush cycle to refill sump trap 214.

[0062] In some embodiments, the ratio of the volume of flush water transmitted through rim channel 236 during a flush cycle to the volume of flush water transmitted through jet hole 240 during a flush cycle may be approximately 7:1, 6:1, 5:1, 4:1, 3:1, 2:1, 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, or 1:7. Optionally, the ratio of the volume of flush water transmitted through rim channel 236 during a flush cycle to the volume of flush water transmitted through jet hole 240 during a flush cycle may be less than or equal to 7:1, 6:1, 5:1, 4:1, 3:1, 2:1, 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, or 1:7. Alternatively, the ratio of the volume of flush water transmitted through rim channel 236 during a flush cycle to the volume of flush water transmitted through jet hole 240 during a flush cycle may be greater than or equal to 7:1, 6:1, 5:1, 4:1, 3:1, 2:1, 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, or 1:7.

[0063] Trapway 206 may comprise a first upstream weir 226 configured to contain the water that collects in sump trap 214. First upstream weir 226 may be a high point of a lower wall of trapway 206 that is downstream of the first downstream portion 214u of trapway 206 and may be positioned above a highest point of trapway inlet 207. In some embodiments, first upstream weir 226 may be positioned above the highest point of toilet bowl 202 – trapway 206 interface by an offset distance of about 0.5 inches, about 1 inch, about 1.5 inches, about 2 inches, about 2.5 inches, or about 3 inches. In some embodiments, first upstream weir 226 may be positioned above the highest point of toilet bowl 202 – trapway 206 interface by an offset distance greater than or equal to 2 inches, 2.5 inches, 3 inches, 3.5 inches, or 4 inches. In some embodiments, first upstream weir 226 may be positioned above the highest point of toilet bowl 202 – trapway 206 interface by an offset distance less than or equal to 6 inches, 5.5 inches, 5 inches, 4.5 inches, or 4 inches.

[0064] Trapway 206 may be configured to fluidly connect to a sewer system via a trapway outlet 220. As a result, sewer gases may enter trapway 206 through trapway outlet 220. The water that is contained in sump trap 214 between flush cycles may form a water seal in toilet bowl 202. The water seal may prevent sewer gases which may have entered trapway 206 from leaking out of toilet bowl 202. Between flush cycles, the water seal in toilet bowl 202 may be vertically lower than first upstream weir 226. In some embodiments, a vertical distance between the water seal in toilet bowl 202 and first upstream weir 226 may be about 0.1 inches, about 0.2 inches, about 0.3 inches, about 0.4 inches, or about 0.5 inches. In some embodiments, a vertical distance between the water seal in toilet bowl 202 and first upstream weir 226 may be greater than or equal to 0.2 inches, 0.5 inches, 0.8 inches, or 1 inch. In some

embodiments, a vertical distance between the water seal in toilet bowl 202 and first upstream weir 226 may be less than or equal to 2 inches, 1.8 inches, 1.5 inches, or 1.2 inches.

[0065] Trapway 206 may comprise a lower trap 216 positioned downstream of first upstream weir 226 between a second upstream portion 216u of trapway 206 and a second downstream portion 216d of trapway 206. Between flush cycles, water may collect in lower trap 216 to form a pair of water seals to provide a second barrier against sewer gases which may enter trapway 206 via trapway outlet 220. The downstream water seal of the pair of water seals may be vertically higher than an upstream water seal of the pair of water seals. Trapway 206 may comprise a second downstream weir 228 configured to contain water in lower trap 216. Second downstream weir 228 may be a high point of a lower wall of trapway 206 that is downstream of the second downstream portion 216d of trapway 206.

[0066] Container 218 may house a connecting tube 230 configured to provide flow communication between container 218 and trapway 206. Connecting tube 230 may extend from an interior region of container 218 into trapway 206. In some embodiments, connecting tube 230 may be coupled to trapway 206 at a position between sump trap 214 and lower trap 216. A trapway-tank interface 212 may be positioned between sump trap 214 and lower trap 216 and may be configured to couple to connecting tube 230. In some embodiments, connecting tube 230 may comprise a backflow preventer.

[0067] FIG. 3 shows a perspective cutaway view of a dual-trap toilet, in accordance with some embodiments. Specifically, FIG. 3 illustrates a cross-sectional view of a toilet 300 comprising a toilet bowl 302, a toilet tank 304, a trapway 306, and a flush control 308. In some embodiments, toilet 300 may include one or more features of toilet 200 shown in FIG. 2 and/or toilet 100 shown in FIGS. 1A and 1B.

[0068] Toilet tank 304 may comprise one or more features of toilet tank 204 of toilet 200 shown in FIG. 2. In some embodiments, toilet tank 304 may be configured to house a container 318, a flush valve 324, and a fill valve 334. Container 318 and flush valve 324 may include one or more features of container 218 and flush valve 224, respectively. Fill valve 334 may be configured to fluidly connect to a water supply in order to facilitate the transmission of flush water from the water supply to toilet tank 304. In some embodiments, fill valve 334 may comprise a backflow preventer.

[0069] Container 318 may have an irregular toroidal (i.e., "donut"-shaped) structure defined by an inner wall 342, a continuous side wall 346, and an upper wall 344 that together divide container 318 into an inner chamber 318I and a vacuum chamber 318V. In between flush cycles, the flush water in tank 304 may be divided between a region of the toilet tank outside of container 318, vacuum chamber 318V, and inner chamber 318I.

[0070] Vacuum chamber 318V may have a closed upper end and may be configured to contain pressurized air when toilet 300 is between flush cycles. The pressurized air in vacuum chamber 318V may have a pressure greater than the ambient pressure of air in the toilet tank. A connecting tube may fluidically couple the upper end of vacuum chamber 318V to trapway 306. As a result of the coupling between trapway 306 and the upper end of vacuum chamber 318V, trapway 306 may also contain pressurized air when the toilet is between flush cycles.

[0071] Inner chamber 318I may have an upper end that is open to tank 304, allowing air to flow freely between inner chamber 318I and the region of the tank that is outside of the container. Inner chamber 318I may also house flush valve 324. Upon initiation of a flush cycle, a flush valve seal may be lifted from an inlet to flush valve 324 to open flush valve 324, and flush water may be discharged from tank 304 and container 318 through flush valve 324 and into toilet bowl 302. The discharging flush water may reduce the pressure of the air contained in vacuum chamber 318V of container 318 and air contained in trapway 306 of the toilet. This reduction in pressure may induce a siphon that pulls the contents of toilet bowl 302 into trapway 306 and subsequently into the sewer system.

[0072] Toilet bowl 302 may be fluidly coupled to flush valve 324 via a fluid pathway 322. A flush valve gasket 310 may form a mechanical seal between flush valve 324 and fluid pathway 322 in order to prevent water from leaking out of toilet tank 304 and into toilet bowl 302 in between flush cycles. In some embodiments, fluid pathway 322 may be in flow communication with a rim channel 336 and/or a jet channel 338. Rim channel 336 may include one or more features of rim channel 236 shown in FIG. 2. Jet channel 338 may include one or more features of jet channel 238 shown in FIG. 2.

[0073] Trapway 306 may comprise one or more features of trapway 206 of toilet 200 shown in FIG. 2 and/or trapway 106 of toilet 100 shown in FIGS. 1A and 1B. Trapway 306

may comprise a sump trap 314 (defined by a first upstream portion 314u of trapway 306, a sump area 314a in toilet bowl 302, and a first downstream portion 314d of trapway 306), a first upstream weir 326, a lower trap 316 (positioned between a second upstream portion 316u of trapway 306 and a second downstream portion 316d of trapway 306), and a second downstream weir 328. Trapway 306 may be fluidly coupled to toilet tank 304 via a trapway-tank interface 312. In some embodiments, trapway 306 may comprise an outlet 320 configured to fluidly connect to a drainage pipe into a sewer system.

[0074] FIG. 4 shows a partial cross-sectional view of a dual-trap toilet, in accordance with some embodiments. Specifically, FIG. 4 shows a partial cross-sectional view of a toilet 400. Toilet 400 may comprise a toilet bowl 402 that is fluidly coupled to a toilet tank via a flush valve outlet 404. Toilet bowl 402 may be fluidly coupled to a trapway 410 through a trapway inlet 411. A sump trap 412 may be defined by a first upstream portion 412u, a sump area 412a, and a first downstream portion 412d of trapway 410. A first upstream weir 416 of trapway 410 may be positioned downstream of sump trap 412. A lower trap 414 may be positioned between a second upstream portion 414u and a second downstream portion 414d of trapway 410, and a second downstream weir 418 may be positioned downstream of lower trap 414. Trapway 410 may be fluidly coupled to a toilet tank via a trapway-tank interface 408. In some embodiments, one or more features of toilet 400 may include one or more features of toilet 300 shown in FIG. 3, toilet 200 shown in FIG. 2, and/or toilet 100 shown in FIGS. 1A-1B.

Connecting tube interface

[0075] The trapway of a dual-trap toilet may be fluidly coupled to a connecting tube that is positioned within the toilet tank. The connecting tube may provide flow communication between a toilet tank container and a portion of the trapway that contains a volume of pressurized air. Similarly, the toilet bowl of the dual-trap toilet may be fluidly coupled to a flush valve in the toilet tank. Upon initiation of a flush cycle, flush water may be discharged into the toilet bowl via the flush valve in order to cause the contents of the toilet bowl to be pulled into the trapway. In some embodiments, the dual-trap toilet may have one or more gaskets that are configured to provide an effective seal between components in the toilet tank and the trapway and/or the toilet bowl.

[0076] FIGS. 5A-5C show various views of components of a dual-trap toilet for connecting a connecting tube between a toilet tank and a trapway, in accordance with some embodiments. Specifically, FIGS. 5A-5C show various views of a toilet deck 500 comprising a tank-trapway interface 502, a flush water outlet 504, a connecting tube coupling 506, and a flush water flow path 508. Tank-trapway interface 502 may be fluidly coupled to a connecting tube 514 in order to provide flow communication between a first volume of pressurized air that is contained in an upper portion of a container 518 in the toilet tank and a second volume of pressurized air that is contained in the trapway. Flush water outlet 504 may be fluidly coupled to a flush valve assembly that is positioned in the toilet tank. Flush water flow path 508 may be configured to transmit flush water that is discharged by a flush valve to a toilet bowl of the dual-trap toilet.

[0077] A first gasket 510 may be positioned between the toilet tank and toilet deck 500. Specifically, first gasket 510 may be positioned between a lower end of the flush valve assembly that is housed in the toilet tank and flush water outlet 504. In some embodiments, first gasket 510 may provide a seal around a flush valve assembly by forming a seal around a portion of the flush valve assembly through which flush water from the flush valve may pass from the toilet tank into the toilet bowl. The seal may prevent flush water from leaking into the toilet bowl between flush cycles. First gasket 510 comprise one or more flexible and/or compressible materials, such as rubber or any natural or synthetic elastomer. In some embodiments, first gasket 510 may have a foam specification 1A3.

[0078] A second gasket 512 may be positioned between the toilet tank and toilet deck 500. Specifically, second gasket 512 may be positioned between a lower end of connecting tube 514 and connecting tube coupling 506. In some embodiments, second gasket 512 may provide a seal around connecting tube 514 by forming a seal around a portion of the conduit through which pressurized air may pass between container 518 and the trapway. The seal may prevent pressurized air and/or vacuum from leaking. The seal that is formed between connecting tube 514, the toilet tank, and toilet deck 500 may allow for a vacuum to be held in an upper end of container 518, in connecting tube 514, and/or in the trapway during flush cycles. In some embodiments, the seal may allow for pressurized air to be held in the upper end of container 518, in connecting tube 514, and/or in the trapway between flush cycles. Second gasket 512 comprise one or more flexible and/or compressible materials, such as

rubber or any natural or synthetic elastomer. In some embodiments, second gasket 512 may have a Durometer softness of 20-60 Shore A.

[0079] First gasket 510 and second gasket 512 may be provided separately from one another. Providing first gasket 510 and second gasket 512 separately from one another, rather than providing a single gasket with multiple through-holes intended to provide both seals, may allow for the preciseness of the fit and the effectiveness of the seal of each of the gaskets to be improved.

[0080] Close-up view of first gasket 510 and second gasket 512 are provided in FIGS. 5D-5E. First gasket 510 and/or second gasket 512 may have a generally annular shape that encircles a central flow path through which water and/or air flows. In some embodiments, rather than being provided in the form of a conventional o-ring, first gasket 510 and/or second gasket 512 may be shaped to provide an improved seal that is more tightly and precisely fitting, is easier to install, and is more robust against leaks. In some embodiments, first gasket 510 may comprise a first recess and/or protrusion 522 configured to receive the flush valve assembly and/or to protrude into toilet deck 500. In some embodiments, 512 may comprise a second recess and/or protrusion 526 configured to receive connecting tube 514 and/or to protrude into toilet deck 500. In some embodiments, a flipped configuration may be used, for example in which a protrusion extends upwards into the toilet tank and a recess receives a component from below.

[0081] In some embodiments, first gasket 510 may include a first collar portion 520 formed around first recess 522, wherein the outer circumference (and/or diameter) of first collar portion 520 may be larger than a circumference (and/or diameter) of first recess and/or protrusion 522. First collar portion 520 may have a circumference (and/or diameter) that is larger than the outer circumference (and/or diameter) of first recess and/or protrusion 522. First collar portion 520 may have a greater height (e.g., in the flow direction through the gasket), a lesser height, or the same height as the height of first recess and/or protrusion 522 formed in first gasket 510. First collar portion 520 may have a greater height (e.g., in the flow direction through the gasket), a lesser height, or the same height as the height of recess and/or protrusion 522. In some embodiments, an inner circumference (and/or diameter) of first recess and/or protrusion 522 may be greater, lesser, or equal to the outer circumference

(and/or diameter) of first recess and/or protrusion 522. An upper portion of first gasket 510 may be configured to receive a hex nut.

[0082] In some embodiments, second gasket 512 may include a second collar portion 524 formed around second recess/protrusion 526, wherein the outer circumference (and/or diameter) of second collar portion 524 may be larger than a circumference (and/or diameter) of second recess and/or protrusion 526. Second collar portion 524 may have a circumference (and/or diameter) that is larger than the outer circumference (and/or diameter) of second recess and/or protrusion 526. Second collar portion 524 may have a greater height (e.g., in the flow direction through the gasket), a lesser height, or the same height as the height of second recess and/or protrusion 526 formed in second gasket 512. Second collar portion 524 may have a greater height (e.g., in the flow direction through the gasket), a lesser height, or the same height as the height of second recess and/or protrusion 526. In some embodiments, an inner circumference (and/or diameter) of second recess and/or protrusion 526 may be greater, lesser, or equal to the outer circumference (and/or diameter) of second recess and/or protrusion 526. An upper portion of second gasket 512 may be configured to receive a hex nut.

[0083] FIGS. 6A-6D show various cross-sectional views of an interface 600 between a toilet tank 602 and a toilet deck 604, showing a valve gasket and a vacuum gasket, in accordance with some embodiments. An exploded view of interface 600 is shown in FIG. 6E. Toilet tank 602 may house a flush valve assembly 606 and a connecting tube 610. In some embodiments, connecting tube 612 may be housed within a container 628 that is positioned in toilet tank 602. In some embodiments, toilet deck 604 may comprise a flush water outlet 610 configured to receive an opening in flush valve assembly 606. Flush water outlet may be fluidically coupled to a fluid pathway/manifold 636 (which may be similar to or include one or more features of fluid pathway 322 shown in FIG. 3). In some embodiments, toilet deck 604 may comprise a connecting tube coupling 616 configured to receive an opening in connecting tube 612.

[0084] A first gasket 608 may be positioned between a lower end of flush valve assembly 606 and flush water outlet 610. A second gasket 614 may be positioned between a lower end of connecting tube 612 and connecting tube coupling 616. First gasket 608 may include one or more features of first gasket 510 shown in FIG. 5. Second gasket 614 may include one or

more features of second gasket 512 shown in FIG. 5. In particular, first gasket 608 and second gasket 614 may comprise collared portions and recessed and/or protrusion portions. The recesses and/or protrusions may allow for first gasket 608 and/or second gasket 614 to be compressed by forces acting in multiple different directions, for example including a vertical direction and a horizontal direction as explained below. Compression by forces acting in multiple different directions may allow for a tighter and more secure fit to be achieved, and for a more effective and robust seal to be formed. A first nut 632 and a second nut 630 may be disposed in an upper portion of first gasket 608 and second gasket 614, respectively.

[0085] Second gasket 614 may comprise vacuum gasket seals at multiple points to allow for repeatable, stable vacuum formation without loss of vacuum. A first vacuum gasket seal may be a face seal 618. Face seal 618 may vertically compress a collared portion of second gasket 614 between toilet tank 602 and toilet deck 604. A second vacuum gasket seal 620 may horizontally compress a recessed portion of second gasket 614 between a lower portion of connecting tube 610 and connecting tube coupling 616. A third vacuum gasket seal may be a piston seal 622. Piston seal 622 may horizontally or radially compress a recessed/protruding portion of second gasket 614 between a lower portion of connecting tube 610 and a terminal portion of connecting tube coupling 616. In some embodiments, first gasket 608 may comprise one or more gasket seals analogous to seals 618-622, for example a face seal and/or a piston seal.

[0086] A third gasket 624 may be positioned around flush valve assembly 606. Third gasket 624 may be coupled to container 628 and may, in some embodiments, be configured to sit on or near a bottom surface of an inner portion of tank 602. In some embodiments, third gasket 624 may be configured to facilitate installation. For example, third gasket 624 may be symmetrical in shape (e.g., symmetric about a central plane that is level with the bottom surface of tank 602 when third gasket 624 is installed) to ensure ease of installation. Third gasket 624 may be annular in shape and may comprise a central through-hole through which a lower portion of flush valve assembly is configured to extend. An outer edge of third gasket 624 may comprise an upper lip configured to extend over a top, internal surface of the bottom of container 628 and a bottom lip configured to extend underneath a bottom, external surface of the bottom of container 628.

[0087] A fourth gasket 626 may be positioned between connecting tube 612 and a bottom surface of an inner portion of tank 602. Fourth gasket 626 may be configured to prevent flush water from leaking out of tank 602. Fourth gasket 626 may be annular in shape and may comprise a central through-hole through which connecting tube 612 is configured to extend. An outer edge of gasket 626 may comprise a lip portion that extends laterally away from connecting tube 612 along a bottom, internal surface of tank 602.

[0088] In some embodiments, as shown in FIGS. 6B-6E, interface 600 may include a manifold plate 634. Manifold plate 634 may comprise a plurality of legs that rest on a bottom surface of tank 602 between flush valve 606 and fluid pathway/manifold 634. The position of manifold plate 634 in tank 602 may be fixed by a plurality of bolts 638 and a plurality of rubber grommets 640. Manifold plate 634 may compress gaskets 608, 614, 624, 626, and/or a donut gasket 642 to prevent vacuum and water leaks. A top view and a bottom view of an exemplary manifold plate are shown in FIG. 7A and FIG. 7B, respectively.

Exemplary Embodiments

[0089] Below is an enumerated listing of certain embodiments. In some embodiments, any one or more features of any one or more of the embodiments below may be combined with any one or more of the other embodiments, even if the dependencies of the embodiments do not explicitly indicate that the embodiments may be combined in such manner. In some embodiments, any one or more of the features of any one or more of the embodiments below may be combined with any one or more features or aspects otherwise disclosed in this application.

1. A toilet assembly, comprising:
a toilet tank to hold flush water;
a flush valve assembly positioned in the toilet tank;
a toilet deck;
a toilet bowl;
a trapway in flow communication with the toilet bowl;
a container positioned in the toilet tank;
a connecting tube extending from an interior of the container to the trapway,

a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly; and

a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube;

wherein:

the container is in flow communication with the toilet tank, the container having an open lower end and a closed upper end,

the trapway comprises a sump trap, a first upstream weir, a lower trap, and a second downstream weir, and

the connecting tube is coupled to the trapway at a position between the sump trap and the lower trap and provides flow communication between the container and the trapway.

2. The toilet assembly of embodiment 1, wherein the first gasket comprises a recess receiving the flush valve assembly.

3. The toilet assembly of any one of embodiments 1-2, wherein the first gasket comprises a protrusion extending into the toilet deck.

4. The toilet assembly of embodiment 3, wherein the first gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

5. The toilet assembly of any one of embodiments 1-4, wherein the second gasket comprises a recess receiving the connecting tube.

6. The toilet assembly of any one of embodiments 1-5, wherein the second gasket comprises a protrusion extending into the toilet deck.

7. The toilet assembly of embodiment 6, wherein the second gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

8. The toilet assembly of any one of embodiments 1-7, wherein, between flush cycles, the container comprises pressurized air positioned above flush water.

9. The toilet assembly of any one of embodiments 1-8, wherein, upon discharging water into a flush valve core to initiate a flush cycle, reduced pressure is created in pressurized air in the trapway.

10. The toilet assembly of any one of embodiments 1-9, wherein, upon a toilet tank water level falling to a lower edge of a head of the flush valve to break a siphon, and re-filling the toilet tank with water to end a flush cycle, increased pressure is created in pressurized air in the trapway.

11. The toilet assembly of any one of embodiments 1-10, wherein, between flush cycles, pressurized air in the trapway is pressurized at a pressure greater than or equal to 0.5 cm of water above atmospheric pressure and less than or equal to 5 cm of water above atmospheric pressure.

12. The toilet assembly of any one of embodiments 1-11, wherein the first upstream weir is positioned above a highest point of a trapway inlet by an offset distance of greater than or equal to 2 inches.

13. The toilet assembly of any one of embodiments 1-12, wherein the first upstream weir is positioned at point that, between flush cycles, is vertically higher than a water seal of the toilet bowl by a distance of greater than or equal to 0.2 inches.

14. The toilet assembly of any one of embodiments 1-13, wherein the connecting tube comprises a backflow preventer.

15. The toilet assembly of any one of embodiments 1-14, wherein the flush valve assembly comprises a valve body extending from a valve inlet to a valve outlet and a valve cover having a seal to enclose the valve inlet.

16. The toilet assembly of any one of embodiments 1-15, wherein the container comprises a continuous side wall, an upper end wall, and an inner wall that together bound a vacuum chamber of the container.

17. The toilet assembly of embodiments 16, wherein the inner wall bounds an inner chamber of the container.

18. A toilet assembly, comprising

a toilet tank to hold flush water;

a flush valve assembly positioned in the toilet tank;

a toilet deck;

a toilet bowl;

a trapway in flow communication with the toilet bowl;

a container positioned in the toilet tank;

a connecting tube extending from an interior of the container to the trapway, and

a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly, wherein the first gasket comprises a recess receiving the flush valve assembly and a protrusion extending into the toilet deck;

wherein:

the container is in flow communication with the toilet tank, the container having an open lower end and a closed upper end,

the trapway comprises a sump trap, a first upstream weir, a lower trap, and a second downstream weir, and

the connecting tube is coupled to the trapway at a position between the sump trap and the lower trap and provides flow communication between the container and the trapway.

19. The toilet assembly of embodiment 18, wherein the first gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

20. The toilet assembly of any one of embodiment 18-19, wherein an outer diameter of the protrusion of the first gasket is wider than an inner diameter of the recess of the first gasket.

21. The toilet assembly of any one of embodiments 18-20, comprising a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube, wherein the second gasket comprises a recess receiving the connecting tube and a protrusion extending into the toilet deck.

22. The toilet assembly of embodiment 21, wherein the second gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion of the second gasket.

23. The toilet assembly of any one of embodiments 21-22, wherein an outer diameter of the protrusion of the second gasket is wider than an inner diameter of the recess of the second gasket.

24. The toilet assembly of any one of embodiments 18-23, wherein, between flush cycles, the container comprises pressurized air positioned above flush water.

25. The toilet assembly of any one of embodiments 18-24, wherein, upon discharging water into a flush valve core to initiate a flush cycle, reduced pressure is created in pressurized air in the trapway.

26. The toilet assembly of any one of embodiments 18-25, wherein, upon a toilet tank water level falling to a lower edge of a head of the flush valve to break a siphon, and re-filling the toilet tank with water to end a flush cycle, increased pressure is created in pressurized air in the trapway.

27. The toilet assembly of any one of embodiments 18-26, wherein, between flush cycles, pressurized air in the trapway is pressurized at a pressure greater than or equal to 0.5 cm of water above atmospheric pressure and less than or equal to 5 cm of water above atmospheric pressure.

28. The toilet assembly of any one of embodiments 18-27, wherein the first upstream weir is positioned above a highest point of a trapway inlet by an offset distance of greater than or equal to 2 inches.

29. The toilet assembly of any one of embodiments 18-28, wherein the first upstream weir is positioned at point that, between flush cycles, is vertically higher than a water seal of the toilet bowl by a distance of greater than or equal to 0.2 inches.

30. The toilet assembly of any one of embodiments 18-29, wherein the connecting tube comprises a backflow preventer.

31. The toilet assembly of any one of embodiments 18-30, wherein the flush valve assembly comprises a valve body extending from a valve inlet to a valve outlet and a valve cover having a seal to enclose the valve inlet.

32. The toilet assembly of any one of embodiments 18-31, wherein the container comprises a continuous side wall, an upper end wall, and an inner wall that together bound a vacuum chamber of the container.

33. The toilet assembly of embodiment 32, wherein the inner wall bounds an inner chamber of the container.

34. The toilet assembly of any one of embodiments 1-17 or 21, wherein the second gasket comprises a face seal.

35. The toilet assembly of any one of embodiments 1-17 or 21, wherein the second gasket comprises a piston seal.

Conclusion

[0090] In some embodiments, dual-trap toilets described and/or shown herein may share any one or more characteristics in common with dual-trap toilets described, shown, and/or referenced in PCT publication no. WO2022046876A1, in PCT publication no. WO2022051331A1, and/or in PCT application no. PCT/US2021/060307 (filed Nov 22, 2021), the entirety of each of which is hereby incorporated by reference.

[0091] Any one or more characteristics of any of the embodiments (including claims) described, shown, and/or referenced herein may be combined, in whole or in part, with any one or more characteristics of any one or more other embodiments (including claims) described, shown, and/or referenced herein.

[0092] The foregoing description, for the purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the techniques and their practical applications. Others skilled in the art are thereby enabled to best utilize the techniques and various embodiments with various modifications as are suited to the particular use contemplated.

[0093] Although the disclosure and examples have been fully described with reference to the accompanying figures, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of the disclosure and examples as defined by the claims. Finally, the entire disclosure of the patents and publications referred to in this application are hereby incorporated herein by reference.

CLAIMS

1. A toilet assembly, comprising:

a toilet tank to hold flush water;

a flush valve assembly positioned in the toilet tank;

a toilet deck;

a toilet bowl;

a trapway in flow communication with the toilet bowl;

a container positioned in the toilet tank, and

a connecting tube extending from an interior of the container to the trapway,

a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly; and

a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube;

wherein:

the container is in flow communication with the toilet tank, the container having an open lower end and a closed upper end,

the trapway comprises a sump trap, a first upstream weir, a lower trap, and a second downstream weir,

the connecting tube is coupled to the trapway at a position between the sump trap and the lower trap, and provides flow communication between the container and the trapway.

2. The toilet assembly of claim 1, wherein the first gasket comprises a recess receiving the flush valve assembly.

3. The toilet assembly of any one of claims 1-2, wherein the first gasket comprises a protrusion extending into the toilet deck.

4. The toilet assembly of claim 3, wherein the first gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

5. The toilet assembly of any one of claims 1-4, wherein the second gasket comprises a recess receiving the connecting tube.

6. The toilet assembly of any one of claims 1-5, wherein the second gasket comprises a protrusion extending into the toilet deck.

7. The toilet assembly of claim 6, wherein the second gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

8. The toilet assembly of any one of claims 1-7, wherein, between flush cycles, the container comprises pressurized air positioned above flush water.

9. The toilet assembly of any one of claims 1-8, wherein, upon discharging water into a flush valve core to initiate a flush cycle, reduced pressure is created in pressurized air in the trapway.

10. The toilet assembly of any one of claims 1-9, wherein, upon re-filling the toilet tank with water to end a flush cycle, increased pressure is created in pressurized air in the trapway.

11. The toilet assembly of any one of claims 1-10, wherein the flush valve assembly comprises a valve body extending from a valve inlet to a valve outlet and a valve cover having a seal to enclose the valve inlet.

12. The toilet assembly of any one of claims 1-11, wherein the container comprises a continuous side wall, an upper end wall, and an inner wall that together bound a vacuum chamber of the container.

13. The toilet assembly of claim 12, wherein the inner wall bounds an inner chamber of the container.

14. The toilet assembly of any one of claims 1-13, wherein the second gasket comprises a face seal.

15. The toilet assembly of any one of claims 1-14, wherein the second gasket comprises a piston seal.

16. A toilet assembly, comprising
a toilet tank to hold flush water;

a flush valve assembly positioned in the toilet tank;

a toilet deck;

a toilet bowl;

a trapway in flow communication with the toilet bowl;

a container positioned in the toilet tank, and

a connecting tube extending from an interior of the container to the trapway,

a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly, wherein the first gasket comprises a recess receiving the flush valve assembly and a protrusion extending into the toilet deck; and

wherein:

the container is in flow communication with the toilet tank, the container having an open lower end and a closed upper end,

the trapway comprises a sump trap, a first upstream weir, a lower trap, and a second downstream weir,

the connecting tube is coupled to the trapway at a position between the sump trap and the lower trap, and provides flow communication between the container and the trapway.

17. The toilet assembly of claim 16, wherein the first gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion.

18. The toilet assembly of any one of claims 16-17, wherein an outer diameter of the protrusion of the first gasket is wider than an inner diameter of the recess of the first gasket.

19. The toilet assembly of any one of claims 16-18, comprising a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube, wherein the second gasket comprises a recess receiving the connecting tube and a protrusion extending into the toilet deck.

20. The toilet assembly of claim 19, wherein the second gasket comprises a collar portion having a wider diameter than an outer diameter of the protrusion of the second gasket.

21. The toilet assembly of any one of claims 19-20, wherein an outer diameter of the protrusion of the second gasket is wider than an inner diameter of the recess of the second gasket.

22. The toilet assembly of any one of claims 19-21, wherein the second gasket comprises a face seal.

23. The toilet assembly of any one of claims 19-22, wherein the second gasket comprises a piston seal.

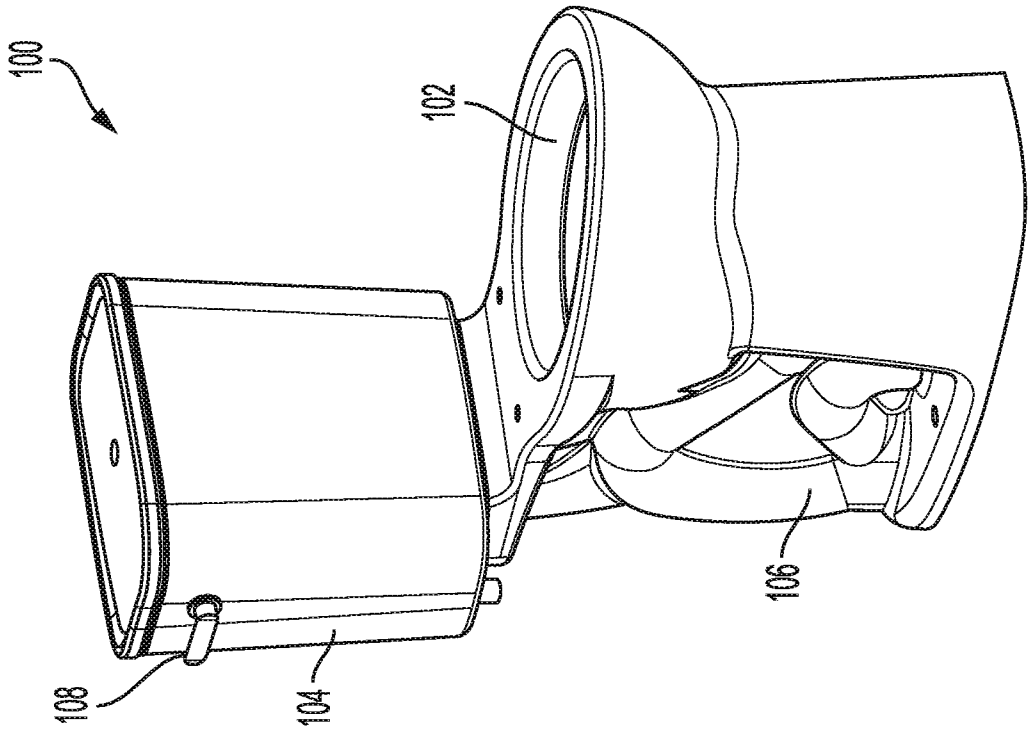


FIG. 1B

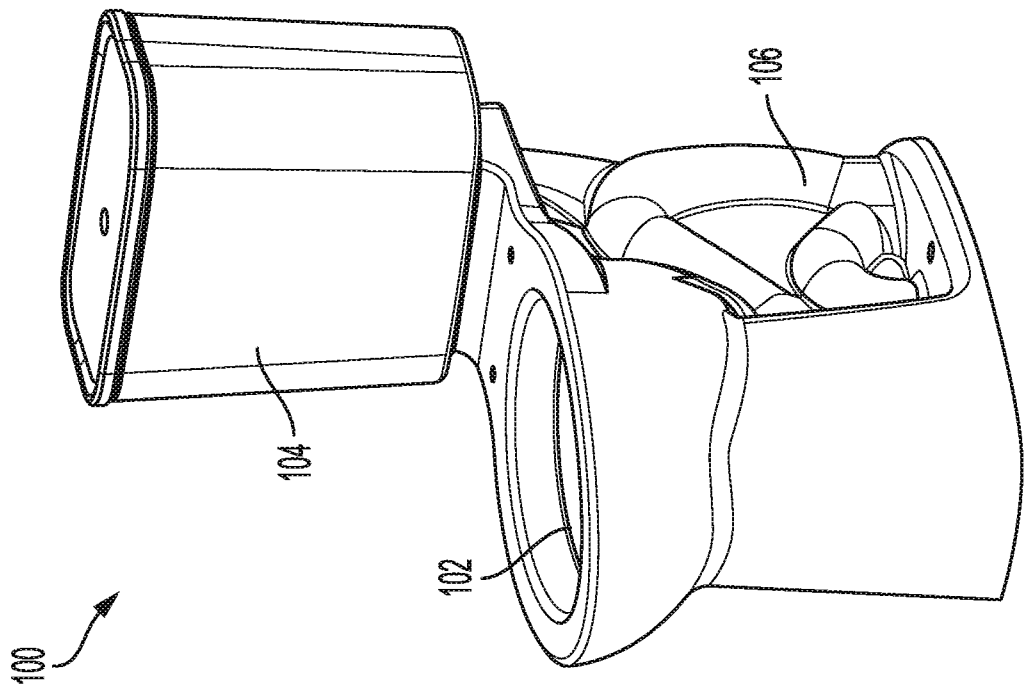


FIG. 1A

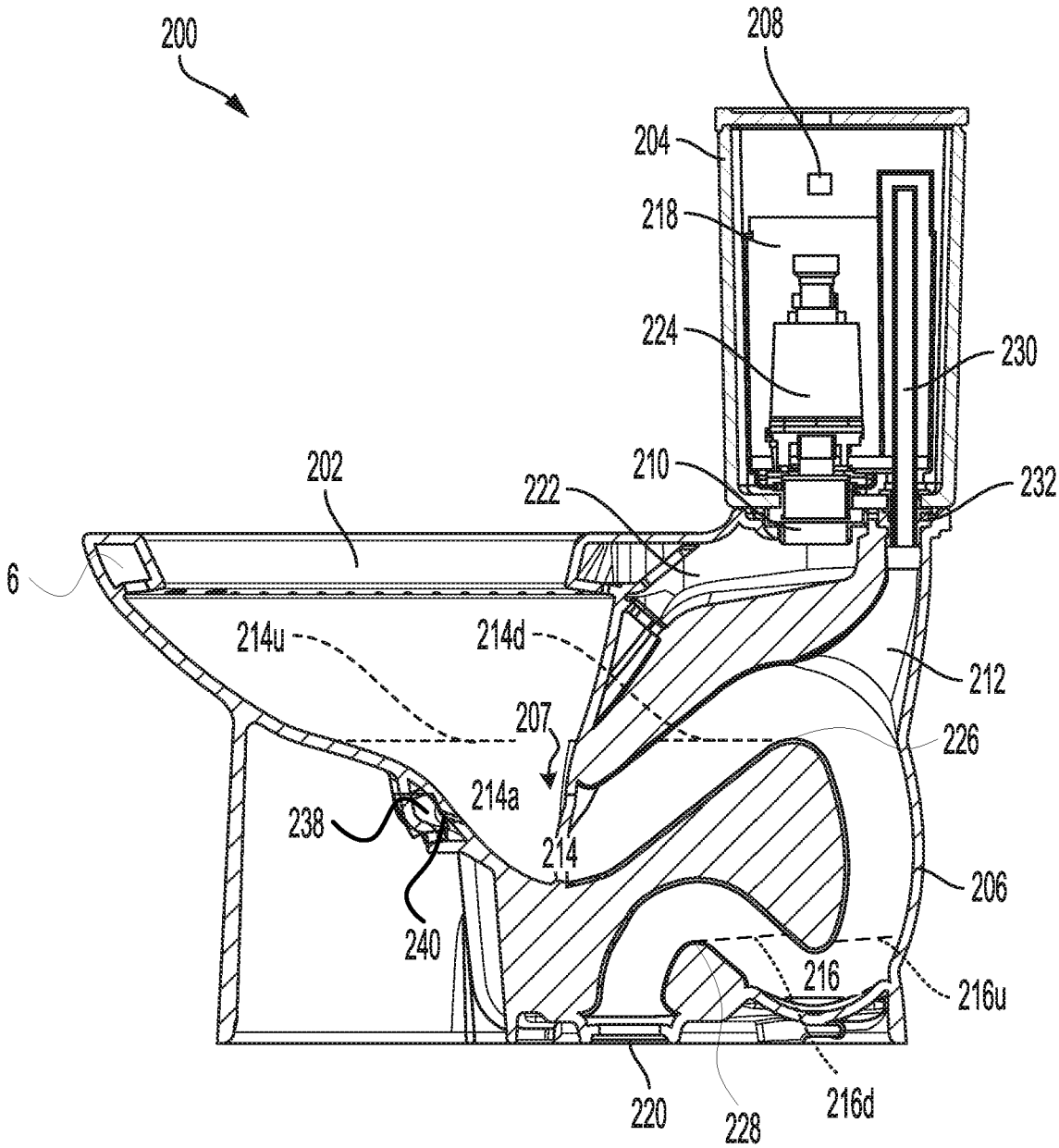

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218
224
230
210
202
222
232
6
214u
214d
212
207
226
214a
238
214
206
240
216
216u
220
228
216d

FIG. 2

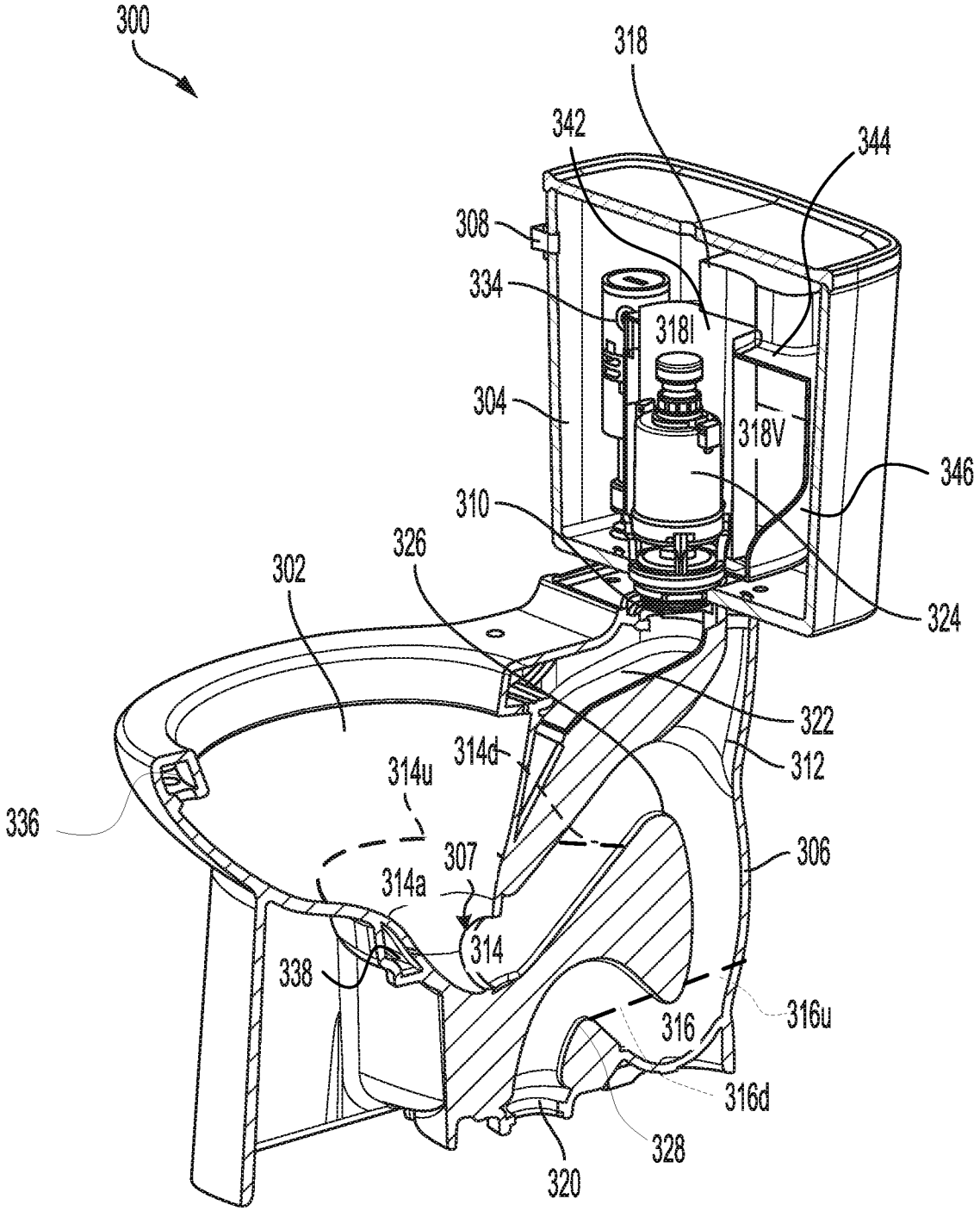

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318
342
344
308
334
318I
304
318V
346
310
326
302
324
322
314d
312
314u
336
307
306
314a
314
338
316u
316
316d
328
320

FIG. 3

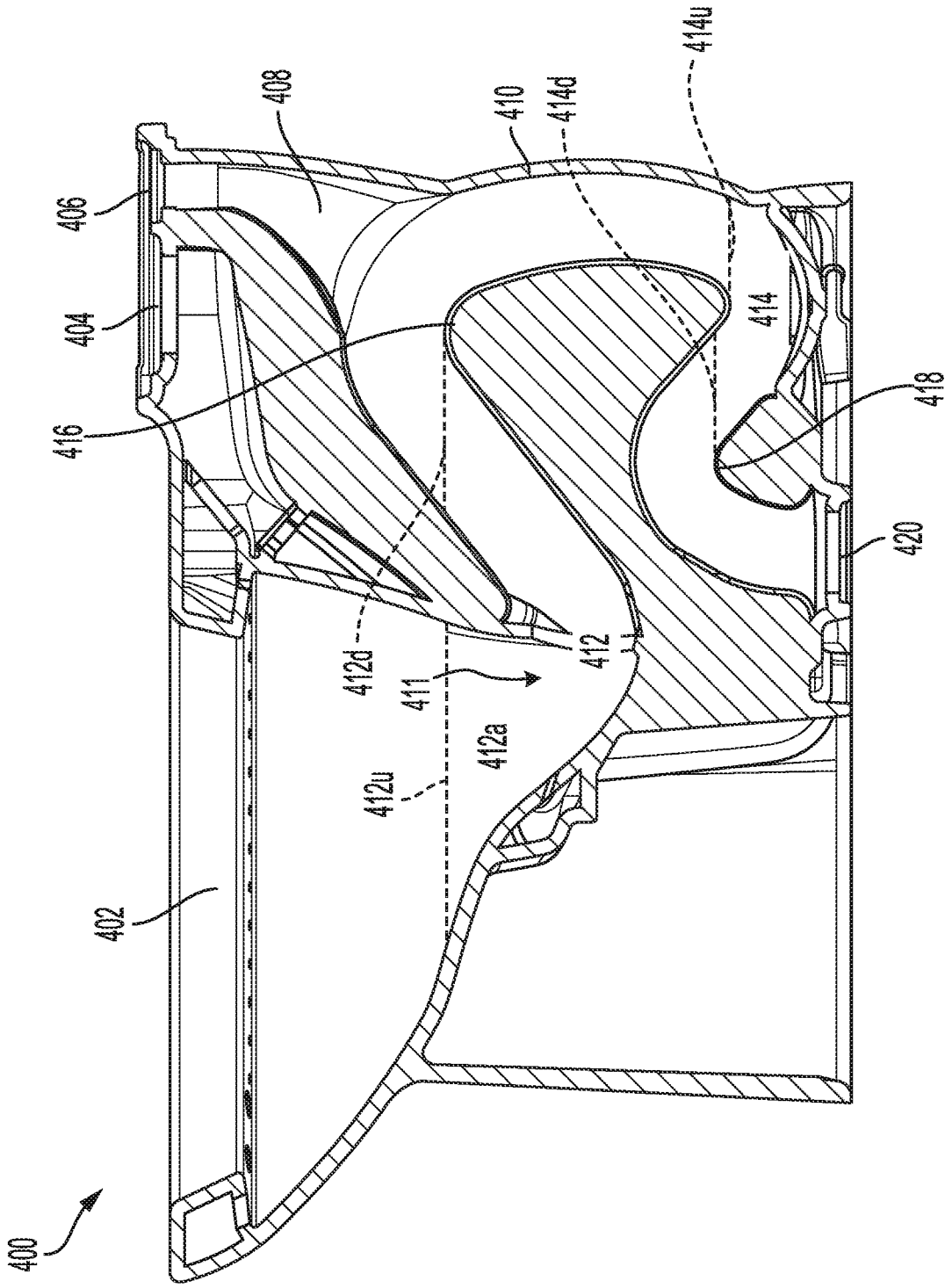

400
402
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FIG. 4

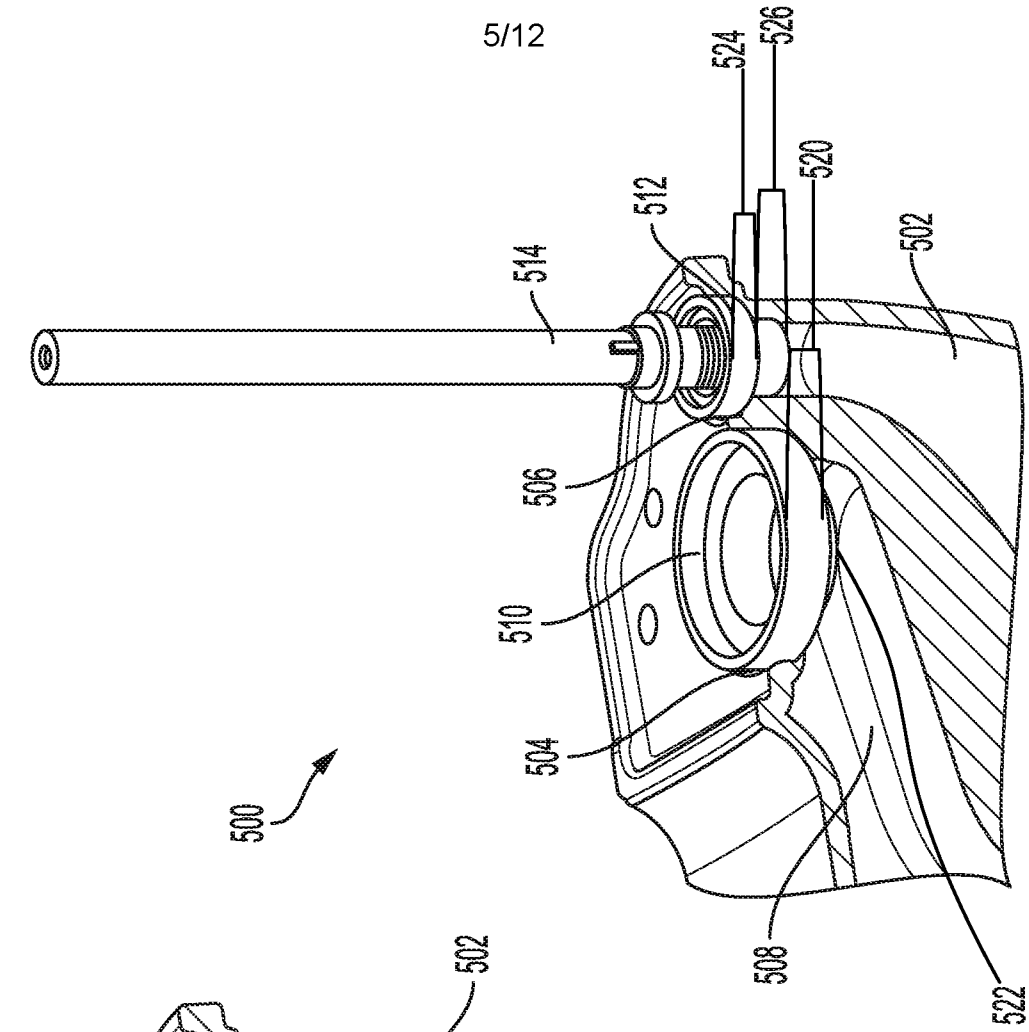


FIG. 5C

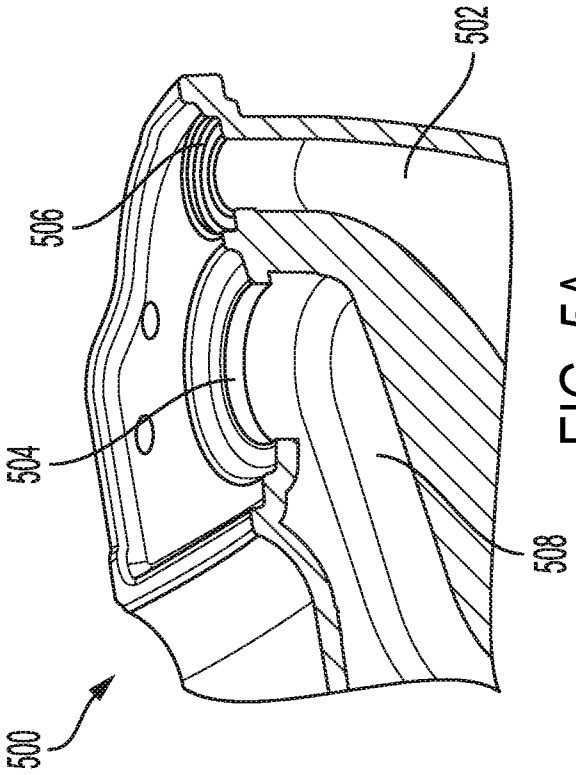


FIG. 5A

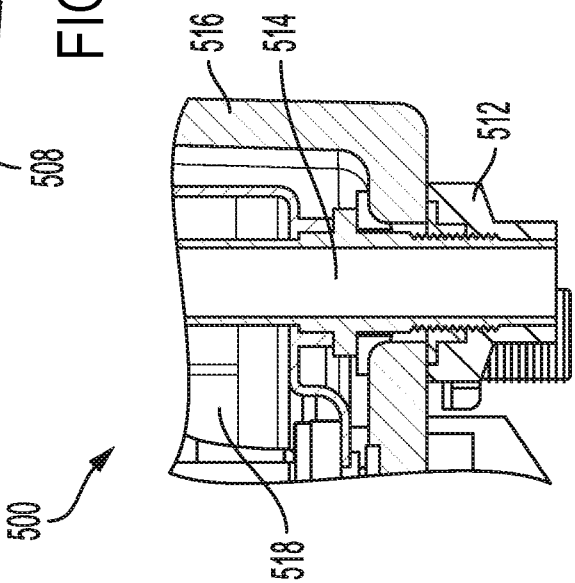


FIG. 5B

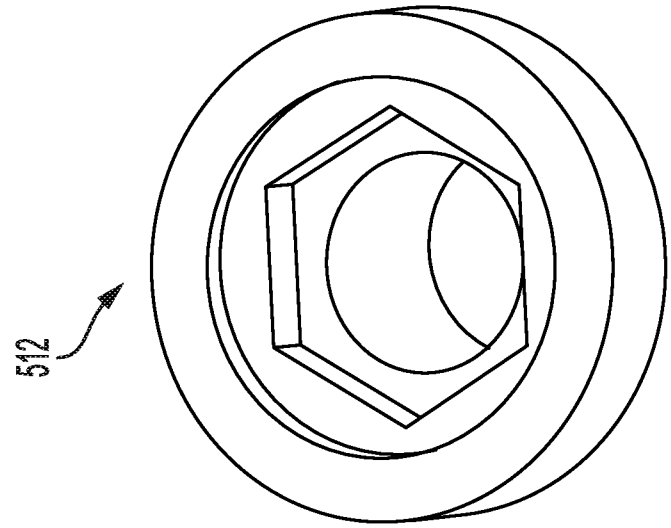


FIG. 5E

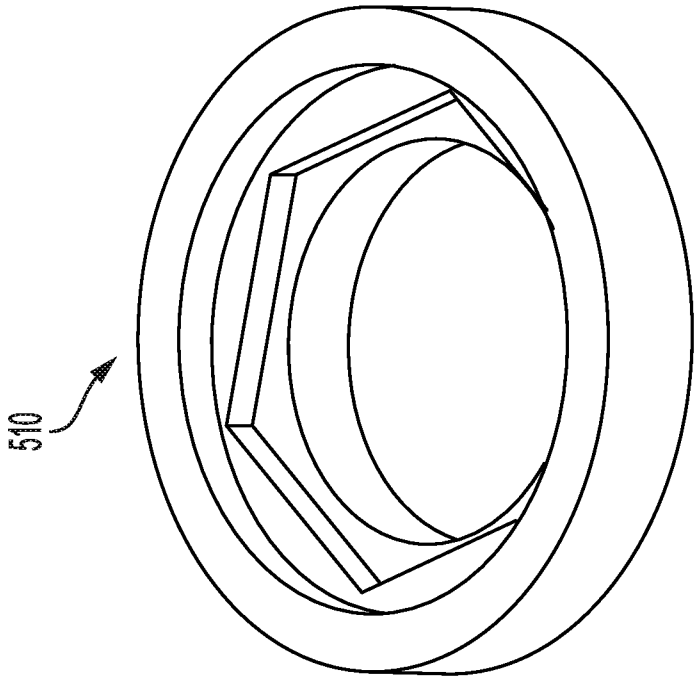


FIG. 5D

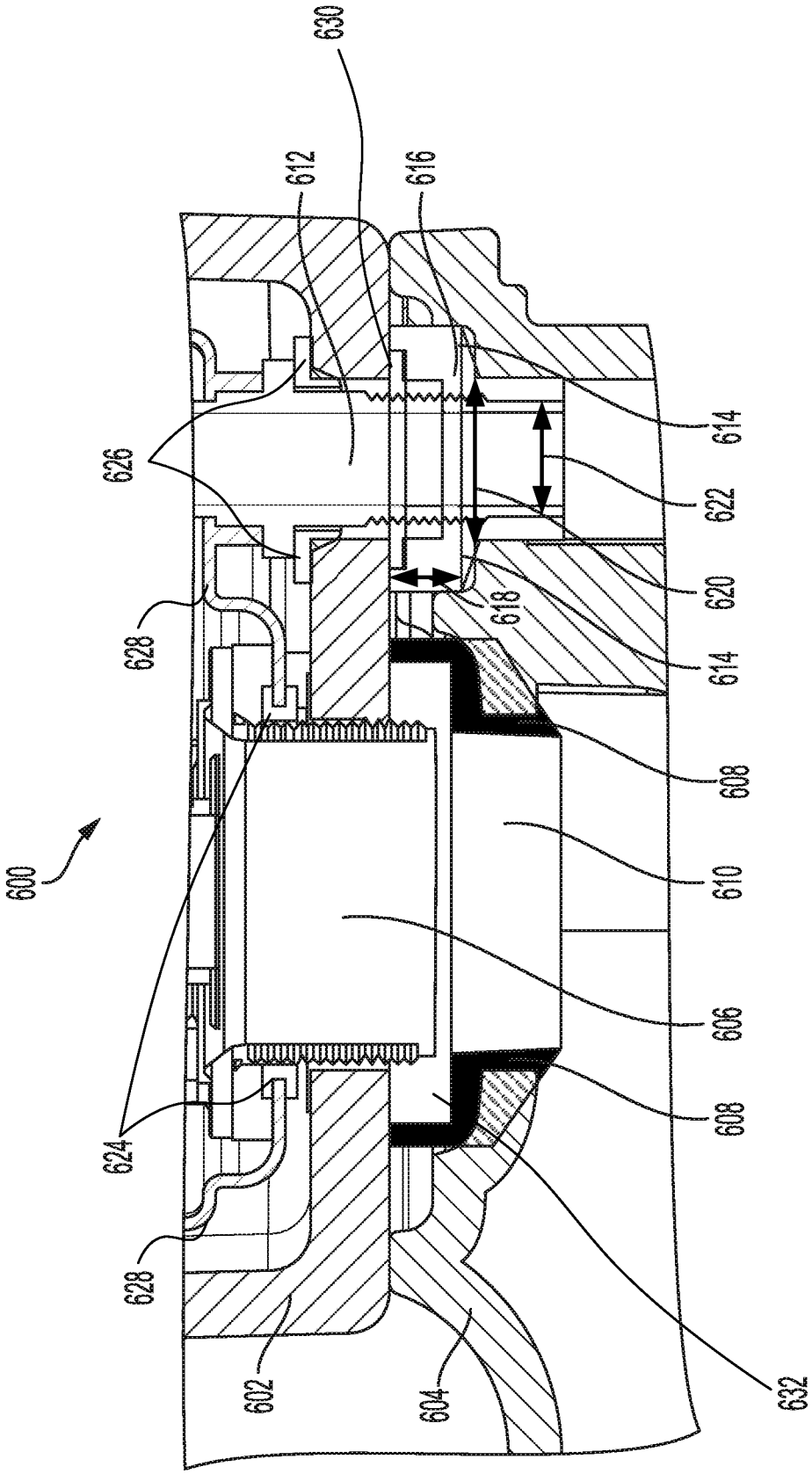

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FIG. 6A

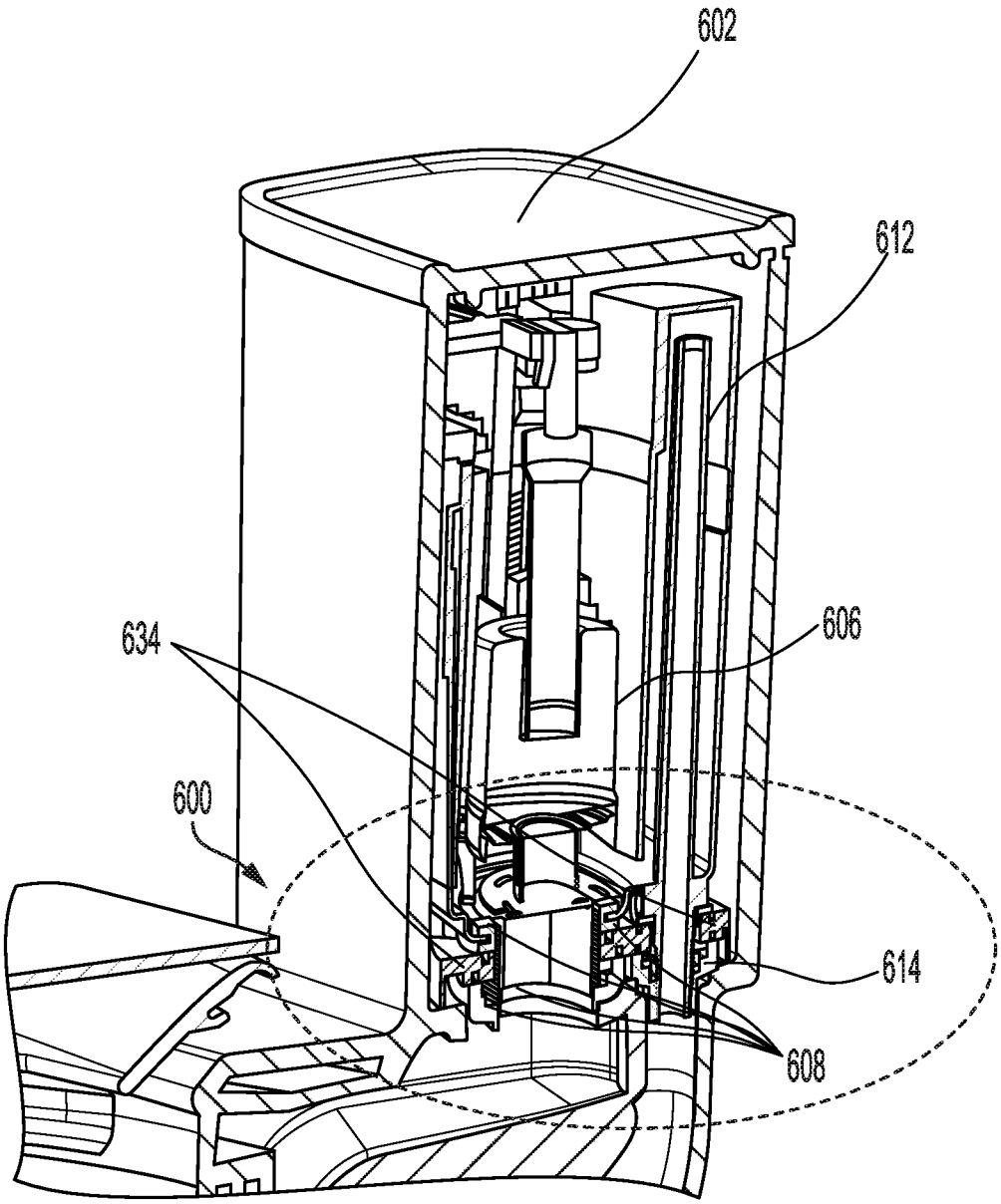


FIG. 6B

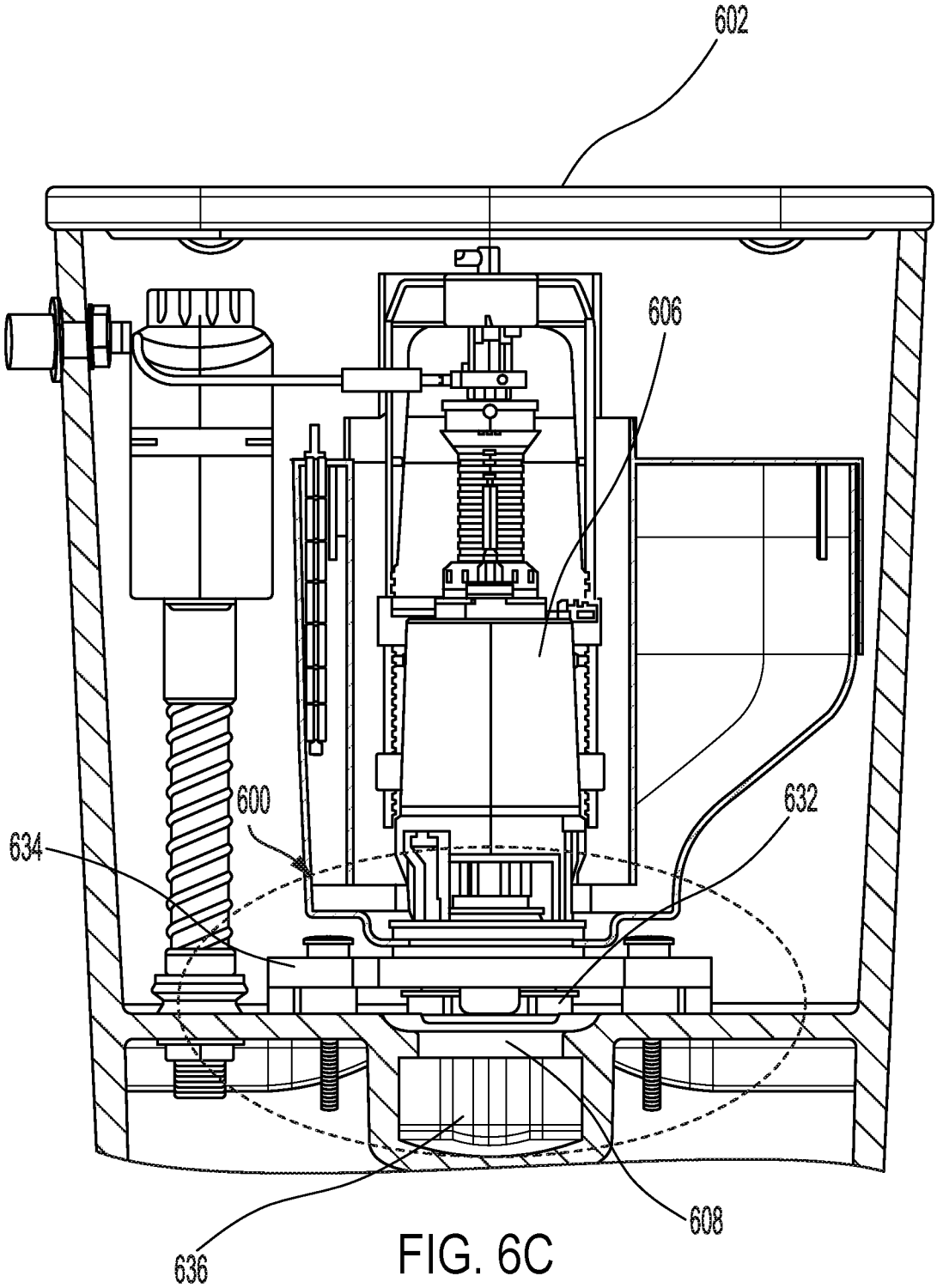


FIG. 6C

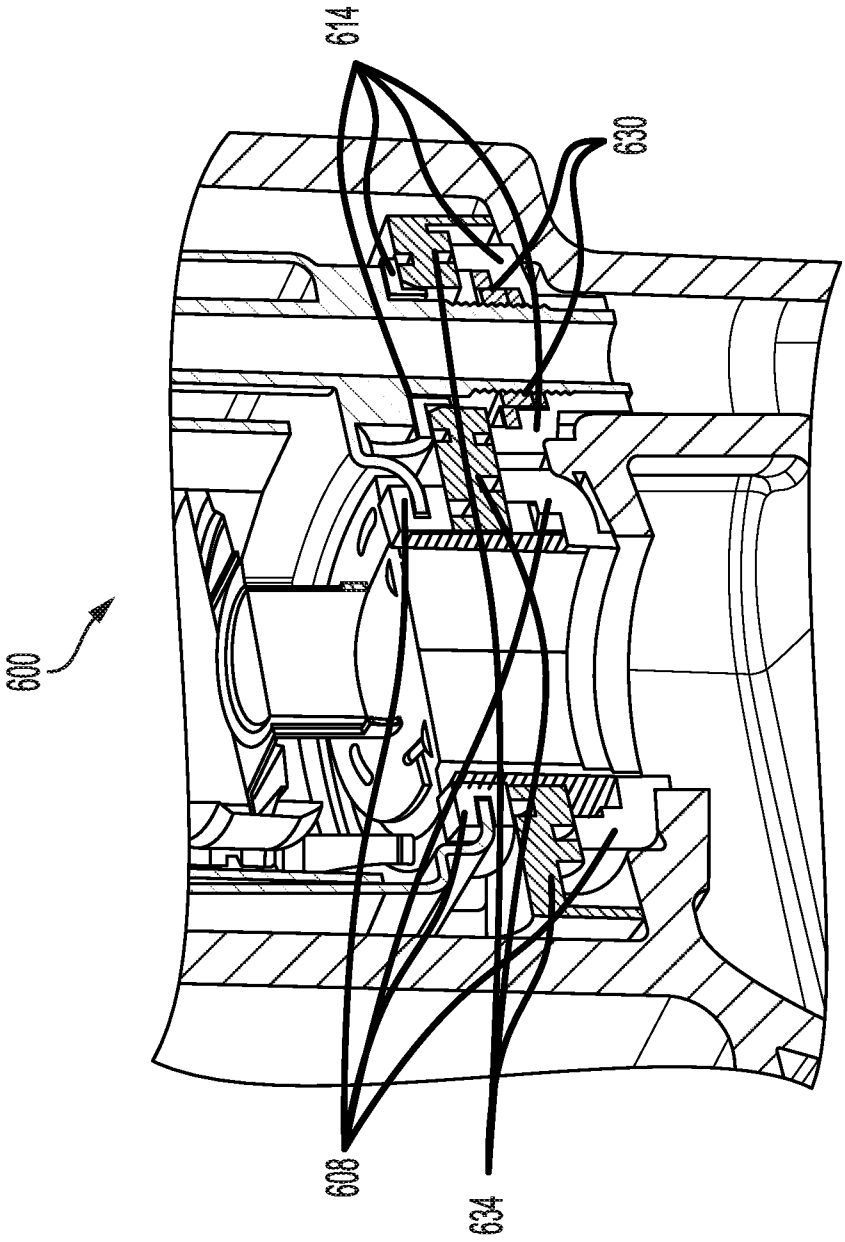


FIG. 6D

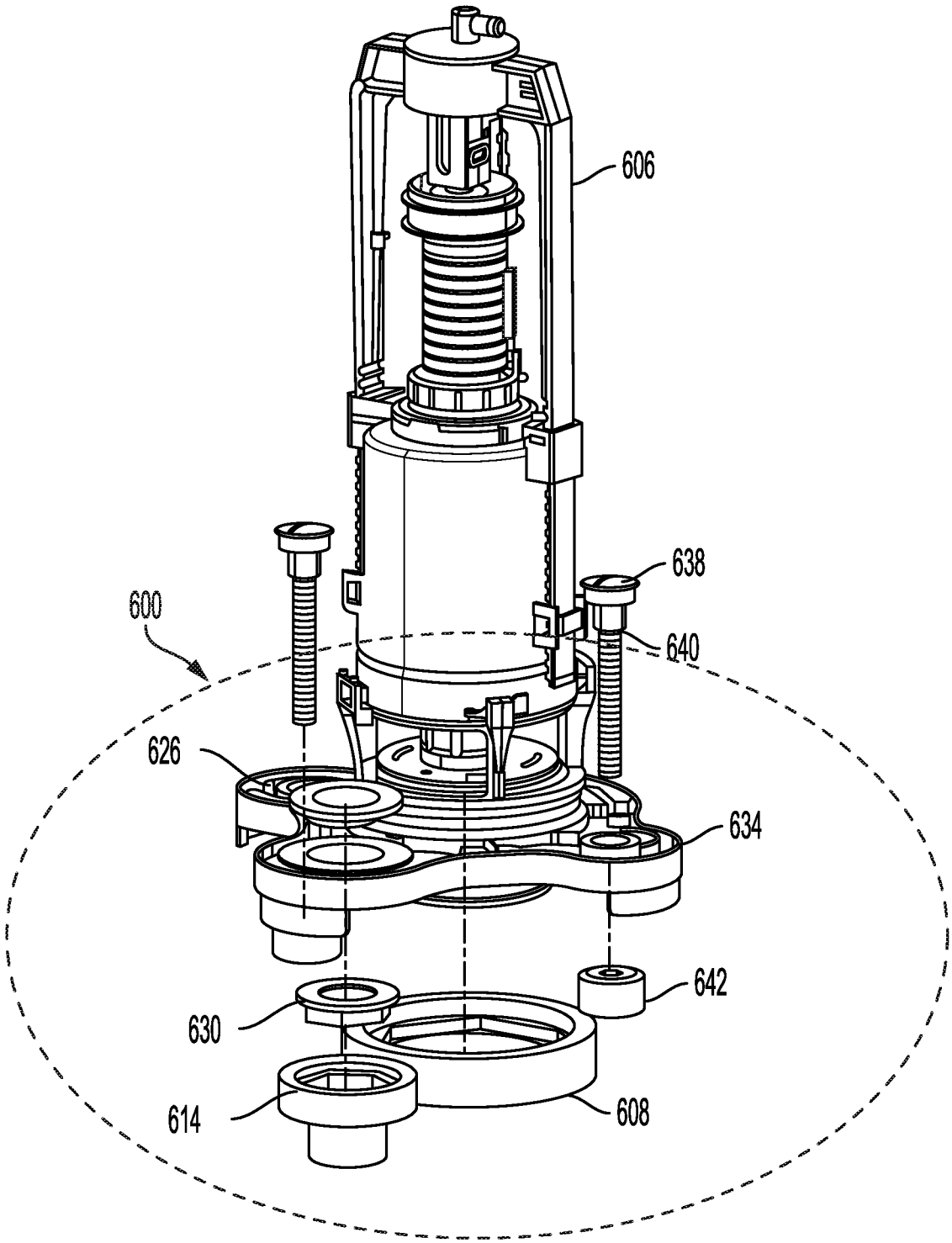


FIG. 6E

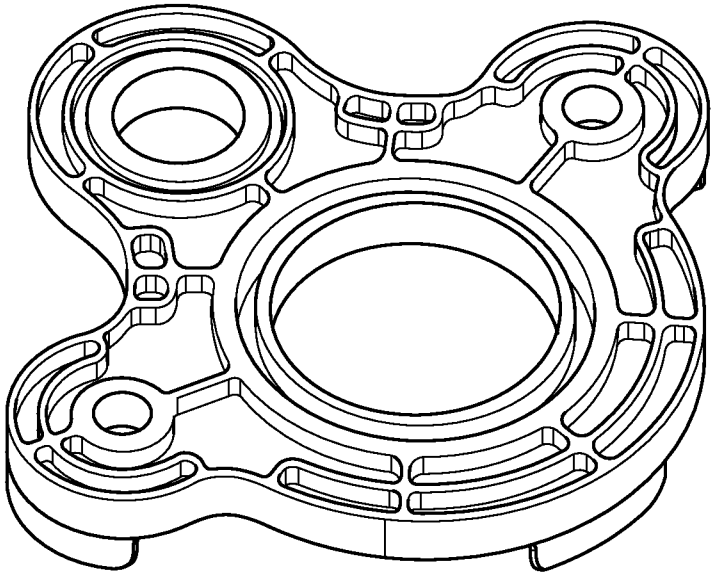


FIG. 7A

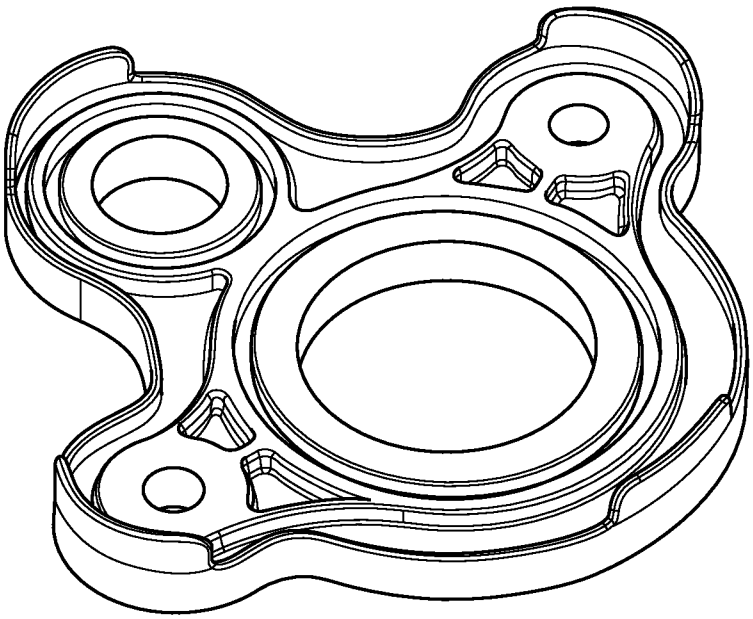


FIG. 7B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US23/18703

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. E03D 11/18; E03D 1/14; E03D 3/10; E03D 11/02 (2023.01)
ADD. E03D 5/00 (2023.01)

CPC - INV. E03D 11/18; E03D 1/141; E03D 3/10; E03D 11/02
ADD. E03D 5/00

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
See Search History document

Electronic database consulted during the international search (name of database 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 5,426,794 A (HENNESSY ARNOLD) 27 June 1995; figures 1-2; column 3, lines 1-55	1-4
Y	GB 882702 A (IDEAL BOILERS & RADIATORS LTD) 15 November 1961; figures 1-2; page 1, lines 70-80	1-4
Y	US 2,838,764 A (SMITH HARRY F) 17 June 1958; figure 1; column 2, lines 25-35	2, 3/2, 4/3/2
A	JP 3216845 B2 (TOTO LTD) 09 October 2001; see machine translation	1-4

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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	Date of mailing of the international search report
09 June 2023 (09.06.2023)	SEP 0 8 2023
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US23/18703

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 5-15, 19-23
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
-***-Please See Supplemental Page-***-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
Group I: Claims 1-4

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US23/18703

-***-Continued From Box No. III: Observations where unity of invention is lacking-***-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-4 are directed toward a toilet assembly, comprising: a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube.

Group II: Claims 16-18 are directed toward a toilet assembly, comprising wherein the first gasket comprises a recess receiving the flush valve assembly and a protrusion extending into the toilet deck.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Group I include a toilet assembly, comprising: a second gasket positioned between the toilet tank and the toilet deck and forming a seal around the connecting tube, which are not present in Group II.

Group II include a toilet assembly, comprising wherein the first gasket comprises a recess receiving the flush valve assembly and a protrusion extending into the toilet deck, which are not present in Group I.

The common technical features of Groups I-II are a toilet assembly, comprising: a toilet tank to hold flush water; a flush valve assembly positioned in the toilet tank; a toilet deck; a toilet bowl; a trapway in flow communication with the toilet bowl; a container positioned in the toilet tank, and a connecting tube extending from an interior of the container to the trapway, a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly; wherein: the container is in flow communication with the toilet tank, the container having an open lower end and a closed upper end, the trapway comprises a sump trap, a first upstream weir, a lower trap, and a second downstream weir, the connecting tube is coupled to the trapway at a position between the sump trap and the lower trap, and provides flow communication between the container and the trapway.

The common technical features of Groups I-II are disclosed by US 5,426,794 A (HENNESSY) in view of US 2,838,764 A (SMITH). Hennessy discloses a toilet assembly (10; figures 1-2), comprising: a toilet tank (12) to hold flush water (water at level 16); a flush valve assembly (25) positioned in the toilet tank (as shown); a toilet deck (top deck of toilet upon which tank 12 rests as shown); a toilet bowl (32); a trapway (42) in flow communication with the toilet bowl (as shown); a container (78) positioned in the toilet tank (as shown), and a connecting tube (48) extending from an interior of the container to the trapway (as shown), wherein: the container is in flow communication with the toilet tank (as shown), the container having an open lower end and a closed upper end (container 78 is closed at its upper end and has an opening 76 at its lower end; figures 1-2; column 3, lines 40-55), the trapway comprises a sump trap (40), a first upstream weir (weir between trap 40 and trap 44), a lower trap (44), and a second downstream weir (weir indicated at 54), the connecting tube is coupled to the trapway at a position between the sump trap and the lower trap (as shown), and provides flow communication between the container and the trapway (vacuum conduit 48 provides communication between the interior of container 78 and the trapway 42 between traps 40 and 44 as shown; figures 1-2; column 3, lines 1-15 and 40-55). Hennessy fails to disclose a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly. Smith discloses a first gasket (19; figure 1) positioned between the toilet tank (1) and the toilet deck (2) and forming a seal around the flush valve assembly (5, 15, collectively). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Hennessy's toilet assembly to include a first gasket positioned between the toilet tank and the toilet deck and forming a seal around the flush valve assembly as taught by Smith because, as Smith discloses, the gasket has sufficient stretchability so that it may be stretched over the flange and provide a fluid tight seal between the tank and the top wall of the bowl (smith; column 2, lines 45-65).

Since the common technical features are previously disclosed by the Hennessy and Smith references, the common features are not special and so Groups I and II lack unity.