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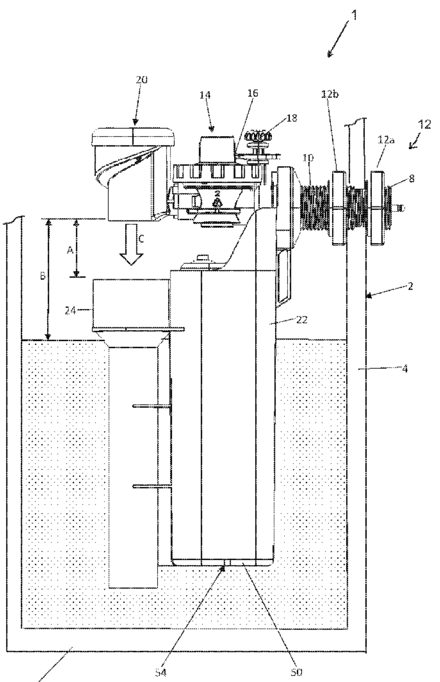

FIG. 1

(57) **Abstract:** Embodiments include an assembly including a fluid valve assembly including an outlet, and a filling tube adjacent to the fluid valve assembly, where the filling tube includes an inlet aperture at least partially axially aligned with the outlet. An outlet aperture is positioned at a specific distance from the inlet aperture forming a space or air gap between the inlet aperture and the outlet aperture. A moveable float is configured and arranged to control a sealing member of the fluid valve based at least in part on the position of the moveable float relative to the outlet.

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FLUID VALVE SYSTEMS

RELATED APPLICATIONS

[0001] This application claims priority to United Kingdom Application No. 1808145.5, filed on May 18, 2018, entitled “A FLOAT ASSEMBLY FOR A TOILET”, United Kingdom Application No. 1808147.1, filed on May 18, 2018, entitled “A FLUID VALVE ASSEMBLY FOR A TOILET CISTERN”, and United Kingdom Application No. 1808142.2, filed on May 18, 2018, entitled “A FLUID VALVE ASSEMBLY FOR A WATER STORAGE TANK” the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] A toilet cistern usually includes a fill valve arranged to supply water to fill the toilet cistern. Typically, the fill valve is connected to the domestic water supply. The water stored within the toilet cistern is considered to be non-potable, and must be isolated from the plumbing system to prevent contamination of the drinking water supply within the property. Incidents have been identified where non-potable water contained with the toilet cistern has been siphoned back into the plumbing system due to the manner in which the fill valve is installed within the cistern. If the outlet of the fill valve is in contact with the water within the cistern, it is possible that a siphon action may be created as water flows back down the inlet pipe when filling stops.

[0003] In order to prevent siphoned backflow of non-potable water, regulations in the United Kingdom require fill valve assemblies to prevent or at least limit back flow in the inlet pipe, for example by using a check valve. In addition, a “Type AG” air gap must be included. The “Type AG” standard requires a visible, unobstructed and complete physical air break between the lowest level of water discharge and the level of potentially contaminated fluid downstream (otherwise referred to as the critical water level) within a cistern, vessel, fitting or appliance. Accordingly, if a siphoning action is created in the inlet pipe, air will be drawn in to the inlet pipe rather than water from the cistern. Further, United Kingdom regulations require that the air gap between the outlet of the fill valve and the water level within the cistern must not be less than 20 mm, or twice the internal diameter of the inlet pipe, whichever is the greater. In addition, the water must not discharge from the valve at more than 15° from the vertical centerline of the water stream.

[0004] A “Type AG” air gap is typically achieved in a toilet cistern by locating the outlet of the fill valve at a fixed spaced location above the water level. Water discharges from the fill valve outlet and falls into the body of water within the cistern. While this solution addresses the “Type AG” air gap requirements, it is deemed to be undesirable due to the noise generated by the water as it falls into the cistern from the fill valve. Furthermore, the extent to which noise can be minimized by reducing the height of the fill valve outlet is limited by the minimum regulatory height.

[0005] It is known to utilize fill tubes within a toilet cistern to minimize noise. A fill tube is connected to the fill valve outlet, and water from the fill valve discharges directly into the fill tube. The fill tube extends downwardly into the body of water in the cistern, and a gap is defined between the bottom of the fill tube and the base of the cistern through which the water empties into the cistern from the fill tube. Although the water level within the fill tube is the same as the cistern water level, the discharge noise from the fill valve is attenuated by the fill tube. However, as the fill tube is connected to the fill valve, the water within the valve is capable of being siphoned back into the fill valve. Therefore, cisterns employing such fill tube arrangements do not comply with current regulations.

[0006] A fill valve assembly often includes a float that is connected to the valve such that it closes the valve when the water level reaches a pre-defined maximum level, and opens the valve when the water level falls below this level to allow the flow to re-fill the cistern. Traditional ballcock valves include a float attached via a lever arm to the fill valve, which controls in the incoming water supply. When the cistern is empty, the ballcock float is suspended at the end of the lever arm, which pivots downwardly. During use, the fill valve is open and water enters the cistern. When the water level reaches the ballcock float, the float begins to rise with the water level until it eventually pivots the lever to a position where it closes the fill valve, which corresponds to a pre-set water level in the cistern. When the toilet is flushed, a flush valve is opened by the flush lever and water begins to pour out of the cistern into the toilet bowl. As soon as the float begins to fall, the fill valve opens and water begins entering the cistern. This means that the toilet is emptying and filling at the same time. The rate that the water empties through the flush valve is greater than the rate of filling and the flush valve eventually closes. Nonetheless, a significant volume of the incoming water leaves the cistern in addition to the original flush volume leading to a significant volume of wasted water.

[0007] Delayed fill valves address this problem by only allowing a cistern to start refilling once the flush cycle has been completed. Delayed fill valves usually include a float chamber or float shroud within which the float is located. The float shroud includes a small inlet aperture in its base. As the cistern fills, the float shroud fills as water enters the float shroud through the inlet aperture in the base and/or by flowing into the upper end of the float shroud. As the float rises, and the fill valve closes. When the toilet is flushed, the water leaves the cistern at a high flow rate. However, the size of the aperture in the base of the float shroud is significantly smaller in diameter than the flush outlet. Accordingly, the flow rate from the shroud is far lower and the shroud takes longer to empty. Consequently, the water level in the shroud falls at a much slower rate than the water level in the cistern. The size of the aperture in the shroud is selected such that the float only falls to a level at which the fill valve opens once the flush volume has left the cistern, and the cistern's flush valve has closed.

[0008] As a further water saving measure, toilet cisterns are also provided with a 'dual flush' valve system. Dual flush valves allow a full flush, in which the full flush volume empties from the cistern, and a 'partial' flush, in which a reduced amount of water is emptied into the bowl. For example, dual flush valve assemblies are provided which use a siphon valve in which the siphoning action created in the siphon during flushing is used to control the volume of flushed water. During flushing, the water falling through the cistern siphon draws water from within the cistern. The half flush setting on a dual flush valve interrupts the siphon effect by providing an air inlet aperture to the siphon that halts the siphon action once it is uncovered. The height of the aperture determines the volume of the 'half flush'. A dual flush valve can result in water savings of two to three liters per flush.

[0009] Problems have been experienced where delay flush valves and dual flush valves are used in combination. During a full flush, the water within the float shroud fully empties before the water level in the cistern rises again to the level of the shroud inlet aperture. However, during a 'half flush' cycle, the water level does not fall below the level of the inlet aperture and the float shroud does not fully empty. Therefore, when the cistern begins to refill, the lag between the water level in the cistern rising and the water level in the shroud rising is less, and the float rises sooner. The height of the float is closer to the height of the water within the cistern, and thus the float rises to a height where it closes the fill valve before the water level in the cistern has reached the height required for a full flush volume.

Consequently, when the user attempts to operate a full flush, the water volume is not sufficient, and the user will often flush for a second time, which negates the intended water saving function of the delay fill and dual flush valves.

[0010] Different sized cisterns having different volumes that require different water levels to function properly. The water level is determined by the uppermost height of the float, and therefore to vary the water height, the fluid valve assembly must be adjustable in height to vary the uppermost height of the float. For side entry fill valve assemblies, the height of the fluid valve assembly is determined by the height at which the inlet pipe enters the cistern, and this can be set during manufacture depending on the cistern and fill height required. However, for bottom entry fill valve assemblies, the inlet pipe enters the cistern through the base and the height of the float is determined by the position at which it is secured along the inlet pipe. While minor adjustment of the water height can be achieved using an adjustment screw, the height of the float is substantially fixed. Accordingly, fill valve assemblies of varying lengths must be manufactured to accommodate cisterns of varying volumes.

[0011] It is therefore desirable to provide an improved fluid valve assembly and float assembly to address the above described problems and/or which offers improvements generally.

SUMMARY

[0012] Some embodiments include a fluid control assembly comprising a fluid valve assembly coupled to an inlet pipe, and a filling tube coupled to, integrated with, or positioned adjacent to the fluid valve assembly, where the filling tube includes an inlet aperture. Some embodiments include a fluid outlet assembly coupled to or integrated with the fluid valve assembly. In some embodiments, the fluid outlet assembly comprises an outlet aperture positioned at a specific distance from the inlet aperture forming a space or air gap between the inlet aperture and the outlet aperture. In some embodiments, the outlet aperture and inlet aperture are at least partially aligned to enable fluid to travel from the fluid valve assembly and across the air gap and at least partially into the inlet aperture when a valve of the fluid valve assembly is actuated to an open or on position. Further, some embodiments include a valve actuating assembly configured and arranged to control the valve.

[0013] In some embodiments, the valve actuating assembly comprises at least one moveable float. In some embodiments, the at least one moveable float comprises a variable buoyancy float including a plurality of chambers, and where one of the chambers of the plurality of chambers includes an air bleed aperture.

[0014] Some embodiments include at least one moveable float that is positioned at least partially around the filling tube. In some embodiments, the at least one moveable float is positioned adjacent the filling tube. Some further embodiments include a float shroud, where the at least one moveable float is at least partially positioned within the float shroud. Some embodiments include a base of the float shroud that includes an aperture configured to allow fluid to enter the float shroud.

[0015] In some embodiments, the valve actuating assembly includes a control rod coupled to a float at one end and a linkage of the valve actuating mechanism at the opposite end. Some embodiments include an actuating portion of the linkage configured to cause a sealing portion of a diaphragm of the valve to move into or away from a sealing engagement to control fluid flow through the valve.

[0016] In some embodiments, the inlet pipe is generally perpendicular to the filling tube. In some embodiments, the inlet pipe comprises a support pipe generally parallel to the filling tube. In some embodiments, the support pipe comprises a support of the fluid valve assembly, where the fluid valve assembly is coupled to the support pipe by a connector tube. In some further embodiments, the support pipe is configured to be locked to the connector tube with a locking assembly.

[0017] In some embodiments, the locking assembly comprises a first locking element provided on the connector tube that is configured to engage with a corresponding second locking element on the support tube to axially fix the connector tube in position relative to the support tube and to allow vertical adjustment of the connector tube relative to the support tube.

[0018] Some embodiments further comprise a locking member movable between a locked position in which the first and second locking element are in locking engagement and the locking member prevents release of the first and second locking elements from said locking engagement, and an unlocked position in which the first and second locking elements may be released from locking engagement to allow vertical adjustment of the connector tube relative to the support tube.

[0019] In some embodiments, the fluid outlet comprises a fluid flow channel defined between an inlet and outlet configured to impart a rotational force to fluid passing through the fluid flow channel. In some embodiments, the filling tube, valve actuating assembly and outlet aperture are axially aligned.

[0020] Some embodiments include an assembly comprising a fluid valve assembly including an outlet, and a filling tube adjacent to the fluid valve assembly, where the filling tube includes an inlet aperture at least partially axially aligned with the outlet. Some embodiments include an outlet aperture positioned at a specific distance from the inlet aperture forming a space or air gap between the inlet aperture and the outlet aperture. Some embodiments include a moveable float configured and arranged to control a sealing member of the fluid valve based at least in part on the position of the moveable float relative to the outlet.

[0021] In some embodiments, the moveable float comprises a variable buoyancy float including a plurality of chambers, where one of the chambers of the plurality of chambers includes an air bleed aperture. In some embodiments, the filling tube is circumferentially surrounded by the moveable float.

DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 shows a cross-section view of a toilet cistern including a fluid valve assembly according to an embodiment of the invention.

[0023] FIG. 2 shows a cross-section view of the fluid valve assembly of FIG. 1 according to an embodiment of the invention.

[0024] FIG. 3 is shows an outlet assembly of a fluid valve assembly according to an embodiment of the invention.

[0025] FIG. 4 shows a cross-section view of a fluid valve assembly according to another embodiment of the invention.

[0026] FIG. 5 shows a cross-section view of a toilet cistern including the fluid valve assembly of FIG. 4 according to an embodiment of the invention.

[0027] FIG. 6 shows a view from below of a float in accordance with some embodiments of the invention.

[0028] FIG. 7 shows an isometric view of a float in accordance with some embodiments of the invention.

[0029] FIG. 8 shows a cross-section view of a toilet cistern including a fluid valve assembly according to a further embodiment of the invention.

[0030] FIG. 9 shows a cross-section view of the fluid valve assembly of FIG. 8 according to a further embodiment of the invention.

[0031] FIG. 10 shows a partial perspective view of the fluid valve assembly of FIG. 8 according to a further embodiment of the invention.

[0032] FIGS. 11 and 12 show a side cross-sectional views of the fluid valve assembly of FIG. 8 according to a further embodiment of the invention.

[0033] FIG. 13 shows a side view of the fluid valve assembly of FIG. 8 according to a further embodiment of the invention.

DETAILED DESCRIPTION

[0034] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

[0035] The following discussion is presented to enable a person skilled in the art to make and use embodiments of the invention. Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art, and the generic principles herein can be applied to other embodiments and applications without departing from embodiments of the invention. Thus, embodiments of the invention are not intended to be limited to embodiments shown, but are to be accorded the widest scope consistent with the principles and features disclosed herein. The following detailed description is to be read with reference to the figures, in which like elements in different figures have like reference numerals. The figures, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of embodiments of the invention. Skilled artisans will recognize the examples provided herein have many useful alternatives that fall within the scope of embodiments of the invention.

[0036] Referring to FIG. 1, showing a cross-section view of a toilet cistern assembly 1 that comprises a cistern 2 having a side wall 4 and a base 6 forming a tank capable of containing a fluid. Some embodiments of the invention include a side entry inlet pipe 8 that extends horizontally through the side wall 4 of the cistern 2. The side entry inlet pipe 8 can be connected to a domestic water supply by a user or installer of the toilet cistern assembly 1. In some embodiments, the inlet pipe 8 includes a threaded outer surface 10. In some embodiments of the invention, locking nuts 12 can be provided on the threaded inlet pipe 8 on opposing sides of the side wall 4. For example, some embodiments include a first locking nut 12a that can be located on an external side of the cistern's side wall 4, and a second locking nut 12b that can be located on an internal side of the cistern's side wall 4. In some embodiments, the locking nuts 12 can be tightened in opposing axial directions to clamp against the side wall 2 to secure the inlet pipe 8 to the cistern 2. In an alternative embodiment of the invention described below, the inlet pipe 8 may extend through the base 6 of the cistern 2. Alternatively, the arrangement may include only a single external nut, which tightens against the external side of the cistern's side wall 4, and draws part of the fluid valve assembly into a clamped arrangement against the internal surface of the cistern 2.

[0037] In some embodiments of the invention, the toilet cistern assembly 1 includes a fluid valve assembly 14 that is connected to the inlet pipe 8 for controlling a flow of water from the inlet pipe 8 into the cistern 2. In some embodiments of the invention, the fluid valve assembly 14 comprises a valve 16, a valve actuating assembly 18 capable of being actuated to open or close the valve 16, and an outlet assembly 20. In further embodiments of the invention, the fluid valve assembly 14 further includes a float shroud 22 and a filling tube 24. In some non-limiting embodiments, the filling tube 24 is coupled to the float shroud 22. In the embodiment shown in FIG. 1 the filling tube 24 is integrally molded with the float shroud 22 such that the tube 24 and shroud 22 form part of the same integral component. Alternatively, the filling tube 24 may be connected to but not necessarily integrally formed with the float shroud 22. Other embodiments can include those where the filling tube 24 is not directly connected to the float shroud 22.

[0038] FIG. 2 shows a cross-section view of the fluid valve assembly 14 of FIG. 1 according to an embodiment of the invention. In some embodiments, the valve 16 comprises a housing 26 having an inlet 28 connected to the inlet pipe 8. In some embodiments, the housing 26 includes a main body 30 and a cap 32. In some embodiments, the main body 30 includes a connector pipe 34 including the inlet 28 at one end, which connects to the inlet pipe 8. Some embodiments include an inlet chamber 36 located at the opposing end of the connector pipe 34. In some embodiments, the inlet chamber 36 is arranged vertically at 90 degrees to the connector pipe 34. In some embodiments, the connector pipe 34 is in an open or fluid connection with the inlet chamber 36, and enters the inlet chamber 36 proximate its base 38. Some further embodiments include an outlet connector 40 that is located on the opposing side of the inlet chamber 36 to the connector pipe 34. In some embodiments, the outlet connector 40 is not in open connection with the base of the inlet chamber 36, being partitioned from the inlet chamber 36 by the side wall 42 of the inlet chamber 36.

[0039] In some embodiments, the fill valve assembly 14 includes a diaphragm 44 located at the upper end 36a of the inlet chamber 36. In some embodiments, the diaphragm 44 includes a sealing portion 46 that is configured and arranged to seat against the upper edge of the inlet chamber 36 to close the inlet chamber 36 and prevent fluid flow therethrough. In some embodiments, the diaphragm 44 includes an outwardly extending skirt 45. In some embodiments, the skirt 45 includes an upwardly extending rim 47 at its outer edge that locates within a corresponding groove in the cap 32. For example, in some embodiments, the skirt 45 can be clamped between the cap 32 and the main body 30, and the rim 47 is held and retained within the groove 49. In some embodiments, the skirt 45 can seal against the outer edge of the groove 49 and can be urged and held in place by water pressure. In some alternative embodiments, the diaphragm 44 may include other sealing structures such as ribs, labyrinth seals, and other structures.

[0040] In some embodiments of the invention, at least a portion of the diaphragm 44 may comprise a polymer-based material including one or more homopolymers, one or more copolymers, or mixtures thereof. In some embodiments. In some embodiments of the invention, the material may comprise an elastomeric polymer such as rubber or silicone. In some embodiments, the rubber may be a natural rubber (e.g., such as natural gum rubber), a synthetic rubber, or combinations thereof. In other embodiments, the material may comprise a butyl or butylene rubber, ethylene propylene diene monomer (EPDM) rubber, neoprene rubber, nitrile rubber, silicone rubber, a polyurethane rubber, a fluoro-silicone, chloroprene rubber, nitrile rubber, or combinations thereof. In yet further embodiments, the material may include recycled rubber, a silicone sponge or foam or a polyurethane sponge or foam.

[0041] In some further embodiments of the invention, at least a portion of the diaphragm 44 may comprise a polymer-based matrix material including one or more materials. For example, some embodiments include a material that comprises one or more polymers infused with (or including a dispersion of) filler elements, filler compounds, and/or filler mixtures. For example, in some embodiments, at least a portion of the material can comprise a polymer-based matrix material including filaments or particles dispersed in a matrix to form a composite material. For example, some embodiments may include a filler that can comprise a fibrous material. In some embodiments, at least a portion of the filler can be oriented in a preferred direction. In some other embodiments, the material can comprise a fiber-filled matrix material including natural or synthetic filaments dispersed in a matrix to form a fiber composite material. Some embodiments include a filler material at least partially dispersed through at least a portion of the material. In some embodiments, the filler material can be amorphous or crystalline, organic or inorganic material. In some embodiments, the particle size of the filler material can be in the micron range. In some further embodiments, at least some portion of the filler material can be sub-micron. In some other embodiments, at least a portion of the filler can comprise a nano-sized particle filler material.

[0042] Referring to at least FIGS. 1 and 2, in some embodiments of the invention, the float shroud 22 can comprise an elongate chamber 53 having side walls 48 and a base 50. In some embodiments, the elongate chamber 53 can be open at its upper end 52. Some embodiments include an aperture 54 provided in the base 50 of the shroud 22 that can allow fluid to enter the chamber. Accordingly, in some embodiments, the interior of the float shroud 22 can be in fluid communication with the body of the cistern 2, and the water level within the float shroud 22 can reach an equilibrium with a water level in the cistern 2.

[0043] In some embodiments, the fill valve assembly 14 includes a float 56 positioned within the float shroud 22. In some embodiments of the invention, the float 56 and the float shroud 22 can be configured such that the float 56 is received within the float shroud 22 with a close sliding fit. In this instance, in some embodiments of the invention, the float 56 can be configured to slide axially in the vertical direction within the float shroud 22, with the side walls 48 of the float shroud 22 acting as a guide for the float 56. In some embodiments, the float 56 can be connected to a push rod 58 which forms part of the valve actuating assembly 18 that can actuate the valve 16. In some embodiments, the float 56 is formed of a molded plastic and includes a threaded channel or a channel including at least a threaded portion that is integrally molded into a side edge of the float 56. In some embodiments, the channel can receive the threaded push rod 58, and the threaded engagement between the threaded portion of the channel and the push rod 58 can fix the float 56 to the push rod 58. In some embodiments, rotation of the threaded push rod 58 relative to the float 56 can enable the position of the float 56 along the length of the push rod 58 to be adjusted. This varies the height at which the float 56 causes the push rod 58 to close the fluid valve assembly 14, and hence vary the full flush volume of the cistern 2. In some embodiments, conventional non-threaded adjustment devices can be used.

[0044] In some embodiments, an upper end of the push rod 58 can be connected to a linkage 60. In some embodiments, the linkage 60 can be arranged such that an upwards movement of the push rod 58 can cause an actuating portion of the linkage 60 to pivot downwardly (i.e., towards the float 56). In some embodiments of the invention, the actuating portion of the linkage 60 can include one or more sealing members that can close a bleed vent in the cap 32 of the valve housing, which causes the sealing portion 46 of the diaphragm 44 to move into sealing engagement with the upper end of the inlet chamber 36 to close the inlet chamber 36 and prevent flow to the outlet assembly 20. Conversely, in some embodiments of the invention, movement of the push rod 58 in the downward direction (i.e., towards the float 56) can pull the linkage 60 downwards and cause an actuating portion of the linkage 60 to pivot upwardly which can uncover the bleed vent. This can cause the diaphragm 44 to move out of sealing engagement with the inlet chamber 36 under the action of the inlet water pressure, and allow flow to the outlet assembly 20.

[0045] Referring to FIG. 2, in some embodiments, the float 56 includes a main body 164 having side walls 166 and an upper wall 168. In some embodiments, the float 56 is open at its base 169. In some embodiments, the float 56 includes a plurality of chambers 170 that are formed within the body 164 of the float 56 which are defined by partition walls 172 within the main body 164. In some embodiments, the float 56 chambers 170 are open at the base 169 and closed at the upper end by the upper wall 168. Therefore, in some embodiments, air pressure within the chambers 170 prevents water from entering the chambers 170 and maintains the buoyancy of the float 56.

[0046] In some embodiments of the invention, the outlet connector 40 can connect the inlet chamber 36 to the outlet assembly 20. In some embodiments, the outlet assembly 20 is substantially cylindrical and includes an inner chamber 64 and an outer chamber 66. In some embodiments, the inner chamber 64 and outer chamber 66 are concentric with the outer chamber 66 being arranged radially outwards of the inner chamber 64. In some embodiments, the outer chamber 66 can define a fluid channel having an inlet 77 at its lower end and an outlet 79 at its upper end. Referring also to FIG. 3, in some embodiments, the valve actuating assembly can include a channel defined by the outer chamber 66 is configured such that it extends around the inner chamber 64 in a coiled or spiral arrangement. In some embodiments, the inner chamber 64 can include a cylindrical wall 68 forming a channel that is open at the upper and lower ends. In some embodiments, the outer chamber 66 has an inner wall defined by the wall 68 of the inner chamber 64. In some embodiments, the outer chamber 66 also includes an outer wall 70 that is radially spaced from the inner wall 68 with the chamber 66 being defined by the space between the inner wall 68 and outer wall 70. In some embodiments, the outer wall 70 extends to a greater axial height than the inner wall 68 such that the upper edge of the outer wall 70 is located above the upper edge of the inner wall 68. In some embodiments, the, outer chamber 66 also includes a base 72 that connects the outer wall 70 to the inner wall 68. In some embodiments, the outlet connector 40 connects to the outer chamber 66 at the lowest point of the outer chamber 66, which is approximately level with the base of the inner chamber 64.

[0047] In some embodiments of the invention, the outlet connector 40 can be in fluid connection with the outer chamber 66 to supply fluid into the outer chamber 66. As shown in

FIG. 3 the base 72 of the outer chamber 66 winds upwardly around the outer circumference of the inner chamber 64 in a spiral arrangement with the height of the outer wall 70 decreasing as the base 72 spirals upwards; the vertical position of the upper edge of the outer wall 70 remains constant around its periphery while the vertical position of the lower edge increases with the increase in height of the spiral base 72. Further, in some embodiments, a cap 74 can be provided as shown to close the cylindrical upper end of the outer chamber 66, and thus enabling water flowing within the outer chamber 66 to flow inwardly and fall into the inner chamber 64 through the gap between the upper end of the inner chamber wall 68 and the cap 74. In some embodiments of the invention, the spiral configuration of the outer chamber 66 can cause the water flowing through the outer chamber 66 to rotate around the inner chamber 64 as it flows upwardly to the upper edge of the inner chamber 64. In some embodiments, as the upper edge of the inner chamber 64 is lower than the upper edge of the outer chamber 70, water flows over the upper edge of the inner chamber 64 in a weir type arrangement. Under these circumstances, the rotational element of the flow can cause the water to spin as it falls down the outlet channel 64, which defines an outlet nozzle. Further, in some instances, the spin imparted to the flow can collimate the flow as it falls through the outlet channel 64, which may reduce one or both of noise from the outlet flow and nozzle spray.

[0048] The non-limiting embodiment of the illustration of FIG. 3 shows that an aperture 76 can be formed centrally within the cap 74. In some embodiments, the aperture 76 can comprise a smaller radius than the inner chamber 64. In some embodiments of the invention, an inner lip 78 can extend downwardly from the aperture and can form a barrier wall which directs the water overflowing from the outer channel 66 downwardly into the inner channel 64 and prevents water spraying upwardly out of the aperture 76. In some embodiments, the aperture 76 can enable air to flow into the outlet channel 64, which provides an anti-siphon feature. Specifically, in some embodiments, if a siphoning vacuum is created, air may be drawn into the outlet assembly 20 rather than the negative pressure acting to draw water from the cistern.

[0049] Referring to FIGS. 1-3, in some embodiments, the filling tube 24 can be located beneath the outlet assembly 20. In some embodiments, the filling tube 24 can be arranged to catch free-falling water expelled from the outlet assembly 20, as indicated by arrow C shown in the illustration of FIGS. 1 and 3, enabling the water to flow down into the cistern 2, reducing noise and splash back. In some embodiments, the filling tube 24 can include an elongate cylindrical body 80. In some embodiments, the filling tube 24 can include a radially stepped mouth section 82 at its upper end that is wider than the main cylindrical body 80. Some embodiments include a tapered section 84 in the form of a truncated cone that connects the mouth portion 82 and the lower main body 80 and provides a transition between the two sections avoiding a stepped shelf that would lead to splash back from within the filling tube 24. In some embodiments, the filling tube 24 is open at its upper and lower ends.

[0050] In some embodiments, the upper edge 86 of the filling tube 24 defines the opening to the filling tube 24 that is vertically spaced from the lower edge 88 of the outlet assembly 20 at which is located the outlet aperture 89, so that the outlet aperture 89 of the outlet assembly 20 is spaced from in the inlet aperture 87 of the filling tube 24. Specifically, in some embodiments, the upper edge 86 of the filling tube 24 is spaced from the lower edge 88 of the inner chamber 64 of the outlet assembly 20 which defines a fill nozzle. In some embodiments, the outlet assembly 20 and filling tube 24 both include longitudinal axes extending along their lengths. In some embodiments, the filling tube 24 and outlet assembly 20 can be arranged such that they are axially aligned, meaning that the longitudinal axis of the filling tube 24 is substantially aligned and substantially coaxial with the longitudinal axis of the inner chamber 64 of the outlet assembly 20. In some embodiments, this helps ensure that the stream of water falling from the outlet assembly 20 is also axially aligned with the filling tube 24, and as such flows directly into the filling tube 24. While it is not essential that the two elements are precisely axially aligned, the closer the alignment, the more likely it is that the stream of water from the outlet assembly 20 will fall directly into the filling tube 24 without contacting the walls thereby reducing noise and splash back from the filling tube 24.

[0051] In some embodiments, the upper edge 86 of the filling tube 24, at which is located at the inlet aperture 87 of the filling tube 24, is spaced from the lower edge 88 of the outlet assembly 20, at which is located the outlet aperture 89, by a distance A which defines the air gap between the two components. In some embodiments, during use, the outlet aperture 89 at the lower edge of the outlet assembly 20 is spaced from the surface of water in the cistern 2 by a distance B shown in FIG. 1. Further, the unobstructed air gap A ensures that if a siphoning effect is generated in the inlet pipe 8, air is drawn into the outlet assembly 20 through the air gap A. This prevents a vacuum from being created between the outlet assembly 20 and the filling tube 24 that would draw water from within the filling tube 24 into the outlet assembly 20 with the potential consequence of contaminated water entering the domestic plumbing system. In some embodiments, the air gap A is selected to define a safe gap A across which it is not possible to draw water from the cistern. In one embodiment the air gap A is at least about 20 mm. In another embodiment the air gap is at least about 25 mm.

[0052] In some embodiments, the outlet assembly 20 and filling tube 24 both form part of the fluid valve assembly 14. Both the outlet assembly 20 and filling tube 24 are connected as part of the fluid valve assembly 14 such that they are fixed in position relative to each other. This enables the air gap A to be fixed during manufacture and hence avoids the need for an installer to have to set the air gap during installation. As well as simplifying installation, the fixed air gap A ensures that the fluid valve assembly 14 is compliant with regulations regardless of the standard of installation. In some embodiments, the fluid valve assembly 14 including the outlet assembly 20 and filling tube 24 can be manufactured as a prefabricated and preassembled component that requires little or no assembly on site.

[0053] In the embodiment shown in FIGS. 4 and 5, a fluid valve assembly 15 can include a variable buoyancy float 256 in place of the float 56. In this non-limiting embodiment, some or all of the other components of the fluid valve assembly 15 can comprise those of fluid valve assembly 15. In some other embodiments, one or more of the components may differ or not be included. In some embodiments, the variable buoyancy float 256 can comprise a main body 264 having side walls 266 and an upper wall 268. In some embodiments, the variable buoyancy float 256 is open at its base 269. In some embodiments, a plurality of chambers 270 are formed within the body 264 of the variable buoyancy float 256 which are defined by partition walls 272 within the main body 264. In some embodiments, the chambers 270 are open at the base 269 and closed at the upper end by the upper wall 268. Therefore, in some embodiments, the air pressure within the chambers 270 prevents water from entering the chambers 270 and maintains the buoyancy of the variable buoyancy float 256. In some embodiments, one of the chambers 274 is provided with an aperture 276 formed in the upper wall 268 which defines an air bleed aperture 278 allowing air to enter and exit the chamber 274. In some embodiments, the air bleed aperture 278 includes a spigot 280 formed on and extending upwardly from the upper wall 268 having the aperture 276 extending therethrough. In some embodiments, the presence of the air bleed aperture 278 in the chamber 274 means that in operation, air can exit the chamber 274, which allows water to enter the chamber 274 during filling while the remaining chambers 270 remain filled with air.

[0054] FIG. 5 shows an operational arrangement of the fluid valve assembly 15 in which the cistern 2 is filled to the full flush volume and the water inlet 8 has been closed by the fluid valve assembly 15. In some embodiments, the float shroud 22 can fill with water to the same level as the water level within the cistern 2. In some instances, during operation, the chamber 270 can contain no water due to the air pressure within the chamber 270 and the fact that the chamber 270 is closed at its upper end (bounded by upper wall 268). In the non-limiting operational illustration of FIG. 5, the chamber 274 has filled with water up to the same level as the float shroud 22 and the cistern 2 (marked by fill line 3). In some embodiments, this occurs as the water level in the float shroud 22 rises and water reaches the base 269 of the chamber 274 and begins to enter the chamber 274 and force the air within the chamber 274 out through the air bleed aperture 278. In some embodiments, due to the size of the aperture 276, there is a lag between the water level in the chamber 274 and the water level in the shroud 22, but the two levels can eventually equilibrate. In some embodiments, the volume of air evacuated from the chamber 274 reduces the overall volume of the air within the variable buoyancy float 256, and consequently, the buoyancy of the variable buoyancy float 256 decreases.

[0055] Some operational conditions of the fluid valve assembly 15 can include a partial-flush condition. For example, in some embodiments, during a partial flush operation, the water level in the cistern 2 falls, as does the water level in the shroud 22. In some instances, during operation, at its lowest level, the water level can remain above the base 269 of the variable buoyancy float 256. In addition, in some embodiments, the size of the aperture 276 can limit the rate at which air is able to re-enter the chamber 274 as the water level in the shroud 22 and cistern 2 falls. Accordingly, a lag is introduced between the rate at which the water level in the cistern 2 falls and the rate at which the water level in the chamber 274 can fall, with the majority of the water being retained with the chamber 274 during the time the partial flush volume takes to exit the cistern 2. Therefore, due to the water remaining within the chamber 274, the buoyancy of the variable buoyancy float 256 continues to be reduced. Consequently, as the cistern 2 begins to refill and the water level within the shroud 22 rises, the reduced buoyancy of the variable buoyancy float 256 means it does not rise as quickly as when fully buoyant. This introduces a lag between the rising water level in the cistern 2 and the height of the variable buoyancy float 256. As the variable buoyancy float 256 does not rise as quickly as when fully buoyant, the water level in the cistern 2 is able to reach the full flush volume before the variable buoyancy float 256 rises to the level where it closes the fluid valve assembly 15.

[0056] In some embodiments, when the full flush operation is selected, the water level in the cistern 2 falls to a level below the lower edge 50 of the float shroud 22 and below the base 269 of the variable buoyancy float 256. Once the water level falls below the base 269 of the float 256, the water in the chamber 274 begins to drain out. The rate at which the water drains is limited by the flow of air into the aperture 276, but the period between the water level falling below the base 269 of the float and then rising to this level again during filling is more than sufficient for the chamber 274 to empty fully. In some embodiments, the float shroud 22 also empties fully in this period. Therefore, as the water level reaches the level of the aperture 54 in the shroud 22, the shroud 22 begins to fill with a normal level of lag behind the cistern 2 level. In some embodiments, when the water level in the shroud 22 reaches the variable buoyancy float 256, the variable buoyancy float 256 is in a fully buoyant state and rises at the faster rate. Although some water may enter the chamber 274 as the variable buoyancy float 256 rises, the variable buoyancy float 256 remains substantially fully buoyant as it rises to a valve shut-off position. In some embodiments, once the variable buoyancy float 256 reaches this position and stops rising, the water level continues to rise within the chamber 274 due to the lag cause by the small diameter of the aperture 276. In some embodiments, the chamber 274 fills to the same level as the shroud 22 and cistern 256 and the variable buoyancy float 256 is then ready to accommodate a full or partial-flush with the water level returning to the same full-flush volume regardless of the previously selected flush operation.

[0057] Referring to FIGS. 6 and 7, some embodiments include a float 356 that includes a main body 364 having an outer side wall 366, an upper wall 368 and an inner wall 371. In some embodiments, the float 356 is open at its base end 369. In some embodiments, the inner wall 371 defines a central channel 373 extending axially through the float 356 that is open at both ends. In some embodiments, the central channel 373 is configured to receive the fill tube 324 to locate the float 356 around the fill tube 324. In some embodiments, a plurality of chambers 370 are formed within the body 364 of the float 356 which are defined by partition walls 372 which segregate the internal volume of the main body 364. In some embodiments, the plurality of chambers 370 are open at the base end 369 and closed at the upper end by the upper wall 368.

[0058] In some embodiments, the float 356 includes a channel 380 integrally molded into the side wall 366 of the main body 364. In some embodiments, the channel 380 is substantially circular in cross-section and has an open channel 382 extending along its outer edge 384 configured such that the channel 380 is substantially "C"-shaped. In some embodiments, a threaded portion 386 is located at the upper edge of the channel 380. In some embodiments, the channel 380 is configured to axially receive the push rod 58 which engages with the threaded portion 386. In some embodiments, the "C"-shape of the channel 380 allows it to extend around a substantial portion of the circumference of the push rod 358, and more than 380 degrees, which enables it to retain the push rod 58 within the channel 380 which acts as a guide. In some embodiments, a concave scalloped channel 390 extends axially along the length of the opposing side. In some embodiments, the float shroud 22 includes a corresponding convex axially extending internal ridge that can cooperate with the scalloped channel 390 to guide the float 356 during axial movement within the shroud 22.

[0059] In some embodiments, the buoyancy variation chamber 374 is provided with an aperture 376 formed in the upper wall 368 which defines an air bleed aperture 378 allowing air to enter and exit the buoyancy variation chamber 374. In some embodiments, the air bleed aperture 378 includes a spigot 389 formed on and extending upwardly from the upper wall 368 having the aperture 376 extending therethrough.

[0060] Referring to FIG. 8, some further embodiments of the invention include a toilet cistern assembly 401 comprising a cistern 402 having side walls 404 and a base 406 forming a tank capable of retaining a fluid. In some embodiments, the toilet cistern assembly 401 includes a bottom entry support tube 408 that extends vertically through the base 406 of the cistern 402. In some embodiments, the bottom entry support tube 408 can be connected to the domestic water supply. In some embodiments, the support tube 408 functions as an inlet pipe for cistern 402 and functions to provide fluid to the cistern 402 when coupled to a fluid supply. In some embodiments, the support tube 408 includes a threaded outer surface 410 at its lower end 408a that extends through an aperture 407 in the base 406 of the cistern 402. In some non-limiting embodiments of the invention, locking nuts 412 are provided on the threaded support tube 408 on opposing sides of the base 406. For example, some embodiments include a first locking nut 412a located on the external side 406a of the cistern base 406, and a second locking nut 412b is located on the internal side 406b of the base 406. In some embodiments, the locking nuts 412a, 412b can be tightened in opposing axial directions to secure the support tube 408 to the base 406 such that it extends substantially vertically into the cistern 402.

[0061] In some embodiments of the invention, the fluid valve assembly 414 can be connected to the support tube 408. Thus, with the support tube 408 secured to the base 406, the support tube 408 can provide the function of holding and supporting the fluid valve assembly 414 in position within the cistern 402. In some embodiments of the invention, the fluid valve assembly 414 can comprise a valve 416 for controlling the flow of water from the support tube 408 into the cistern 402. In some embodiments of the invention, the fluid valve assembly 414 further includes a valve actuator 418 for controlling or actuating the valve 416, and an outlet assembly 420 from which water flows into the cistern 402 from the support tube 408.

[0062] As shown in FIG. 9, the valve 416 can comprise a housing 426 having an inlet 428 in fluid connection with the support tube 408. In some embodiments of the invention, the housing 426 includes a main body 430 and a cap 432. Further, in some embodiments of the invention, the main body 430 includes a connector pipe 434 including the inlet 428 positioned at its lower end. In some embodiments, a diaphragm seal is located at the upper end of the connector pipe 434. For example, in some embodiments, an outlet connector 440 is located downstream of the connector pipe 434 on the opposing side of a sealing portion 446 of a diaphragm 444. In some embodiments, the sealing portion 446 is configured and arranged to seat against the upper edge 448 of the connector pipe 434 to close the connector pipe 434 and prevent fluid flow therethrough.

[0063] In some embodiments of the invention, the fluid valve assembly 414 further includes a float shroud 422 and a filling tube 424. In some embodiments of the invention, the float shroud 422 comprises an elongate hollow chamber 423 having side walls 449 and a base 450. In some embodiments of the invention, the chamber 423 is open at its upper end 452. In some embodiments of the invention, the aperture 454 is provided in the base 450 of the float shroud 422 that can allow fluid to enter the chamber 423 of the float shroud 422. In this instance, the interior of the float shroud 422 (chamber 423) can be in fluid communication with the body of water in the cistern 402, and the water level within the flout shroud 422 can reach an equilibrium with the water level in the cistern 402.

[0064] In some embodiments of the invention, a float 456 is housed within the float shroud 422, where the float 456 and the float shroud 422 are configured such that the float 456 is received within the float shroud 422 with a close sliding fit. In some embodiments of the invention, the float 456 is configured to slide axially in a vertical direction within the float shroud 422, with the side walls 449 of the float shroud 422 acting as a guide for the float 456. Alternatively, in other embodiments, the float 456 may be suspended directly in the body of water of the cistern, without a float shroud. In this alternative embodiment, the float 456 is connected directly to a threaded valve actuator, and threaded adjustment of the float up and down the actuator varies the water height in the cistern 402.

[0065] In some embodiments of the invention, the float 456 can be connected to the vertical push rod 458 which forms part of the valve actuating assembly 418. In some embodiments of the invention, the float 456 can be formed of a molded plastic. In some embodiments of the invention, the float 456 can include a threaded channel or a channel 459 including at least a threaded portion that is integrally molded into a side edge of the float 456. In this instance, the channel 459 receives the threaded push rod 458 and the threaded engagement between the threaded portion of the channel 459 and the push rod 458 fixes the float 456 to the push rod 458. In some embodiments of the invention, rotation of the threaded push rod 458 relative to the float 456 can enable the height of the float 456 along the length of the push rod 458 to be adjusted, to vary the height at which the float 456 causes the push rod 458 to close the valve 414, and hence vary the full flush volume of the cistern 402.

[0066] Referring to FIG. 10, showing a partial perspective view of the fluid valve assembly 414 of FIG. 8, at its upper end, the push rod 458 is connected to a linkage 460. The linkage 460 is arranged such that an upwards movement of the push rod 458 can cause an actuating portion of the linkage 460 to pivot downwardly (i.e. towards the float shroud 422). In some embodiments, this causes the sealing portion 446 of the diaphragm 444 to move into sealing engagement with the upper end of the connector pipe 434, which closes the connector pipe 434 and prevents fluid flow to the outlet assembly 420. Conversely, movement of the push rod 458 in the downward direction (towards the float shroud 422) can pull the linkage 460 downwards and causes the diaphragm 444 to move out of sealing engagement with the connector pipe 434 and allows flow to the outlet assembly 420.

[0067] Referring again to FIG. 9, in some embodiments, the outlet connector 440 connects the connector pipe 434 to the outlet assembly 420. In some embodiments, the outlet assembly 420 is substantially cylindrical and includes an inner chamber 464 and an outer chamber 466. In some embodiments, the inner chamber 464 and outer chamber 466 are concentric with the outer chamber 466 being arranged radially outwards of the inner chamber 464. In some embodiments, the outer chamber 466 defines a fluid channel having an inlet 477 at its lower end and an outlet 479 at its upper end. The channel defined by the outer chamber 466 is configured such that it extends around the inner chamber 464 in a coiled or spiral arrangement. In some embodiments, the inner chamber 464 includes a cylindrical wall 468 forming a channel that is open at the upper and lower ends as described. In some embodiments, the outer chamber 466 has an inner wall defined by the wall 468 of the inner chamber 464. In some embodiments, the outer chamber 466 also includes an outer wall 470 that is radially spaced from the inner wall 468 with the chamber 466 being defined by the space between the inner wall 468 and outer wall 470. In some embodiments, the outer wall 470 extends to a greater axial height than the inner wall 468 such that the upper edge of the outer wall 470 is located above the upper edge of the inner wall 468. In some embodiments, the outer chamber 466 also includes a base 472 that connects the outer wall 470 to the inner wall 468. In some embodiments, the outlet connector 440 connects to the outer chamber 466 at the lowest point of the outer chamber 466, which is approximately level with the base of the inner chamber 464.

[0068] Referring again to FIG. 8 and FIG. 9, in some embodiments, the filling tube 424 can be located beneath the outlet assembly 420. In some embodiments, the filling tube 424 is arranged to catch free-falling water expelled from the outlet assembly 420, as indicated by arrow C. In this instance, the water passes down into the lower end of the cistern 402, reducing noise and splash back. In some embodiments, the filling tube 424 includes an elongate cylindrical channel 480 that extends through the float shroud 422. In some embodiments, the filling tube 424 includes a radially stepped mouth section 482 at its upper end that is wider than the main cylindrical channel 480. In some embodiments, a tapered section 484 in the form of a truncated cone connects the mouth portion 482 and the lower portion of the elongate cylindrical channel 480 and provides a funneled transition between the two sections avoiding a stepped shelf that would lead to splash back from within the filling tube 424.

[0069] In some embodiments, the filling tube 424 is open at its upper and lower ends, and the upper edge 486 of the filling tube 424 defines the opening to the filling tube 424. This upper edge 486 is vertically spaced from the lower edge 488 of the outlet assembly 420 which is located at outlet aperture 489, so that the outlet aperture of the outlet assembly 420 is spaced by an air gap from inlet aperture 487 of the filling tube 424. In some embodiments, the upper edge 486 of the filling tube 424 can be spaced from the lower edge 488 of the inner chamber 464 of the outlet assembly 420 which defines the fill nozzle. More specifically, in some embodiments, the upper edge 486 of the filling tube 424, at which is located the inlet aperture 487 of the filling tube 424, is spaced from the lower edge 488 of the outlet assembly 420, where the outlet aperture 489 is located, by a distance A which defines the air gap between the two components. Further, in some embodiments, the outlet aperture 489 at the lower edge of the outlet assembly 420 can be spaced from the surface of the water by a distance B. In some embodiments, the clear, visible and unobstructed air gap A ensures that if a siphoning effect is generated in the inlet pipe, air is drawn into the outlet assembly 420 through the air gap A. This prevents a vacuum from being created between the outlet assembly 420 and the filling tube 424 that would draw water from within the filling tube 424 into the outlet assembly 420 with the potential consequence of contaminated water entering the domestic plumbing system. The air gap A is selected to define a safe gap A across which it is not possible to draw water from the cistern. In one embodiment the air gap A is at least 5 mm, preferably more than 10 mm and yet more preferably at least 20 mm. In other embodiments, the air gap is at least 25 mm.

[0070] In some embodiments, the outlet assembly 420 and filling tube 424 both include longitudinal axes extending along their lengths. In some embodiments, the filling tube 424 and outlet assembly 420 can be arranged such that they are axially aligned, meaning that the longitudinal axis of the filling tube 424 is aligned and coaxial with the longitudinal axis of the inner chamber 464 of the outlet assembly 420. This ensures that the stream of water falling from the outlet assembly 420 is also axially aligned with the filling tube 424, and as such flows directly into the filling tube 424. While it is not essential that the two elements are precisely axially aligned, the closer the alignment the more likely it is that the stream of water from the outlet assembly 420 will fall directly into the filling tube 424 without contacting the walls, thereby reducing noise and splash back from the filling tube.

[0071] In some embodiments, the filling tube 424 is integrally formed as part of the float shroud 422 and extends vertically through the float shroud 422. In some embodiments, the cylindrical channel 480 of the filling tube 424 defines an inner wall of the float shroud 422 and is connected at its base to the annular base 450 of the float shroud 422. In some embodiments, the float 456 includes a main body 484 having an outer side wall 484a, an upper wall 488 and an inner wall 490. In some embodiments, the float 456 is open at its base. In some embodiments, the inner wall 490 of the float 456 defines a central channel 491 extending axially through the float 456 that is open at both ends. In some embodiments, the central channel 491 is configured to receive the filling tube 424 and to locate the float 456 around the filling tube 424.

[0072] In some embodiments, the cylindrical channel 480 of the filling tube 424 extends through the central channel 491 of the float 456 such that the float is located radially outwards of the tube body 480, extending around the circumference thereof with a substantially toroidal form. In some embodiments, the tube body 492 therefore acts as a guide for the float 456 which slides up and down about the central tube 491 within the float shroud 422.

[0073] In some embodiments, the outlet assembly 420, float shroud 422 and filling tube 424 form part of the fluid valve assembly 414. In some embodiments, the outlet assembly 420 and filling tube 424 are connected as part of the fluid valve assembly 414 such that they are fixed in position relative to each other. This enables the air gap A to be fixed during manufacture and hence avoids the need for an installer to have to set the air gap during installation. As well as simplifying installation, the fixed air gap A ensures that the fluid valve assembly 414 is compliant with regulations regardless of the standard of installation. In some embodiments, the fluid valve assembly 414 can be manufactured as a prefabricated and preassembled component that requires little or no assembly on site.

[0074] During operation, in some embodiments, it can be necessary to vary the height of the fluid valve assembly 414 within the cistern 402 to vary the height of the water level within the cistern 402. To address this problem, in some embodiments, the fluid valve assembly 414 is connected to the support tube 408 such that the vertical position of the fluid valve assembly 414 along the length of the support tube 408, and hence the height of the fluid valve assembly 414 relative to the base 406 of the cistern 402, can be adjusted while the fluid valve assembly 414 remains in open fluid connection with the support tube 408. In some embodiments, the fluid valve assembly 414 includes a connector tube 494 extending vertically downwards from the fluid valve assembly 414. In some embodiments, the connector tube 494 connects to the float shroud 422, filling tube 424, and the housing 426 of the valve 416. Accordingly, the position of the outlet assembly 420 and filling tube 424 are fixed due to their connection via the connector tube 494. In some embodiments, the connector tube 494 has an inner diameter substantially equal to the outer diameter of the upper end 496 of the support tube 408. In this way the connector tube 494 is configured to slidably receive the upper end 496 of the support tube 408. In some embodiments, the upper end 496 of the support tube 408 includes a pair of parallel circumferential grooves 498 formed in the outer surface of the support tube 408 proximate the distal end. In some embodiments, o-ring seals 500 can be located in the circumferential grooves 498. In some embodiments, the o-ring seals 500 can provide a seal between the inner surface 501 of the connector tube 494 and the outer surface 505 of the support tube 408 that prevents fluid from flowing out of the lower end of the connector tube 494 between the connector tube 494 and the support tube 408. In some embodiments, the o-ring seals 500 can maintain a seal between the support tube 408 and connector tube 494 as the support tube 408 slides within the connector tube 494. In some embodiments, the length of the support tube 408, and the position of the o-rings 500 along the support tube 408 can be selected such the o-rings 500, and hence the seal between the support tube 408 and the connector tube 494, is above the filled water level within the cistern.

[0075] In some embodiments of the invention, the support tube 408 can include a series of circumferential protrusions or annular ribs 502 arranged along a locking section 503 of the support tube 408 that is axially spaced from the distal end of the support tube 408. In some embodiments, the ribs 502 can extend radially outwards from the outer surface 505 of the support tube 408, and are axially and regularly or irregularly spaced from each other along the length of the locking section 503 of the support tube 408. In some embodiments, the ribs 502 can be interspaced by a series of recesses 504. In some embodiments, the inner surface 501 of the connector tube 494 can comprise a pair of annular, axially spaced protrusions forming locking teeth 506. In some embodiments of the invention, locking teeth 506 can be arranged proximate the lower end of the connector tube 494 at its opening. In some embodiments of the invention, a recess 506a can be defined between the locking teeth 506 that is sized and configured to receive the ribs or protrusions 502 of the support tube 408.

[0076] As shown in FIG. 10, the connector tube 494 includes a plurality of expansion channels or slots 508 extending axially and including an opening 509 at the lower edge 511 of the connector tube 494. In some embodiments, the expansion slots 508 can allow the lower end of the connector tube 494 to radially expand or splay outwardly. In some embodiments, the expansion slots 508 extend upwardly from the lower edge 511 of the connector tube 494 and terminate at a position axially spaced above the locking teeth 506 (shown in FIG. 9 and described earlier). In some embodiments, the expansion slots 508 can extend through the locking teeth 506 creating a circumferential break. In some embodiments, the locking teeth 506 extend circumferentially around the inner surface 501 of the connector tube 494 but do not extend across the gaps defined by the expansion slots 508. In some embodiments, the presence of the expansion slots 508 can enable the lower end of the connector tube 494 to radially expand to enable the locking teeth 506 to travel over the ribs 502 of the support tube 408. In some embodiments, this can enable the connector tube 494 to be axially moved relative to the support tube 408. In some embodiments, the locking teeth 506 have tapered leading and trailing edges in the axial direction to allow them to slide over the ribs 502. In some embodiments, the ribs 502 can include tapered leading and trailing edges, where the uppermost edge of each rib 502 defines the leading edge.

[0077] In some embodiments, the o-ring seals 500 can ensure that the seal between the connector tube 494 and support tube 408 is maintained during axial adjustment. In some embodiments, the ribs 502 define series of axial locking positions, where with each locking position, the locking teeth 506 resiliently flex back to their original radial position and locate either side of the ribs 502 corresponding to the locking position and locate within the recesses 504 axially either side of the rib 502. In this configuration, the connector tube 494 may be further axially adjusted by applying a force in either axial direction.

[0078] In some embodiments, a locking collar 510 is provided to axially lock the connector tube 494 in a selected locking position relative to the support tube 408. In some embodiments, the locking collar 510 is substantially cylindrical and is positioned at least partially around the connector tube 494. In some embodiments of the invention, the body 512 of the locking collar 510 is integrally molded with the float shroud 422, and connects the float shroud 422 to the connector tube 494. In some embodiments, the locking collar 510 has an inner diameter corresponding to the outer diameter of the connector tube 494 and is configured such that the connector tube 494 and locking collar 510 are able to slide relative to each other. In some embodiments, the locking collar 510 has a locking ring 512 at its lower end defined by a region of increased wall thickness. It will be appreciated that in other embodiments the locking collar may be separate from the float shroud, and as described above in certain embodiments the float could be provided without a float shroud 422.

[0079] In the arrangement shown in FIG. 8 the locking collar 510 is in a locked position, where the locking collar 510 has been moved to its lowermost axial position at the lower end 511 of the connector tube 494. As shown in FIG. 11, in some embodiments, the connector tube 494 includes a flange portion 514 at the lower end 511 that is structured to create a stop to define the lower position limit of the locking collar 510. In some embodiments, when in the locked position the locking ring 512 of the locking collar 510 can be axially aligned with the locking teeth 506 of the connector tube 494. In some embodiments, the inner diameter of the locking collar 510 corresponds to the normal, unexpanded diameter of the connector tube 494. In some embodiments, when located about the lower end of the connector tube 494 in the locking position, the locking collar 510 can radially restrict the connector tube 494, and prevent the lower end of the connector tube 494 from radially expanding. As described above, in some embodiments, the expansion of the connector tube 494 can enable the locking teeth 506 to splay outwardly and move axially over the locking ribs 502. In some embodiments, the locking collar 510 therefore locks the connector tube 494 with the locking teeth 506 located in position about the corresponding locking rib 502 by preventing the locking teeth 506 from moving axially over the locking ribs 502. This creates a mechanical interlock between the locking teeth 506 and the locking rib 502 that holds the connector tube 494 in the selected locking position. In some embodiments, an increased thickness of the locking ring section 512 can strengthen the locking collar 510 at the region of maximum radial stress. In some embodiments, low profile rib 513 is provided on the outer surface of the connector tube 494 at a position in which it is axially substantially level with the upper edge of the locking ring 512 in the locked position. In some embodiments, the rib 513 can provide a mechanical feedback as the locking ring 512 passes over the rib 513 that indicates to the user that the lower locking position has been reached.

[0080] In some embodiments, during assembly, the connector tube 494 can be inserted over the support tube 408 and moved to the required axial locking position. In some embodiments, the locking collar 510 can be moved to the locking position to lock the connector tube 494 in position and fix the height of the fluid valve assembly 414. As the float shroud 422 and filling tube 424 are integral with the locking collar 510, the locking position also corresponds to the lowermost position of the filling tube 424. Further, as the connector tube 494 includes a flange portion 514 at the lower end 511 that creates a stop to define the lower position limit of the locking collar 510, the flange portion 514 can set the air gap between the outlet assembly 420 and the filling tube 424 by fixing the axial spacing between the outlet assembly 420 and the filling tube 424. Accordingly, the air gap is therefore easily, consistently and accurately set during installation in some embodiments.

[0081] In some embodiments, the height of the fluid valve assembly 414 can be adjusted by moving the locking collar 510 to an unlocked position, as shown in FIG. 12. In this instance, the locking collar 510 can moved axially upwards away from the lower end 511 of the connector tube 494 to the unlocked position in which the locking ring 512 is axially spaced above the locking teeth 506. Referring to FIG. 13, in some embodiments, a lug 516 can be located on the connector tube 494 immediately beneath the valve 416. Further, in some embodiments, an upper flange section 518 projects radially outwards from the upper end of the locking collar 510 that may be gripped by the user to pull the locking collar upwards. In some embodiments, the flange section 518 includes a movable release tab 520. In some embodiments, in an uppermost position, the tab 520 can engage the lug 516 which acts as a stop member to limit upward movement of the locking collar along the connector tube 494. In some embodiments, once the locking ring 512 has moved axially above the locking teeth 506, the connector tube 494 is once again able to axially expand and the position or height of the connector tube 494 adjusted.

[0082] In some embodiments, following installation of the fluid valve assembly 414, a water supply can be connected and the support tube 408 and connector tube 494 can fill with water. In some embodiments, connector tube 494 can be provided with locking tabs 524 to prevent accidental removal of the connector tube 494 from the support tube 408. In some embodiments, locking tabs 524 can be located above the locking teeth 506 on opposing sides of the connector tube 494, and can be pivotable and radially movable relative to the main body of the connector tube 494. In some embodiments, support tube 408 includes guide channels 526 formed on opposing sides of its outer surface within which the locking tabs 524 are received. In some embodiments, guide channels 526 can terminate a short distance from the upper end of the support tube 408. In some embodiments, locking tabs 524 can be axially restrained by the locking collar 510 which holds the locking tabs 524 in an inwardly depressed state as received within the channels 526 of the support tube 408. In some embodiments, if the user attempts to pull the connector tube 494 past an upper most position, the locking tabs 524 can engage with the upper ends of the channels 526 to prevent further retraction. In this position, the locking ring 512 can prevent release of the locking tabs 524, and the locking collar cannot be moved past the locking tabs 524 due to the engagement of the release tab 520 with the lug 516.

[0083] In some embodiments, the release tab 520 can be pivotable relative to the locking collar 510, and may be pivoted outwardly to a release position. In some embodiments, in the release position, the release tab 520 can move axially past the lug 516 allowing further axial travel of the locking collar 510. This additional travel is sufficient to allow the locking ring 512 to move past the locking tabs 524 allowing them to retract and release from the guide channels 526. In use, once the user is certain that removal of the connector tube 494 and fluid valve assembly 414 is required, the supply water can be turned off and the locking collar 510 pulled upwardly to the unlocked position. In some embodiments, the connector tube 494 may then be pulled upwardly until the locking tabs 524 engage the upper ends of the channels 526 and further movement is not possible. The user may then pull the release tab 520 outwardly to allow the locking ring 512 to release the locking tabs 524, and the connector tube 494 may then be fully removed from the supply tube 408.

[0084] It will be appreciated that the terms protrusions, grooves, recesses, teeth, tabs and slots are used to define structures that enable engagement, and these terms are used generically throughout to define a first structure that engages, couples, and/or interlocks with at least a second structure. Moreover, the term ‘engagement’ is contemplated broadly to mean two or more structures being engaged, coupled, and/or interlocked via a friction mechanism.

[0085] It will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein. Various features and advantages of the invention are set forth in the following claims.

CLAIMS

1. A fluid control assembly comprising:
   a fluid valve assembly coupled to an inlet pipe;
   a filling tube coupled to, integrated with, or positioned adjacent to the fluid valve assembly, the filling tube including an inlet aperture;
   a fluid outlet assembly coupled to or integrated with the fluid valve assembly, the fluid outlet assembly comprising an outlet aperture positioned at a specific distance from the inlet aperture forming a space or air gap between the inlet aperture and the outlet aperture, wherein the outlet aperture and inlet aperture are at least partially aligned to enable fluid to travel from the fluid valve assembly and across the air gap and at least partially into the inlet aperture when a valve of the fluid valve assembly is actuated to an open or on position; and
   a valve actuating assembly configured and arranged to control the valve.

2. The fluid control assembly of claim 1, wherein the valve actuating assembly comprises at least one moveable float.

3. The fluid control assembly of claim 2, wherein the at least one moveable float comprises a variable buoyancy float including a plurality of chambers, and wherein one of the chambers of the plurality of chambers includes an air bleed aperture.

4. The fluid control assembly of claim 2, wherein the at least one moveable float is positioned at least partially around the filling tube.

5. The fluid control assembly of claim 2, wherein the at least one moveable float is positioned adjacent the filling tube.

6. The fluid control assembly of claim 2, further comprising a float shroud, wherein the at least one moveable float is at least partially positioned within the float shroud.

7. The fluid control assembly of claim 6, wherein a base of the float shroud includes an aperture configured to allow fluid to enter the float shroud.

8. The fluid control assembly of claim 1, wherein the valve actuating assembly includes a control rod coupled to a float at one end and a linkage of the valve actuating mechanism at the opposite end.

9. The fluid control assembly of claim 8, wherein an actuating portion of the linkage is configured to cause a sealing portion of a diaphragm of the valve to move into or away from a sealing engagement to control fluid flow through the valve.

10. The fluid control assembly of claim 1, wherein the inlet pipe is generally perpendicular to the filling tube.

11. The fluid control assembly of claim 1, wherein the inlet pipe comprises a support pipe generally parallel to the filling tube.

12. The fluid control assembly of claim 11, wherein the support pipe comprises a support of the fluid valve assembly, wherein the fluid valve assembly is coupled to the support pipe by a connector tube.

13. The fluid control assembly of claim 12, wherein the support pipe is configured to be locked to the connector tube with a locking assembly.

14. The fluid control assembly of claim 13, wherein the locking assembly comprises a first locking element provided on the connector tube that is configured to engage with a corresponding second locking element on the support tube to axially fix the connector tube in position relative to the support tube and to allow vertical adjustment of the connector tube relative to the support tube.

15. The fluid control assembly of claim 14, further comprising a locking member movable between a locked position in which the first and second locking element are in locking engagement and the locking member prevents release of the first and second locking elements from said locking engagement, and an unlocked position in which the first and second locking elements may be released from locking engagement to allow vertical adjustment of the connector tube relative to the support tube.

16. The fluid control assembly of claim 1, wherein the fluid outlet comprises a fluid flow channel defined between an inlet and outlet configured to impart a rotational force to fluid passing through the fluid flow channel.

17. The fluid control assembly of claim 1, wherein the filling tube, valve actuating assembly and outlet aperture are axially aligned.

18. An assembly comprising:
a fluid valve assembly including an outlet;
a filling tube adjacent to the fluid valve assembly, the filling tube including an inlet aperture at least partially axially aligned with the outlet;
an outlet aperture positioned at a specific distance from the inlet aperture forming a space or air gap between the inlet aperture and the outlet aperture; and
a moveable float configured and arranged to control a sealing member of the fluid valve based at least in part on the position of the moveable float relative to the outlet.

19. The assembly of claim 18, wherein the moveable float comprises a variable buoyancy float including a plurality of chambers, wherein one of the chambers of the plurality of chambers includes an air bleed aperture.

20. The assembly of claim 18, wherein the filling tube is circumferentially surrounded by the moveable float.

AMENDED CLAIMS
received by the International Bureau on 24 October 2019 (24.10.2019)

1-20. (Cancelled)

21. (New) A fluid control assembly for a cistern of a toilet comprising:

an outlet assembly comprising a lower portion defining an outlet assembly fluid outlet;

a filling tube comprising an upper portion defining a filling tube fluid inlet and a lower portion defining a filling tube fluid outlet; and

wherein the outlet assembly is configured and arranged to supply a fluid to the cistern during a filling operation;

wherein the outlet assembly fluid outlet is spaced from filling tube fluid inlet by an air gap;

wherein the fill tube is configured and arrange to supply the fluid from the outlet assembly to a lower portion of the cistern; and

wherein the fill tube is configured and arranged to maintain a fill tube fluid level that is substantially equal to a cistern fluid level during at least a portion of the filling operation.

22. (New) The fluid control assembly of claim 21,

further comprising a fluid valve assembly;

wherein the outlet assembly and filling tube are coupled to the fluid valve assembly such that the air gap between the outlet assembly fluid outlet and the fill tube fluid inlet are in a fixed position relative to each other whereby the need to set the air gap is avoided.

23. (New) The fluid control assembly of claim 21,

wherein the outlet assembly further comprises a cap comprising an aperture wall defining an aperture; and

wherein the aperture wall is configured and arranged to direct the fluid away from the aperture to the outlet assembly fluid outlet.

24. (New) The fluid control assembly of claim 21,

further comprising a float assembly comprising:

a float comprising at least one chamber, and

a float shroud comprising a float shroud aperture located in a lower portion thereof; and wherein the float shroud is configured and arranged to achieve a float shroud fluid level that is substantially equal to the cistern fluid level and the fill tube fluid level when the filling operation is complete.

25. (New) The fluid control assembly of claim 21,

further comprising a float assembly comprising:

a float shroud comprising a float shroud aperture located in a lower portion thereof, and

a float comprising float chamber and a variable float chamber, each comprising an upper portion;

wherein the variable float chamber comprises a float chamber aperture position in the variable float chamber upper portion;

wherein during a fill operation, air can exit the variable float chamber through the float chamber aperture; and

wherein during a fill operation, the float chamber remains filled with air.

26. (New) The fluid control assembly of claim 22,

wherein the outlet assembly further comprises a cap comprising an aperture wall defining an aperture; and

wherein the aperture wall is configured and arranged to direct the fluid away from the aperture to the outlet assembly fluid outlet.

27. (New) The fluid control assembly of claim 22,

further comprising a float assembly comprising a float shroud and a float; and

wherein the float shroud is coupled to the fluid valve assembly in fixed position relative to each other; and

wherein the float is adjustably coupled to the fluid valve assembly by a push rod; and

wherein a float location relative to the push rod is configured and arranged to control the fluid level of the cistern.

28. (New) The fluid control assembly of claim 23,

wherein the outlet assembly further comprises an outer chamber and an inner chamber;

wherein the outer chamber winds upwardly around the inner chamber in a spiral arrangement; and wherein the outer chamber is configured and arranged to direct the fluid to the cap; and

wherein the aperture wall is configured and arranged to direct the fluid to the inner chamber.

29. (New) The fluid control assembly of claim 23,

further comprising a float assembly comprising:

a float shroud comprising a float shroud aperture located in a lower portion thereof, and

a float comprising float chamber and a variable float chamber, each comprising an upper portion;

wherein the variable float chamber comprises a float chamber aperture position in the variable float chamber upper portion;

wherein during a fill operation, air can exit the variable float chamber through the float chamber aperture; and

wherein during a fill operation, the float chamber remains filled with air.

30. (New) The fluid control assembly of claim 25,

wherein the float further comprises a central channel;

wherein the fill tube extends through the central channel such that the float is located radially outwards of the tube body.

31. (New) The fluid control assembly of claim 26,

wherein the outlet assembly further comprises an outer chamber and an inner chamber;

wherein the outer chamber winds upwardly around the inner chamber in a spiral arrangement; and

wherein the outer chamber is configured and arranged to direct the fluid to the cap; and

wherein the aperture wall is configured and arranged to direct the fluid to the inner chamber.

32. (New) The fluid control assembly of claim 26,

further comprising a float assembly comprising a float shroud and a float; and

wherein the float shroud is coupled to the fluid valve assembly in fixed position relative to each other; and

wherein the float is adjustably coupled to the fluid valve assembly by a push rod;

wherein a float location relative to the push rod is configured and arranged to control the fluid level of the cistern.

33. (New) The fluid control assembly of claim 26,

further comprising a float assembly comprising:

a float shroud comprising a float shroud aperture located in a lower portion thereof, and

a float comprising float chamber and a variable float chamber, each comprising an upper portion;

wherein the variable float chamber comprises a float chamber aperture position in the variable float chamber upper portion;

wherein during a fill operation, air can exit the variable float chamber through the float chamber aperture; and

wherein during a fill operation, the float chamber remains filled with air.

34. (New) The fluid control assembly of claim 27,

further comprising a fluid valve assembly;

wherein the outlet assembly and filling tube are coupled to the fluid valve assembly such that the air gap between the outlet assembly fluid outlet and the fill tube fluid inlet are in a fixed position relative to each other whereby the need to set the air gap is avoided.

35. (New) The fluid control assembly of claim 29,

wherein the float further comprises a central channel;

wherein the fill tube extends through the central channel such that the float is located radially outwards of the tube body.

36. (New) The fluid control assembly of claim 29,

further comprising a fluid valve assembly;

wherein the outlet assembly and filling tube are coupled to the fluid valve assembly such that the air gap between the outlet assembly fluid outlet and the fill tube fluid inlet are in a fixed position relative to each other whereby the need to set the air gap is avoided.

37. (New) The fluid control assembly of claim 31,

further comprising a float assembly comprising:

a float comprising at least one float chamber, and

a float shroud comprising a float shroud aperture located in a lower portion thereof; and

wherein the float shroud is configured and arranged to achieve a float shroud fluid level that is substantially equal to the cistern fluid level and the fill tube fluid level when the filling operation is complete.

38. (New) The fluid control assembly of claim 37,

wherein the float shroud comprises a float shroud aperture located in a lower portion thereof;

wherein the at least one float chamber comprises a float chamber and a variable float chamber, each comprising an upper portion;

wherein the variable float chamber comprises a float chamber aperture position in the variable float chamber upper portion;

wherein during a fill operation, air can exit the variable float chamber through the float chamber aperture; and

wherein during a fill operation, the float chamber remains filled with air.

39. (New) The fluid control assembly of claim 38,

further comprising a float assembly comprising a float shroud and a float; and

wherein the float shroud is coupled to the fluid valve assembly in fixed position relative to each other; and

wherein the float is adjustably coupled to the fluid valve assembly by a push rod;

wherein a float location relative to the push rod is configured and arranged to control the fluid level of the cistern.

40. (New) The fluid control assembly of claim 39,

wherein the float further comprises a central channel;

wherein the fill tube extends through the central channel such that the float is located radially outwards of the tube body.

STATEMENT UNDER ARTICLE 19 (1)

Applicant requests entry of the following claim amendments under Article 19 which are presented below with markings to show changes relative to the original claims. A clean version of the claims (with no markings to show changes) is appended to this response. No new matter is added in the amendment to this claim.

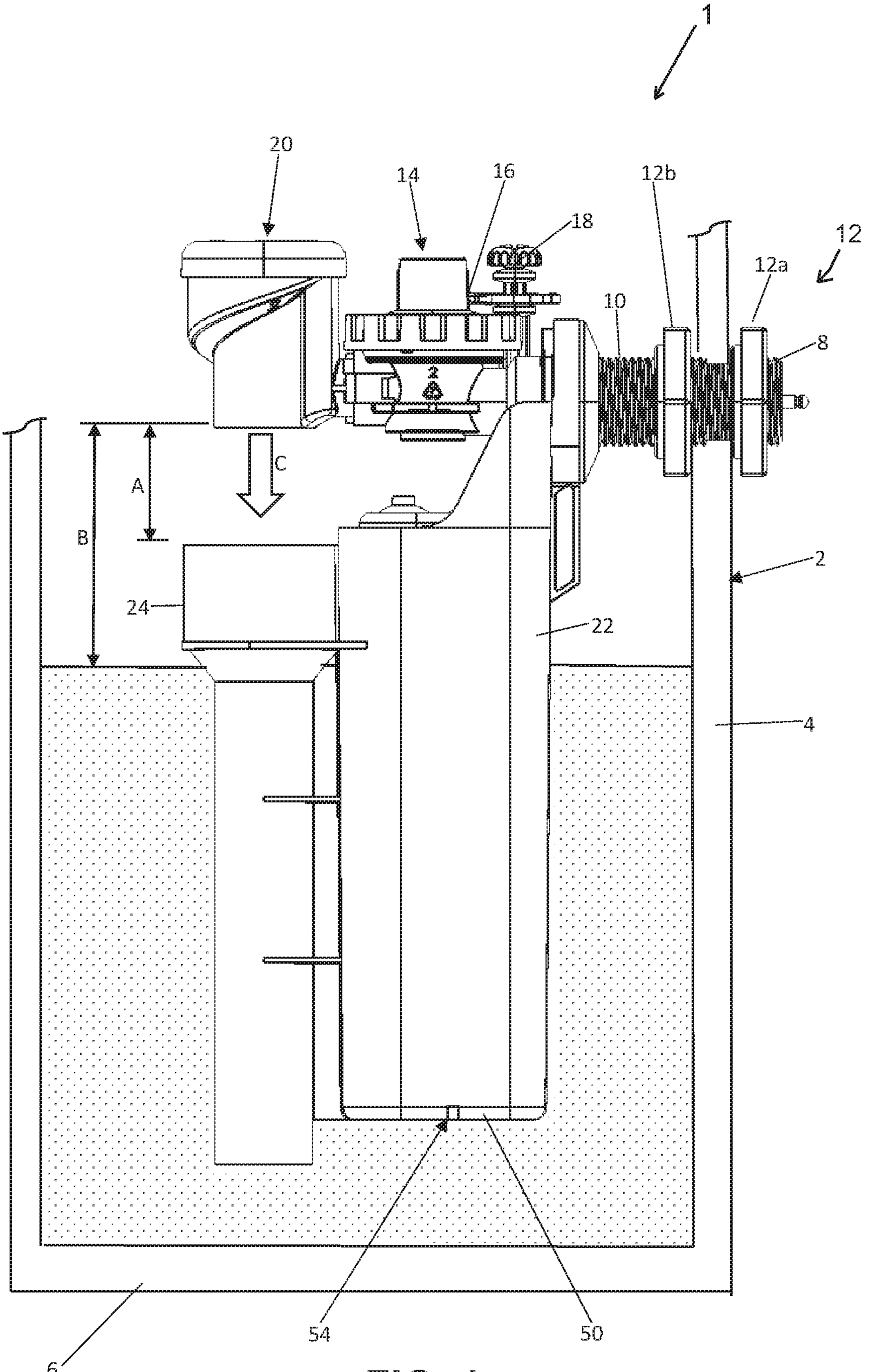

FIG. 1

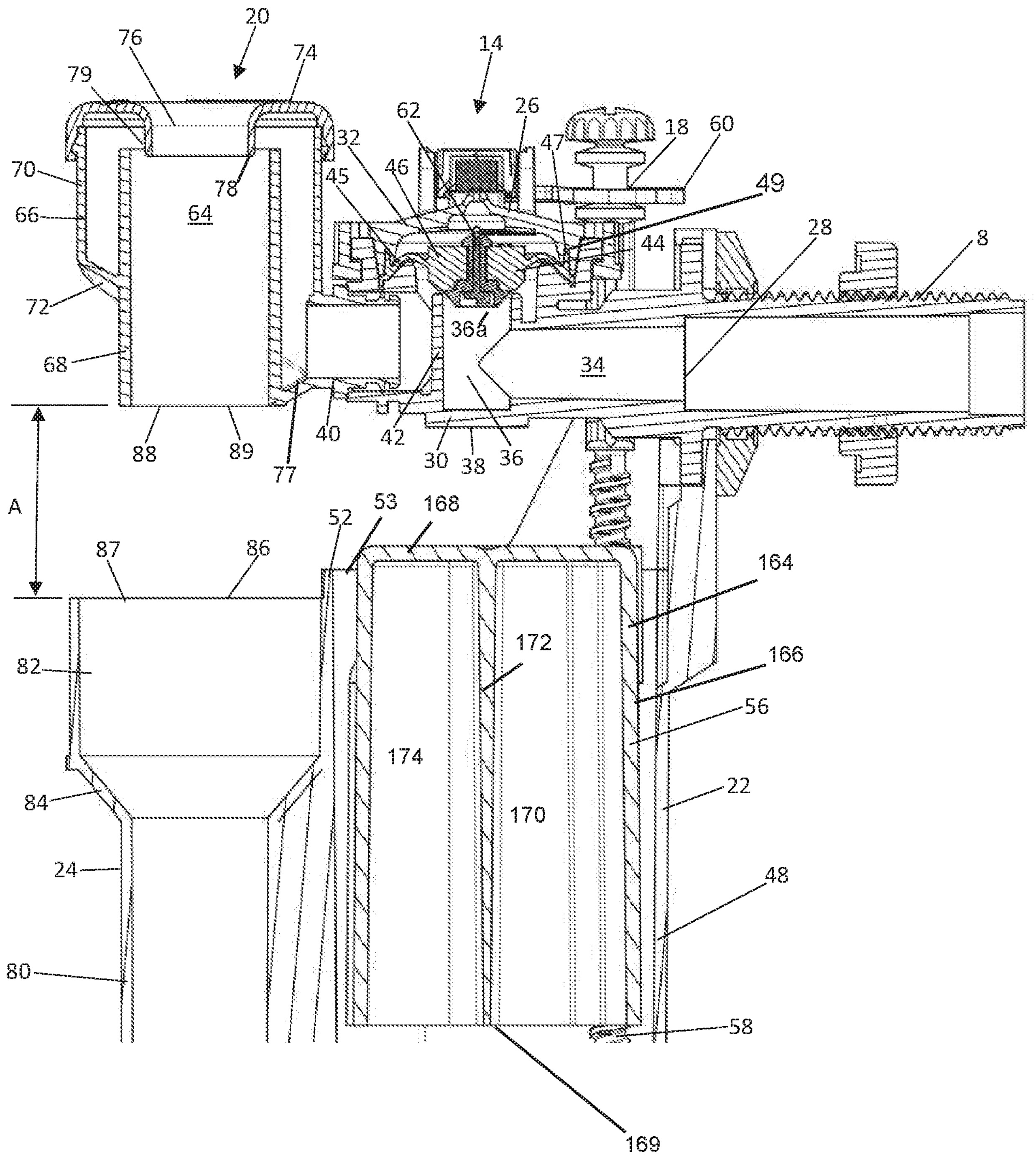
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FIG. 2

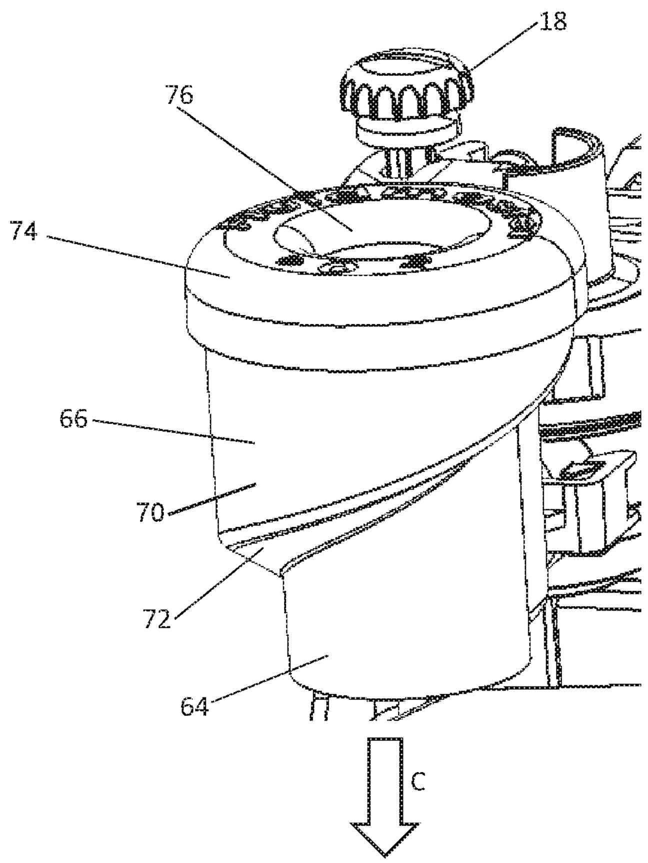

FIG.3

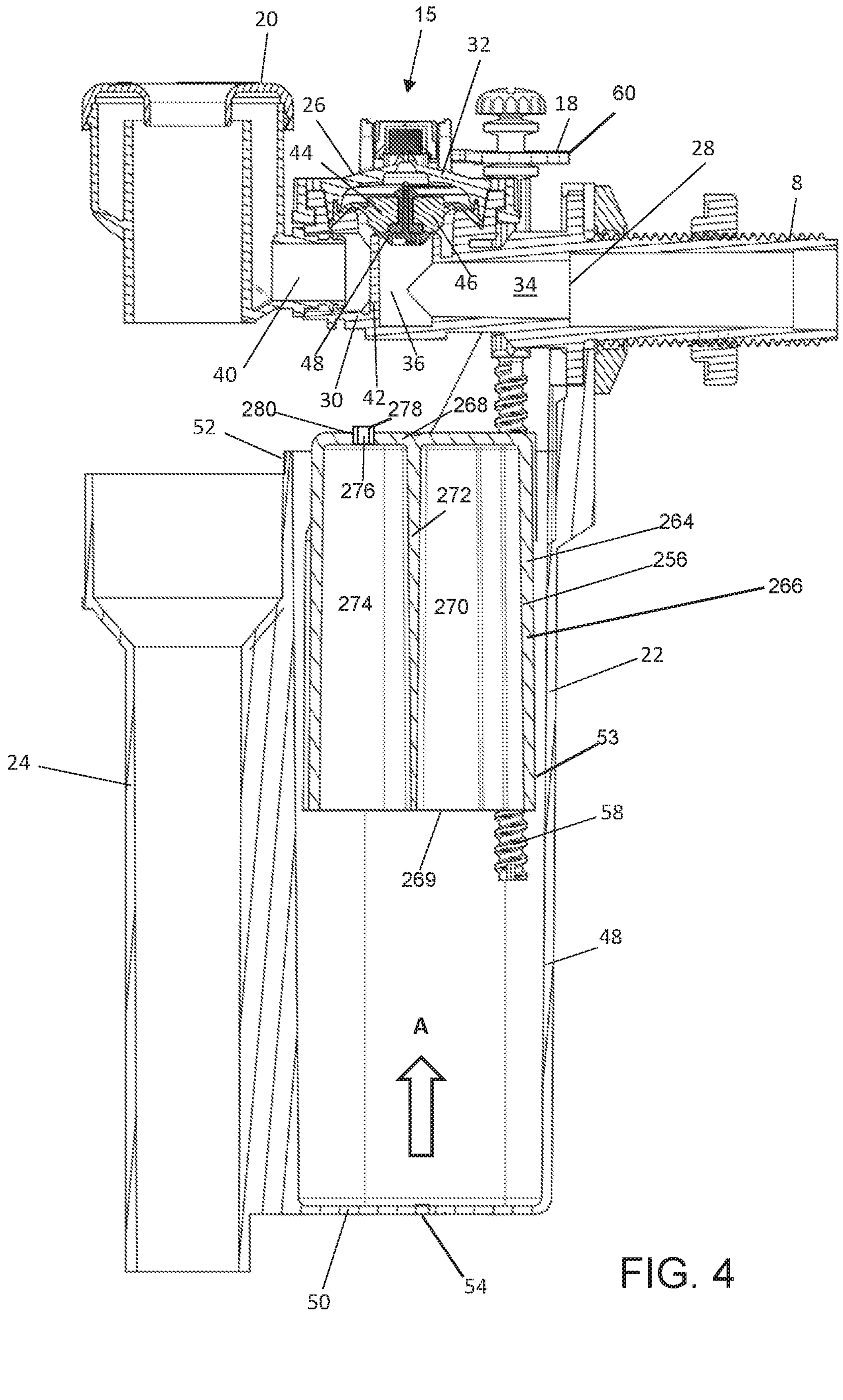
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FIG. 4

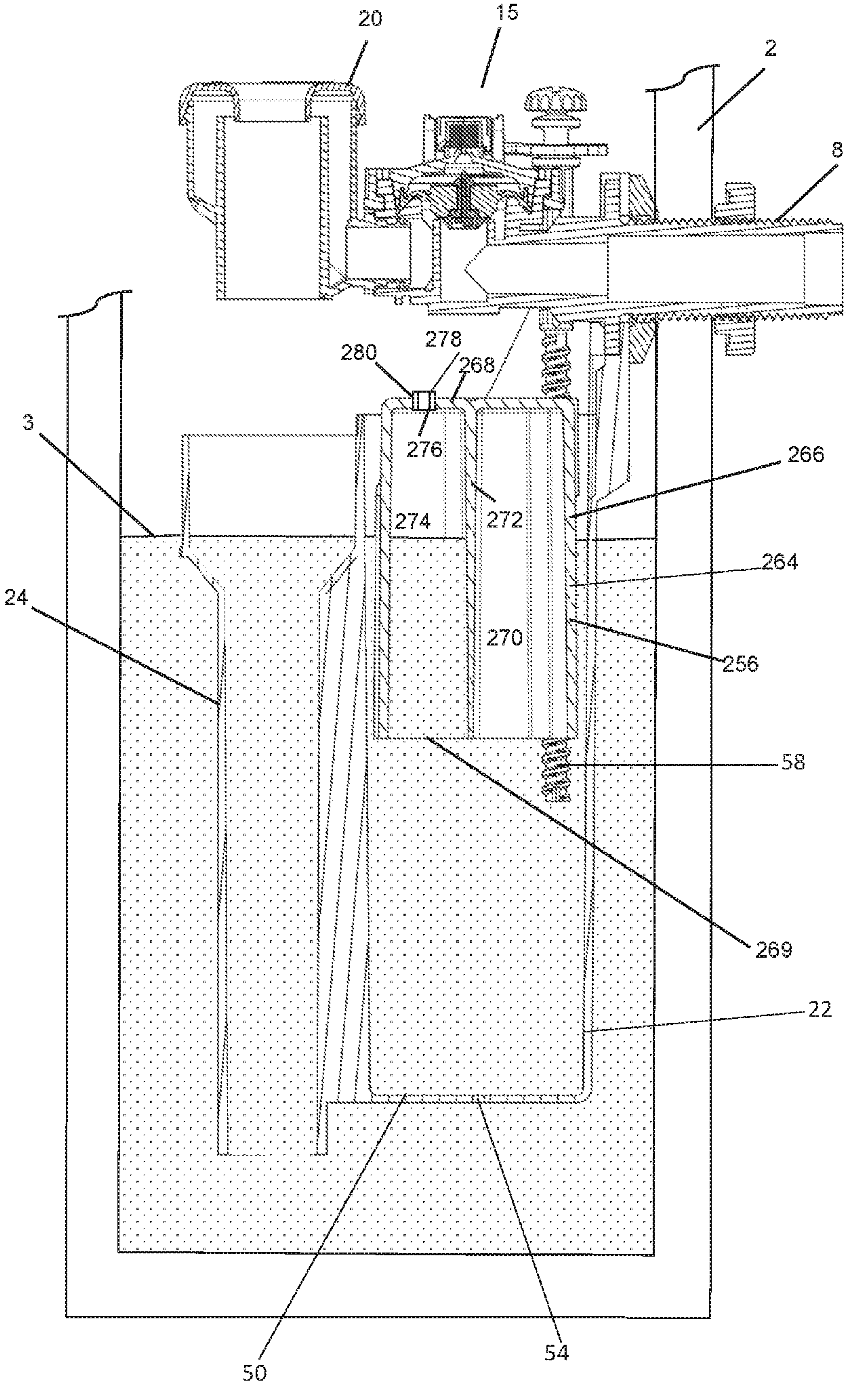
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FIG. 5

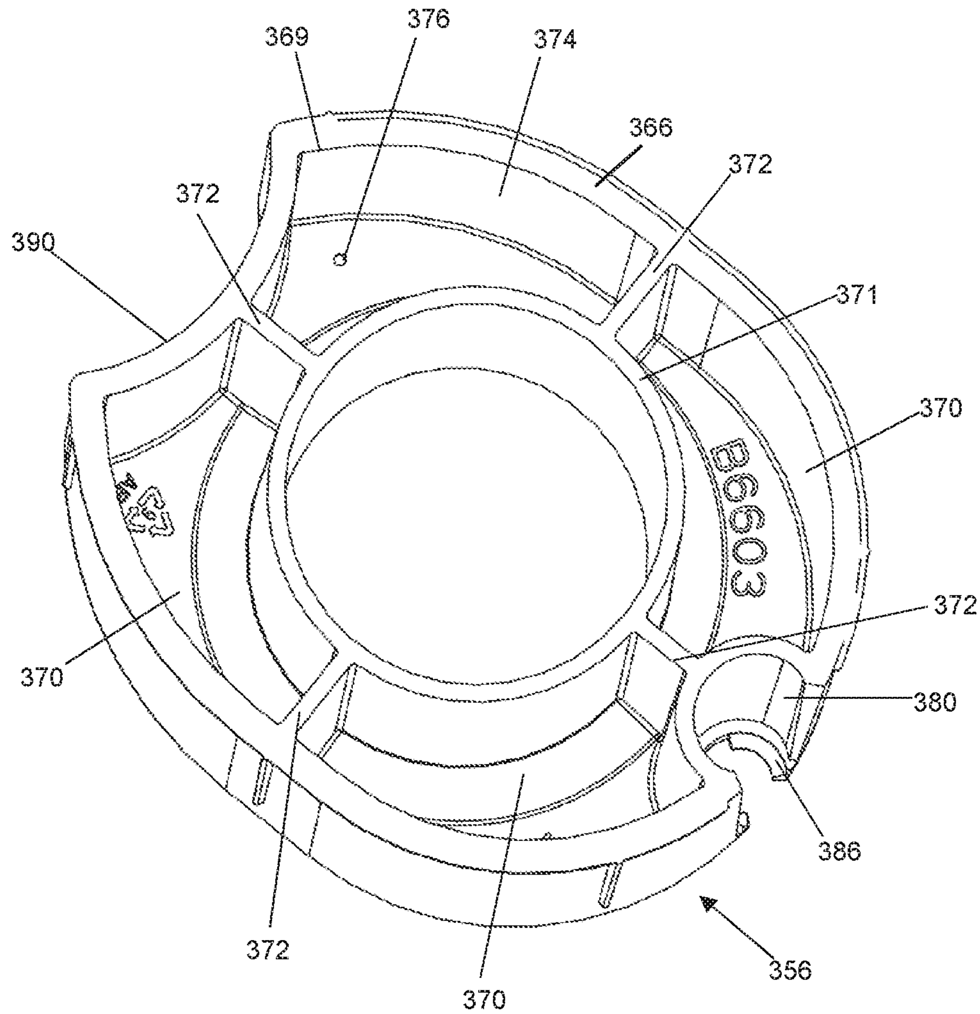
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FIG. 6

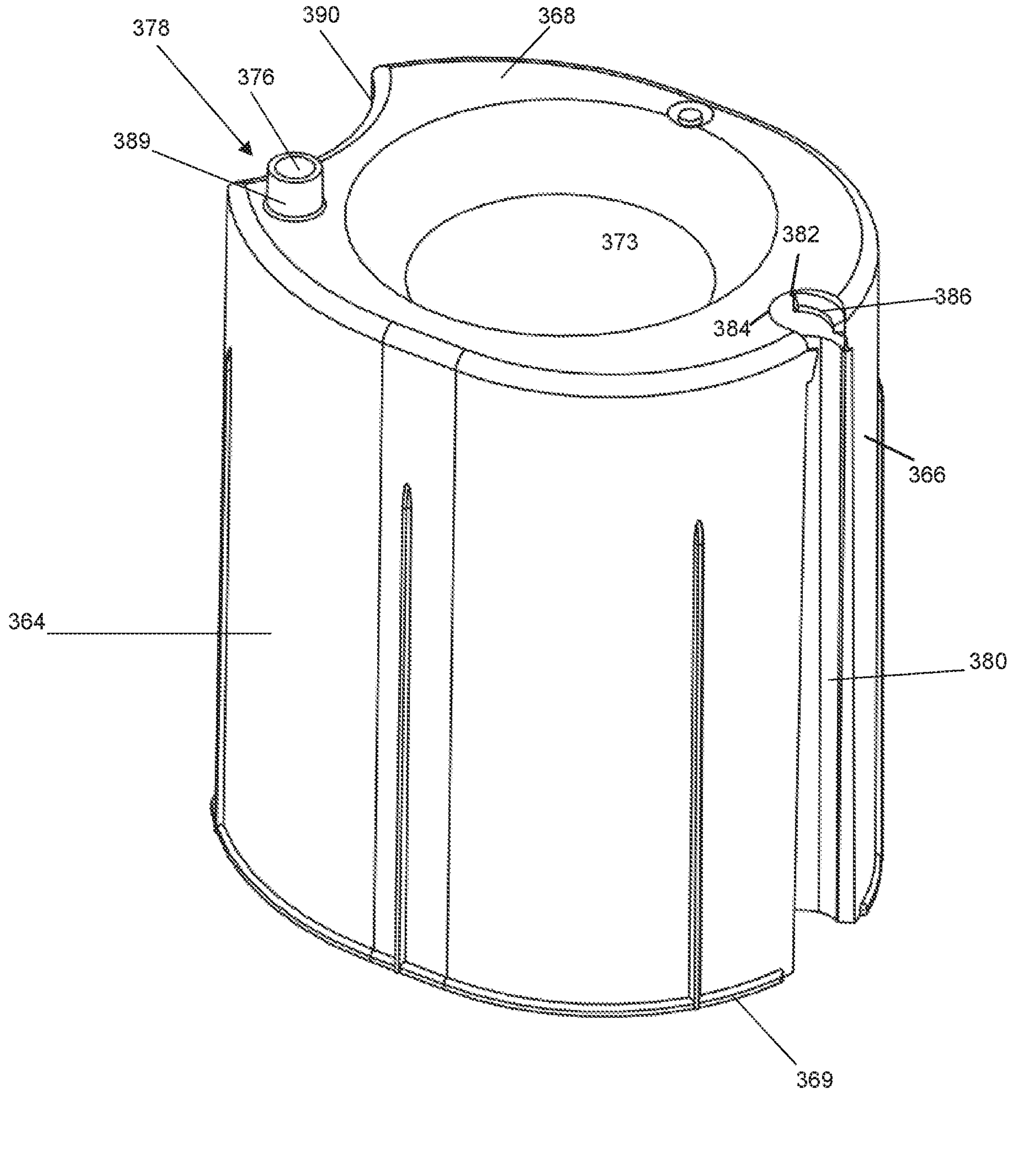

FIG. 7

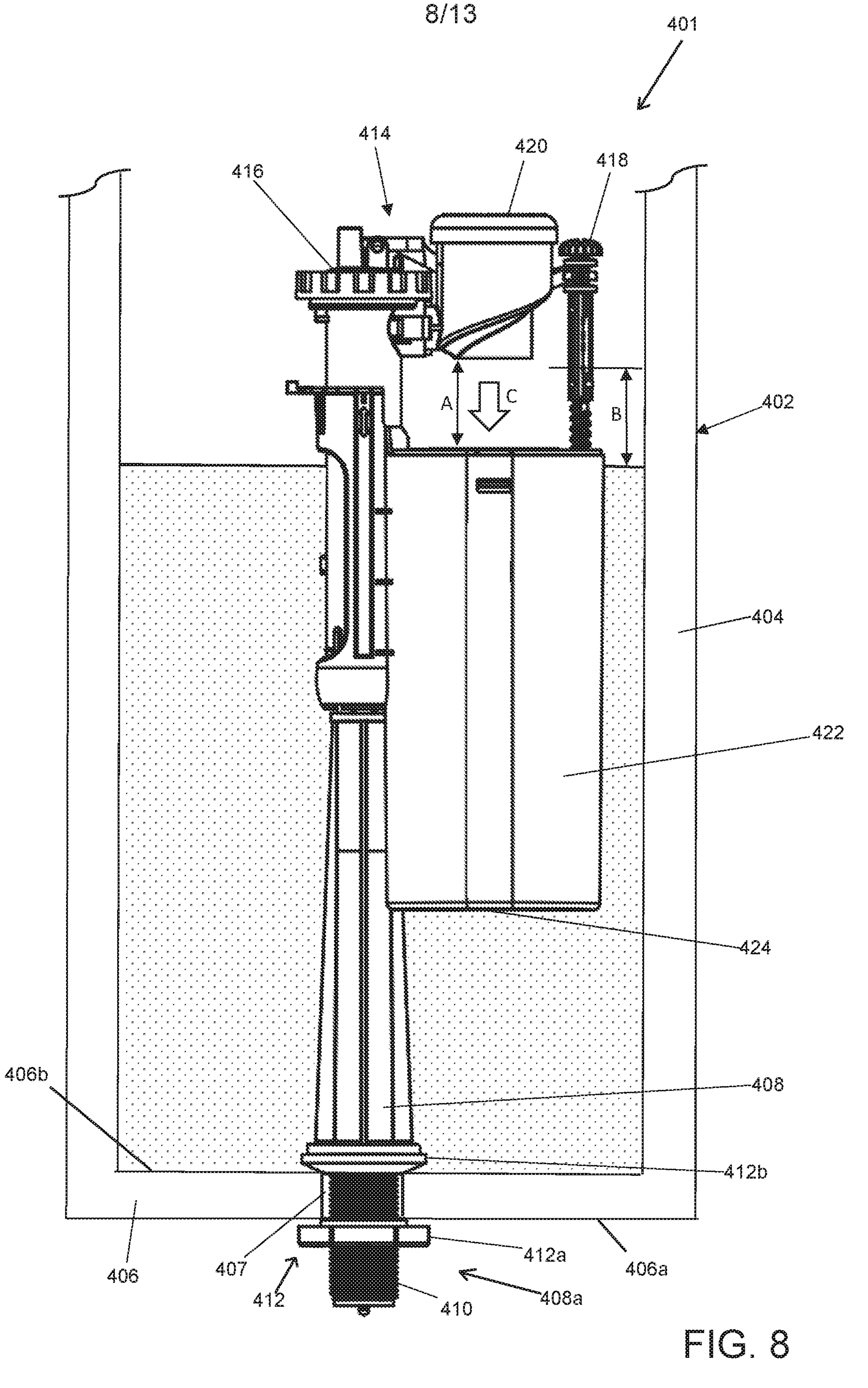
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FIG. 8

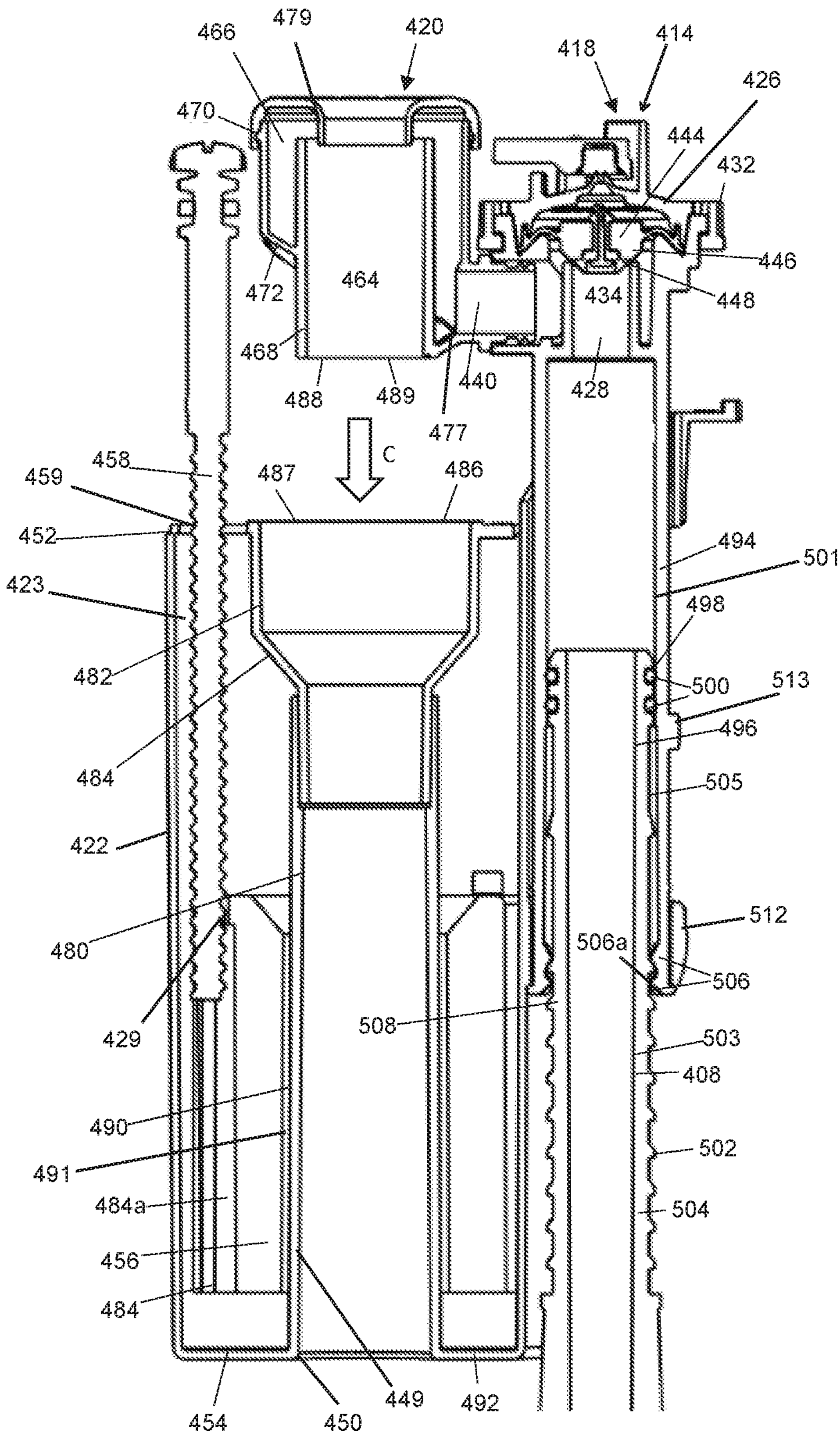
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FIG. 9

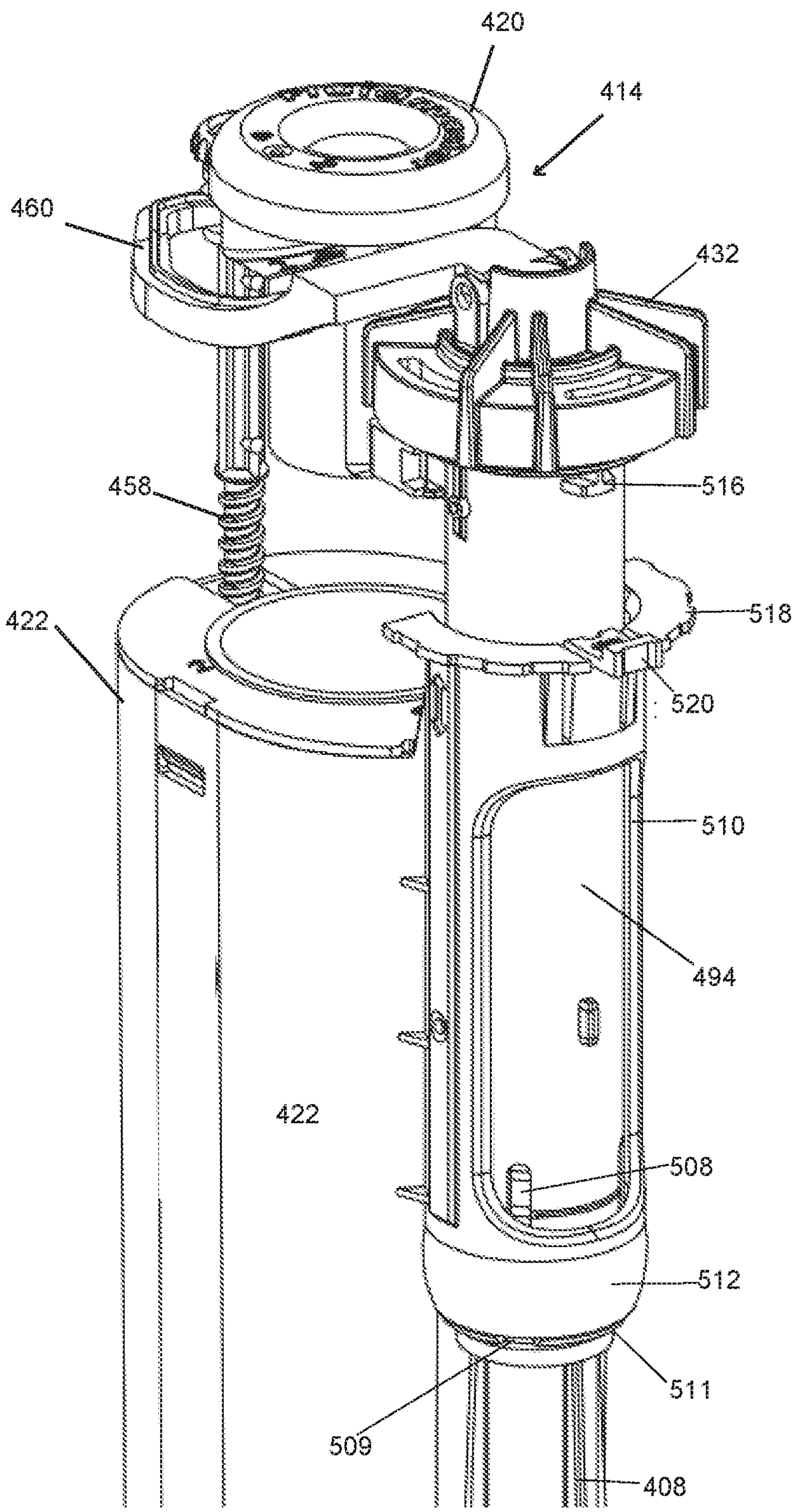
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FIG. 10

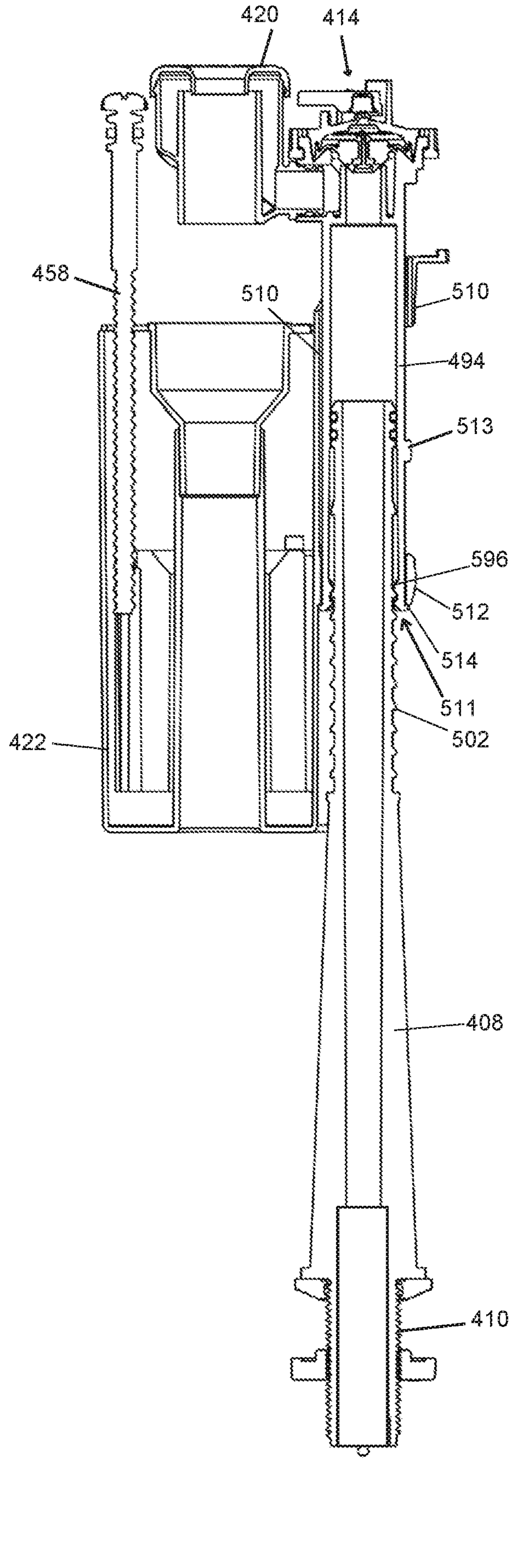

FIG. 11

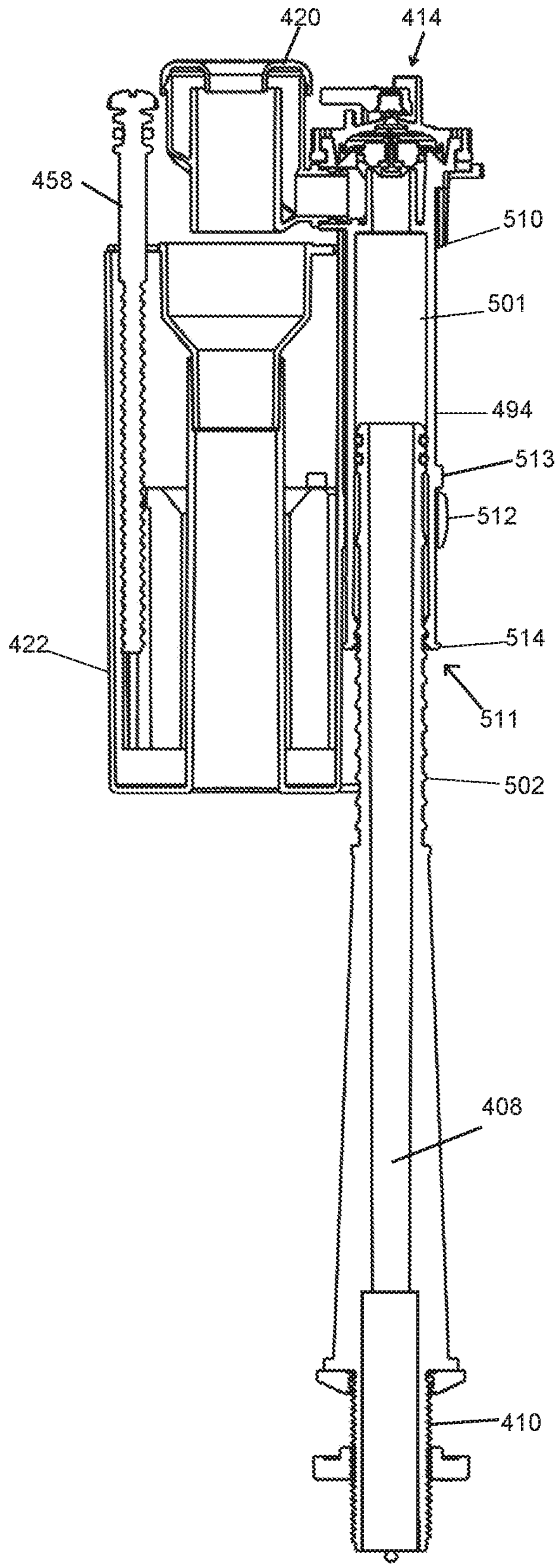

FIG. 12

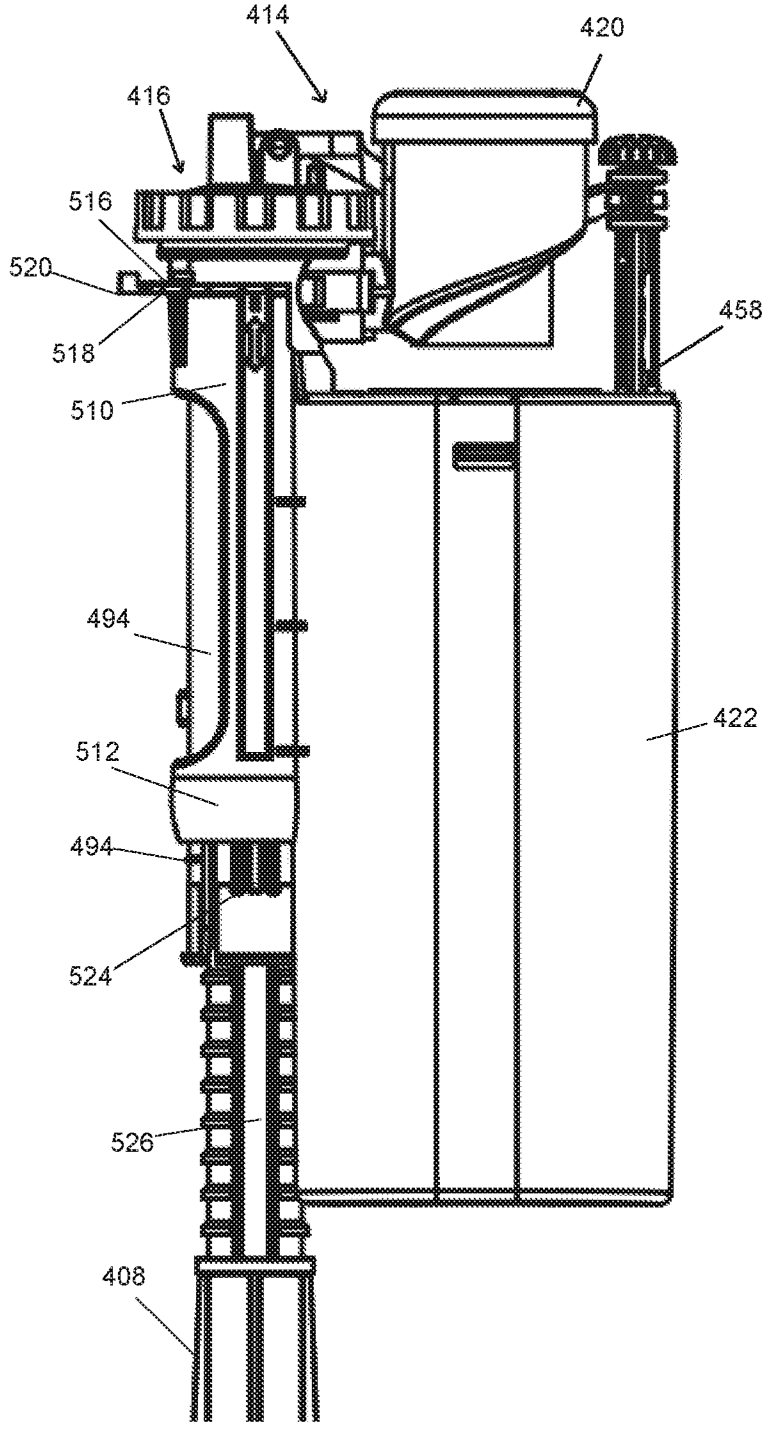

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/033137

A. CLASSIFICATION OF SUBJECT MATTER

E03D 1/33(2006.01)i, E03D 1/32(2006.01)i

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)
E03D 1/33; E03D 1/35; F16K 21/18; F16K 27/12; F16K 31/18; F16K 31/22; F16K 31/26; F16K 31/385; E03D 1/32

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:
fluid valve assembly, filling tube, air gap, valve actuating assembly, float, float shroud

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0083902 A1 (FUKUZAWA et al.) 02 April 2009 See paragraphs [0058]-[0076]; and figures 2, 5-6, 10-13.	1-5,8-15,17-20
Y		6-7,16
Y	US 6003541 A (NICHOLS-ROY, DAVID) 21 December 1999 See column 7, lines 44-50; and figures 2-3.	6-7
Y	US 2003-0230345 A1 (WEY, PAUL) 18 December 2003 See paragraph [0027]; and figures 6-7.	16
A	US 5439025 A (JOHNSON, DWIGHT N.) 08 August 1995 See claims 1-2; and figure 5.	1-20
A	EP 2639484 A1 (LI, FEIYU) 18 September 2013 See paragraphs [0046]-[0059]; and figure 3.	1-20

☐ 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
"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
26 August 2019 (26.08.2019)	**27 August 2019 (27.08.2019)**

Name and mailing address of the ISA/KR	Authorized officer
International Application Division Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea	LEE, Dal Kyong
Facsimile No. +82-42-481-8578	Telephone No. +82-42-481-8440

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2019/033137

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009-0083902 A1	02/04/2009	CN 101397810 A	01/04/2009
		CN 101397810 B	02/01/2013
		JP 2009-097327 A	07/05/2009
		US 8166997 B2	01/05/2012
US 6003541 A	21/12/1999	AT 232932 T	15/03/2003
		AU 4646497 A	24/04/1998
		AU 730741 B2	15/03/2001
		CA 2266952 A1	09/04/1998
		CA 2266952 C	11/01/2005
		EP 0929722 A1	21/07/1999
		EP 0929722 B1	19/02/2003
		JP 2001-507415 A	05/06/2001
		JP 3655318 B2	02/06/2005
		US 5715859 A	10/02/1998
		US 5836346 A	17/11/1998
		US 5975125 A	02/11/1999
		US 6142174 A	07/11/2000
		WO 98-14669 A1	09/04/1998
US 2003-0230345 A1	18/12/2003	AT 312980 T	15/12/2005
		DK 1371787 T3	24/04/2006
		EP 1371787 A2	17/12/2003
		EP 1371787 A3	21/01/2004
		EP 1371787 B1	14/12/2005
		ES 2254899 T3	16/06/2006
		US 6755209 B2	29/06/2004
US 5439025 A	08/08/1995	US 5255703 A	26/10/1993
		US 5337781 A	16/08/1994
		US 5421361 A	06/06/1995
EP 2639484 A1	18/09/2013	AU 2011-328736 A1	13/06/2013
		AU 2011-328736 B2	14/06/2018
		CN 102466045 A	23/05/2012
		CN 102466045 B	06/11/2013
		EP 2639484 A4	11/10/2017
		JP 2013-545945 A	26/12/2013
		JP 6002878 B2	05/10/2016
		US 2013-0228238 A1	05/09/2013
		US 9422699 B2	23/08/2016
		WO 2012-062189 A1	18/05/2012