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(54) **Title:** DRAIN CLEANING AND MAINTENANCE SYSTEM AND METHOD

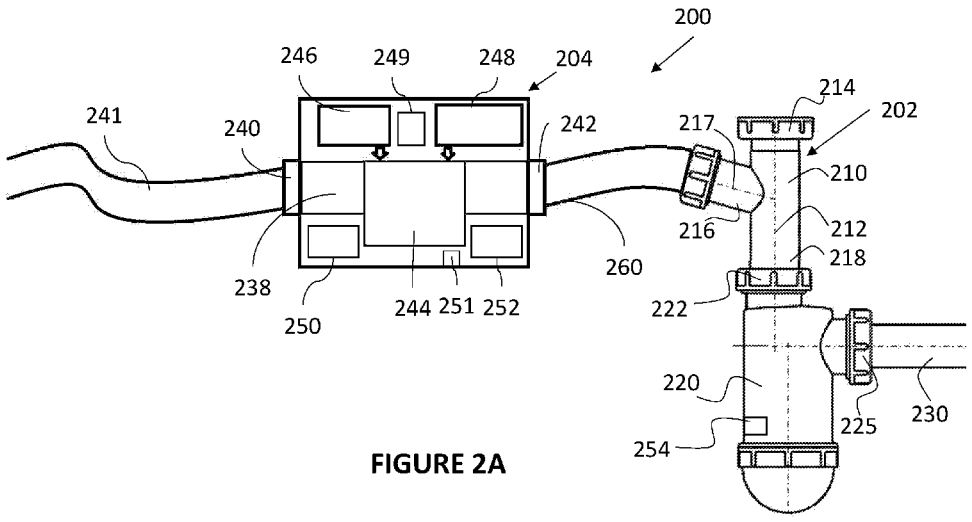


FIGURE 2A

(57) **Abstract:** A drain cleaning and maintenance system, including a drain trap, having a first inlet in fluid communication with a drain of a plumbing fixture, a second inlet in fluid communication with the drain trap and a cleaning and maintenance assembly. The assembly includes a maintenance-assembly inlet in fluid communication with a source of pressurized liquid, and a maintenance-assembly outlet in fluid communication with the second inlet. An electronic valve has an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet. An electronic controller is adapted to transition the electronic valve between the open state and the closed state, to allow liquid flow from the source to the drain trap via the second inlet.

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DRAIN CLEANING AND MAINTENANCE SYSTEM AND METHOD

FIELD AND BACKGROUND OF THE INVENTION

The present invention generally relates to drain systems, and specifically to systems and methods for maintenance and cleaning of drain systems from debris, biofilm formation, and/or bacterial or fungal growth within the drain system.

In typical plumbing, a drain trap, also known as a siphon, is disposed below or within a plumbing fixture, and is shaped and configured to prevent sewer gases from entering buildings. Typically, the drain trap is formed as a U-shaped bend in the drain pipe. Due to its shape, a typical drain trap retains a small amount of liquid therein at all times, and particularly after use of the plumbing fixture. This trapped liquid seals the remainder of the drain pipe leading to the sewage, thereby preventing sewer gases from reentering the environment via back-flow through the drain pipe. Essentially all plumbing fixtures, including sinks, bathtubs, and toilets, are equipped with either an internal or external trap.

Prior art Figures 1A and 1B show an exemplary conventional drain pipe connector **100**, which connects a drain portal **102** disposed in a plumbing fixture **103** such as a sink or bathtub to a drain pipe **104** leading to the sewage. Drain pipe connector **100** includes a first connector ring **105** connecting drain portal **102** to a U-shaped drain trap **106**, and a second connector ring **108**, connecting the trap **108** drain pipe **104**.

Because drain traps are a local low-point in the plumbing, heavy objects, such as jewelry that is inadvertently dropped into the fixture **103**, as well as hair, sand, and other debris, tend to be collected in drain traps, such as trap **106**. This limits the size of objects that flow through the trap into pipe **104**. As such, typical drain traps are designed such that they can be disassembled for removal of objects captured therein, or have another cleaning mechanism.

In addition to capturing debris and objects that inadvertently enter the plumbing, drain traps and drain pipe connectors also encourage the formation of biofilm and the accumulation of bacteria. This is, in part, the result of use of tap water which is not sterile, and due to the fact that sinks are used to wash contaminated objects, for example when people wash their hands after going to the bathroom, or wash dirty dishes. Such formation

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of bacteria or biofilm is illustrated in Figures 1A and 1B as layer **110** disposed at the lower end of trap **106**, where the trap bends.

As seen in Figure 1A, bacteria from the trap **106** may "climb" up the drain pipe, for example by air flow out of the drain trap via the drain portal **102**, as indicated by arrow **120**. Such backflow of bacteria may contaminate the fixture **103** drained by drain portal **102**, and may also contaminate the air, or open space, of the room in which the plumbing fixture **103** is disposed.

The problem of bacteria backflow is further compounded by the fact that water draining from the fixture, via drain portal **102** and into trap **106**, impinges upon the biofilm **110** formed in the trap **106**, as indicated by arrow **130** in Figure 1B. The water impinging on the biofilm causes contaminated aerosol from the biofilm **110** to be released into the air in the trap **106**, facilitating backflow of such aerosol out of trap **106** via drain portal **102** and into the fixture **103** and the room in which it is disposed, as indicated by arrow **122** in Figure 1B.

Various mechanisms have been proposed in the prior art for removing the bacteria or dirt from the drain trap. According to some methods, clean water, which may include a sterilizing, antibacterial or antifungal substance, is poured down the drain portal (e.g. **102** in Fig. 1A) into the trap, in an attempt to remove at least part of the bacteria growth or dirt. However, the water pressure of water flowing from the drain portal is relatively low, and the direction of flow is such, that the sterilizing water does not impinge directly on the bacteria growth or dirt to break it up. Additionally, the flow of sterilizing water or liquid may be insufficient to replace all the liquid within the trap, leaving stagnant liquid in the trap to develop new, or additional, bacteria growth.

Prior art Figure 1C shows another exemplary solution that has been proposed, in which water from a drain hose **150** of a water based appliance, such as a dishwasher **152**, is fed into the drain pipe **154** upstream of drain trap **106**. In some cases, the appliance may have a second drain hose **156**, connected directly to the sewage. In this arrangement, liquid from the appliance reaches the drain trap, and theoretically could rinse, or remove, the dirt or bacteria growth from the drain trap. However, the problems mentioned above occur in this case as well – the pressure of the liquid from the appliance is low, so that the liquid

does not impinge directly on the dirt layer to break it up, and may be insufficient to replace al the liquid within the trap.

There is thus a need in the art for a system for draining a plumbing fixture, which prevents formation of a dirt layer or bacteria growth on a drain trap of the plumbing fixture, and is capable of removing or cleaning a dirt layer or bacteria growth already formed.

SUMMARY OF THE INVENTION

In accordance with an embodiment of the present invention, there is provided a drain cleaning and maintenance system, including a drain trap, having a first inlet in fluid communication with a drain of a plumbing fixture, a second inlet, in fluid communication with the drain trap; and a cleaning and maintenance assembly, disposed on an inlet line leading to the second inlet. The cleaning and maintenance assembly includes a maintenance-assembly inlet, adapted to be in fluid communication with a source of pressurized liquid, a maintenance-assembly outlet in fluid communication with the second inlet, and a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet. An electronic valve has an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet. An electronic controller is adapted to transition the electronic valve between the open state and the closed state, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, liquid flows from the source to the drain trap via the second inlet.

In accordance with another embodiment of the present invention, there is provided a drain device, including a drain trap, having a first inlet, adapted to be in fluid communication with a drain of a plumbing fixture and a second inlet and a cleaning and maintenance assembly, integrally formed with the drain trap. The cleaning and maintenance assembly includes a maintenance-assembly inlet, adapted to be in fluid communication to a source of pressurized liquid, a maintenance-assembly outlet in fluid communication with the second inlet, and a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet. An electronic valve having an open

state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet. An electronic controller is adapted to transition the electronic valve between the open state and the closed state, and a power source adapted to power the electronic valve and the electronic controller, wherein, when the maintenance-assembly inlet is in fluid communication to the source of pressurized fluid and the electronic valve is in the open state, liquid flows from the source to the drain trap via the second inlet to clean the drain trap.

In accordance with another embodiment of the present invention, there is provided a method of cleaning and maintaining a drain trap of a drain, the drain trap having first inlet. The method includes providing a cleaning and maintenance assembly, which includes a maintenance-assembly inlet, a maintenance-assembly outlet, a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet, a electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet, and an electronic controller adapted to transition the electronic valve between the open state and the closed state. The method further includes connecting the maintenance-assembly outlet of the cleaning and maintenance assembly to a second inlet in fluid communication with the drain trap, and while the electronic valve is in the closed state, connecting the maintenance-assembly inlet of the maintenance assembly to a source of pressurized liquid. The method also incudes, using the electronic controller, transitioning the electronic valve from the closed state to the open state, thereby to enable liquid from the source to flow through the pipe and the second inlet into the drain trap and to impinge on interior walls of the drain trap to clean the walls of the drain trap.

BRIEF DESCRIPTION OF THE FIGURES

The foregoing discussion will be understood more readily from the following detailed description of the invention, when taken in conjunction with the accompanying Figures (1-12), in which:

Figures 1A, 1B, and 1C (PRIOR ART) are schematic illustrations of prior art drain pipe connectors, including a drain trap;

Figures 2A, and 2B are schematic illustrations of a drain cleaning and maintenance system according to embodiments of the present invention;

Figure 3 is a schematic illustration of another drain cleaning and maintenance system according to embodiments of the present invention;

Figure 4 is a schematic illustration of an integrally-formed drain cleaning and maintenance system according to embodiments of the present invention;

Figure 5 is a schematic illustration of another integrally-formed drain cleaning and maintenance system according to embodiments of the present invention;

Figures 6A, 6B, 6C, 6D, 6E, 6F, and 6G are, respectively, an exploded perspective view illustration, an assembled perspective view illustration, a partly assembled view perspective illustration, a side view planar illustration, a front view planar illustration, and two cross-sectional illustrations of another integrally-formed drain cleaning and maintenance system according to embodiments of the present invention;

Figures 6H and 6I are a side view planar illustration and a cross-sectional illustration of the integrally formed drain cleaning and maintenance system of Figures 6A to 6G, including a unidirectional valve at a drain outlet leading into the system;

Figures 7A, 7B, 7C, 7D, 7E and 7F are, respectively, an exploded perspective view illustration, two partially assembled perspective view illustrations, an assembled perspective view illustration, a side view planar illustration, and a cross-sectional illustration of another integrally-formed drain cleaning and maintenance system according to embodiments of the present invention;

Figure 8 is a schematic illustration of yet another drain cleaning and maintenance system according to embodiments of the present invention;

Figure 9 is a schematic illustration of a further drain cleaning and maintenance system according to embodiments of the present invention;

Figures 10A, 10B, 10C, and 10D are, respectively, a front view planar illustration and three sectional illustrations of a nozzle for connecting a drain cleaning and maintenance assembly of any one of Figures 2A to 9 to a drain assembly;

Figures 11A and 11B are, schematic sectional illustrations of another nozzle for connecting a drain cleaning and maintenance assembly of any one of Figures 2A to 9 to a drain assembly, in a rest state and in a flow state;

Figures 12A, 12B, and 12C are schematic illustrations of embodiments of connections of any of the cleaning and maintenance assemblies of Figures 2A to 9 to a drain assembly using different nozzles as in Figures 10A to 11B, according to embodiments of the present invention; and

Figure 13 is a schematic flow chart of a method of installing the cleaning and maintenance system of any one of Figures 2A to 9 according to embodiments of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles of the inventive systems and methods for maintenance and cleaning of drain systems, may be better understood with reference to the drawings and the accompanying description.

Before explaining at least one embodiment of the invention 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 the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

In the context of the present application and claims, the term “downstream” relates to a pipe or element, which would be reached by a liquid passing through the drain, at a later time. As such, pipe segment A is downstream of pipe segment B if water draining through the plumbing system would reach pipe segment A after passing through pipe segment B.

In the context of the present application and claims, the term “upstream” relates to a pipe or element, which would be reached by a liquid passing through the drain, at an earlier time. As such, pipe segment A is upstream of pipe segment B if water draining

through the plumbing system would reach pipe segment A before passing through pipe segment B.

In the context of the present application and claims, the term "drain trap" relates to any device connecting between a drain and a sewage pipe, which retains liquid therein. The term "drain trap" includes, for example, a U-trap, a P-trap, a Q-trap, an S-trap a gully trap, a floor trap or nahni trap, a bottle trap, a siphon, and an intercepting trap.

In the context of the present application and claims, the term "pressurized liquid" relates to a liquid having a pressure of at least 2 bar.

In some embodiments, the present invention provides a solution to the formation of a dirt layer and/or bacterial or fungal growth in a drain trap or siphon.

In some embodiments, the present invention includes an electronically controllable valve which controls flow of water or another liquid from a high-pressure source directly into a drain pipe connector or directly into a drain trap, downstream of the drain, for cleaning of the drain trap and for replacing all the liquid held within the drain trap. For example, the control may be by a computerized controller.

Reference is now made to Figures 2A and 2B, which are schematic illustrations of an electronically-operated drain cleaning and maintenance system **200** according to embodiments of the present invention.

As seen in Figures 2A and 2B, drain cleaning and maintenance system **200** includes a drain assembly **202**, and a cleaning and maintenance assembly **204**.

Drain assembly **202** includes a linear pipe segment **210** having a longitudinal axis **212**. An inlet-end **214** of linear pipe segment **210** is adapted to be connected to a drain portal of a plumbing fixture, such as a sink. Linear pipe segment **210** includes a second inlet **216**, the second inlet having a longitudinal axis **217** angled relative to longitudinal axis **212**, such that, when fluid flows from second inlet **216** into linear pipe segment **210**, the fluid will turn at an obtuse angle α. The angle at which liquid flows from second inlet **216** into linear pipe segment **210** ensures that the fluid flowing through the second inlet impinges on walls of the linear pipe segment, and/or on walls of additional components of drain assembly **202** downstream of second inlet **216**, for cleaning thereof.

An outlet-end **218** of linear pipe segment **210**, downstream of second inlet **216**, is connected to a drain trap, or siphon, **220** via a first connector **222**. Drain trap **220** is

connected to a sewage drain pipe **230** via a second connector **225**. In some embodiment, first connector **222** and/or second connector **225** may be drain trap nuts as commonly used in the art of plumbing. However, any other suitable connection mechanism is considered to be within the scope of the present invention.

Cleaning and maintenance assembly **204** includes a pipe **238** having a maintenance-assembly inlet **240**, adapted to be connected, via a maintenance inlet pipe **241**, to the water mains or to another source of water flowing at a high pressure, and a maintenance-assembly outlet **242** connected or connectable to second inlet **216** of the drain assembly **202**. The source of water flowing at a high pressure has an absolute pressure of at least 2 bar, and in some embodiments has an absolute pressure in the range of 3 to 5 bar.

Cleaning and maintenance assembly **204** further includes an electronic valve **244**, having an open operative state in which liquid can flow through pipe **238** between maintenance-assembly inlet **240** and maintenance-assembly outlet **242**, and a closed operative state in which fluid flow through pipe **238**, e.g. from maintenance-assembly inlet **240** to maintenance-assembly outlet **242**, is blocked. An electronic controller **246** is adapted to control transitioning of electronic valve **244** between the open and closed operative states. A power source **248**, such as one or more suitable batteries, are adapted to power electronic valve **244** and electronic controller **246**.

In the embodiment shown in Figure 2A, the maintenance-assembly outlet **242** of cleaning and maintenance assembly **204** is connected to second inlet **216** of drain assembly **202** by a pipe **260**.

In the embodiment shown in Figure 2B, the maintenance-assembly outlet **242** of cleaning and maintenance assembly **204** is connected directly to second inlet **216** of drain assembly **202**, without requiring an intervening pipe.

It is a particular feature of the present invention that maintenance inlet pipe **241** may be connected to a split portion of a hose or pipe leading to the plumbing fixture, as explained in further detail hereinbelow. However, as explained hereinbelow, cleaning and maintenance assembly **204** ensures that liquid flowing out of maintenance-assembly outlet **242** retains the water pressure present in that hose or pipe, as opposed to water flowing into the drain through the plumbing fixture, in which the water pressure is greatly reduced. For example, the dimensions of pipe **238**, maintenance inlet pipe **241**, and, where relevant, pipe

260, may be selected to maintain the fluid pressure within pipe **238** substantially equal to the pressure emanating from the water mains or from the source of the liquid. As such, pipes **238**, **241** and **260** may have similar diameters, and/or may be substantially linear to avoid significant loss of pressure by the liquid following curves and turns. In other embodiments, the dimensions of pipe **238**, maintenance inlet pipe **241**, and, where relevant, pipe **260**, may be selected to increase the fluid pressure within pipe **238** relative to the pressure emanating from the water mains or from the source of the liquid, for example by using pipes having decreasing diameters, and the like.

In some embodiments, cleaning and maintenance assembly **204** may further include, or be associated with, a communication interface **250**, such as a transceiver, for communication with a remote control unit, or with a device of a controlling operator. In such embodiments, electronic controller **246** may receive control inputs from the remote control unit, via communication interface. For example, electronic controller **246** may receive a control input to transition electronic valve **244** to the open state at a specific time of day, or after a specific event. In some embodiments, the remote control unit may be part of a "smart house" control module, for example operable by a user via a suitable application running on a computing device, such as a mobile phone.

As another example, electronic controller **246** may send output messages, via communication interface **250**, to the remote control unit or to the device of the controlling operator. For example, electronic controller **246** may provide periodic maintenance reminders (e.g. replace battery, clean or replace filters or valves) or may provide indications when the system malfunctions. In some such embodiments, cleaning and maintenance assembly **204** may further include on or more sensors **251** adapted to sense conditions in the vicinity of assembly **204**, to identify whether it is operating correctly. For example, assembly **204** may include an audio sensor adapted to sense sounds made by the flow of water through pipe **238**, and the electronic controller is adapted to provide a malfunction notification when the electronic controller transitions electronic valve **244** to be open, but sensor **251** does not provide to the electronic controller a signal indicating that it senses the sound of water flowing through pipe **238**.

In some embodiments, electronic controller **246** may be programmable. For example, the electronic controller may be programmed to transition electronic valve **244**

to the open state at a first set of specific times of day, and to transition electronic valve **244** back to the closed state a predetermined duration after each of the specific times of day. In some such embodiments, electronic controller **246** may further be associated with a clock or timer **249**.

In some such embodiments, programming of electronic controller **246** may be accomplished from the remote control unit, communicating the programmed times of day and duration to electronic controller **246** via transceiver **250**. In other embodiments, programming of electronic controller **246** may be accomplished directly, for example via a user interface **252** forming part of maintenance assembly **204** and functionally associated with electronic controller **246**. User interface **252** may include one or more input interfaces, such as a keyboard, touch pad, mouse, or suitable buttons. User interface **252** may further include one or more output interfaces, such as a screen or display, or an audio output such as a speaker.

In some embodiments, electronic controller **246** may be functionally associated with, or may receive input from, one or more sensors **254**. The sensor(s) **254** may be disposed within drain assembly **202** and may provide input indicative of the need for maintenance and/or cleaning of siphon **220**, such as input indicating the formation of biofilm within the siphon.

A user would install cleaning and maintenance assembly **204** by initially ensuring that the power source **248** is charged. The user would then connect maintenance inlet pipe **241** between maintenance-assembly inlet **240** and the water mains or other source of liquid at a high pressure, and connect maintenance-assembly outlet **242** to second inlet **216** of the linear pipe segment **210**, either directly or using intervening pipe **260**. If the user is retrofitting a drain in which the linear drain pipe does not have a second inlet, prior to installing the cleaning and maintenance assembly **204**, the user may also replace the existing linear drain pipe with linear drain pipe **210** having the second inlet **216**.

In some embodiments, the user could program electronic controller **246** to operate at desired times, or send an activation signal to electronic controller **246** from a remote control unit, such as a suitable application on the user's mobile phone.

In other embodiments, the electronic controller **246** may be preprogrammed to transition the electronic valve **244** to the open state at specific times and for specific

durations. In such embodiments, no additional programming is required, and once installed, the cleaning and maintenance assembly would operate automatically without the user needing to remember to activate the cleaning and maintenance assembly, or that maintenance/cleaning is required.

In some embodiments, when liquid flows through pipe **238** from maintenance-assembly inlet **240** to maintenance-assembly outlet **242**, the absolute pressure at maintenance-assembly outlet **242** is at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, or at least 95% of the absolute pressure at maintenance-assembly inlet **240**. In some embodiments, cleaning and maintenance assembly **204** is devoid of a pumping mechanism pumping liquid toward maintenance-assembly outlet **242**, or of another mechanism for increasing the absolute pressure of water within cleaning and maintenance assembly **204**, after the liquid has entered maintenance-assembly inlet **240**. In some embodiments, the only volume of cleaning and maintenance assembly **204** suitable for water flow therethrough is the volume of pipe **238**.

Reference is now made to Figure 3, which is a schematic illustration of another electronically-operated drain cleaning and maintenance system **300** according to an embodiment of the present invention. System **300** is substantially similar to system **200** described hereinabove with respect to Figures 2A and 2B. The main change between the two systems is that in Figure 3, siphon **320** of drain assembly **302** includes second inlet **316**, such that cleaning and maintenance assembly **204** is connected directly to siphon **320**. A longitudinal axis **317** of second inlet **316** is disposed at an angle to a longitudinal axis **321** of siphon **320**, and to water flow through the siphon. In the embodiment of Figure 3, the linear pipe segment (**210** in Figures 2A and 2B) may be obviated, or may be replaced by a linear pipe segment that does not include a second inlet.

In the embodiments shown in Figure 3, maintenance-assembly outlet **242** of maintenance assembly **204** is connected to second inlet **316** of siphon **320** by pipe **260**. However, it is to be appreciated that cleaning and maintenance assembly **204** may be connected to second inlet **316** directly, substantially as shown in Figure 2B.

The angle at which water flows into siphon **320** from second inlet **316** ensures that the fluid flowing through the second inlet impinges on walls of the siphon for cleaning thereof.

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The components and functionalities of cleaning and maintenance assembly **204** of Figure 3 are substantially identical to those shown in Figures 2A and 2B, and for brevity, their detailed description is not repeated herein. Similarly, cleaning and maintenance assembly **204** of Figure 3 is designed to at least maintain, and in some embodiments also increase, the water pressure of water flowing through the cleaning maintenance assembly, and to allow the water to impinge directly on walls of the siphon for cleaning thereof, substantially as described hereinabove.

When installing cleaning and maintenance assembly **204** in system **300**, the user would ensure power supply and connect maintenance inlet pipe **241** substantially as described hereinabove with respect to Figures 2A and 2B. The user would connect maintenance-assembly outlet **242** of maintenance assembly **204** to second inlet **316** of siphon **320**, either directly or using intervening pipe **260**. If the user is retrofitting a drain in which the siphon does not have a second inlet, prior to installing the cleaning and maintenance assembly **204**, the user may also replace the existing siphon with siphon **320** having the second inlet **316**. Programming of cleaning and maintenance assembly **204** would be substantially as described hereinabove with respect to Figures 2A and 2B.

As described hereinabove with respect to Figures 2A and 2B, the drain cleaning and maintenance assembly of Figure 3 may be pre-programmed, and may operated automatically at regular times or intervals, without requiring the user attention for cleaning and maintenance of the drain.

Reference is now made to Figure 4, which is a schematic illustration of yet another electronically-operated drain cleaning and maintenance system **400** according to an embodiment of the present invention. System **400** is substantially similar to system **300** described hereinabove with respect to Figure 3. The main change between the two systems is that in Figure 4, cleaning and maintenance assembly **404** is integrally formed with siphon **420** as a single unit, such that water flowing through pipe **438** of cleaning and maintenance assembly **404** flows directly into siphon **420**, e.g. through a wall thereof. In some embodiments, siphon **420** including cleaning and maintenance assembly **404** may be manufactured as a single unit, e.g. having a unitary plastic housing. In such embodiments, the linear pipe segment (**210** in Figures 2A and 2B) may be obviated, or may be replaced by a linear pipe segment that does not include a second inlet.

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The components and functionalities of cleaning and maintenance assembly **404** of Figure 4 are substantially identical to those shown in Figures 2A and 2B, and for brevity, their detailed description is not repeated herein. Cleaning and maintenance assembly **404** of Figure 4 is designed to at least maintain, and in some embodiments also increase, the water pressure of water flowing through the cleaning and maintenance assembly, and to allow the water to impinge on walls of the siphon for cleaning thereof, substantially as described hereinabove with respect to Figures 2A and 2B and to Figure 3.

When installing cleaning and maintenance assembly **404** in system **400**, the user would replace the existing siphon with siphon **420** including cleaning and maintenance assembly **404**. The user would ensure power supply to components of the cleaning and maintenance assembly, and would and connect pipe **441** substantially as described hereinabove with respect to Figures 2A and 2B. Programming of cleaning and maintenance assembly **404** would be substantially as described hereinabove with respect to Figures 2A and 2B.

As described hereinabove with respect to Figures 2A and 2B, the cleaning and maintenance assembly of Figure 4 may be pre-programmed, and may operated automatically at regular times or intervals, without requiring the user attention for cleaning and maintenance of the drain.

Reference is now made to Figure 5, which is a schematic illustration of another integrally-formed electronically-operated drain cleaning and maintenance system **500** according to an embodiment of the present invention.

System **500** is substantially similar to system **400** described hereinabove with respect to Figure 4. The main change between the two systems is in the structure of the drain assembly.

Specifically, drain assembly **502** of system **500** includes a linear pipe segment **510**, slidably disposed within siphon **520**, which is connected to, or integrally formed with, a sewage drain pipe **530**.

Siphon **520** is a unitarily formed element, including a downward flow path **522** and an upward flow path **524**, separated by a wall **526**. Downward flow path **522** is in fluid communication with upward flow path **524** via a removable drain trap cap **528**, sealingly

arranged about a lower end of drain trap **520**. Sewage drain pipe **530** is in fluid communication with upward flow path **524**.

Linear pipe segment **510** is disposed within downward flow path **522**. However, a diameter of linear pipe segment **510** (indicated by D1) is smaller than a diameter of downward flow path **522** (indicated by D2), such that fluid can flow from linear pipe segment **510** to the entire length of downward flow path **522**.

Linear pipe segment **510** is adapted to be connected to a drain portal **503** of a plumbing fixture, such as a sink, via a unidirectional valve **540**.

Because drain trap **520** is integrally formed with sewage drain pipe **530**, in some embodiments, the height at which drain trap **520** is installed, relative to portal **503**, may be determined by a height of the center of sewage drain pipe **530**. As such, the installation conditions may require a longer linear pipe segment **510** to bridge the gap between the heights of the portal and of the sewage pipe. To facilitate different size gaps, linear pipe segment **510** is slidable relative to downward flow path **522** of drain trap **520**. Additionally, in some embodiments, linear pipe segments **510** may have different longitudinal lengths. The length of linear pipe **510**, and the extent to which it is disposed within trap **520**, are determined once at the time of installation. It is required that the end of linear pipe **510**, distal to portal **503**, be disposed above the water level within the drain trap, and approximately at the vertical center of sewage drain pipe **530**, to ensure that the linear pipe segment is in fluid communication with the pressure equalizing mechanism described hereinbelow.

Unidirectional valve **540** allows running water to flow, and seals the passage between the drain trap and the fixture when no water is flowing. The unidirectional valve is normally closed, such that when no water flows into/onto the unidirectional valve, the unidirectional valve is sealed to fluid flow into and/or out of drain trap **520** and linear pipe segment **510**, thereby preventing back flow of bacterial and/or contaminated aerosol from pipe **510** into the plumbing fixture. As such, the unidirectional valve **540** is normally closed.

When water flows into unidirectional valve **540**, it applies pressure thereto which causes the unidirectional valve to open. As such, when water drains through the portal of the plumbing fixture and into unidirectional valve **540**, the weight of the water causes the

unidirectional valve to open a gap through which the water can flow into linear pipe segment **510**. While water is draining through the gap, the water flow inhibits air flow through the gap in the opposing direction (out of linear pipe segment **510**) and as such during that time back flow of contaminated aerosol and/or bacteria is very limited and/or inhibited.

The increased pressure in linear pipe segment **510**, caused by the use of the unidirectional valve **540** is relieved by a pressure equalizing element **550**. Pressure equalizing element **550** comprises a tube, or conduit, which in some embodiments may be integrally formed with drain trap **520**, and is in fluid communication with downward flow path **522** via a first end thereof which extends from a bore **527** in an upper portion of wall **526**, above a water level in drain trap **520**. Because of the fluid flow communication between the linear pipe segment **510** and downward flow path **522**, pressure equalizing element **550** is also in fluid communication with linear pipe segment **510**. In some embodiments, a second unidirectional valve **552** is disposed within pressure equalizing element **550**, adjacent bore **527**, to prevent fluid flow from pressure equalizing element **550** to downward flow path **522**. Second unidirectional valve **552** ensures that there will be no back flow of gas from the sewage to downward flow path **522**, for example if pressure in the upward flow path **524** increases (e.g. because of a blockage in the sewage).

In some embodiments, pressure equalizing element **550** is in fluid communication with upward flow path **524**, downstream of second unidirectional valve **552**, via a pathway **554** in the conduit of pressure equalizing element **550**. As such pressure equalizing element **550** is in fluid communication with sewage drain pipe **530**. In some embodiments, a second end of pressure equalizing element **550** is sealed by a cap **560**, such that fluid flowing from the first end of pressure equalizing element toward the second end, can exit the pressure equalizing element via pathway **554**.

In use, when gas pressure accumulates in downward flow path **522** above a water level **568** of drain trap **520**, the pressurized gas flows into pressure equalizing element **550** via second unidirectional valve **552** and flows toward the second end of the pressure equalizing element. Because the second end of the pressure equalizing element is sealed by cap **560**, the pressurized gas flows through pathway **554** to upward flow path **524**, and from there can flow to sewage drain pipe **530**. As such, pressure equalizing element **550**

serves to equalize the gas pressure between linear pipe segment **510** and downward flow path **524** of drain trap **520**, which is fluidly connected to sewage pipe **530**.

Due to the pressure differential between linear pipe segment **510** and downward flow path **522** (above the water level of trap **520**) and upward flow path **524** of drain trap **520**, gas will flow from bore **527**, through the unidirectional valve **552** into the pressure equalizing element **550** toward the second end thereof, and from there via pathway **554** to upward flow path **524** and to sewage pipe **530**, thereby relieving the pressure and enabling proper functioning of unidirectional valve **540**. Furthermore, because the bacteria and/or contaminated aerosols that the invention is designed to block are disposed within linear pipe segment **510**, the airborne bacteria and/or contaminated aerosol may also flow through pressure equalizing element **550** away from portal **502**, and be trapped downstream of drain trap **520**, thereby further reducing or eliminating the chance of contaminated backflow through portal **502**. Unidirectional valve **552**, and the higher pressure in downward flow path **522**, prevent backflow of gas from sewage pipe **530** to downward flow path **522** or linear pipe segment **510**.

Siphon **520** includes a second inlet **566**, which is disposed at an angle to downward flow path **522**. Maintenance-assembly outlet **242** of cleaning and maintenance assembly **204**, described in detail hereinabove with respect to Figures 2A and 2B, is connected directly to second inlet **566** of siphon **520** for automatic maintenance and cleaning of the siphon, substantially as described hereinabove with respect to Figure 2B. However, in some embodiments, cleaning and maintenance assembly **204** may be connected to siphon **520** by a connecting pipe **260**, as shown in Figure 2A, or may be integrally formed with the siphon as shown in Figure 4.

In some embodiments, sliding of linear pipe segment **510** into downward flow path **522** is limited by second inlet **566** or by a connection of cleaning and maintenance assembly **204** thereto, e.g. by maintenance-assembly outlet **242** or by pipe **260**.

It is to be appreciated that the cleaning and maintenance assembly **204** may be used together with any pressure-equalizing drain trap, for example as described in U.S. Patent Application Publication No. 2021/0388589 which is incorporated by reference as if fully set forth herein.

As described hereinabove with respect to Figures 2A and 2B, the cleaning and maintenance assembly of Figure 5 may be pre-programmed, and may operated automatically at regular times or intervals, without requiring the user attention for cleaning and maintenance of the drain.

Reference is now made to Figures 6A, 6B, 6C, 6D, 6E, 6F, and 6G, which are, respectively, an exploded perspective view illustration, an assembled perspective view illustration, a partly assembled view perspective illustration, a side view planar illustration, a front view planar illustration, and two cross-sectional illustrations of another integrally-formed drain cleaning and maintenance system **600** according to embodiments of the present invention.

System **600** is substantially similar to system **500** described hereinabove with respect to Figure 5. One main difference between the two systems is in the location of the cleaning and maintenance assembly within the system. System **600** includes a siphon **620**, which is connected to, or integrally formed with, a sewage drain pipe **630**, substantially as shown in Fig. 5.

Reference is additionally made to Figures 6H and 6I, which are a side view planar illustration and a cross-sectional illustration of the integrally formed drain cleaning and maintenance system **600** having a drain assembly **602** including a unidirectional valve **640**. Drain assembly **602** includes a linear pipe segment **610**, slidably disposed within siphon **620**, substantially as shown in Fig. 5.

Siphon **620** is a unitarily formed element, including a downward flow path **622** and an upward flow path **624**, separated by a wall **626**. Downward flow path **622** is in fluid communication with upward flow path **624** via a removable drain trap cap **628**, sealingly arranged about a lower end of drain trap **620**. Sewage drain pipe **630** is in fluid communication with upward flow path **624**. Drain cap **628** is described in further detail hereinbelow.

As described hereinabove with respect to Figure 5, linear pipe segment **610** may be adjusted to accommodate for different drain trap heights.

System **600** may include unidirectional valve **640** and a pressure equalizing element **650**, substantially as described hereinabove with respect to Figure 5.

System **600** is distinct from the systems described hereinabove in that the cleaning and maintenance assembly **204** is disposed within cap **628** of the drain trap. Specifically, cap **628** includes a cylindrical portion **660** and a base **670**, the base defining a second inlet **676** at the center thereof. The power source, here shown as batteries **678**, and the electronic controller **246** are disposed within base **670**, and are protected from liquid by a cover **680**.

Electronic valve **244**, which may be a solenoid valve, is disposed within cover **680**, such that maintenance-assembly inlet **240** is disposed within second inlet **676**, and maintenance-assembly outlet **242** is disposed within cylindrical portion **660** of cap **628**. As such, maintenance-assembly inlet **240** of cleaning and maintenance assembly **204** is in fluid communication with a second pipe leading to the source of fluid, via the second inlet **676**. Additionally, when electronic valve **244** is open and permits fluid flow from maintenance-assembly inlet **240** to maintenance-assembly outlet **242**, the fluid flows from the maintenance-assembly outlet directly into the siphon **620**, in a direction oriented toward the drain assembly **602**.

In some embodiments, a pressure increasing tube **690** may extend from maintenance-assembly outlet **242** into siphon **620**. Pressure increasing tube **690** terminates in an orifice **692** having a smaller diameter than maintenance-assembly outlet **242**, thus increasing the pressure of the fluid flowing through the electronic valve (when the valve is open). Additionally, pressure increasing tube **690** ensures that fluid flow through the cleaning and maintenance assembly reaches a high enough portion of the walls of siphon **620** to facilitate cleaning thereof, substantially as described hereinabove. Furthermore, pressure increasing tube **690** may enable the fluid to be released above the water level in the siphon, and can replace the fluid within the siphon.

The components and functionalities of system **600** not explicitly mentioned herein are substantially identical to those shown in Figure 5, and for brevity, their detailed description is not repeated herein. Similarly, the cleaning and maintenance assembly of system **600** is designed to at least maintain, and in some embodiments also increase, the water pressure of water flowing through the maintenance assembly, and to allow the water to impinge on walls of the siphon for cleaning thereof, substantially as described hereinabove.

As described hereinabove with respect to Figures 2A and 2B, the cleaning and maintenance assembly of Figures 6A to 6I may be pre-programmed, and may operated automatically at regular times or intervals, without requiring the user attention for cleaning and maintenance of the drain.

Reference is now made to Figures 7A, 7B, 7C, and 7D, which are, respectively, an exploded perspective view illustration, a partially assembled perspective view illustration, an assembled perspective view illustration, and a cross-sectional illustration of another integrally-formed drain cleaning and maintenance system **700** according to embodiments of the present invention.

System **700** is substantially similar to system **600** described hereinabove with respect to Figures 6A to 6I. The main distinction between the two systems is in the location of the electronic controller and power source of the cleaning and maintenance assembly.

In system **700**, electronic valve **244**, and in some embodiments also pressure increasing tube **690**, are disposed within cap **628** of the siphon **620**, as shown for system **600**. However, electronic controller **246** and power source **248**, which are more sensitive to getting wet, are disposed in a dedicated compartment **702** on the exterior of siphon **620**.

As described hereinabove with respect to Figures 2A and 2B, the cleaning and maintenance assembly of Figures 7A to 7D may be pre-programmed, and may be operated automatically at regular times or intervals, without requiring the user's attention for cleaning and maintenance of the drain.

Turning now to Figure 8, which is a schematic illustration of another electronically-operated drain cleaning and maintenance system **800** according to an embodiment of the present invention. System **800** is substantially similar to system **200** described hereinabove with respect to Figures 2A and 2B. The main change between the two systems is that siphon **220** (of Figures 2A and 2B) has been replaced by a U-shaped drain trap **820** in Figure 8. As a result, the sewage drain pipe **830** of Figure 8 is bent, as compared to the linear sewage drain pipe **230** of Figures 2A and 2B.

The components and functionalities of cleaning and maintenance assembly **204** of Figure 8 are substantially identical to those shown in Figures 2A and 2B, and for brevity, their detailed description is not repeated herein. Similarly, cleaning and maintenance assembly **804** of Figure 8 is designed to at least maintain, and in some embodiments also

increase, the water pressure of water flowing through the maintenance assembly, and to allow the water to impinge on walls of the drain trap for cleaning thereof, substantially as described hereinabove.

Installation and programming of cleaning and maintenance assembly **204** in system **800** would be substantially identical to the installation described hereinabove with respect to Figures 2A and 2B.

As described hereinabove with respect to Figures 2A and 2B, the cleaning and maintenance assembly of Figure 8 may be pre-programmed, and may operated automatically at regular times or intervals, without requiring the user attention for cleaning and maintenance of the drain.

Reference is now made to Figure 9, which is a schematic illustration of a further electronically-operated drain cleaning and maintenance system **900** according to an embodiment of the present invention. System **900** is substantially similar to system **800** described hereinabove with respect to Figure 8. One main difference between the two systems is that in Figure 8, U-shaped drain trap **920** includes second inlet **916**, such that cleaning and maintenance assembly **204** is connected directly to U-shaped drain trap **920**, typically to a linear segment thereof. A longitudinal axis **917** of second inlet **916** is disposed at an angle to a longitudinal axis **921** of the drain trap **920** at the location of connection, and to water flow through the drain trap at that location. In the embodiment of Figure 9, the linear pipe segment (**210** in Figures 2A, 2B, and 8) may be obviated, or may be replaced by a linear pipe segment that does not include a second inlet.

In the embodiments shown in Figure 9, maintenance-assembly outlet **242** of cleaning and maintenance assembly **204** is connected to second inlet **916** of drain trap **920** by pipe **260**. However, it is to be appreciated that cleaning and maintenance assembly **204** may be connected to second inlet **916** directly, substantially as shown in Figure 2B.

The components and functionalities of cleaning and maintenance assembly **204** of Figure 9 are substantially identical to those shown in Figures 2A and 2B, and for brevity, their detailed description is not repeated herein. Similarly, cleaning and maintenance assembly **204** of Figure 9 is designed to at least maintain, and in some embodiments also increase, the water pressure of water flowing through the maintenance assembly, and to

allow the water to impinge on walls of the siphon for cleaning thereof, substantially as described hereinabove.

When installing cleaning and maintenance assembly **204** in system **900**, the user would ensure power supply and connect maintenance inlet pipe **241** substantially as described hereinabove with respect to Figures 2A and 2B. The user would connect maintenance-assembly outlet **242** of maintenance assembly **204** to second inlet **916** of drain trap **920**, either directly or using intervening pipe **260**. If the user is retrofitting a drain in which the drain trap does not have a second inlet, prior to installing the cleaning and maintenance assembly **204**, the user may also replace the existing drain trap with drain trap **920** having the second inlet **916**. Programming of cleaning and maintenance assembly **204** would be substantially as described hereinabove with respect to Figures 2A and 2B.

As described hereinabove with respect to Figures 2A and 2B, the cleaning and maintenance assembly of Figure 9 may be pre-programmed, and may operated automatically at regular times or intervals, without requiring the user attention for cleaning and maintenance of the drain.

Reference is now made to Figures 10A, 10B, 10C, and 10D, which are, respectively, a front view planar illustration and three sectional illustrations of a nozzle **1000** for connecting a drain cleaning and maintenance assembly of any one of Figures 2A to 9 to a drain assembly. Figures 10B, 10C, and 10D are taken along section lines C-C, A-A, and D-D, respectively.

As seen, nozzle **1000** includes a neck portion **1002** and a head portion **1004**, the head portion having a greater diameter than the neck portion. An interior pipe **1006** extends along the interior of neck portion **1002** and head portion **1004**, the pipe having a nozzle inlet at neck portion **1002** and being blocked at head portion **1004**. A first plurality of nozzle outlets **1008** are arranged in a first hemisphere about head portion **1004**, and a second plurality of nozzle outlets **1010** are arranged in a second hemisphere about head portion **1004**, beneath the first hemisphere. In the illustrated embodiment, each nozzle outlet **1010** is disposed between two nozzle outlets **1008**. Each of nozzle outlets **1008** and **1010** is in fluid communication with pipe **1006**.

When nozzle **1000** is disposed within a pipe, or flow path, such as within maintenance-assembly outlet **242** of the cleaning and maintenance assembly of Figure 2B

or within an outlet of intervening pipe **260** of Figure 2A, pressurized liquid flowing from the cleaning and maintenance assembly into the second inlet flows into pipe **1006**, and from there is distributed to nozzle outlets **1008** and **1010**, such that the water impinges on walls of linear pipe segment **210** and/or of siphon **220** in a plurality of directions, determined by the orientation of nozzle outlets **1008** and **1010**.

It is to be appreciated that nozzle **1000** may be designed and configured in accordance with a specific application, or drain assembly, in which it is installed. As such, nozzle **1000** may have more nozzle outlets or fewer nozzle outlets than those shown in the drawings. Nozzle **1000** may have nozzle outlets in one or more angular orientations about the circumference of the head portion. Nozzle **1000** may have nozzle outlets at a single location, or at multiple locations along the longitudinal axis of pipe **1006**.

In some embodiments, one or more of the nozzle outlets of nozzle **1000** may extend beyond the footprint of head portion **1004**. For example, one or more of the nozzle outlets may comprise an outlet pipe or conduit.

Figures 11A and 11B show schematic sectional illustrations of another nozzle **1100** for connecting a drain cleaning and maintenance assembly of any one of Figures 2A to 9 to a drain assembly, in a rest state and in a flow state.

As seen in Figures 11A and 11B, nozzle **1100** includes a main pipe **1106** having a nozzle inlet **1102** and terminating at three nozzle outlets **1108a**, **1108b**, and **1108c**, each pointing in a different angular direction. As such, as seen in Figure 11B, when water or another liquid flows into nozzle inlet **1102**, the water flows out of nozzle outlets **1108** in the directions indicated by arrows **1110a**, **1110b**, and **1110c**, respectively.

It is to be appreciated that nozzle **1100** may be designed and configured in accordance with a specific application, or drain assembly, in which it is installed. As such, nozzle **1100** may have more nozzle outlets or fewer nozzle outlets than those shown in the drawings. Nozzle **1100** may have nozzle outlets in one or more angular orientations. Nozzle **1100** may have nozzle outlets at a single location, or at multiple locations along the longitudinal axis of pipe **1106**.

In some embodiments, one or more of the nozzle outlets of nozzle **1100** may extend beyond the footprint of the nozzle. For example, one or more of the nozzle outlets may comprise an nozzle outlet pipe or conduit.

Figures 12A, 12B, and 12C are schematic illustrations of embodiments of nozzles for connection of any one of the cleaning and maintenance assemblies of Figures 2A to 9, e.g. maintenance assembly **204** of Figure 3, to a drain assembly, e.g. drain assembly **302** of Figure 3, according to embodiments of the present invention.

As seen in Figures 12A to 12C, siphon **320** of drain assembly **302** includes a second inlet **316**. The maintenance-assembly outlet of maintenance assembly **204** is connected to second inlet **316** via pipe **260**. In the illustrated embodiment, siphon **320** is integrally formed with a drain receptacle **1200**, and is installed beneath a bottom surface **1202** of a plumbing fixture, such as a sink. Drain receptacle **1200** is in fluid communication with a drain portal **1204** of the pluming fixture.

In the embodiment shown in Figure 12A, end **1210** of pipe **260** disposed within second inlet **316** is open, allowing water, or another liquid, to flow freely through pipe **260** and into siphon **320**, at the angle defined by second inlet **316**, without any further obstructions. In this arrangement, no nozzle is used.

In the embodiment shown in Figure 12B, a nozzle **1220** is disposed at end **1210** of pipe **260** within second inlet **316**. Nozzle **1220** includes two nozzle outlets **1222** and **1224**, allowing water to flow out of end **1210**, and to be redirected to flow into an upstream portion and into a downstream portion of siphon **320**, as indicated by arrows.

Figure 12C shows a nozzle **1240**, which is substantially similar to nozzle **1220** of Figure 12B. However, nozzle **1240** includes a third nozzle outlet bore **1242** along a longitudinal axis of pipe **260**, in addition to nozzle outlets **1222** and **1224**. As such, at least some of the flow from pipe **260** into siphon **320** continues in its original direction, through nozzle outlet **1242**.

Reference is now made to Figure 13, which is a schematic flow chart of a method of installing the cleaning and maintenance system of any one of Figures 2A to 9 according to embodiments of the present invention.

At step **S1300**, a maintenance-assembly outlet of a cleaning and maintenance assembly, for example as described hereinabove with respect to any one of Figures 2A to 9, is connected to a drain inlet of a drain system upstream of a drain trap, or to an inlet directly into the drain trap. When the cleaning and maintenance assembly is integrally formed with the drain trap, as shown in Figure 4, step **S1300** may be obviated.

At step **S1302**, which typically occurs while the electronic valve (e.g. **244** of Figure 2A and 2B) of the cleaning and maintenance assembly is in a closed state, the maintenance-assembly inlet of the cleaning and maintenance assembly is connected to a source of pressurized water or another liquid. In some embodiments, the source of pressurized water may be the water mains. In some such embodiments, prior to step **S1302**, at step **S1304**, a pipe extending from the water mains to the plumbing fixture, e.g. to a faucet thereof, may optionally be split, such that one portion of the pipe is connected to the faucet, and the other section of the pipe is connected to the cleaning and maintenance assembly at step **S1302**.

At step **S1306**, the electronic valve of the cleaning and maintenance assembly is controlled to be in the open state, so that water flowing from the pressurized source through the cleaning and maintenance assembly cleans and maintains the drain trap.

Typically, the control is automatic, as described hereinabove with respect to Figures 2A to 9. In some such embodiments, prior to step **S1306**, at step **S1308**, the cleaning and maintenance assembly may be programmed to be in the open state at specific times, or may receive an input, from a remote control unit, instructing it to control the electronic valve to be in the open state.

In some embodiments, programming of the cleaning and maintenance assembly comprises applying a default program to the cleaning and maintenance assembly, and may be carried out during manufacturing of the cleaning and maintenance assembly.

In some embodiments, the cleaning and maintenance assembly may be pre-loaded with a plurality of default programs, and programming of the cleaning and maintenance assembly may include selecting one of the plurality of default programs.

It is to be appreciated that unless specifically stated otherwise, all fluid pressures mentioned in the present application and claims are absolute pressures.

It is to be appreciated that, when the pressurized washing liquid flows directly into the drain trap, at an angle relative to flow from the drain into the drain trap, cleaning of the drain trap walls is more effective than when the pressurized washing fluid flows into the drain trap together with flow from the drain into the drain trap.

Various exemplary embodiments of the present invention are provided hereinbelow:
Embodiment 1: A drain cleaning and maintenance system, including:

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a drain trap, having a first inlet in fluid communication with a drain of a plumbing fixture;

a second inlet, in fluid communication with the drain trap; and

a cleaning and maintenance assembly, in fluid communication with the second inlet, the cleaning and maintenance assembly including:

a maintenance-assembly inlet, adapted to be in fluid communication with a source of pressurized liquid;

a maintenance-assembly outlet in fluid communication with an interior of the drain trap;

a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

an electronic controller adapted to transition the electronic valve between the open state and the closed state; and

a power source adapted to provide power to the electronic valve and the electronic controller,

wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, liquid flows from the source of pressurized liquid to the drain trap via the electronic valve.

Embodiment 2: The drain cleaning and maintenance system of embodiment 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, an absolute output-pressure of liquid flowing out of the maintenance-assembly outlet is at least 70% of an absolute input-pressure of the liquid when it flows into the maintenance-assembly inlet.

Embodiment 3: The drain cleaning and maintenance system of embodiment 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute output-pressure is at least 75% of the absolute input-pressure.

Embodiment 4: The drain cleaning and maintenance system of embodiment 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute output-pressure is at least 80% of the absolute input-pressure.

Embodiment 5: The drain cleaning and maintenance system of embodiment 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute output-pressure is at least 85% of the absolute input-pressure.

Embodiment 6: The drain cleaning and maintenance system of embodiment 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute output-pressure is at least 90% of the absolute input-pressure.

Embodiment 7: The drain cleaning and maintenance system of embodiment 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute output-pressure is at least 95% of the absolute input-pressure.

Embodiment 8: The drain cleaning and maintenance system of any one of embodiments 1 to 7, wherein when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, a pressure differential between absolute pressure of liquid flowing into the maintenance-assembly inlet and the absolute pressure of liquid flowing out of the maintenance-assembly outlet is at most 30%.

Embodiment 9: The drain cleaning and maintenance system of any one of embodiments 1 to 7, wherein when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the pressure differential is at most 25%.

Embodiment 10: The drain cleaning and maintenance system of any one of embodiments 1 to 7, wherein when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the pressure differential is at most 20%.

Embodiment 11: The drain cleaning and maintenance system of any one of embodiments 1 to 7, wherein when the maintenance-assembly inlet is connected to the source of

pressurized liquid and the electronic valve is in the open state, the pressure differential is at most 15%.

Embodiment 12: The drain cleaning and maintenance system of any one of embodiments 1 to 7, wherein when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the pressure differential is at most 10%.

Embodiment 13: The drain cleaning and maintenance system of any one of embodiments 1 to 7, wherein when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the pressure differential is at most 5%.

Embodiment 14: The drain cleaning and maintenance system of any one of embodiments 1 to 13, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, an absolute input pressure of liquid flowing into the maintenance-assembly inlet is at least 2 bar.

Embodiment 15: The drain cleaning and maintenance system of any one of embodiments 1 to 13, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute input pressure is at least 2.5 bar.

Embodiment 16: The drain cleaning and maintenance system of any one of embodiments 1 to 13, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute input pressure is at least 3 bar.

Embodiment 17: The drain cleaning and maintenance system of any one of embodiments 1 to 13, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute input pressure is at least 4 bar.

Embodiment 18: The drain cleaning and maintenance system of any one of embodiments 1 to 13, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute input pressure is in the range of 2 to 5 bar.

Embodiment 19: The drain cleaning and maintenance system of any one of embodiments 1 to 13, wherein, when the assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, the absolute input pressure is in the range of 3 to 5 bar.

Embodiment 20: The drain cleaning and maintenance system of any one of embodiments 1 to 19, wherein, the electronic controller is adapted to maintain the electronic valve in the open state for a duration sufficient for flow of the pressurized liquid flow from the source to the drain trap to replace at least a majority of liquid within the drain trap.

Embodiment 21: The drain cleaning and maintenance system of any one of embodiments 1 to 20, wherein the cleaning and maintenance assembly is external to the drain trap and is disposed on an inlet line leading to the second inlet, wherein the maintenance-assembly outlet is in fluid communication with the drain trap via the second inlet.

Embodiment 22: The drain cleaning and maintenance system of any one of embodiments 1 to 21, further including a linear pipe segment disposed upstream of the drain trap, the linear pipe segment having a pipe-inlet adapted to be in fluid communication with the drain of the plumbing fixture and a pipe-outlet in fluid communication with the drain trap, the linear pipe segment including the second inlet.

Embodiment 23: The drain cleaning and maintenance system of any one of embodiments 1 to 21, wherein the drain trap further includes the second inlet.

Embodiment 24: The drain cleaning and maintenance system of any one of embodiments 1 to 23, wherein the second inlet is angled relative to a flow-path from the drain to the drain trap or within the drain trap.

Embodiment 25: The drain cleaning and maintenance system of any one of embodiments 1 to 24, wherein the maintenance-assembly outlet of the cleaning and maintenance assembly is connected directly to the second inlet.

Embodiment 26: The drain cleaning and maintenance system of any one of embodiments 1 to 24, wherein the maintenance-assembly outlet of the cleaning and maintenance assembly is connected to the second inlet via a connector pipe segment.

Embodiment 27: The drain cleaning and maintenance system of any one of embodiments 1 to 20, wherein the cleaning and maintenance assembly is integrally formed with the drain trap and with the second inlet, as a unitary structure.

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Embodiment 28: The drain cleaning and maintenance system of embodiment 27, wherein the cleaning and maintenance assembly is disposed on or in a side wall of the drain trap, such that flow from the second inlet into the drain trap is angled relative to water flow through the drain trap.

Embodiment 29: The drain cleaning and maintenance assembly of embodiment 27, wherein at least a portion of the cleaning and maintenance assembly is disposed at a base of the drain trap.

Embodiment 30: The drain cleaning and maintenance assembly of embodiment 29, wherein the second inlet is disposed at the base of the drain trap and accommodates the maintenance-assembly inlet.

Embodiment 31: The drain cleaning and maintenance assembly of embodiment 29 or embodiment 30, wherein the maintenance-assembly outlet is in fluid communication directly with the drain trap.

Embodiment 32: The drain cleaning and maintenance assembly of any one of embodiments 29 to 31, wherein the electronic valve is disposed within the drain trap.

Embodiment 33: The drain cleaning and maintenance assembly of any one of embodiments 29 to 32, wherein the electronic controller and the power source are disposed within the drain trap.

Embodiment 34: The drain cleaning and maintenance assembly of any one of embodiments 29 to 32, wherein the electronic controller and the power source are disposed on an exterior wall of the drain trap.

Embodiment 35: The drain cleaning and maintenance system of any one of embodiments 1 to 34, wherein the drain trap includes a siphon.

Embodiment 36: The drain cleaning and maintenance system of any one of embodiments 1 to 35, wherein the drain trap includes a U-shaped drain trap.

Embodiment 37: The drain cleaning and maintenance system of any one of embodiments 1 to 36, wherein the maintenance assembly further includes a communication interface, functionally associated with the electronic controller and adapted to enable delivery of control inputs from a remote control unit to the electronic controller.

Embodiment 38: The drain cleaning and maintenance system of any one of embodiments 1 to 36, wherein the maintenance assembly further includes a communication interface,

functionally associated with the electronic controller and adapted to enable delivery of maintenance outputs from the electronic controller to a remote control center.

Embodiment 39: The drain cleaning and maintenance system of any one of embodiments 1 to 38, wherein the electronic controller is programmable.

Embodiment 40: The drain cleaning and maintenance system of any one of embodiments 1 to 39, further including a user interface including at least one of an input interface enabling a user to provide input to the electronic controller and an output interface enabling a user to perceive output of the electronic controller.

Embodiment 41: The drain cleaning and maintenance system of any one of embodiments 1 to 40, wherein the cleaning and maintenance assembly further includes a timer, functionally associated with the electronic controller.

Embodiment 42: The drain cleaning and maintenance system of any one of embodiments 1 to 41, further including at least one sensor adapted to sense at least one condition in the drain trap and to provide a sensor-input to the electronic controller, the sensor-input indicative of required maintenance of the drain trap.

Embodiment 43: The drain cleaning and maintenance system of any one of embodiments 1 to 42, further including a nozzle including a nozzle-inlet and at least one nozzle-outlet, the nozzle being disposed within a flow path from the maintenance-assembly outlet to the drain trap, such that liquid flowing from the maintenance-assembly outlet flows through the nozzle-inlet and is redirected out of the at least one nozzle-outlet into the drain trap.

Embodiment 44: The drain cleaning and maintenance system of any one of embodiments 1 to 43, wherein the drain cleaning and maintenance assembly is devoid of a pumping mechanism.

Embodiment 45: The drain cleaning and maintenance system of any one of embodiments 1 to 44, wherein the pipe is the only volume of the drain cleaning and maintenance assembly adapted to have liquid disposed therein.

Embodiment 46: A drain device, including:

a drain trap, having a first inlet, adapted to be in fluid communication with a drain of a plumbing fixture and a second inlet; and

a cleaning and maintenance assembly, integrally formed with the drain trap, and including:

a maintenance-assembly inlet, adapted to be in fluid communication to a source of pressurized liquid;

a maintenance-assembly outlet in fluid communication with the second inlet;

a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

an electronic controller adapted to transition the electronic valve between the open state and the closed state; and

a power source adapted to power the electronic valve and the electronic controller,

wherein, when the maintenance-assembly inlet is in fluid communication to the source of pressurized fluid and the electronic valve is in the open state, liquid flows from the source to the drain trap via the second inlet to clean the drain trap.

Embodiment 47: The drain device of embodiment 46, wherein the second inlet is angled relative to a flow-path from the drain to the first inlet.

Embodiment 48: A drain device, including:

a drain trap, having a first inlet, adapted to be in fluid communication with a drain of a plumbing fixture and a second inlet; and

a cleaning and maintenance assembly including:

a maintenance-assembly inlet, extending through the second inlet, and adapted to be in fluid communication to a source of pressurized liquid;

a maintenance-assembly outlet in fluid communication directly with an interior of the drain trap;

a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

an electronic controller adapted to transition the electronic valve between the open state and the closed state; and

a power source adapted to power the electronic valve and the electronic controller,

wherein, when the maintenance-assembly inlet is in fluid communication to the source of pressurized fluid and the electronic valve is in the open state, liquid flows from the source of pressurized fluid to the drain trap via the electronic valve to clean the drain trap.

Embodiment 49: The drain device of embodiment 48, wherein the drain trap includes a drain trap cap, disposed at a lower end thereof, and wherein the electronic valve, the pipe, and the maintenance-assembly outlet are disposed within the drain trap cap.

Embodiment 50: The drain device of embodiment 49, wherein the electronic controller is disposed within the drain trap cap.

Embodiment 51: The drain device of embodiment 49 or embodiment 50, wherein the power source is disposed within the drain trap cap.

Embodiment 52: The drain device of embodiment 49, wherein the electronic controller is disposed in a compartment on the exterior of drain trap.

Embodiment 53: The drain device of embodiment 49 or embodiment 52, wherein the power source is disposed in a compartment on the exterior of the drain trap.

Embodiment 54: The drain device of any one of embodiments 46 to 53, wherein, when the maintenance-assembly inlet is connected to the source of pressurized fluid and the electronic valve is in the open state, liquid flows from the source to the drain trap at an absolute pressure substantially equal to the absolute pressure in the source of liquid.

Embodiment 55: The drain device of any one of embodiments 46 to 54, wherein the drain trap includes a siphon.

Embodiment 56: The drain device of any one of embodiments 46 to 55, wherein the maintenance assembly further includes a communication interface, functionally

associated with the electronic controller and adapted to enable delivery of control inputs from a remote control unit to the electronic controller.

Embodiment 57: The drain device of any one of embodiments 46 to 56, wherein the electronic controller is programmable.

Embodiment 58: The drain device of any one of embodiments 46 to 57, further including a user interface including at least one of an input interface enabling a user to provide input to the electronic controller and an output interface enabling a user to perceive output of the electronic controller.

Embodiment 59: The drain device of any one of embodiments 46 to 58, wherein the cleaning and maintenance assembly further includes a timer, functionally associated with the electronic controller.

Embodiment 60: The drain device of any one of embodiments 46 to 59, further including at least one sensor adapted to sense at least one condition in the drain trap and to provide a sensor-input to the electronic controller, the sensor-input indicative of required maintenance of the drain trap.

Embodiment 61: The drain device of any one of embodiments 46 to 60, further including a nozzle including a nozzle-inlet and at least one nozzle-outlet, the nozzle being disposed within the second inlet, such that liquid flowing from the maintenance-assembly outlet flows through the nozzle-inlet and is redirected out of the at least one nozzle-outlet into the drain trap.

Embodiment 62: A method of cleaning and maintaining a drain trap of a drain, the drain trap having a first inlet, the method including:

(a) providing a cleaning and maintenance assembly, including:

a maintenance-assembly inlet;

a maintenance-assembly outlet;

a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

an electronic controller adapted to transition the electronic valve between the open state and the closed state; and

a power source adapted to power the electronic valve and the electronic controller;

(b) connecting the maintenance-assembly outlet of the cleaning and maintenance assembly to a second inlet in fluid communication with the drain trap;

(c) while the electronic valve is in the closed state, connecting the maintenance-assembly inlet of the maintenance assembly to a source of pressurized liquid; and

(d) transitioning the electronic valve from the closed state to the open state, by means of the electronic controller, thereby to enable liquid from the source to flow through the pipe and the second inlet into the drain trap and to impinge on interior walls of the drain trap to clean the walls of the drain trap.

Embodiment 63: The method of embodiment 62, further including:

(e) maintaining the electronic valve in the open state for a predetermined duration, sufficient to replace all the liquid in the drain trap.

Embodiment 64: The method of embodiment 62 or embodiment 63, wherein the transitioning is in response to the electronic controller receiving an input indicative of the need for the transitioning.

Embodiment 65: The method of embodiment 64, wherein the input is received from a sensor disposed in, or in the vicinity of, the drain trap.

Embodiment 66: The method of embodiment 694, wherein the input is received from a remote control unit, via a communication interface functionally associated with the electronic controller.

Embodiment 67: The method of embodiment 62 or embodiment 63, wherein the electronic controller includes a programmable electronic controller, the method further including, prior to the transitioning, programming the programmable electronic controller to carry out the transitioning step at at least one predetermined time or at a predetermined frequency.

Embodiment 68: The method of any one of embodiments 62 to 67, wherein the connecting the maintenance-assembly outlet to the second inlet of the drain trap includes connecting the maintenance-assembly outlet directly to the second inlet.

a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims. All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention.

CLAIMS

1. A drain cleaning and maintenance system, comprising:

(a) a drain trap, having a first inlet in fluid communication with a drain of a plumbing fixture;

(b) a second inlet, in fluid communication with the drain trap; and

(c) a cleaning and maintenance assembly, in fluid communication with the second inlet, the cleaning and maintenance assembly comprising:

(i) a maintenance-assembly inlet, in fluid communication with a source of pressurized liquid;

(ii) a maintenance-assembly outlet in fluid communication with an interior of the drain trap;

(iii) a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

(iv) an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

(v) an electronic controller adapted to transition the electronic valve between the open state and the closed state; and

(vi) a power source adapted to power the electronic controller and the electronic valve,

wherein, when the electronic valve is in the open state, liquid flows from the source of pressurized liquid to the drain trap via the electronic valve.

2. The drain cleaning and maintenance system of claim 1, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, an absolute output-pressure of liquid flowing out of the maintenance-assembly outlet is at least 70% of an absolute input-pressure of the liquid when it flows into the maintenance-assembly inlet.

3. The drain cleaning and maintenance system of claim 1, wherein when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, a pressure differential between an absolute pressure of liquid flowing into the maintenance-assembly inlet and an absolute pressure of liquid flowing out of the maintenance assembly outlet is at most 30%.

4. The drain cleaning and maintenance system of any one of claims 1 to 3, wherein, when the maintenance-assembly inlet is connected to the source of pressurized liquid and the electronic valve is in the open state, an absolute pressure of liquid flowing into the maintenance-assembly inlet is at least 2 bar.

5. The drain cleaning and maintenance system of any one of claims 1 to 4, wherein, the electronic controller is adapted to maintain the electronic valve in the open state for a duration sufficient for flow of the pressurized liquid flow from the source of pressurized fluid to the drain trap to replace at least a majority of liquid within the drain trap.

6. The drain cleaning and maintenance system of any one of claim 1 to 5, wherein the cleaning and maintenance assembly is external to the drain trap and is disposed on an inlet line leading to the second inlet, wherein the maintenance-assembly outlet is in fluid communication with the drain trap via the second inlet.

7. The drain cleaning and maintenance system of any one of claims 1 to 6, further comprising a linear pipe segment disposed upstream of the drain trap, the linear pipe segment having a pipe-inlet adapted to be in fluid communication with the drain of the plumbing fixture and a pipe-outlet in fluid communication with the drain trap, the linear pipe segment including the second inlet.

8. The drain cleaning and maintenance system of any one of claims 1 to 6, wherein the drain trap further includes the second inlet.

9. The drain cleaning and maintenance system of any one of claims 1 to 8, wherein the second inlet is angled relative to a flow-path from the drain to the drain trap or within the drain trap.

10. The drain cleaning and maintenance system of any one of claims 1 to 9, wherein the maintenance-assembly outlet of the cleaning and maintenance assembly is connected directly to the second inlet.

11. The drain cleaning and maintenance system of any one of claims 1 to 9, wherein the maintenance-assembly outlet of the cleaning and maintenance assembly is connected to the second inlet via a connector pipe segment.

12. The drain cleaning and maintenance system of any one of claims 1 to 5, wherein the cleaning and maintenance assembly is integrally formed with the drain trap and with the second inlet, as a unitary structure.

13. The drain cleaning and maintenance system of claim 12, wherein the cleaning and maintenance assembly is disposed on or in a side wall of the drain trap, such that flow from the second inlet into the drain trap is angled relative to water flow through the drain trap.

14. The drain cleaning and maintenance assembly of claim 12, wherein at least a portion of the cleaning and maintenance assembly is disposed at a base of the drain trap.

15. The drain cleaning and maintenance assembly of claim 14, wherein the second inlet is disposed at the base of the drain trap and accommodates the maintenance-assembly inlet.

16. The drain cleaning and maintenance assembly of claim 14 or claim 15, wherein the maintenance-assembly outlet is in fluid communication directly with the interior of the drain trap.

17. The drain cleaning and maintenance assembly of any one of claim 14 to 16, wherein the electronic valve is disposed within the drain trap.

18. The drain cleaning and maintenance assembly of any one of claim 14 to 17, wherein the electronic controller and the power source are disposed within the drain trap.

19. The drain cleaning and maintenance assembly of any one of claims 14 to 17, wherein the electronic controller and the power source are disposed on an exterior wall of the drain trap.

20. The drain cleaning and maintenance system of any one of claims 1 to 19, wherein the drain trap comprises a siphon.

21. The drain cleaning and maintenance system of any one of claims 1 to 19, wherein the drain trap comprises a U-shaped drain trap.

22. The drain cleaning and maintenance system of any one of claims 1 to 21, wherein the maintenance assembly further includes a communication interface, functionally associated with the electronic controller and adapted to enable delivery of control inputs from a remote control unit to the electronic controller.

23. The drain cleaning and maintenance system of any one of embodiments 1 to 21, wherein the maintenance assembly further includes a communication interface, functionally associated with the electronic controller and adapted to enable delivery of maintenance outputs from the electronic controller to a remote control unit.

24. The drain cleaning and maintenance system of any one of claims 1 to 23, wherein the electronic controller is programmable.

25. The drain cleaning and maintenance system of any one of claims 1 to 24, further comprising a user interface including at least one of an input interface enabling a user to provide input to the electronic controller and an output interface enabling a user to perceive output of the electronic controller.

26. The drain cleaning and maintenance system of any one of claims 1 to 25, wherein the cleaning and maintenance assembly further comprises a timer, functionally associated with the electronic controller.

27. The drain cleaning and maintenance system of any one of claims 1 to 26, further comprising at least one sensor adapted to sense at least one condition in the drain trap and to provide a sensor-input to the electronic controller, the sensor-input indicative of required maintenance of the drain trap.

28. The drain cleaning and maintenance system of any one of claims 1 to 27, further comprising a nozzle including a nozzle-inlet and at least one nozzle-outlet, the nozzle being disposed within a flow path from the maintenance-assembly outlet to the drain trap, such that liquid flowing from the maintenance-assembly outlet flows through the nozzle-inlet and is redirected out of the at least one nozzle-outlet into the drain trap.

29. The drain cleaning and maintenance system of any one of claims 1 to 28, wherein the drain cleaning and maintenance assembly is devoid of a pumping mechanism.

30. The drain cleaning and maintenance system of any one of claims 1 to 29, wherein the pipe is the only volume of the drain cleaning and maintenance assembly adapted to have liquid disposed therein.

31. A drain device, comprising:

(a) a drain trap, having a first inlet, adapted to be in fluid communication with a drain of a plumbing fixture and a second inlet; and

(b) a cleaning and maintenance assembly, integrally formed with the drain trap, and including:

(i) a maintenance-assembly inlet, adapted to be in fluid communication to a source of pressurized liquid;

(ii) a maintenance-assembly outlet in fluid communication with the second inlet;

(iii) a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

(iv) an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

(v) an electronic controller adapted to transition the electronic valve between the open state and the closed state; and

(vi) a power source adapted to power the electronic valve and the electronic controller,

wherein, when the maintenance-assembly inlet is in fluid communication to the source of pressurized fluid and the electronic valve is in the open state, liquid flows from the source to the drain trap via the second inlet to clean the drain trap.

32. A method of cleaning and maintaining a drain trap of a drain, the drain trap having a first inlet, the method including:

(a) providing a cleaning and maintenance assembly, including:

a maintenance-assembly inlet;

a maintenance-assembly outlet;

a pipe disposed between the maintenance-assembly inlet and the maintenance-assembly outlet;

an electronic valve having an open state allowing flow of liquid, from the maintenance-assembly inlet to the maintenance-assembly outlet, through the pipe, and a closed state blocking flow of liquid from the maintenance-assembly inlet to the maintenance-assembly outlet;

an electronic controller adapted to transition the valve between the open state and the closed state; and

a power source adapted to power the electronic valve and the electronic controller;

(b) connecting the maintenance-assembly outlet of the cleaning and maintenance assembly to a second inlet in fluid communication with the drain trap;

(c) while the valve is in the closed state, connecting the maintenance-assembly inlet of the maintenance assembly to a source of pressurized liquid; and

(d) transitioning the valve from the closed state to the open state, by means of the electronic controller, thereby to enable liquid from the source to flow through the pipe and the second inlet into the drain trap and to impinge on interior walls of the drain trap to clean the walls of the drain trap.

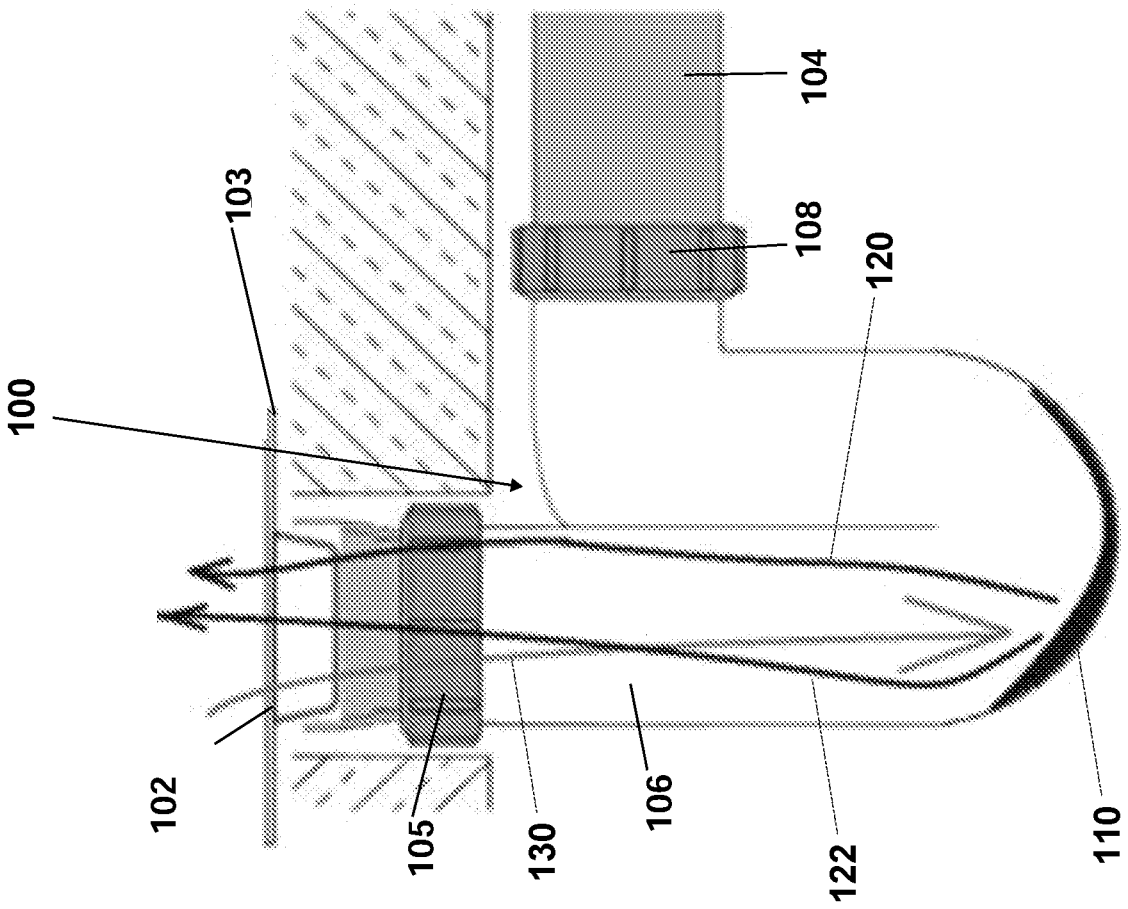


Fig. 1B (Prior art)

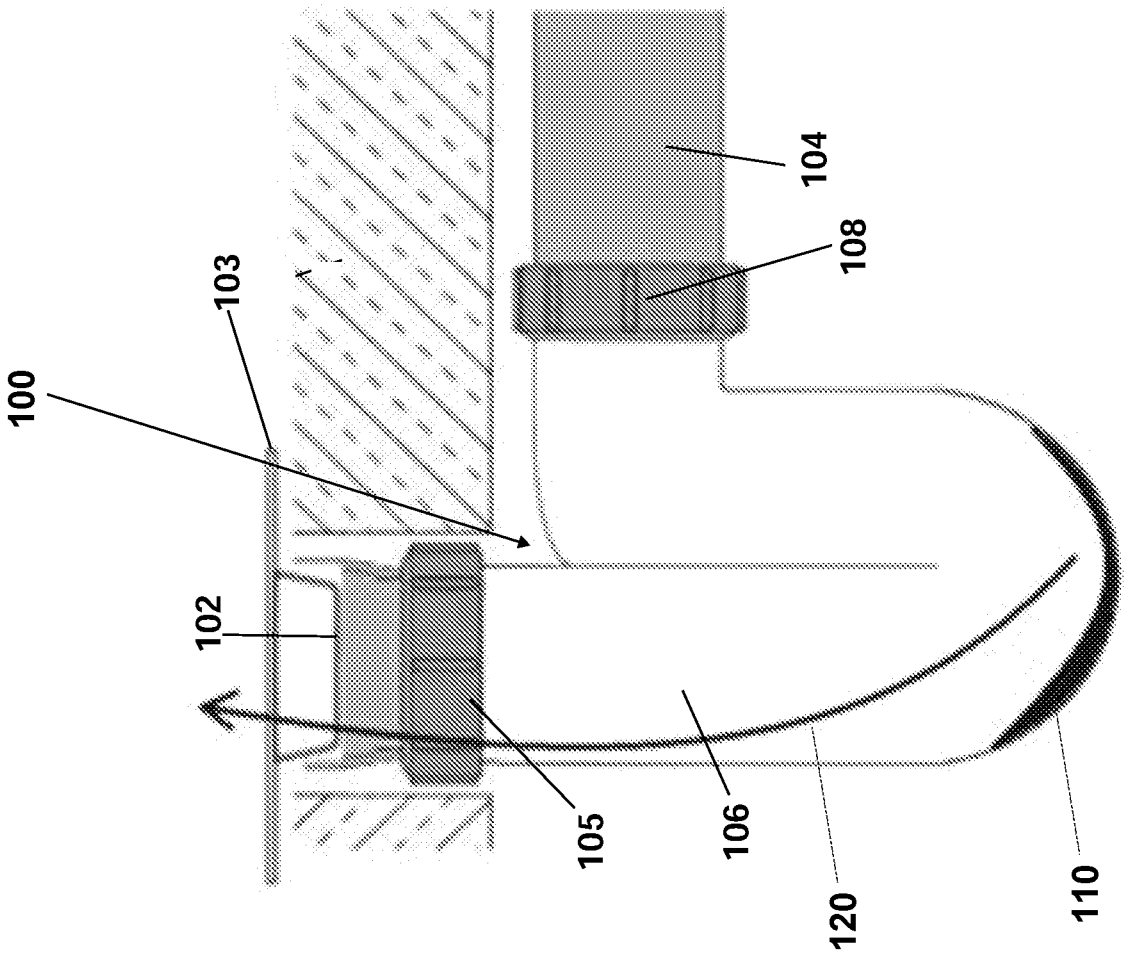


Fig. 1A (Prior art)

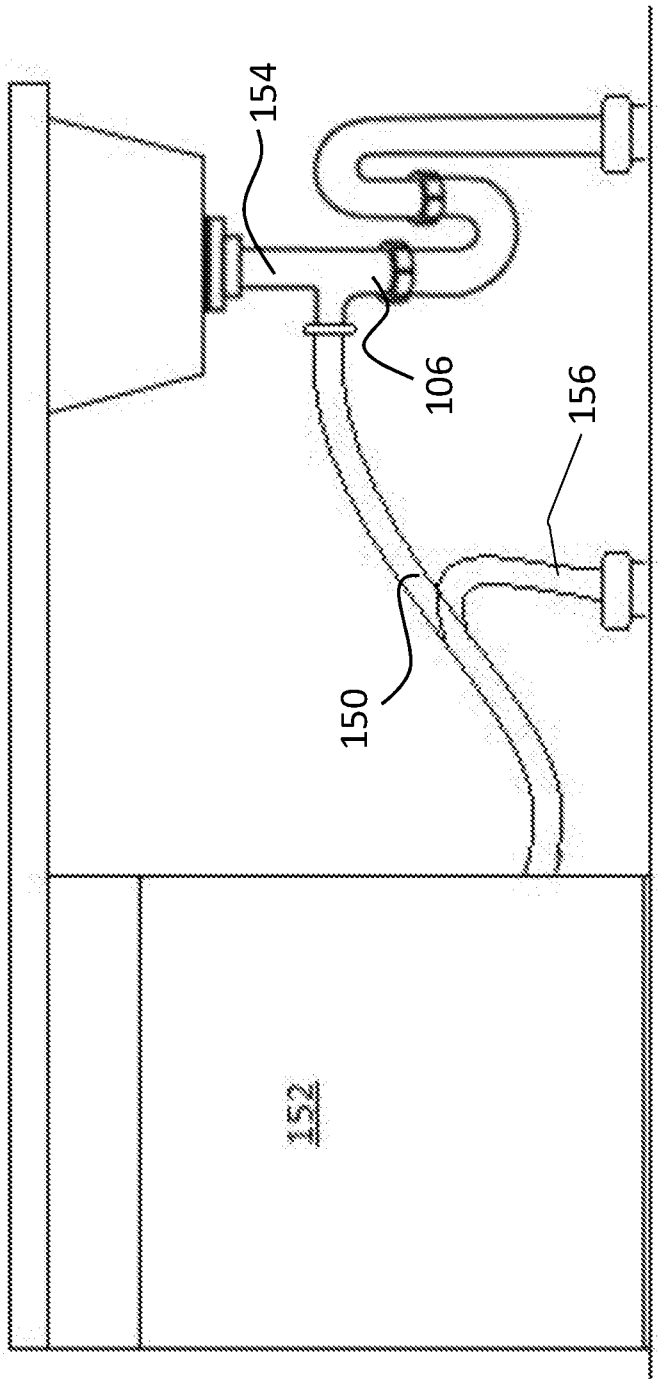


FIGURE 1C – PRIOR ART

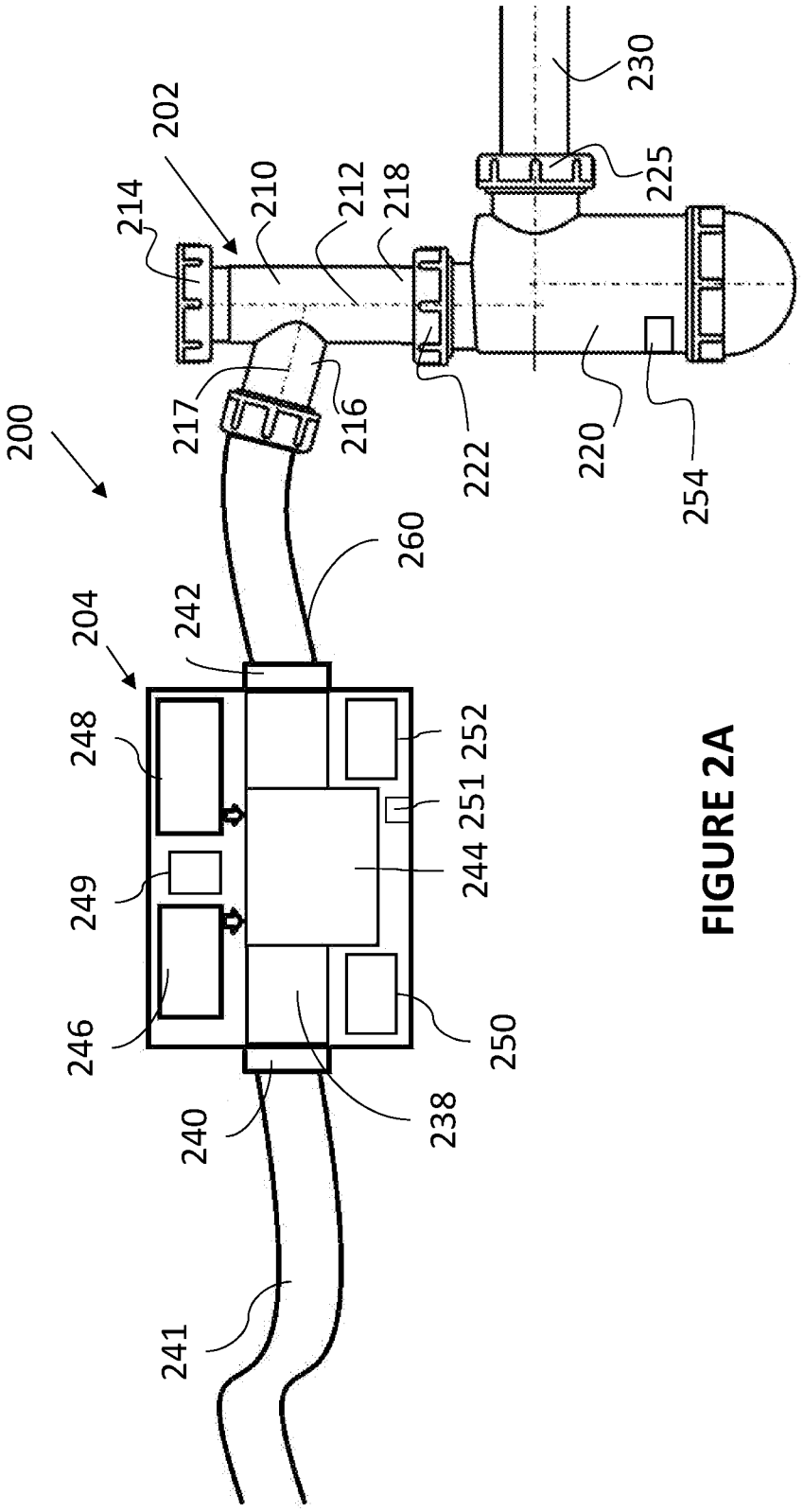

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FIGURE 2A

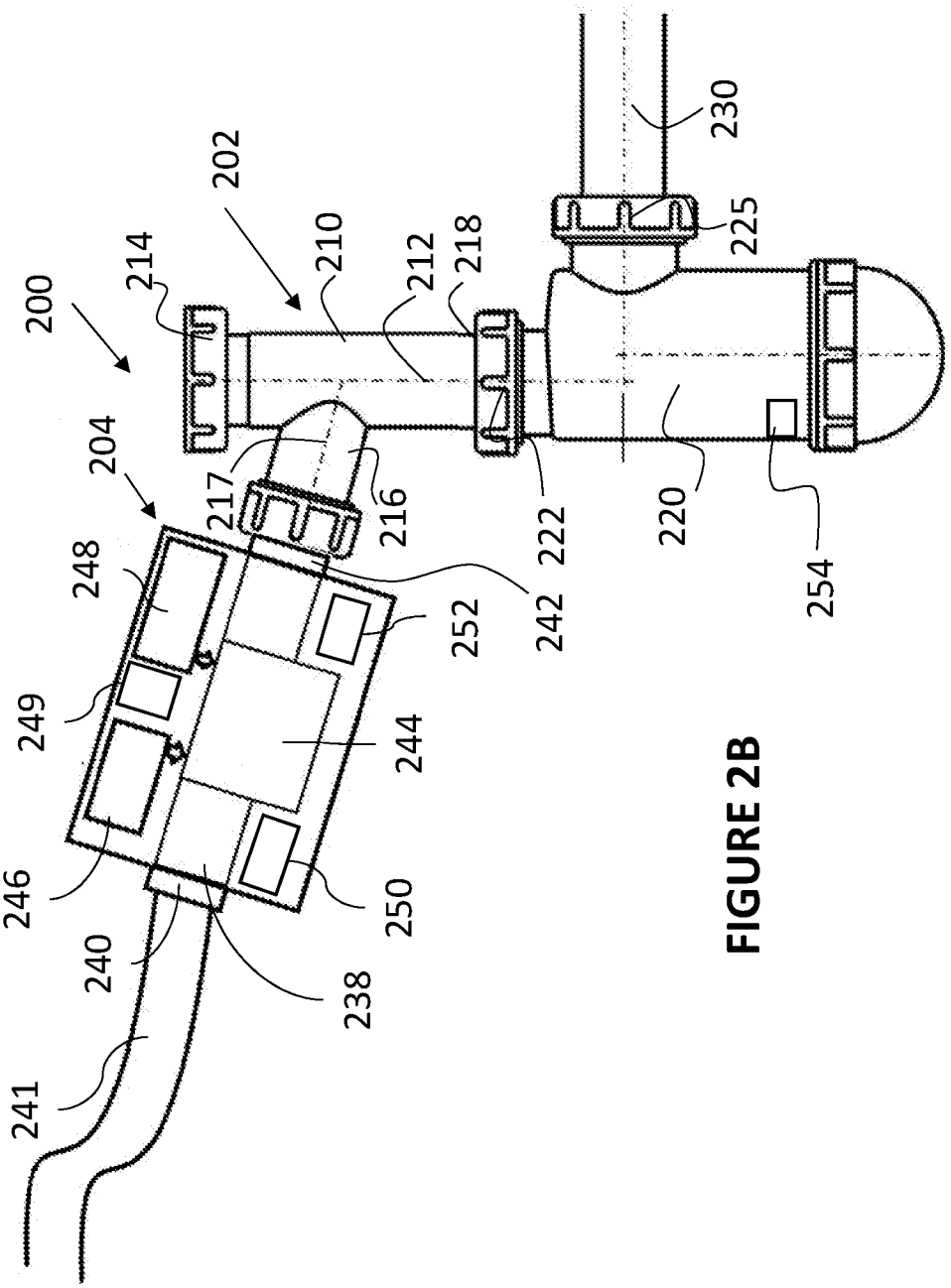

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FIGURE 2B

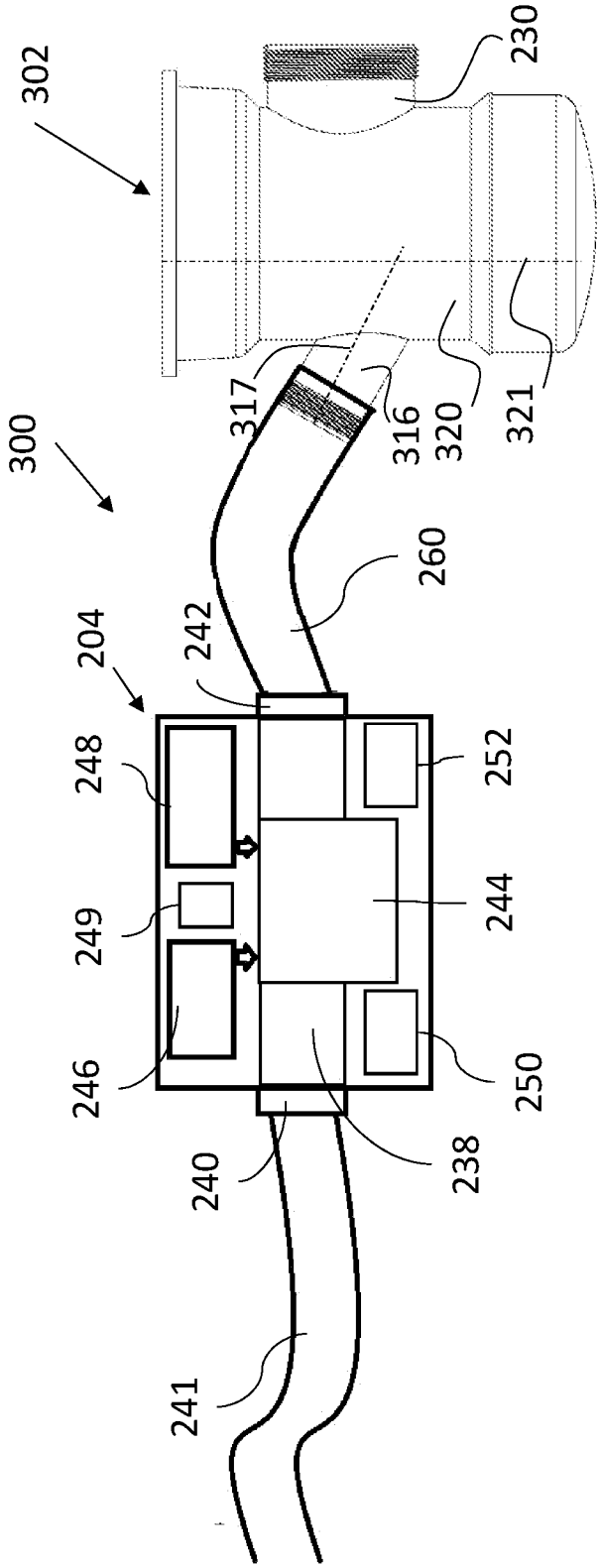

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FIGURE 3

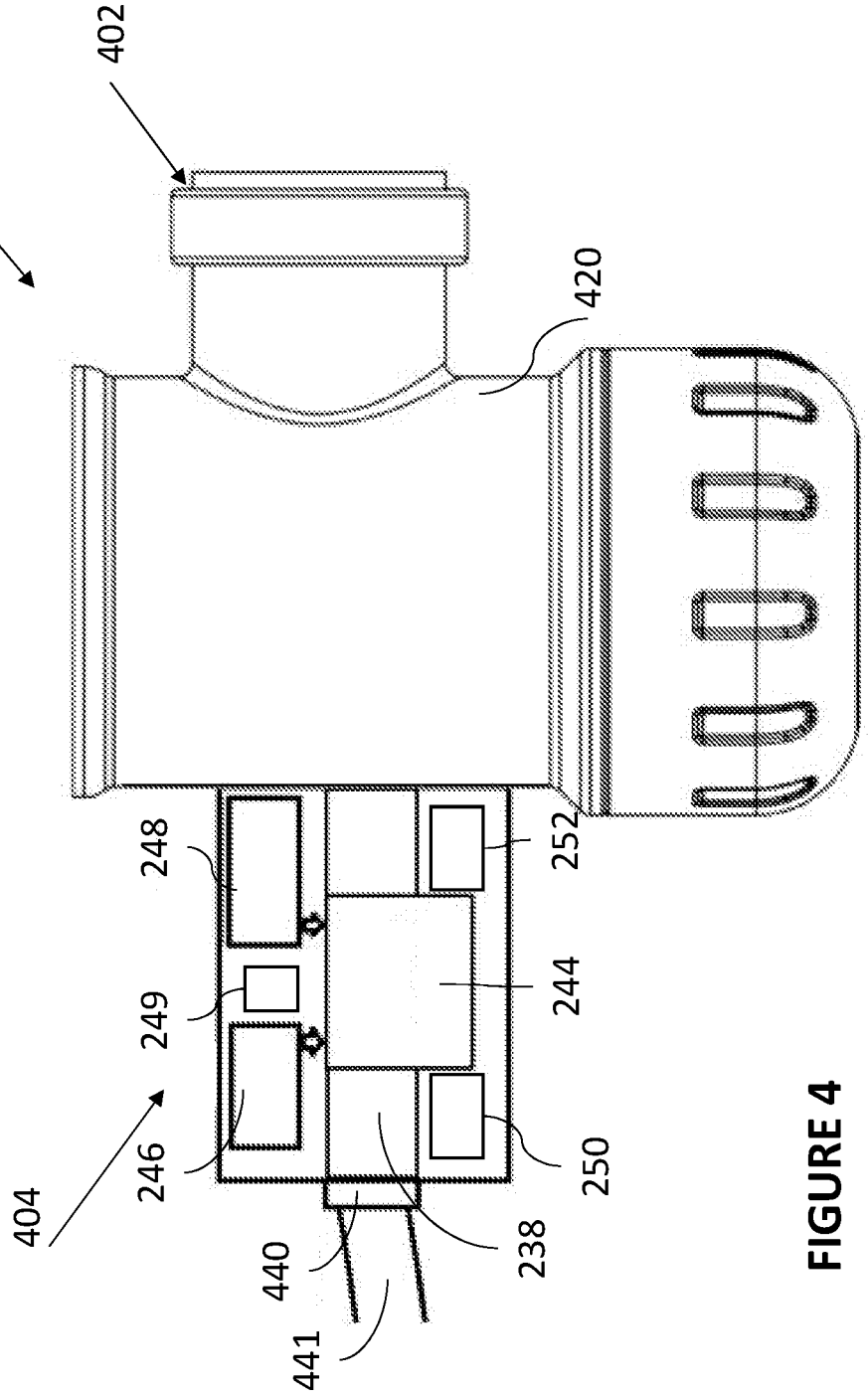


FIGURE 4

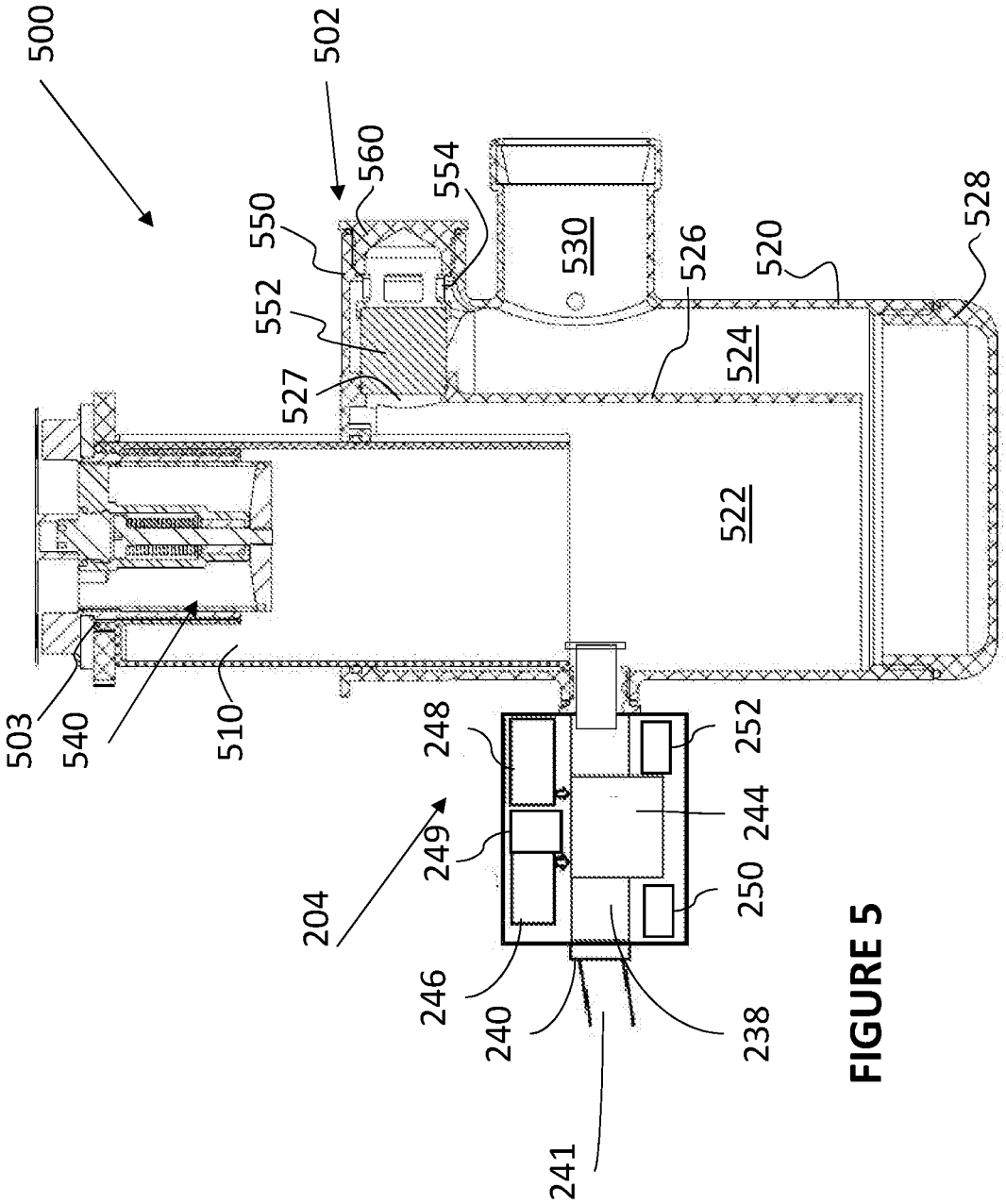

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FIGURE 5

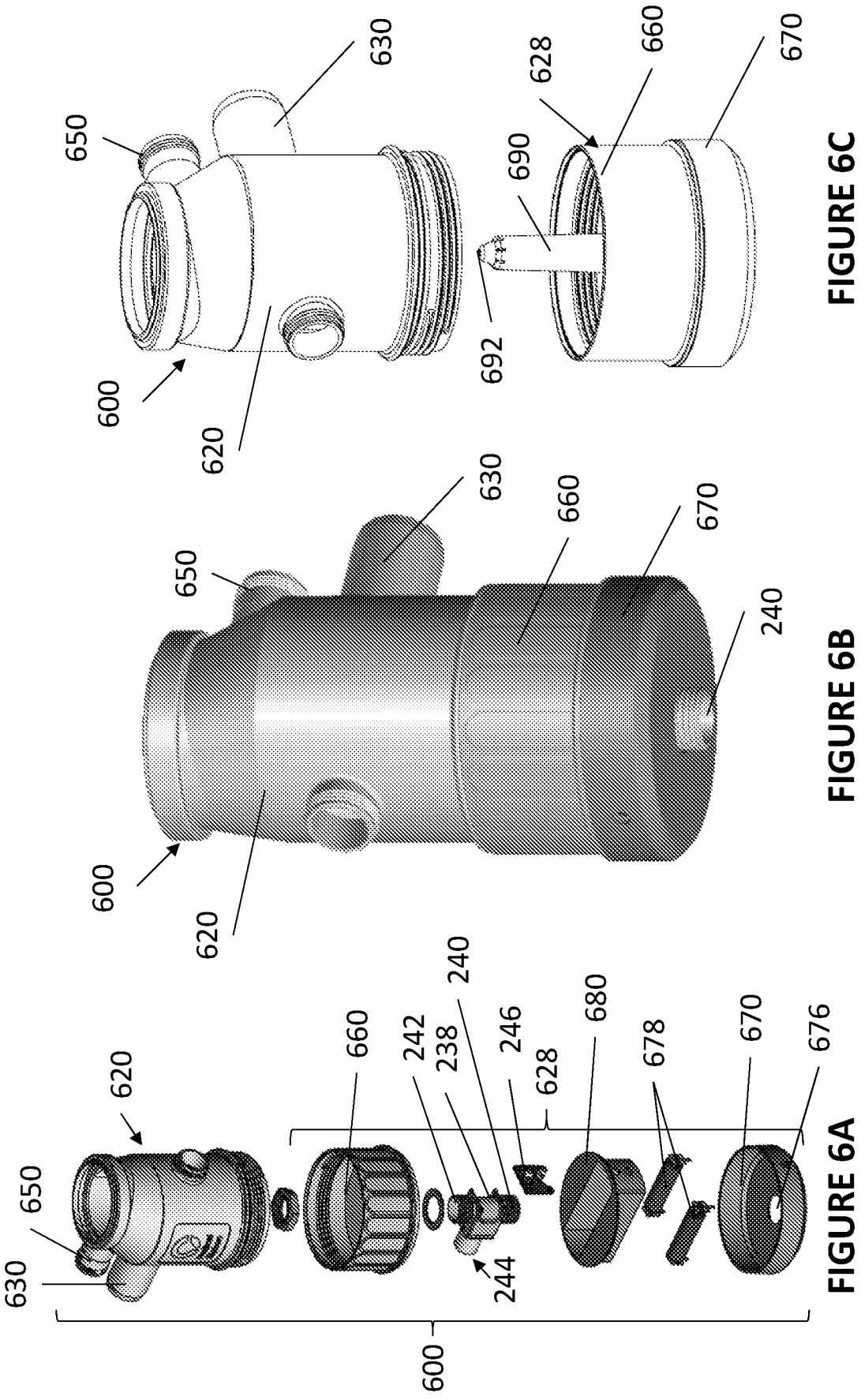


FIGURE 6C

FIGURE 6B

FIGURE 6A

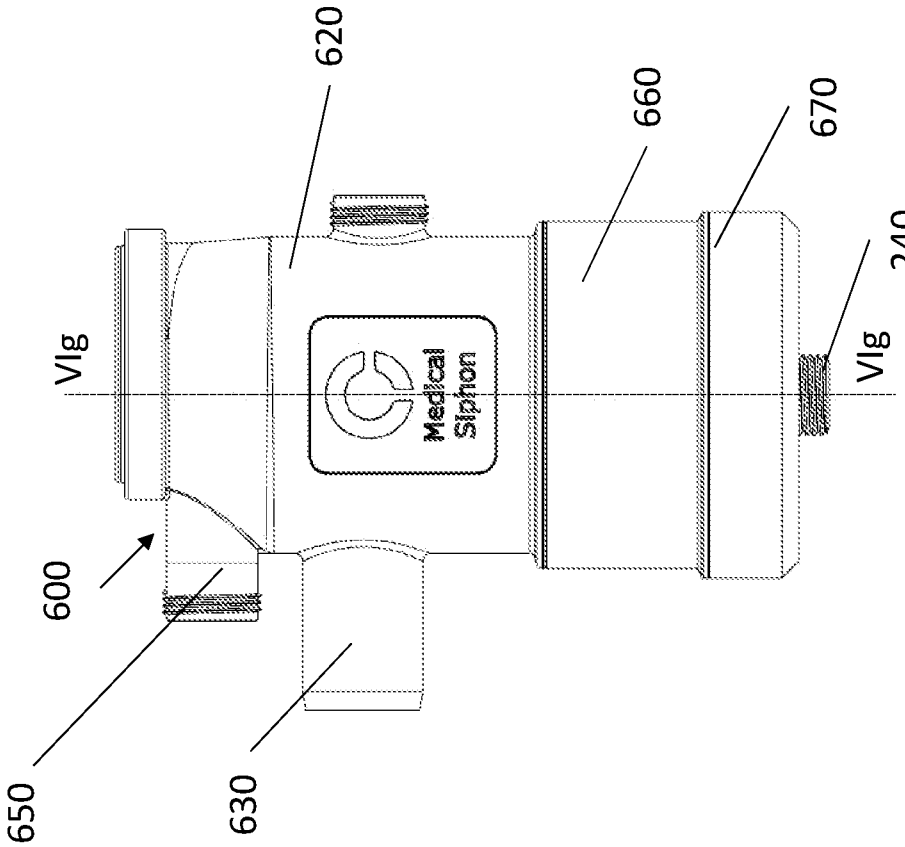


FIGURE 6E

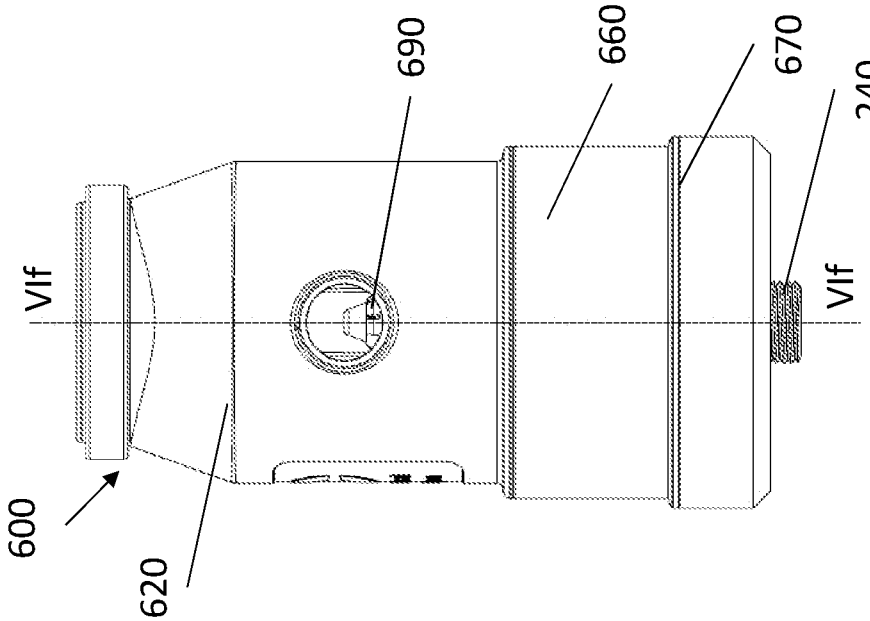


FIGURE 6D

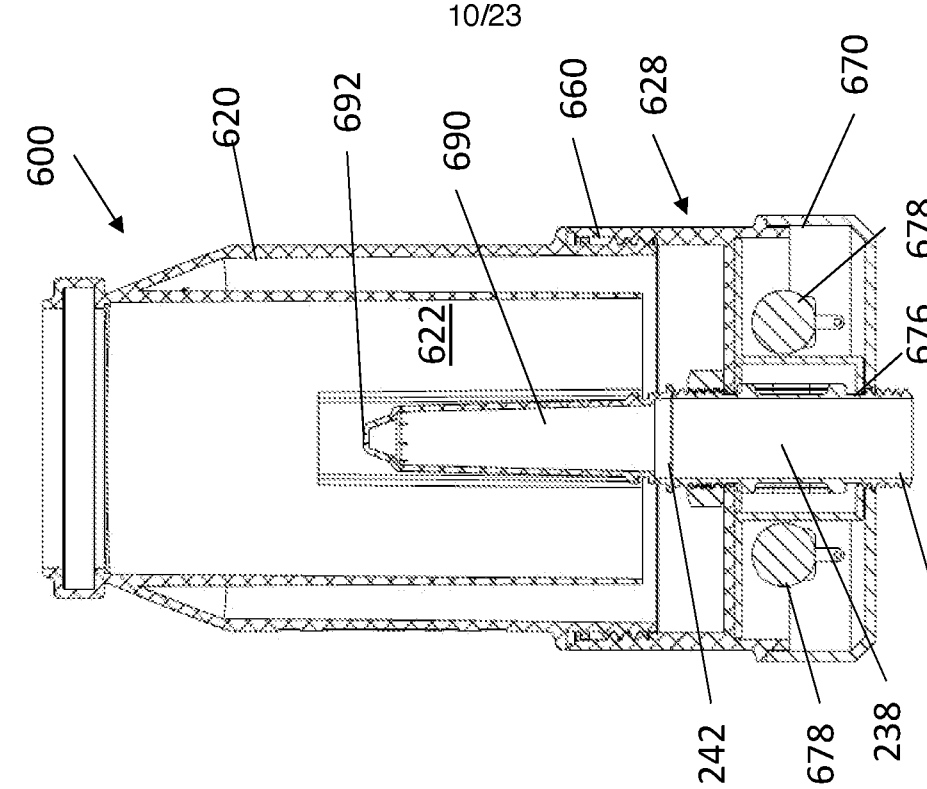


FIGURE 6G

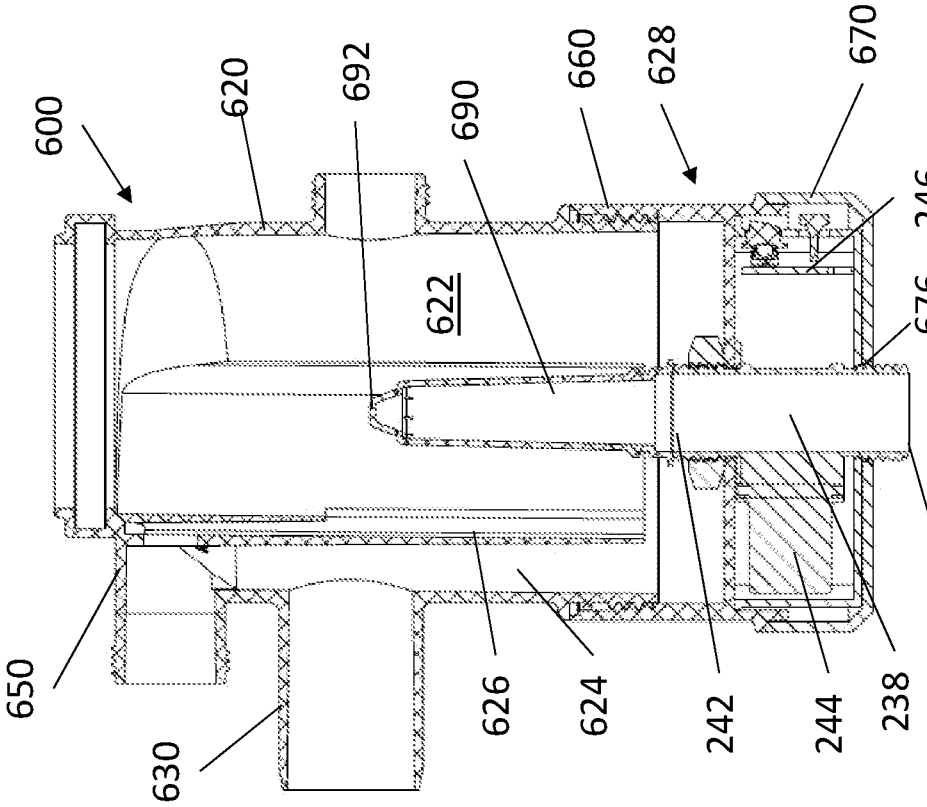


FIGURE 6F

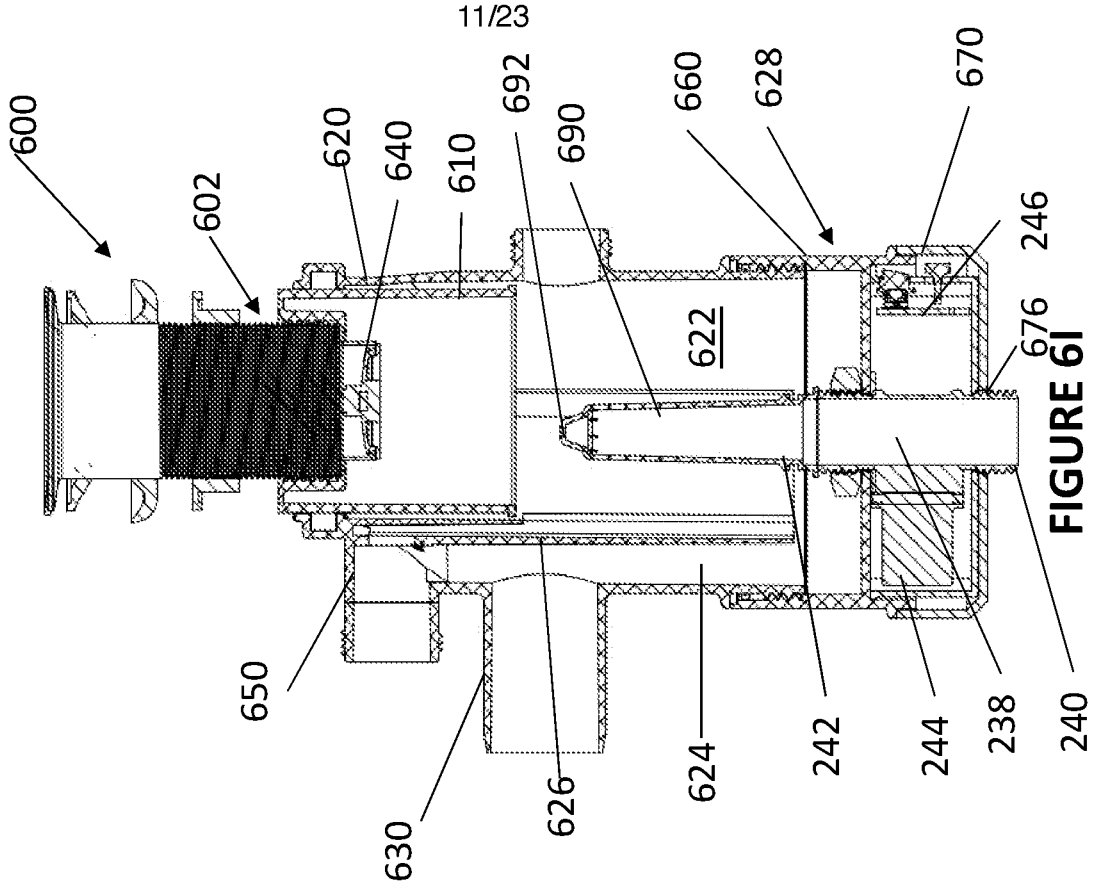


FIGURE 6I

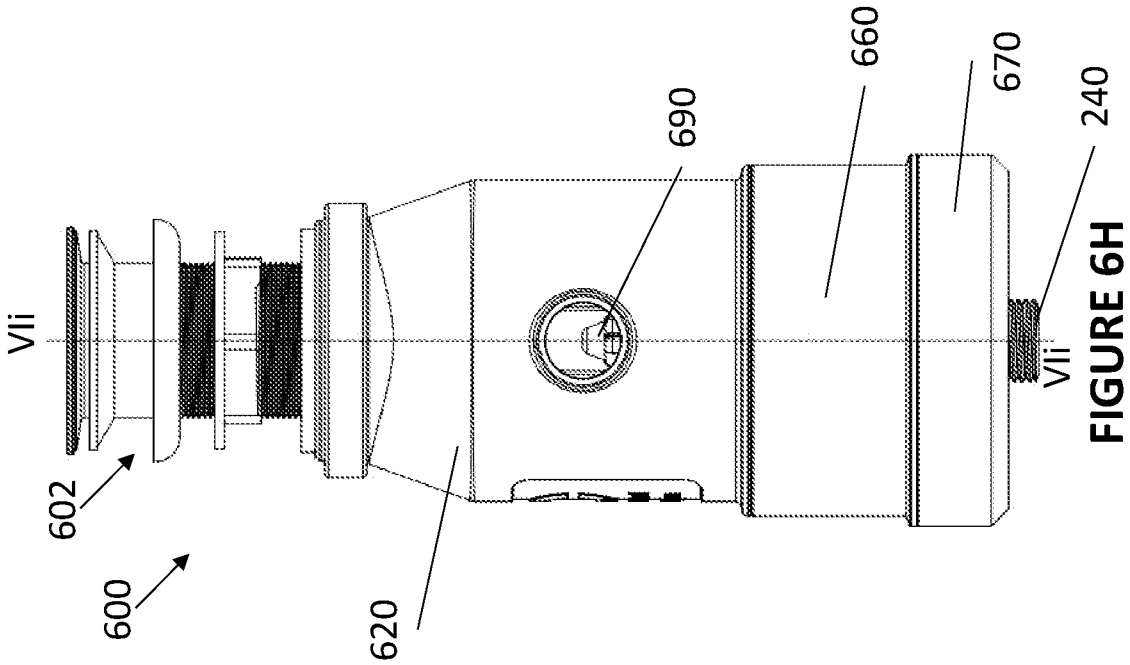


FIGURE 6H

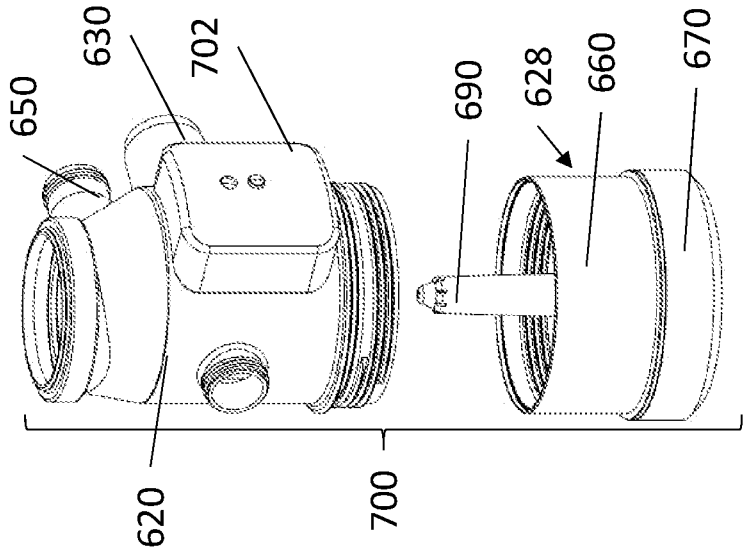


FIGURE 7C

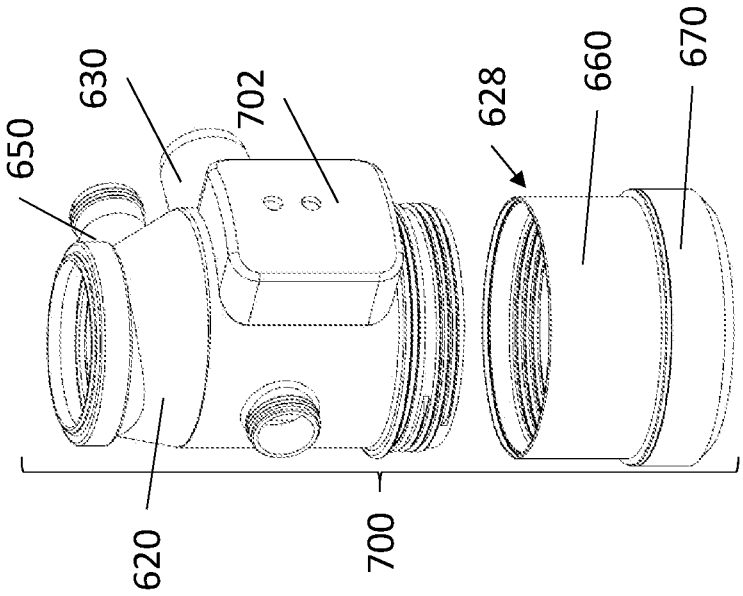


FIGURE 7B

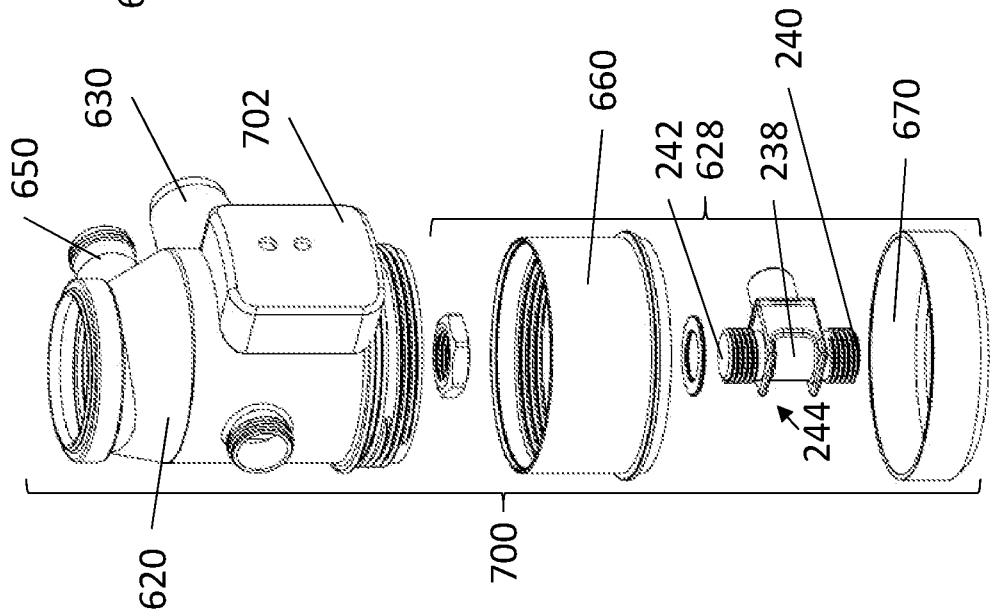


FIGURE 7A

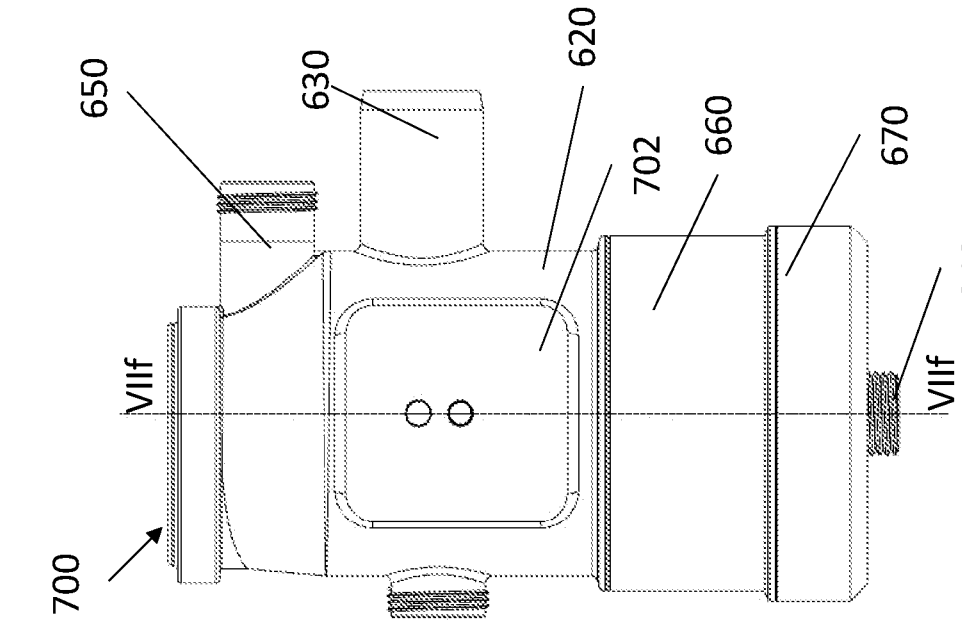


FIGURE 7E

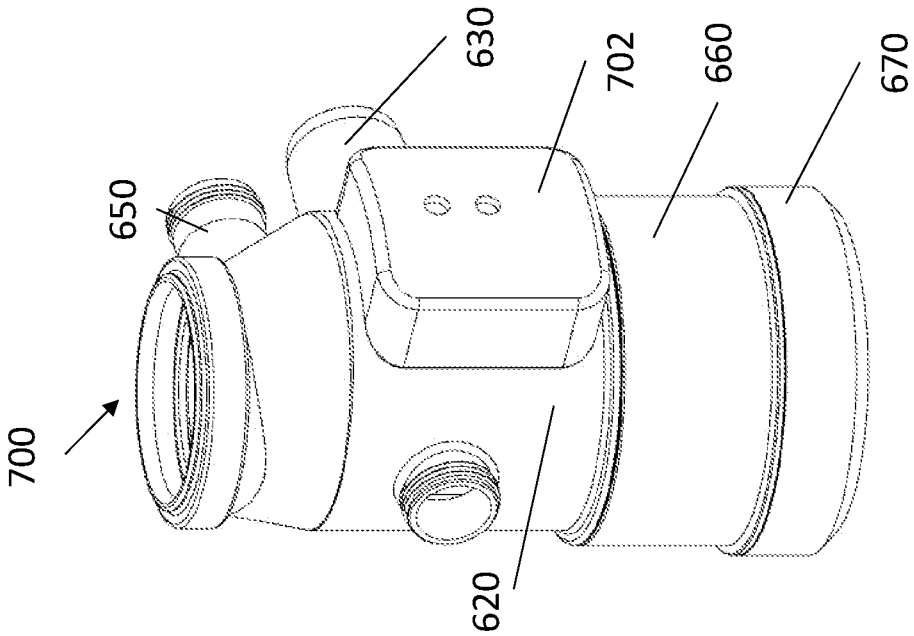


FIGURE 7D

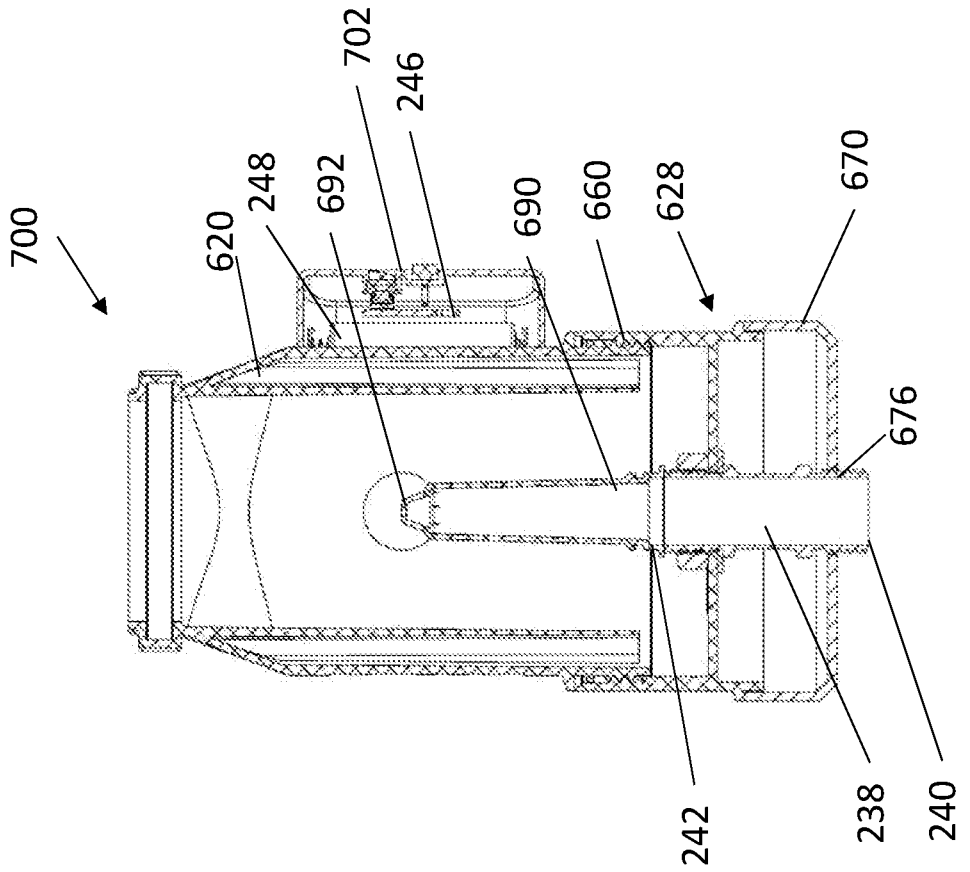


FIGURE 7F

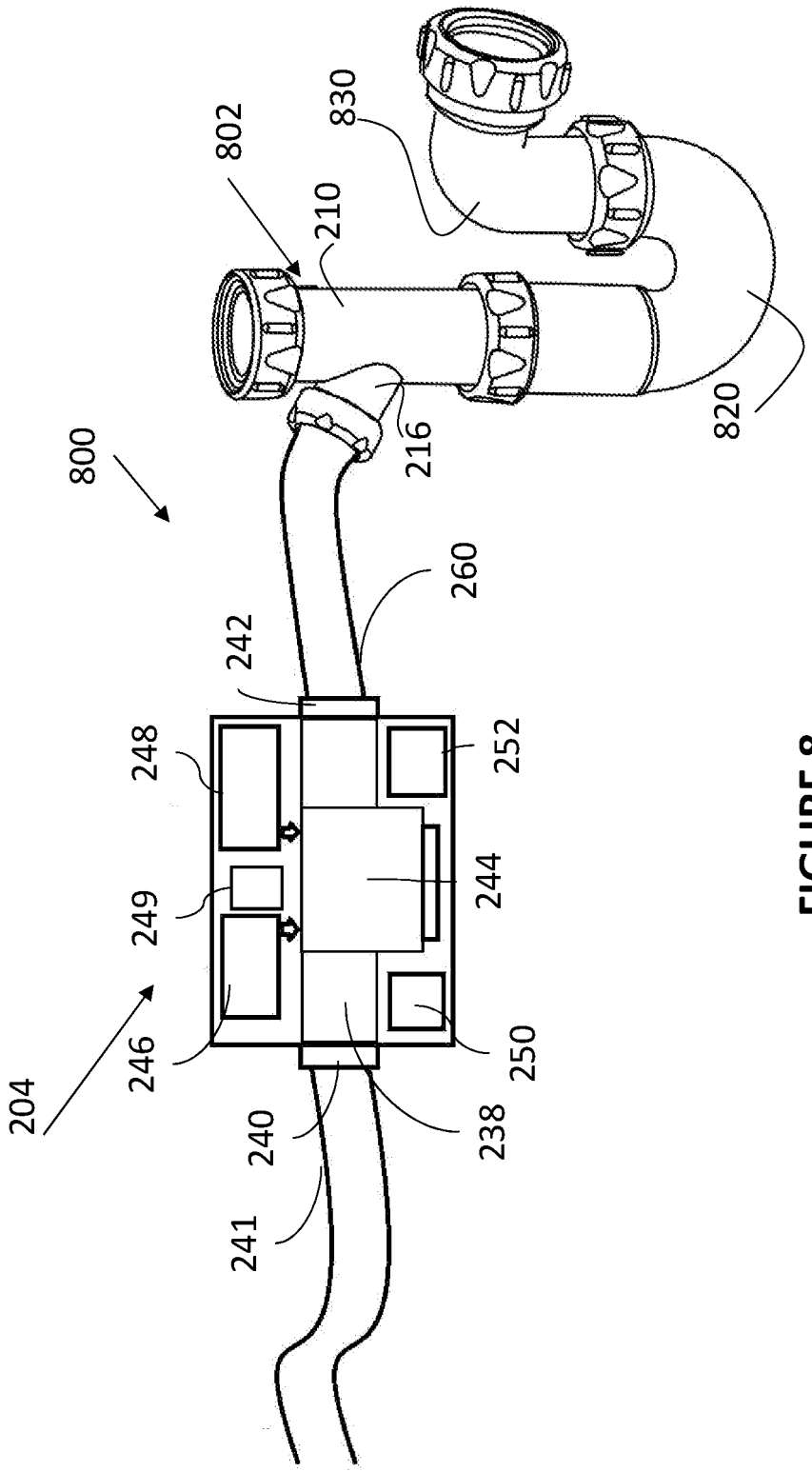

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FIGURE 8

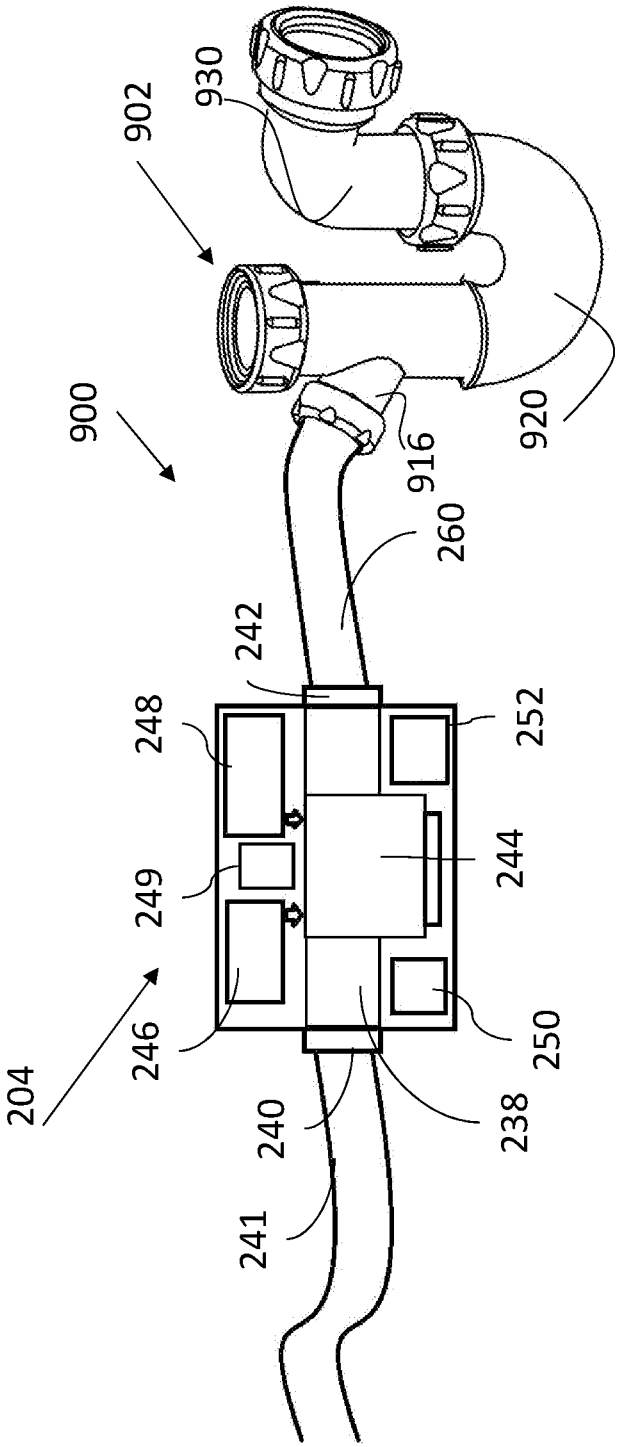

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FIGURE 9

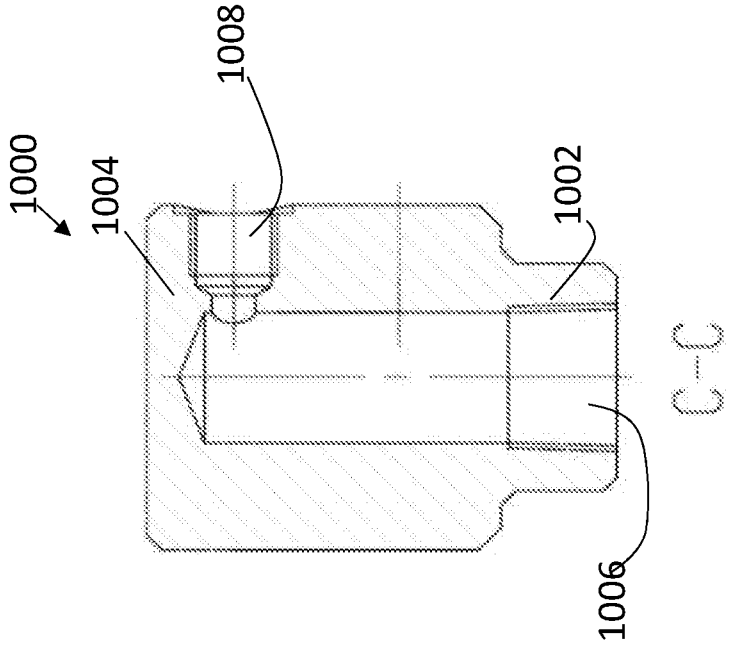


FIGURE 10B

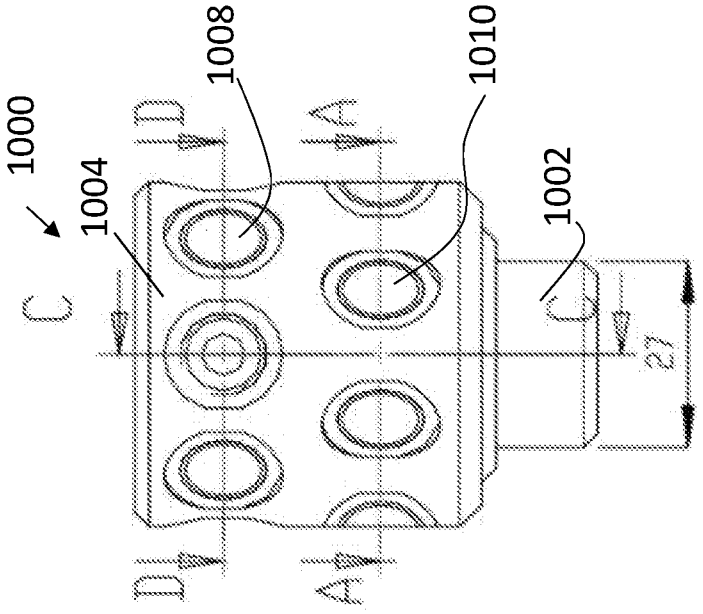


FIGURE 10A

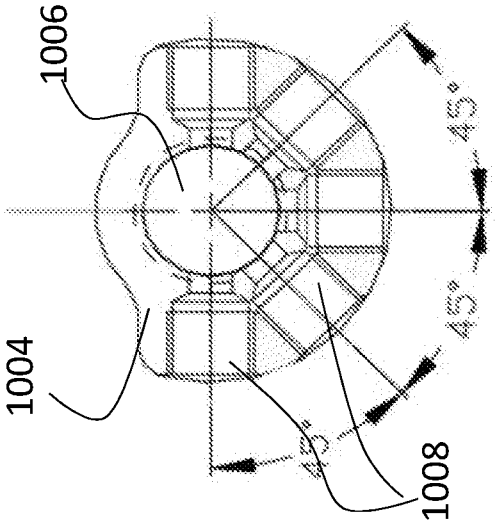


FIGURE 10D

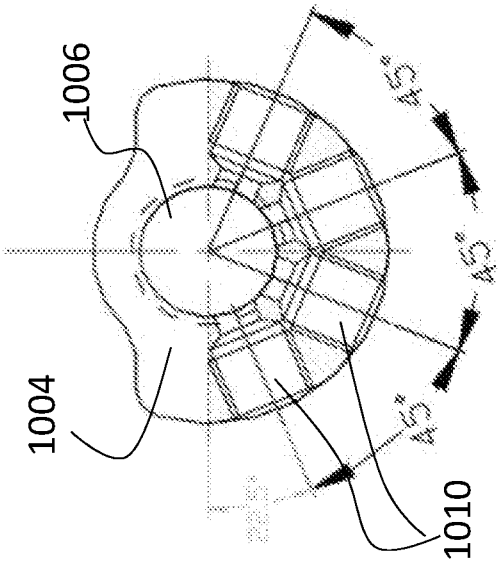


FIGURE 10C

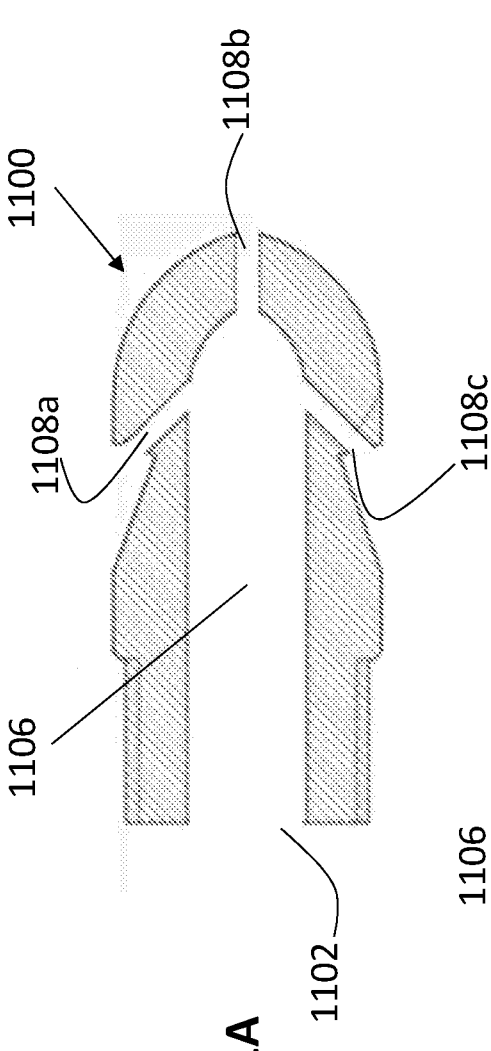


FIGURE 11A

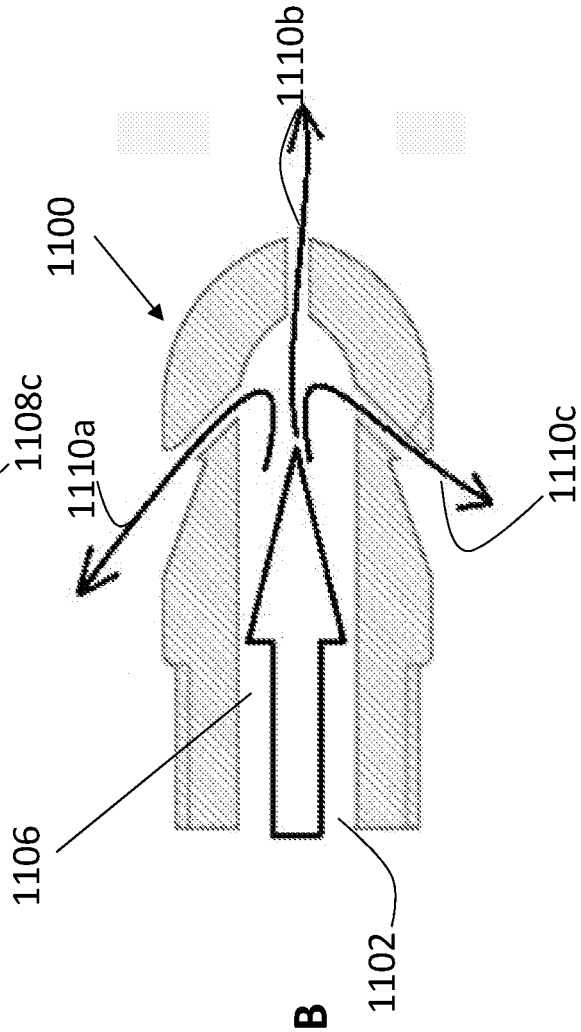


FIGURE 11B

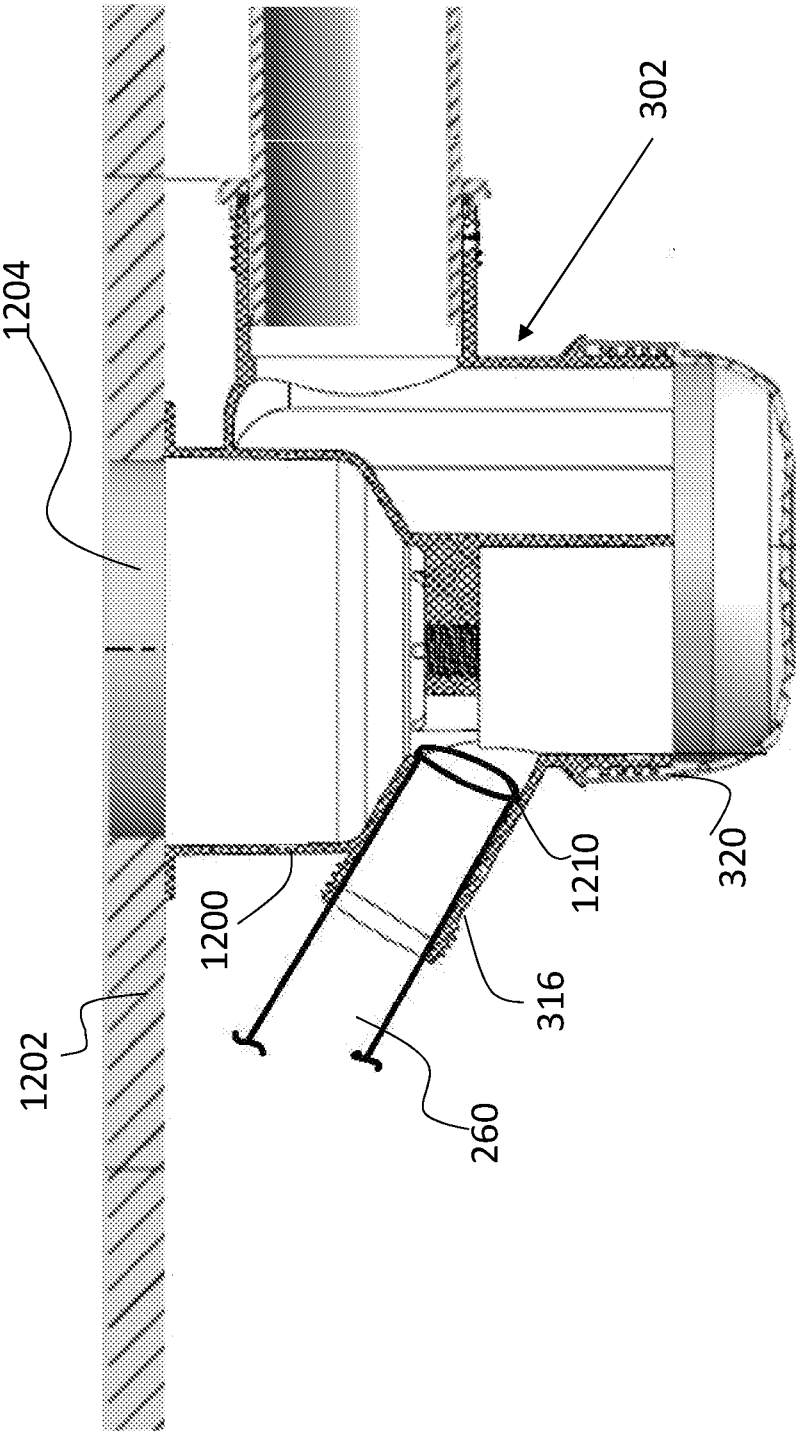


FIGURE 12A

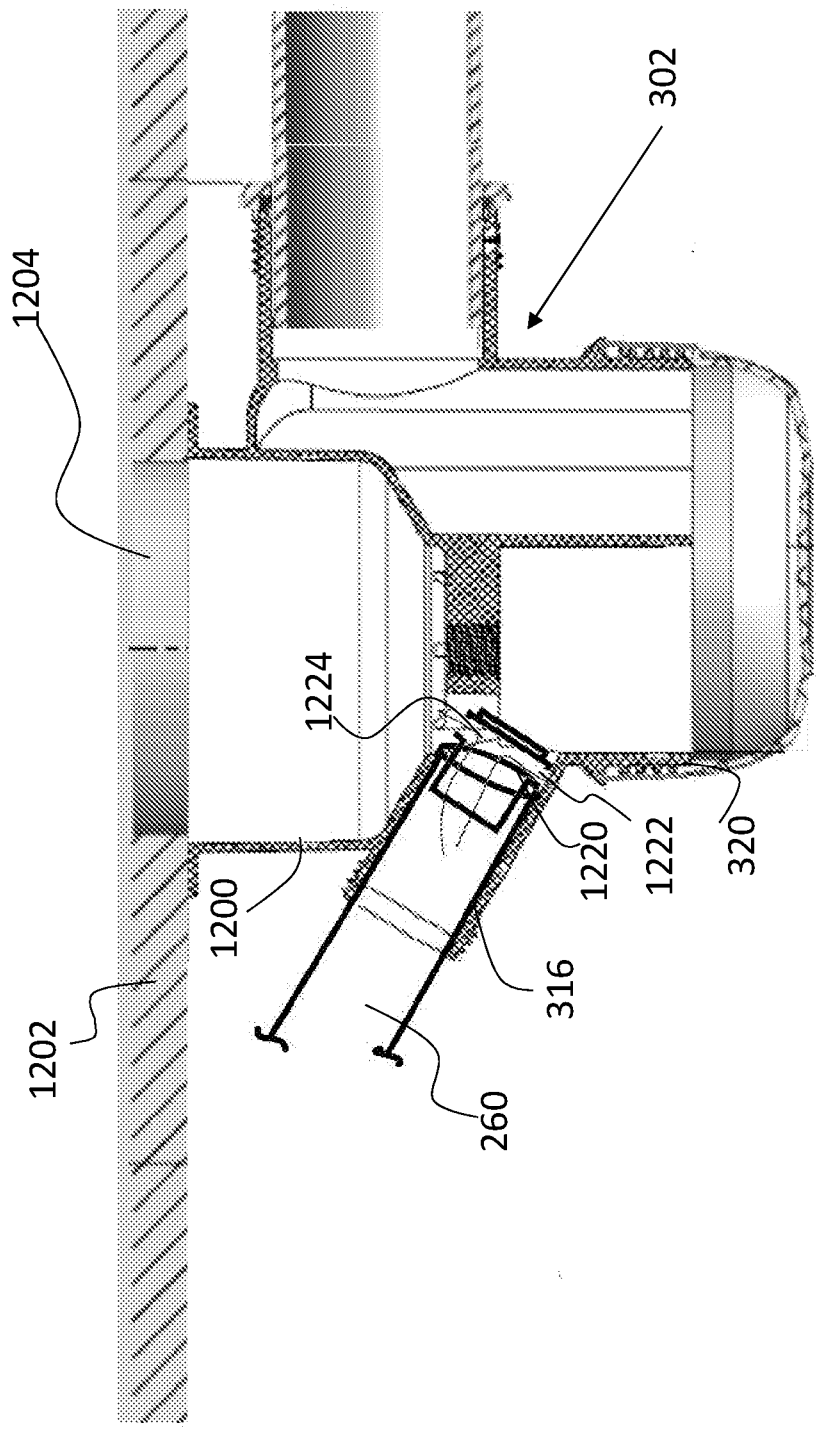


FIGURE 12B

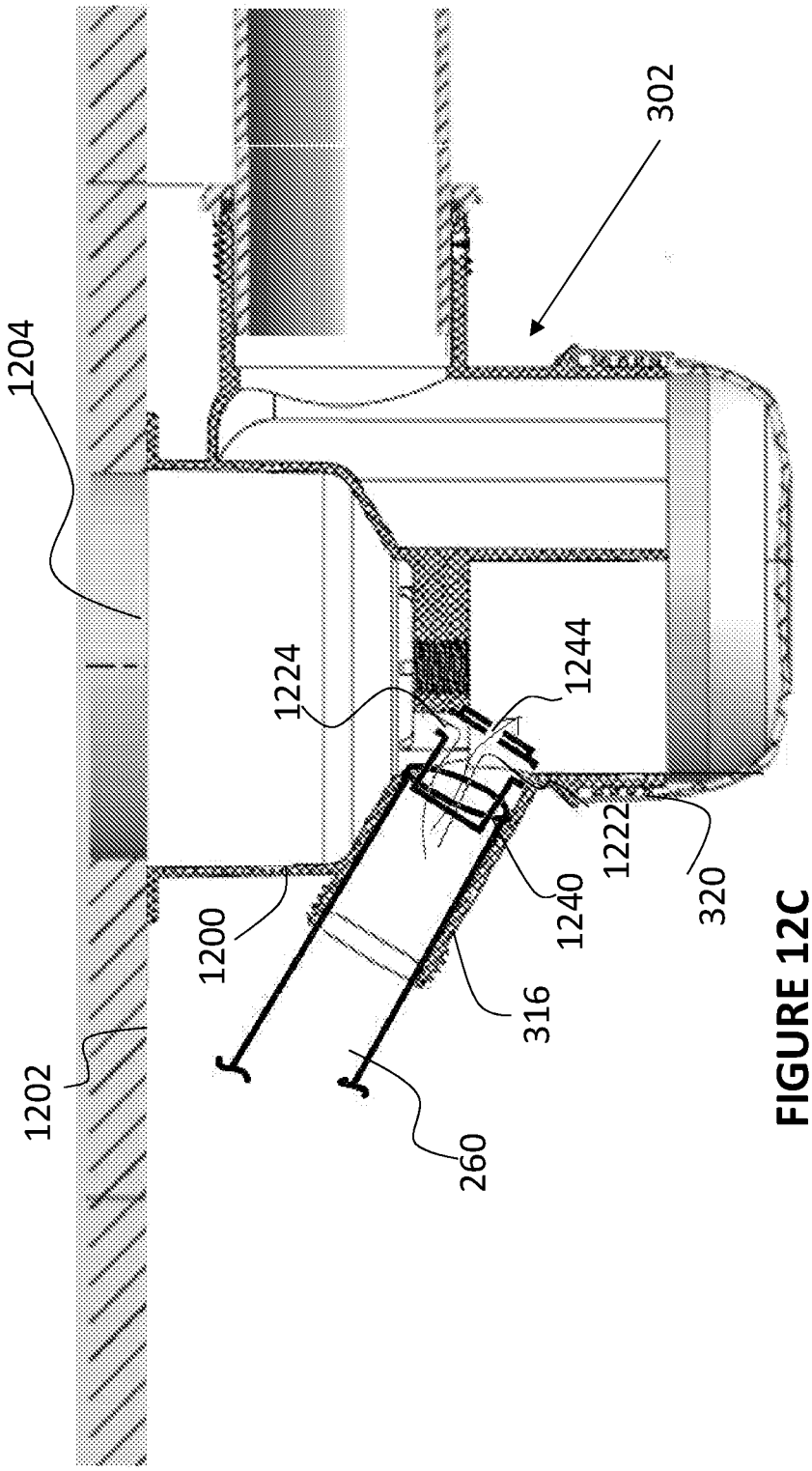


FIGURE 12C

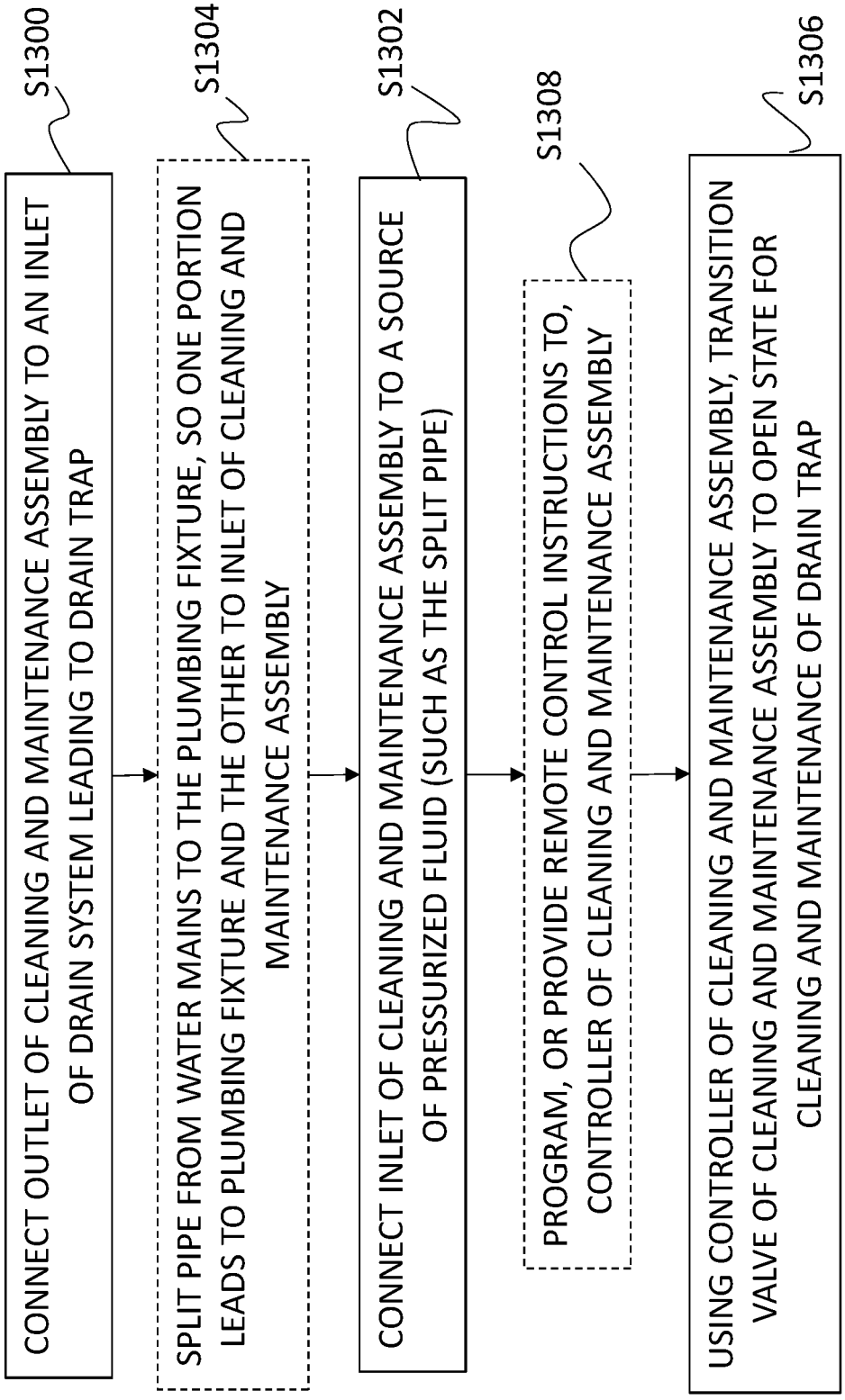

S1300
CONNECT OUTLET OF CLEANING AND MAINTENANCE ASSEMBLY TO AN INLET OF DRAIN SYSTEM LEADING TO DRAIN TRAP
S1304
SPLIT PIPE FROM WATER MAINS TO THE PLUMBING FIXTURE, SO ONE PORTION LEADS TO PLUMBING FIXTURE AND THE OTHER TO INLET OF CLEANING AND MAINTENANCE ASSEMBLY
S1302
CONNECT INLET OF CLEANING AND MAINTENANCE ASSEMBLY TO A SOURCE OF PRESSURIZED FLUID (SUCH AS THE SPLIT PIPE)
S1308
PROGRAM, OR PROVIDE REMOTE CONTROL INSTRUCTIONS TO, CONTROLLER OF CLEANING AND MAINTENANCE ASSEMBLY
S1306
USING CONTROLLER OF CLEANING AND MAINTENANCE ASSEMBLY, TRANSITION VALVE OF CLEANING AND MAINTENANCE ASSEMBLY TO OPEN STATE FOR CLEANING AND MAINTENANCE OF DRAIN TRAP

FIGURE 13